

Assessment of the Socio-Economic and Environmental Impact of Hurricanes Dennis and Emily on Jamaica



Planning Institute of Jamaica
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EXECUTIVE SUMMARY

This report was prepared in the three-week period (July 18 – August 5) following the passage of Hurricanes Dennis and Emily and builds on preliminary estimates presented on July 13, 2005. Assessment of the impacts of both hurricanes was combined due to the short period between the occurrences of the two events.

The report is divided into 6 sections. Section I provides a description of the meteorological conditions associated with the two events and communities and population affected. Sections II-V analyse the social sectors – health, education and housing; the productive sectors - agriculture, mining, tourism and manufacturing; infrastructure – water supply/sanitation, transport/road/bridges, telecommunications, and airports; and the environmental impact respectively. Section VI provides a summary of the cost of damage and losses; and an analysis of the macroeconomic impact of the hurricanes.

Total damage was estimated at \$5 976.91 million or US\$96.87 million. This is equivalent to 1.2 per cent of the previous year's GDP. Infrastructure was the most affected area with damage and losses of \$4 826.05 million, followed by the Productive sectors (\$ 796.25 million); and the social sectors (\$260.14 million).

Transport/Roads and Bridges was the most affected sub-sector with total damage and losses of \$4 271.89 million, or 71.5 per cent of the total impact. This was followed by Water Supply and Sanitation, \$400.00 million, and Agriculture and Livestock \$379.90 million. Considering indirect losses only, Transport/Roads and Bridges was the most affected sub-sector \$514.00 million, followed by Waste Management \$55.40 million, Electricity \$50.00 million and Manufacturing \$30.4 million.

Although the costs of the disasters represent a relatively small proportion of the GDP, the disaster is likely to have a significant impact on the economy. The rate of growth of GDP for 2005 without the disaster was estimated by the PIOJ at 3.6 per cent but has been

adjusted downwards to 1.2 per cent taking into account the effects of the disaster. The rate of inflation which was projected at 9 per cent has been revised upwards to 14.3 per cent to reflect the impact of the disaster and the continued increase in oil prices on the international market.

Between the two events there were 7 reported casualties. The livelihood of 8 000 farm families in 11 parishes was directly affected by the Hurricanes as was that of over 1 000 fisher folk. A total of 209 000 persons suffered varying levels of dislocation due to Hurricane Dennis, while 122 590 were similarly affected as a result of Hurricane Emily.

The impact on the environment was manifest mainly through landslides; debris flow; and soil erosion. The combined effect of sedimentation, sewage contamination due to washed out pit latrines and broken sewage systems are likely to cause damage to the coastal ecosystems, especially along the south eastern and north east coasts.

I. INTRODUCTION

1. Description of the Events

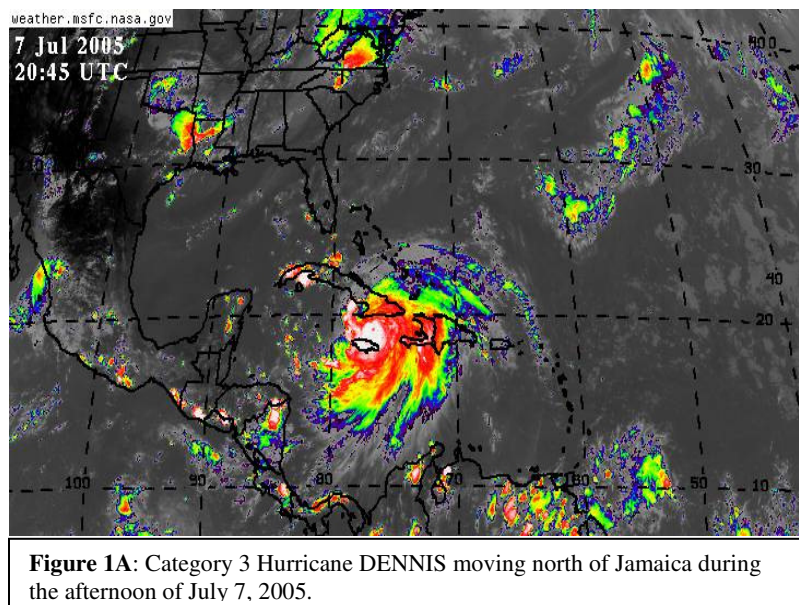
Hurricane Dennis - The Meteorological Phenomenon

A strong Tropical Wave entered the Caribbean on July 4, 2005, producing heavy showers over much of the Lesser Antilles as it moved westwards. The system developed a closed circulation during the evening and was named the fourth Tropical Depression of the 2005 Atlantic Hurricane Season at 10:00 that night. Its location was latitude 12.5° N, longitude 63.1° W, or about 160 kilometres west-northwest of Grenada, in the Windward Islands.

Further development of the system was rapid, prompting the issuance of a Hurricane Warning for the island on July 6 when it was upgraded to a Category 1 hurricane, with wind speeds of 130 km/h, at 5:00 p.m. The system further intensified to Category 2 status on July 7.

The path that Hurricane Dennis took was just as forecasted (see Figure 1A & 1B), except for the rate of intensification and the speed of movement. Its centre was located approximately 60 kilometres east of Morant Point at 10:00 a.m. on July 7. Moving adjacent to the

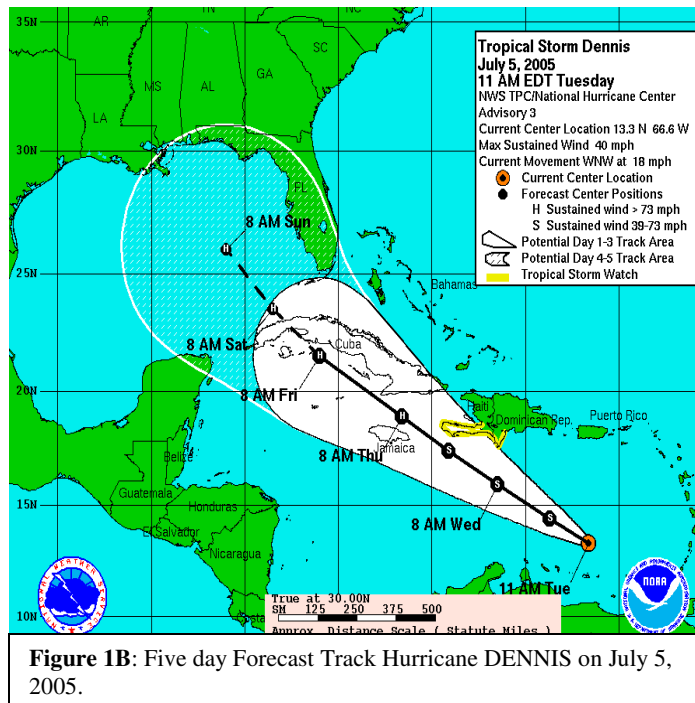
island's north-eastern coastline, but remaining over the warm Caribbean waters, the centre was pinpointed at 50 kilometres northeast of Port Antonio at 1:00 p.m. and then 120 kilometres north of that town at 4:00 p.m. that day. The strengthening phase continued as Hurricane Dennis became a Category 3 hurricane at 4:00 p.m. and reached



Category 4 by 10:00 p.m. the same evening. By that time, it had started to move away from Jamaica and was located at about 140 kilometres north of Falmouth.

Hurricane force winds were then said to extend approximately 85 kilometres, and tropical storm force winds 220 kilometres from the centre of the system.

The Meteorological Service's Doppler radar first detected outer bands of showers and heavy



thunderstorms during the morning of July 6, spreading from east to west across the island. There was some abatement during the afternoon; however, scattered showers and thunderstorms were again observed late that night and gradually increased in extent, duration and intensity on July 7. The hurricane continued to produce significant rainfall across sections of the island through July 8, although with varying intensities.

The Hurricane Warning was discontinued for the island at 5:00 a.m. on July 8, 2005, while Hurricane Dennis was located near 250 kilometres north of Montego Bay, and looking to make landfall on central Cuba.

Tables 1.1 and 1.2 show rainfall amounts collected at selected rainfall stations across the island during the period July 6-8, 2005. Table 1.1 utilizes data from rainfall stations from the parishes of St. Mary, Portland, St. Thomas, Kingston & St. Andrew, St. Catherine and Clarendon.

Table 1.1: Comparison of Hurricane Dennis' Cumulative Point Rainfall (July 6-8, 2005) with Climatological Mean

Station/Parish	Dennis Rainfall (mm)				30-yr Mean	% of Mean
	6 th	7 th	8 th	Total		
St. Mary						
Castleton Gardens	320.0			320.0	118	271
Brandon Hill	21.8	306.6	8.8	337.2	109	309
Ft. George Botanical Gdns.	316.0			316.0	-	-
Industry	26.4	95.7	45.6	167.7	-	-
Long Road	31.6	332.2	6.0	369.8	-	-
Portland						
Comfort Castle	-	357.6	2.3	359.9	-	-
Moore Town	-	258.4	40.5	298.9	395	76
Plantain Garden	54.8	197.8	0.4	253.0	166	152
Sherwood Forest		290.9		290.9	-	-
Shirley Castle	-	408.0	108.0	516	85	607
Spring Garden	-	159.2	11.0	170.2	131	130
Swift River	311.0			311.0	182	171
St. Thomas						
Amity Hall	2.7	298.4	61.3	362.4	160	227
Hordley Estate	220.1		30.1	250.2	-	-
Morant Bay	16.0	261.4	21.0	298.4	137	218
Norris	40.3	343.5	6.9	390.7	-	-
Plantain Garden	54.8	197.8	0.4	253.0	166	152
Ramble	28.6	325.0	0.0	353.6	196	180
Kingston/St. Andrew						
Constant Spring	24.0	370.0	0.0	394	108	365
Golden Spring	41.2	393.1	0.0	434.3	-	-
Lawrence Tavern	30.0	287.0	7.5	324.5	147	221
Mavis Bank	84.0	497.6	41.6	623.2	62	1005
Mona	61.7	280.0	19.0	360.7	39	925
Norbrook	27.1	340.4	14.2	381.7	-	-
N. Manley Int'l Airport	11.9	296.6	3.4	311.9	40	780
Rose Hill	75.0	367.8	17.6	460.4	128	360
St. Catherine						
Bois Content	20.0	92.0	0.0	112.0	-	-
Bybrook	8.0	155.5	36.0	199.5	152	131
Charm Hole	25.0	269.0	90.0	384.0	152	253
Enfield	20.0	236.0	16	272.0	154	177
Grass Piece	17.3	207.2	36.0	260.5	140	186
New Hall	19.0	212.0	25.4	256.4	180	142
New Works	14.0	222.0	22.5	258.5	178	145
Swansea	11.1	230.2	67.0	308.3	121	255
Wakefield	15.0	155.0	23.0	193.0	151	128
Worthy Park Estate	10.0	140.0	50.0	200.0	118	169
Clarendon						
Beckford Kraal	9.0	218.0	17.1	244.1	124	197
Ritchies	354.1			354.1	-	-
Rock River	20.3	265.2	23.4	308.9	107	289
Thompson Town	5.2	224.0	62.0	291.2	154	189
Trout Hall	254.0		0.0	254.0	138	184

Source: Meteorological Division

**Table 1.2: Comparison of Highest One-Day Rainfall Totals (mm) on July 7, 2005
with Climatological Return Periods for Selected Parishes**

Parish/Station	Highest 24-hour Total	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
St. Mary							
Castleton	306.6	175	270	335	415	475	535
Portland							
Moore Town	258.4	232	340	412	502	569	635
Shirley Castle	408.0	269	381	455	548	618	687
Swift River	-	206	310	379	467	532	596
St. Thomas							
Morant Bay	261.4	158	225	270	326	368	409
Plantain Garden	197.8	165	248	302	371	423	474
Ramble	325.0	148	249	317	402	465	527
Kingston/St. Andrew							
Constant Spring	370.0	137	221	279	351	404	460
Half-Way-Tree	100.0	130	184	236	301	350	399
Lawrence Tavern	287.0	120	196	250	322	374	427
Mavis Bank	497.6	139	242	313	400	465	529
Mona	280.0	109	189	242	309	359	408
St. Catherine							
Enfield	236.0	110	177	221	277	318	360
New Works	222.0	133	185	234	296	342	388
Wakefield	155.0	135	189	240	305	353	400
Worthy Park	140.0	118	187	233	291	334	376
Clarendon							
Beckford Kraal	218.0	107	154	186	226	255	285
Rock River	265.2	129	176	220	276	318	358
Thompson Town	224.0	135	177	218	269	307	345
Trout Hall	-	112	175	217	269	308	347

Source: Meteorological Division

These stations were thought to be the most severely affected by Hurricane Dennis, on the basis of radar reports and local observations. Note that the island had been experiencing above-normal rainfall since the latter part of April hence a high level of soil saturation. In Table 1.2, the highest 1-day totals at specific stations in the same parishes are measured against amounts for significant rainfall return periods.

