NACIONES UNIDAS

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Distr.
LIMITED

LC/MEX/L.836
13 December 2007

ORIGINAL: ENGLISH

INFORMATION ON DISASTER RISK MANAGEMENT CASE STUDY OF FIVE COUNTRIES

JAMAICA

This document has not undergone formal editing.

07-12

Original title:
Information on disaster risk management. Case studies of five countries: Jamaica

LC/MEX/L.836

This study was prepared by David A. Y. Smith, Ph.D., P. Eng., as part of the study carried out under the framework of the Information Program and Indicators for Disaster Management project, financed by the Inter-American Development Bank (IDB) and executed by the Economic Commission for Latin America and the Caribbean (ECLAC), Sub regional Headquarters in Mexico. The task was coordinated by Ricardo Zapata, ECLAC Focal Point on Disaster Evaluation, and Roberto Meli, ECLAC consultant.

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A. RISK EXPOSURE TO NATURAL HAZARDS AND DATA QUALITY

Jamaica, as a result of its location in the north–western Caribbean basin, is prone to numerous specific natural hazards. These include hurricanes, of which recent hurricanes experienced within the last few years (and in fact since 1988 with hurricane Gilbert), have reminded us of Jamaica's great vulnerability to the effects of this hazard. Next, it is also envisaged that a large earthquake could do considerable damage to sectors of the population and to infrastructure and could result in displacement and homelessness among large sections of the population, particularly in the highly urbanized areas of the Kingston Metropolitan Area (KMA). These two hazards, though perhaps not the most frequent, have the potential to do the most widespread damage to the population and to infrastructure. Floods are the most frequently occurring natural hazard in Jamaica, and are often linked with severe weather systems, frontal systems and troughs, and less often with hurricanes and storms. Next to floods, landslides are the most frequently occurring hazard for Jamaica. Tsunami events appear to be very infrequent around the coastline of Jamaica. Events have been recorded however, in 1755 and more recently in 1907.

In all, over 300,000 references on the general topic of disaster risk were found to exist. It is therefore clear that there is abundant data dealing with this issue. Largely due to the fact that these documents have been produced through research initiatives, or as commissioned studies, the quality of the data appears to be quite rich. With respect to the accessibility of these data, in the Jamaican context the central storage locations are primarily at ODPEM and at CARDIN.

Among technical agencies, access to data and information is reasonably easy. The Land Information Council of Jamaica coordinates data access and sharing for the Government agencies with Geographic Information Systems. Some private companies also share data with the ODPEM at no cost. Access to information by the public has been more difficult, although the use of websites to disseminate information to the public is becoming more popular. ODPEM disseminates information for its public information and awareness program through its website, schools, libraries, public lectures and workshops. The public is guaranteed the right to all but personal information by the Access to Information Act.

The awareness of the public to floods is evident, as they are described in much detail after each occurrence in the visual and written media. In recent years a trend has been evident in which victims of flooding have either requested relocation or have agreed to relocation. It is clear that these residents have developed a full perception of this hazard, its possible effect (vulnerability) and the degree of loss likely to be experienced in the future and have decided not to accept the level of risk involved in remaining at the vulnerable location. From the perspective of hurricanes, hurricane Gilbert in 1988 and Ivan in 2004 have done much to sensitize the populace about the risks and vulnerabilities associated with this hazard. The threat of earthquakes, which has held a less prominent position in the public consciousness, has been boosted through the holding of simulation exercises that have been portrayed in the media.

B. THE RISK MANAGEMENT STRUCTURE

The management of *ex ante* and some *ex post* emergency planning issues is overseen primarily by the Office of Disaster Preparedness and Emergency Management (ODPEM). ODPEM's mandate covers more than disaster response, and includes preparedness, response, mitigation, prevention and recovery. Each parish has a Parish Disaster Committee including Government, Private Sector and NGO representatives. The national system of sub—committees is mirrored at the parish level. Below the parish level, some communities also have disaster committees called Zonal Committees, which link with the Parish Disaster Committees.

There are a number of functional plans for evacuation, communication, mass casualty events, aircraft accidents, pandemics, pest infestations, etc. Of these, the primary plan is the National Disaster Plan, which is a comprehensive document setting out mitigation, preparedness, response and recovery procedures for a variety of hazards, both natural and man—induced. ODPEM is responsible for coordinating the response to national threats and emergencies, with coordination being carried out from the National Emergency Operations Centre (NEOC). Under the post—impact conditions, ODPEM also coordinates the relief efforts, which also incorporates the input of the international community. There are standing procedures which govern rehabilitation of critical services. For example, hospitals receive priority attention for road clearance and reconnection of power and water supplies after any disaster. Shelters are also given a high priority.

The existence of documented policies, plans and procedures at national and parish levels has allowed a consistent approach to response. Further, simulation exercises and real events have provided opportunities for testing and improvement of the system. The present governance structures therefore allow risk management to be incorporated at local levels, with Parish Councils being given more technical tools, such as hazard maps and risk analyses to guide them in their decision—making.

The integrated nature of the Jamaican risk management system encourages data and information exchange among agencies as well as decision—makers. In the past, the appreciation by the technical agencies of Government of the importance of risk reduction has not been matched at the policy and political level. More recently, however, and particularly after hurricane Ivan in 2004, there has been a marked increase in the acceptance of issues related to vulnerability reduction and mitigation. As an example, the Planning Institute of Jamaica has included risk reduction in its medium term development strategy plan, and Cabinet has agreed to various suggestions for reducing coastal vulnerability.

Jamaica has successfully integrated public, private, technical, scientific and voluntary sectors as well as local Government authorities and communities into its disaster risk management structure, and therefore represents a good example of an integrated approach to risk management. The inclusion of mitigation in the national medium term development plan also indicates that there is a real effort to integrate risk reduction into national development.

C. RISK FINANCING AND RISK TRANSFER

The Government of Jamaica does not have a policy of Risk Transfer and so, Government assets are largely uninsured. This culture is however changing, as many Statutory Bodies and Executive Agencies do insure their property. The fact remains however that as a policy, the Government assumes its own risk. This policy results in the reallocation of funding from ongoing programs to fund response initiates. In 1989, after hurricane Gilbert, a National Disaster Fund was started; however this has not been adequately maintained. For the most part, Government physical assets are uninsured or underinsured. Exceptions include properties owned by statutory corporations such as port and airport authorities, as well as utility companies that can independently access the insurance markets.

As part of a historical strategy to address the financial and economic impact of risks from natural disasters, Jamaica has (as has many other Caribbean islands) successfully leveraged international insurance capital and has been able to transfer much of the risk, particularly for commercial, but also for residential properties, on to the international insurance and reinsurance markets. During the mid 1990's, Caribbean countries experienced insurance rate increases between 200%—300% on account of shortages of insurance cover, due to indemnity payments made for large hurricane and earthquake losses worldwide.

Many of the small property and business owner segments expect Government assistance in times of crisis. Others decide to self—insure, assuming that the returns on funds saved from insurance premiums may be sufficient to finance remediation works. In most cases however, this does not work, as the savings are absorbed into working capital.

D. SCENARIOS OF EXTREME EVENTS

Two extreme event scenarios are discussed in the main report. The first was a Category 5 hurricane (wind speeds above 155 mph) approaching from the south—east, and the second a Magnitude 7 earthquake with epicentre in the Wag Water Belt area.

The scenario hurricane could be expected to have a significant impact on the entire population of Jamaica, but more so for the residents and infrastructure along the south coast. All urban centres would be expected to be at risk, but particularly the KMA region. It is to be expected that the scenario hurricane could result in a tally of homeless individuals somewhere in the order of 20,000 – 30,000. The emergency network would therefore have to gear up to accommodate these numbers in shelter locations. The immediate coastline areas of St Thomas, Kingston, St Catherine and Clarendon would likely have to be evacuated. Storm surge hazard maps indicate that the coastal strip of Kingston would be inundated, as would the access road to the international airport. This coastal strip includes many inner—city communities, which are vulnerable, as they do not have updated infrastructure that is capable of withstanding a natural disaster of this magnitude. Sections of the Portmore area, which itself is perhaps the most densely populated area located on the south coast of Jamaica exposed to this hazard, would have to be evacuated. The provision of an adequate number of shelters is expected to pose some challenges, as there is presently a lack of adequately trained individuals to satisfy this requirement. It is unlikely that this extreme event would be able to destroy the entire country to the same degree. In real events so far, there have therefore been options for relocating resources from less damaged to more damaged areas, until external assistance has become available.

Unlike hurricanes, the possible effects of earthquakes are more of an unknown. Major structures in New Kingston and Downtown are likely to survive such an event, although minor structural damage is a distinct possibility. Geological conditions at our major ports also make them more vulnerable to significant damage. The provision of water will be a major problem. Disruption of sewage lines will also likely occur, posing possible threats to health and causing contamination of piped water where these systems survive and may be adjacent to one another. The secondary effects of an earthquake have implications which also need to be considered. Disturbance of the harbor could mean that ships would not be able to enter until the channel had been surveyed and re—established. The container port is located on reclaimed landfill, which could be prone to liquefaction under earthquake loading. Extensive damage to the Norman Manley International Airport would leave Montego Bay's Sangster International Airport as the only port of entry for relief supplies coming in by air. Interestingly, a recent earthquake simulation exercise carried out by the ODPEM on the 100th anniversary of the 1907 earthquake, revealed several weaknesses in the response mechanisms and in particular in the search and rescue capabilities.

ACKNOWLEDGEMENTS

Acknowledgement is hereby given to the contributions of Dr. Barbara Carby, formerly the Director of the Office of Disaster Preparedness and Emergency Management (ODPEM) and Ms. Pat Shako, Environmental Economist, in the preparation of this document.

I. INTRODUCTION AND BACKGROUND

1. General Objectives

The United Nations Economic Commission for Latin America and the Caribbean (ECLAC) has, over the last thirty years, implemented a methodology aimed at assessing the social, economic and environmental impact of disasters.

More recently, ECLAC, with IDB support, has initiated a technical cooperation project entitled **Information Program for Disaster Risk Management**, whose objective is to provide decision makers in Latin America and the Caribbean with the necessary tools to develop and implement risk management strategies.

The specific objectives of this project are summarized as:

a) Improving the availability and use of risk information so as to better identify investment priorities in prevention, and in guiding the post–disaster recovery process.

b) Providing policy–makers with a method of evaluating the ability of their countries to reduce their vulnerability to disasters, their ability to bear and/or manage risk, and a means of assessing the effectiveness of their policies and investments on disaster risk management performance; and

c) Facilitating the exchange of technical information for risk management policy and programs in the region.

In the first instance, the program is directed to decision makers in the economic sphere. The aim at this level being to demonstrate that the financial burden, imposed by one, or a succession of different disasters, may be reduced through prudent risk management and disaster mitigation policies.

In the second instance, the program is aimed at those in charge of the operative offices of disaster management at all levels of Government. The aim at this level is therefore to provide the necessary information to facilitate an improvement in response actions for all stages of a disaster.

Finally, the program is intended to make those in charge of providing technical–scientific information on hazards and risks of disasters, aware of the kind of information needed by decision makers.

2. Project Activities

The ECLAC/IDB program has been divided into four phases, outlined as follows:

a) Definition of a Conceptual Framework and development of specific Methodologies for the evaluation and design of strategies for risk management;

b) **Undertaking pilot case studies and a national dialogue on policies**;

c) Comparison, at the regional level, of national experiences derived by the case studies; and

d) Preparation of a final report containing the results of the three previous phases, as well as policy proposals and risk management strategies for disasters that could be adopted by countries in the region.

It was intended that a preliminary version of the output of the first phase be provided to the teams carrying out the case studies, as a guide for performing the required tasks.

The second phase constitutes the primary part of the component that is presented in this report. Its objectives, activities and expected outputs are summarized in Section two following.

II. SCOPE OF WORK FOR PILOT CASE STUDIES

In all, five national case studies are to be undertaken to address the general objectives described above. In these studies, existing policies for the prevention of risk for emergency management, and for recovery and reconstruction are to be examined.

In order to have a wide range of scenarios to be considered, representative countries have been selected from the Latin American and Caribbean sub–regions that have different economic sizes and levels of development. These are Jamaica, Colombia, Chile, Mexico and Nicaragua.

The objectives of each study are to:

1) Identify sources of information/analysis on natural disaster risk in the specific country. Evaluate their quality, adequacy and accessibility.

2) Evaluate the perception of risk among the population.

3) Determine and assess the risk management mechanisms applied before and after a natural disaster.

4) Determine the way(s) in which risk is borne at varying levels of the society.

5) Develop scenarios of extreme events that would affect the studied populations.

6) Evaluate the methodologies proposed in the first phase of the overall program.

For each country, the following items will be investigated:

- Information on risk and on risk perception;
- Risk management; and
- Financial management of risk.

III. COUNTRY BACKGROUND

1. Geography and climate

Jamaica has a total area of 11,244 square kilometres and is the third largest island in the Caribbean. It is 236 kms long and between 35 and 82 kms wide. The island is extremely mountainous and less than one—fifth of the land is relatively flat, in the form of coastal plains, inland valleys, flood plains and river terraces. Of the remainder, much of the land is very steep. The highest peaks are in the east where the Blue Mountains peak at 2,256 metres. More than one—half of the country is at least 305 metres above sea level and over one—half of the land has slopes of over 20%.

Figure 3.1

MAP OF JAMAICA

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Many rivers radiate from these highlands, chief among them being the Rio Grande, which collects much of the drainage of the island's north–east slopes, and the Yallahs River, which drains the central southern and south–eastern slopes. To the south–west of the island, the Black River drains an adjacent morass, which is home to the largest herbaceous wetland system in Jamaica.

Jamaica's climate is tropical marine. The mountainous terrain, the north–east Trade Winds and land–sea breezes all act to modify the climate. These give rise to micro and macro-scale spatial variations in the seasonal distribution of rainfall. The average annual rainfall for the country as a whole is 195.8 cm, with a wide range being experienced between locations. In the Blue Mountain areas for example and the north–eastern coastal areas, which lie in the path of the trade winds, as much as 375 cm of rainfall is received annually. Kingston lies on the leeward side of the Blue Mountain range and receives on average 125 cm of rainfall annually. Although the annual overall total rainfall is high, droughts that occur outside the rainfall seasons pose a serious problem for agriculture and the provision of potable water for urban areas.

Exceptionally heavy precipitation occurs under the influence of hurricanes and tropical depressions. Thirty–seven hurricanes and tropical storms were recorded between 1900 and 1991. During the same period there were 20 floods and four island–wide droughts. Considerable crop damage is also caused by high winds, even in the years when there are no hurricanes and tropical storms.

2. Population

At the end of 1998, the mean population of Jamaica was estimated at 2,566,900. In addition, for that year the Statistical Institute of Jamaica (STATIN) estimated the crude birth rate to be 19.96 per 1,000 mean population and the crude death rate to be 6.7 per 1,000 mean population. By the end of 2005, the population had increased to 2,660,700, while the numbers for the two other parameters had decreased to 15.76 and 5.85 respectively per 1,000 mean population. The gender ratio has remained constant over the past five years with 99.8 males per 100 females. Two important current demographic trends in Jamaica are the contraction in the household size and the proportion of the population in the younger age groups. These are attributed to the significant decline in the fertility rate over the last two decades. From an overall perspective, Jamaica's population is aging, in that approximately 10% is in the age group 60 years and over. It is still at this stage however, considered to be a relatively young population with a median age of 26 years.

Larger households and a larger proportion of children are more common in rural areas, as are female headed households and lower consumption expenditure. The Survey of Living Conditions (SLC 1997) reports that the proportion of households with female heads was 44.7% of total households in 1997, which is not significantly different from the 1996 figure of 43.8%. A micro–scale survey conducted in the inner city district of Kingston in 1990 indicated that 49.4% of the households surveyed were female headed.

The SLC (1997) reports an average household size of 3.9 persons. The proportion of households with five or more members declined from 44.2% of all households in 1975 to 33.5% in 1992. The proportions for 1997 represent 2.6% points decrease for households with 6+ members, and 2.4% points increase for households with two to four members, over those for 1996. In the 1990 survey of the inner city of Kingston the average size of households was 2.75. Within this inner city area, the majority of households occupied one room, 17% occupied two rooms and 5.8% occupied three rooms. Six and a half percent (6.5%) owned their own property, 45.5% paid rent and 47.2% were squatters.

The island's working age population (15–64) years increased to 62.3% up by approx. 3% points since 1991 and comprised 825,500 males and 807,000 females.

The population density of Jamaica is 216 persons per square kilometre. This is comparatively high for the Caribbean and Latin America, and is eight times the average for lower middle income countries. In a Caribbean context, population density ranges from a low of 28 persons per square kilometre in the Bahamas (although this is misleading, as it is not at all representative of the specific population density on the island of New Providence), to a high of 600 persons per square kilometre in Barbados. The island of St. Lucia probably represents a median or average value for the region, with a population density of 250 persons per square kilometre.

The parish of Kingston has the highest population density of 1,838 persons per square kilometre, followed by St. Andrew with 484 persons per square kilometre. The parish of Trelawny had the lowest population density, with 32 persons per square kilometre (Population Census 1991). The regional disparities in population densities impact on regional threats to natural resources and environmental problems, in that, in some areas population pressure may lead to catastrophic and unsustainable use of natural resources while other areas remain under—utilised and underdeveloped. Rural areas are low population density areas, and environmental concerns for these areas are therefore largely associated with the way in which the rural population uses resources, rather than with the problems usually associated with large populations.

The parish of Kingston was classified as being 100% urban in the 1991 census, followed by St. Andrew with 87% and St. Catherine with 70.7%. The Kingston Metropolitan Area (KMA), which includes the city of Portmore, is one of the largest urban areas in the Caribbean and contains approximately 26% of the country's population. More significantly, the land area of the KMA zone has now expanded westward and is currently experiencing an annual growth rate of 2.30%, which represents the fastest growing of the country's urban areas. This extensive, rapid and poorly managed urbanisation can be expected to contribute significantly to pollution of the air and water resources and to severe waste management problems. Highly polluted water and air borne pollutants are known to increase morbidity and respiratory diseases and other illnesses. In addition, this type of urbanisation exposes the population to greater threats from both natural and anthropogenic hazards, as uncontrolled developments and squatter settlements typically expand into high risk areas.

The population of most of the other parishes is still predominantly rural, varying from 71.2% rural in Clarendon to 91.3% in Hanover— the most rural parish in Jamaica. Nine of the 14 parishes are over 70% rural (Statistical Institute of Jamaica).

The table following gives population estimates for all parishes for the years 1991, 1996, 1999, 2000 and 2001.

Table 3.1

DISTRIBUTION OF POPULATION IN PARISHES FOR 1991, 1996, 1999, 2000 AND 2001 (STATIN)

	1991		1996		1999		2000		2001	
	Population	%	Population	%	Population	%	Population	%	Population	%
Kingston & St. Andrew	646 100	26.9	691 500	27.4	710 500	27.4	716 000	27.5	719 900	27.5
St. Thomas	85 300	3.6	89 400	3.5	91 700	3.5	92 400	3.5	92 700	3.5
Portland	76 500	3.2	78 600	3.1	79 200	3.1	79 400	3	79 400	3
St. Mary	109 200	4.3	111 800	4.4	112 800	4.4	112 800	4.3	112 900	4.3
St. Ann	150 600	6.3	158 200	6.3	163 400	6.3	164 900	6.3	167 300	6.4
Trelawny	71 400	3	72 500	2.9	72 500	2.8	72 500	2.8	72 500	2.8
St. James	156 200	6.5	169 800	6.7	178 200	6.9	180 800	6.9	182 600	7
Hanover	66 400	2.8	67 900	2.7	67 700	2.6	67 500	2.6	67 200	2.6
Westmoreland	128 900	5.4	134 800	5.3	139 000	5.4	140 600	5.4	141 800	5.4
St. Elizabeth	146 100	6.1	149 000	5.9	148 800	5.7	148 600	5.7	148 300	5.7
Manchester	161 600	6.7	177 500	7	185 900	7.2	188 800	7.2	192 400	7.3
Clarendon	215 980	9	223 800	8.9	227 700	8.8	228 300	8.8	229 400	8.8
St. Catherine	384 500	16	402 600	15.9	411 600	15.9	413 200	15.9	414 700	15.8

3. General ecology

The marine ecology of the island can be characterised by three primary ecosystems: mangroves, sea grasses and coral reefs. Mangrove colonies contribute to bio—diversity through the provision of nursery and habitat areas for juvenile fish and non—motile species. In addition, during times of rainfall induced flooding, mangrove stands serve to filter out fine sediments occurring in flood waters from entering to the sea. These colonies also serve to attenuate the negative effects of storm surge during the passage of hurricanes, through acting as a “soft” barrier against the incursion of the sea. Sea grasses, which form the second primary tropical ecosystem, play a key role in the regeneration of sandy beaches that are common throughout the Caribbean. This is achieved through a symbiosis with coralline algae, which is frequently found to be a major component of Caribbean beaches. Through their role in beach and (subsequently) dune building, sea grasses therefore also contribute in an indirect way to the reduction in vulnerability of coastal areas. From this perspective, it is important that the many tourism developments that are taking place in Jamaica and in other Caribbean nations be done in a manner whereby removal of sea grass beds is carried out in tandem with replacement strategies. Finally, coral reefs provide a very important ecological and physical function for these islands. In addition to also being a source of sand for adjacent beaches, these reefs provide a physical barrier against the incursion of hurricane waves. They therefore serve to reduce vulnerability of the shorelines in their lee and so should be preserved as much as possible. Threats to the sustainability of these organisms come, *inter alia,* typically from polluted seawater, from micro–organisms, from construction activities and from land—based pollution due to agriculture and sewage.

On the terrestrial side, Jamaica presently has large tracts of forest, particularly in the eastern sections of the island. Over the past several years, agricultural practices have contributed to the deforestation of several watersheds, which in turn results in a major problem related to the water borne transport of silt during flood events. In some instances, flood water transported sediments have resulted in the nearly complete wash–out of communities who have built in areas that were previously perceived to be safe, but which were in fact in a floodplain.

The following Table 3.2 gives a summary of land use and forestry areas, in 1989 and also in 1998, in square kilometres.

The table shows that in the period between 1989 and 1998, there have been only minor reductions in the forest cover. In addition, other STATIN information indicates that the use of charcoal as a fuel has remained relatively constant and at a low level, in comparison to other energy forms. These points to the fact that deforestation has primarily taken place as a result of changing agricultural practices, leading to some instability of watershed slopes.

Jamaica depends on surface and underground water for its supply of potable water. Water pumped from wells or collected from rivers undergoes treatment at a number of plants throughout the island, is stored in reservoirs and then distributed to the public. Monitoring of water quality is carried out by the National Water Commission's laboratory as well as by the Ministry of Health. Salinity levels, as a result of sea—water incursion, have been detected in a number of wells, and this has resulted in closure of those wells. Nitrate pollution has also caused closure of several wells, particularly on the plains of Kingston and St Catherine. Traditionally, septic pits have been used for the disposal of sewage, but because of the nitrate pollution, there has been an effort to enforce building of sealed septic tanks in areas not served by sewage plants to minimize the pollution of potable water from well systems.

Table 3.2.

LAND USE AND FORESTRY AREAS (1989 AND 1998): STATIN

Land Use	1989	1998
Built up land	531	523
Buildings/other infrastructure	519	523
Bauxite land	12	49
Agricultural land	4 150	4 026
Fields	2 732	2 745
Plantations	831	823
Other agricultural land	587	458
Other non—forest areas	136	136
Bare rock	9	9
Small islands	2	2
Herbaceous wetland	109	109
Water	17	16
Total non—forest land use/cover	4 817	4 734
Forest	3 429	3 402
Land Use	1989	1998
Bamboo	28	30
Mangrove	98	97
Land Use	1989	1998
Closed broadleaf	887	882
Disturbed broadleaf	1 812	1 786
Short open dry	121	121
Swamp	24	23
Tall open dry	421	420
Pine forest plantation	50	43
Mixed land use/cover	2 708	2 828
Jamaica (Forestry Dept.)	10 964	10 964
Scale discrepancy	27	27
Jamaica (Survey Dept.)	10 991	10 991

IV. RISK EXPOSURE TO NATURAL HAZARDS AND DATA SOURCES

Jamaica, as a result of its setting within the Caribbean basin, is prone to numerous specific natural hazards (Figure 4.1a). Recent hurricanes experienced within the last few years (and in fact since 1988 with hurricane Gilbert), have reminded us of Jamaica's great vulnerability to hurricane effects. It is envisaged also that a large earthquake could do considerable damage to sectors of the population and to infrastructure and could result in displacement and homelessness among large sections of the population, particularly in the highly urbanized areas of the Kingston Metropolitan Area (KMA). The strongest recorded earthquake was the 1692 event which destroyed Port Royal, at that time the commercial capital of the country. The last major earthquake occurred nearly a century ago in 1907. This earthquake had an estimated magnitude of 6.5, with an epicentre just five miles inland from Buff Bay on the north–east coast. More recently, in 1993, there was another moderate earthquake with epicentre in the hills above Kingston. This event had a magnitude of 5.4. In addition, regular flooding events associated with troughs and frontal systems are known to affect people and communities right across the island. Finally, even though Jamaica has not in recent times been affected by a major tsunami, there is some risk of occurrence of this type of phenomenon, as a result of submarine landslides either at the island coastline, or from submarine features further away. Tsunamis were reported from the 1692 and 1907 earthquakes. Within a regional context, the following figure (Figures 4.1b) provides an indication of the primary causes of fatalities from natural disasters and also, the islands where most of these have occurred. Over 6,000 people have lost their lives in the Caribbean over the last 30 years due to natural disasters. In the Greater Antilles, these have been primarily due to hurricanes, floods and earthquakes.

