Flood Risk in Jamaica : Recent Damage and Loss due to tropical cyclones in Jamaica.

Report prepared as part of the Climate Change and Inland Flooding in Jamaica: Risk and Adaptation Measures for Vulnerable Communities : Disaster Risk Management and Policies in Jamaica.

David Smith[1] and Arpita Mandal[2]

Caribbean territories are highly vulnerable to the impacts of hazards, which may be natural, resulting from hydro-meteorological, seismic or geologic triggers or anthropological. Studies of damage and loss due to floods in the Caribbean are few and studies relating damage to intensity of the event are even fewer. For example, the EM-DAT database indicates that 119 floods occurred in the Caribbean since 1983. This resulted in 4983[3] deaths, 3,963,286 people affected and damage of 866,325,000 US dollars[4]. Of this figure, 3353 (67%) deaths occurred in a single event in Hispaniola in 2004. The figures for damage are missing for 99 of the 119 events.

It has been suggested that disaster risk reduction requires good data not just on the impact of hazards, but also on the nature, magnitude and extent of hazards to be effective. In the Caribbean, assessments of damage and loss have been carried out by the governments of affected countries or by UN ECLAC. While these studies may indicate the severity of the event; few non-economic data are quantified, nor are data presented so that damage can be related quantitatively to the severity of events or compared quantitatively between events, though some qualitative analysis is possible. Notwithstanding this, economic damage and loss due to tropical cyclones in the Caribbean are significant proportion of GDP with some events causing damage and loss of more than 100% of GDP.

In 1988, Hurricane Gilbert inflicted an estimated USD1.1 billion of damage to Jamaica[5]. Hurricane Hugo in 1990 caused USD3.6 billion damage to Antigua and Barbuda, St. Kitts and Nevis, Montserrat, and the British Virgin Islands. Floods in Jamaica in 2002 caused damage of USD116 million. In Grenada, Hurricane Ivan caused economic impact of over 200% of GDP and caused economic impact of USD 75,500 *per capita* in the Cayman Islands[6]. Over six thousand people died in the region as a result of heavy rainfall and Tropical Cyclones Ivan, Jeanne and Frances in 2004 and UN-ECLAC estimates that the economic impact of the cyclones was USD5.593 billion that year. The Turks and Caicos Islands suffered economic impact amounting to 25% of GDP due to Hurricane Ike in 2008. During the same year Cuba was hit by three storms and four million persons were affected while nearly 1000 persons died in Haiti as a result of cyclones.

---

[1] Institute of Sustainable Development, Disaster Risk Reduction Center, The University of the West Indies, Mona Campus, Jamaica.

[2] Department of Geography and Geology, The University of the West Indies, Mona Campus, Jamaica.

[3] This figure includes a figure of 600 for the 1985 floods in Puerto Rico for which other sources give significantly fewer deaths (Quinones & Johnson 1987, USGS File 87-123 indicates 170 deaths).

[4] http://www.emdat.be/advanced_search/index.html accessed 2014/07/08

[5] http://www.emdat.be/

[6] Source: UN ECLAC The impact of Hurricane Ivan in the Cayman Islands 2004

According to Carby (2011) flooding is common and widespread in the Caribbean, affecting nearly 90% of countries in the region. Jamaica experiences recurring high levels of damage caused by flooding (ECLAC 2001[7]). Analysis of the assessments of damage and loss since 2001 (ECLAC 2001, 2002; PIOJ 2004, 2005 a&b, 2007 2008, 2010, 2012) (see Table 1) indicates that largest losses were caused by tropical cyclones but that flooding was not related to storm intensity.

Table 1 Damage & Loss in Jamaica since 2001[8]

YEAR	MONTH	HAZARD	Total Damage and Loss (USD millions)	Total Damage and Loss (% of GDP)	Roads & Bridges as a percentage of Total Damage & Loss
1988	9	Gilbert	1378[9]	65	
2001	10/11	Rain	325		
2001	10/11	Michelle	53.64	0.8	62
2002	5/6	Rain	51	0.7	60
2003	5	Rain	N/A	N/A	N/A
2004	5	Rain	N/A	N/A	N/A
2004	9	Ivan	580	8	9
2005	7	Dennis	96.8	1.2	71
2005	10	Wilma	56	0.7	N/A
2007	8	Dean	329	3.4	9
2008	8	Gustav	214	2.1	74
2010	10	Nicole	239.6	1.9	82
2012	10	Sandy	107	0.8	18

[7] ECLAC report Lc/Car/G.672 7 (2001) *Jamaica: Assessment Of The Damage Caused By Flood Rains And Landslides In Association With Hurricane Michelle, October 2001* p4.