Tables 1.1 and 1.2 indicate that the Mavis Bank station recorded the highest rainfall volume of 497.6 mm. Table 1.3 shows the highest rainfall intensities for selected rainfall rates for Mavis Bank, located in the hills of the Blue Mountains. The highest rainfall intensities occurred between the hours of 5 and 6 p.m.

This rainfall station is close to the sources of several of the rivers that flow through the parishes of Portland, St. Thomas, St. Mary, and Kingston & St. Andrew.

Table 1.3: Rainfall Intensity Data for Mavis Bank Rainfall Station during passage of Hurricane Dennis on July 7, 2005.

Period	No. of Hours	Rainfall Amount (mm)	Rate (mm/h)
3:00 – 9:00 p.m.	6	299	49.8
5:00 – 9:00 p.m.	3	159	53.0
5:00 – 7:00 p.m.	2	120	60.0
5:00 – 6:00 p.m.	1	65	65.0

Source: Meteorological Division

Rainfall Analysis

Rainfall analysis revealed the following:

- Except for the Moore Town station in Portland, the 3-day rainfall totals were all above normal having exceeded the 30-year (1951-1980) mean for July.
- The 3-day rainfall totals for Mavis Bank and Mona in St. Andrew were ten and nine times the 30-year mean, respectively.
- The three-day totals for Shirley Castle in Portland and Norman Manley Int'l Airport in Kingston were between six and eight times the 30-year mean.
- The maximum 24-hour rainfall for the 10-year return period was exceeded on July 7 by the stations at Ramble in St. Thomas, Lawrence Tavern and Mona in Kingston & St. Andrew, Enfield in St. Catherine, Beckford Kraal, Rock River and Thompson Town in Clarendon.

- Stations exceeding the maximum 24-hour rainfall for the 5-year return period included Castleton in St. Mary, Shirley Castle in Portland, Morant Bay in St. Thomas and New Works in St. Catherine.
- Stations exceeding the maximum 24-hour rainfall for the 2-year return period included Moore Town in Portland, Plantain Garden in St. Thomas and Wakefield and Worthy Park in St. Catherine.

Wind/Atmospheric Pressure Analysis

Although Hurricane Dennis, at its closest proximity to Jamaica, was a Category 2 hurricane with hurricane-force winds extending approximately 75 kilometres from its centre, the winds recorded at stations across the island were barely representative of tropical storm-force. Strongest winds were reported in Montego Bay during the afternoon of July 7, averaging 60 knots, or 111 km/h. Other data retrieved from Automatic Weather Stations on the mainland, as well as offshore the south coast, are given in Table 1.4.

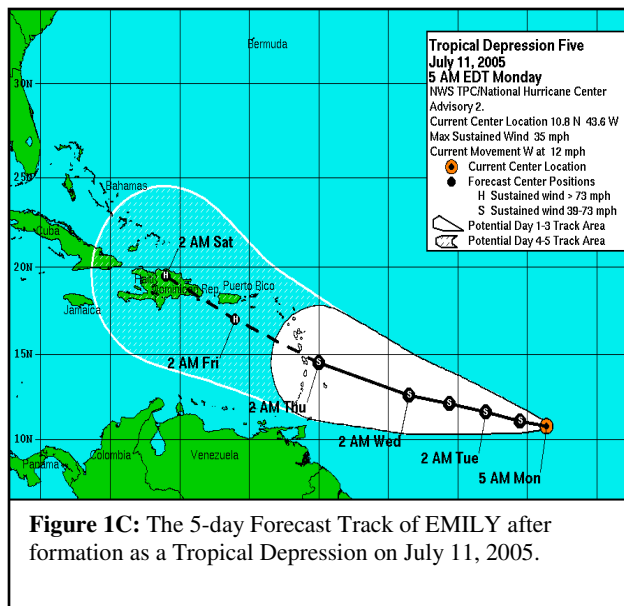
Table 1.4: Extreme Values during passage of Hurricane Dennis, July 6-8, 2005

	Maximum Wind (degrees/knots)	Maximum Gust (knots)	Lowest Pressure (millibars)
Norman Manley International Airport, Kingston	140/32 (08/1400Z)	39 (07/2346Z)	1004.1 (07/1800Z)
Sangster International Airport, Montego Bay	290/60 (07/2049Z)	-	1004.5 (07/2217Z)
Pedro Bank, Pedro Cays	-	-	-
Folly Point, Portland	190/37 (07/1722Z)	-	996.5 (07/1800Z)

Source: Meteorological Division

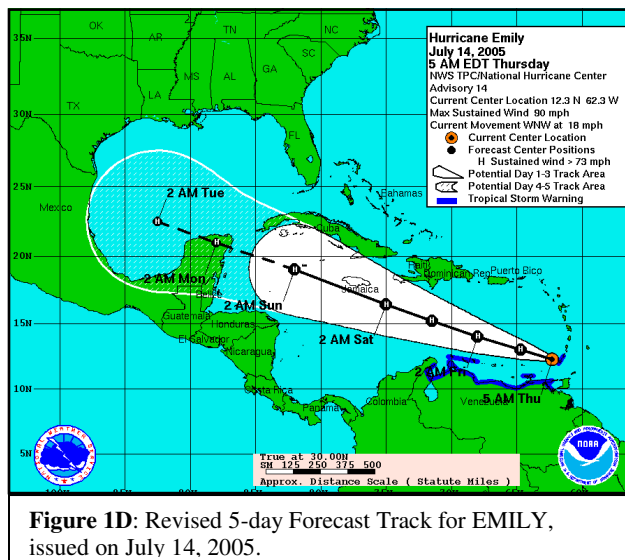
Hurricane Emily - The Meteorological Phenomenon

Awareness of the general public was extremely high as Hurricane Emily emerged, developed and progressed during the week of July 11-17, 2005. Its genesis as a Tropical Wave over the tropical Atlantic Ocean was keenly watched across Jamaica, especially coming in the wake of the passage of Hurricane Dennis along the island's north coast a few days earlier.



At about 4:00 a.m. on July 11, 2005, the Tropical Wave developed into the Atlantic Hurricane Season's fifth Tropical Depression with less than 2000 kilometres to cover before reaching the Windward Island chain. Initial projections (Figure 1C) had the centre of the tropical depression passing through the Lesser Antilles in the vicinity of Dominica, and continuing towards and over the

Dominican Republic between July 15 and 16 (Figure 1C). This was later to be adjusted as the system developed.



As the system strengthened to Tropical Storm Emily, the forecast track gradually shifted more and more to the left, increasing the chance of impact over Jamaica in the coming days. Instead of passing over the Dominican Republic, it was later projected over Haiti, and further adjusted to remain south of

Hispaniola and pass over Jamaica on Saturday, July 16(Figure 1D).

Bulletin Number 1 was issued by Jamaica's Meteorological Service at 5:00 p.m. on July 13, 2005, while Tropical Storm Emily was located about 205 kilometres south of Barbados. The next Bulletin indicated that further strengthening had occurred and Emily was upgraded to a hurricane approximately 1780 kilometres east-southeast of Morant Point. Evacuation of the cays and banks was anticipated within 24 hours and fishers were advised to begin their preparations.

Hurricane Emily became a Category 2 hurricane while located about 1430 kilometres east-southeast of the island's easternmost point, and later strengthened to a Category 4

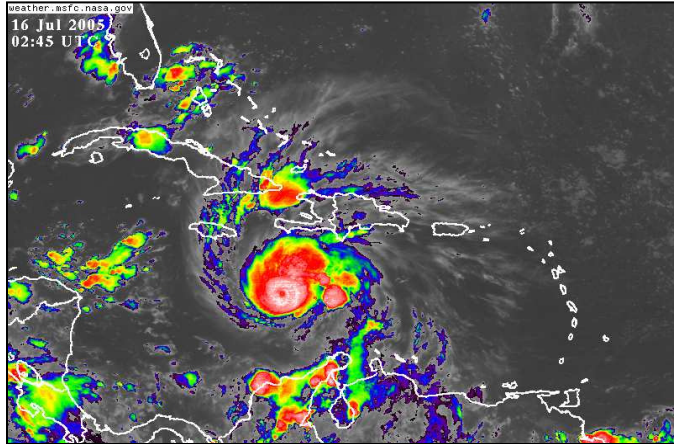


Figure 1E: A Category 4 Hurricane Emily located 425 km southeast of Morant Point, Jamaica at 9:45 p.m. on July 16, 2005.

hurricane on the Saffir-Simpson scale. By this time, fishers were expected to have returned to the mainland, having evacuated the cays and banks. The customary fluctuations in strength of the major hurricane occurred on July 15 with Hurricane Emily weakening to 205 km/h (category 3) by 10:00 a.m. to 165 km/h (category 2) by 4:00 p.m., and then re-intensifying to 185 km/h (category 3) by 7:00 p.m. and then to 215 km/h (category 4) by 10:00 p.m. (Figure 1E).

Jamaica began to feel the effects of the tropical cyclone during the morning of July 16 with moderate to heavy showers spreading from eastern to central, and then to western parishes, while increasing in intensity and duration. Hurricane Emily began its passage over Jamaica's southern waters at that time and was at its closest proximity while passing close to 150 kilometres of the south-western coastline. Hurricane Emily's maximum wind speeds were reported to be about 250 km/h at this time. The system eventually started to move farther away from the island at about 4:00 p.m. on July 16, while rainfall

persisted until the morning of July 17, 2005. The Hurricane Warning was discontinued at 4:00 a.m. on July 17, with the centre located about 390 kilometres west of Negril Point.

Rainfall Analysis

Based on reports received from rainfall stations located in the western half of the country St. Elizabeth was the parish that appears to have been most severely affected. Table 1.5 is a presentation of the rainfall amounts recorded at specific stations across the island over the 2-day period compared with the long-term or 30-year (1951-1980) mean/normal for July.

