Government of Saint Lucia

Landslide Response Plan

[To include mudslide and subsistence]

Rev. February 12, 2005 / March 16, 2005 / October 29, 2005 | August 7, 2006

Developed by the NEMO Secretariat

Approved by *[NEMAC]* *31st January 2008*	*Approved by* *[Cabinet]*
[Date of Approval]	*[Date of Approval]*


Cap Pt.
Pigeon I
Rodney Bay
Gros
Islet
CASTRIES
Grande Cul de Sac Bay
Babonneau
Anse la Raye
Roseau
La Caye
Canaries
Dennery
Mt. Gimie
Praslin
Soufrière
Micoud
Canelles
Desruisseaux
St Lucia I
Choiseul
Laborie
Hewanorra Int'l. Airport
Vieux Fort
Maria Is.

TABLE OF CONTENTS

SECTION 1: Overview

INTRODUCTION

No landslide plan can be written without a hazard assessment.

Over the years a series of maps have been produced that has attempted to address the need for such information. In 2004 the Government of Saint Lucia initiated the SECOND DISASTER MANAGEMENT PROJECT (DMP-II). The project established the National Hazard Mapping and Vulnerability Assessment Committee [HMVA].

The Caribbean Disaster Emergency Response Agency (CDERA) through its Caribbean Hazard Mitigation Capacity Building Programme (CHAMP) and the Caribbean Development Bank (CDB), through its Disaster Mitigation Facility for the Caribbean (DMFC) established collaboration in Hazard Mitigation Planning. The purpose of the collaboration is to promote vulnerability reduction to natural hazards and disasters in CDERA participating states and in CDB's borrowing member countries through hazard mitigation policy and planning and their integration into development planning.

Under the Collaboration technical assistance will be provided to the governments of Belize, Grenada, Saint Lucia to develop national hazard mitigation policies and plans. This enhancement will be informed by hazard mapping and vulnerability assessment (HMVA) studies to be conducted by the CDERA-CDB Collaboration and the Ministry of Physical Development through the World Bank-funded Saint Lucia Emergency Recovery and Disaster Management Project.

STATUTORY AUTHORITY

- Disaster Preparedness and Response Act No 13 of 2000
- The Emergency Powers Act, No. 5 of 1995
- The Constitution of Saint Lucia. Article 17

DISASTER CYCLE

The Disaster Cycle comprises of the following elements:

<u>BEFORE</u>

- Prevention
- Mitigation
- Preparedness

<u>DURING</u>

- DISASTER OCCURS

<u>AFTER</u>

- Response
- Reconstruction / Recovery
- Rehabilitation / Rebuilding

COMPREHENSIVE DISASTER MANAGEMENT

It is understood by the Government of Saint Lucia that the disaster cycle lends itself to a comprehensive approach to disaster management, whether within this organisation or at a National Level.

Comprehensive Disaster Management [CDM] was conceptualised by the Caribbean Disaster Emergency Response Agency [CDERA] as a new direction for disaster management for the 21st century. It moves away from the relief and response mode to a comprehensive approach which takes disaster and mitigation considerations into account during the planning and development stages. It also expands the partners to include economic, social, and environmental planners, architects, engineers, and health professionals among others. *[CDERA Press Release of Feb 27, 2004]*

With the main objective being to integrate Comprehensive Disaster Management into the development planning process it is the Government of Saint Lucia's intension to weave Comprehensive Disaster Management into all sectors as recommended by the Intermediate Results [IR]

GOAL **Regional Sustainable Development enhanced through Comprehensive Disaster Management**			
PURPOSE *'To strengthen regional, national and community level capacity for mitigation, management, and coordinated response to natural and technological hazards, and the effects of climate change.*			
OUTCOME 1: Enhanced institutional support for CDM Program implementation at national and regional levels	OUTCOME 2: An effective mechanism and programme for management of comprehensive disaster	OUTCOME 3: Disaster Risk Management has been mainstreamed at national levels and incorporated into key sectors of national economies (including tourism, health, agriculture and nutrition)	OUTCOME 4: Enhanced community resilience in CDERA states/ territories to mitigate and respond to the adverse effects of climate change and disasters

ST. GEORGES DECLARATION OF PRINCIPLES

It is understood that to as a tool to achievement of the CDM Strategy it is this Agency's undertaking to support Principle Nine of the St. Georges Declaration of Principles for Environmental Sustainability in the OECS.

Where each member state agrees to:

a. Establish at the community, national and regional levels appropriate and relevant integrated frameworks to prevent, prepare for, respond to, recover from and mitigate the causes and impacts of natural phenomena on the environment and to prevent man made disasters;

b. Exchange information with each other, relating to the experiences and lessons to be learnt from the causes and impacts of natural and man made hazards and phenomena on its environment.