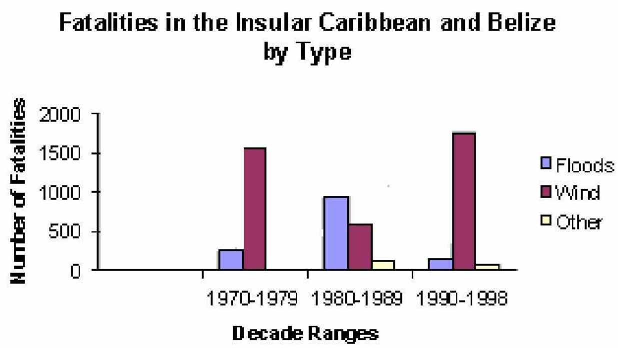
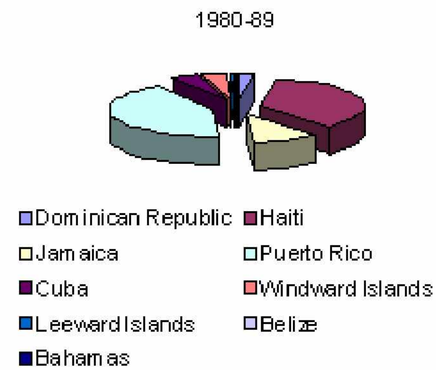


Figure 4.1b

FATALITIES IN THE CARIBBEAN AND BELIZE BY TYPE AND COUNTRY



1. Flooding

A flood can be defined as an abnormally high stream flow, which overflows the natural or artificial banks of a stream or river. In general, four different types of flooding have been known to occur. These are:

a) Flash Floods. These often result from heavy rainfall or cloudbursts over a relatively small drainage area. These types of floods are most common in mountainous areas. Flash floods are difficult to forecast.

b) Riverine Floods. These generally result from large amounts of rainfall falling in river systems with tributaries that drain large land areas. Riverine floods can last from a few hours to days depending on the intensity, amount and distribution of rainfall.

c) Land Based Flooding. Some land areas can be subject to large amounts of rain in a short time. Depending on slope angle, soil porosity, shape and size of the river basin or catchment area and state of deforestation, this can lead to land–based flooding, which can be exacerbated by obstructions in the drainage channels.

d) Ponding. Ponding of water is known to result from a slow build up in depressions, sinks, and areas with soil substrates having a clay base and/or slow percolation rate.

a) Causes of Flooding in Jamaica

Large–scale flooding in Jamaica has most frequently been caused by overflow of rivers, or ponding and overland flow from rising underground water. The floods of 1986 and 2001 are examples of the former, while the floods of 1979 and 2002 (in the parish of Manchester) are examples of the latter. Flash flooding has also been known to occur in the upper reaches of major rivers such as the Rio Grande, Rio Cobre, Rio Minho and Wagwater. In urban settings, severe inundation of streets and communities often follows heavy rains due to blocking of drainage channels by solid waste, and the deteriorating condition of these drains.

b) Flood History

Floods are the most frequently occurring natural hazard in Jamaica, and are often linked with severe weather systems, frontal systems and troughs, and less often with hurricanes and storms.

The Disaster Catalogue at the Office of Disaster Preparedness and Emergency Management (ODPEM) contains written records of flood events in Jamaica that date back to the 19^{th} Century. The analysis presented following is based on information that has been taken from the catalogue for the period 1884–2000. Within this period, some 187 incidents of flooding are reported, however not all reports refer to a specific date or to an easily identifiable location. In addition, some pages of the catalogue are missing.

Figure 4.2 below shows the spatial distribution of flooding by parishes. From this figure, it can be seen that all parishes are affected by flooding, although some more so than others. The records show that Portland has experienced the greatest number of floods, closely followed by St Thomas, Clarendon, St Catherine and Kingston and St Andrew in that order. Manchester and Hanover receive the lowest number of floods.

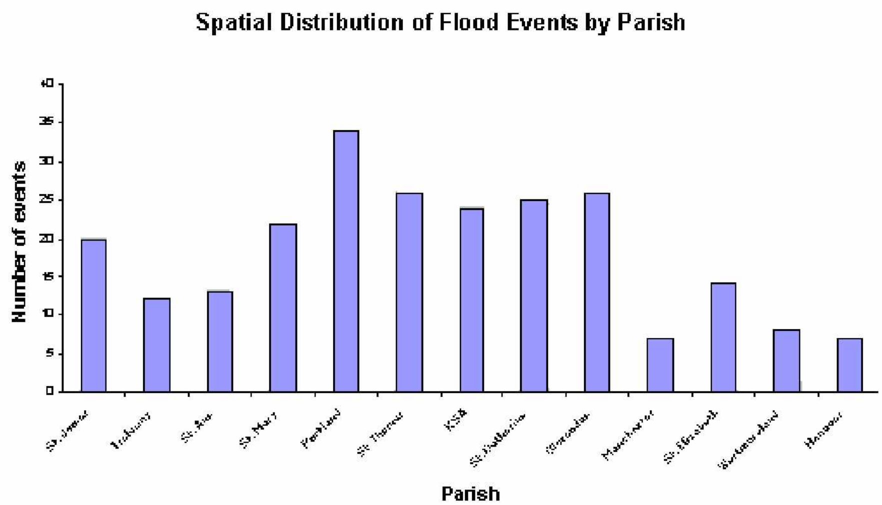
An analysis of those floods where dates have been recorded (Figure 4.3) reveals that the highest numbers of floods occur in October, with a secondary peak in May. September and November share the next highest number of floods. Surprisingly, the months of December and January have also recorded a relatively high number of floods, although traditionally these are dryer months. Floods in those months are usually associated with cold fronts and "northers" (systems associated with extra–tropical storms).

From the historical records, a large flood was noted to occur in 1886. According to the reports, water rose between 18 and 30 metres (60 and 100 ft) in the Cave Valley area. The loss of several bridges was reported in St Catherine and Clarendon, while Kingston also suffered damage. An estimated 162 cm (64 inches) of rain fell in Mandeville, said to be the highest monthly rainfall then on record in Jamaica. Despite the fact that the Rio Cobre rose some 7.5 metres (25 ft) at that time, it did not rise as high as in the floods of November 1874, according to accounts in the Disaster Catalogue.

In November 1909, the eastern end of the island (St. Thomas and Portland) was affected by heavy rains, which caused extensive damage to infrastructure. Reports are that outpouring of flood waters and sediment from the Yallahs River broke the submarine cable located off—shore. Another cable offshore Bull Bay was also broken. The loss of these cables meant that Jamaica was virtually "cut off from the world for several days". [1]

Figure 4.2

FLOOD DISTRIBUTIONS BY PARISH (1884 – 2000) [ODPEM RECORDS]



Although approximately fifty major floods have affected Jamaica since the 1880's, two of these have had significant, positive, long term effects.

On the night of June 12, 1979 intense rainfall, associated with a tropical depression, fell on the western section of Jamaica, resulting in the deaths of 41 persons, and affecting the parishes of Hanover, St James, Westmoreland, St Elizabeth and parts of Trelawny. An estimated 40,000

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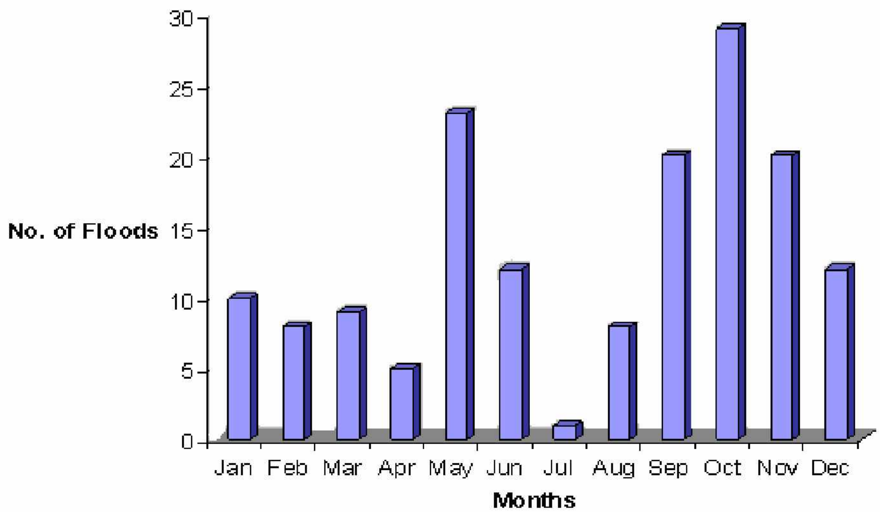
[1] Disaster Catalogue, ODPEM Offices

persons were displaced and there was extensive damage to agriculture, infrastructure, health systems and housing. Four weeks after the rains, several towns were still inundated with water at depths of up to 27 metres (90 feet), and residents had to be ferried by boat. According to O'Hara and Bryce (1984), [2] the rains resulted in damage to approximately 2,500 square kilometres, and affected 1,150 settlements and160,000 persons.

Figure 4.3

FLOOD DISTRIBUTIONS BY MONTH (1884 – 2000)
[ODPEM DISASTER CATALOGUE. RECORDS]



At the time of this flood, there was no national disaster management office in Jamaica. Following the floods, the Office of Disaster Preparedness and Emergency Relief Coordination (ODIPERC) was established in 1980, with the assistance of some international agencies. ODIPERC later evolved into the Office of Disaster Preparedness and Emergency Management (ODPEM), a statutory body established under the Disaster Preparedness and Emergency Management Act of 1993.

Another positive effect of that flood was the relocation of residents of Newmarket, which had been severely affected, to a new town, Lewisville, which was constructed above the flood level.

Unfortunately, Newmarket was allowed to remain intact, and today is again occupied, and continues to be affected by flooding.

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[2] June 1979 Floods in Western Jamaica: A Review of the Physical Effects and Analysis of Damage, Martin O'Hara and Roderick Bryce, 1984, Geological Survey Division.

The second flood that resulted in positive spin–offs occurred in 1985, when rains associated with hurricane Kate caused flooding in the central parishes of St Ann, Clarendon, Manchester and St Elizabeth. Five (5) persons lost their lives, and some 60,000 farming families in southern Clarendon were affected. In addition, there was damage to the road network, as well as loss of power and water supply in many areas.

Following the 1985 floods, the Government of Jamaica made a decision to address the issue of flood hazard. Again, international assistance was sought and the Flood Plain Mapping Project was started. This comprehensive project, which was implemented by the Water Resources Authority (WRA), encompassed flood risk mapping for eight major rivers, development of community flood warning systems and installation of an automated, real time flood warning system for the Rio Cobre River, as well as public awareness programs that were aimed at changing farming and environmental management practices. Even though the program has not continued to its full extent, some aspects of the program are still operating today, with the installation of community flood warning systems in several river basins and some ongoing flood hazard mapping of the 5, 10, 25, 50 and 100 year return period events. Presently, the Flood Water Control Regulation Act is to be revised, to enable the WRA to be able to complete the mapping of all major watersheds in Jamaica.

It is of interest to note that in 1986 between May 23 and June 6, intense rainfall again led to severe flooding in central Jamaica, with average water depths of 2.4 metres (8 feet) covering the central and southern plains.

Some areas experienced inundation depths of up to 4.6 metres (15 ft). This flood resulted in 46 deaths. Over 7,300 ha (18,000 acres) of crops were lost, and damage to roads and other infrastructure was extensive. The cost of damage (direct damage) was estimated at J$415 million (75.5 million dollars).

c) Flood Events in the Second Millennium

Since 2000 there have been a number of severe flood events that have caused dislocation of the population and disruption of economic activities.

From December 29, 2000—January 04, 2001, heavy rains associated with a frontal system caused flooding in Portland, St. Mary, Trelawny, St. Ann, St James, St. Catherine and St. Andrew. The most intense rainfall during that period occurred in Montego Bay, which subsequently experienced the worst effects. For the period Jan 1st and 2nd, 2001, 179.5 mm. and 124 mm of rainfall respectively were recorded at Montego Bay. Overflow of the South Gully inundated the town and caused flooding of many businesses. Houses in close proximity to the gully were also flooded. Damage for this event was estimated at approximately $J200 million (4.4 million dollars).

From October 28th to November 5th 2001, spiral bands associated with Tropical Storm Michelle (later hurricane Michelle), caused heavy rainfall over eastern Jamaica, with Portland and St Mary receiving the heaviest showers. Although the centre of Michelle passed between 550 and 600 km west of Negril, Portland and St Mary suffered extensive flooding as a result of the intense rainfall. Western Jamaica was also affected, as high seas caused severe damage to the coastline.

Photo 4.1

DAMAGE TO THE ABUTMENT OF THE SWIFT RIVER BRIDGE PORTLAND (NOVEMBER 2001)

Photo 4.2

ROAD DAMAGE IN BYBROOK—PORTLAND (NOVEMBER 2001)

The breakdown of damage by sector resulting from the November 2001 flooding was computed in accordance with the ECLAC methodology and is shown following in Table 4.1.

Total damage from this event was calculated at J$ 2,521 million, of which J$ 2,455 million was attributable to direct damage. This was an estimated 0.8% of GDP and 201% of exports at 2000 (Disaster Catalogue, ODPEM).

In 2002, between May 21st and June 4th, intense and prolonged rainfall over Jamaica resulted in severe flooding across the entire island. However, central Jamaica was most affected. Rainfall figures associated with the event showed that unusually intense rain had fallen in several parishes. A summary of these measurements is presented following:

Table 4.1

DAMAGE CAUSED BY HURRICANE MICHELLE [3]

Sector	Direct damage	Indirect damage	Total damage
Social Sector	249.4	10.9	260.3
Infrastructure	1679.9	6.9	1 686.8
Economic Sectors	525.6	49.2	574.8
Total J$m (Dollars)	2 454.9	67	2 521.9 (55m dollars)

i) St Thomas

- Cedar Valley received 4.4 times the 30 yr monthly mean. The 24hr rainfall for May 26, 250 mm, was 93% of the monthly mean.

- Sunning Hill and Serge Island received 109% and 139% of the monthly mean respectively.

ii) St Catherine

- Innswood received 6.3 times the monthly mean.

iii) Clarendon

- Osbourne Store received 6.3 times the monthly mean. Several stations in Clarendon, received more than 100% of the monthly mean in a 24hr period, these were:

    - Beckford Kraal–101%.
    - Trout Hall–184%.
    - Vernamfield–173%.

    - Osbourne Store–228%.

iv) Manchester

- Knockpatrick received 7.8 times the monthly mean.

Six deaths were attributed to the floods. The damage attributable to this event was calculated and is shown in Table 4.2 following.

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[3] Jamaica: An Assessment of the Economic and Other Damages caused by Hurricane Michelle, October 2001. ECLAC Subregional Headquarters for the Caribbean

Table 4.2

DAMAGE CAUSED BY 2002 FLOOD EVENT [4]

Sector	Direct damage	Indirect damage	Total damage
Productive sectors			
Agriculture, livestock	578 163 895	204 995 607	784 965 102
Fisheries			
Tourism	1 175 000		
Manufacturing, distribution		630 600	
Social Sector			
Housing	66 760 000	1 056 000	56 816 000
Health	32 792 000	10 050 697	42 842 697
Education	2 520 000	700 000	3 220 000
Infrastructure			
Transport	1 481 229 000	10 600 000	1 491 829 000
Telecommunication	4 459 000	——	4 457 000
Energy, electricity	——	1 170 000	1 170 000
Water and Sewage	48 700 000	30 000 000	78 700 000
Miscellaneous			
Emergency expenditure	7 616 033	696 000	1 457 603
Total J$ (Dollars)	2 122 414 928	259 898 904	2 472 313 832 (51.2m dollars)

Predictably, the intensity and length of the rainfall caused extensive flooding, with aquifers in Manchester showing increases of up to 90 metres. [5] The extent of that flooding event led the Government to declare five parishes as disaster areas. These were St Thomas, St Elizabeth, Manchester, Clarendon and St Catherine.

2. Hurricane risk

Every year between the months of June to November, the North Atlantic Basin becomes very vulnerable to tropical cyclones. Within this area, these storms are known as hurricanes. They are amazing natural phenomena characterized by high winds, waves, rainfall and surges. They affect both inland and coastal regions.

A tropical cyclone is classified as a hurricane only after it has attained one–minute maximum sustained near–surface (10m) winds of 33m/s or more. Below this, these storms are

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[4] Jamaica: The Macro–Socio–Economic Assessment of the damage done by Flood rains and Landslides, May 2002. ECLAC Subregional Headquarters for the Caribbean.

[5] Resurgence of Flooding at Porous–Harmons, Manchester. Water Resources Authority, November 2002

referred to as Tropical Storms. Hurricanes are commonly classified into categories according to the Saffir–Simpson Scale shown below in Table 4.3.

Table 4.3.

THE SAFFIR—SIMPSON HURRICANE WIND INTENSITY SCALE

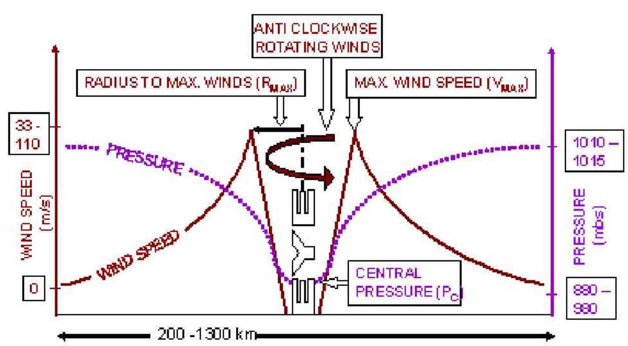
Category	1	2	3	4	5
Vmax (knots)	64–83	84–95	96–113	114–135	>135
Vmax(km/hr)	119–154	155–178	179–210	211–250	>250
Vmax(m/s)	33–43	44–49	50–58	59–70	>70

Figure 4.4 following shows a schematic of the characteristic components of a hurricane. These severe weather systems range in diameter from 200–1300 km. Winds in a hurricane increase from their lowest speeds at the eye (low–pressure centre) to a maximum, immediately beyond the eye. The wind speed then decreases gradually outwards from the eye. Of interest is the fact that winds in the right front quadrant of the hurricane are strongest because of the additional forward component due to the movement of the hurricane.

Two primary indicators of hurricane intensity are wind speed and air pressure in the eye. Half of all hurricane observations have central pressures of 980 mb or lower (James B. Elsner and A. Birol Kara, 1999). [6] Most hurricanes and tropical storms form approximately between the latitudes of 5°N and 25°N off the west coast of Africa, and then track westward across the Atlantic Ocean.

Figure 4.4

CHARACTERISTIC COMPONENTS OF A HURRICANE



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[6] Elsner, J.B. and Kara, A. B. (1999) *Hurricanes of the North Atlantic: Climate and Society.* Oxford University Press, New York, ISBN 0–19–512508–8.

a) Frequency of Occurrence

Hurricane records are archived at the National Hurricane Centre (NHC), Florida. Statistics from each hurricane season are recorded and logged to the overall database. These records date back to 1887, although more accurate and improved record keeping techniques became widely used after around 1950. In addition, with the advent of hurricane hunter aircraft and satellite imagery, it became easier to track the path, growth and decay of these natural systems, and to record their characteristics. Several of these measurements are now collected even in the eye of these storms. From a spatial perspective, the records over the past century show that a wide band of hurricane activity exists across the entire Caribbean and northwest Atlantic, with the least activity occurring in the area of Trinidad.

Computation and mapping of the number of tropical storms and hurricanes that have passed through 1° latitude by 1° longitude grids, and for a period dating from 1900 through to 2004, are mapped in Figure 4.5a for all tropical storms and in Figure 4.5b [7] for Category 1 to five hurricanes.

These diagrams show that Jamaica lies just outside of zones of significantly higher hurricane and storm occurrence. Nevertheless, based on the number of hurricanes shown in these figures, the island has been exposed, on average, to hurricane influences approximately once every 5–10 years.

A more detailed look at the characteristic of storms that have passed relatively close to Jamaica was carried out, using a Smith Warner International in–house program to select only those hurricanes from the NHC records that passed within 400 km of Jamaica. A listing of all such storms (Categories 1–5) is presented in Table 4.4 following.

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[7] Smith Warner International Ltd. 2004

Figure 4.5a

OCCURRENCE OF TROPICAL STORMS IN THE CARIBBEAN

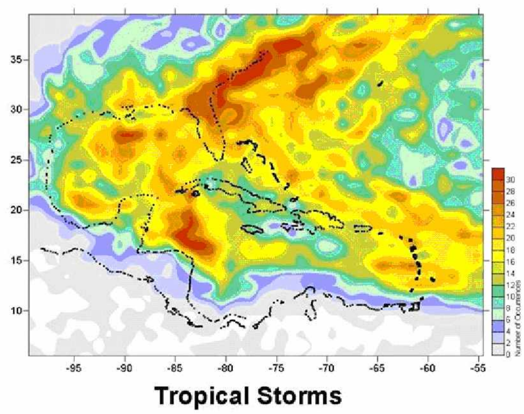


Figure 4.5b

OCCURRENCE OF CATEGORY 1—5 HURRICANES IN THE CARIBBEAN

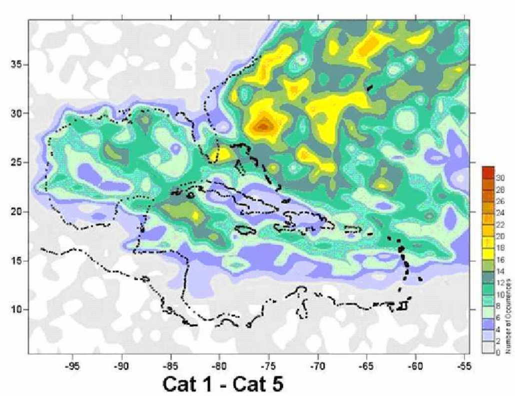


Table 4.4.

LIST OF HURRICANES BETWEEN 1900—2004 PASSING WITHIN 400 KM OF JAMAICA

N°	Name	Num	Date	Lon	Lat	mx Vmax (knts)	Cat	Dist (km)	Vtd (knots)	Pc (mb)	Pn—Pc (mb)
9	Not named 2 1903	611 022	8/11/1903 12:00	78	18.2	100	3	113.91	17.56		
14	Not named 4 1905	716 015	10/4/1905 18:00	77.3	15.8	70	1	248.02	7.25		
17	Not named 5 1909	764 016	8/24/1909 0:00	75.1	18.4	90	2	216.88	22.59		
10	Not named 2 1910	618 015	9/8/1910 18:00	74.2	18.1	70	1	312.96	12.23		
19	Not named 6 1912	801 028	11/18/1912 0:00	78.7	17.6	130	4	195.08	3.62		
11	Not named 2 1915	622 033	8/13/1915 12:00	78.2	18.8	100	3	161.1	13.07		
15	Not named 4 1916	726 016	8/16/1916 0:00	77.1	18	95	2	11.17	20.36		
20	Not named 6 1916	802 014	8/30/1916 12:00	75.1	16.2	85	2	292.35	16.58		
13	Not named 3 1917	677 012	9/23/1917 18:00	77.6	19.1	95	2	139.96	8.58		
8	Not named 19 1933	607 018	10/29/1933 12:00	77.9	17.8	85	2	102.98	3.63		
18	Not named 5 1935	779 01	10/21/1935 6:00	76	16.5	75	1	201.37	7.64		
12	Not named 2 1938	645 009	8/12/1938 0:00	76.8	16.8	70	1	135.89	24.44		
16	Not named 4 1944	749 015	8/20/1944 6:00	74.4	17.4	105	3	298.06	12.7		

/Continues

Table 4.4. (Conclusion)

No	Name	Num	Date	Lon	Lat	mx Vmax (knts)	Cat	Dist (km)	Vtd (knots)	Pc (mb)	Pn—Pc (mb)
3	Charlie 1951	138.022	8/17/1951 12:00	73.9	16.8	95	2	371.31	19.05		
4	Cleo 1964	161.018	8/25/1964 0:00	74.6	18.4	130	4	271.78	11.22		
2	Carmen 1974	115.011	8/31/1974 18:00	77.9	17.2	75	1	134.51	18.99		
1	Allen 1980	19.023	8/6/1980 0:00	73.8	17.8	140	5	358.14	21.54	945	68
5	Gilbert 1988	338.016	9/12/1988 12:00	75.3	17.6	110	3	195.08	16.44	960	53
6	Iris 2001	409.017	10/7/2001 6:00	75.3	16.9	75	1	226.18	16.65	991	22
7	Ivan 2004	422.035	9/10/2004 23:03	76.9	17.6	130	4	46.06	11.02	926	87

The table indicates that 20 hurricanes, ranging from category one to 5, have passed within a distance of 400 km of Jamaica over the 105 year period considered (this translates roughly to a frequency of one hurricane every five (5) years). Of these, there have been six Category 1 hurricanes, six Category 2, four Category 3, three Category 4 and one Category 5. Further, it can be seen that these storms have not been evenly spaced in a temporal sense. Between 1900 and 1917, nine of these hurricanes occurred. Again, five hurricanes occurred between 1933 and 1951. Between 1964 and 2004, a forty year span, only six hurricanes of note passed this close to Jamaica. This distribution indicates a cyclical nature to the occurrence of hurricanes near to a particular island, or, more likely, within the Caribbean basin.

Damage from these hurricane systems can occur as a result of storm surge, waves, wind and rainfall, with the approach characteristics of each hurricane system tending to bias the damage occasioned to one or two of these parameters.

b) Storm Surge and Wave Action

The storm surge phenomenon is comprised of numerous components. These include:

- The rise in water level as the low pressure in the “eye” of the hurricane pulls up the water beneath it;
- The effect of the hurricane winds pushing the coastal waters towards the shore;

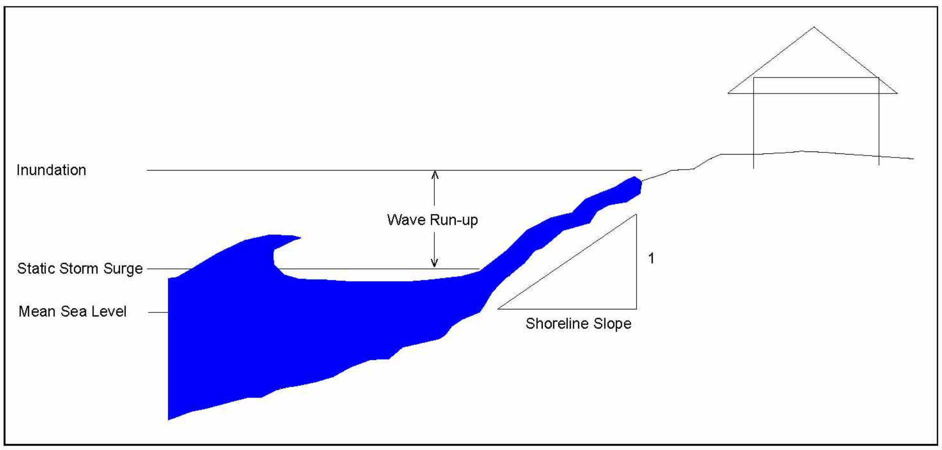
- An increase in the mean sea level as waves break in the surf zone;
- High tide occurrences during the passage of the hurricane; and
- Global sea level rise effects.

In addition to these quasi–static effects, there will also be wave run–up onto the shoreline, which is not defined as being a part of the storm surge, but is considered to be a dynamic effect causing a zone of temporary inundation.

A schematic diagram showing the quasi–static and dynamic effects is presented in Figure 4.6 following.

Figure 4.6

DEFINITION SKETCH FOR STORM SURGE AND INUNDATION



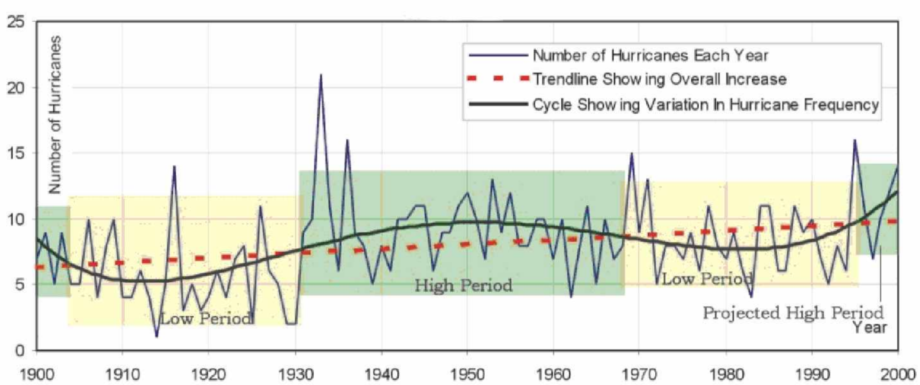
In Jamaica, there has been little or no island–wide mapping of storm surge and/or inundation limits. Storm surge mapping was done for Kingston and Montego Bay under the Caribbean Disaster Mitigation Project using the TAOS model, however these predictions require some degree of refinement, and they need to be interpreted with care. Recently, the Caribbean Institute for Meteorology and Hydrology (CIMH) in Barbados has provided estimated Caribbean–wide storm surge heights for approaching hurricanes using the TAOS model. ODPEM also does storm surge approximations for approaching systems using the Hurrevac program; however there is need for the entire coastline to be mapped at much higher levels of resolution. A storm surge assessment was also carried out for a significant section of the south coast of Jamaica, stretching from Kingston west to Savanna–la–mar. This work was done as part of an IDB sponsored South Coast Sustainable Development Study.