[8] From PIOJ & ECLAC reports of the incidents

[9] Data from Céline Charvériat. 2000 Natural disasters in Latin America and the Caribbean : an overview of risk http://www.iadb.org/res/publications/pubfiles/pubwp-434.pdf accessed 2014-09-30

Flooding is related to rainfall; both within the event itself and to the amount of rain falling in the days prior to the event. This is well illustrated by Hurricane Michelle; most damage was caused by the rain falling during the development of the system and not by the passage of the cyclone itself (ECLAC 2001), and also by Tropical Storm Nicole. In the case of Nicole, Jamaica had experienced five months of above average rainfall prior to the event (range 115%-172% of the 30-year monthly mean)[10].

Resultant damage from high rainfall events may be caused by floods or landslides. Damage during floods may also include damage caused by debris flow and occurs mainly to infrastructure. The agricultural sector also suffers significant losses, mainly to crops, but also to livestock. Damage to the electricity sector is related more to high wind speed than to rainfall. In most cases, damage to the communications sector apart from damage to postal service facilities was not estimated. Flood events damage roads and bridges and cause damage to agriculture. High wind events (e.g. Hurricanes Ivan, Dean and Sandy) create most damage to housing, the electrical transmission sector and crops.

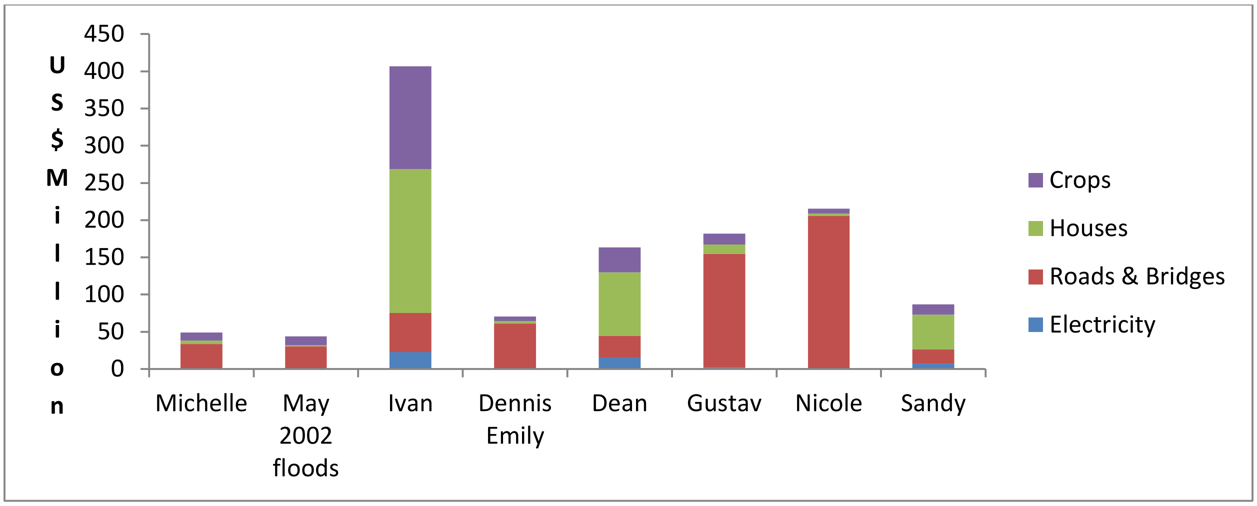


Figure 1 Damage due to Meteorological events in Jamaica by Sector[11]

For the events recorded, the majority of damage is caused to public property, particularly roads and bridges, then housing and crops (see Table 2). In the case of Gustav, Total Damage and Loss (TDL) was US$213 million of which 76% was infrastructural damage, mostly roads and bridges (74% of total). Figures for Nicole are similar, of the USD$ 239 million TDL, damage to roads and bridges was 82%. Tropical storm Nicole caused US$240 million in Damage and Loss, equivalent to 2% of GDP. Hurricane Allen caused damage and loss which was the equivalent of 2% of GDP, while flood events in 1986 caused Damage and loss of 3% of GDP and a flood event in 1991 caused 6% of GDP[12].