SITUATION ANALYSIS

Hazard analysis and experience have confirmed that Saint Lucia is at risk from numerous hazards, both natural and technological:

- Meteorological Hazard: Hurricanes, Tropical Wave, Tropical Storm, Storm Surge, Flooding, Land Slides, Drought

- Seismic/Volcanic Hazard: Volcanic Eruption, Earthquake, Tsunami [Marine and land based]

- Technological: Fire, Explosion, Hazardous Material Spill, Mass Poisoning, Pollution, Civil Unrest

- Other: Plague, Mass Causality, Epidemic Outbreak, Dam Failure, Office Violence, Terrorism, Bomb Threat/Explosion, Utility Failure

ASSUMPTIONS

- That the Government of Saint Lucia shall respond to a National Disaster.

- That Emergencies in Saint Lucia may be categorised in two ways:

    - Those that are preceded by a build-up [slow onset] period, which can provide NEMO with advance warnings, which is used to facilitate timely and effective activation of national arrangements

    - Other emergencies occur with little or no advance warning thus requiring mobilization and almost instant commitment of resources, with prompt support from the Government of Saint Lucia just prior to or after the onset of such emergencies

SECTION 2: Baseline Data

WHAT IS A LANDSLIDE?

It is a down slope transport of soil and rock resulting from naturally occurring vibrations, changes in direct water content, removal of lateral support, loading with weight, and weathering or human manipulation of water course and slope composition.

LANDSLIDE TYPES

- Rotational
- Translational
- Debris flow
- Debris avalanche

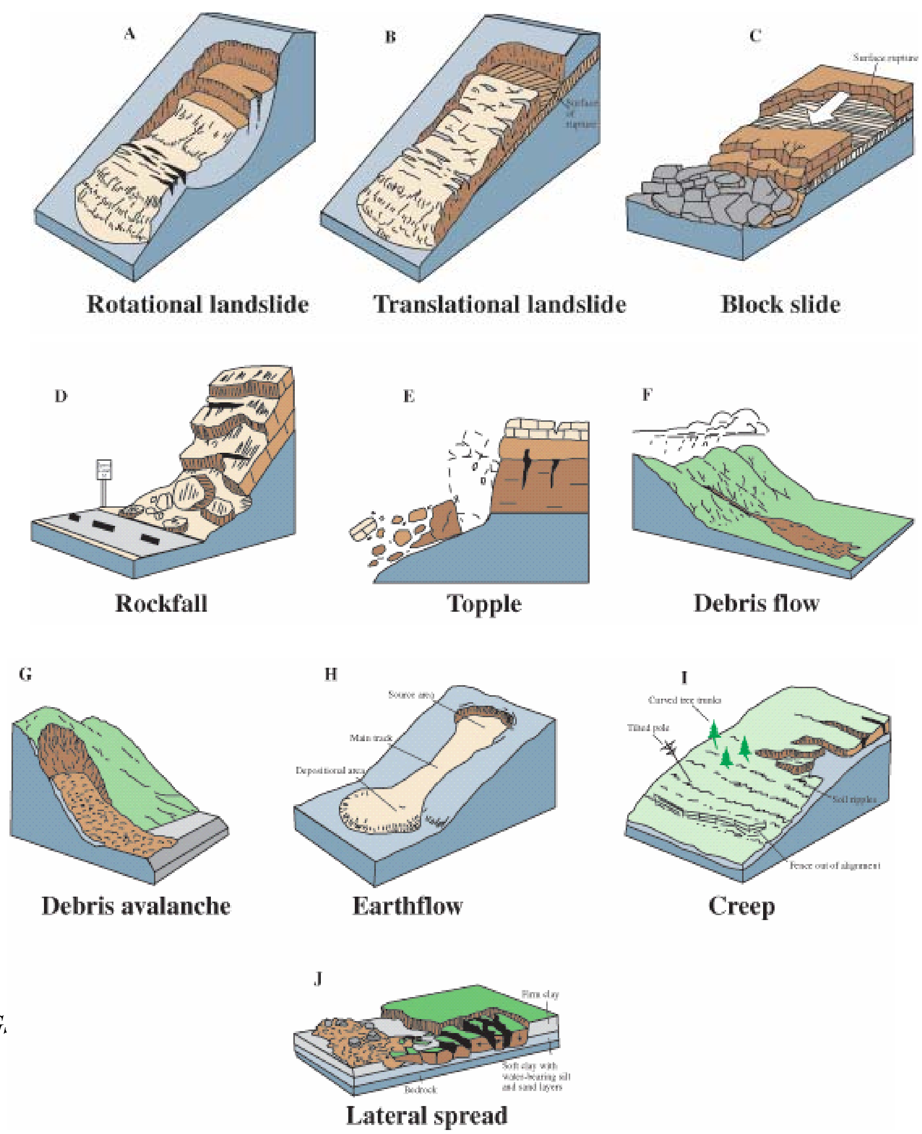


Photo Credit: USG.

CHARACTERISTICS

Landslides vary in types of movement (falls, slides, topples, lateral spread, flows) and may be secondary effects of heavy storms, earthquakes, and volcanic eruptions. Landslides are more widespread than any other geological event.

LIKELY IMPACT

Physical Damage

- Anything on top of or in the path of a Landslide will suffer damage
- Rubble may block roads, lines of communication or waterways. Indirect effect may include loss of productivity of agricultural or forest lands.
- Flooding.
- Reduced property values, destruction of buildings.
- Casualties- fatalities may occur due to slope failure.

