DAMAGE ASSESSMENT REPORT FROM
29TH DECEMBER 2000 - 4TH JANUARY 2001
HEAVY RAINS

Prepared by the Office of Disaster Preparedness and Emergency Management

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1.0 INTRODUCTION

1.1 BACKGROUND

Jamaica is located to the north west of the Caribbean, approximately 800 km from Florida peak. The area of the island is approximately 11,400 sq.km. The island is relatively mountainous and hilly with the highest mountain peak – the Blue Mountain- rising 7,402 ft above sea level.

The islands' rainfall is derived from several weather phenomenon. The major rainy period is during the hurricane season that starts from June 1st to November 30th. Heavy rains also occur during the months November to April and are due to cold frontal systems that descend from the north.

One of the many frontal systems descended and lingered over Jamaica from the 29th December 2000 to the 4th January 2001. This system brought heavy rains. The highest recorded rainfall per day for that period was on the 1st January 2000, in the amount of 179.9 mm. The volume of water from the rains and the short length of time that the rains fell caused extreme damage, severe flooding and several landslides, in the majority of the north and northwestern parishes.

Previous heavy rains also occurred during 30th November to 4th December 2000. These rains escalated the intensity of flooding and landslides during the 2001 rains. The previous rains saturated soil and rock materials. The Parishes also experienced some flooding during that period. During the Jan 2001 rains the absorptive capacity of the soil was therefore unable to recover, as a result, surface drainage increased.

Agriculture and road/bridge infrastructures were damaged or destroyed in most parishes. Trelawny was reported as the parish that was affected the most from the heavy rains with a preliminary estimated flood damage loss of $13,451,800.00. Several families were evacuated due to flooding for example, in the Wakefield Community, Trelawny, but there were no reported death or injury to date.

1.2 AIMS AND OBJECTIVES

The aim of this report is to focus on the damage caused by landslides and floods from the rains of December 31st 2000 to January 4th 2001, in several north- northwestern communities, these parishes are:

- Portland
- St. Mary
- Trelawny
- St. Ann
- St. James
- St. Catherine
- St. Andrew

The report is to make recommendations on appropriate mitigation strategies that could be implemented in these areas.

The objectives are to:

1. Identify the causes of the landslides and flooding.
2. Determine the vulnerability caused by the landslide.
3. Identify the needs and priorities for mitigation and emergency preparedness.
4. Determine the economic impact of landslides and floods in each parish.

1.3 METHODOLOGY

Preliminary information concerning effects of the heavy rains was collected and recorded from distress reports from residence in the affected areas. Confirmation from response authorities like the JDF and JFB was also used to compare reports and to plan appropriate responses.

Secondary research was done directly in the field as site investigations. Pictures and details of the incidences were taken. Parishes that were visited were: Trelawny, Portland, St. Mary and St. James. Representatives who were present in the field were; the Parish

Council Coordinator or representative, Parish Disaster Coordinator, Regional Coordinator and persons from the Mines and Geology Division.

Some preliminary information of the rains effect on the economy was also collected by information that was sent from parish councils.

2.0 RAINFALL DATA

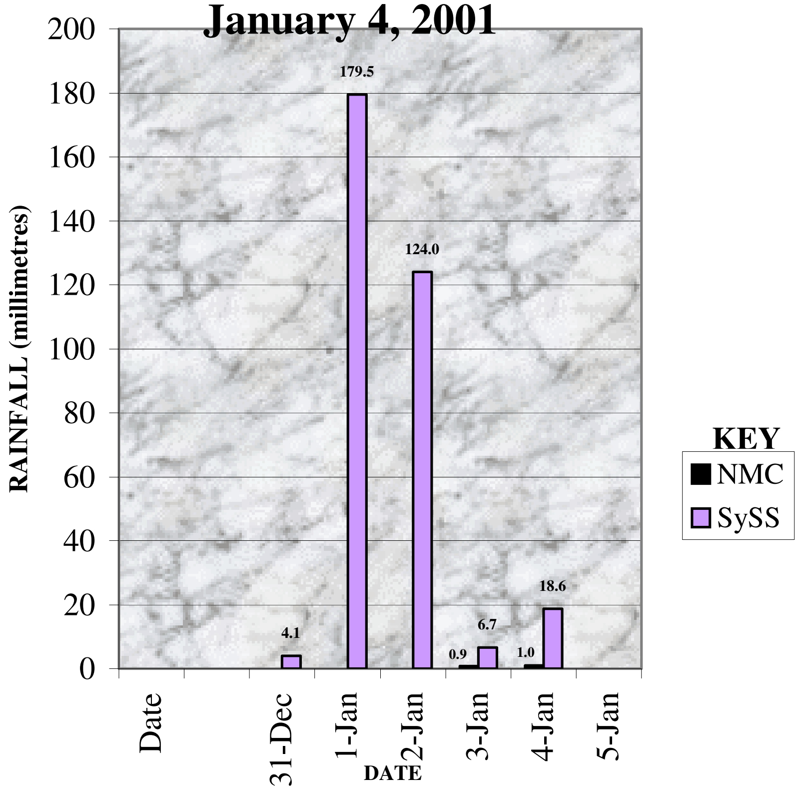
Several north and northwestern parishes in Jamaica experienced severe weather conditions during the period December 31st 2000 to January 4th 2001. This disturbed weather was caused by a frontal system that lingered over part of the island for the majority of those days. On January3rd, the northwestern parishes and the interior of the southern parishes also experienced showers before the rains deceased.