Table 1.5: Comparison of Hurricane Emily's Cumulative Point Rainfall (July 15-16, 2005) with Climatological Mean

Station/Parish	Emily Rainfall (mm)			30-yr Mean	% of Mean
	15 th	16 th	Total		
Manchester					
Spur Tree	367.0		367	52	706
St. Elizabeth					
Appleton	10.8	80.0	91	189	48
Barton Isle	96.5		97	117	83
Fort Charles	101.6		102	53	192
Fullerwood	0.0	290.0	290	94	309
Holland	25.4	203.2	229	183	125
Mountainside	330.0		330	83	398
Pepper	80.0	110.4	190	-	-
Potsdam	392.0		392	-	-
Westmoreland					
Non-Pariel	0.0	297.0	297	201	147
Hanover					
Jericho	36.6		37	-	-
Lucea	-	36.7	37	139	27
Mount Peto	75.0	43.6	119	251	47
St. James					
Sangster Int'l Airport	-	101.2	101	53	190
Trelawny					
Braco	141.1		141	35	403
Orange Valley	-	128.0	128	31	413
Quickstep	11.1	57.8	69	259	80
Rio Bueno	-	125.0	125	61	205
Sawyers	-	130.2	130	-	-

Source: Meteorological Division

The results are indications of the rainfall amounts being normal, and above or below normal and show that with the exception of five stations, rainfall amount had exceeded the 30 year mean between 90 and 600 per cent. This situation was most noticeable in Manchester. Table 1.6 compares the highest recorded one-day rainfall total with the climatological return periods for representative stations in western Jamaica.

**Table 1.6: Comparison of Highest One-Day Rainfall Totals (mm) on
July 15 & 16, 2005
with Climatological Return Periods for Selected Parishes**

Parish/Station	Highest 24-hour Total	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Manchester							
Spur Tree	-	98	140	173	211	239	267
St. Elizabeth							
Appleton	80.0	90	124	145	172	192	212
Fullerswood	290.0	101	112	137	169	192	215
Holland	203.2	90	123	144	171	190	210
Mountainside	-	98	167	213	271	315	358
Westmoreland							
Non-Pariel	297.0	123	197	246	308	354	400
Hanover							
Lucea	36.7	103	145	172	206	232	257
Mount Peto	75.0	112	181	227	285	328	370
St. James							
Sangster Int'l Airport	101.2	84	147	188	239	279	316
Trelawny							
Braco	-	101	146	186	237	274	312
Orange Valley	128.0	121	157	191	233	265	296
Quickstep	57.8	109	137	163	195	220	244
Sawyers	130.2	-	-	-	-	-	-

Source: Meteorological Division

Analysis of the reports from the stations listed in Tables 1.5 and 1.6 revealed that:

- The rainfall amounts for Hurricane Emily were above normal for several stations.

- The stations at Spur Tree in Manchester, Braco and Orange Valley in Trelawny and Mountainside and Fullerwood in St. Elizabeth reported largest above normal deviations during Hurricane Emily.
- The rainfall for Fullerswood and Holland in St. Elizabeth, on July 16, exceeded the maximum 24-hour rainfall for a 50-year return period, and Fullerswood's rainfall also exceeded the 100-year return period.
- The rainfall for Non-Pariel in Westmoreland, on July 16, exceeded the maximum 24-hour rainfall for a 10-year return period.
- The rainfall for Orange Valley in Trelawny and for Sangster International Airport in St. James, on July 16, exceeded the maximum 24-hour rainfall for a 2-year return period.

Note should be taken that soil moisture would likely have been at highly saturated levels due to the rainfall produced by the passage of Hurricane Dennis, prior to Hurricane Emily, during the period July 7-8, 2005.

Wind/Atmospheric Pressure Analysis

Although Hurricane Emily, at its closest proximity to Jamaica, was a strong Category 4 hurricane with hurricane-force winds extending approximately 110 kilometres, and tropical storm-force winds about 240 kilometres from its centre, the winds recorded at stations across the island were not representative of tropical storm-force. Unofficial reports to the Meteorological Service seemed to suggest that the strongest winds were experienced over St. Elizabeth and other southwestern sections of the island; however, only near-gale strength was recorded at one station in that area. Elsewhere, gale-force winds were recorded in Montego Bay during the evening of July 16. Other data retrieved from Automatic Weather Stations on the mainland, as well as offshore the south coast, are given in Table 1.7.

Table 1.7: Extreme Values during passage of Hurricane Emily, July 16-17, 2005

	Maximum Wind (degrees/knots)	Maximum Gust (knots)	Lowest Pressure (millibars)	Maximum Rainfall (mm)
Norman Manley International Airport, Kingston	100/28 (16/2039Z)	31 (16/2031Z)	1009.5 (16/2041Z)	-
Sangster International Airport, Montego Bay	080/36 (16/2251Z)	-	1010.1 (16/2129Z)	101.2 (16 th)
Pedro Bank, Pedro Cays	030/29 (16/2300Z)	-	1010 (16/0600,1400,1500,1900)	276.4 (16 th)
Folly Point, Portland	100/11 (17/0229Z)	-	1010.8 (16/2229Z)	132.4 (16 th)

Emergency Actions

For both events the National Emergency Operations Centre (NEOC) was activated and various emergency and welfare activities were carried out. In the case of Hurricane Dennis search and rescue operations began on July 7 for sections of the island which were under threat from rising waters, covering communities in Clarendon, St. Thomas, St. Andrew, St. Catherine and Kingston. In the days following, four medical evacuations and aerial reconnaissance damage assessment flights were also undertaken. Welfare items were delivered by trucks to the parishes of St. Thomas, Portland and St. Catherine and the Jamaica Defence Force assisted with food drops to marooned communities in the parishes of St. Andrew and St. Thomas.

By 11 July, 5 days after the disaster occurred, six shelters remained open in four parishes and housed approximately 299 persons, down from 66 shelters housing three thousand and fourteen (3 014) persons on July 8, 2005. Approximately 70 per cent of persons housed were located in the parish of St. Thomas.

In preparation for Hurricane Emily evacuation orders were issued for approximately 38 coastal and flood prone communities island wide. Several shelters were also opened in the parishes of Westmoreland, St. Thomas, Manchester, Hanover, Portland, St. Mary,

Clarendon and Trelawny. Three thousand five hundred and ninety four (3 594) persons were sheltered in 11 parishes at the peak of the event. Approximately 60 per cent of persons housed during Hurricane Emily were located in the parish of St. Catherine. In the Post Hurricane Emily period, Welfare and Relief operations were carried out in affected areas and for shelters in operation. A multi-agency Rapid Damage Assessment Team conducted aerial reconnaissance of affected parishes. This indicated that the parishes worst affected were St. Elizabeth and Manchester.

Food supplies valuing \$691 000 and emergency supplies and stocks valuing \$ 8.4 million were distributed to affected communities and shelters. Non food supplies distributed through ODPEM included blankets and bed sheets, plastic sheetings, tarpaulins, water containers, kerosene lamps and flashlights. The overall cost was 10.6 million.

International Assistance

Following the passage of both hurricanes, the Government of Jamaica indicated that it would not seek international assistance for reconstruction and rehabilitation given the observed impact of the events and the fact that that it was early in the hurricane season. The support from the international community was thus limited to emergency relief. Support included a shipment of food supplies from Cuba and two shipments from Venezuela which provided food, lamps, drinking water, medical supplies, mattresses and bedding. The Red Cross, UNFPA and Pan-American Health Organisation (PAHO) collaborated in the provision of some 1 000 hygiene kits with the former also providing blankets, tents and plastic sheeting. UNICEF provided hot meals to 150 children in St. Catherine over a three day period, contributed food packets to families in St. James, water containers, emergency kits, water purifications tablets, oral dehydration salts, tarpaulins, among other things. Other agencies including the Japanese International Cooperation Agency (JICA) were involved in the transportation of supplies and personnel.

Affected Population

The heavy and continuous rainfall which affected the island in July 2005, as a result of Hurricanes Dennis and Emily affected the population in different ways and with varying degrees. This resulted in landslides; flooding and damage to physical infrastructure, which impacted directly and indirectly on the agriculture, energy, tourism, housing, transport and other key sectors.

The parishes that were hardest hit by Hurricane Dennis were St. Thomas, Portland, St. Mary, St. Catherine and St. Andrew. Hurricane Emily had the greatest impact on the southern parishes of St. Elizabeth, Manchester and Clarendon with minor impact on the parish of Trelawny. However, all parishes across the island suffered some level of damage and the population experienced varying levels of dislocation (See Figure 1F). A Large number of persons were dislocated due to Hurricane Dennis (209 082) than to Emily (122 590) (see Table 1.8).

Table 1.8: Jamaica: Estimated Affected Population Due To Heavy Rainfall and Flooding From Hurricanes Dennis and Emily

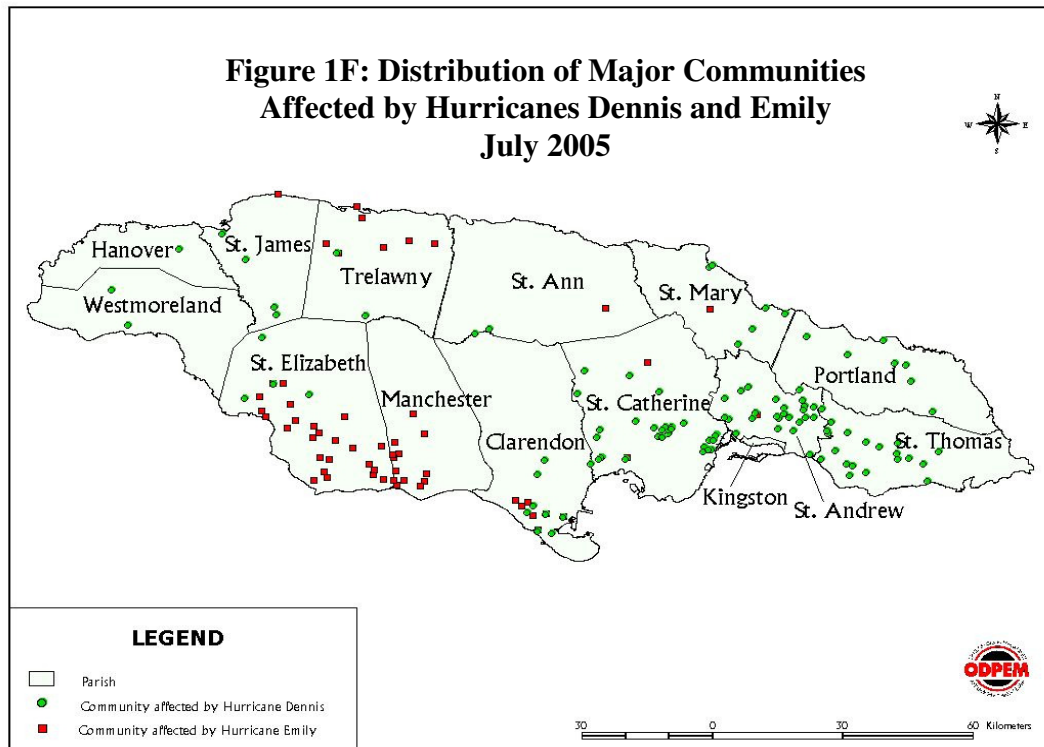
	Population Census 2001	%	End of Year Population 2002	%	End of Year Population 2003	%	End of Year Population 2004	%	Projected Population At the time of Hurricane Dennis and Emily	Estimated Population Affected during Hurricane Dennis	Estimated Population Affected during Hurricane Emily
Jamaica	2,607,633	100.0	2,622,465	100.0	2,638,275	100.0	2,650,933	100.0	2,659,470	209,082	122,590
Kingston and St. Andrew	651,879	25.0	653,811	24.9	656,406	24.9	660,623	24.9	662,366	32,558	8,321
St. Thomas	91,604	3.5	91,919	3.5	92,485	3.5	92,608	3.5	93,038	23,254	
Portland	80,205	3.1	79,980	3.0	80,396	3.0	80,211	3.0	80,517	7,784	
St. Mary	111,467	4.3	111,593	4.3	112,592	4.3	112,797	4.3	113,115	5,529	11,701
St. Ann	166,762	6.4	168,970	6.4	171,098	6.5	172,652	6.5	173,508	1,782	11,947
Trelawny	73,066	2.8	72,903	2.8	73,183	2.8	73,023	2.8	73,174	2,013	14,289
St. James	175,126	6.7	178,370	6.8	180,138	6.8	181,682	6.8	182,563	5,702	1,397
Hanover	67,037	2.6	66,658	2.6	66,696	2.5	66,341	2.5	66,425	4,781	
Westmoreland	138,947	5.3	140,266	5.3	141,383	5.4	142,478	5.4	143,054	7,803	
St. Elizabeth	146,404	5.6	145,754	5.6	146,163	5.5	145,858	5.5	146,136	6,345	21,343
Manchester	185,801	7.1	189,485	7.2	191,863	7.3	194,744	7.3	195,764		7,568
Clarendon	237,025	9.1	237,865	9.1	240,088	9.1	241,096	9.1	242,208	10,787	18,750
St. Catherine	482,308	18.5	484,892	18.5	485,785	18.4	486,819	18.4	487,632	100,744	27,274

Source: Population Census 2001

Demographic Statistics 2004

Note: (i) Population Projections by the Social Policy, Planning and Research Division, PIOJ.