---

[10] Smith unpublished analysis of data from the Jamaica Meteorological Service

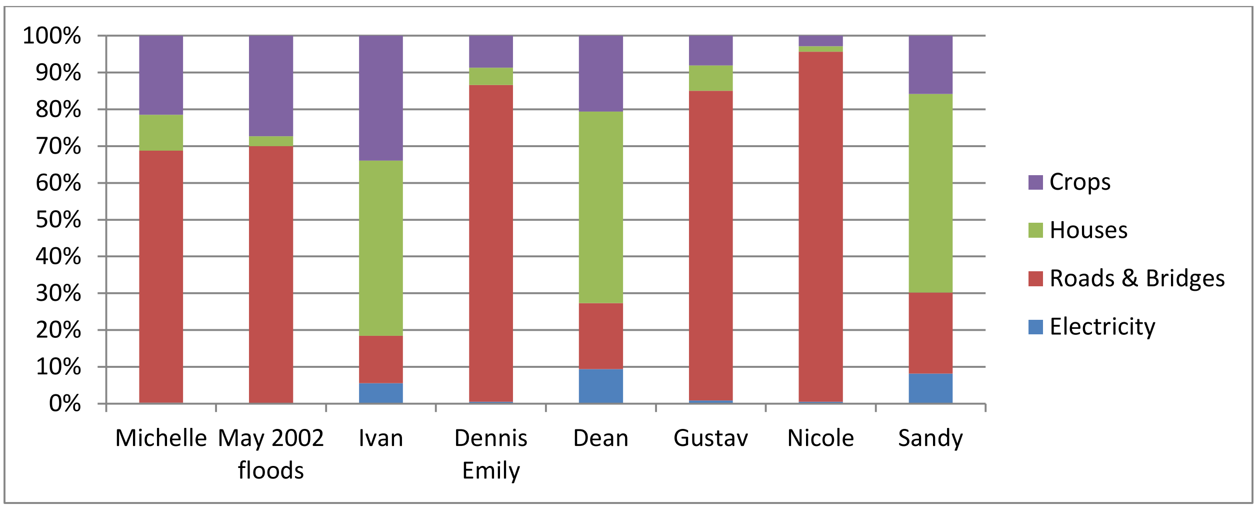
[11] Data from PIOJ and ECLAC reports

[12] Céline Charvériat. 2000. Ibid

Table 2 Damage due to meteorological events in Jamaica by exposed elements (US$ millions)[13]

EVENT name	Total DALA	Damage	Loss	Roads & Bridges	Houses	Crops	Electricity
Michelle	53.64	52.23	1.43	33.40	4.79	10.47	0.13
May 2002 floods	51.00	51.02	5.37	30.57	1.15	11.93	0.00
Ivan	580.00	358.79	221.21	52.56	193.51	138.01	22.57
Dennis Emily	96.87	85.25	11.62	60.91	3.30	6.16	0.32
Dean	329.34	205.61	123.74	29.24	85.17	33.67	15.33
Gustav	213.99	200.10	13.88	153.11	12.50	14.66	1.49
Nicole	239.60	227.18	12.42	204.79	3.19	6.19	1.08
Sandy	107.10	103.04	4.06	19.14	47.00	13.76	7.09
TOTALS	**1672**	**1283**	**394**	**584**	**351**	**235**	**48**

Figure 2 Percentage of damage to various exposed elements caused by Meteorological events