Other storm surge assessments, where they do occur, are usually carried out by the private sector on a site—specific basis, as part of the EIA process for development applications that must be vetted by the National Environment and Planning Agency (NEPA). It should be noted, however, that the Inter–American Development Bank (IDB) is funding a storm surge mapping project for the city of Portmore, adjacent to Kingston, and a part of the KMA. This mapping exercise is quite timely, as Portmore is potentially vulnerable to hurricane induced damage, and significant discussion has ensued in the past three (3) years in a public forum, as to this vulnerability.

One other point of interest relating to the issue of quantification of hurricane damage and mapping of the potential extents of damage, is the fact that latest research indicates possible cyclical trends that may, or may not, be due to climate change effects. A review of the historical hurricane data base [8] for the Caribbean region as a whole provides some insight to this issue, which is highlighted graphically in Figure 4.7 below.

Figure 4.7

MULTI—DECADAL TRENDS OF HURRICANE OCCURRENCE (SWI, 2002)



The diagram shows that for the 100 year period between 1900 and 2000, the number of hurricanes occurring each year has varied considerably. When a trend curve is superimposed onto this data, it can be seen that the data is characterized by approximately a 70 year cycle. In addition, there appears to be a trend of an increasing numbers of hurricanes occurring each year. Of interest is the fact that the data points to the commencement of a period of higher hurricane occurrences, which started in approximately 1995.

As is the case with storm surge mapping, little or no mapping of hurricane wave heights has been done for Jamaica. It should be noted, however, that it is possible to carry out near real–time prediction of hurricane wave heights, as these systems move past Jamaica. This was

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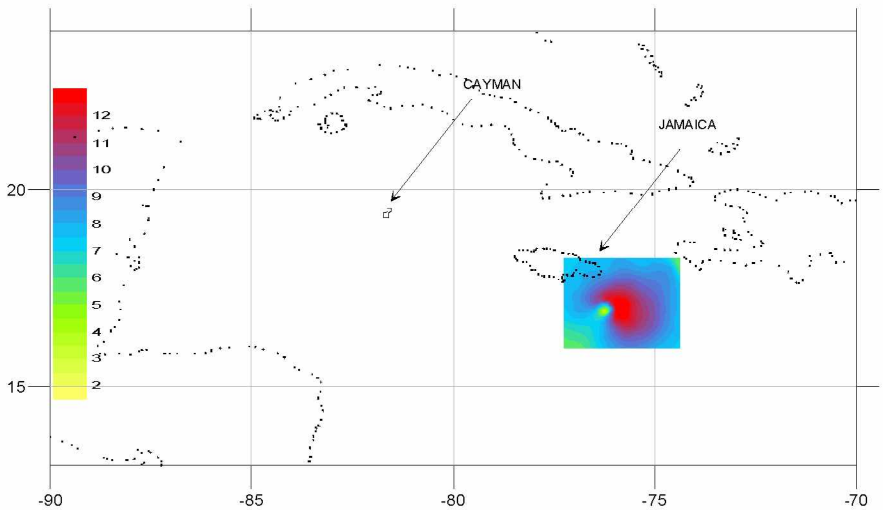
[8] Smith, D.A.Y., Warner, P.S., and Banton, J.D., *Long Term Variability of Hurricane Trends*, International Conference on Coastal Engineering, 2002.

done for hurricane Ivan in 2004, as it tracked past Jamaica. [9] An example of this wave prediction is presented in Figure 4.8, which shows the wave field around hurricane Ivan as it moved westward and south of Jamaica. This type of analysis allows for a preliminary assessment of the areas that are likely to be worst hit by surge from a passing hurricane, thereby providing a powerful management tool to an agency such as ODPEM.

Figure 4.8

HURRICANE IVAN WAVE FIELD SOUTH—EAST OF JAMAICA (WAVE HEIGHTS IN METRES, COLOUR CODED) [SWI 2005]



3. Seismic risk

Jamaica lies within a belt of seismicity that stretches from Central America south to Trinidad, and which defines the boundaries of the Caribbean Tectonic Plate (Figure 4.9 – orange dots show earthquake epicentres and green triangles show locations of volcanic activity). Jamaica's vulnerability to the earthquake hazard is a matter of historical record, given the 1692 Port Royal event and the Great Earthquake of 1907 that destroyed the city of Kingston.

The level of destruction that is likely to occur in any future major quake will be a function of the actual size of the tremor, the location of the epicentre, the geology of the areas affected and the quality of construction of the residential, commercial and infrastructural assets. The first two of

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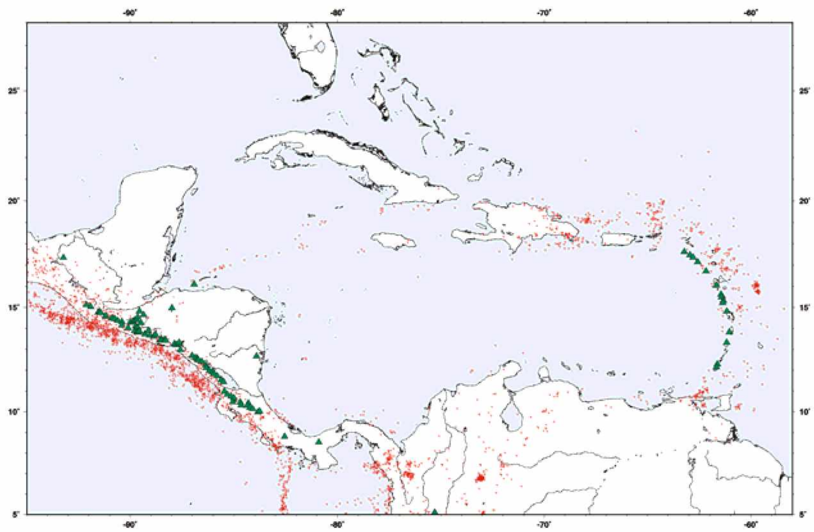
[9] Smith, D.A.Y., Warner, P.S., Jervis, G. and Banton, J.D., *Assessing Hazards and Vulnerabilities – A Caribbean Perspective*. Conference on the Solutions to Coastal Disasters, 2005.

these parameters are not controllable; however the degree of vulnerability of the society is a direct function of its investment in preparedness and mitigation.

Figure 4.9

LOCATION OF EARTHQUAKE EPICENTRES [UNECLAC]



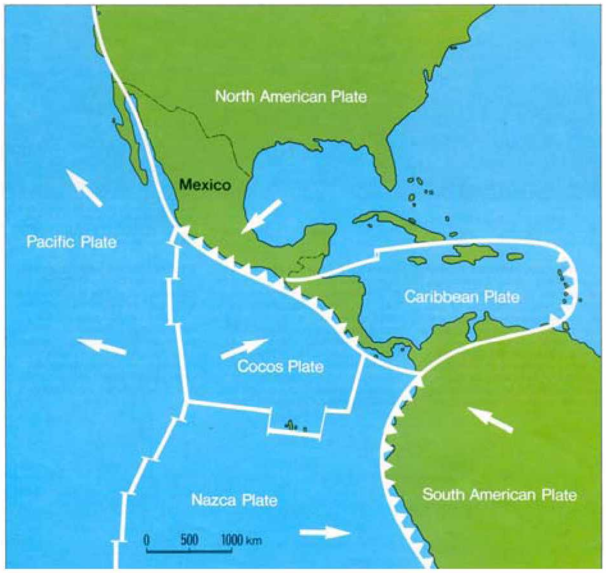
a) Earthquakes

Earthquakes are naturally occurring phenomena triggered by the movement along tectonic plates (Figure 4.10) and fault lines that unleash seismic energy in the form of both body waves and surface waves. In layman's terms, the former travel through the earths crust and are imperceptible to man, while the latter, as the name suggests, travel along the surface of the earth, displacing the ground as they proceed and this displacement or movement is what we feel. This tectonic shift can be small, as when a short section of the fault moves a small distance, thus generating a mild earthquake. Scores of these occur in Jamaica every year and are perceived only by the sensitive seismic receptors on earthquake monitors throughout the island and in fact the world at large. In other cases, the movement can occur over large distances, shifting perhaps several tens to hundreds of metres and generating powerful and destructive earthquakes.

The point at which the earthquake occurs is called the focus, and this is typically between five and 50 km deep below the ground surface, while the epicentre is the point on the earth's surface directly above the focus. In terms of size, earthquakes are measured by both Magnitude and Intensity. The magnitude is the actual physical strength of the quake, which is measured most commonly by the open ended Richter Scale. This was first developed in the middle of the last century. The magnitude measures the amount of energy released by the tremor and it is a logarithmic scale with an increase of one signifying a thirty–fold increase in energy.

Figure 4.10

TECTONIC PLATE BOUNDARIES IN THE CARIBBEAN AREA



Earthquake intensity on the other hand measures the earthquakes' effect at a particular location. The larger the quake, the greater the intensity given an equal distance from the epicentre, and equally the further from the epicentre the less intense the earthquake will be, all other factors (such as the geology) being equal. Several intensity scales have been developed but the most commonly used is the Modified Mercalli Scale. Intensity scales, because they are based on perceived effects of the tremor, have another utility in that they allow the approximate evaluation of quakes that occurred before the development of the Richter Scale. Thus, based on historical record, we are able to estimate the size of events such as the Kingston Earthquake (Tremor) of 1907.

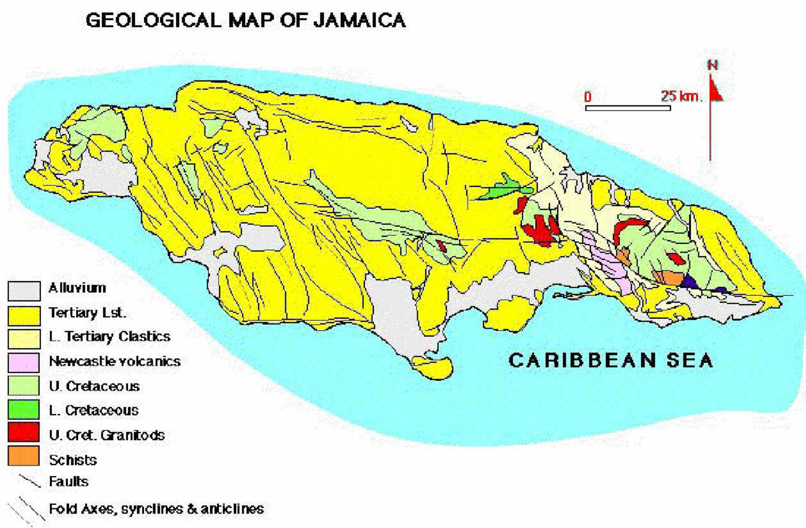
There is, however, some danger in such a practice, as it relies on the subjective perception of the writers of such historical record. In addition, it is necessary to take into account the changes in building standards that have occurred over time. It is for this reason that it is necessary to be wary of statistical analysis in terms of frequency of earthquakes of a particular size. That, coupled with the fact that historical records occupy typically less than one tenth of 1% of the geologic record, suggests that such analysis should be approached with a healthy dose of scepticism, and would be skewed towards more frequent events.

b) Geological Factors

In simple terms, Jamaica's geology can be divided into two sections. Referring to Figure 4.11. [10] Below, the western two thirds of the island is dominated by limestone and its derivatives (shown in yellow) for the most part, with alluvial plains (grey) and older cretaceous inliers (green) being the exception. The eastern third has some limestone also but in addition it has both sedimentary and igneous rocks derived from what is loosely called the Blue Mountain Massif. The two sections are separated by the large Wagwater Fault system that runs roughly from the Kingston Metropolitan Area (KMA) along the Wagwater River to St Mary. A look at the Geological Map of Jamaica will reveal hundreds of minor faults throughout the island with heavy faulting surrounding the KMA.

Figure 4.11

GEOLOGICAL MAP OF JAMAICA



Differing types of geology transmit the surface waves of earthquakes in different ways. Massive bedrock quickly dissipates the energy of these waves, while loose or unconsolidated material actually amplifies their effects. As an example, the Great Mexico City quake of 1985 had an epicentre closer to Acapulco but was felt more in Mexico City because that city sits on a "bowl" of clay that enhanced the destructive energies of the surface waves.

This suggests that the more vulnerable areas of Jamaica are those that are not founded on areas where massive bedrock occurs close to the surface, such as Mandeville in the mid–central

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[10] Map drawn by Gabi Gutierrez —Alonso Courtesy— www.fiu.edu/orgs/caribgeol/jamaica.

area of the island. Of concern here is the fact that the largest population centre, the KMA, sits on relatively loose soils (alluvium) and as such is at a heightened hazard risk. To aggravate matters, saturated soils, reclaimed land and organic rich soils (peat) are at even further risk because of their limited strength and tendency to failure under seismic loads (liquefaction). These latter type soils are all found in the major industrial, commercial and transportation areas of the country. In fact the harbours of both Kingston and Montego Bay are vulnerable, as is the Norman Manley International Airport and most of downtown Kingston, as these areas sit on large tracts of reclaimed lands. It is of crucial importance that these factors be taken into account in evaluating the ability of Jamaica to be rehabilitated in a timely manner in the event of a major earthquake, since if these essential sectors were to be damaged, the flow of relief aid and the reconstruction effort would be severely affected.

c) Building Codes

The magnitude of ground acceleration has been the subject of a study commissioned by the Caribbean Disaster Mitigation Project (CDMP) funded through USAID and the OAS. That report suggested peak accelerations of between 0.35 and 0.75g for the worst case and between 0.15 and 0.4 g for the best—case scenario, both with a 10% chance of having this limit exceeded within 50 years. Given these recommendations, it is of some relevance to compare this with the actual building codes that obtain in the country today.

Historically, Jamaica's building code was developed following the 1907 earthquake with the passing of the Building Act of the Kingston and St Andrew Corporation. That Act "provided regulations for the design and construction of buildings and even prohibited structures above 60 feet" (KMA Seismic Study Report). Given even those regulations, it was and must still be appreciated, that building technologies improved over the years and with them so did the codes applied to more modern structures.

The National Building Code published in 1983 included seismic loading recommendations that were based largely on the Structural Engineers Association of California (SEAOC), which recommended a peak acceleration of 0.3g with the same 10% probability of exceeding the limit within 50 years. Further research and adaptation of the Caribbean Uniform Building Code (CUBIC) suggested a similar application to that of the SEAOC recommendation. Finally, at the request of the Government of Jamaica, a Building Code Review Committee was set up and their report was published in 1993. Based on that report, the experiences of the January 1993 Woodford Earthquake and work done by Adams and Pereira, the latest revision has increased the level of ground shaking, for which buildings should be designed, to 0.4g, all other probability factors remaining the same. This however falls below the worst—case scenario suggested by the CDM study.

The Building Code is now undergoing another review with the input of the Jamaica Institution of Engineers. It is hoped that once the code is updated it will be promulgated.

Unfortunately, the establishment of a building code is only half of the equation. If regulations are not adhered to, either through ignorance, negligence lacks of enforcement or a combination of any or all of the above, then they are in some sense meaningless. The lack of enforcement can be due to corruption, budgetary constraints, or a combination of the two. The Parish Councils who are charged with enforcing these standards in rural communities simply do not have the resources to adequately staff their inspectorates with sufficient numbers of qualified people to not only review drawings but also to carry out physical inspections. In the absence of these on—site inspections, the structural integrity of for example a housing development may be compromised by negligence or simply an unscrupulous effort to save money, even though it has been suggested (anecdotal information) that the cost of including earthquake design features may be as low as 3% of initial construction costs.

As a result of ignorance and a lack of enforcement, large areas of the KMA presently have unregulated structures that are being constructed regularly. One needs only to look at the second storey “additions” to houses in areas such as Portmore to realise this. These structures often have limited reinforcement and inadequate foundations and generally have not had the benefit of engineering design. Thus the owners of these buildings are ignorant of the design codes and the hazard risk that they are exposing themselves and their families to. Sadly, it is the poorer sector of the society who is most likely to be affected by these circumstances.

In conclusion, the seismic hazard risk faced by Jamaica in general and the KMA in particular is real. Despite the statistical limitations inherent in the risk analysis, the country can expect a Magnitude 7 earthquake in the future, although how near in the future is beyond science at the moment. This tremor, if close enough to the vulnerable communities in the eastern part of the island, and in particular to the KMA, will be aggravated by unfavourable geology and will cause widespread damage to structures that have not adhered to the building codes for a variety of reasons. Given the above circumstances, combined with the poor state of the nations’ accident and emergency services, including its hospital network, the possible loss of life and the economic cost of the property damage could be overwhelming. On the positive side, most residential structures constructed within the last thirty to forty years are of reinforced concrete blocks with lightweight roofs. This renders the probability of catastrophic collapse at least of single storey structures, somewhat less.

4. Landslide hazards

Next to floods, landslides are the most frequently occurring hazard for Jamaica. Slope instability results from a combination of geological, climatic and anthropogenic factors. Weathered rocks, steep slopes, intense rainfall and clearing of land and cutting of slopes for development make landslides an ongoing problem. The National Works Agency records show that the cost of clearing landslide debris and constructing retaining walls has been between J$230 to J$400 (4m to 7m dollars) million per year since approximately 2001.

Two major north–south corridors which link Kingston to the north coast are routinely closed due to landslides occurring after any major flood event, sometimes requiring weeks of rehabilitation. In addition landslides also disrupt water distribution systems (through loss of pipes) as well as power supplies (through loss of poles).

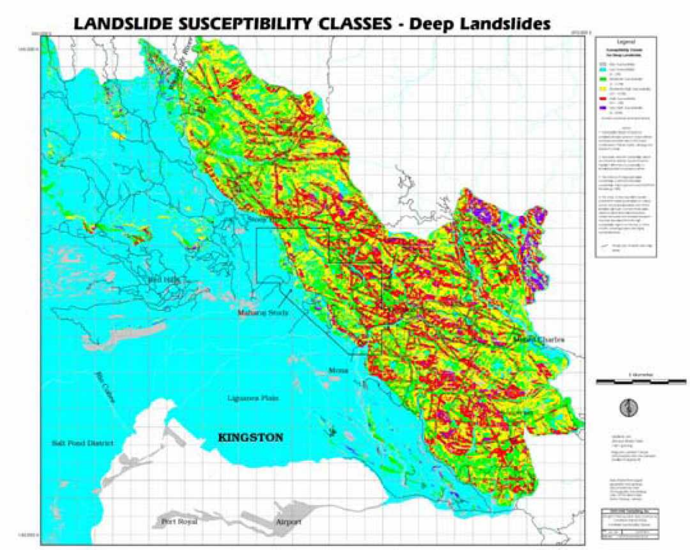
Entire communities have also been devastated by landslide action. In the mid–late 1980’s for example, the community of Preston Lands was affected by landslide activity, which destroyed the school, roads and farm lands. Most residents had to leave their homes and relocate elsewhere. In another community–Askenish–landslide susceptibility mapping was used to guide the relocation of residents to safer areas at the onset of landslide activity. This proactive approach proved the value of hazard mapping, as the areas to which persons were relocated were not affected by subsequent landslide activity.

Recognition of the landslide threat has led to landslide susceptibility mapping of the worst affected parishes by the Mines and Geology Division of the Government of Jamaica, and the Unit for Disaster Studies of the University of the West Indies. These maps show the areas that are most susceptible to landslides, and, along with other hazard maps, are used to guide technical agencies in the development approval process

One such map showing the landslide susceptibility of the hills immediately to the north of the KMA is given in Figure 4.12 following. What can be clearly seen is the extensive landslide susceptibility in this area.

Figure 4.12

LANDSLIDE SUSCEPTIBILITY MAP FOR NE JAMAICA (MINES AND GEOLOGY)



5. Tsunami hazard

Tsunami events appear to be very infrequent around the coastline of Jamaica. From a historical perspective, the effects of a tsunami were recorded on the shoreline of Jamaica on November 1,

1755. That tsunami had maximum observed amplitude of six metres, and an estimated return period of greater than 200 years. The source of this tsunami was Lisbon, Portugal.

More recently, on January 14th 1907, a tsunami was observed on the shoreline of Kingston, where the main damage occurred. The available historical record for this event does not list the height of water attained, or the strength of the tsunami. [11] In summary, however, the occurrence of tsunami on the shoreline of Jamaica is considered to be a rare event.

6. Summaries of natural disasters

A summary of disasters that have affected Jamaica since 1900 is given in Table 4.5 below. It is recommended, however, that the numbers be treated with some caution, as they do not appear to include some known events. In addition, the categories *Windstorm* and *Flooding* are expected to include the effects of hurricanes, although the data is not presented in this manner.

7. Sources and quality of data

A search of the literature relating to hazards, risks and vulnerability for the Caribbean in general and Jamaica in particular, indicates that there are at this time over 300,000 relevant references. Within Jamaica, the most extensive references relating to these topics are to be found in the ODPEM library and at the Caribbean Disaster Information Network (CARDIN). Regionally, the office of the Caribbean Disaster Emergency Management Agency (CDERA) houses several of these references.

Two reference documents from this reference list are described here. The first, "A Bibliography of Natural Hazards in the Caribbean", 2001, is published by CARDIN and sponsored by ECHO and OAS/USAID. This document focuses on publications that have originated within the Caribbean region and in particular those which may have been authored within the University of the West Indies. The hazards covered by this document include flooding, landslides, earthquakes, hurricanes, volcanic activity and drought. Comprehensive listings of those references that are specific to Jamaica are given in Appendix I. This reference document was developed through a regional cooperative effort, with contributions from the varied Caribbean disaster organisations. The references presented are in the form of research papers, books, theses, articles in journals, papers presented, technical reports, etc.

The second reference is noteworthy as it attempts to quantify the country's progress in risk management. It is entitled "Measurement of Disaster Risk and Disaster Risk Management in Jamaica: Indicators of disaster risk and risk management: program for Latin America and the Caribbean: Summary Report— Omar D. Cardona, July 2005."

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[11] Deane, C., Thom, M., Edmunds, H. "Eastern Caribbean Coastal Investigations (1970–73); Volume II–Natural Forces". 1973.

Table 4.5

SUMMARY OF NATURAL DISASTERS IN JAMAICA FROM 1900 TO 2005

	N° of events	Killed	Injured	Homeless	Affected	Total affected	Damage (Dollars)
Drought	3	0	0	0	100 000	100 000	6 000
Avg. per event		0	0	0	33 333	33 333	2 000
Earthquake	1	1 200	0	0	90 000	90 000	30 000
Avg. per event		1 200	0	0	90 000	90 000	30 000
Epidemic	4	46	0	0	300	300	0
Avg. per event		12	0	0	75	75	0
Flood	13	767	0	53 422	845 290	898 712	1 262 740
Avg. per event		59	0	4 109	65 022	69 132	97 134
Slides	1	40	0	0	0	0	0
Avg. per event		40	0	0	0	0	0
Windstorm	23	574	225	99 420	1 224 516	1 324 161	1 793 912
Avg. per event		25	10	4 323	57 572	57 572	77 996

Created on Nov—14—2006.—Data version v06.06
(Source:"EM—DAT: The OFDA/CRED International Disaster Database, www.em—dat.net—Université catholique de Louvain—Brussels—Belgium")
*Events recorded in the CRED EM—DAT. First Event: Jan/1900, Last Entry: Oct/2005.

In this report, Jamaica's progress in disaster risk management was evaluated using a set of indices developed by Cardona et al. Specifically, Jamaica's performance was measured as part of a study involving Latin America and the Caribbean. The results are summarized in the 2005 report quoted above.

The study examined a number of indices, one of which was a Risk Management Index (RMI) that was designed to assess risk management performance. The index is presented as a qualitative measure of management based on a set of desirable targets. The national index seeks to measure the distance between the actual risk management status and the desirable status. The RMI is the average of four composite indicators —Risk Identification, Risk Reduction, Disaster Management and Governance and Financial Protection.

These composite indicators were further sub–divided as follows:

a) Risk Identification

- Systematic inventory of disasters and losses
- Hazard Monitoring and forecasting

- Hazard evaluation and mapping
- Vulnerability and risk mapping
- Public information and community participation
- Risk management training and education

b) Risk Reduction

- The extent to which risk is taken into account in land use and urban planning
- Management of river basins and environmental protection
- Implementation of control and protection techniques prior to hazard events
- Relocation of persons living in disaster–prone areas and improvements to housing in these areas
- Updating and enforcement of safety standards and construction codes
- Reinforcement and retrofitting of public and private assets

c) Indicators of Disaster Management

- Organization and coordination of emergency operations
- Emergency response planning and implementation of warning systems
- Supply of equipment, tools and infrastructure
- Simulation, updating and testing of inter–institutional response capability
- Community preparedness and training
- Rehabilitation and reconstruction planning

d) Governance and Financial Protection Indicators

- Decentralized organizational units, inter–institutional and multi–sector coordination
- Availability of resources for institutional strengthening
- Budget allocation and mobilization
- Existence of social safety nets and funds
- Insurance coverage and loss transfer strategies for public assets
- Housing and private sector insurance and reinsurance coverage

The period used for calculation of the RMI was 1985–2000. According to the study, Jamaica made adequate progress in identifying risk. Further the country showed very strong improvement in the disaster management area in the mid 1900's to 2000.

Detailed results of the evaluation carried out are as follows:

Risk Identification

Year	Index
1985	12
1990	34
1995	40
2000	53

Risk Reduction

Year	Index
1985	11
1990	30
1995	30
2000	30

Disaster Management Index

Year	Index
1985	54
1990	50
1995	55
2000	60

Financial Protection and Governance

Year	Index
1985	13
1990	35
1995	36
2000	36

Risk Management Index

Year	Index
1985	22
1990	38
1995	40
2000	45

The authors of the report consider that although good progress has been made, the country has not yet reached a level close to that desired. Of the 11 countries studied in Latin America and the Caribbean, Jamaica ranked third behind Costa Rica and Chile in the Risk Management index. According to the authors, the probable effectiveness of risk management in most countries does not surpass sixty percent, and most countries average 20%–30%. The RMI given however is not related to this average or the 60% mark. The indices show that for the 15 year period leading up to 2000, Jamaica made progress in all areas of risk management which were measured.

A third document of note is the "Disaster Catalogue" which is available at the ODPEM Offices. This unpublished catalogue documents hazards and disasters which have affected Jamaica over the past three hundred years. Many accounts are taken from journals, newspaper clippings and Government departmental reports. As such, it may be difficult to verify the accuracy of some reports. Nevertheless, it is a valuable historical record.