Several flood prone communities islandwide were issued evacuation notices. In the case of Hurricane Dennis, 66 (sixty-six) emergency shelters were opened to assist persons who required such assistance.



The Ministry of Agriculture reported that 6 700 farm families in 11 parishes have been affected by Hurricane Dennis and 1 500 by Hurricane Emily. Based on reports from the Fisheries Division, fishermen in the parishes of Portland and St Thomas suffered severe losses of fish traps, ponds and other infrastructure during the passage of Hurricane Dennis. Fishermen in the parishes of Westmoreland, St. Elizabeth, Manchester, Clarendon and St. Catherine and suffered losses due to Hurricane Emily. It was also reported that approximately 1000 fisher folk on the Pedro and Morant Cays were severely affected during Emily.

Between 80 000 and 100 000 JPS customers lost electricity supply during both events. Water supply to residents throughout the island was disrupted during both events. Based on report by the National Water Commission (NWC), approximately 93.0 per cent of

their customers were affected resulting from varying levels of damage done to NWC water systems during Emily.

Casualties

Seven persons lost their lives as a direct result of the hurricanes, 6 in St. Elizabeth and 1 in St. Thomas. The Ministry of Health (MOH) reported that a 35 year old male drowned due to flooding caused by Dennis in Georgia, St. Thomas while in St. Elizabeth 5 persons drowned in a freak accident due to flooding and one was electrocuted by lightening. The casualties in St. Elizabeth comprised 4 adults aged 20-35 years, one of whom was a female and two children aged 4 years and 5 months, respectively.

II. SOCIAL SECTORS

1. Education

Damage to the education sector by either event was minimal. The Ministry of Education, Youth and Culture reported that the Content Gap All Age School has suffered roof damage to the tune of approximately \$1 million. There were no other reports of significant damage to school buildings, however there were many incidents of leaking. Despite these incidents, neither the school population nor educational services were disrupted as both events occurred while schools were on the summer break.

2. Housing

Flooding and landslides associated with Hurricanes Dennis and Emily resulted in considerable damage to housing particularly in eastern and southern parishes. Much of the damage to housing is related to the fact that many Jamaicans live in locations that are at increasing risk for natural disasters (See Figures 2A and 2B).



Figure 2A: Spontaneous residential settlements situated on slopes with vast amount of vegetation removed.

These locations include river terraces, river channels, gully banks and unstable slopes. Some of these areas, for example, Bull Bay, St. Andrew, have been made even more vulnerable by the fact that large sections of the population squat on fragile lands. In addition, uncontrolled coastal development, especially the building of homes, has also increased vulnerability to natural hazards.

Some 121 communities island-wide, many of which are located in St. Thomas, St. Catherine, Clarendon, Kingston and St. Andrew, were affected by flooding and landslides due to Hurricane Dennis. Initial estimates indicated direct damage to dwellings and household effects amounting to approximately \$100.0 million in these areas. Approximately 6 000 households were reportedly in need of housing assistance.



Figure 2B: House on bank of gully in Ten Miles Bull Bay

Using the average household size of 3.7 persons (Population Census 2001), it can be seen that there are approximately 22 200 such persons needing assistance.

Hurricane Emily in contrast, impacted fewer communities than Hurricane Dennis with 66, mainly in the parishes of St. Elizabeth and Manchester, being affected by flooding, landslides and wind damage.

Table 2.1: Damage to Dwellings and Household Effects in Selected Parishes- Hurricanes Dennis & Emily

Area	Totally Destroyed	Major Damage	Moderate Damage	Minor Damage	Household Effects
Kingston & St. Andrew	35	140	34	54	28
Trelawny	-	-	114	4	52
St. Mary	1	5	1	3	
Clarendon	-	1	5	26	302
Portland	13	18	-	2	57
St. Ann	-	11	2	3	1
TOTAL	49	175	156	92	440

Source: Ministry of Labour and Social Security

The breakdown of housing impact by parish (selected parishes) shows that 50 dwellings were completely destroyed and approximately 175 suffered major damage (See Table 2.1). It is important to note that many of these dwellings housed multiple households.

The Ministry of Water and Housing (MOWH) reported that two joint venture housing projects were affected by the passing of Hurricane Dennis, namely, Kennedy Grove in Clarendon and White Water Meadows in St. Catherine. Both projects were affected by deposits of silt and debris on roads and emergence of potholes resulting from flood waters. The estimated cost of repairs is approximately \$1.2 million. Occupants of Kennedy Grove were affected by rising waters and flooding at the main entrance of the development while 20 units in White Water Meadows received minor damage to windows and doors.

The MOWH reported no significant damage to their housing projects as a result of Hurricane Emily.

The effect of Hurricane Dennis on National Housing Development Corporation (NHDC) housing projects was largely influenced by the state of completion of the various sites. Generally, where projects were completed with paved roadways and adequate drainage and where marled roads were properly stabilized and compacted, the effect of the hurricane was minimal. On the other hand, sites with long standing off-site drainage problems, incomplete on-site drainage works, and sites located on steep terrain where roads have been cut and left exposed sustained damage. The magnitude of the damage on any one site was not severe and the damage was confined mainly to souring of roadways and displacement of loose marl. Projects adversely affected include Callallo Mews, Riverton, Mt. Edgecombe, Norwich, St. Benedicts, Melbrook, Whitehall II and III and Deeside.

Public Buildings – Correctional Facilities

The **Department of Correctional Services** reported that following the passage of Hurricane Dennis correctional facilities island-wide suffered damage to the tune of approximately \$23.6 million (See Table 2.2). Damage to roofs, structures and sentry boxes accounted for 33.7 per cent of the total while that to electrical and sewerage systems accounted for 22.5 per cent. Most of the reported damage was in the Adult Correctional Centres and in those centres closest to the coast. Those most badly affected were Tower Street (General Penitentiary), St. Catherine (Spanish Town prison) and Fort Augusta (Women's prison). The value of crops lost at two of the prison farms run by the Correctional Services Production Company (COSPROD) is estimated at \$0.6 million. The COSPROD losses are likely to increase after assessments have been completed at the other farms.

**Table 2.2 Department of Correctional Services Jamaica
Preliminary Estimated Damage and Losses Hurricane Dennis
J\$ million - July 2005**

Damage/Loss	Correctional Centres	Head Office	Staff College	Transport Centre	Staff Qtr/Club	Probation Aftercare Office	TOTAL
Roof	2.3	0.2	n/a	0.2	0.3	n/a	3
Structure	2.9	-	0.1	0.1	0.4	n/a	3.5
Sentry Boxes	1.45	-	-	-	-	-	1.45
Electrical System	2.1	0.1	-	0.2	0.3	n/a	2.7
Sewerage System	2.1		0.1	0.2	0.2	n/a	2.6
Stand By Generator	0.4	-	-	-	-	-	0.4
Water System	1.45	-	0.1	-	0.2	-	1.75
P.B.X. System	0	-	-	-	-	0.1	0.1
P.A. System	0.6	-	-	-	-	-	0.6
Communication Equipment	1.25	-	0.2	-	-	-	1.45
Machinery Equipment	0.95	-	-	-	-	-	0.95
Computer Equipment	1.4	-	-	0.1	-	0.2	1.7
Trade Training Equipment	1.5	-	-	-	-	-	1.5
Uniform Stock	0.3	-	-	-	-	-	0.3
Fencing Walls	0.9	-	-	-	-	-	0.9
COSPROD							
Poultry Houses	0.1	-	-	-	-	-	0.1
Pig Pens	-	-	-	-	-	-	0
Livestock	-	-	-	-	-	-	0
Poultry	-	-	-	-	-	-	0
Crops	0.6	-	-	-	-	-	0.6
GRAND TOTAL	20.3		0.5	0.8	1.4	0.3	23.6

n/a - not available

Source: Department of Correctional Services

3. Health

The total estimate for loss and damage incurred by the health sector, as a result of Hurricanes Dennis and Emily, amounted to \$55.5 million (See Table 2.3).

**Table 2.3: Summary of Damage to the Health Sector (J\$ million) –
Hurricanes Dennis & Emily**

Item	Damage - Dennis			Damage- Emily		
	Total	Direct	Indirect	Total	Direct	Indirect
Partial or total destruction of infrastructure	2.63	2.58	0.05	0.00	0.00	0.00
Loss of equipment and furniture	0.64	0.62	0.02	0.00	0.00	0.00
Loss of vaccines	0.00	0.00	0.00	0.00	0.00	0.00
Vector Control	16.54	6.00	10.54	3.23		3.23
Water Quality Monitoring	1.88		1.88	0.11		0.11
Environmental Health Sanitation	0.58	0.39	0.19	0.02		0.02
Latrine Replacement	16.98	14.97	2.02	1.98	1.98	0.00
Health Education Programme	3.14	2.89	0.24	0.07	0.00	0.07
Epidemiological/Shelter Surveillance	0.52	0.00	0.52	0.32	0.00	0.32
Supplementation of folic acid	0.15	0.15	0.00	0.00	0.00	0.00
Vehicles	4.00	0.00	4.00	0.03	0.00	0.03
MOH Emergency Operations Centre	2.48	0.00	2.48	0.19	0.00	0.19
TOTAL	49.53	27.60	21.93	5.94	1.98	3.96

Source: Ministry of Health

Approximately \$49.5 million was incurred due to Hurricane Dennis (56.0 per cent of which is categorized as direct damage). Some \$3.3 million related to damage to health infrastructure and equipment while the estimated cost of latrine replacement was \$16.9 million. Importantly, there was no loss of vaccines or pharmaceuticals. On the other hand, damage and losses incurred due to Hurricane Emily were much less amounting to \$5.9 million with vector control accounting for over 50 per cent of that amount.

III. PRODUCTIVE SECTORS

1. Agriculture

Estimates of damage caused by Hurricanes Dennis and Emily to the agriculture sector totalled \$379.9 million in direct losses. Approximately 6 700 farmers were impacted by Hurricane Dennis while Hurricane Emily affected 1 499 farmers. Of the total direct losses incurred by the sector, Domestic Crops (vegetables, roots and tubers) accounted for approximately \$111.9 million. Also included in the total estimate are Banana - \$54.0 million; Coffee - \$153.0 million; and Cocoa - \$30 million. All parishes, except Kingston, were affected with Portland (\$24.9 million); St. Mary (\$41.6 million); St. Thomas (\$20.4 million); St. Elizabeth (\$17.8 million) and Manchester (\$37.2 million) experiencing the highest levels of losses. Irrigation equipment valuing approximately \$960 000 was included in the total estimate.

Close to 1 300 hectares of crops were lost or damaged during both events (See Table 3.1). Consistent with the location of greatest impact of Hurricane Dennis more than 60 per cent of the area (hectares) of crops damaged was in Portland, St. Thomas and St. Mary.