The PIOJ reports of damage and loss indicate that 3544mm of rain fell over six days during TS Nicole (PIOJ 2010). The all-island rainfall for the month of September 2010 was 270% above the thirty year mean and all parishes experienced higher than normal rainfall both in September and the months prior to the event (ibid). Some rainfall stations recorded more rain in a single day than the monthly mean for September. This was similar to the May 2002 rains where several stations exceeded the Parish 30-year mean in a single day, but contrasted with Hurricane Sandy where the majority of stations did not exceed the 30 year mean during the event. Hurricanes Dean and Ivan could be classified as events with high wind speeds and heavy rain. In Hurricane Dean several stations received between 117% and 217% of the 30 year mean rainfall (PIOJ 2007). In the case of Ivan, rainfall exceeded 30 year means for several stations, in one case by 300% (PIOJ 2004).

---

[13] Data from ECLAC and PIOJ DALA for each event

Many of the factors leading to high levels of flood risk have been identified in more than one report on flood events. The factors (see Table 3) recur and limited progress has been made in flood risk reduction. They include poor design, placing infrastructure in hazard-prone areas and poor environmental management and land use practices, especially in hilly areas. The main recommendations center around mapping the hazards, managing watersheds and improving construction practice. Table 4 compares recommendations made in 2001 & 2002 with those made in 2010 following TS Nicole.

Table 3 Factors noted in DALA reports that increase risk or lead to damage and loss.

Hazard	Intense Rainfall exceeding the 30 –year mean within a short period e.g. 100% or more of the mean falling within a single event. Periodicity of events varies from 1 in 2 to 1in 100 years.
	Rainfall levels above those planned for
	Excessive rise in water table in some locations as a result of recharging the aquifer
	Higher than average rainfall in the period before the event
Exposure	Houses sited in flood-prone or low lying areas
	Roads built in valleys or low lying areas
Vulnerability	Inadequate sizing of drains for roads built in exposed places
	Some roads only built for a 1 in 5 year event[14] and many built for 1 in 10
	Poor environmental or watershed management
	Planning and design flaws such as floor level not being elevated above the ground
	Improper maintenance of drains
	Developing new housing, without adequate sizing of peripheral drains
	Inappropriate land use on hillsides, increasing runoff

Table 4 Recommendations made after the floods of 2001-02 and following TS Nicole[15]

Action	Recommendations made 2001- 2002	Recommendations following Nicole 2010
Map Hazards.	Identify areas vulnerable to floods and landslides, use data to inform change to land use & settlement patterns.	Map flood prone areas that can be used for non-residential purposes such as agriculture.
	Expand coverage of hazard maps for floods & other risks	Map sinkholes in flood-prone depressions, plan buffer zones around them, keep them open and improve drainage capacity.
	Implement flood hazard mapping, increase the number of rain gauges and water level recorders for Portland; adopt regulation guidelines for flood plain use; prepare technical guidelines illustrating appropriate standards and criteria for siting and dimensioning of buildings and hydraulic structures;	Install rainfall intensity gauges in Watershed Management Units to improve analysis of extreme events and forecasting to mitigate flooding.
		Increase hydrologic mapping of river flooding
Reduce Hazards	Improve management of watersheds and steep hillsides and implement soil conservation. Including:	Watershed rehabilitation and diversification of livelihoods: replanting trees, slope stabilization with grass, training in construction techniques. UNDP
	Minimizing the removal of trees on steep slopes	
	Halting the use of fire for clearing land	
	Promoting to farmers appropriate land management practices that reduce soil loss	