It should also be noted that ODPEM has compiled reports on hazard impact events which document the cause of the event, its effects, level of damage and the response to the incident.

An overview of these varied reference documents provides some insight into the adequacy, quality and accessibility of reference data relating to natural disaster risk applicable to Jamaica In addition, it is useful to note the likely users of this data. These typically will include decision makers within Government of Jamaica agencies, who will wish to access the data and recommendations in order to consider them for use in the context of national planning initiatives. Then, it is to be expected that the disaster managers at ODPEM will require access to these data in order to assist in developing pre–, during and post–strategy plans. This latter data use will rely more on an analysis of historical events, and on the documentation of models that have been used to predict the likely extent of impacts resulting from the various hazard scenarios. When combined with a sound knowledge of the socio–economic characteristics of threatened areas, then the risk profile of these communities becomes evident. Finally, the reference data is of interest to the scientific community, who is primarily responsible for the investigation of these natural hazard phenomena, their extents and likely impacts. It is important, therefore, that this latter group be made aware of the requirements of the first two.

In terms of the available database therefore, first, it is clear that there is abundant data dealing with this issue, which have been produced over the years by researchers throughout the region. In many instances these documents have been produced by UWI scientists, or by personnel attached to regional or national disaster management agencies. In other cases, investigations carried out by engineers or practitioners in the disaster management and risk reduction arena has added to this vast body of work.

Second, it is necessary to speak to the quality of these many reference documents. Largely due to the fact that these documents have been produced through research initiatives, or as commissioned studies, the quality of the data appears to be quite rich. In many cases, the conclusions presented and the observations made have had the benefit of being supported by actual events. It is in fact evident, that following the occurrence of each natural hazard event, a number of papers and theses have been produced dealing with the pre, during and post stages of these events.

Finally, with respect to the accessibility of these data, it can be seen that in the Jamaican context, the central storage locations are primarily at ODPEM and at CARDIN. These institutions are both located in Kingston and are therefore readily accessible to Government agencies, etc. One point of note, however, is that the library at ODPEM could benefit significantly from having a metadata base of all reports incorporated into an electronic format, and/or the documents themselves being copied to microfiche. As an example, attempts to obtain the results of a public risk perception survey, carried out by ODPEM in 2000, proved futile, as no one in that organization, including the library personnel, were aware of the whereabouts of this document.

8. Perception of risk

As indicated above, surveys have been carried out by ODPEM in 2000, to obtain a representative sampling of the public perception to risk. Unfortunately, it was not possible to obtain a copy of that document as it was not in the library system. Nevertheless, there are some observations that can be made relative to the perception of risk in Jamaica. These are outlined following:

- With respect to flooding, the data shows that there have been regular and extensive floods over the period of record, in a variety of locations throughout Jamaica. In some instances, many of the areas that have been affected appear to have suffered repeatedly as a result of heavy rainfall. In other cases, developmental inputs appear to have triggered a predisposition to flooding. In either case, the awareness of the public to these events is evident, as they are described in much detail after each occurrence in the visual and written media. In yet other instances, people who have been removed from flood prone areas have returned to these same locales, *in full knowledge of the risk faced.* The reasons for this may be economic, or may be due to a reluctance to relocate from a familiar area. In recent years a trend has been evident in which victims of flooding have either requested relocation or have agreed to relocation. The most recent example is that of hurricane Ivan in which residents of three coastal communities affected by storm surge agreed to be relocated inland. This major exercise involved development of new residential areas complete with infrastructure. It is clear that these residents have developed a full perception of the hazard, its possible effect (vulnerability) and the degree of loss likely to be experienced in the future (total) and have decided not to accept the level of risk involved in remaining at the vulnerable location.

- ODPEM's efforts at relocation over the years have shown that persons occupying rented, leased or illegally occupied premises are more willing to relocate than persons owning land (Carby, pers. Comm. 2006).

- For hurricanes, the latter half of the last century was initially characterized by a direct hit by hurricane Charlie in 1951. Between 1951 and 1980, there were two hurricanes (Cleo and Carmen) which came within 400 km of Jamaica. These hurricanes were accompanied by a lot of rain, but did not present as intense hurricanes. In 1980, an intense hurricane, Allen (Category 5), which tracked north of Jamaica, caused a significant amount of damage on the north coast (Photo 4.3). This damage was associated almost entirely with the phenomenon of storm surge and wave action, and raised the public consciousness to the risks associated with that particular hazard.

- Some complacency however appeared to have developed before that, because of the wide temporal gap in hurricane effects that occurred between 1951 and 1980. The hurricane, however, that completely raised the perception of risk for the present generation of Jamaicans was Gilbert. This was a relatively intense hurricane that affected all of Jamaica with hurricane force winds, rainfall and in certain locations, storm surge. As one example of the effect of this hurricane on the population, it was endowed with a personality and referred to in popular song. By the time of hurricane Ivan in 2004, people were much more aware of the dangers inherent in approaching hurricanes.

Photo 4.3

STORM SURGE DAMAGE TO TRIDENT HOTEL IN PORT ANTONIO (ALLEN, 1980)

- Perception of earthquake risk within the Jamaican population has been perhaps less acute than for hurricanes and floods, simply due to the fact that major earthquakes have been less frequent. The population in general is aware of the earthquake in 1692 that resulted in the submergence of parts of Port Royal. This however, is treated as an historical event. More recently, in 1907, there was also a major earthquake that affected the capital Kingston. Here again, even though this resulted in significant damage and disruption, there are very few Jamaicans alive today who would remember that event. In 1993, a relatively large quake affected Kingston, however, damage was limited. An ongoing public awareness program has, however increased public perception of this hazard. Of note is the fact that over one hundred businesses and companies participated in a 2006 earthquake drill for the New Kingston area, the heart of the financial and business district in the capital Kingston. It is evident that the participants recognised the risk of death and injury to staff and clients posed by ignorance of what to do in an earthquake, and the importance of preparing staff and clients for this eventuality. The high level of participation of schools in Earthquake Awareness Day activities also suggests an understanding of the threat posed by the hazard, even if the risk to the schools has not been quantified. The activities for this day in 2005 attracted more than 5,000 children of various ages. More recently, a simulation exercise was held in the KMA by ODPEM, to coincide with the 100th anniversary of the January 1907 earthquake. A scenario was prepared for simulation, which was characterised by a 6.5 magnitude earthquake (on the Richter scale) occurring at shallow depth with epicentre located near Buff Bay in the Wagwater Belt. The earthquake was considered to last for 30 seconds, with aftershocks occurring for some time. Damage was reported to have been recorded in the parishes of Kingston, St. Andrew and St. Catherine. The simulation revealed many weaknesses in the Search and Rescue aspect of the disaster response mechanisms, which point to the need for training of emergency personnel in this area. Snapshots of the simulation exercise and the initial findings were broadcast on national television, thereby helping to raise the perception of exposure to risk from this hazard. Internally within ODPEM, a post–scenario briefing was conducted to analyze the thoroughness of the exercise and to examine the lessons learned, in order to be able to act on these findings in the event of future actual earthquakes. In summary, there is a lack of experience of actual earthquake events in Jamaica due to the infrequency of this hazard, but there is a level of awareness that has been generated through public awareness activities and through the staging and publicizing simulation events from time to time.

V. THE DISASTER MANAGEMENT SYSTEM

1. The risk management structure

The management of *ex ante* and some *ex post* emergency planning issues is overseen primarily by the Office of Disaster Preparedness and Emergency Management (ODPEM). ODPEM as we know it was formed in 1993, as a statutory body under the Disaster Preparedness and Emergency Management Act. This office is run by a Director General, who reports to a Board of Directors. The office has four (4) directorates: Corporate Services; Mitigation, Planning and Research; Information and Training; and Preparedness and Emergency Operations. It is funded by budgetary subventions from the Government of Jamaica. However more recently, projects funded by donor agencies and the proceeds of a commercial arm of the agency (equipment rentals) have assumed increasing importance as budgetary allocations have decreased.

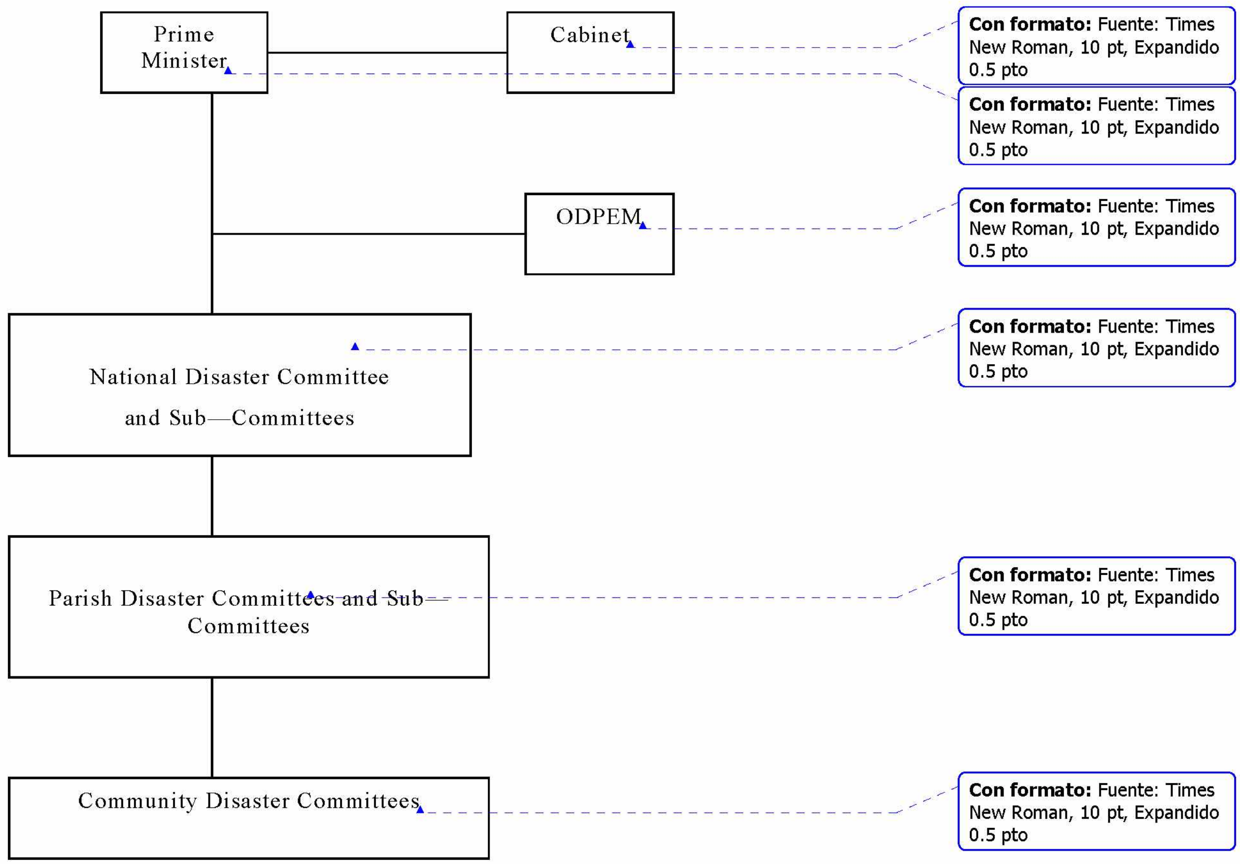
ODPEM's mandate covers more than disaster response, and includes preparedness, response, mitigation, prevention and recovery (although there is less focus on recovery in the mandate). The recovery phase of disaster response has most recently been handled by the Office of National Reconstruction, which was set up after hurricane Ivan. ODPEM falls under the Ministry of Land and Environment, but the Prime Minister is the chairman of a National Disaster Committee, of which ODPEM is the secretariat. The National Disaster Committee encompasses representatives from all relevant sectors. The Committee meets annually, in May, but its six sub—committees meet at a minimum once per quarter .These sub–committees are responsible for defining policy, ensuring that plans and procedures are in place and updated regularly, and reviewing and adopting methodologies for risk management by different organs of Government. They cover the areas of Health, Communications, Operations, Public Awareness, Mitigation, Recovery, Damage Assessment and Finance.

Each parish has a Parish Disaster Committee chaired by the Custos or Mayor and including Government, Private Sector and NGO representatives. The national system of sub–committees is therefore mirrored at the parish level. Below the parish level, some communities also have disaster committees called Zonal Committees, which link with the Parish Disaster Committees.

The national risk management structure can be represented by a line diagram as shown below (Figure 5.1a shows the administrative structure, while Figure 5.1b shows the operational).

Figure 5.1a.

NATIONAL DISASTER MANAGEMENT STRUCTURE (ADMINISTRATIVE)

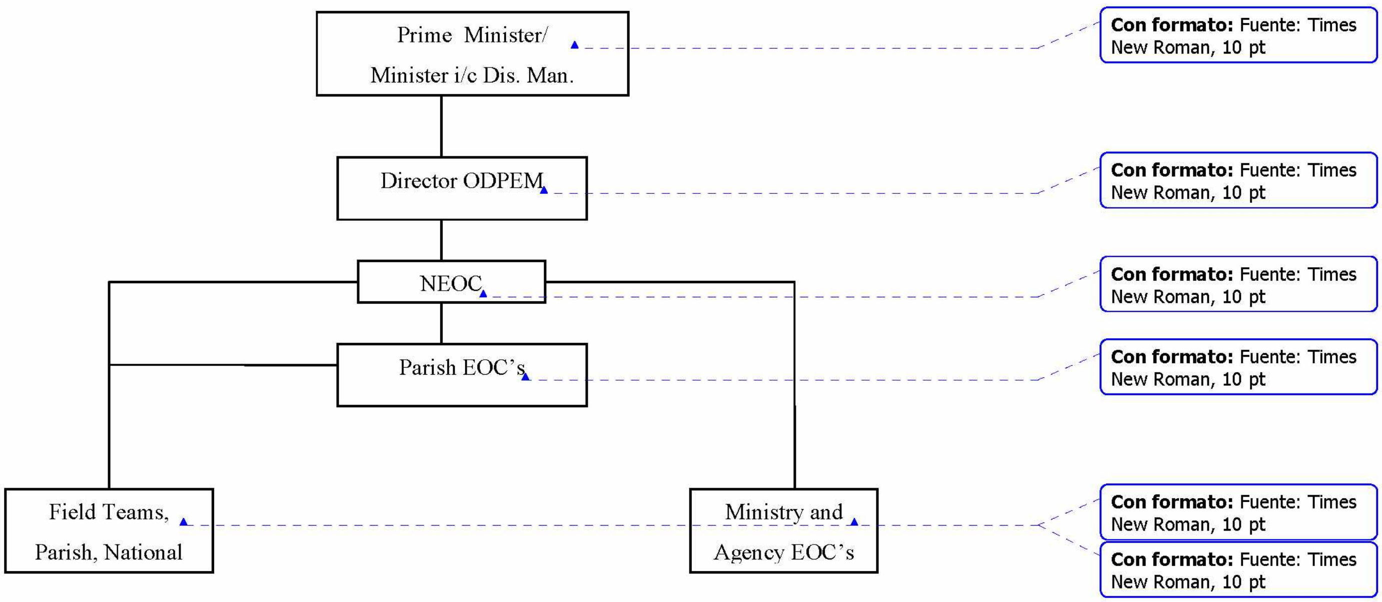


One of the operating constraints of ODPEM pertains to the fact that the present Disaster Management Legislation does not give ODPEM any legal authority for enforcement. The agency therefore uses a system of goodwill and moral suasion. It should however, be noted that a review of the legislation is now being undertaken.

The Director General has suggested that an optimum structure would be to have an ODPEM office in each Parish. This could be staffed by one person having a first degree in the Natural, Physical or Social Sciences.

Figure 5.1b

OPERATIONAL STRUCTURE



In addition to the national office in Kingston, the agency has regional offices in Montego Bay; Mandeville; Kingston; and Port Maria; staffed by one Regional Coordinator in each regional office. However, there is a lack of technical capacity at the parish level. Part of this reporting chain includes the Parish Disaster Committees, which are responsible for disaster management in their parishes. Under the National Disaster Plan, they have primary responsibility for events affecting less than 20 families. For events affecting over 20 families, assistance will be given from the national level (ODPEM). Some parishes are able to discharge this mandate, whereas others do not. In addition, parishes should be able to carry out their own preparedness and mitigation programs as the parish councils have some autonomy and responsibility for approving building plans, development applications and road and drainage network maintenance. In reality, few parishes carry out strategic and operational planning exercises related to disaster management. It should be noted, however, that the employment of trained physical planners by all parish councils has provided the opportunity for the parish councils to develop a more integrated approach to hazard management.

The optimum operating structure would however, be to have an ODPEM staff member in each parish, rather than in each region. This person would provide much–needed technical support to the Parish Disaster Committee, as well as be able to oversee and implement ODPEM's in–parish programs.

Under the present structure, ODPEM has a limited number of middle–managers, which appears to negatively affect their ability to carry out work. An organisational review was scheduled to start in November 2005. This review is expected to result in the restructuring and strengthening of the organisation.

a) Policies and Plans

The National Disaster Plan is a comprehensive document setting out mitigation, preparedness, response and recovery procedures for a variety of hazards, both natural and man–induced. There are also functional plans for evacuation, communications, mass casualty events, aircraft accidents, pandemics, pest infestations, etc. A Hazard Mitigation Policy details the Government's policy in this area.

At the parish level all parishes have a parish disaster plan, though they do not all update these annually. Some communities also have community plans. This initiative is ongoing through ODPEM and the Jamaica Red Cross, with the target being that all communities should have disaster plans and trained teams. Communities with the highest vulnerability to flooding have been targeted first.

ODPEM has encouraged all Government Ministries and agencies as well as the private sector to develop contingency and continuity plans, and runs workshops on continuity planning, which are well supported by the Private Sector.

2. Mitigation, preparedness and prevention

Following are some strategies that are used by ODPEM to promote mitigation, preparedness and prevention.

- Mitigation strategies are aimed at promoting hazard and risk mapping and vulnerability assessments, and incorporating hazard and risk maps in national development and physical planning. In order to facilitate this, funding has been sought for flood and landslide mapping, as components of projects which include establishment of flood warning systems as well as community mitigation interventions.

- As part of the Development Approval process, NEPA, or any Parish Council, will submit development plans to ODPEM for review. NEPA submits plans of nine lots and over, and the Parish Councils submits those of fewer than nine lots, where these are planned for high risk areas. ODPEM makes recommendations for mitigation measures or for non–approval. Environmental Impact Assessments (EIAs) are required by law for sensitive and/or major projects, and hazard impact analyses are required as part of the EIA report. These are also passed to ODPEM for review.

- ODPEM does have a GIS system and a full time person (CUSO volunteer) who works in this area. It is assessed that the cost of maintaining this GIS system, including staffing, would be J$3 million per year (50,000 dollars). The agency plans to integrate GIS technology into all its operations. So far, mapping has been done for specific hazards only. Themes that have been partially mapped in GIS include:

  - Hazards: flooding, land slide, storm surge, seismic (epicentre locations)
  - critical facilities (in progress)
  - drainage systems (in progress)

- Sensitization of parishes to the importance of hazard mitigation techniques, and the transfer of knowledge and skills to these communities.

- Hazard maps prepared under ODPEM's projects are presented to the local authorities (Parish Councils) for their use. ODPEM has also embarked on a program of workshops for planners employed to the Councils, on the integration of hazard maps into the Parish development planning and approval process. Communities are also sensitised to the importance and use of these maps.

- ODPEM does damage assessment reports for extreme events. This practice has been discontinued since the adoption of the ECLAC methodology, which represents a more comprehensive assessment of the economic impact of an event. However the agency continues to do reports on each event, documenting the experience and lessons learnt as well as areas for improvement. In addition, plans and procedures are updated based on events. The ECLAC methodology is used by the national damage assessment team, and is applied whether or not an ECLAC mission is requested. ODPEM also carries out non–structural vulnerability analyses for private sector interests as part of a wider program of encouraging business preparedness and continuity planning in the private sector.

- Further to what has been stated above, it should be noted that there have been three ECLAC training missions in Jamaica and three damage assessments. As a result of this, the application of the ECLAC methodology has been institutionalized within ODPEM and other relevant Government of Jamaica agencies such as the Planning Institute of Jamaica (PIOJ).

- Advocacy and support of other agencies.

- The role of advocating for appropriate risk management practices is one of the most important carried out by the agency. This is done through presentations to policy —level groups, including the National Disaster Committee, presentations and papers delivered at conferences and workshops and organising multi–sectoral national level conferences (National Disaster Management Conference).

- In addition the agency supports the efforts of a variety of organisations by, *inter alia*, identifying funding for multi–agency projects, sitting on a variety of committees and providing technical inputs such as document reviews.

- ODPEM is putting in a Communications Network with radios in each parish.

- During the response to hurricane Ivan, most emergency communications were done by cellular and fixed line phones. Although the phone networks proved to be fairly reliable, there is need for a national emergency radio telecommunications system. There are plans by the Government to introduce an island wide digital network, which would be shared by all the emergency response agencies. However funding has not yet been identified to achieve this. In the meantime, ODPEM is establishing a VHF network which will provide radio communications into most of the island.

- The preparedness program also includes maintaining the national emergency stores in Kingston as well as regional stores at ODPEM's regional centres. In addition, parishes are encouraged to maintain parish stores. These emergency stores contain supplies such as bedding, lighting, tents and water containers, which are usually required in the immediate post—impact period. Food stocks are not maintained, as food is acquired from the private sector under Memoranda of Understanding which include credit arrangements.

- An updated shelter list is maintained and shelters are inspected by a multi–agency team before June of each year. As there are no purpose–built shelters, public schools and community centres are designated as shelters.

- It is worthy of note that since hurricane Ivan, the PDC's and Committees have been more sensitised to the issue of disaster preparedness. As a result, the data collection and response mechanisms for hurricanes Dennis and Emily in 2005 were much better than with hurricane Ivan the year before (2004).

- Hurricane Ivan did much to sensitise the country to the need for disaster preparedness and the capacity to mount quick and efficient responses.

- Since Ivan, the Parish Disaster Committees have improved their response capacity. The reporting and passing of data and information to the national level from the parish level has shown a marked improvement in 2005 over 2004.

- A program of community flood warning systems were started by ODPEM in the 1980's under the World Meteorological Organisation (WMO) funded Flood Plain Mapping Project. Under this project, the Aenon Town community was given the skills to forecast and respond to floods threatening their community. The program has continued through various projects supported by donor agencies. The program has now been expanded to include: flood and landslide hazard mapping by the Water Resources Authority (WRA) and the Mines and Geology Division (MGD); training of community teams in basic search and rescue techniques and first aid; community hazard mapping; contingency planning; and shelter management. Maps produced by the WRA and MGD are given to the parish councils for use by the parish and communities.

- The move to a hazard management approach to community interventions has the added advantage of exposing several agencies and communities to the importance of an integrated approach to hazard management. The project teams include the WRA, MGD, Meterorological Services, National Works Agency, Fire Brigade, Red Cross, and Social Development Commission as well as Parish Disaster Committees.

3. Public awareness programs

Public awareness and education are important aspects of the national risk management program. ODPEM targets all sectors of the population, providing information on the major hazards affecting the country. The inhomogeneity of the target population requires the use of different strategies and approaches. These include:

a. Marking of anniversaries of major events —the opportunity is taken to focus on the threat and how to reduce or prevent its impact via exhibitions and the electronic and print media

b. Interventions in schools —carrying out earthquake and fire drills, sponsoring competitions and giving talks to students

c. Staging workshops and seminars for private and public sector organisations on contingency planning, continuity planning, vital records protection

d. Sensitisation lectures and talks to all who make a request. The target is to respond to 100% of requests for talks, lectures and community meetings and so far this has been achieved

e. Training of community groups

f. Assisting organisations in development of their disaster plans

g. Assisting private and public sector organisations to carry out drills and simulation exercises to test their plans

h. Promoting development of family disaster plans and a high level of individual preparedness

Learning from disasters in other countries and incorporating the lessons learnt into the public awareness program

There is a program for persons with disabilities in which ODPEM runs special workshops in conjunction with the disabilities association. These workshops aim to give persons with disabilities the information they need to protect themselves and their households. They are also encouraged to register with the Parish Disaster Committees.

4. National forecasting, warning and alerting systems

The ability to forecast the impact of hazards and to warn the population in time is critical to saving lives and reducing damage to property. The national forecasting, warning and alerting agencies are an integral part of the risk management structure. The primary monitoring, forecasting and warning agencies are the National Meteorological Service, the Earthquake Unit and the Water Resources Authority. These agencies monitor conditions related to weather, seismic activity and floods, respectively, and maintain close links with ODPEM.

The landslide susceptibility mapping done by the Mines and Geology Division and the University of the West Indies, though not providing warnings in the strictest sense, do provide information which is used to alert communities to the risk of landslides during heavy rainfall.

Once a threat is detected, the agencies will notify ODPEM, which has the responsibility of:

i) Alerting the National Response Team (NRT) and the National Disaster Committee, and

ii) Advising the public of the threat, as well as which measures should be taken to safeguard life and property. All Parish Disaster Committees are alerted as part of the NRT, as are community disaster management teams. ODPEM activates the National Emergency Operations Centre based on the forecasts of the NMS.

Forecasting capacity for floods is more limited as lack of real–time reporting rainfall intensity and stream flow gauges does not permit the WRA to provide forecasts for flooding except for the Rio Cobre River, which has an automated flood warning system. For this river, rainfall data is tele–metred into the WRA, permitting warnings to be issued ahead of time. In general, however, the possibility of flooding has to be based on predictions of rainfall levels and knowledge of previous flood conditions.

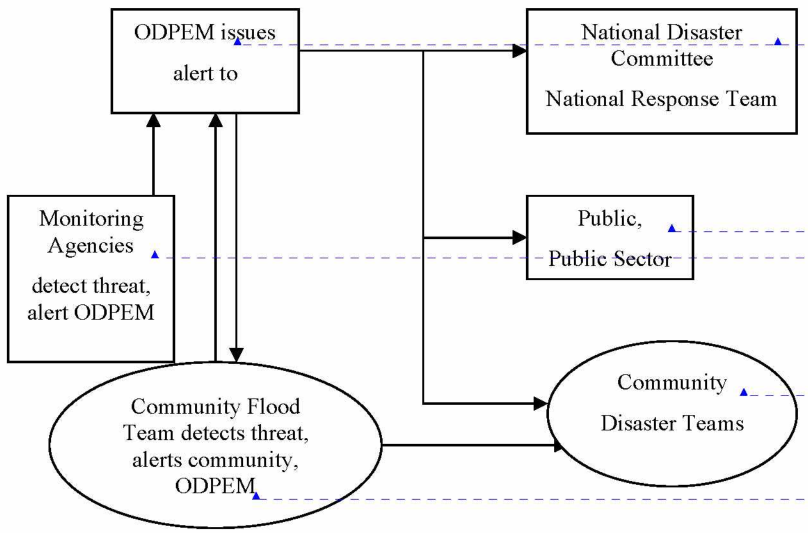
ODPEM's public alerts are issued as news releases which are carried by all media houses. The releases are also posted on the ODPEM website.