Table 3.1: Area (ha) of Selected Crops Damaged or Destroyed during Hurricanes Dennis and Emily

CROP	Hurricane Dennis	Hurricane Emily
	hectares	hectares
Legumes	n/a	190
Pulses	40	n/a
Vegetable	130	181
Condiments	55	74
Cereals	40	20
Fruits	n/a	133
Banana	180	n/a
Plantain	110	n/a
Ground Provisions	55	58
TOTAL	610	656

n/a not available or negligible

Source: Rural Agricultural Development Authority

Sugar

The sugar cane industry suffered no significant damage. This was owing to the hardy nature of crops which allowed them to withstand substantial wind impact and the fact that the storms occurred at the end of the cropping period when the sugar cane fields were in the very early stages of growth.

Citrus

No estimates of hurricane damage were produced for the citrus industry. Damage to plantations from wind, rain and flooding brought on by the storms was negligible. The largest citrus growing areas were not in the direct path of the storm.

Livestock, Dairy, and Poultry

Total estimated damage to livestock, dairy and poultry industries was \$30.0 million (Table 3.2). The loss resulted mainly from flooding which led to the drowning of animals and birds. Fifty colonies of bees were also destroyed.

**Table 3.2: Selected Livestock Destroyed During
Hurricanes Dennis and Emily**

LIVESTOCK	NUMBER REPORTED LOST		
	Hurricane Dennis		Hurricane Emily
Poultry			
Broilers	151500		1400
Layers	6000		n/a
Goats	981		15
Pigs	1001		23
Cattle	195		n/a
Sheep	30		n/a
Bee Colonies	50		n/a
TOTAL	159757		1438

n/a not available or negligible

Source: Rural Agricultural Development Authority

Fisheries

Loss and damage to the fisheries sub-sector as a result of Hurricanes Dennis and Emily was estimated at \$365.15 million (See Tables 3.3 and 3.4). This included \$25.0 million in losses to ornamental fish, representing 25 per cent of brood stock and some \$330.0 million in damage to gear and equipment. Damage was reported in several key areas of the sector with Hurricane Dennis mainly affecting the parishes of Portland and St. Thomas and Hurricane Emily the parishes of St. Elizabeth, Clarendon, St. Catherine, Manchester and Westmoreland. All affected parishes reported that between 70 per cent and 90 per cent of fish traps were either missing or destroyed after both events.

Due to the course of Hurricane Emily across Jamaican maritime space, the Pedro Cays were mostly affected. Approximately 1 000 fishers inhabit the North-east and Middle Cays on the Pedro Bank and most of them evacuated both cays. There was reported damage to the Pedro Cays infrastructure and most significantly to fish traps. The Pedro Bank is the most productive fishing ground for Jamaica and the continual maintenance and integrity of the infrastructure cannot be overemphasized.

Since Hurricane Dennis, the fishery waters have been relatively choppy and not conducive for effective fishing operations. This has resulted in a shortage of fresh fish across most fishing communities and is likely to have a negative impact on the livelihood of fishers, at least in the short run.

Table 3.3 Estimated Loss Fisheries due to Hurricanes Dennis and Emily

Item	Hurricane Dennis \$ (million)	Hurricane Emily \$ (million)	TOTAL \$ (million)
Ornamental Fish	25.00		25.00
Shrimp	1.35		1.35
Food Fish	5.80	3.00	8.80
Aqua & Marine Gear & Equipment	330.00		330.00
TOTAL	362.15	3.00	365.15

Source: Fisheries Division

Table 3.4: Estimated Loss of Fishing Gear and Equipment due to Hurricanes Dennis and Emily

Parish	Communities Affected	Percentage (%) loss
Portland	n/a	70-78
St. Thomas	Rocky Point Yallahs Roselle	70 - 75
St. Elizabeth	Great Bay, Calabash Bay Billings Bay Frenchman's Cove Parrottee, Black River	70 - 90
Clarendon	Rocky Point Farqhar Barmouth Welcome Beauchamp	90
St. Catherine	Old Harbour Bay Helshire	70 - 90
Manchester	Alligator Pond	80 - 90
Westmoreland	n/a	70 – 90

n/a – not available

Source: Fisheries Division

2. Mining & Quarrying

The Jamaica Bauxite Institute has reported that there was no direct damage to the bauxite/alumina sub-sector as a result of Hurricane Dennis. WINDALCO, however, reported lost output of about 10 000 tonnes due to flooding at some of its facilities. There is no detailed assessment of damage to Quarrying activities.

3. Tourism

No estimate of direct damage to hotel infrastructure was reported. Direct damage to the Berrydale and Grants Level Rafting Attractions in Portland is estimated at \$2.5 million.

This represents the cost to replace approximately 125 bamboo rafts at a cost of \$4 000 each plus \$1.5 million for effecting repairs to damaged buildings. No estimates of indirect cost which would include loss of income for rafters and other workers have so far been compiled. In the hotel industry, indirect cost might have been incurred by some properties as stay was extended for some visitors at reduced or no costs. Damage to the island's road network resulted in inaccessibility to some hotels and villas.

4. Manufacturing

In the manufacturing sector, the estimates of damage were reported for the Caribbean Cement Company only. The total estimated cost of damage to the firm was \$48.7 million. This is comprised of \$18.3 million direct costs incurred as under:

Desilting	- \$14 million
Community Cleanup	- \$3 million
Cleanup on Plant & Quarry	- \$0.3 million

The indirect costs of \$30.4 million represent foregone production of cement, clinker and gypsum.

Overall, for the manufacturing sector, the impact of the two hurricanes on the operations of firms related mainly to the indirect costs associated with production downtime of approximately 2 – 3 days. This loss has not been quantified into monetary terms. Feedback from the manufacturing sector indicated that some companies activated disaster management plans in their organizations and so minimized damaged.

IV. INFRASTRUCTURE

Based on the preliminary assessments, infrastructure suffered the greatest level of damage, mostly to water mains, roads and bridges. Direct damage is estimated at \$3 757.89 million, while indirect damage is put at \$514 million.

1. Public Utility Systems

During and after the passage of Hurricanes Dennis and Emily most communities retained power supplies. Water supplies also remained in tact in most areas.

Electricity

With respect to Hurricane Dennis, the Jamaica Public Service Co. (JPSCO) estimated damage at approximately \$70.0 million, \$20.0 million of which was categorized as direct costs and were associated with the damage to the electricity generation, transmission and distribution facilities.

Approximately 100 000 customers lost electricity supply during Hurricane Dennis and close to 80 000 during Hurricane Emily. Areas most affected during Hurricane Dennis are shown in Table 4.1.

**Table 4.1: Areas Most Badly Affected by Loss of Electricity
– Hurricane Dennis**

Parish	Number of Customers Affected
Kingston & St. Andrew	41 000
East Kingston & St. Thomas	25 000
Portland	17 500
St. James	6 000

Source: JPSCO

Water Supply and Sanitation

Estimates of damage sustained by National Water Commission's (NWC) systems because of the two hurricanes amounted to \$400 million. Most water supply systems in the NWC's Eastern Division (St. Mary, Portland, St. Thomas, Kingston, St. Andrew, St. Catherine and Clarendon) were either damaged or disrupted as a result of Hurricane Dennis. The Western Division fared much better as fewer systems in this region were affected. During the initial days following Hurricane Dennis, NWC made efforts to put all systems into operation, especially water supply facilities that serve large population centres and important public institutions (hospitals and airports). Steps were also taken to restore other disrupted systems in the shortest possible time. Six days after Hurricane Dennis just under 400 of the 460 water supply systems were operating with between 90 and 95 per cent of the Commission's production capacity available to customers across the country. At that time, one (1) of the 68 wastewater systems, Yallahs, remained out of operation or compromised.

During Hurricane Dennis significant damage was suffered in several areas of the Yallahs pipeline that takes water from St. Thomas to the Mona Reservoir, St. Andrew. The Yallahs Wastewater Treatment Plant also suffered damage. The cross country 21 ft. raw water Ginger River pipeline that takes water to the Seaview Water Treatment plant was dislocated in two locations as a result of landslides. Speedy repair of this pipeline was hindered by the onslaught of Hurricane Emily which caused a further land slippage in the area of the pipeline. Water supply systems at Griffin, Craig Hill and Drummond in rural St. Andrew were also extensively damaged and require complete reconstruction in parts. Thirteen (13) days after the passage of Hurricane Emily approximately 380 water systems (serving about 93 per cent of the customers) were operating. With the passage of Hurricane Emily some of the NWC's systems across the country were also affected. The lead forms of damage related to flooding, damaged intakes, broken mains, land slippages and electro-mechanical breakdown.

Irrigation

Irrigation systems operated by the National Irrigation Commission were affected by both Hurricanes Dennis and Emily to the tune of \$30.4 million (Table 4.2). Damage related to Hurricane Dennis included: flooding to pumping stations at Freetown in Clarendon, Spring Village in St. Catherine and Braco in Trelawny; damage to access roads and structures in Clarendon, St. Catherine and St. Elizabeth; collapse of sections of the Caymanas siphon in St. Catherine; lightning damage to the Hounslow Office; and deposition of silt and debris on open canals in St. Thomas, St. Catherine, Clarendon, St. Elizabeth and Trelawny. For Emily, damage involved: dislocation to sections of pipeline in the new Beacon and Little Park schemes; flooding to some pumping stations along with roads and farmlands in the Hounslow scheme, St. Elizabeth; dislocation of 20 meters of pipeline in Braco, Trelawny; and flooding of pump houses in the Black River Upper Morass close to Santa Cruz.

Table 4.2: Estimates of Flood Damage to NIC Systems Caused by Hurricanes Dennis and Emily

Description	Hurricane Dennis (\$ Million)	Hurricane Emily (\$ Million)	Total (\$ Million)
Access roads and irrigation structures	15.1	4.7	19.8
Electrical equipment at pumping stations	5.70	3.6	9.2
Cleanup of silt and debris	4.75	0	4.75
Offices and housing	1.15	0.5	1.65
Total	21.70	8.7	30.4

Source: National Irrigation Commission

2. Telecommunications

Cable and Wireless has set estimates of damage caused by Hurricanes Dennis and Emily at \$42.2 million. The breakdown is shown in Table 4.3.

Table 4.3: Damage to Telecommunications due to Hurricanes Dennis & Emily

Nature of Damage	(J\$ million)
Telephone Network	8.5
Radio Equipment	11.5
Transmission & Distribution	10.2
External Plant and other Network Elements	12
TOTAL	42.2

Source: Cable & Wireless, Jamaica

No reports of damage or loss were received from the other telecommunications service providers. Despite the damage, there were no major disruptions in telephone services.

3. Transport, Roads and Bridges

Severe flooding and land slippage resulted in major damage to roads and drains across the island totalling \$4271.89 million.

In the case of Hurricane Dennis the majority of the damage to roads was concentrated in the eastern parishes of St. Thomas, St. Mary, St. Andrew and Portland. St. Thomas had the highest density of damaged roads (See Figures, 4A and Appendix 4A). The Yallahs fording was completely destroyed by the flood waters associated with Hurricane Dennis. This major transport infrastructure link between Kingston and eastern Jamaica was one of the significant infrastructural casualties in the parish (Figure 4B). By far, most of the damage to roads took place in upland interior areas where roads have been constructed on hilly terrain, some of which are highly susceptible to landslides and debris flow.



Figure 4B: Damaged Yallahs Fording

However, coastal roads in St. Thomas and Portland also suffered badly from the hurricane. The main causes of damage to roads were landslides and breakaways. There were also a few cases where entire sections of roadways were washed out.

Unlike Hurricane Dennis, damage to roads by Emily was far more widespread, affecting the parishes of Kingston and St. Andrew, St. Catherine, Trelawny, St. Elizabeth and Manchester. (See Figure 4C and Appendices 4B and 4C). St. Elizabeth was by far the parish with the highest density of badly affected roads. Flooding was the primary cause of damage to roads, especially in the low lying areas of southern St. Elizabeth and northern Trelawny.