The moderate to heavy rains from the system caused severe flooding and landslides in St. James, Portland, St. Ann, St. Catherine, Trelawny and St. Mary. Minor incidences occurred in St. Andrew. This resulted in damages to housing, agriculture, roads/bridges, the latter were reported as having the most damages.

One of the factors that may have generated the severity of the landslides and flooding was the saturation of the soil from previous heavy rains that occurred in early December 2000 in some of the Parishes.

The graph below demonstrates the amount and irregularity of rainfall that was recorded during the December 31st, 2000 to January 4th 2001(data taken from the preliminary report, January 16th, 2001, Climate Branch, Meteorological Service, Jamaica).

Bar Graph of Rainfall recorded at the National Meteological Centre NMC (Kingston) and at Synoptic Sub Station SySS (Montego Bay) for December 31, 2000 - January 4, 2001



Data source: Climate Branch, Meteorological Service, Jamaica.

Figure 1

3.0 GENERAL CHARACTERISTICS

3.1 PROFILES OF THE AFFECTED PARISHES

PORTLAND

Location: The Northeast tip of the island.

Area: Approx. 814 sq.km

Land-use: Agriculture contributes to the main financial sector of the economy.

Rivers: The main rivers are the Rio Grande, Swift, Buff Bay and Spanish River. Other minor rivers flowing through the parish include Daniels, Little Spanish, Priestmans and Back Rivers.

Elevation: Blue Mountain Peak – 7402 ft.
Catherine Peak – 5000 ft.

Geology: White Limestone, Yellow Limestone and Sedimentary Rocks are the dominant geological formations in this parish. The sedimentary formations are Richmond, Wagwater and Cretaceous Sedimentary rocks. Volcanics are also present in small amounts. This Parish has a high fault density that contributes to the instability of the land. This factor of instability is seen especially in the hilly interiors.

Because of the parish's position on the island, Portland experiences hard lashes of bad weather. Cloud masses laden with moisture are forced to rise when they reach the mountains of Portland; at that height the moisture is cooled and then condensation of the moisture takes place; this subsequently produces rain, most of which falls in the Portland area. The amount and intensity of the rains are just some factors for the instability of the land and soil in this area.

Landslides were reported on the eastern side of the parish where sedimentary formations- Richmond, Wagwater, and Cretaceous Sedimentary formations are located.

ST. MARY

Location: Northeast of Jamaica.

Area: 657.86 sq km

Land-use: Tourism is now the fastest growing sector of the economy.
Agriculture remains the backbone of the Parish's economy.

Geology: The Parish can be noticeably divided into two sections:

1. The geological formations on the eastern side of the parish consist mainly of sedimentary rocks (sandstone, siltstone or shale). Two of the major formations are the Wagwater and the Richmond formations. Under tropical conditions these formations tend to weather easily and erode during periods of heavy rainfall. Intricate surface drainage is also another topographic feature recognized in the eastern section of this Parish.
The eastern section of the parish experienced landslides especially the District of Richmond.

2. The geological formation on the western section of the parish is made up of the White Limestone Group. This formation is not as unstable as the formations located on the eastern section of the parish. The texture ranges from chalky and marly beds to brecciated types to very hard to

compact rocks. This section has predominantly underground features.
Landslides were not reported from this section.

TRELAWNY

Location: Northwestern Jamaica

Area: 874-643 km

Rivers: The main river is Martha Brea, which has its source in the cockpit country.

Land-use: Agriculture is the main focus of Trelawny's economy.

Geology: The area is predominantly White Limestone that has been eroded into a region of elevations and depressions, dissected by deep sinkholes and steep sided circular hills.
Few landslides were reported in this area.