14 PIOJ, ECLAC & UNDP (2002).

15 Made in the reports on the events by ECLAC and PIOJ

	Constructing, where appropriate diversion drainage channels, spillways, check dams & waterways of earth or wood	
	Promoting and enforcing proper development planning, so that development does not take place on riverbanks. River and watercourse bank protection including:	Enforce setbacks standards for gullies and streams.
	Cease mining gravel & sand from the upper reaches of riverbeds;	
	Retain vegetation on gully and stream banks & plant fruit and forest trees along watercourses when possible;	
	Construct minor river training works to prevent undercutting of developed areas;	
	Clear watercourses of excess debris;	Implement a continuous maintenance programme for drains
		Protect gully banks by removing encroaching structures.
		Map gullies and drains in main towns
		Improve ecosystem management to make them more resilient to natural hazards and reduce severity of natural hazards.
Reduce exposure	Assess whether people should be allowed to build in high flood risk areas of Bybrook or Swift River	Demarcate no build zones, especially in proximity to gullies.
		Delineate areas above a certain elevation where residential development can take place, and implement measures to maintain floodwaters at an elevation below the residential development.
Reduce vulnerability	Reduce vulnerability of lifelines	
	Carry out hazard vulnerability audits (HVA) for roads lifelines, schools, critical buildings	
	Carry out HVA on roads in flood plains	
	Rationalize systems of land use in watersheds, review physical planning and land use standards.	
	Implement education programme on those traditional practices that destabilize watersheds.	
Disaster Risk Reduction	Implement Flood Control Master Planning to be implemented by the Water Resources Division.	Develop a floodwater control master plan
		Amend the Water Resources Act to make regulation of Floodwater Control the responsibility of the WRA. Facilitate mapping of flood prone areas, hydrologic run-off assessments & modelling to determine flood boundaries for different return periods, and determine what structures should be allowed
	Implement the watershed policy	
	Set building standards for houses in flood prone areas including standards for elevation of the floor above the ground	
	Agree on an flood event standard for new construction	
	Increase main road drainage to accommodate a 1 in 25 year event and local roads to 1 in 10.	
	Subject new road construction to EIA	

Policy and Plans

The Disaster Preparedness and Emergency Management Act is the legislative instrument that guides most activities with respect to DRM in Jamaica. The Act establishes the Office of Disaster Preparedness and Emergency Management. ODPEM has made good progress in implementing the Hyogo framework (Carby 2011). Factors that limit progress include a lack of financial resources and possibly a lack of political will (Carby 2011).

The Water Resources Authority has produced flood hazard maps for some rivers (Rio Cobre, Rio Grande, Rio Minho and Hope River) as well as maps of past flood events, however, these should be updated as development within the watersheds has increased since they were produced and many of the maps are over 20 years old (Carby 2011). The National Disaster Action plan contains no procedures for Floods, simply a listing of the agencies that would be involved in a response. In contrast, there are detailed plans for earthquakes and hurricanes (ODPEM). Aspects relevant to floods are mentioned in the sub procedures. Mitigation measures in the National Disaster Plan include preventing development in drainage and flood plains as well as:

- Building codes and construction standards
- Cleaning and maintaining drains
- Preventing encroachment of development on natural drain ways and flood plains
- Structural improvements and alterations of drain ways
- Management of the shoreline
- Reduction of upstream run-off and sedimentation
- Future hazard studies
    - Location of landslip hazards
    - Tsunami construction and mitigation standards
    - Cumulative hazard mapping
    - Hurricane computer simulation
    - Sea level rise

(taken from ODPEM pp. 198-199)

While there are clearly stated policy intentions to create no build zones and to otherwise limit development in areas which are exposed to hazards, the reality in Jamaica is that housing as well as other developments have been allowed to take place in hazard prone areas. Also, houses that are built in these areas are not built so that vulnerability is reduced. Carby (2011) indicates that this lack of enforcement has led to loss of life.

While addressing the reasons for the lack of enforcement is beyond the scope of this intervention, it is clear that more data on flood risk should be made available to improve the ability of Jamaica to deal with floods. This includes updating hazard maps and increasing their coverage as well as generating data on exposure and vulnerability. Improved data on flood risk should be made available to planners and engineers to allow for the implementation of the recommendations of the post-event reports with regards to infrastructure and housing. A survey of disaster managers and planners from 8 Caribbean countries carried out by the UWI in 2010 indicated that many spatial planners have access to data but it is not often in digital form or at the scale required for their work. Only 3 of the eight countries had watershed boundaries, five had data on historical impacts but only three had such data digitally, and while all had data on rainfall, only 3 possessed it in digital form. This severely hampered the ability of planners to be able to manipulate the data so that they could incorporate it into planning decisions (Ross, Smith &

McGhie 2012[16]). The study also found that data on rainfall often did not include intensity information, and that data on wind was mainly collected at the airport but not at other places (ibid).