Immediately after both events, the National Works Agency (NWA) moved to effect temporary restoration of roads and bridges islandwide including the Palisadoes main road to facilitate access to communities and critical institutions. The cost associated with these activities was estimated at \$ 405 million (Hurricane Dennis) and \$ 109 million

(Hurricane Emily). As at July 25, the NWA estimated the cost of rehabilitation of roadways, walls, bridges, and river training at \$ 2 898 million.

The estimated cost of damage to the parochial road network for both events is set at \$859.89 million. This reflects information from all Local Authorities except St. Catherine, Hanover, and the Portmore Municipality. The cost of damage on parochial roads, drains etc. related to the passage of Hurricane Dennis (\$515.95 million) was 50 per cent higher than that for Hurricane Emily and the effect was more widespread.

4. Airport, Ports, and Industrial Facilities

Estimates of indirect damage for the Norman Manley International Airport totalled \$11.0 million. No direct costs were incurred. For the Sangster International Airport the total cost of damage was put at \$0.55 million, comprising \$0.43 million in direct damage and \$0.12 million indirect. Direct damage was to airfield/approach, lighting facilities and air conditioning equipment caused by high winds and heavy rainfall. Indirect costs were incurred primarily to cover labour used to protect assets prior to the storm and post-hurricane clean-up activities.

The Port Authority of Jamaica reported that an island-wide survey revealed that there was no damage to its property, plant and equipment.

V. IMPACT ON THE ENVIRONMENT

1. General

a) Overview

Hurricanes release heat energy at rate of 50 trillion to 200 trillion, which is equivalent to energy exploding 10 megaton bombs every 20 minutes. With this strength these natural events have large disruptive impacts on the environment. Vulnerability and risks associated with hurricanes are related to three broad factors: vulnerable locations and populations pressures; poverty and affluence; and environmental degradation. Large numbers of people live in areas that are at increasing risk. However, in general the poor live in the most marginal locations in disaster prone area such as riverbanks, unstable hillsides, deforested lands, or fragile water catchments.

Hurricanes Dennis and Emily (both category 4 hurricanes) occurred within eight days of each other. Hurricane Dennis followed a path north of the island while Hurricane Emily followed a southerly path. Both hurricanes caused intense rainfall over the entire island but especially in the parishes closer to the path that they travelled.

Based on the environmental assessment the following major conclusions were reached:

- For both hurricanes, wind damage was minimal. Most of the environmental damage resulted from flooding associated with the intense rainfall; and as such
- flooding, landslips, and erosion were the major impacts of Hurricane Dennis and Emily.
- Due to the minimal wind damage experienced, the effects on natural vegetation and fauna appear to be minimal.
- Concentration of suspended solids in rivers was high but will likely return to normal without any major damage to river ecosystems.
- There is a risk that coastal waters of the south eastern coast will be affected by the damage to two sewage ponds in Yallahs resulting in the flow of raw sewage into the Yallahs River.

- Pre-existing conditions such as deforestation, highly saturated soils, and erosion may combine with hurricane events to increase risks and vulnerability
- Suspended solids flowing into the sea may affect coastal ecosystems.

b) Pre-Existing Environmental Conditions

The environmental impacts of Hurricanes Dennis and Emily must be understood in the context of the pre-existing environmental conditions. The island's geology, topography and drainage patterns have influenced the response to the elements of hurricanes Dennis and Emily.

- Jamaica's population is largely concentrated in the coastal areas that are vulnerable to storm surges and flooding. Many persons occupy highly vulnerable locations such as riverbanks, unstable hillsides, deforested lands, or fragile water catchments.
- Jamaica's continental shelf is most extensive on the south coast and the floor (bathymetry) of coastal waters is characterized by shoals, "fishing banks", cays, patch reefs, and seagrass beds. Several large rivers drain sediment-laden runoff to the coastal waters along the eastern, central and western sections of the coast, and extensive floodplains coalesce from Kingston through St Catherine and Clarendon. Distinctive coastal landforms and ecosystems in the coastal areas include the Palisadoes peninsula, the Portland Bight peninsula, embayments, and sandy and shingle beaches.
- Much of Jamaica's agricultural production takes place upon steep hillsides in the interior of the island. These areas are characterized by steep well-weathered slopes, highly fractured geological formations and well-developed networks of rivers and gullies draining north and south from a central east-west trending rugged mountainous axis. As such, erosion and landslides are serious problems affecting the agricultural sector.

- Solution depressions are characteristic of Jamaica's limestone topography; they accommodate extensive farming activities and interior settlements. They are drained through sinkholes and become inundated when floodwaters exceed the capacity for drainage.
- In Jamaica, poor watershed management leads to soil erosion and increases flooding. Surface, ground and coastal water are degraded by poor waste water management and agricultural run-off.
- Prior to the arrival of Hurricane Dennis, the island had been experiencing above-normal rainfall since the latter part of April hence there was a high level of soil saturation. This served to exacerbate the impact of the hurricane and the associated hazards of flooding, landslides, and debris flows.

2. Impact of the Hurricanes

Estimates of damage and losses to the environment are still being calculated. Flooding, landslips and erosion were the major impacts of Hurricane Dennis; minimal wind damage was reported from some areas at high elevations in the eastern end of the island. Some details of damage and losses sustained include landslides and debris flow, destruction of sewage treatment plants in Yallahs, St. Thomas; destruction of residential housing in Bull Bay, St. Andrew, destruction of pit latrines, an oil spill in the Kingston Harbour, and damage to forests.

a) Coastal Areas:

The National Environment and Planning Agency has reported that coral reefs on the north and south coasts were affected by high levels of sedimentation as evidenced from silt plumes at the mouth of major drainage channels. There was significant pile up of debris on the fishing beaches, an indication that there may have been disruption to nursery habitats especially for juvenile marine organisms.



Figure 5A: Beach erosion due to wave action in Ocho Rios. Photo Credits: NEPA

The beach in the vicinity of the Ocho Rios Harbour was affected by wave action which removed significant amounts of sand from the eastern end of the beach (Figure 5A)¹ and deposited same on the western end

The Cane River – Seven Miles, Bull Bay displayed massive bank erosion on both the eastern and western sides in the vicinity of the Black’s marl quarry and the Cane River community (Figure 5B). Some areas along the western bank showed land loss of approximately 4.5 metres to 6 metres. Erosion of banks appeared greatest on the western side. This bank erosion also resulted in the loss of electricity poles for the high tension electricity transmission wires (Figure 5C). These were however subsequently replaced along the roadway by the utility company.

¹ All photographs in this section courtesy of NEPA

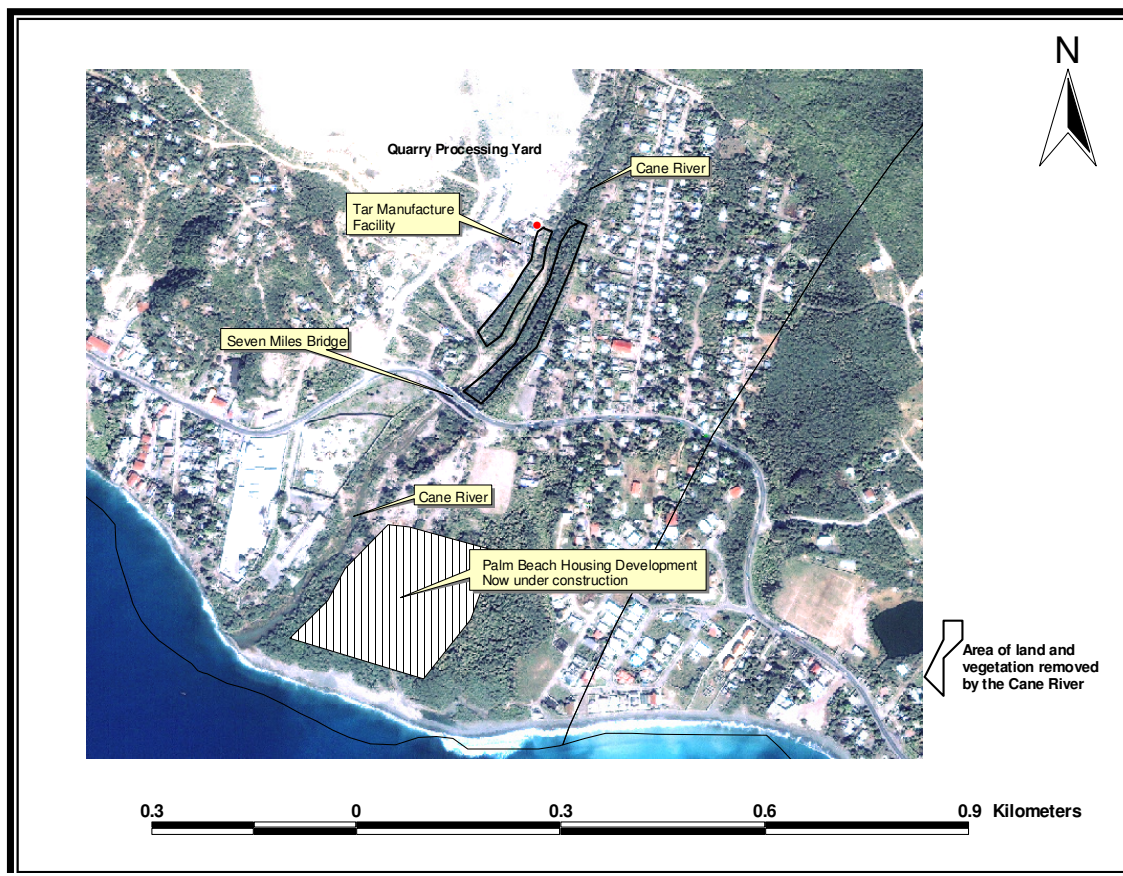


Figure 5B: Map showing area of land and vegetation removed by the Cane River

The community of Sugar Loaf Hill, Fair Way West in Bull Bay is extremely vulnerable to flooding as a result of the location in the flood plain of a river/ stream (Figure 5D). Several structures along the southern side of the main road abutting this gully/ stream



Figure 5C: Damaged housing unit and electricity pole as result of erosion of Cane River Banks.

have been damaged by flood waters. Major damage resulted from erosion which undermined the land abutting the main road at one point thus presenting a possible threat to the stability of the roadway (Figure 5F).



Figure 5D: Vulnerable Sugar Loaf Hill Community



Figure 5E: Erosion of land along main road near Sugar Loaf Hill

In Eleven Miles, Bull Bay, St. Thomas, erosion along the banks of Petonvale Gully drainage channel resulted in the loss of land and the exposure of sewerage systems as some pipes for individual septic systems were affected. The Yallahs fording was completely destroyed by the flood waters associated with Hurricane Dennis. This major transport infrastructure link between Kingston and eastern Jamaica was one of the significant infrastructural casualties in the parish. Suspended solids concentration in the river was very high giving the water at the fording a chocolate appearance.

Two of the three sewage treatment ponds serving the Yallahs Housing Scheme initially developed by the Ministry of Housing circa 1980 were. This has resulted in the flow of raw sewage into the Yallahs River (Figure 5F and 5G). All three sewerage ponds were unfenced and within close proximity of the original bank of the river channel.



Figures 5F and 5G
Untreated Sewage
effluent flowing into
Yallahs River from
damaged Pond.



b) Interior Upland Areas:

In Portland, the communities of Fellowship, Grants Level, Berridale, Windsor and Milbank were the ones most severely affected. There were several land slippages in hilly areas of the Rio Grande Valley at Millbank. In the community of Fellowship (which has a history of flooding as a result of the Rio Grande River and Sandy Rivers overflowing their banks during periods of heavy or sustained rainfall) there was significant mud deposition (Figure 5H).