Community flood alert teams also provide important forecasting and warning services to the communities in which they operate. These teams are responsible for monitoring staff gauges which measure river levels. Once a critical level is reached, the teams alert the community so that measures can be taken to protect the residents. The teams also relay information back to ODPEM on the level of flooding and effects on the community. ODPEM will also alert the flood alert teams if the possibility of flooding exists.

There is no reliable method for forecasting earthquakes. The Earthquake Unit provides twenty–four hour monitoring of seismic activity for Jamaica, and relays the location of earthquake epicentres to ODPEM, usually within a few hours of the earthquake occurring. The unit also provides information on the seismic hazard, including return periods for earthquakes of given magnitudes and location of active faults.

Figure 5.2

NATIONAL WARNING AND ALERTING MECHANISM



Media houses in Jamaica are privately owned. However they exhibit a high level of cooperation with ODPEM in ensuring that alerts and warnings are relayed to the public in a timely manner. In addition to reading news releases, they provide time for interviews by ODPEM personnel without charge. This access to the electronic media has resulted in a high level of awareness of hazards and applicable precautionary measures among the population.

a) Response Operations

The National Disaster Plan sets out procedures, roles and responsibilities for response operations. Parish Disaster Committees are responsible for developing and maintaining parish plans. ODPEM is responsible for coordinating the response to national threats and emergencies. Coordination is carried out from the National Emergency Operations Centre (NEOC). Located at ODPEM's Kingston headquarters. Parishes also set up Parish Emergency Operations Centres (PEOCs). EOCs are staffed by emergency managers, as well as representatives from fire, police, health, transport, utilities, public works, NGOs and other agencies as necessary. In addition, for major threats, ministries, agencies and NGOs will set up their EOCs which liaise with the NEOC.

Once a threat is detected, ODPEM is responsible for deciding if and when the NEOC will be activated, and will advise the parishes to activate their EOCs. For localised threats, parishes will activate their EOCs as necessary and advise ODPEM. The NEOC can be activated at either Level one or Level two depending on the nature of the threat. For Level one activation, the NEOC is staffed by ODPEM staff, whereas for Level two activations the NEOC is staffed by a full multi–agency team. The staffing of the NEOC permits management of any crisis, and the composition of the team is adjusted to the particular threat. Private Sector representatives from the utilities and communications sectors are also part of the NEOC Team.

Functions of the NEOC include:

i) Pre–Impact

Alerting and call–out of National Response Team including parishes
Alerting of community teams
Issuing warnings to the nation
Issuing precautionary advice
Directing opening, staffing of shelters
Organising pre–positioning of supplies, equipment
Organising activation of PEOCs
Ensuring availability of communications

ii) During Impact

Coordinating rescue, medical assistance
Issuing advice to the public
Updating the nation

iii) Post–impact

Immediate impact assessment and creation of national needs list
Coordinating rescue
Coordinating rehabilitation
Management of shelters as well as displaced population outside of shelters
Coordinating ongoing damage and impact assessment
Coordinating needs assessment
Coordinating international assistance
Receiving and tracking supplies – local and international
Issuing regular updates via media, websites

b) Coordination of Relief

There is a well developed Welfare and Relief Policy and Plan which guides relief assessment and distribution. The plan speaks to accountability and transparency issues. In order to reduce overlap, duplication of efforts and gaps, assistance to the affected population after any disaster is managed at the parish level. National and Local Government representatives and NGOs comprise the Parish Welfare Team which carries out assessments, distributes relief and reports back to the national level. Supplies are distributed from the NEOC to parishes based on their assessments, and parishes are responsible for maintaining a distribution and recording system. All relief received should be signed for at every level. Signed lists are returned to ODPEM. Rehabilitation grants are usually provided after major events. For these grants field teams assess each claim, by inspecting the affected premises, and assessing the level of loss. A recommendation is made for the level of assistance. Government and NGO resources are combined to achieve the goal of assisting the affected population. This integration of NGOs into the relief system increases efficiency and adds a level of transparency to relief operations.

Relief can also include economic support for vulnerable families. After hurricane Ivan, female–headed households and household with young children were assisted with grants for food and school books and uniforms. Households which had lost their means of earning an income were given bridging grants while crops were re–planted or tools–of–trade were replaced. In addition to relief through ODPEM, the Ministry of Agriculture makes grants available for farmers and fisherfolk whose livelihoods have been affected by disasters.

In order not to compromise the viability of local businesses in the aftermath of a disaster, it is the Government's policy to purchase food and other needed supplies locally, wherever possible. This also has the added benefit of reducing transportation costs.

c) Coordination of the International Community

The role of the International Community is recognised in the National Disaster Plan, and major donor partners are invited to attend meetings of the National Disaster Committee.

At the start of the hurricane season, the international community is briefed as to the state of national preparedness. Once there is a major event, the Ministry of Foreign Affairs and the UNDP are co–chairs of meetings with the International Community. This includes embassies, missions, and donor agencies. Information exchange is achieved through regular briefing meetings convened at UNDP Headquarters. At these meetings situation updates are given, the official needs list is presented and donors make their pledges. Any assistance received is noted and efforts are made to coordinate external agencies which want to participate in response. The link between the international community and the NEOC is maintained through the Director General (Figure 5.3).

d) Rehabilitation

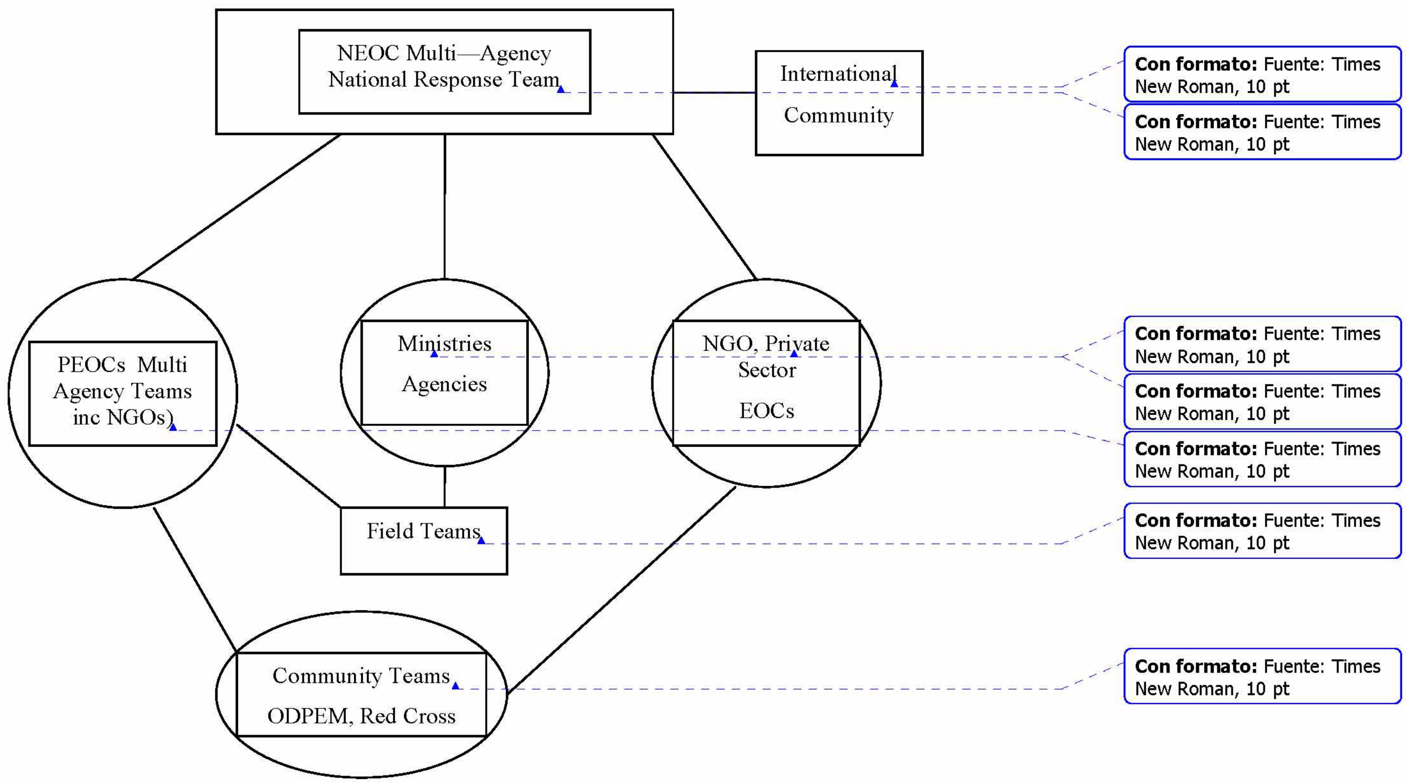
All post–impact emergency activities are coordinated by the NEOC. There are standing procedures which govern rehabilitation of critical services. For example, hospitals receive priority attention for road clearance and reconnection of power and water supplies after any disaster. Shelters are also given high priority. Decisions on which routes are to be cleared first are made from the NEOC, which ensures coordination among the utility companies and road clearance so that there is agreement on priorities.

In cases where piped water is interrupted, water is trucked to the affected areas.

Close collaboration with the Ministry of Health ensures regular inspection of shelters and increased surveillance of environmental and public health parameters. Health requirements, including monitoring and vector control supplies are included in the national needs list.

Figure 5.3

EMERGENCY MANAGEMENT ORGANIZATIONAL STRUCTURE



e) Recovery

Recovery operations for limited impact events such as localised floods are managed by ODPEM. In the past this has included relocation of affected families, provision of housing units (in cooperation with an NGO), mitigation interventions and hazard mapping. Because of the widespread effects of hurricane Ivan, an Office for National Reconstruction (ONR) was established to guide the recovery process. Recovery operations post–Ivan included relocation of three communities, repairs to schools and health facilities and road reconstruction among other activities.

The relocation of communities was necessary because of major damage incurred from storm surge. Lands for relocation were subject to hazard analysis by ODPEM and other technical agencies prior to being approved for relocation. Housing units constructed had to meet basic code requirements for small dwellings.

The established systems and procedures worked well in the response to hurricane Ivan. The major difficulties encountered were related to lack of capacity at parish level, which led to interruptions in information flow back to national level and late reporting. There were also instances of departures from the established procedures, which caused some dislocation and delays in relief distribution. The positive outcome was that lessons from Ivan were taken on board by the Parish Disaster Committees, resulting in significant improvement in responses to later threats.

5. Government policy on risk financing and risk transfer

The Government of Jamaica does not have a policy of Risk Transfer. Rather, Government assets are, for the most part, uninsured. This culture is changing, as many Statutory Bodies and Executive Agencies do insure their property. The fact remains however that as a policy, the Government assumes its own risk.

There being no adequate risk management fund, resources for response are provided from funding diverted from ongoing programs. In addition, there is no dedicated funding for risk reduction, thus perpetuating the vulnerability of national assets to natural hazards.

There is a National Disaster Fund (NDF), however, which was started in 1989, after hurricane Gilbert. The fund reached a maximum of J$21 million. However, the present standing of this fund is at about J$5M (approximately 80,000 dollars); as this fund was drawn down on after hurricane Ivan in order to fund the coordination of the relief efforts. ODPEM was able to double the value of the fund, which started at J$4 million, through investment management. Had regular contributions been added by the GOJ, the fund would now be at a significant value.

There are indications that the GOJ is examining the matter of disaster funding, as the Minister of Finance recently received a grant from the Government of Japan to examine the feasibility of establishing a Caribbean Catastrophe Fund.

VI. ECONOMIC IMPACTS

1. Background

Large catastrophic events like hurricanes have direct costs as they lead not only to large losses of capital stock and inventories but also indirect costs in lost income, employment or services which result from lost productive capacity. These events jeopardize internal and external macroeconomic stability leading to larger than anticipated public sector and balance of payments deficits. For example, the direct effects of hurricane Gilbert on Jamaica in 1988 amounted to 956 million dollars, representing 27% of GDP, with half from losses in agriculture, tourism and industry, 30% in housing, and 20% in economic infrastructure. As a result of the hurricane, losses in export earnings were estimated at 130 million dollars, representing 14% of exports, and the Government incurred 220 million dollars in additional expenditures while the public sector deficit increased from an earlier expected 2.8% of GDP to 10.6%, also fuelling inflation.

GDP growth performance in 2004 was less than originally forecast by the Government of Jamaica (GOJ). In the first two quarters of that year, economic activity grew by 2.7% and the economy was on target for a moderate improvement over growth performance of 2.3% in 2003. However as a result of hurricanes Charley and Ivan in the third quarter, real income growth for the year fell to 1.1% (see Appendix II for details on macro–economic impacts of hurricane Ivan). Also, as a result of hurricane–related expenditure, there was some slippage in GOJ's fiscal targets. Nevertheless, initiatives aimed at maintaining macroeconomic stability were successful. Exchange rate depreciation was moderate and inflation climbed marginally into double digits. Also, the Bank of Jamaica was able to keep interest rates on a downward path. The current account balance of the Balance of Payments (BOP) deteriorated as a result of a substantial increase in import expenditure related to increased investment and consumption and rising oil prices. Nevertheless, the overall balance in the BOP moved into surplus as a result of capital inflows, leading to further accumulation in net international reserves.

2. Sectoral analysis

a) Agriculture

After expansion of 4.7% in 2003, agriculture output contracted by 11.5% in 2004 as a result of the impact of drought conditions in the last quarter of 2003 and the devastation wreaked on the sector by hurricanes Charley and Ivan in the third quarter of 2004. Losses in the agriculture sector due to hurricane Ivan were estimated at J$8.55 bn, approximately 1.9% of GDP. Following a decline in production in the first half of the year, domestic agriculture (vegetables, legumes, fruits and ground provisions) which accounts for approximately 60% of agricultural output, lost close to 30% of acreage under cultivation. Output of export crops, with the exception of sugar, also declined sharply. hurricane Ivan totally destroyed banana production in the third quarter. Substantial losses, estimated at J$2.1 bn, were also experienced in the coffee, cocoa and citrus sectors.

b) Tourism

Due to the impact of hurricane Ivan, cruise ship arrivals declined by 2.9% in 2004, compared to a growth of 30.9% in 2003. There was modest growth of 1.3% in total visitor arrivals in 2004, compared to growth of 16.5% in 2003. Visitor expenditure rose by 6.4% to 1,437 mn dollars.

c) Mining

Mining activity continued to grow buoyed by increased demand for alumina driven by the upturn in world economic activity in general, but particularly in China. Mining activity grew by 3.3% in 2004 (slightly less than the 3.3% in 2002 and the 4.9% in 2003), and the value—added in the mining industry increased by nearly 10% during the first half of 2004. Total bauxite production in the first half of 2004 increased by 7.6% compared to 3.9% during the corresponding period in 2003. Alumina production rose by 10.7% compared with growth of approximately 4% in the fist half of 2003. However, the third and fourth quarters witnessed a deceleration in growth performance in the mining sector as a result of the destruction of physical infrastructure by hurricane Ivan. There was a contraction of 56.5% in bauxite production and growth of 4.9% in alumina production in the fourth quarter.

d) Manufacturing

Value–added in manufacturing expanded by 3% in 2004, following declines of 0.8% in 2002 and 2003. A major contributor to this growth was the re–opening of the oil refinery which had been temporarily closed in 2003 for major repairs. The refinery was closed again for repairs in the third quarter of 2004. Third quarter production in the manufacturing sector was also constrained by power outages, inadequate water supplies and transport bottlenecks as a result of hurricane Ivan.

e) Construction

Driven by reconstruction and rehabilitation efforts post hurricane Ivan, construction activity expanded by 3.2% in 2004, following growth of 2.4% and 1.2% in 2002 and 2003 respectively. Growth was also fuelled by a number of large projects in the road, seaport and hotel sectors.

3. Prices and inflation

Hurricane Ivan dealt a significant blow to the authorities' efforts to contain inflation within single digits and supply bottlenecks in the agriculture sector forced food prices upwards. The effects as at the end of the 3rd quarter 2005 saw inflation at approximately 17% up to that time, above the rate of 13.7% for the entire year in 2004, and above the single digit targets that were achieved during 1997 to 2002.

4. Financing of the public sector investment program (PSIP)

Given the lack of fiscal savings, GOJ has been very dependent on donors for financing for the PSIP. In part because of hurricane Ivan, grant funding increased substantially in FY 2004/05, rising to J$6.5 bn. (1.2% of GDP) from J$0.5 bn (0.1% of GDP) in FY 2003/04. This facilitated the significant rise in PSIP expenditure in FY 2004/05 to J$11 bn from J$5.7 bn in FY 2003/04. The remainder of the financing, J$4.3 bn was sourced through domestic and external loans.

Depending on the sources of financing for rehabilitation, in the long run the impact of disasters at the aggregate level can be positive, negative or neutral. Jamaica, for more significant events, may receive external financial assistance on a loan basis for rehabilitation of physical infrastructure, however for events such as floods, which may have a significant impact on the economy (due to significant impacts on agriculture), there may be negligible financial assistance provided.

For hurricane Ivan, the Jamaican Government used the ECLAC methodology to quantify the extent of losses to the economy. Excerpts of the assessment are outlined in Appendix II. The main critique of the users of the ECLAC methodology has related to the extensive data requirements of the model, which is extremely challenging to collect, especially after an event, and the time required in relation to the timing of offers for assistance.

VII. RISK TRANSFER

1. The property insurance market in the caribbean

Caribbean nations on the whole, are exposed to high levels of risk from natural disasters, primarily hurricane and windstorm risks, but also significant concentrations of earthquake, volcano, and flood risks. As part of a historical strategy to address the financial and economic impact of such risks, many Caribbean islands have successfully leveraged international insurance capital and have been able to transfer much of the risk, particularly for commercial but also residential properties, on to the international insurance and reinsurance markets. The same has not been the case, however, for public sector assets and infrastructure, many of which remain heavily exposed and implying large potential fiscal liabilities if natural catastrophes were to disable such assets.

Global catastrophes such as past hurricanes or earthquakes around the world generated significant reinsurance shortages in the early to mid 1990's resulting in dramatic rate increases in the Caribbean. During the mid 1990's, Caribbean countries experienced insurance rate increases between 200%–300% on account of shortages of insurance cover, due to indemnity payments made for large hurricane and earthquake losses worldwide. From a developmental perspective, this experience of market shocks discouraged prudent 'risk hedging' policies in the form of promoting wider–spread insurance practices both in the public and private sectors of the Caribbean. To illustrate, the average variation on typical catastrophe insurance rates in the Caribbean and internationally, within the past decade, fluctuated between 30% and 50%.

Perhaps due to the overly high dependence on the international insurance industry, the local industry of the Caribbean has not accumulated capital of its own to better 'buffer' international rate movements and achieve a more optimal mix of risk bearing capital, leveraging both domestic and international funds. The domestic insurance industries are generally highly fragmented which accentuates the relatively low levels of available risk capital in a significant portion of the industry.

Another area for development is the adoption of mitigation based pricing incentives since the lack of sufficient risk differentiation for pricing purposes tends to penalize those who have already undertaken productive vulnerability reduction measures. Welcome signs in the regulatory sphere include the tax deductibility of catastrophe insurance reserves in some countries, which help meet the objective of increasing risk bearing capacity.

Policy coverage restrictions are generally designed and imposed by foreign reinsurers, and their effect falls on the policyholders rather than on the insurance companies. Historically, there have been very mixed feelings as to the industry's role for a proactive involvement in promoting hazard and vulnerability mitigation measures. While not denying the inherent benefit of such measures, the insurance companies' concerns centre on the implementation complexities and costs, particularly as reinsurers are seen as unlikely to share in these costs. Most insurance companies view the leadership role for mitigation measures as residing with their Governments.

The insurance markets are intensively competitive for the property insurance classes–a competition primarily seeking reinsurance commission revenues rather than underwriting, or 'risk taking' profits. The larger Caribbean insurance markets contain insurance companies (with sizeable market shares), forming part of broader commercial groups. It is estimated, however, that several insurance companies are under–capitalized and markets are saturated.

2. Observations on Caribbean/Jamaican Market Characteristics

The year 2004 was one in which the insurance and reinsurance markets worldwide experienced severe losses in the Caribbean as a consequence of four major hurricanes. Assessed insured losses in the region have been put at 2.7 bn dollars with 30% being property damage and 70% being Business Interruption. These losses exclude the 2% deductible and the effect of the average clause for underinsurance.

In Jamaica the experience was: 7100 claims for 5.9 billion or 96 million dollars, which represents less than 2% of the total sums insured. Cayman estimates are close to 1.4 billion dollars which are in excess of 28% of the sums insured. The Jamaican experience showed losses were prevented by lessons learned in Gilbert about the importance of construction and hurricane straps to strengthen roofs. In comparison to damages sustained in Grenada and Cayman, which were a direct consequence of poor building construction, the majority of the property damage from hurricane Ivan occurred to properties that were either not insured or uninsurable. The latter were those edifices that continue to be built in low lying areas, riverbeds and other watersheds which are prone to flooding and land slides.

The proportion of residential and commercial properties in Jamaica covered by insurance is significantly higher than in most developing countries, on account of both the susceptibility to natural disasters but also on the influence of tourism and the requisite insurance of tourist facilities. Detailed figures for Jamaica are unavailable, but in comparison with the insurance density in United States (3.3% of GDP for the property and casualty business), the average for the OECS, Barbados and Trinidad and Tobago is 2.3% of the combined countries' GDP.

The number of general/property insurance companies in the Eastern Caribbean, however, is large. The ratio of premiums earned ($149 m.) to number of primary companies writing property business (numbering 145) is just a little over $1 million, i.e., the average premium written per company. In contrast, the average premium written per company in United States (2,500 companies in total), is $112 million or a multiple of one hundred times that of the Eastern Caribbean.

However, such a comparison may not be necessarily meaningful given the different levels of development and insurance markets and economies of scale. Nevertheless, if one takes the relative populations serviced by insurance companies, the results are: 14,000 inhabitants are served by each insurance company in the Eastern Caribbean versus 107,000 inhabitants in United States served by each company. This would suggest a potentially over–extended industry in the Eastern Caribbean which implies inefficiencies of scale in terms of both operating costs and risk management.

A significant share of companies, however, effectively function as agencies with little desire to operate as genuine risk underwriters. While most of the Eastern Caribbean countries do not admit non—registered insurance companies, the actual insured base in each country is likely higher than reported due to non–admitted providers. In those countries where non–registered companies are allowed to conduct business, large commercial and tourist properties are directly insured abroad.

Due to the non–reporting nature of these businesses at the Caribbean level, figures on this market are difficult to estimate although via the tallying of the total market value of insurable assets and comparison of these with the premiums collected annually, one could, by process of elimination deduce the quantity of assets insured directly abroad.

On average, 75% of the OECS market is held by Trinidadian and Barbadian companies (prior to reinsurance). Expense ratios in the Caribbean are relatively high, between 30%–40% of premium income compared to United States average expense ratio of between 26%–28%. Expense ratios reflect the costs of business acquisition, brokerage fees, underwriting fees, administrative costs and overhead as a percentage of annual premiums earned. In the Caribbean, due to the relatively small size of companies and diseconomies of scale, expense ratios constitute a higher percentage of annual premium income, despite the fact that administrative and staff costs are generally lower than in United States Such costs as well as low retentions of underwriting risks prevent a quicker build up of capital reserves/surplus, than could otherwise be achieved.

Some larger and special risk categories (e.g.: power utilities), have also over recent years found it impossible to obtain full, and in some cases, any, affordable insurance. On occasions such risks have voluntarily devised very high self–insured deductible levels aimed to cover the expected loss damage potential and separate self–insurance funding for business interruption. These risk management arrangements have served to attract greater levels of insurance/reinsurance cover for the higher, less exposed, risk levels. Furthermore, the insurance cost and availability difficulties have prompted trade associations (e.g. Caribbean Hotel Association–CHA), to employ risk management techniques and/or off–shore captive insurance company arrangements to buy reinsurance on a group basis.

3. Recent limited–basis pooling initiatives

For the most part, Government physical assets such as buildings, schools, libraries, roads, and some hospitals are uninsured or underinsured. Exceptions include properties owned by statutory corporations such as port and airport authorities, as well as utility companies that can independently access the insurance markets.

Utility companies in particular, in order to reduce insurance cost, have been actively considering a regional self–insurance program with the Caribbean Development Bank (CDB) and the Caribbean Electric Utilities Service Corporation (CARILEC). Although in the conceptual stage, the program's principal concepts include a backstop credit line in the initial years of premium accumulation. As the fund grows, the utility companies are expected to rely less on the line of credit until it eventually becomes a standby support to be used only after the fund is depleted because of claims arising from a catastrophe event at the uppermost loss levels.

In 1993, The Caribbean Hotel Association (CHA) retained a US–based risk management firm to perform a pan–Caribbean study regarding wind storm risks to its members' properties to see if there was some way of reducing the upward spiralling costs of insurance. The computer–generated wind study performed by a sub–contractor of the risk management firm provided a probable maximum loss profile of the region and divided the Caribbean into six different risk zones. The study suggested that there appeared to be enough diversification of risks among these zones to allow a regional insurance company for the CHA properties to survive a 1.3% probability of a major storm disaster event. Using the expected loss (EPL) information as the starting point, and based on their own financial modelling capabilities, the risk management firm determined a capitalization figure for a regional insurance company to sell 'all risks' property insurance to each of the 1,000 CHA or so members. The risk management firm then created, and today manages, a Bermuda insurance company whose exclusive clientele are members of the CHA.

A 1996 CARICOM working paper on Insurance suggested a regional approach between Governments and the Private Sector to enable the diversification of risk and a reduction on the reliance of the Caribbean region on the global reinsurance market. It also suggested that legislators throughout the region should adopt a consistent set of building codes as set out in CUBIC, to specify appropriate material specifications, the retrofitting of existing structures and use of protective devices for the region which to a large extent are exposed to similar perils. These specifications could then be used by Town planners, architects, builders, mortgage companies and insurance companies to ensure that future construction can work together to mitigate loss levels.

In a follow up to this working paper, the CARICOM heads of Government requested the assistance of the World Bank in establishing a risk insurance fund. On the 26th February, 2007, this initiative became a reality, as the World Bank hosted a Donor Pledging Conference for the world's first ever multi–country catastrophe insurance pool. At the conference, donors pledged 47 million dollars (€35.7 million) to the reserve fund of the **Caribbean Catastrophe Risk Insurance Facility (CCRIF)**, which is intended to provide participating Governments from the region with immediate access liquidity if hit by a hurricane or earthquake. It was estimated that by pooling their risk, the eighteen (18) participating member countries could save up to 40% in individual premium payments. The CCRIF is intended to be fully functional by the start of the 2007 hurricane season, and represents an important shift from a disaster response mode to an *ex–ante* disaster management and mitigation mode. It is intended that Governments will purchase catastrophe coverage in a manner similar to the purchase of business interruption insurance, which would provide them with an early cash payment after a major hurricane or earthquake. The 18 participating countries are Anguilla, Antigua and Barbuda, the Bahamas, Barbados, Belize, Bermuda, British Virgin Islands, the Cayman Islands, Dominica, Grenada, Haiti, Jamaica, Montserrat, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Trinidad and Tobago and the Turks and Caicos Islands. Pledges were received from Bermuda, Canada, France, the United Kingdom, the Caribbean Development Bank and the World Bank, and donors included Japan, and the European Union among others.