This Parish was reported as the worst hit by the heavy rains. Extreme flooding was reported in several areas. The geological features of this parish and the low maintenance of the depressions were some of the factors that contributed to the intensity of the disaster in the area.

ST. ANN

Location: The north coast of the island.

Area: 1212.6 sq. km

Land-use: Agriculture, cultivation is predominantly confined to the crown lands in the hill. Livestock is also produced.

Geology: White Limestone Group is the main formation found in this parish. There are several popular hills and mountains in this area. This includes the Dry Harbour Mountain, Mount Alba, Irons Mountain, Murray Mountain, Mount Diablo and Mount Zion.

There were no landslides reported in this area. This may be due to the stability of the limestone. Flooding though, occurred along the roadways.

Rivers and Waterfalls: From these mountains and hills numerous rivers originate, the Whiter, Great, Dunns, Roaring, Caver and the Pedro rivers. The more popular waterfalls are Dunns River Falls, the Llandovery and the Roaring River Falls.

ST. JAMES

Location: Northwest of Jamaica

Size: 621.4 sq. km.

Rivers: Great River, Montego River

Main Elevation: Stretch from St. Elizabeth, the Nassau Mountains extends across St. James, and end in the hills at a point just south of Montego Bay.

Land-use: Agriculture is popular along with large-scale cattle rearing. The Parish contains several manufacturing establishments. The most urban town in St. James is Montego Bay, which is one of the more popular resort areas on the island. Construction of new houses, resorts, restaurants and roads are constantly being done. The majority of these buildings are built on the steep slopes.

Geology: The geology in St. James is rather complex in structure due to the network of faults. The White Limestone dominates the area. A few minor sedimentary formations are also located in this section. The Coastal Group and Alluvium deposits border the north of the Parish on the coastline. Some beds in St. James in the basal section possess the properties of 'freestone' being soft when quarried and hardened on exposure to the atmosphere (Hughes 1975, The Mineral Resources of Jamaica as sited in Porter, *et al,* Minerals and Rocks of Jamaica.)

ST. CATHERINE

Location: South Coast of Jamaica

Area: 1191 sq. km.

Land-use: Agriculture, St. Catherine is one of the major sugar producing parishes.
Industry – the largest salt producing plant in the Caribbean is located in this parish.

Geography: The Linstead Basin makes up one of the largest and most important basins in Jamaica – the Rio Cobre Basin. This area comprises over 300 sq. miles and includes extensive agricultural lands. St. Catherine Plains occupy the southern part of the Rio Cobre River Basin.

Geology: The North of the Parish is mainly made up of White Limestone whereas the south is made up of Alluvium deposits. Note though that the Hellshire area is predominantly White Limestone.
A minor landslide was reported in this Parish.

4.0 TYPES OF HAZARDS AND AREAS AFFECTED

4.1 INTRODUCTION

Landslides and flooding were the two main hazards that affected the Parishes. Flooding was reported mainly in the low-lying regions of the parishes, usually where a major or minor river, gully or culvert is located. Landslides were usually reported in areas where the Richmond Formation (a formation that is comprised of sandstone and shale) had disintegrated and eroded. The deterioration of this formation is usually due to Jamaica's tropical climate which leaves a soft, crumbly, weak structure that gets easily disturbed when saturated by prolonged rains.

4.2 FACTORS THAT CAUSED FLOODING

Flooding was reported in the parishes of **Portland, St. Mary, St. Ann, St. James, Trelawny, and St. Catherine**. There were several factors that influenced the extent of the flooding:

- **The severity of rains during a short period of time (approximately one week).**
- **The rate at which water entered the stream system,**
- **Location of residential areas and**
- **The maintenance of drainage networks**.

Reports of flooding also came from swampy areas example **Halls Avenue, Trelawny** or where depressions/sinkholes were filled to their capacity.

Topography also influenced the extent of the flooding. Steeper terrains encouraged water run-off over surfaces and less infiltrated the soil. Examples were seen in **King Street, St. James; John Town, Portland and Moore Town, St. Mary.**

Run-off in these steeper terrain areas also scoured roads. This was due to the fact that little or no drainage systems were built on the sides of the road to channel the water. Some roads that were affected were**, Swift River, Portland; Mt. Herman, Portland; Grandville Road, Trelawny; Green Pond, St. James; Rose Mount Main Road, St. James; Crichton Heights, St. James.**