The UWI study indicates that digital data on hazards are not readily available. Such data are required to implement the recommendations made within the DALA reports. As a result, the Disaster Risk Reduction Centre of the Institute for Sustainable Development at the University of the West Indies established the Caribbean Risk Atlas[17]. This is being populated with data on hazards and these data can be made available to planners and disaster managers. Data generated from this project will be placed on the CARISKA site and access given to planners, disaster managers and other stakeholders. The site will facilitate sharing spatial data and allow data owners to manage who can view and download their data. Some training of potential users of the site has taken place, and the site is being populated with baseline data on hazards and other factors including location of emergency facilities.

---

[16] Ross, A., Smith, D.C. & McGhie, E. (2012). *Caribbean Risk Atlas - Establishing Data Needs In The Caribbean* Unpublished.

[17] http://cariska.mona.uwi.edu/

References

Carby, B. (2011). Caribbean implementation of the Hyogo Framework for action HFA mid-term review. Caribbean Risk Management Initiative UNDP. http://www.preventionweb.net/files/18197_203carby.caribbeanimplementationoft.pdf accessed 2014-09-29

Charvériat, C. (2000). Natural disasters in Latin America and the Caribbean : an overview of risk http://www.iadb.org/res/publications/pubfiles/pubwp-434.pdf accessed 2014-09-30

ECLAC (2001) Jamaica: Assessment Of The Damage Caused By Flood Rains And Landslides In Association With Hurricane Michelle, October 2001 *…. Implications For Economic, Social And Environmental Development.* http://www.cepal.org/cgi-bin/getProd.asp?xml=/publicaciones/xml/4/9884/P9884.xml&xsl=/portofspain/tpl-i/p9f.xsl&base=/portofspain/tpl/top-bottom.xsl

ODPEM (1997) National Disaster Action Plan for Jamaica. http://www.odpem.org.jm/DisastersDoHappen/NationalDisasterPlans/tabid/57/Default.aspx accessed 2014-10-08

PIOJ, ECLAC & UNDP (2002). Jamaica: Macro-Socio-Economic Assessment Of The Damage Done By Flood Rains And Landslides May 2002 http://www.pioj.gov.jm/Portals/0/Sustainable_Development/May%202002%20Flood%20Rains.pdf

PIOJ (2004). JAMAICA Macro-Socio-Economic and Environmental Assessment of the Damage done by Hurricane Ivan Sept 10-12, 2004 http://www.pioj.gov.jm/Portals/0/Sustainable_Development/Hurricane%20Ivan.pdf

PIOJ (2005). Assessment of the Socio-Economic and Environmental Impact of Hurricanes Dennis and Emily on Jamaica. http://www.pioj.gov.jm/Portals/0/Sustainable_Development/Dennis%20Emily%20Report.pdf

PIOJ (2005). Assessment of the Socio-Economic and Environmental Impact of Hurricane Wilma on Jamaica http://www.pioj.gov.jm/Portals/0/Sustainable_Development/Hurricane%20Wilma.pdf

PIOJ (2007). Assessment Of The Socio-Economic And Environmental Impact Of Hurricane Dean On Jamaica. http://www.pioj.gov.jm/Portals/0/Sustainable_Development/Hurricane%20Dean.pdf

PIOJ (2008). Assessment Of The Socio-Economic And Environmental Impact Of Tropical Storm Gustav On Jamaica http://www.pioj.gov.jm/Portals/0/Sustainable_Development/Tropical%20Storm%20Gustav.pdf

PIOJ (2010) Jamaica Macro Socio-Economic And Environmental Assessment Of The Damage And Loss caused by Tropical Depression No. 16/Tropical Storm Nicole. http://www.pioj.gov.jm/Portals/0/Sustainable_Development/Tropical%20Storm%20Nicole_Impact%20Assessment_Final.pdf

PIOJ (2013). Jamaica Macro Socio-Economic And Environmental Assessment Of The Damage And Loss Caused By Hurricane Sandy. http://www.pioj.gov.jm/Portals/0/Sustainable_Development/Final%20%20DaLA%20Report%20Hurricane%20Sandy_Update.pdf

Disclaimer