FACTORS CONTRIBUTING TO VULNERABILITY

- Settlements built on steep slopes, softer soils and cliff tops
- Settlements built at the base of steep slopes, on mouths of streams from mountain valleys.
- Roads, communication lines in mountain areas
- Buildings with weak foundations
- Buried Pipelines and brittle pipes.
- Lack of understanding of landslide hazard

PREPAREDNESS MEASURES

Community Education after identification of areas most at risk from landslides. The basic information required:

- Knowledge of where past Landslides have occurred derived from local records and knowledge of certain types of rocks prone to landslides.
- Monitoring, warning and evacuation systems

MITIGATION MEASURES

- Capture and drainage of water before it reaches potential slope area
- Underground drainage by using sub-surface pipes
- Land Reform by terracing/re-shaping

TYPICAL POST-DISASTER NEEDS

- Search and rescue (use of earth removal equipment)
- Medical assistance
- Emergency shelter for homeless.

LEGISLATION

Legislation is an effective tool for the implementation of Landslide management activities.

In some cases specific legislation concerning Landslides is enacted. In other cases, Landslide management and Landslide response activities have legal support from several different legislation.

ECONOMIC IMPACT [SOURCE: http://isis.uwimona.edu.jm/uds/Land_St_Lucia.html]

- *The cost of just clearing landslide debris ranges from $38, 000 to $146,000 per year which represents 2 to 6 percent of the annual road maintenance budget (J. Fevrier, Personal Comm., 1985). The range reflects differences between a normal year and a bad year with many triggering storms. In a normal year, $77,000 to roads would be added to the slide clearance figure. This represents expenditures for retaining walls, drainage, fill replacement, and similar work.*

- *Obviously, a very large landslide will result in unusually high repair coasts. The Barre de L'Isle landslide, triggered by the August 3, 1980 passage of Hurricane Allen, illustrates the cost which may result from a major landslide. This landslide initially blocked the main East Coast road on St. Lucia connecting Castries and Dennery. This severed the main route used to transport tourists arriving via the international airport at Vieux Fort to hotels and tourist facilities close to Castries. The landslide affected the main switchback curve on the East Side of the ridgecrest. The upper part of the switchback was carried away while the slide debris came to rest on the lower switchback (Fig. 14). Clearance alone would not restore the road. A masonry retaining wall at the toe and three gabion structures within the failed area were constructed to stabilize the landslide. The gabons were placed at an average cost of $ 7.00 per cubic meter (Ministry of Communications, Works, and Transport, Written Comm., 1985). This figure includes excavation of the basket sites as well as assembling and filling of each basket with rock. It also includes the clearing of small landslides induced during site excavation. Work started in October 1980 and was completed by September 1982. The entire repair cost roughly $462,000. Of this total, forty-seven percent went for materials, twenty percent for labour, seventeen percent for equipment operation, and sixteen percent for transportation.*

- *In November 1981, a single, moderate-sized landslide occurred on St. Lucia southeast of the community of Forestiere (Fig. 12). Starting near the top of the ridge next to Piton Flore, this debris flow carried away bananas and coconut trees.*

  As the slide mass moved downslope, is swept away or buried banana and coconut trees owned by other farmers. This 1-hectare debris flow resulted in a loss of standing crop and near-future production valued at $4,000 (G. Charles, Personal Comm., 1985).

LANDSLIDE MAPPING

Before the Landslide can be effectively controlled, it is essential to know the likely extent of Landslide areas so that the area under management can be decided. Landslide maps are needed for this purpose. These can be prepared at different levels of sophistication from simple maps of past slides to comprehensive maps showing areas that would be most likely to slide with a given probability.

The simple map of past landslides, or of the area in a particular event are relatively easy to prepare after each Landslide. If aerial photographs can be taken after the Landslide, the affected area can be delineated on a topographic map. Alternatively, surveys can be made after the Landslide to collect information on the extent of Landslide by observing debris marks and interviewing local residents. These maps can be used to show the areas at risk in a manner easily understood by the public. Maps of the area should be prepared after major Landslides, partly as a check on the accuracy of more sophisticated Landslide plain maps.

The need for accuracy in preparing a Landslide map has been emphasised because of the importance that the map can assume. The Landslide map will be used as the basis of Landslide management, which has as its aim the control of development on the Landslide plain. Any inaccuracies in the map could lead to developments being permitted that will subsequently be at risk of Landslide, or preventing developments that run no risk of being affected.

- Currently in Saint Lucia the Ministry of Physical Development has a limited collection of Landslide and Debris Flow maps [see below]. The Ministry is also collaborating with the University of Bristol on the Management of Slope Stability in Communities [MOSAIC] Project. The project outcomes are to have communities understand slope stability; identify stability issues through Community Projects.

- In 2004 The Government of Saint Lucia with a loan from the World Bank commenced a Vulnerability Assessment and Hazard Mapping Project.

- The Saint Lucia Red Cross with a project funded by DipECHO 2004 conducted a Vulnerability Capacity Assessment with Communities which empowered the Communities to conduct Vulnerability Assessment and Hazard Mapping for their Community.