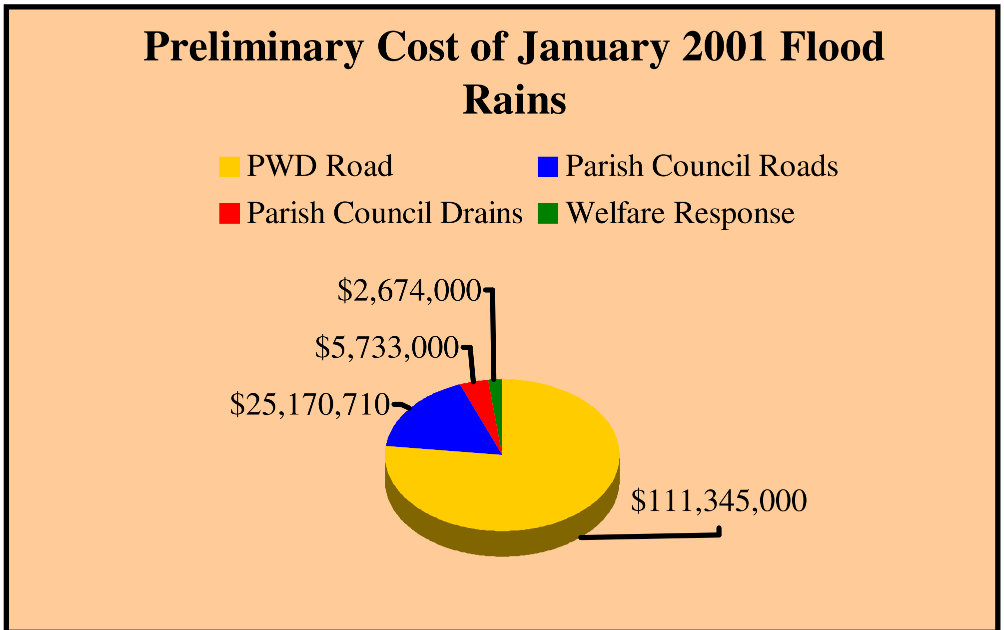
4.3 FACTORS THAT CAUSED LANDSLIDES

Landslides were reported in the parishes of **St. Andrew, Portland, St. Mary, Trelawny** and **St. Catherine**. Landslide is a general term for the results of rapid mass movement (Montgomery, 1995). The landslides were activated by the saturation of the soil/rock by the heavy rains. The increase in pore pressure decreased the rocks resistance to shearing stress (Montgomery, 1995) and caused the fracturing and sliding of the material.

Landslides were also present in areas with steep slopes; one spectacular landslide that is still a treat to the community is in **Moore Town, Portland**. This landslide was activated by the rains, and had cut off the main road. A wooden house that was located below the edge of the road was shifted several meters from its original position by the weight of the debris from the landslide (see figure 11). Most of these landslides occurred on the Richmond Formation.

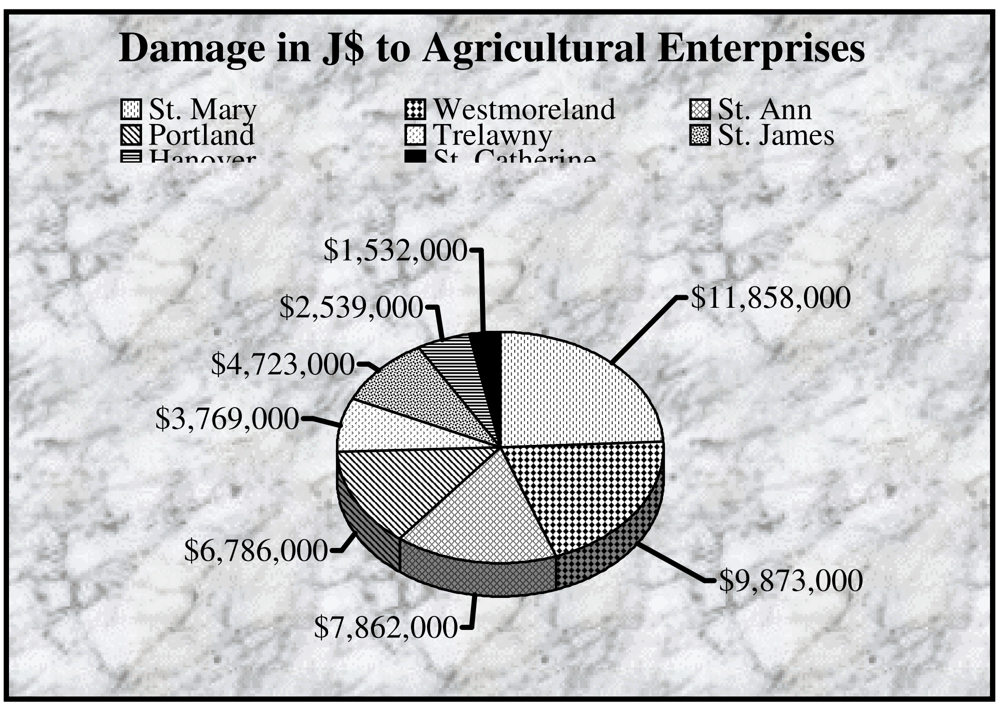
Approximately fourteen (14) minor landslides were identified at Mount. Herman, Portland. Landslides also broke away sections of road infrastructure where communities were cut off examples were seen in Mt. Herman, Portland; Belfield Line, St. Mary.