4. Incentives and disincentives to risk–based pricing

For many homeowners, the answer to soaring insurance rates, during the three years following 1992, was to reduce or eliminate their coverage. With the lack of statistics, it is difficult to measure the degree to which capital stocks are underinsured. The industry realizes that home insurance is a discretionary expense, and once terminated, consumers seldom renew. Local Governments are, of course, concerned since the greater the non–insurance (or underinsurance) by a population, the longer it takes for the local economy to recover from catastrophic events.

Policy conditions also provide for the amount of claim to be reduced to the extent that the amount of insurance purchased (sum insured) is less than the full insurable value at the time of loss (the 'average clause'). Some variations of this exist, e.g., the adjustment is only made if the policy sum insured is less than 85% of the full market value. Policyholders in Caribbean nations with weak currencies and/or high inflation such as Jamaica are especially vulnerable to these provisions. Socioeconomic and behavioural factors also merit consideration on both the supply and the demand sides of the catastrophe insurance market and it is helpful to segment property assets into their ownership classes:

- Private Dwellings Small/Indigenous, Medium, Large
- Private Businesses Small/Informal, Medium, Large
- Public Ownership Building Structures, Utilities, Public Infrastructures

With regard to private dwellings and business properties, the owners' disposable income levels comprise an important factor in the demand for catastrophe insurance, the annual cost of which is near 1% of a structure's value. This substantiates the observation that the small/informal sectors only purchase catastrophe insurance to the extent of lending institutions' requirements (and these can be limited to the amount of outstanding loan principal balances). It is estimated that between 25% and 40% of dwelling stock is uninsured with the small/indigenous segment being the least insured. Furthermore, insurance premiums are higher (less affordable) in areas which suffer frequent storm events.

Medium and large dwelling owners, without the same affordability constraints almost universally carry catastrophe insurance, as is the case with medium and large business property owners. In the case of the latter, business interruption insurance (stoppage as a consequence of catastrophe perils), is seldom purchased although this could mitigate employers' loss of income and employees' loss of pay while a workplace was idle. Larger businesses especially have access to insurance brokers (as opposed to insurance companies' own agents), who are adept at placing covers with 'foreign' insurance companies, i.e., operating without local registration, characteristically from United States or Europe. Such arrangements are especially prevalent in those Caribbean nations where foreign currency is readily accessible for premium remittances.

Small property and business owner segments in the less advantaged sectors do not partake of insurance coverage because some small dwelling and business property owners do not understand or respect the traditional insurance mechanism. Many expect Government assistance in times of crisis. Others decide to self–insure, assuming that the returns on funds saved from insurance premiums may be sufficient to finance remediation works, although most times the savings are absorbed into working capital. Governments as a matter of ongoing policy should undertake public education programs and publicity on risk management and the prudent use of insurance for protection.

5. Developing insurance for low income communities

One of the primary challenges for Governments in disaster prone regions is the protection of low income communities and the development of incentives for community participation in risk management measures. The properties, particularly the housing stock of low income communities is generally fragile, many times not built according to building codes, and this fact makes them difficult to insure even if affordability was not an issue. However, affordability is also an issue, therefore Governments have the dual challenge of (i) promoting structural measures to reduce the vulnerability of low income housing assets and (ii) improving economic welfare of such communities to begin allowing a phased–in process of risk management using the insurance mechanism.

Due to the above factors, it is imperative that the Government exploit to the fullest extent the range of tools available for hazard mitigation in order to reduce exposures of low income dwellings, while at the same time making transparent what the Government risk liability consists of and what risk liabilities should be borne by the communities themselves. This sort of strategy calls for a two–track approach whereby public funds for 'mitigation works' are made available to these communities in exchange for an explicit public insurance policy which is limited in its coverage but which allows low income communities to be adequately protected if they follow the appropriate practices of vulnerability reduction. Non–participating individuals or communities, while not completely exempt from aid in the event of a major catastrophe, would nevertheless receive second priority than those homeowners who had taken pro–active measures at mitigation and who thus would be explicitly covered for insurance purposes and up to a specified limit, by the Government. Such a system would engender inter–community competition in vulnerability reduction measures and at the same time raise the level of awareness regarding the nature of insurance policies and risk sharing.

6. Market implications from hurricanes Frances and Ivan

The overall loss to the reinsurance market from hurricanes Frances and Ivan may not be substantial individually on the global market; however, the aggregation of losses has impacted the results of reinsurers that are active in the Caribbean.

One of the local insurance companies severely affected by hurricane Ivan was Dyoll Group Limited. The erosion of Dyoll's capital base came principally as a result of the reinsurance shortfall following a deluge of claims arising from property damage as a result of hurricane Ivan. The vast majority of the claims originated in the Cayman Islands, amounting to $850 million, and contributed to the company's deficit of $1.1 billion, wiping out its capital base. The Jamaican Supreme Court granted an order in June 2005 to wind up the insurance company, because the claims by policyholders exceeded its reinsurance limits.

7. The structure of the Caribbean insurance markets

The specific characteristics of existing insurance markets need to be taken into account before considering the structure of pooled or alternative risk financing approaches. In the Caribbean region, the traditional insurance structure involves the proportional treaty contracted with reinsurers, whereby, some 70% of written risks are 'ceded' to reinsurers who take on that proportion of risks as well as the corresponding premium income.

For local insurers, however, the transfer of premium income collected is rewarded with commissions paid back by the reinsurers for bringing in and administering the client business. Local insurers also traditionally reinsure another 20% of their retained risk under 'catastrophe excess of loss' (XL) treaties. These are differentiated from proportional or quota share treaties in that they pay no commissions and the premium rate is based on a quantification of a specified limit on payable losses. XL re–insurance, thus requires a more meticulous assessment of risks, exposure and actuarial probabilities. Netting the XL reinsurance cover, Caribbean companies tend to retain a net risk equalling about 20%–24% of the total originally insured amounts.

Examining the above arrangements, the analysis shows that increased welfare in terms of reducing individual country risk can be obtained through pooling such financial risks across different risk zones in the Caribbean. As with portfolio diversification, a larger risk pool not only lowers the minimum net risk capital requirement (and thus increases the surplus capital available), but also allows for more efficient reinsurance arrangements which can be contracted on a larger value base. The analysis of insured loss potentials is a multi–disciplinary effort which takes into account physical weather/geological phenomena, engineering structural analysis, and financial loss estimation. Generally, the estimated expected loss (EPL) is a function of all three, i.e.

a) The probability distribution of hazard events of varying intensities,

b) The structural vulnerability parameters of buildings or physical assets subject to such hazards, and

c) The value of such assets and their associated expected losses in currency terms, when subjected to hazard events and associated structural damages.

VIII. DISCUSSIONS, SCENARIOS AND RECOMMENDATIONS

1. The risk management system

The existence of documented policies, plans and procedures at national and parish levels has allowed a consistent approach to response. Further, simulation exercises and real events have provided opportunities for testing and improvement of the system.

Information is available to decision–makers from a number of sources. Generally, scientific and technical agencies, including the University of the West Indies, provide information on hazards which threaten the country. This information includes a variety of hazard and risk maps, some at regional and some at community level scales. Very importantly, this scientific information is translated for use at a community level in the form of community flood alert systems. Less work has been done in the area of the social and behavioural sciences, but statistics relating to socio–economics and demographics are available, if to a lesser extent.

The documented history of impacts of hazards goes back over three hundred years. Analysis of this record allows a qualitative estimation of the vulnerability of various communities to various hazards. However no quantitative methodology for vulnerability assessment has been developed or used in order to guide development or community vulnerability reduction interventions.

Adequate information is available to guide mitigation approaches. The development approval process presently incorporates hazard analysis, and recommendations are made for mitigation measures. Technical agencies can also recommend that a development not be approved based on the level of the risk faced. However, hazard risk is not the only consideration involved in development decisions. It is therefore rare that a development will be stopped because of the possibility of future impact of hazards. There have been examples of inadequate monitoring of the implementation of recommended mitigation measures, leading to flooding of approved developments.

The present governance structures allow risk management to be incorporated at local levels. Parish Councils under law have the responsibility for planning and development approvals within their parishes, as well as for road and drainage works. They are now being given more technical tools, such as hazard maps and risk analyses to guide them in their decision–making. The question is whether the Parish Councils have the staff and will to enforce regulations designed to reduce vulnerability.

Under a new proposal, Community Disaster Management Committees and Teams will be incorporated into the new Parish Development Committee structure as one of its sub–committees. This will provide a development context for these groups, in addition to the preparedness and response functions which they presently carry out. This should allow more consistent integration of hazard and vulnerability management into development at the community level.

The integrated nature of the Jamaican system encourages data and information exchange among agencies as well as decision—makers. Agencies work together on the sub–committees of the National Disaster Committee during and outside of crises. This builds networks and relationships, and promotes information exchanges and discussions. There is no cost to the national disaster management agency for data provided by partner agencies.

In the past, the appreciation by the technical agencies of Government, of the importance of risk reduction has not been matched at the policy and political level. More recently, however, and particularly after hurricane Ivan, there has been a marked increase in the acceptance of issues related to vulnerability reduction and mitigation. The Planning Institute of Jamaica has included risk reduction in its medium term development strategy plan, and Cabinet has agreed to various suggestions for reducing coastal vulnerability. Consideration is also being given to the delineation of especially vulnerable areas and no–build zones.

The recent inclusion of cost–benefit analyses by the National Works Agency (NWA) for their maintenance programs as well as for bridge design is also a most encouraging sign that this preferred culture is becoming institutionalized.

The most urgent need is for the adoption of quantitative methods for measuring and tracking vulnerability and consistent risk analysis and mapping to support decision–making.

Vulnerability and risk assessments of critical facilities and lifeline systems are urgently needed. This will require greater and more sustained inputs from the annual budget, in order that the dependence on project funding for the risk management program can be reduced.

Among technical agencies, access to data and information is reasonably easy. The Land Information Council of Jamaica coordinates data access and sharing for the Government agencies with Geographic Information Systems. Some private companies will also share data with the ODPEM at no cost.

Access to information by the public has been more difficult, although the use of websites to disseminate information to the public is becoming more popular. ODPEM disseminates information for its public information and awareness program through its website, schools, libraries, public lectures and workshops. The public is guaranteed the right to all but personal information by the Access to Information Act.

The ODPEM has placed a high level of emphasis on preparedness and public awareness, particularly sensitization of the school–age population. This has led to the public actively seeking information on hazards and precautionary measures, as well as a growing number of inquiries on specific hazard information for construction of homes.

Interest in preparedness has also improved in the private sector. Support for activities such as Disaster Preparedness Month, Disaster Preparedness Day for Businesses and Earthquake Awareness Week has increased, with businesses requesting non–structural vulnerability analyses, earthquake and fire drills and assistance with simulation exercises and continuity planning. Businesses also contribute to the national program through corporate sponsorships. The role of the Jamaica Institution of Engineers in leading the current revision of the National Building Code should also be noted.

The adoption of the ECLAC methodology has allowed a thorough analysis of economic impacts of an event. However, loss evaluation methodologies need improvement, and particularly the forecasting of probable losses and rapid post–impact assessments. This will require better data bases for value of resources and property and use of GIS to combine the hazard information, financial information, probability of occurrence, etc. to produce loss estimates. Probable loss estimates would allow rapid post impact assessments, with field work essentially verifying projections.

Jamaica has successfully integrated public, private, technical, scientific and voluntary sectors as well as local Government authorities and communities into its disaster risk management structure, and therefore represents a good example of an integrated approach to risk management. The inclusion of mitigation in the national medium term development plan also indicates that there is a real effort to integrate risk reduction into national development.

Despite the above, however, there is room for improvement, and recommendations are made here for the future direction and improvement of the programme:

a) Preparedness

Although a high level of preparedness presently exists in the risk management system, there is the need for improvements in the following areas:

- **Simulation exercises** should be regularly organized, particularly at the parish level. This will allow participants to become familiar with plans, roles and responsibilities. ODPEM should be given adequate funding in its budget to carry out one exercise per parish until the parishes assume this responsibility in a satisfactory way.

- **Community preparedness** interventions, including the establishment of community early warning systems, should be expanded, and these should be funded under the national budget, in addition to any funding received through projects.

- **Emergency stocks** should be increased to a level adequate to provide for, at minimum, a category two hurricane event.

- There is urgent need for **a workable plan for supplying water** should the primary storage reservoirs be lost. This plan **must** provide for adequate supplies to hospitals.

- **Community centres** should be designed primarily as shelters, and should be able to withstand high magnitude events. Existing community centres should be retrofitted to act as shelters.

- **The National Disaster Fund** should receive annual inputs from the Government in order to achieve a specified target within three (3) years. This target can be calculated based on the amounts spent on response, relief and rehabilitation over the last five years.

b) Emergency Response

Training is urgently needed for the Fire Services in Urban Heavy Rescue. This training should also be offered to the National Works Agency, the Parish Councils, the Jamaica Defense Force and the Jamaica Institution of Engineers.

c) Risk Reduction

- **Vulnerability assessments** of critical facilities and lifeline systems should be carried out

- **A planned program of retrofitting** for these elements should be undertaken to address the weaknesses identified

- **The national risk analysis and mapping program** should be supported by the national budget. There should be a commitment to an annual allocation specifically for risk mapping of all major hazards.
- **ODPEM's Geographic Information Systems** capacity should continue to be developed to allow modeling and a higher level of hazard analysis as well as risk mapping. Consideration should be given to the establishment of a full–time GIS post within this agency.

- There is the need for **quantitative approaches** by all sectors if risk analyses are to be carried out. As a start, public assets should be documented, valued and mapped. Vulnerability analyses and scenario – based damage modeling should also be done.

- The **Cost/Benefit analyses** on mitigation measures and maintenance programs started by the National Works Agency should be encouraged, continued and adapted across the public sector.

d) Recovery

In order to facilitate the recovery process, explicit, documented procedures for ensuring that risk reduction approaches are integrated into the recovery process are required.

2. Ability to cope with extreme events

a) Extreme Hurricane

i) Scenario. The scenario to be adopted for the extreme hurricane is one that can be advised by a review of the most intense hurricanes to have passed through the Caribbean. Table 8.1 below taken from a United States Department of Commerce website, lists the 10 most intense tropical hurricanes on record, measured as a function of central pressure. It is noted that hurricane Gilbert, which made a direct hit on Jamaica, is ranked second on this list. Interestingly, it retained a number one ranking until 2005, when hurricane Wilma took over that spot. Not surprisingly, Gilbert did tremendous damage to Jamaica.

Table 8.1

TOP 10 CARIBBEAN HURRICANES RANKED BY INTENSITY

Most intense Atlantic hurricanes. Intensity is measured solely by central pressure.			
Rank	Hurricane	Season	Min. pressure
1	Wilma	2005	882 mbar (hPa)
2	*Gilbert	1988	888 mbar (hPa)
3	"Labor Day"	1935	892 mbar (hPa)
4	Rita	2005	895 mbar (hPa)
5	Allen	1980	899 mbar (hPa)
6	Katrina	2005	902 mbar (hPa)
7	Camille	1969	905 mbar (hPa)
	Mitch	1998	905 mbar (hPa)
9	Ivan	2004	910 mbar (hPa)
10	Janet	1955	914 mbar (hPa)

Source: United States Department of Commerce.

It is estimated (NOAA) that hurricane Gilbert had the following characteristics:

- It resulted directly in 45 deaths
- Over 700 mm (27 inches) of rain fell in the mountainous areas of Jamaica, which resulted in inland flash flooding

- The hurricane resulted in the destruction of crops, buildings, houses and roads and even turned small aircraft into shambles

- It severely damaged all but two medical facilities across the island

- It damaged 50% of the water supply

- Total estimated damages were approximately 2 billion dollars (2006 dollars)

- Due to its extreme intensity and path of destruction, the name Gilbert was retired in the spring of 1989, and will never be used for another Atlantic hurricane. It was replaced by Gordon in the 1994 Atlantic hurricane season

Given these characteristics, the scenario that appears to be a realistic extreme one would be described as follows:

Strength: Category 5 hurricane approaching from the south—east (e.g. see image below).

Central Pressure: 885 mbar

Maximum Wind speeds: 185 mph sustained

ii) Discussion. The scenario hurricane could be expected to have significant impact on the entire population of Jamaica, but more so for the residents and infrastructure along the south coast. All urban centres would be expected to be at risk, but particularly the KMA region, which has a wide mix of housing styles and resistance to hurricane winds. Outside of the KMA, the stock of housing varies from reinforced concrete block to simple wooden structures. As a direct result of the passage of hurricane Gilbert in 1988, the use of hurricane straps became widespread in the construction industry for residential dwellings. It is to be hoped therefore that wind induced damage may be somewhat more contained for newer residential buildings than obtained during Gilbert. For commercial construction, most buildings consist of reinforced concrete block. Hurricane Ivan in 2004 left over 18,000 homeless as a result of flood waters and high winds, therefore it is to be expected that the scenario hurricane could result in a tally of homeless individuals somewhere in the order of 20,000–30,000. The emergency network would therefore have to gear up to accommodate these numbers in shelter locations. In summary, the wind hazard will have a potentially major impact on the landscape of the country. A category 5 hurricane will have wind speeds above 155 mph (70 m/s). These wind speeds can be expected to have devastating impacts on the many low income houses that exist in the inner city communities, as well as several of the rural communities. Unless properly fasted to rafters, many roofs would be removed and the occupants of these homes exposed to the elements. In hilly regions, the wind velocities could be amplified, making the impacts worse, as the wind will accelerate while going up and over hills.

For the scenario hurricane, depending on the expected surge height and actual approach direction, the immediate coastline areas of St Thomas, Kingston, St Catherine and Clarendon would likely have to be evacuated. The two figures following, Figures 8.1 and 8.2 (taken from an ongoing Smith Warner International project, sponsored by the IDB and CDERA) show the predicted storm surge for the Kingston and Portmore areas respectively for the one in 150 year return period event. This is considered to be a very infrequent event, which would be equivalent to a strong Category 5 hurricane, and is therefore not dissimilar from the scenario hurricane. The maps show that the coastal strip of Kingston would be inundated, as would the access road to the international airport. This coastal strip includes many inner–city communities, which are vulnerable, as they do not have updated infrastructure that may be capable of withstanding a natural disaster of this magnitude. It is uncertain whether or not the airport itself would be submerged, as there are believed to be some inconsistencies in the elevation data for this facility, however it is expected that the runway would be under water and closed for perhaps a few days.

For the Portmore area (Figure 8.2 following), which is perhaps the most densely populated area located on the south coast of Jamaica exposed to this hazard, the mapping shows that a significant part of this community (adjacent to Kingston Harbour) would have to be evacuated. Other low lying coastal areas would also have to be evacuated.

There are however, two major challenges related to evacuation. These are:

1) The Portmore community; and

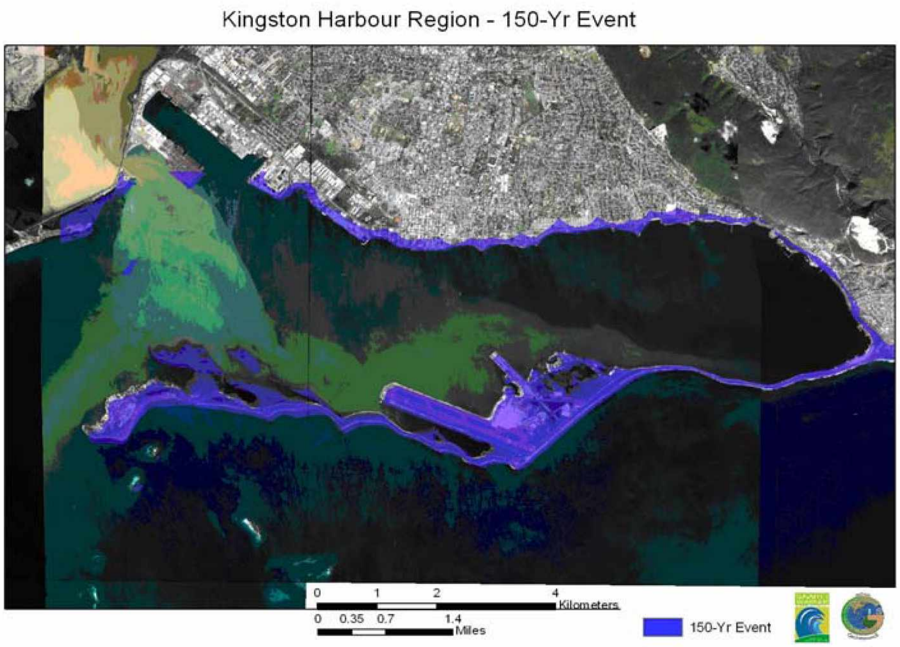
2) The ability to shelter large numbers of evacuees.

There is an evacuation plan for Portmore and the Portmore Disaster Committee is active and well organized under the leadership of the Mayor of Portmore. The Portmore Evacuation Plan has been exercised in a simulated test, and has been activated on several occasions. The actors and public are therefore familiar with it.

The major challenge with evacuating Portmore relates to the fact that most residents do not wish to leave – however it can be anticipated that if a Cat. 5 storm were approaching they would make the decision to move, some albeit belatedly. Traffic management would then become a key issue, with success hinging on the use of the new toll road. The bottleneck which can be expected at Marcus Garvey Drive would likely be the limiting factor on evacuation speed. Under the Portmore Evacuation Plan, no evacuation is planned after the onset of tropical storm force winds, so if the Portmore population delays evacuation it is likely that the residents will have to shelter on higher ground within Portmore.

Fig. 8.1

STORM SURGE MAP FOR KINGSTON–1 IN 150 YEAR EVENT



However, there are only a few options for shelters of last resort within Portmore–the modelling of the storm surge levels indicates that this parameter is predicted to be higher in the areas of Hunts Bay, Waterford, Dawkins Pond and Hellshire. Other areas such as Greater Portmore appear to be more sheltered from inundation and therefore schools or other buildings in this zone could be used as refuges of last resort. It is expected that this decision would be made at the time, depending on conditions and model outputs. . However it should be noted that there is a possibility for extensive loss of life in Portmore if residents do not heed evacuation instructions.

A storm threatening Portmore would also threaten Port Royal, and so transportation is provided for evacuation from Port Royal. Again, residents there do not have a history of evacuating when advised to do so. It is therefore highly likely that the majority of these residents would remain in Port Royal. The residents' plan is to use the old naval hospital, a raised, sturdy wooden structure, as the refuge of last resort. (Carby, pers. comm. 2006). The damage to the Palisadoes road during hurricane Ivan, and the storm surge prediction shown in the preceding figures, suggest that they would most likely be cut off for up to two to three days.

Fig. 8.2

STORM SURGE MAP FOR PORTMORE–1 IN 150 YEAR EVENT

For communities outside of Greater Kingston, evacuation transportation is provided only for special needs populations, such as the disabled. It is therefore inherently assumed that most persons would be able to make their own arrangements to get to safe shelter. Parish Disaster committees usually have stand–by arrangements for transportation to be provided by owners of buses.

For an evacuation of the scale envisioned, it is expected that there would be severe challenges with housing evacuees, should the majority decide to go to public shelters. The total shelter space for Kingston is about 20,000–but supplies for that many evacuees are not routinely stocked. As such, evacuees are always advised to take supplies and bedding with them to shelters. In addition, sanitary facilities at the shelters are typically inadequate since they are not designed for 24 hour use. Other challenges would relate to being able to provide hot meals immediately after the event–since roads would still be impassable, and the provision of water could be a challenge if distribution lines were disrupted. Only some shelters have water tanks, and the provision of stand–by electricity, since shelters do not have generators. Water distribution by trucks would have to wait until roads were cleared. Some system of water rationing would therefore have to be implemented in order for the needs of the entire affected population to be met.

The shelter system is highly dependent on the NGO's and on volunteer services. Hot meals are usually provided by the major NGOs, but it is likely that the number of hot meals per day would have to be limited, in order to ensure that all shelters could be adequately supplied initially.

From a management perspective, the provision of an adequate number of shelter managers is a necessity, in order to ensure adequate rest and rotation. This, however, is also expected to pose some challenges, as there is presently a lack of adequately trained individuals to satisfy this requirement. On the other hand, fewer challenges are expected with the staffing of the NEOC, as there are adequate numbers of sufficiently trained personnel to accommodate a two–shift rotation at that facility.

One other point of note is that for isolated areas, landslides routinely cause communities in the hilly interior to be cut off from road access once there are heavy rains or an earthquake. For a low frequency event, airlift capacity could be challenging, especially if the Jamaica Defence Force helicopters are needed for security or medical assignments. Generally, these rural communities have stocks in shops for about a week. After seven days they would need to be re–supplied. Water is not usually a problem, since there are typically numerous unpolluted streams which can be accessed by these communities. As helicopter re–supplies have been carried out on many occasions, this is not expected to be problematic.

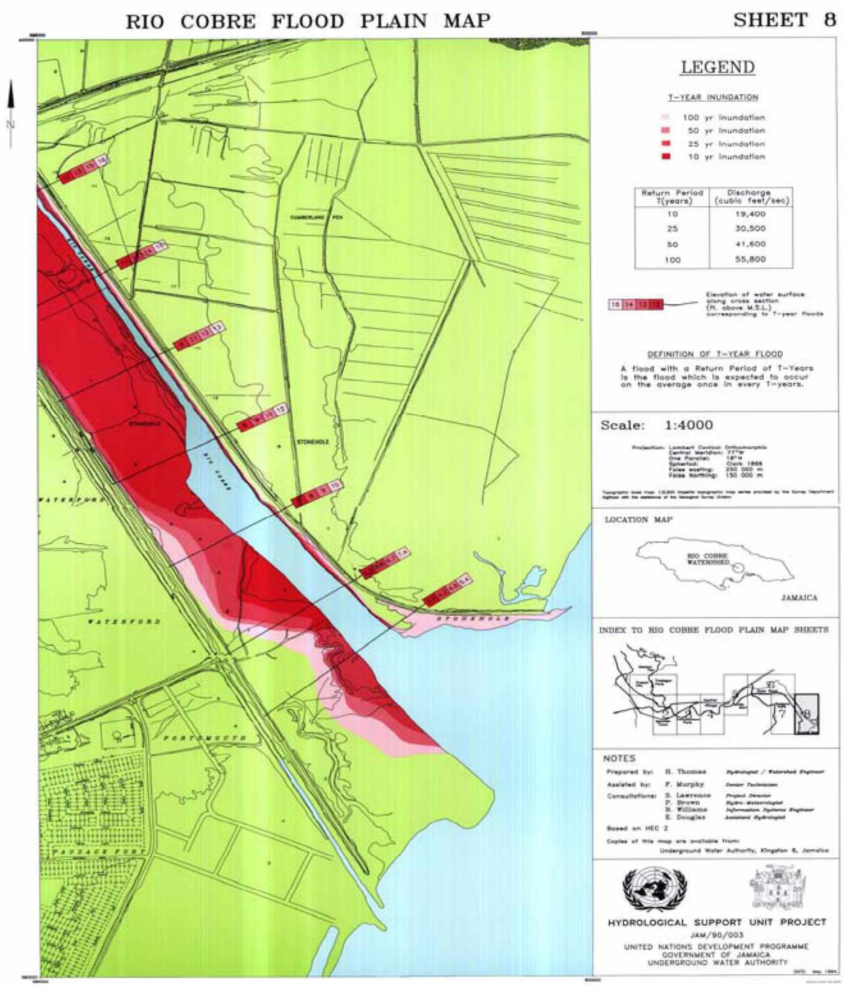
Challenges for the health care sector in the case of an extreme event (hurricane or earthquake), are related to the availability of resources. Hurricanes have not been high casualty events over the past several decades, so existing systems have not been called upon to cope with mass casualties. The major problems have been related to the integrity of structures–many facilities suffer leaking roofs–and supplies for vector control. It should be noted that the Mass Casualty Plan has been exercised on several occasions, so the actors are familiar with its procedures.