Figure 5H Deposition of mud on roadway at Fellowship from flooding caused by the Sandy River

Slope failure was particularly evident in a small section of Millbank where shale soils coupled with the relatively steep slopes makes the community susceptible to land slippages. Approximately six houses were damaged and crops destroyed by a landslide (Figure 5I and 5J).



Figures 5I and 5J: Housing units and vegetation at Millbank damaged by landslide

In St. Mary, the Junction main road, Broadgate and, Pencar River Bridge were amongst the most severely affected areas. Land slippages were observed along the Junction main road. The material from these landslides contributed to the high suspended solid load at the mouth of the Wag Water River (**Figure 5K**). River bank erosion occurred in a section of Broadgate sited along the banks of the Wag Water River.



Figure 5K: Silt plume near the mouth of the Wag Water River moving in a north westerly direction towards Robins Bay

There was evidence of erosion at the base of the pilings of the bridge at the Fort George District spanning the Pencar River (Figure 5L). Erosion was also observed along the bank of the Pencar River in the vicinity of the bridge (Figure 5M).



Figure 5L: Pencar River Bridge at Fort George showing exposed bridge support



Figure 5M: Erosion of bank of Pencar River in vicinity of the Bridge at Fort George

Roadslides, resulting in blocked roads and undercutting, were noted for areas including Gordon Town, Guava, Mavis Bank, Chestervale to Clydesdale and New Castle. In areas such as Irish Town and Content Gap some houses were destroyed while others were threatened by future slides.

The community of Maryland, St. Andrew was affected by sediments and debris washed down by the river due to the heavy rainfall. This material blocked the road. The heavy rains of Hurricane Dennis caused the river to change its channel. A family in the community had their property affected by this shift of the channel (Figure 5N & 5O).



Figure 5N & 5O: Property at Maryland affected by change in river channel

On the outskirts of Irish Town landslides and soil creep were observed. Some dwellings in the community are at risk from slope movement (Figure 5P).

At the Blue Mountain Coffee Craigton Estate in Irish Town, evidence of a landslide could be seen. The soil under one of the estate's pump house facility was washed away (Figure 5Q).



Figure 5P: House at Irish Town at risk from landslide owing to location in path of moving soil mass



Figure 5Q: Foundation of Craigton Coffee Estate pump house at Irish Town exposed by landslide

In Redlight there was blockage of roads by landslides. Minor flooding also occurred as a result of landslides blocking the normal drainage flow/ channels. It was observed that the general practice is to deposit material from land slides into nearby gullies or on the down slope of the slides. Erosion was also evident along the roadway linking Redlight and Newcastle (Figure 5R).



Figure 5R: Eroded roadside and fallen power line along Red Light to New Castle Main road

In Hillside, St. Thomas, debris from a tributary was deposited by flood waters that overflowed the banks of the stream. These deposits had noticeable effects on four residential structures. For other communities in St. Thomas such as Richmond Vale, Trinityville, Spring Bank, and Somerset, damage was mainly associated with landslides that resulted in roadblocks, destruction of utility poles and wires, undercutting of roads and partial destruction of residential structures.

c) Forestry:

Preliminary estimate of damage to forests amounted \$13.5 million. Loss related mainly to damage to infrastructure due to failure of retaining structures, and damage to plantations including breaking and toppling of mature and immature timber stock and newly established stands (Table 5.1).

Table 5.1: Estimates of Damage to Forests

Item	Final Estimates Dennis (\$ million)	Preliminary Estimates Emily (\$ million)	TOTAL (\$ million)
Road Infrastructure	8.5	1.0	9.5
Forest Plantations	3.0	0.5	3.5
Buildings	0.5	-	0.5
TOTAL	12.0	1.5	13.5

Source: Forestry Department

Approximately 50 per cent of the damage occurred in the parishes of St. Andrew, St. Thomas and Portland. Damage to roads included blockages, scouring of surfaces and failure of retaining/drainage structures. Damage to buildings included roof and subsequent water effects.

VI. SUMMARY DAMAGE AND LOSSES AND MACROECONOMIC EFFECTS

Based on preliminary assessment, the impact of Hurricanes Dennis and Emily on Jamaica amounted to \$5 976.91 million or US\$96.87 million. Of this total, \$5 259.80 million refers to direct losses while \$717.11 million refers to indirect losses (Table 6.1).

**Table 6.1:- Preliminary Costs of Damage and Losses caused by
Hurricanes Dennis & Emily (J\$ million)**

Sector and Sub-sector	J\$ million				
	Direct	Indirect	Total	Private	Public
Total	5259.80	717.11	5976.91		
Social					
Housing	203.70	n/a	203.70	108.60	95.10
Education and Culture	1.00	n/a	1.00		1.00
Health	29.58	25.86	55.44		55.44
Productive					
Agriculture and Livestock	379.90	n/a	379.90	379.90	
Fisheries ^[1]	365.15	n/a	365.15	365.15	
Mining	n/a	n/a	0.00		
Tourism	2.50	n/a	2.50	2.50	
Manufacturing - Cement	18.30	30.40	48.70	48.70	
Infrastructure					
Electricity ^[2]	20.00	50.00	70.00		
Water Supply and Sanitation	400.00	n/a	400.00		400.00
Transport/Roads and Bridges	3757.89	514.00	4271.89		4271.89
Telecommunications	42.20	n/a	42.20	42.20	
Irrigation	25.65	4.75	30.40		30.40
Airports	0.43	11.13	11.56	0.12	11.44
Environment					
Forestry	13.50	n/a	13.50		13.50
Waste Management	n/a	55.40	55.40		55.40
Emergency Operations	n/a	25.57	25.57	24.09	1.48

[1] Includes \$25 million in losses to ornamental fish farmers, representing 25 per cent of brood stock.

[2] Estimate is for Hurricane Dennis only.

The total amount of damage and losses is equivalent to 1.2 per cent of the country's GDP for the previous year.

Infrastructure was the most affected sector having sustained damage and losses of \$4 826.05 million, followed by the Productive sectors \$796.25 million. The social sectors experienced a much lower impact \$260.14 million. The single most affected sub-sector is Transport/Roads and Bridges which sustained total damage and losses of \$4 271.89 million, or 71.5 per cent of the total impact. This is followed by Water Supply and Sanitation, \$400.00 million, and Agriculture and Livestock \$379.90 million. Considering indirect losses only, Transport/Roads and Bridges is the most affected sub-sector \$514.00 million, followed by Waste Management \$55.40 million, Electricity \$50.00 million and Manufacturing \$30.4 million. Given this information it can be generalized that Hurricanes Dennis and Emily combined destroyed or damaged the assets of transport infrastructure, disrupted water supply systems, and agricultural crops.

The adverse effect of the hurricanes on real GDP growth is not expected to be as severe as with Hurricane Ivan. Agriculture is the only sector that is expected to record a decline during July - December, due in part to the loss of both domestic and export crops. Hurricanes Dennis and Emily impacted negatively on banana and coffee production, slowing the recovery process for these export crops from the effects of Hurricane Ivan in September 2004. Consequently, agricultural performance for July – December 2005 is expected to weaken. The Bauxite & Alumina industry was minimally affected by the Hurricanes. Damage to road infrastructure, houses and the National Water Commission (NWC) plants caused by the hurricanes is likely to spur activity in the Construction & Installation sector. In this sector, residential and non-residential activities are expected to increase due mainly to reconstruction activities. In Manufacturing & Processing the sector's growth performance should improve as minimal damage was incurred.

Compared with previous hurricanes in the Caribbean area, the economic cost of the two hurricanes as a proportion of GDP was small (Table 6.2). However, the real economic impact of hurricanes will be reflected in a reduction of the GDP growth target for 2005.

**Table 6.2: Selected Hurricanes in the Caribbean and their Impact
(1988 – 2005)**

Hurricanes	Year	Country	Impact (% of GDP)
Gilbert	1988	Jamaica	65
Hugo	1989	Montserrat	200
Debbie	1994	St. Lucia	18
Luis and Marilyn	1995	Antigua	65
Luis and Marilyn	1995	St. Kitts and Nevis	85
Georges	1998	St. Kitts and Nevis	50 (sugar harvest)
Lenny	1999	Barbuda	95 (primary sector of GDP)
Michelle	2001	Jamaica	1
Ivan	2004	Grenada	200
Ivan	2004	Jamaica	8.0
Dennis and Emily	2005	Jamaica	1.0

Source: Assessment of the Socio-Economic and Environmental Impact of Hurricane Ivan on Jamaica, October 2004

MACROECONOMIC EFFECTS

Overview of Domestic Policies

The macroeconomic programme was guided by the policy objectives established in the Medium Term Socio-Economic Policy Framework 2004/5 – 2006/7. For 2004/5, the objectives included the maintenance of a stable macroeconomic environment to foster economic growth; enhancing international competitiveness; and, lowering the fiscal the fiscal deficit.

The Economy in the Year of the Disaster: The First Two Quarters of the Year

For January – June 2005, the six months prior to the hurricanes, real Gross Domestic Product (GDP) for the economy was projected to remain flat relative to January – June 2004. Real Gross Domestic Product for the Agriculture, Forestry and Fishing sector fell by 24.4 per cent. During the first three months of the calendar year the sector declined by an estimated 29.1 per cent due mainly to the residual effects of Hurricane Ivan and drought conditions.

For the second quarter, the decline in agriculture GDP is projected to slow to 19 per cent given the gradual recovery of banana, coffee and domestic crop production (Table 7.1)

Table 7.1 Real GDP Growth by Sectors

	Jan-Dec 2004 Revised	Jan-Mar 2005 Revised	Apr-Jun 2005 Estimated	Jan-Jun 2005 Estimated	Jul-Dec 2005 Projected	Jan-Dec 2005 Projected
GOODS PRODUCING SECTORS	1.3	-3.7	-1.1	-2.5	2.8	0.1
Agriculture, Forestry & Fishing	-8.9	-29.1	-19.0	-24.4	-3.4	-15.8
Mining & Quarrying	2.6	0.8	0.1	0.5	11.3	5.6
Manufacturing	3.0	-3.3	-2.0	-2.7	2.1	-0.4
<i>of which: Food, Beverages & Tobacco</i>	4.2	-3.6	-3.0	-3.3	1.0	-1.4
<i>Other Manufacturing</i>	1.4	-2.9	-0.7	-1.8	3.3	0.7
Construction & Installation	5.0	11.5	11.9	11.7	2.0	6.6
SERVICES SECTORS	1.2	1.9	0.8	1.3	2.3	1.8
Electricity & Water	-0.1	0.4	2.5	1.5	10.5	5.9
Transport, Storage & Communication	0.9	2.2	-0.2	1.0	3.0	2.0
Distributive Trade	1.3	1.8	1.7	1.7	1.1	1.4
Finance & Insurance Services	-0.7	-0.4	1.1	0.4	1.5	0.9
Real Estate & Business Services	2.1	1.9	2.0	2.0	1.7	1.8
Producers of Government Services	0.2	0.6	0.4	0.5	0.4	0.5
Miscellaneous Services (incl. Household & Private Non-Profit Institutions)	4.1	5.5	-1.4	2.0	4.0	3.0
<i>of which: Hotels, Restaurants & Clubs</i>	4.6	6.8	-2.4	2.2	5.4	3.7
Less Imputed Bank Service Charge	5.1	2.1	0.7	1.4	1.0	1.2
TOTAL GDP AT CONSTANT PRICES	0.9	-0.2	0.1	0.0	2.6	1.2

Source: Statistical institute of Jamaica and Planning Institute of Jamaica

In other areas of production, the Mining & Quarrying sector recorded real GDP growth of 0.5 per cent for January - June 2005 relative to the corresponding period of 2004. Real GDP for the Construction sector was estimated to have increased by 11.7 per cent while the Manufacturing & Processing sector declined by 2.7 per cent.