- Caribbean Disaster Management Project (CADM) conducted by the Caribbean Disaster Emergency Response Agency conducted Vulnerability Assessment of three pilot areas with the outputs being the creation of Evacuations plans designed by the Community. Saint Lucia has been short listed for Phase II.

STRUCTURAL COUNTERMEASURES

These measures rely on building structures to change to reduce the impact of Landslides. They usually come in the form of a retaining wall.

Structural measures can be expensive, largely because they have to be built on a large scale if they are to be at all effective. Without regular maintenance it is easy for the installations to fall into disrepair and fail when required. These structures are most effective when they form part of a well-thought out Landslide control strategy and are combined with the non-structural measures, such as land-use regulation and Landslide forecasting.

NON-STRUCTURAL COUNTERMEASURES.

Control of Landslide Development.

Landslide maps indicate areas that are subject to Landslides and thus development needs to be controlled if Landslide damage is to be reduced. A variety of methods is available for controlling development and the particular methods adopted will depend on the legal and administrative systems of the country. Usually, control will involve some form of land-use regulations. These need to be set in the appropriate legal context, depending on the planning system of the country.

Regulations establish zones where types of development are recommended. These zones must be based on an accurate Landslide maps so that the effect of the regulations is clear to all concerned.

Regulations do not need to prohibit all development on the Landslide plain. There is a whole range of activities with different vulnerabilities to Landslides that can be considered for the Landslide area. These include wildlife reserves, including wetlands; and secondary transport routes and car parks. On the other hand, there are facilities that should never be located in the Landslide areas because they will be needed in times of a Landslide emergency. These include hospitals, clinics, telephone exchanges, electricity sub-stations and emergency operation centres.

Some non-structural measures mentioned in CDERA web page are:

Agronomic

- Reforestation, planting of deep rooting trees to prevent surface slips
- Ground cover with grass or agricultural crops

Engineering

- Use of **Gabion** construction to protect water course valleys and control the flow of water down slope

<u>Landslide Forecasting</u>

Improve the forecasting capacity through new equipment and the development of specific quantitative mechanisms.

Define the quantitative conditions that determine the need for of evacuation specific areas in Saint Lucia.

A forecast experiment of landslide is conducted with the use of a mesoscale rainfall model may be possible.

<u>Landslide Early Warning Monitoring Systems.</u>

In most cases the occurrence of a landslide can be accurately projected through observation and a simple the application of a simple model. It does mean there will need to be a monitoring of conditions and the formulation of a database spanning years for the projection to be of value.

Rainfall event + Landslide Event
= Projection for the landslide to repeat under the same conditions.

<u>Public Awareness.</u>

The general population also needs to know how to respond in case of an emergency. The population has the right to know that they live in a hazard-prone area. When a hazard is threatening, the population has to be warned that the hazard is approaching or about to occur/impact so measures of protection, like evacuation, can be taken. However, in several cases the people are not warned in time or, if they are, they do not believe that the hazard is approaching and they do nothing.

This is due to:

1. The authorities think that the population 'will panic'
2. The population does not believe the authorities.
3. The population believes the authorities but is reluctant to take action because they do not want to evacuate and leave their property behind.

With a good and adequate permanent public awareness campaign and good warning messages this problems can be sorted out.

In general, the public must know:

1. That there is a Landslide risk.
2. That there is a high probability that a Landslide will occur.
3. The effects of a Landslide if it occurs. How can the people be affected?
4. The response measures governmental agencies would execute if there is a threat of a Landslide and/or if it has occurred.
5. The measures the people have to take to protect themselves and their belongings, particularly regarding evacuation.
6. How can the people participate in the planning process and in preparation activities for an evacuation such as simulation exercises.

In general, public awareness campaigns, particularly regarding disaster preparedness, must be permanent, since hazards do not impact every day and disasters do not occur every year, the population must be sensitised all year long.

Simulation Exercises

Simulation exercises are supposed to test the response and level of preparedness of response personnel and the status of plans and equipment. Simulation exercises are normally executed to test governmental, private and social organisations involved in the response. This is very good for most of emergency procedures that involve only response organisations; but what about emergency functions that involve the population, such as evacuation, for instance? In these cases, the population has to be involved as well, both in the planning and in the testing of planning (simulation exercises): evacuation exercises must involve the population at risk that lives in an area that would be evacuated under a specific threat of a specific hazard; in our case, although these statements are valid also for hurricanes, we refer to evacuation in the case of a Landslides. Not involving the population in simulation exercises, together with a deficient public awareness campaign, has, in several countries, caused problems with evacuation of the population at risk once the Landslide threat is present.

So, disaster management organisations must first determine vulnerable areas at risk and then estimate their population and determine the resources needed to conduct an adequate evacuation once a Landslide threat is present. The population must be informed about these activities and must be involved in the planning, organisation, execution and evaluation of evacuation simulation exercises. Yearly simulation exercises or, at least, one every two years will educate the population and make them accustomed to participate not only in simulations but also during a real event.