Other hazards that must be taken into account in a hurricane will be flooding and winds. Flood hazard mapping presently exists for several major rivers, however it is strongly recommended that the existing maps be updated and the mapping program be expanded to include more major rivers. A sample of the mapping for the Rio Cobre River is shown in Figure 8.3 following. The mapping shows that in this case, the 100 year floods boundaries are well contained within the river training structures for this river at the reach where it passes the municipality of Portmore and as it enters the Hunts Bay water body adjacent to Kingston Harbour.

In considering an extreme hurricane scenario for Jamaica, it should be noted that even the most severe event is unlikely to destroy the entire country to the same degree. In real events so far, there have therefore been options for relocating resources from less damaged to more damaged areas, until external assistance has become available.

Fig. 8.3

FLOOD MAPPING FOR THE RIO COBRE (PORTMORE TO KINGSTON HARBOUR)



b) Severe Earthquake

i) Scenario

Magnitude: 7

Likely Sources

1) Eastern Jamaica: (1) faults associated with the Blue Mountains block/Wagwater Belt; (2) Plantain Garden Fault; (3) Extension of the South coast Fault offshore Kingston/Bull Bay; (4) North Jamaica fault offshore Western Portland/Eastern St. Mary

2) Central Jamaica: (5) Spur Tree or Santa Cruz Fault; (6) Rio Minho—Crawle River Fault or splays; (7) South Coast Fault

3) Western Jamaica: (8) Montpelier—Newmarket Fault; (9) Duanvale Fault; (10) Maryland Fault; (11) Extension of the South coast fault offshore Black River to the west

Ground Acceleration (Spectral):

At short periods (0.2 second) horizontal ground motion of 40%—70% of gravity (0.4g—0.7g) is predicted out to about 20 km from the epicentre. These areas will experience intensity IX to X on the European Macroseismic Scale (EMS—1998). The long period (1s) effect is lower (Jamaica Spectral Seismic Hazard Maps, 2006). Beyond the meizoseismal zone intensities will fall to IX and then VIII over distances of 20—40 kilometers. Note that site effects can amplify the accelerations stated above by up to 1.5 times (Wiggins—Grandison, Kebeasy & Husebye, 2003; OAS/CDMP Seismic Hazard Report on Kingston, 1999).

*(*The EMS scale may be observed or downloaded from website http://www.gfz—potsdam.de/pb5/pb53/projekt/ems/).*

ii) Preamble

Earthquakes can cause damage to life and property in several ways. These may occur through:

1) Being directly on a surface fault break;

2) Being near enough to the fault to experience the direct heave of the hanging wall marked by very high ground velocity and acceleration;

3) Ground shaking associated with passing seismic waves, especially the shear and surface waves;

4) Amplified ground movement caused by alluvial ground with or without accompanying settlement, fissures and/or liquefaction;

5) Triggered landslides and/or tsunamis.

Of the effects described above, (3) is the most prevalent in Jamaica, and is the only effect predicted by standard seismic hazard maps. It should be noted that effect (4) will be of importance for Kingston, parts of Portmore, Black River and any place where buildings exist on alluvial terrain. Ground fissures, liquefaction and settlement in past earthquakes have tended to be confined to areas where the water table is high such as around the edges of harbors and in zones of reclaimed land. Often ground settlement is also associated with man—made embankments such as approaches to bridges etc. Landslides and rock falls of varying sizes typically litter the mountainous landscape following a significant earthquake.

Tsunamis were reported in harbors of the north and south coasts of Jamaica following the 1692 and the 1907 earthquakes, which were the largest to have affected eastern Jamaica. For Kingston harbor all reported cases were as a result of local tsunamis caused by the described subsidence at Port Royal on each occasion.

iii) Discussion

Unlike hurricanes, the possible effects of earthquakes are more of an unknown. The time of occurrence, the location of the epicentre, duration and depth are all factors which will dictate the level of effects. A review of past earthquakes that have affected Jamaica since the Port Royal earthquake of June 7th 1692 reveals that the impact of the earthquake on the existing landforms is most prominent in locations where the geology allows the most impact to occur. In other words, during an earthquake, it is actually the geological framework that determines where the fault ruptures are likely to occur, how strongly the ground will shake and the locations where landslides, liquefaction, etc. will be most likely to occur. It is precisely the combination of relatively weak geology and reclaimed land sites, which are housing critical port (both air and sea) facilities that renders the KMA a location that is very vulnerable to this hazard. Mapping exists that shows the locations of measured epicentres across Jamaica and in its nearshore waters within the last century. The majority of these have occurred in the vicinity of the Wag Water Fault in the eastern section of the island.

In attempting to predict the likely effects of a Magnitude 7 event in Jamaica it is of some import to look back at the major quakes of the recent past and the levels of destruction reported. In Jamaica, significant earthquakes (estimated magnitudes in parentheses) occurred on: January 14, 1907(6.9), March 1, 1957(6.5), February 26, 1978(4.5), January 13, 1993(6.1) and June 12, 2005 (6.1). At least three of these were located in the eastern half of the island while the 1957 event was centered in western Jamaica, though its effects were felt throughout the island.

In the case of the 1907 event the levels of destruction of assets are difficult to compare with the scenario presented here, because of varying factors that include the quality of buildings and the fact that significant losses occurred due to the fires that erupted as a result of ruptured gas lines. The most reasonable event that should be examined for comparison is the recent tremor of 1993, for two reasons. First due to the amount of data collected as a result of this tremor and second because it affords the opportunity to see how buildings constructed with the benefit of more recent engineering standards and codes performed.

Ahmad and Wiggins—Grandison [12] from the Department of Geology and Seismic Research Unit (University of the West Indies) report that the earthquake occurred at just after 12:11 pm local time on January 13, 1993. The tremor had a magnitude of 5.4 and was located some 15 km NNE of Half Way Tree, which is in the centre of the capital city of Kingston. They further reported that the following earthquake—induced geotechnical phenomena occurred:

- Ground shaking occurred for between 10 and 14 seconds, which was accompanied by both horizontal and vertical displacement.

- There was isolated ground failure including settlement, cracking fissures and pockets of liquefaction.

- Significant landslides occurred both on—shore and in submarine regions;

- There was increased activity in some springs, notably the Rockfort Mineral Springs.

That report cites the Office of Disaster Preparedness and Emergency Management (ODPEM) reporting that just over 500 families were affected island wide, many of whom had structures that were either damaged or completely destroyed. There were, in addition, numerous cases of individual houses, roads, infrastructural works and other assets that suffered damage but by no means could the damage be said to be widespread. Insurance estimates and anecdotal evidence puts the total cost at around $250 million Jamaican Dollars. In fact Ahmad states in his paper that no comprehensive multi—disciplinary post—quake damage assessment was carried out, and as such the real economic cost is unknown.

One of the reasons for this is that in several areas of the capital, properties whether they are residential or commercial are un—insured and as such without the damage assessment study significant losses are unrecorded. As an example individual losses in isolated sections of Kingston such as August Town were higher than in most other areas. The matter is further complicated by the fact that in many of these areas the housing stock may either be old or has been put up with minimal adherence to modern engineering practice. The August Town damage referred to earlier occurred in structures made of un—reinforced block walls.

What is known is that the major engineered structures in New Kingston, the downtown commercial district and the air and sea—ports, performed as designed. The fact that in a city of close to 850,000 inhabitants, ODPEM reported only 500 families affected, suggests that most structures also performed as designed.

We can use, to some extent, the damage from the 1993 event and the performance of our building and infrastructural stock to try and model what would likely happen in a Magnitude 7 event. Such an exercise involves a lot of assumptions about location of the quake, its depth and

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[12] (Ahmad, Rafi, 1993——The Jamaica Earthquake of 1993: Geology and Geotechnical aspects–The Journal of the Geological Society of Jamaica Wiggins–Grandison, Margaret, 1993 –The Earthquake of January 13, 1993– Newsletter, The Jamaican Society of Scientists and Technologists)

other parameters. However, given that a Magnitude 7 earthquake would release almost 900 times the energy of the 1993 event and assuming an eastern epicentre (i.e. in the Wag Water belt) we could expect the following:

- More significant and longer ground shaking than the 10 to 14 seconds of 1993, and greater horizontal and vertical displacement.

- Widespread ground failure including settlement, cracking, fissures and pockets of liquefaction leading to significant structural damage in buildings and houses not built to code. In some areas localised geological factors may lead to damage to structures built to code and though containment may prevent loss of life, many structures would be irreparable.

- Landslides in vulnerable areas such as Jacks Hill, Papine, Norbrook, Gordon Town, Irish Town, and Upper Hope Pastures (all in the northern KMA region) are expected to be massive and depending on the time of day may result in serious casualties. It must be remembered that a 1988 quake cut the Jacks Hill Main Road in two and caused the collapse of one large dwelling house.

- Significant damage to the road network particularly in the landslide prone areas mentioned above.

- Submarine landslips may occur either damaging or cutting off our major air and seaports.

- Fissures and liquefaction features around harbours and lakes/ponds.

- Springs such as Rockfort may either increase or decrease in flow volume causing flooding in the former case.

- Newly formed land on the south and east sides of Port Royal would be prone to subsidence.

- Damage to abutments and bridge approaches, which become vulnerable at high intensities due to ground failure or shifting of the structure off of the abutments.
- Power failure in the worst affected zones.

- Water supply pipes may break or be disconnected at the joints, wherever weakest.

- The marine telephone cables off the Bull Bay coast will break for an eastern Jamaica epicentre as has happened in the past, even in 1993.
- Damage to the port of Kingston.

- Disturbance of bottom sediments in Kingston Harbour which would affect the shipping channel.

- Possible damage to power generation facilities in Kingston.

The aforementioned major structures in New Kingston and Downtown such as the Pegasus Hotel and the Bank of Jamaica Building are likely to survive such an event, although minor structural damage is a distinct possibility. Geological conditions at our major ports also make them more vulnerable and the generality of the housing stock and infrastructural assets also represent likely areas of significant damage. Loss of human life will largely be a function of the time of day when the earthquake occurs and all indications suggest that a nighttime tremor could involve significant casualties. The ability of the Government agencies to respond in terms of fire and rescue, hospitals, food and shelter provision and general emergency response is expected to be severely restricted.

There is an existing earthquake plan [13] which sets out the procedures to be followed in the event of an earthquake, including inspection of buildings, management of debris and emergency medical care among others. However, there is no recent experience in managing the effects of a major earthquake, a fact which is very important. It is possible, however, to consider some worst case scenarios resulting from a strong earthquake with a magnitude of 7 with respect to the disaster management agencies, and these are examined here.

1) The Collapse of Large Structures

The fire service is not trained in the skills of urban heavy rescue, so search and rescue efforts within large collapsed structures will be difficult. On the positive side however, modern multi—storey structures are designed by qualified engineers who take into account the Building Code and earthquake resistant requirements, so the likelihood of large—scale structural collapses is minimized. Fire fighting will be hampered by disruptions to the water distribution systems. Fortunately however, there are many other sources of water such as swimming pools, which could be used. In addition, the Fire Service routinely uses water trucks to provide additional water during fire—fighting operations.

2) Loss of Major Water Storage Facilities

Catastrophic loss of either the Hermitage or Mona reservoirs would be devastating, and can be expected to cause high loss of life in the heavily populated communities below these reservoirs, as there is no real—time warning system for failure. Unfortunately operations would likely be concentrated on recovery rather that search and rescue in such a situation. No modelling or quantitative risk analysis has been done to assess the risk of such a loss.

The provision of water in such circumstances will be a major problem. Water would have to be trucked into the KMA region from adjoining parishes, which would be a slow and costly venture. It is expected that there will be some stored water since many households do have tanks. However those tanks which survive the shaking will provide water for at most a week, if that long. Disruption of sewage lines will also likely occur, posing possible threats to health and

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[13] Carby, Barbara E. A scientific basis for earthquake contingency planning: an example from Jamaica. Proceedings, 4th International Conference on Civil Engineering, May 4–6, 1997, Sharif University of Technology, Tehran, I.R. Iran, Volume 1 Structural Engineering, pp 345–355

causing contamination of piped water where these systems survive and may be adjacent to one another. Fortunately, most of the public is aware of how to treat contaminated water for drinking through the use of bleach and/or boiling of water.

Experience has shown that in earthquakes most rescues are performed by the persons at the scene. In this regard there are expected to be plenty of willing hands, some of whom would have been trained as members of community disaster committees and response teams. Since residential structures in low income areas tend to be lightweight, one can expect fewer deaths in these areas. However there is an unfortunate culture of adding vertically to one storey houses without engineering advice. This may result in collapse of these structures in middle income areas. Since these structures are made from concrete blocks, there is the likelihood of serious injury.

Challenges to health care will be from lack of adequate supplies for treatment of injuries, since public hospitals are already stretched to capacity in the management of day to day injuries. The other problem area will be the state of the medical facilities, many of which are housed in older structures. As no vulnerability analysis of these structures has been done, the full effects cannot be anticipated. However since no non—structural mitigation measures have been put in place, it is likely that there will be considerable damage to non—structural elements, which could render a facility useless even if it survives the earthquake. On the positive side there is a pool of highly skilled and trained medical personnel available, and there is a mass casualty plan in place which includes the coordination of the private health care providers.

One potential problem area for hospitals is the provision of water. The volumes of water used by the large hospitals means it is economically impractical to have storage adequate for any prolonged period. This means that if the major national storage systems are lost, a high percentage of the emergency water supply system will have to be dedicated to keeping hospitals functioning.

The mass casualty plan calls for the use of refrigerated containers for storing bodies should morgues be full. Mass burial is not regarded as a primary option, but rather as a last resort.

The problem of isolated communities mentioned above would also occur in an earthquake. Fortunately however, in an earthquake food supplies on and in the ground would not be affected, so no shortage of basic food is anticipated.

There is an established procedure for restoring road access after any event. This includes pre–positioning of equipment and the use of contractors. Delays usually occur where there is the need for rebuilding of roadways and bridges, especially in steep or hilly terrain. On the whole, restoration of access ways along main highways would generally be completed within a period of days if bridges and retaining walls were intact.

The secondary effects of an earthquake have implications which also need to be considered. Disturbance of the harbour could mean that ships would not be able to enter until the channel had been surveyed and re–established. The container port is located on reclaimed landfill, which could be prone to liquefaction under earthquake loading. This means that trade would be affected for longer periods than in a post–hurricane situation. The effects on the

Norman Manley International Airport, and most importantly the runway, are also an unknown. As an example, in the Kobe earthquake, properly engineered fill areas did do well. Survival of the runway will therefore depend on its engineering design. Extensive damage to the Norman Manley International Airport would leave Montego Bay's Sangster International Airport as the only port of entry for relief supplies coming in by air. Supplies could then be moved by road into Kingston.

The cement factory, the bauxite and power generation plants and the flour mill, could all suffer damages to machinery, which could put them out of production for long periods of time. This in turn could lead to negative macro–economic impacts.

c) Observations

In summary, the following observations are offered:

- A low frequency, high–magnitude event would certainly pose severe challenges for the emergency management system. As became evident in New Orleans, things can go very wrong very quickly, even when resources are available.

- The emergency management procedures in Jamaica are well documented and personnel are trained. However, much will depend on:

  - The level of damage occasioned,

  - The loss of emergency management personnel – have they escaped injury, can they report for duties, etc.

  - The reaction of the population, especially in a post–earthquake scenario where there is no previous experience, and on

  - The ability of the emergency management personnel to adapt and think on their feet.

A listing of hazard management activities, that are driven by existing plans and policies, is given in Table 8.2 following.

Table 8.2.

SUMMARY OF HAZARD MANAGEMENT ACTIVITIES FROM PLANS AND POLICIES FOR JAMAICA

Situation	Mitigation	Preparedness	Response	Recovery
Roads Impassable	Roads already exist	Pre-position Equipment	Start clearing in order of priority. Publicise alternate routes	Reconstruct roads with adequate drainage. Reroute where indicated.
Bridge damage	EQ/Flood–resistant design	Earthquake/Flood–resistant design	Inspection and closure	Repair/rebuild to code
Flooding	Adequate drainage systems, River Training. Elevate floor levels	Swift water rescue teams Flood warning systems Prepare shelters	Rescue Evacuation Sheltering	Assistance to affected population, Repair protection systems
Damage to hospitals	Design new structures to code	Discharge non–critical patients Relocate patients from vulnerable hospitals Develop agreements with private providers	Evacuate if necessary, Partial closure, Reduce, suspend elective procedures	Repairs done to code
Damage to water distribution system	Relocate pipelines	Prepare trucks, Identify vulnerable areas Shut down pumps in flood–prone areas Educate Population to store water	Truck water to affected communities Prioritise repair activities	Repair damage, Reroute where possible
Loss of major water storage systems	None	Identify alternate sources and possibilities for rerouting flow Identify available transportation resources	Use alternative sources identified Truck water	Repair, rebuild

/ Continues

Table 8.2. (Conclusion)

Situation	Mitigation	Preparedness	Response	Recovery
Damage to Power distribution system	Replace old poles, wires Reroute where possible	Shut down system at identified threshold	Replace poles, wires	Increase depth of burial of poles if applicable Reroute where possible
Damage to telephone system	Bury land lines Increase wind–resistant specifications for cell towers	Provide emergency power For sites	Repair lines, towers	Replace lost lines, increase specifications where necessary
Landslides	Hazard mapping, slope stabilization measures	Preposition equipment in critical areas	Clear roads according to predefined priorities	Repair roads Reroute where necessary
Population vulnerable to multiple threats	Enforce planning and zoning laws	Public awareness program Early warning systems	Provide emergency shelter, medical care, rescue	Relocate vulnerable population
Post—impact threats to public health	Adequate surveillance and monitoring systems in place Immunisation and treatment programmes	Educate population in water treatment, vector control, personal hygiene	Increased surveillance, vector control, Increased public information dissemination, Provide potable water, Treat affected persons	Restock Continue surveillance and monitoring
Mass Casualty Event	Varies according to hazard	Plan development and testing, Training of personnel Establish Agreements with private hospitals	Deploy medical teams to sites Establish field hospitals as indicated, Include private providers in response	Retrofit during repairs and recovery Restock

This table summarizes the actions to be taken in managing various situations according to the policies and procedures laid out in the National Disaster Plan and Mitigation Policy for Jamaica, as well as in plans of utility companies, the Ministry of Health and other members of the National Response Team It should be noted that these situations can arise from a variety of hazards, and as such are not hazard specific. A list of relevant plans and policies for Jamaica is given in Appendix III.

3. Workshop recommendations

A second workshop was held on 9th November, 2006 at the offices of the Planning Institute of Jamaica (PIOJ), the Government of Jamaica agency responsible for setting planning policy at a national level. Following the main presentations, a period of general discussions ensued. During the various discussions and debates the following points were raised, which are presented here in the context of recommendations that should be considered for implementation in order to improve the overall disaster management process:

- The appropriateness of using schools as shelters versus the use of other multi–use structures was questioned. This issue was raised since the damage to school property resulting from shelter inhabitants was often greater than the damage resulting from the disaster. In addition, the delay in getting children back to school, until repairs were made, was problematic.

    - ***RECOMMENDATION*** – *Government agencies should move towards the use of designated multi–use areas in schools only, such as gymnasia.*

- Disaster mitigation and vulnerability reduction plans that are prepared at the Parish level are not always well known at the community level, as the dissemination of information does not always work well.

    - ***RECOMMENDATION*** – *Establish fluent and well working lines of communication between ODPEM, the Parish Councils and the communities.*

- The recovery efforts and in particular the distribution of relief supplies has occasionally been hindered by political interference.

    - ***RECOMMENDATION*** – *In spite of this factor, technicians should try to act in accordance with the previously developed disaster management plans.*

- The distribution of risk mapping was not widespread and therefore mitigation actions, such as relocation, were not always easy to be implemented.

    - ***RECOMMENDATION*** – *Ensure that parish and community representatives work with populations at risk to advise them of the dangers inherent in remaining in dangerous areas. Support this work, wherever possible, with available mapping at a scale that can be easily understood and appreciated by the people in the communities.*

- The location of critical facilities such as the fire station was often in hazardous zones. An example was cited of the destruction of a Fire Station during the passage of hurricane Allen in 1980.

    - ***RECOMMENDATION*** – *Ensure that any new critical facility is sited outside of the zone of maximum hazards, in accordance with available risk mapping. Where* *such mapping is not available, it should be carried out prior to the selection of a location for the facility in question.*

- The National Disaster Fund (NDF) even though topped up by the Government in 2005, remains at an insufficient level.

  - ***RECOMMENDATION*** *– Develop a relationship between the magnitude of the fund and the annualized estimate of disaster damage based on historical assessment. This approach may reinforce for the policy makers the relationship between the required size of the fund and the average annual requirements for mitigating natural disasters.*

- There is a major problem relating to the lack of insurance for public infrastructure. The Government has opted to be its own insurer, however, often after a disaster, there are insufficient funds to carry out this mandate.

  - ***RECOMMENDATION*** *– Government should move immediately to insure its infrastructure. This insurance should be placed in a manner that takes advantage of the considerable amount of infrastructure that will need to be insured. This approach could result in more affordable premiums.*

- ODPEM now has a National Hazard Risk Reduction Policy

- Donor agencies have expressed the viewpoint that "mitigation does not attract a lot of recognition, whereas the provision of aid after an event does".

  - ***RECOMMENDATION*** *– There is a need to recognize the importance of mitigation actions in a manner that is acknowledged on the international stage and also by the political decision makers.*

Other conclusions reached/recommendations made included:

- The results of the final component of the project should be disseminated throughout the five countries, as agencies will be able to draw on the positive experiences from other countries.

- The involvement of the communities is an essential ingredient to the proper operation of the disaster management system.

- Risk transfers for public sector infrastructure should be increased.

- There is presently insufficient mapping and methodology to represent and define vulnerability for all areas of Jamaica.

- There is strong public perception of risk from natural hazards, as a result of relatively recent events. The fact that the Planning Institute of Jamaica was the host of the workshop is evidence of the importance of this topic to the national fabric.

- There was unanimous agreement that there needs to be more communication between the political directorate and the technocrats and disaster managers, to ensure a smoother flow in the distribution of relief supplies.

Appendixes

Appendix I

LISTING OF RELEVANT REFERENCES FROM CARDIN

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Appendix II

ECONOMIC OVERVIEW – HURRICANE IVAN

Economic Sector Losses – Hurricane Ivan

A detailed loss assessment was conducted after Hurricane Ivan using the ECLAC methodology, compiled approximately one month after the event. The productive sectors – including agriculture and livestock, food processing, mining, commerce and tourism – sustained significant damage and losses. The disaster impact on each of the productive sectors is described below.

A. Agriculture and livestock

While agriculture and livestock production had grown by a sizable 5.7 % in 2003 over the previous year's, below normal rainfall had in fact produced a decline in the sector's gross domestic production in the first half of 2004. This reduction was due to the presence of dry conditions in the central and western parishes, which is where crops for domestic consumption are produced and experienced a drop of around 6.5 %. Traditional agricultural exports, however, had shown a vigorous growth in the first half of 2004, when a 7.7 % increase in gross output was registered, recuperating from a steady decline in the past ten years.

Hurricane Ivan brought about strong winds, heavy rainfall and floods that affected the assets and production of the agriculture and livestock sector. Winds broke, bent and uprooted plants and trees; excessive humidity and water logging of soils also affected crops and plantations; winds and floods destroyed or damaged the sector's infrastructure.

The following is a brief account of the damage and losses sustained by both the domestic and export oriented activities in the sector.

Domestic production

Due to the action of strong winds and floods, physical infrastructure and equipment for the agriculture and livestock sector – including farm buildings and equipment, farm roads, irrigation equipment, etc. – sustained significant damage and destruction, as were also large extensions of permanent plantations whose trees were broken or uprooted. Losses of lands due to the action of upstream erosion and to silting were not significant in extension and value, when compared to production losses. Most affected parishes were those of St. Catherine, Clarendon, Manchester, St. James, Hanover and St. Mary.

In regard to crops, losses occurred in the production of vegetables, fruits, banana and plantains, ground provisions and tree crops for domestic consumption. In the case of livestock, poultry, goats and pigs were most affected and milk production has decreased due to the death of dairy cattle.

Based on a preliminary survey of damage and losses conducted by the Ministry of Agriculture, it has been estimated that a total of 11,100 hectares of agricultural producing land were affected in one way or another, and that a total of 117,700 farmers sustained damages and losses.

The apiculture, fisheries and aquaculture activities also sustained significant damage and losses. Many trees that provided food for honeybee activities were destroyed and production of honey was affected. The action of the sea, through storm surge, caused severe damages to coastal line resources and to artisan and industrial fishery fleets and equipment. The catch of fish temporarily declined as a combined result of the reduced fleet capacity and of the migration of fish to other places where food was available. Finally, ponds used for aquaculture sustained damage; fish stock and inputs were destroyed. Details of damage and loss estimates for this sector are included in Table 6.1.

Traditional export production

Bananas The winds of Hurricane Ivan inflicted heavy damage to virtually the entire area devoted to banana plantations in Jamaica, which is most evident in the parishes of St. Mary, Portland St. James and St. Thomas. Trees were broken or uprooted in an estimated surface area of 4,272 hectares and the entire production of bananas both for export and for domestic consumption has been lost. This is a very serious setback for these activities that had managed to increase output by 1.4 % in the first half of 2004.

It is anticipated that the plantations can be resuscitated and that full production would be achieved in a period of 6 to 9 months, during which no significant production was obtained. In addition to the loss of production over the stated period, there was expected to be a negative impact on employment. Other than the limited labour that was required for the rehabilitation of the plants and farms, nearly 8,000 persons were out of work for the aforementioned period in the export oriented activities.

As the new banana plants reach maturity and begin production, workers will be able to return in a staged fashion. Direct damage to export banana plantations exclusively, can be measured by the cost of resuscitating the plants in 2,226 hectares, using unit costs derived by the Banana Export Company Limited. These damages were estimated as J$ 278.35 million. Losses in production over the next six to nine months, while the plantations are being resuscitated, have been estimated as J$ 930 million. Of that figure, approximately J$ 400 will represent losses sustained in the present year, and the $530 will occur in 2005. This will have a negative impact on the balance of payments as they represent exports that will not be made to the tune of 15 million dollars.

In summary, the total impact on the banana export activities will reach $1,208.35 million, of which $278.35 million (22 %) are direct damages and $930 million are indirect losses that will accrue in the present and following year (see Table 6.1).