In the area of Services, the Financial Services sector grew by 0.4 per cent relative to the corresponding period of 2004. Hotels, Restaurants & Clubs, which is representative of performance in the tourism industry, grew by 2.2 per cent.

External trade data for January - April 2005 showed the external trade balance at negative US\$924.8 million, from negative US\$690.8 million during the corresponding four months of 2004. Total merchandise exports were valued at US\$497.5 million, a decline of 6.2 per cent (or US\$32.7 million) compared with January – April 2004. Merchandise imports for the same period were US\$1 422.3 million reflecting an increase of approximately 16.5 per cent (or US\$201.3 million).

The Economy without the Disaster

Prior to the occurrence of the hurricanes, real GDP was forecasted to grow by 3.6 per cent during 2005, driven mainly by a return to normalcy particularly in Agriculture which was severely affected by Hurricane Ivan in 2004. Inflation was projected at 9.0 per cent.

From a fiscal perspective, and consistent with economic targets established in the country's Medium Term Social and Economic Framework (MTSEF), the budget for FY2005/06 was formulated to achieve a balance.

The Expected Performance with the Disaster

Despite the impact of the hurricanes on other areas of the economy, the fiscal target for a balanced budget for FY2005/2006 will still be achieved.

The impact of Hurricanes Dennis and Emily has resulted in a downward revision in the projected GDP growth. For calendar year 2005 real GDP for the economy overall, is expected to grow by 1.2 per cent relative to 2004. The flat performance in the first half of the year will be surpassed during July - December 2005 when the GDP is expected to increase by 2.6 per cent compared with the corresponding period of 2004. Growth during the second half will reflect increases in GDP for the Goods Producing and the Services

sectors approximating 2.8 per cent and 2.3 per cent respectively. The growth will be led by Mining & Quarrying, Electricity & Water and Hotels, Restaurants & Clubs, given:

1. the normalization of activities during July - December of the current year compared with the corresponding period of July - December 2004 when sectors were adversely affected by hurricane Ivan²;
2. strong growth in bauxite production during July - December;
3. higher levels of production of refined petroleum products during July - December this year compared with 2004.³

However, the inflation target for calendar year 2005 which was set at 9.0 per cent before the hurricanes has been revised upwards. This is owing to the combined effect of the hurricane disasters and pre-existing drought conditions on agriculture production which subsequently led to shortages in the supply of some domestic crops. The resultant price increases have yielded a revised inflation rate projection.

The inflation rate for July – December is therefore expected to be 6.6 per cent, resulting in an annual inflation rate for calendar year 2005 of 14.3 per cent. Prices in the second half of the year are likely to be influenced by:

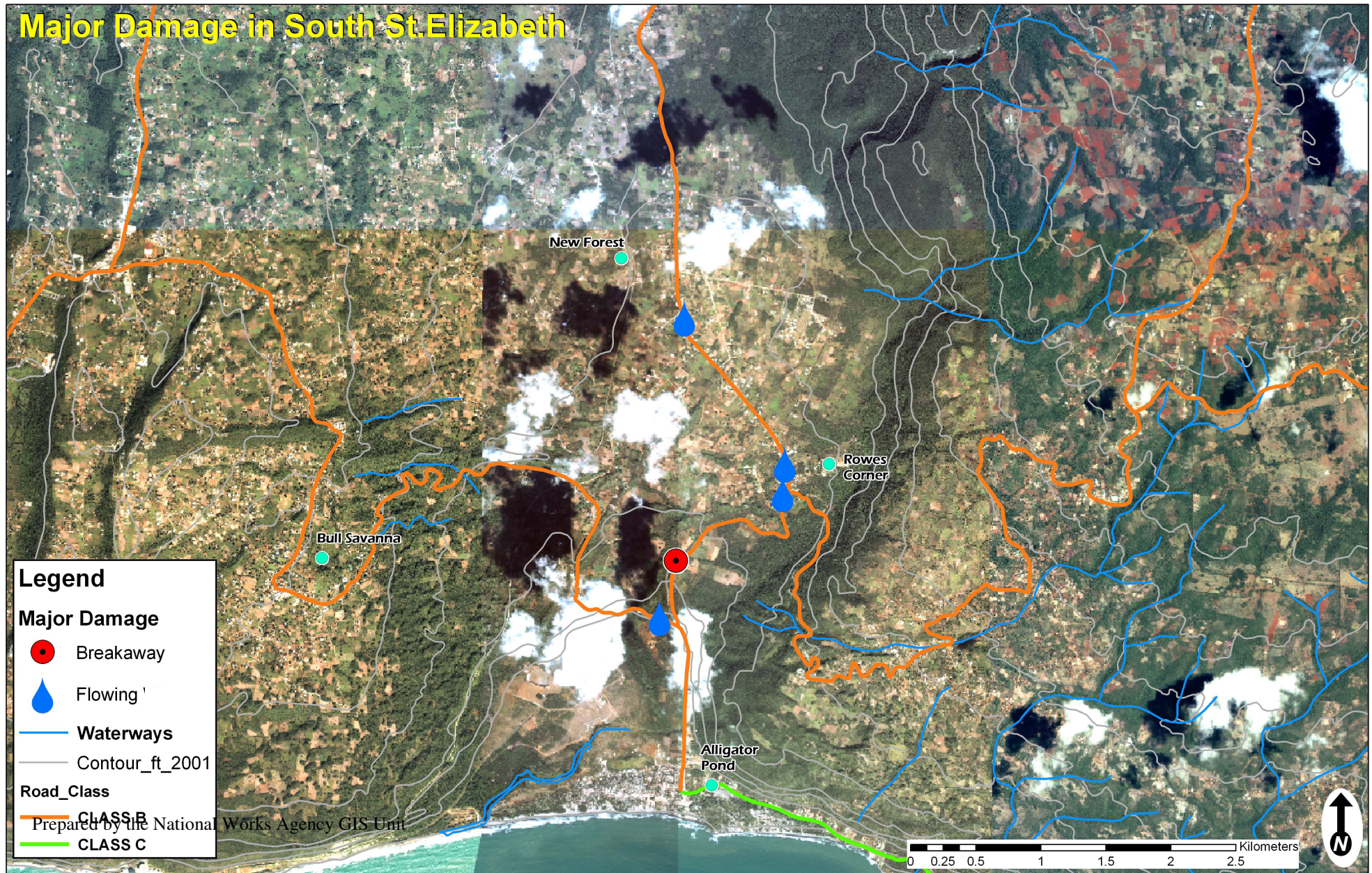
1. a shortage of locally produced food, as a result of the damage incurred by the Agriculture sector from Hurricanes Dennis and Emily;
2. increased demand for building related products for the repair of residential and physical infrastructure, as well as to prepare for the remainder of the Hurricane season; and
3. continued increase in oil prices on the international market.

² The sectors that were mainly affected by Ivan were Mining & Quarrying and Electricity & water and Agriculture.

³ The refinery was closed twice during July-December 2004; in July for maintenance and repairs and in the latter part of October – December due to a fire.

The Distributive Trade sector is expected to benefit from the passage of the hurricanes given increased demand for hardware related goods and the other hurricane related supplies.

APPENDIX 4C – MAJOR DAMAGE IN SOUTH ST. ELIZABETH
(POST HURRICANE DENNIS)



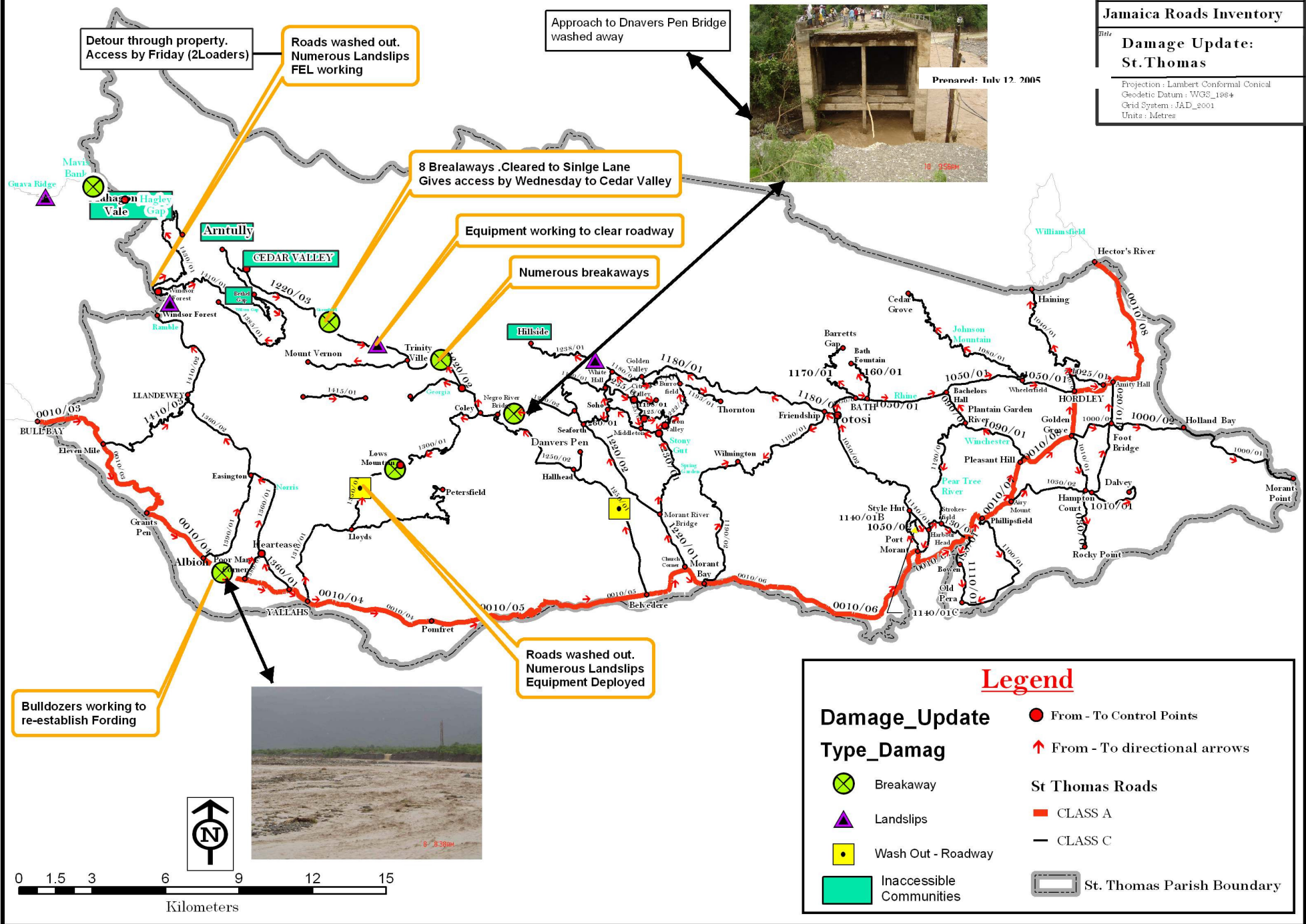
APPENDIX 4A – NWA DAMAGE UPDATE – ST. THOMAS (POST HURRICANE DENNIS)

GIS UNIT
Directorate of Planning & Research
GIS Operator : Alicia Gayle

Jamaica Roads Inventory

Damage Update:
St. Thomas

Projection : Lambert Conformal Conical
Geodetic Datum : WGS_1984
Grid System : JAD_8001
Units : Metres



APPENDIX 4B – NWA DAMAGE UPDATE – ST. ANDREW (POST HURRICANE DENNIS)