Landslide insurance

The primary purpose of Landslide insurance is, of course, to pay for the damage caused by the Landslide, but it is also often recommended as a means to promoting good use of the Landslide area. Insurance premiums that correctly reflect the risk of Landslide, by being based on long-term annual average damages, should provide an indication of the risk of developing in the Landslide area and would deter unsuitable developments there. In practice, this rarely happens. Landslide insurance premiums are usually very high as only those likely to make frequent claims consider insuring themselves against Landslides. This leads to one of two possibilities: the customer decides that the insurance is too expensive and does not insure his or her property or, the insurance companies decide that there will be no profit in underwriting Landslide damage at a premium that customers are willing to pay and decline to offer the business.

Insurance of subsistence is different to a landslide policy.

Evacuation

Evacuation is the emergency response activity by which emergency response organisations take out vulnerable elements from the scope of impact of a specific hazard until the duration of the impact finishes and there is no longer any danger to return to the area where the vulnerable elements originally were.

Evacuation in the case of predictable hazards must be done before the hazard impacts the vulnerable area in order to protect the population therein and their property.

Evacuation must start after the agencies responsible for evacuation are notified by the National Disaster Organisations. Notification is made immediately after warning is received and the decision to evacuate has been made based on the possible effects of the hazard's impact.

Perhaps the most important response activity during a Landslide threat is evacuation. Therefore; if asked to by the governmental authorities, all the population in a specific area at risk must evacuate. This can only be achieved by involving the population in the planning process and by increasing and improving public awareness campaigns. Otherwise, any evacuation plan or procedure is useless. Disaster managers should not assume that the population will evacuate immediately when they tell them to do so. On the contrary, they should start from the assumption that the first reactions of the population when told that a hazard will strike would be disbelief and refusal to evacuate.

So, the best way to achieve an evacuation is to involve the people that live in areas at risk in the planning process. Here we suggest two main activities: public awareness and education campaigns and simulation exercises.

Evacuation should be planned for all the areas susceptible to Landslides. Information about number of inhabitants, roads, and exact delimitation of the zones must be determined by the governmental authorities.

Another important point regarding evacuation is the need to include it in the legislation and the need to establish specific limits of the areas to be evacuated through vulnerability studies and disaster scenarios. This has to be done by disaster management organisations if they want evacuation to be successful.

Returning the population to evacuated areas must be a decision based on the conditions of the evacuated area as they were at least before the threat or impact of the hazard: safety, no-more risk-present, services operating (electricity, water supply, etc.). The decision must be taken by the national disaster management organisations with the advice of organisations responsible for damage assessment, public utilities, and security/evacuation.

This plan is a "stand alone" document that may be activated to support hazard management plans. Evacuation Plans related to this plan are:

Volume

1. Concept of Operations
2. Emergency Shelters [Annual List]
3. Special Needs Evacuation Plan
4. Animal Evacuation and Recovery Plan
5. Traffic Management Plan

Clean-up

In the case of a Landslide, if it occurs, it might carry much damage. Immediate rehabilitation must include cleaning up activities to retire and dispose of mud, silt and debris from affected areas and to dispose of Landslide-damaged objects as well. This will speed up the process of taking the population evacuated back to their homes.

Cleaning up is important not just after the Landslide, but before it occurs. Once the warning is issued, the authorities must clean up all garbage and debris from rivers where they can obstruct the free flow of water.

Cleaning up must be a permanent activity in Landslide areas. Garbage and debris must be collected so they would not be part of the cause of Landslides. Sometimes the time between the warning and the impact of a hazard is not enough to clean up. This must be done before, permanently.

Clean up is a multi agency function. The guiding document is the *Guidelines for Debris Management in a Disaster* and is a stand – alone Volume.

Hazard Mitigation

Saint Lucia has a National Hazard Mitigation Policy and Plan. The initial version of the Hazard Mitigation Plan was drafted in the immediate aftermath of the Tropical Wave of October 26, 1996 that caused serious damage in the village of Anse la Raye and the town of Soufriére. The plan therefore reflected immediately the hard lessons of the Wave, which together with Tropical Storm Debby (September 1994) proved to be a stern teacher.