5.0 ECONOMIC IMPACT



Souce: Preliminary Data from MLSS and Poor Relief 2001

Figure 2



Data from Rural Agricultural Development Authority, December 2000.

Figure 3

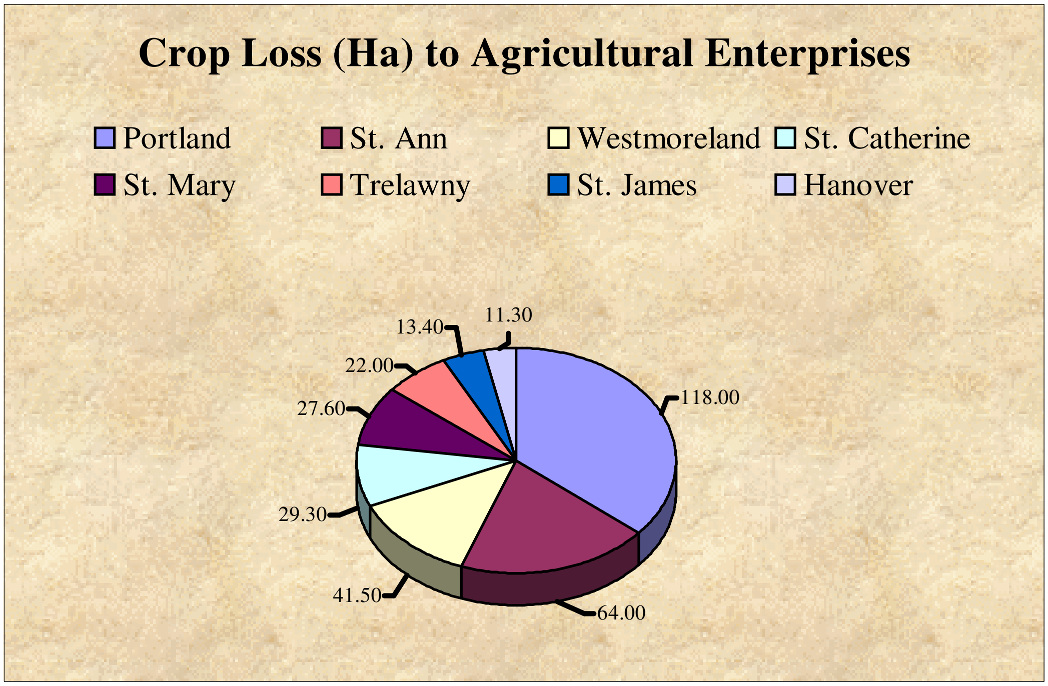


Figure 4 Data from Rural Agricultural Development Authority, December 2000.