Coffee The strong winds accompanying Hurricane Ivan affected the uplands where coffee is grown in the island. They caused the breaking up or uprooting of coffee trees as well as damage to the forest that provides shading to the plantation. In addition, the winds caused the loss of berries for the current crop in the Blue Mountain and lowland coffee areas. This caused a major setback to the increased coffee production that had been achieved in recent times as a result of major resuscitation of coffee tree activities by farmers. The destruction of 5 % of the coffee tree population has been estimated at a value of $992 million. This figure was arrived at by estimating the value of new plants for an estimated area of 2225 acres as well as the rehabilitation of plants and lands in 2630 more acres. It is to be noted that the new coffee trees will only begin producing after a three to five year period, when they reach maturity. The winds caused the loss of berries in nearly 45 % of the coffee-producing area. It has been estimated that this will impede the production and export of 213,000 boxes of Blue Mountain coffee and 41,000 boxes of lower quality coffee. Combined with a respective value of $2050 and $ 951 per box, this will translate into a loss of $475.7 million in export earnings that will have a negative impact of 8 million dollars in the country's balance of payments for 2004.

In addition to the above, a further indirect loss of $97.6 million is anticipated for at least the following three calendar years until the new trees reach maturity. In addition, there exists an insurance scheme for the sector. Insurance is available for coffee production, provided the losses occur after berries are present on the trees, at a rate of 20 dollars per box for the case of Blue Mountain coffee and 12 dollars per box for lowland quality coffee, to a combined maximum amount of 8.8 million dollars. Since Hurricane Ivan, however, a significant number of the coffee trees have not been insured since the premiums are considered to be too high. Reinsurance is available from a number of large international insurance groups including Munich Re and others – whenever the losses exceed 20 % of the expected crop.

Although on this occasion insurance proceeds will assist the coffee growers to recover part of their losses, it is noted that some producers that were already considering their withdrawal from this activity due to the low international prices, and have now decided not to continue their production.

It is estimated that the coffee production activity sustained direct damage amounting to $992 million and total indirect losses of $768.5 million, bringing the total amount of the impact to $1,760.5 million. The indirect losses will have a corresponding negative impact on the balance of payments in view of the reduction in exports that is anticipated, and also a positive consequence due to the amount of expected reinsurance reimbursements (see Table 6.1). It is also to be noted, that the overall impact of this disaster is not restricted to the year of occurrence, but will have medium term consequences due to the destruction of the coffee trees.

Sugar Cane The strong winds and the floods ensuing from the heavy rainfall affected export activities, at a time when efforts were being made to increase the area of recently planted fields, to improve reaping conditions and to increase the sugar-to-cane production ratio. Sugar canes were broken and uprooted in significant extensions, and flooding affected extensive areas. In addition, miscellaneous infrastructure and irrigation systems sustained damage and destruction. Furthermore, future production in both the public and private sectors were expected to decrease, based on preliminary data (supplied by the Sugar Company of Jamaica) that covers approximately 70– 75 % of the entire sugar industry in the country, and which was expected to result in an estimated loss of 190,000 tons of cane, or 15.6 % of last year's production. It is estimated that the direct damage to infrastructure and plantations amount to $521.9 million, and that indirect production losses to the cane producers will reach $365.3 million. The total impact of the disaster caused by Ivan in these activities will thus be $887.2 million (see Table 6.1). It is to be noted that there will occur corresponding losses for the processing of cane and its conversion into sugar, which loss will be accounted for in the Manufacturing sector.

Damage and Losses in the Agriculture and Livestock sector
($Million)

Sector and subsector	Total damage	Direct damage	Indirect losses	Impacts on the external sector: Increase in imports	Impacts on the external sector: Decrease in exports
Total	**8,550.1**	**3,407.0**	**5,143.0**	**440**	**2,784**
1. Agriculture	7,192.4	2,200.4	4,992.0	230	2,784
1.1 Domestic consumption	2,632.7	199.1	2,433.6		
Legumes	43.4		43.4		
Vegetables	396.4		396.4		
Condiments	142.7		142.7		
Fruits	111.3		111.3		
Cereals	76.8		76.8		
Bananas	522.0	120.4	401.6		
Plantains	341.0	78.7	262.3		
Grain provisions (Tubers)	570.6		570.6		
Tree crops	416.5		416.5		
Others	12.2		12.2		
1.2 Traditional Exports production	4,559.7	2,001.3	2,558.4		2,784
Bananas	1,208.4	278.4	930.0		930
Coffee	1,760.5	992.0	768.5		769
Sugar cane	887.2	521.9	365.3		591
Cocoa	27.6		27.6		28
Pimiento	351.0	209.0	142.0		142
Citrus	325.0		325.0		325
2. Livestock	758.6	607.6	151.0		
Broilers	366.5	366.5			
Layers	22.6	22.6			
Goats	149.5	149.5			
Cattle (beef)	28.0	28.0			
Cattle (dairy)	4.7	4.7			
Pigs	32.6	32.6			
Sheep	1.1	1.1			
Donkey	0.1	0.1			
Milk production	26.0		26.0		
Colonies and honey production	127.6	2.6	125.0		
3. Fisheries	342.0	342.0	...	210	
Fisheries	306.0	306.0	...		
Aquaculture	36.0	36.0	...		
4. Infrastructure	257.0	257.0		175	
Agriculture	62.2	62.2			
Livestock	21.0	21.0			
Fishery	85.0	85.0			
Irrigation Systems	88.9	88.9			

Source: ECLAC estimates, based on information from official sources and private sector enterprises.

Cocoa Efforts were being made in 2003 to increase production to take advantage of increasing international prices and demand of the product. However, the scarcity of rains in the first half of 2004 resulted in a declined production (by 47.7 %), especially in Clarendon and St. Mary, the main cocoa producing parishes in the island. The hurricane damaged the trees and compromised the corresponding future production of cocoa in an area of 1100 hectares (2700 acres), thus compounding the problems of the farmers. While the trees are expected to recover promptly, an estimated loss in production of $27.6 million is expected for 2004 due exclusively to the action of the hurricane. This figure represents a loss of foreign exchange earnings and the likelihood of losing some international markets, if production is not restored promptly.

Pimento The physical infrastructure, including warehouses and equipment, and stocks of pimento already processed were damaged or destroyed. On the other hand, some trees were destroyed and berries were lost. Estimates indicate that direct damage amounted to $209 million and that losses in future production would reach $142 million, thus bringing the total effects on the pimento activity to $351 million (see Table 6.1). These losses were expected to have a bearing on the Manufacturing and Export sectors.

Citrus The action of the strong winds caused the loss of many fruits that were in varying degrees of ripening, especially in St. Catherine and Clarendon. It has been estimated that these losses are equivalent to 35 % of the expected production for the remainder of the year for this crop. These indirect losses amount to $ 325 million (see Table 6.1).

Summary - Agriculture

The overall impact of Hurricane Ivan on the Agriculture and Livestock sector, after including damage to its infrastructure and machinery, has been estimated at $8,550 million or its equivalent of 137.9 million dollars, of which direct damage are $3,407 million (40 %) and indirect losses are $5143 million (60 %). See Table 6.1.

B. Manufacturing

The Manufacturing and Processing sector had been performing well in the second quarter of 2004, as indicated by a 6.8 % growth of its real GDP compared with 2003. Hurricane Ivan was expected to have a negative effect on the Food Processing sub sector, since there would be lower volumes of domestic agriculture and livestock products to process due to the damage and losses in the primary sector. While no comprehensive damage and loss assessments were completed up to the time of the preparation of the evaluation, sufficient information was available to the ECLAC team to make order-of-magnitude estimations of the sector's expected performance in 2004 and 2005 as a result of the disaster. The Jamaica Manufacturer's Association conducted a survey that indicated that 5 % of the associates sustained significant damage to their infrastructure, machinery and stocks of products. A preliminary estimate put those direct damages at $210 million.

In addition to those direct damages, due to the temporary absence of electricity and water, the entire Food Processing sector sustained production losses for a limited time. After electricity was restored, other problems prevented them from achieving full operational capacity. It has been conservatively estimated that an average of five production days were lost as a result. Furthermore, the reduction in raw material inputs, due to the losses sustained in the Agriculture and Livestock sector brought about significant production losses for the Manufacturing sector.

These losses were estimated on the basis of the following components: decline in the processing of agricultural and livestock products earmarked for the domestic markets; reduction in the processing of fresh products for export; and a decline in the production of sugar.

For the first component, a study was made to determine the fraction of item-by-item food production that is normally retained by the farmers for local consumption and that should not reach the processing plants and domestic markets. Volumes of the production of each product that were to reach the market and would not be available due to the disaster were subsequently estimated. Then, based on an analysis of wholesale market and farm gate prices, estimates were made to determine the added value of food processing that would not be forthcoming due to the loss in agricultural production. While it is recognized that this was an indirect manner to arrive at the processing sector loss, results thus obtained were indicative of the negative effect in this sector. In addition, an order-of-magnitude estimate was made of losses that would arise in processing poultry and other livestock products.

-2
Damage and Losses in the Food-Manufacturing sector of Jamaica
($Million)

Component	Damage and losses			Sector		Effect on exports
	Total	Direct	Indirect	Public	Private	
Total	**2,204.9**	**210.0**	**1,994.9**	**312.1**	**1,892.8**	**659.5**
Infrastructure, machinery and stocks	210.0	210.0	---	...	210.0	
Domestic sector processing loss	603.9	---	603.9		603.9	--
- Agriculture	421.9		421.9		421.9	
- Livestock	182.0		182.0		182.0	
Export oriented loss	885.0	---	885.0	161.1	723.9	659.5
- Sugar	225.5		225.5	161.1	64.4	--[6]
- Food	659.5		659.5		659.5	659.5
Overall production activity reduction	506.0	---	506.0	151.0	355.0	...

Source: Estimated by ECLAC on the basis of official and private sector information.

In regard to the second loss component, which was based on a sample survey conducted by the Jamaica Exporters Association, a forecast was made on the loss of revenue that would be sustained in the six months following the hurricane due to the unavailability of fresh products for processing and export. In the third component, estimates were made of the losses for the sugar processing plants based on the volume of sugarcane that was lost and in combination with the expected sugar/cane ratio and the prevailing price of sugar.

In summary, it can be stated that Hurricane Ivan imposed total damage and losses of $ 2205 million (US$35.6 million) to the Food Processing sector, of which $1995 million were indirect (90 % of the total) and $210 million direct damages. Furthermore, these losses were expected to translate into a negative effect on the country's balance of payments due to the decrease in exports to the tune of $660 million or 10.6 million dollars (see Table 6.2).

C. Mining sector

The growing world demand for aluminium has caused a sustained growth in the Mining sector of Jamaica, so that its gross domestic product grew by 4.9 % in 2003. In the first half of 2004, the utilized production capacity in the alumina plants was 100.2 % and 95.7 % in the bauxite plants. The Jamaica Bauxite Institute had envisaged a 10 % increase of production for the present year, before the hurricane struck. Production at some of the sector plants was only interrupted for a short period of time before and after the hurricane struck, and the plants only sustained slight damage in non– essential components. Full production operations were resumed shortly after the hurricane. While damage to the plants´ infrastructure and quarrying sites was relatively minor, Ivan's winds and storm surge caused the destruction of sections of port, conveyance and loading facilities in at least two locations (Photo 6.1), so that export operations were affected. Use is presently being made of an alternative port, to expedite exports.

Photo 6.1

DAMAGE TO LOADING FACILITY

Preliminary estimates, pending more detailed assessments for insurance purposes, indicate that direct damage to infrastructure, mainly port related facilities, amounted to $50 million. Estimates of indirect losses were made taking into consideration the temporary stoppage of production of all plants over a period of five days. It was considered that it would be nearly impossible to recover these production losses in the remainder of the year since the plants were operating at nearly 100 % of their capacity. The very high daily production achieved in the months of July and August, just prior to the disaster, was used as a basis to project the losses in the above-mentioned five-day period. The increased operational costs due to the damage in port and related facilities were not deemed significant. The indirect losses were quantified as $980 million, which would have had a corresponding impact on the external sector on account of exports that would not be made in the present year.

The total impact of the disaster on the sector amounted to $1030 million, or its equivalent of 16.6 million dollars. Indirect losses represented 95.0 % of the total impact. The overall impact of these damages and losses in the external sector accounts included $980 million (US$15.8 million) in lost exports and $32 million (US$0.5 million) in imports of materials and equipment to replace damaged infrastructure (see Table 6.3).

3
Estimated Impact of the Hurricane on the Mining Sector of Jamaica
($Million)

Component	Damage and losses			Sector		Effect on external sector
	Total	Damage	Losses	Public	Private	
Total	1,030.0	50.0	980.0	---	1,030	
Infrastructure	50.0	50.0	---			32.0
Production	980.0	---	980.0			980.0

Source: Estimates made by ECLAC on the basis of official and private sector information.

D. Commerce sector

The Food, Beverages and Tobacco sub-sector, which represents 15 % of total sales in the Distributive Trade sector, experienced a 12.2 % downturn in sales in the first half of 2004, mainly due to decreased production of agricultural goods. The decreased amount of agricultural and livestock products expected to reach the market after the losses caused by Hurricane Ivan were expected to be compensated by imports from abroad, so that food availability would be ensured in the country. Because of this, sales and profits in the commerce sub-sector were not expected to be affected in a significant manner, excepting in the event of a delay in import arrivals, and no negative impact was expected in its GDP as a result of the disaster. Nevertheless, supplying the demand of agriculture and livestock goods in the local markets were expected to have an unforeseen impact on the balance of payments.

Estimates were made of this possible effect based on the amounts and prices of those agriculture and livestock goods that should reach the local markets to satisfy domestic demands, and after discounting the amounts of said goods that are normally consumed directly by farmers without going into the commercial channels. The estimated negative impact on the balance of payments was thus estimated to be about J$ 556 million or its equivalent of 9 million dollars.

E. Tourism

The gross domestic product of the Tourism sector in Jamaica has been rising steadily over the past two years, as a result of the industry's recovery from the effects of the September 11 attack in the United States and of the Severe Acute Respiratory Syndrome (SARS) outbreak in 2003.

During the second quarter of 2004, total visitor arrivals grew by 9.4 %, while stopovers increased 12.0 % and cruise passenger arrivals by 5.7 %.

The winds of the hurricane and the associated storm surge caused severe damage to hotel and restaurant infrastructure in the Negril and Treasure Beach tourist areas; other tourist areas located in the vicinity of Kingston (Strawberry Hill) sustained damage as well. Beaches and coral reefs sustained damage due to the action of the storm surge that in some places exceeded 3m in height. Some cruise ships were diverted from Jamaican ports before the arrival of the hurricane.

While the hurricane occurred during a relatively low-occupancy period of the year, revenue losses could be high depending on the time required for rehabilitation of the damaged premises. In most cases, however, hotel owners expected to have achieved full infrastructure recovery before the start of the high tourist season on December 15. Entrepreneurs within the sector made every effort not to lay off any of the skilled employees by resorting to their utilization in maintenance and rehabilitation activities, as well as offering advanced annual leave to the workers, so that they could be available when the high season started.

Based on information furnished by private entrepreneurs, the total impact of the hurricane on the sector amounted to $1590.7 million, or its equivalent of 25.7 million dollars. Of this, $466.3 million represented direct damage, and expected losses of revenue would amount to $1124.4 million. The impact on the external sector was expected to be significant since most of the earnings of tourism were derived from foreign visitor expenditures (see Table 6.4).

Estimated Impact of the Hurricane on the Tourism sector of Jamaica
($Million)

Component	Damage and losses			Sector		Effect on external sector
	Total	Damage	Losses	Public	Private	
Total	1,590.7	466.3	1,124.4		1,590.7	1,054
Infrastructure		466.3				
Revenue loss			1,124.4			

Source: Estimates made by ECLAC on the basis of preliminary private sector information.

F. Infrastructure

Infrastructure was one of the main areas that sustained significant direct damage due to wind, rainfall and runoff. Destruction and damage to infrastructure, however, was minor compared to the indirect effects arising from the temporary absence of the services that the population draws from the infrastructure. The damages and losses sustained by electricity, water supply and telecommunications systems, and by the transport sectors, are described below. However, contrary to the case of the social and productive sectors, information to evaluate damage and losses in the infrastructure sectors were not fully available at the time of the assessment. Some of the entities that provide some of these services were still facing the pressing needs of restoring their systems and facilities, and were thus unable to provide the information that was required. In addition, private enterprises in some sectors engaged consultants to appraise their damage and losses with a view to submitting insurance claims, and were also unable to provide information that was in the process of being completed. Therefore, and contrary to what normally happens in other countries, the estimation of damage and losses in infrastructure was less comprehensive and of more limited accuracy than those of the sectors that have been described in the previous sectors.

Electricity and Water

According to recent data, real GDP for the electricity and water sub-sector grew by 3.8 % in the second quarter of 2004, in comparison with the corresponding period for the previous year. This was due to increased production of both electricity and water. Total electricity generation rose in the quarter to 962.5 million KWh, and the production of water reached a total of 71240 mega litres. The hurricane was expected to affect the sector's performance for the third and fourth quarters.

Electricity sector

The Electricity sector sustained damages and losses that, while small in comparison to other sectors, had a very significant impact on the functioning of the entire Jamaican economy. Just before the hurricane reached the island, power generation was suspended as a precautionary measure. The hurricane's strong winds affected lower voltage transmission lines through the breaking of poles especially those made out of wood, as well as urban distribution grids. Electricity supply was interrupted throughout the island. The Jamaica Public Service Company Limited (JPSCo.), the private entity entrusted with the provision of electricity in the island, began efforts to restore the transmission and distribution service on a staged basis. Priority was assigned to the reconnection of essential public buildings such as hospitals and water purification, production and pumping plants. Depending on the availability of road access, JPSCo. began the process of replacing broken poles and restoring service. Thirty eight days after the disaster, 5 % of users remained without service, especially those located in far away areas where roads were still inaccessible or under repair.

The JPSCo. was expected to sustain a decline in revenues due to the interruption of the power supply. In the absence of detailed information, an attempt was made to estimate these losses and use was made of the average value of revenues in 2003 in combination with the information on service recovery performance described above. In addition, the utility company incurred unforeseen expenditures – including both overtime salaries for employees as well as transport costs – for the repairs to the system, which also had an effect on its financial results for the year. Again, in the absence of itemized information in this respect, order of magnitude estimations were made of these losses.

No estimates were available in regard to the value of the damaged or destroyed assets. Nevertheless, since the JPS undertook the replacement of poles, cable lines and related equipment and materials, drawing from its inventories, which were expected to be replenished with imports later on, a rough estimate was made on the basis of the value of those stocks described in the company's 2003 Annual Report. Preliminary estimates indicated that the electrical sub-sector sustained total damage and losses of some $1398 million (or 22.5 million dollars), of which $589 million were direct damages (42 %) and $809 million indirect losses. Imports amounting to $410 million (or its equivalent of 6.6 million dollars) would have to be made to replenish the inventory of materials and equipment of the utility.

The damage and losses sustained by the electricity sector were expected to result in losses to the sectors and persons that make use of electricity as an input for their activities and production. Despite the availability of emergency generating plants, many activities could not begin their reactivation before electricity was restored or while the service was still suffering interruptions. These indirect losses were estimated and accounted for in most of the sectors analyzed in previous chapters. However, the entire stoppage of electricity supply for at least one day, would have a negative impact on other productive sectors not analyzed in the assessment, and would have an additional effect on gross domestic product.

Water supply and sanitation

Water production and consumption in the first six months of 2004 was slightly above normal, due to a 3.1 % increase in the rural areas. However, as described in the Agricultural sector of the report, total rainfall was 30.3 % below the 40-year mean. The winds from the hurricane produced minor damage to buildings, while flooding and landslides affected water intake works, dislocated water mains and blocked access to some critical facilities. The high sediment content in river and spring water resulted in very high turbidity levels that could not be easily reduced at treatment plants, and some of them were temporarily taken out of operation. But the most significant factor was the lack of electricity that impeded the functioning of key components of the system, including pumping stations and treatment facilities.

Over 600 electricity-dependent facilities, including sewerage plants, were affected in one way or another. While waiting for the restoration of electrical service, the National Water Commission (NWC), under the Ministry of Water and Housing, made efforts to bring back into service those facilities that could be operated on available standby generators, as well as those systems that could be operated through gravity flow distribution. Priority was assigned to hospitals and other critical facilities. As electricity flows were restarted and road access to facilities was restored, water supply was restored.

Approximately 40 days after the hurricane struck, service had been restored in about 97 % of the entire system. Nevertheless, some locations were still suffering from low water pressure, intermittent water supply and even no water, in response to variations in pressure within the system. During the initial days of the crisis, the NWC resorted to distributing water in many localities through the use of tanker trucks, both from its own fleet and renting others from private companies. NWC personnel had to work long hours in order to prepare systems for reenergizing, to rehabilitate damaged plants, and for emergency distribution of water. Increased filtering and treatment of water was made in order to guarantee a minimum quality of drinking water. Therefore, the utility enterprise suffered from loss of revenue and increased operational expenditures over the time required for the resumption of normal activities.

Partial information was available concerning the direct damage sustained by the system. Estimates were made of the losses in revenue that the NWC would sustain, based on the recovery of the service data in combination with the average daily revenue as recorded for 2003.

Operational cost increases were estimated taking into consideration overtime of field personnel, the cost of operation or rental of tanker trucks, increased fuel and water filtering and treatment costs, on the basis of information provided in the annual report of the NWC and of the time required for recovery of the service. It was estimated that the water supply and sanitation sub sector sustained total damage and losses of $578.8 million (US$9.3 million), of which direct damage amounted to $90 million and indirect losses were $488 million. Due to the need to import some equipment and materials from abroad, a $134 million (US$2.2 million) negative impact was sustained by the external sector.

These damages and losses sustained by the water supply and sanitation sub-sector were expected to have an impact on other sectors. In the health sector, for instance, the lack of water created problems in the operation of hospitals and other facilities and the absence of a fully reliable quality in the water supply was partly responsible for increased morbidity rates. In addition, the temporary absence of safe water at homes forced people to resort to purchase bottled water for consumption, thus affecting their household budget.

Transport

The hurricane caused a very negative impact on roads and generated revenue losses in the international airport in the capital city of Kingston.

Road transport

The heavy rains produced by hurricane Ivan and the ensuing floods, land and mud slides inflicted a heavy toll on the road network of the island, including both main roads maintained by the National Works Agency (NWA) and by Parish councils. The storm surge caused heavy damage to the highway connecting Kingston and Norman Manley international airport.

Floods and landslides cut off entire sections of roads; blocked and destroyed drains and culverts; damaged and destroyed retaining walls and bridge approaches; and breached riverbanks and deposited silt on river channels. As result of saturated soils, heavy rainfall and the eroding action of river and streams, slippage of entire sections of roads occurred. High river stages and floods scoured river channels and adjacent roads and related works. Roadway carpeting was badly damaged and many of the major arterial roads sustained damage.

Rehabilitation efforts of the NWA concentrated on clearing the roads to ensure at least single-lane traffic, which was achieved by September 30, 2004. Direct damage to the road system included the cost of removing landslide material, repairing and reconstruction of drainage and ancillary structures, repair and reconstruction of entire sections of different types of roads, and the resurfacing of many roads. In addition, many vehicles were carried away or destroyed by floods.

Indirect losses included the temporary interruption of passenger and cargo traffic in the road network for three to five days, the slower than normal traffic in single lane roads, the use of alternative and lower quality roads, and the increased transport cost due to deterioration of road surfaces. No information on the volumes of traffic for the affected roads, or on the increased unit transport costs in the case of lower quality road surfaces was available at the time of the assessment. Therefore, it was not possible to undertake even an order-of-magnitude estimation of these indirect effects (anticipated to be very high in monetary terms) that would have a negative bearing on the population's well-being. The costs of river training to protect the roads from future damages were estimated as indirect losses. Therefore, the total effect of the disaster on the road transport sector was estimated as $3199 (51.6 million dollars), of which $2403 million refered to direct damage and the remaining $796million represented the underestimated value of indirect losses. Imported equipment and materials for the sector were expected to have an estimated impact of $1280 million or its equivalent of 20.6 million dollars.

Airports

The passage of the hurricane forced the closure for a period of three days of Norman Manley airport in Kingston and of Donald Sangster airport in Montego Bay, which handle international air passenger and cargo transport. Winds damaged roofing in the cargo areas in the runway lighting system, and broke windows at the Norman Manley airport. In addition, several light planes were swept away and turned over by the winds. Operations were resumed after clean-up operations had been completed at both airports. Nevertheless, there occurred losses of revenue that affected financial operations.

These included the decline in passenger service, landing, security, car parking service, and airport improvement fees, as well as income from concessionaires established at the airports. The total impact of the disaster on the sub-sector was estimated at $60 million, of which $47 million were direct damages and $13.1 refered to indirect losses. The airport and airplane owners had insurance covering those damage and losses.

Telecommunications

The Telecommunications sub-sector sustained significant physical plant damage and operational losses. Detailed assessments were carried out, as required by the insurance companies, before reimbursements could be made. Nevertheless, order of magnitude estimates were developed.

The telephone exchange building and equipment located in two locations in central Jamaica were flooded and the service was turned off, which left the St. Elizabeth, Santa Cruz and other neighbouring parishes without telephone communications. The submarine fibre optic cable that links the island with the United States, through which nearly 80 % of the traffic, (including Internet) is routed, was severed in its land section in the Cayman Islands. Traffic was re-routed through satellites but service remained at below standard levels for some time.

Cell phone services sustained damage as antennas were turned out of alignment by the strong winds of the hurricane. The lack of electricity made it necessary for the utilities to resort to use of standby diesel generators and many users were unable to use their phones as they lacked capacity to recharge their units. The utilities incurred increased operational costs and this resulted in lower revenues over the period of recovery, which lasted from between one to two months.

Based on partial information available, it was estimated that the cost of direct damage to the Telecommunications sector was $198.6 million, as required for the repairs and reconstruction of the assets. Scant information available for two of the utilities indicated that indirect losses would be around $1336.7 million. The total amount of the impact of the hurricane on the sector was expected to reach $1535 million.

Appendix III

NATIONAL DISASTER PLANS OF JAMAICA

The National Disaster Plan is comprised of several volumes as listed below:

- National Hurricane Plan
- National Earthquake Plan
- National Emergency Operations Centre Procedures
- National Drought Management Plan
- National Plan for Riots and Civil Unrest
- National Fire Plan
- National Aircraft Crash Plan
- National Transportation Plan
- National Communications Plan
- Management of Incoming Personnel Plan
- Welfare and Relief Assistance Management Plan
- Management of International Assistance
- Procedures for Donating Assistance to Countries Affected by Disaster
- Recovery Plan
- National Oil and Hazardous Materials Spill Plan
- National Mass Casualty Plan
- Parish Disaster Plans
- Major Epidemic Plan
- National Animal Diseases Plan
- National Damage Assessment Plan
- National Media Plan

In addition, The Jamaica Constabulary Force, Fire Brigade and Jamaica Defence Force have orders which detail their response procedures. Major hospitals also develop disaster plans, as do Ministries and Agencies involved in the national response team.

Finally, there is a Portmore Evacuation Plan, which has been developed to aid this large urban community in the advent of a major hurricane or earthquake event.