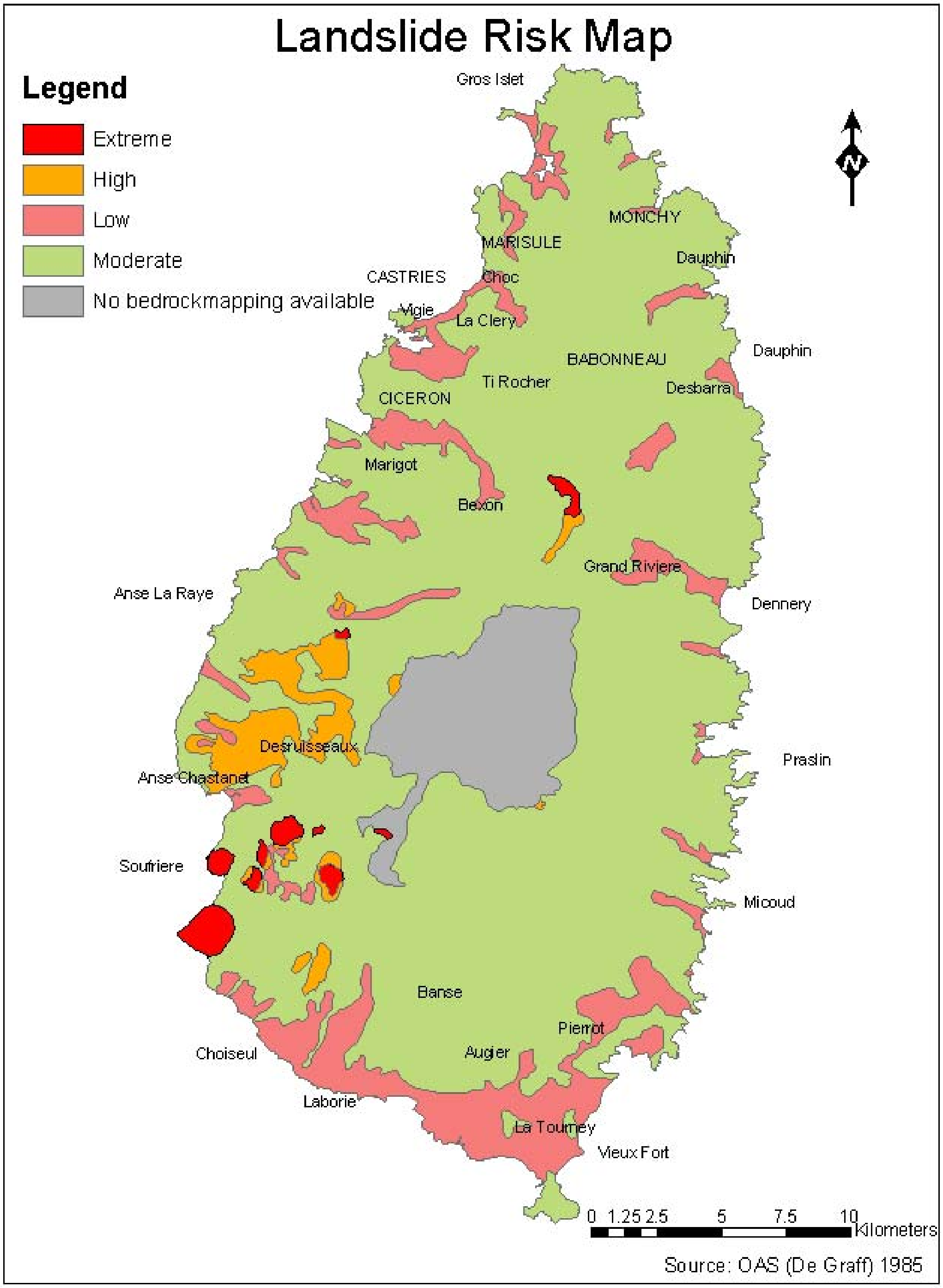
The plan has been revised three times: in January 2001, in December 2002 (by the National Hazard Mitigation Council) and in June 2003 by NEMO. In this last revision the plan has been distributed to all the sectors of society involved for comments and input. A national consultation is being held to revise and approve a 2003 version of the plan.