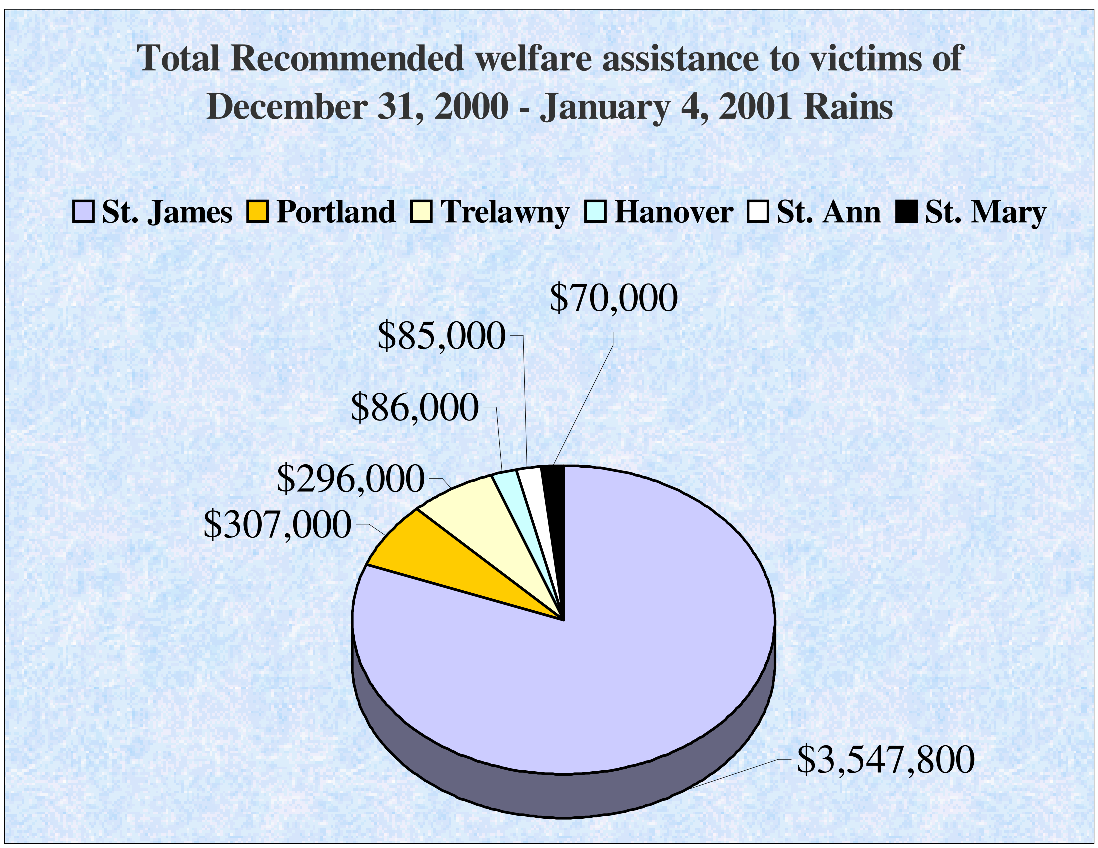


Figure 5 Source from MLSS and Poor Relief, January 2001

6.0 RECOMMENDATIONS

6.1 LANDSLIDES

Techniques that would prevent and reduce the severity and amount of landslides in Jamaica are near difficult if not impossible due to Governments' financial constrains. Majority of these landslides indicate a strong relationship with geology and often occur along steep slopes near road cuts or construction sites. These recent landslides caused little or no human injury, but they certainly affected populations in small communities by isolating them for hours or days from society.

Most preventative measures that could be practiced to reduce landslides are rather expensive especially for areas where population density is low. Several of these measures though will still be mentioned below. It is important for specialized persons to study the area and the characteristics of the lithology before taking steps to control landslides. Some of these measures would be useful in places, for example, **Fellowship – Berridale, Portland**, where the population is relatively high. On Mount Hermon Road, it may be more economical to just remove the debris after landslides occur since they usually exist on the road cuts where there is hardly any settlement around.

Slope Reduction – Reduction of a slide potential of rock material can be done by reducing the steepness of the slope by adding material at the base of the slope. This measure though needs to be monitored due to the fact that settlers might remove this material for their own domestic use.
The type of material and its porosity potential that would be added to the base should have the qualities where it would be able to channel water that would otherwise collect and trigger more land movements.

Retaining Structures – Construction of gabion baskets would stabilize the soil.

- Weight of the formation material,
- Gradient of the slope and
- The population density

would all play a major part in the importance of the construction of these structures.

Weight of the formation material **–** The weight of the retaining wall should be able to accommodate the weight of the soil material that has the potential to become unstable.

Gradient of Slope **–** The intentions to stabilize the slope becomes more difficult with increase slope gradient. The dimensions of the wall that is the length and width should be adjusted depending on the steepness of the slope.

Population Density – Priority should be considered when constructing gabion baskets in populated areas. Densely populated areas where fatal accidents from landslide may occur would take priority over an area with little or no population.

Main roads that link communities should take priority, examples can be seen in **Rose Mount, St. Mary** and **Swift River main road, Portland.**

Planting Vegetation – Planting vegetation on slopes that shows bare rock can also reduce the amount of landslides. This vegetation should not be agricultural for them to be removed, but should be permanently planted. Choose vegetation that has high-density roots and branches and would not attract persons in the area to cut down and use for domestic purposes.

- ❖ **Recognizing the hazard before it becomes disastrous is also important.** From past observations and research, sedimentary rocks especially the Richmond Formation in these northern parishes have been susceptible to landslides. Recognizing this hazard and monitoring where persons settle can prevent fatal incidences from occurring. Areas where there are continuous reports of landslides should not be allowed to be over-populated.

- **Squatters must be monitored and permanently removed/relocated as soon as authorities** know of their intentions. This being a delicate matter, landslide hazard maps should be interpreted and displayed to them when enforcing the law.