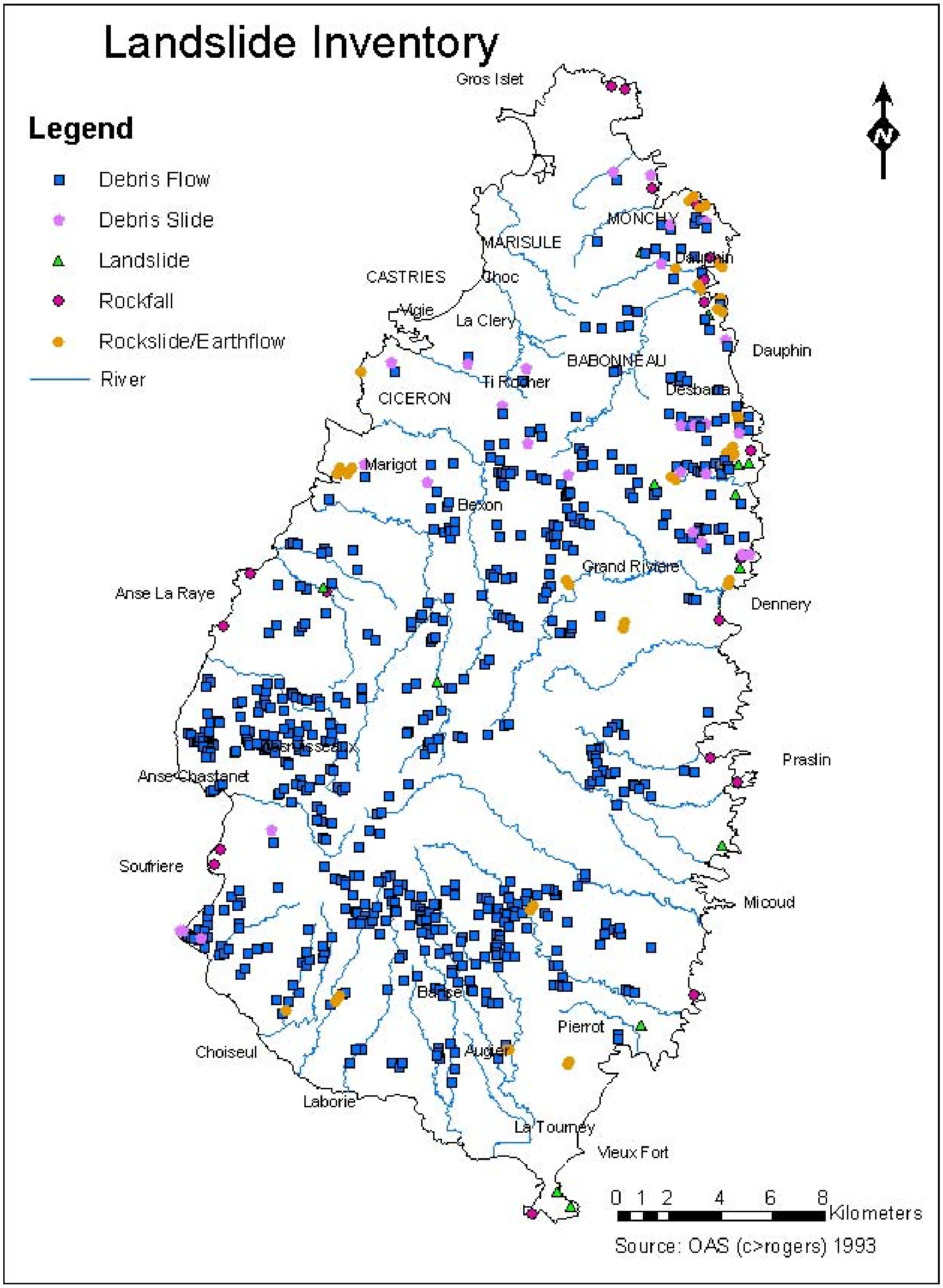
The plan establishes goals and priorities and considers several structural and non-structural mitigation measures. The Hazard Mitigation Documents mention Landslide mapping as one of the most important priorities

Once the Documents are approved they will be the most important tool for the planning, implementation, monitoring and evaluation of structural (and non-structural) mitigation measures, including those related to Landslide management.