- Residence, especially in Portland, should be educated about hazardous areas, **flood prone and landslide prone areas**, when constructing their homes. The Town Planning Department should be involved in advising home owners when constructing their homes.

- A settlement where potential landslides could occur is in **Coffee Piece, St**. **Mary**. There have been reports of movement of land that has caused shifting of several house foundations. In figure 7 shows a stilt of a home that was shifted due to a slump on the land. The owner of the home had to construct a new stilt. His neighbour has also seen large cracks on her land. The area slopes into a gully. This physical evidence obviously indicates a creep or gradual soil movement. **This area needs to be studied before a disaster occurs.**

- The construction of the bridge at the **Pencar River, Fort George, St. Mary,** was highlighted in 'Landslip Investigation, Harris, N. *et al* 1984.' The geology of the area was recognized as an unstable area and was compared with the area of the Annotto River. It was noted that the river at Annotto Bay was removing the loose unstable material from both entrances of the bridge. The emphasis for a proper design for the foundation of the bridge was noted as being necessary to stabilize the bridge. The same was also recommended for the Pencar Bridge.

Pencar Bridge was destroyed in 1999 rains. The temporary road that was built has now been completely destroyed, washed away by the river. **Consideration for the force of the water from the river and the instability of the slopes were obviously not recognized.**

6.2 FLOODING

Flooding is a general and temporary condition of partial or complete inundation of normally dry land areas. Flooding is caused by persistent and intense rainfall that exceeds the absorptive capacity of soil and the flow capacity of natural or man- made watercourses. This causes the watercourse to overflow its banks onto adjacent lands. The following discourse will detail the exact causes of the December 31 to January 4 floods and offer some recommendations.

November to December 2000 was very wet as a result of the November 30-December 5, 2000 rains brought by a broad surface trough. Most of the country experienced rain and there was some flooding. The soil was therefore already saturated by December 31 and could not absorb more water. This lead to brief but severe flooding between January 1 and 5, 2001. The bar graph, figure 1, shows that there was intense rainfall in Montego Bay especially over a two- day period (January 1 and 2).

In areas with steep topography and small drainage basins such as in parts of St. James and Trelawny, floods occur rapidly and rise to a relatively high peak. The areas affected were concentrated and the damage was severe because of the high flow and the sudden onset of the flood.

The impact of the flood was great. Gentle meandering streams therefore became raging destructive rivers (e.g. Pencar River in St. Mary) following the rains, as did many roads and streets especially in Montego Bay, St. James; flooded out families had to be evacuated, roads and bridges were washed away, entire communities were cut-off as a result of landslides and peoples livelihoods were disrupted for example in St. James where several farmers lost approximately 2000 chickens. In Chatam, St. James this lost amounted to more than J$160 000.00 in **one** farmer's case.

There were general characteristics of the areas that were affected by the flooding:

1. Residents live next to a gully or a river.
2. Residents live down hill of squatter settlements.
3. Squatter settlements.
4. Inadequate or lack of drainage especially on the sides of roads.
5. Construction on unstable slopes.
6. Persons living in swampy lands.

The common denominator in all the above characteristics is ***urbanization***. Urbanization in Jamaica is usually accompanied by unsafe practices such as makeshift houses on unstable slopes, deforestation, and inappropriately constructed buildings in high-risk location especially by squatters. A common occurrence and also a problem were unsuitably built and poorly maintained drains; if present at all. The risk of flooding is always increased when drainage is poor. Poor construction and inadequate design specifications have also contributed to the flooding.

During urbanization, vegetation is removed, surfaces are surfaced (e.g. in Norbrook, St. James) with asphalt and concrete, which are relatively impermeable and prevent water from sinking into the ground, so it drains faster over the surface into the stream. Land development will decrease the amount of surface land area available to absorb water runoff (the permeability of the soil is going to be decreased); the construction of roofs, roads and other paved areas therefore increases in the amount of runoff and runoff rate. Urbanization therefore shortens lag time and increases peak discharge, thus increasing the severity of flooding. This shortens the lag time and increases peak discharge of the stream (see figure 6), which means that a greater volume of water runs off faster, increasing the risk of flooding. If the lag time becomes very short, especially dangerous *flash floods* may result.

Removing vegetation (deforestation) leaves the soil unprotected therefore erosion is increased and the soil is washed into streams, rivers and gullies. The soil then “silts up” the channel, decreasing the channel’s volume and thus reducing the stream’s capacity to carry water quickly.

Summary of how modification of the land increases flooding:

1. Deforestation increases run-off.
2. Flash floods are created at the bases of mountains due to accelerated run-off and reduced absorptive capacities of soil.
3. Sediment from erosion “silts up” the gullies and rivers and gradually raises the water level.
4. Increased urbanization increases run-off and contributes to flash flooding.

Good land-use practices improves infiltration and reduces flooding and erosion by delaying the movement of water to the stream and reducing the severity of flooding. The recommendations to reduce flood damage are based on two simple strategies: keeping the flood away from people and keeping the people out of the way of the flood. These strategies compliment each other.

Keeping the flood away from people

This can take the form of ***channel improvements***: cleaning of all watercourses to increase water flow and stabilizing of banks with gabion baskets, and ***elevation of houses on stilts*** and other structural mitigative measures. This will suit the residents of Holland Road in Trelawny. The stilts must be designed to withstand the impact of floating debris and the stilt foundations need to be protected from erosion.

Keeping the people out of the way of the flood

This can take the form of ***floodproofing*** which gives design specifications of buildings and sometimes involves ***permanent relocation of residents living in flood-prone areas*** for example the residents of Albion Lane, St, James who live on the banks of North Gully and those of Holland Road, Trelawny; it provides low level of protection when other solutions are not available. Floodproofing has to be also put in place for road and bridges such as the Pencar River Bridge in St. Mary. ***Zoning*** which prohibits housing developments in high-risk areas is also recommended.

Education, information and training is needed especially for those who live in flood-prone areas. This will help to reduce their susceptibility to flood damage, as they will be able to make informed decisions. Encouraging ***flood insurance*** is key so that individuals will be able to pay for the damage caused by flooding instead of depending on the Government to give them financial assistance

7.0 CONCLUSION

Jamaica would continue to experience severe weather conditions because of its global position. Parishes in the north and northwestern would always experience higher degrees of disturbances from weather than parishes in the south. This factor is justified by the fact that most of the parishes in the south are protected by the rain shadow from the mountains whereas the north and northwestern parishes are not.

The severity of the hazardous incidences (especially flooding) could have been reduced by the maintenance of the network of drains and culverts in the parishes. Residences in all of the parishes agree that the roads and drains are not being maintained. **Drains need to be maintained to reduce the effect of flooding.**

Poor channeling of water from the roads caused extensive road surface damage. But looking closer at the construction of the road, it is obvious that the roads were either constructed within a rigid budget or constructed during a short time span.
Road materials approved by engineering standards and the practice of proper engineering skills when constructing roads in Jamaica need to be enforced. **The better the quality of**

infrastructures constructed in Jamaica the less damage they would experience during heavy rains.

Maintenance does not only relate to the roads, gullies and drains but also the many sinkholes that are located in the parishes. These sinkholes need to be maintained either by the government or small farmers who cultivate in those areas. The government or volunteered agencies should approach people in the communities and educate them about the benefits of maintaining sinkholes.

The most beneficial mitigation measure that could be initiated is the relocation of squatters. Vulnerability and risk assessments should be carried out in these squatter areas If the areas are found to be hazardous prone areas, plans should be put in place to relocate them to places that are habitable.

Finally, it is the responsibility of the government to maintain public infrastructures. The government needs to discourage persons from settling in hazardous prone areas. Appropriate habitable areas need to be determined for persons who would be relocated. These few mitigation measures would definitely be economically beneficial in future disaster management programmes.

9.0 REFERENCES

Atlas for Caribbean Examinations. United Kingdom, Longman Group, p.18, 1991.

Disaster Reports: Hurricane Gilbert – 1988. Jamaica, Emergency Preparedness and

Disaster Relief Coordination Programme of the Pan America Health Organization, p.1-3 1988.

Harris, N. — **Landslip Investigation- Mt. Airy, St. Andrew.** Jamaica, Engineering Geology Unit, p.13, 1984.

Miller, John B. — **Floods – People at Risk, Strategies for Prevention.** New York and Geneva, United Nations Department of Humanitarian Affairs, p.53-56, 78, 1997.

Montgomery, Carla W. — **Environmental Geology.** USA, Wm. C. Brown Publishers, p.121, 125, 128, 157, 157, 1995.

Parish Profiles: Portland, St. James, St. Ann, St. Catherine, Trelawny, St. Mary. Jamaica Information Services, 1991.

Porter, A., et al — **Minerals and Rocks of Jamaica.** Jamaica, Jamaica Publishing House, p.105, 114, 1982.

Portland Report and Damage Assessment- January 3 – 4, 1998. Jamaica, ODPEM, 1999.

Report on the Cost of Damage Incurred due to Hurricane Mitch. ODPEM, 1998.