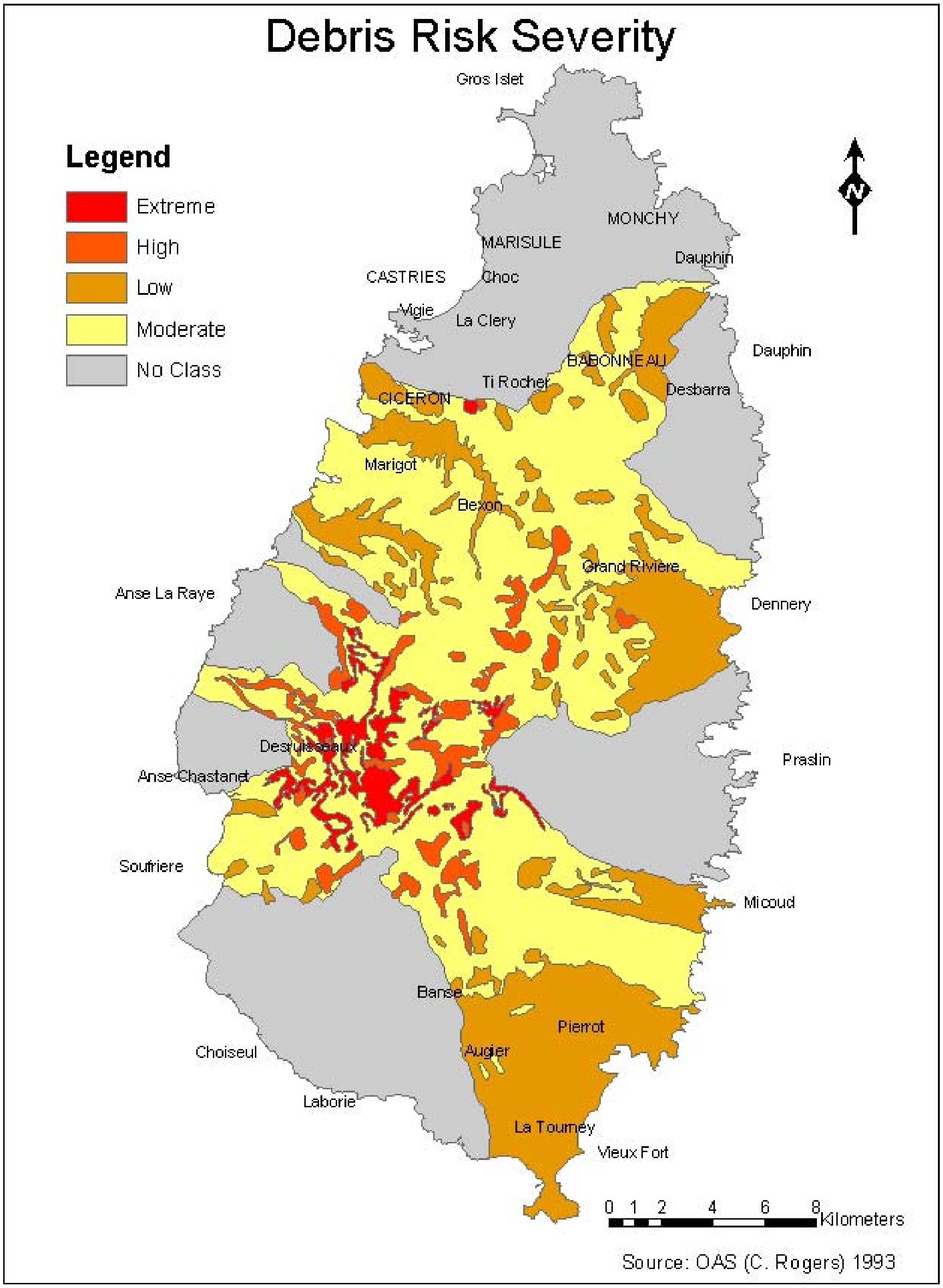
SECTION 3: Maps

Geology Map


Landslide Risk Map
Legend
Extreme
High
Low
Moderate
No bedrockmapping available
Gros Islet
MONCHY
MARISULE
Dauphin
CASTRIES
Choc
Vigie
La Clery
Dauphin
BABONNEAU
Ti Rocher
Desbarra
CICERON
Marigot
Bexon
Grand Riviere
Anse La Raye
Dennery
Desruisseaux
Anse Chastanet
Praslin
Soufriere
Micoud
Banse
Pierrot
Choiseul
Augier
Laborie
La Tourney
Vieux Fort
0 1.25 2.5 5 7.5 10
Kilometers
Source: OAS (De Graff) 1985



Landslide Inventory
Legend
Debris Flow
Debris Slide
Landslide
Rockfall
Rockslide/Earthflow
River
Gros Islet
MONCHY
MARISULE
CASTRIES
Choc
Vigie
La Clery
Dauphin
BABONNEAU
Ti Rocher
CICERON
Desbarra
Marigot
Bexon
Grand Riviere
Anse La Raye
Dennery
Anse Chastanet
Praslin
Soufriere
Micoud
Pierrot
Choiseul
Laborie
La Tourney
Vieux Fort
0 1 2 4 6 8 Kilometers
Source: OAS (c>rogers) 1993


Debris Risk Severity
Legend
Extreme
High
Low
Moderate
No Class
Gros Islet
MONCHY
MARISULE
Dauphin
CASTRIES
Choc
Vigie
La Clery
Dauphin
BABONNEAU
Ti Rocher
Desbarra
CICERON
Marigot
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Anse La Raye
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Soufriere
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Augier
Laborie
La Tourney
Vieux Fort
0 1 2 4 6 8 Kilometers
Source: OAS (C. Rogers) 1993

SECTION 4: Case Studies

There are three possible scenarios (types of landslide) under consideration in Saint Lucia

- Rapid Onset as occurred in 1938 at Ravine Poisson
- Slow Onset as occurred in 1999 at Black Mallet/Maynard
- Sink holes as occurred in 2004 at Tapion

RAVINE POISON [*RAPID*] LANDSLIDE [1938] [SOURCE: Saint Lucia National Archive Authority]

In November, 1938, abnormally heavy rainfall brought about much flooding, as well as a large number of landslides in the island. Major avalanches occurred in the neighbourhood of the public highroad between Castries and Dennery, at L'Abbaye, Ravine Poisson, Ravine Chicole and Ravine Ecrivisse. Of these, the most catastrophic took place at Ravine Poisson on the morning of November 21, 1938. On what has been historically termed "The Black Monday in Saint Lucia's History", nearly half of the mountain on the western side of the Ravine collapsed, sending a deluge of liquid clay racing for about three to four hundred yards, burying everything in its path.

The residents of a hamlet situated near the base of the mountain had absolutely no warning of an impending disaster. As one eyewitness described it, the incident occurred as suddenly as lightening. It began first as a rumbling sound, immediately followed by the sight of a huge mass of earth plunging downward, instantaneously engulfing the cluster of homes and their, over one hundred, stunned occupants.

News of the disaster reached the capital, Castries, at about 11:30 a.m., but did not relay the full extent of the damage. Despite the fact that a two lorry rescue squad was dispatched to the scene immediately, its progress was severely impeded by the heavy flooding occurring in the Cul de Sac area at that time.

The first officials who were finally able to reach the scene described it as follows, "The sight all the way to Ravine Poisson was one of death and desolation. The swirling waters racing madly by and every now and again dead bodies were passed on the roadside, brought down by the water. Ravine Poisson itself presented a sight that was most unbelievable. Dead bodies were seen everywhere. Here and there crushed beyond recognition, while sticking up out of the watery clay itself could be seen hands, legs and heads of people caught in the turmoil of the liquid racing clay."

Rescuers worked frantically to search for survivors and treat the injured, ever aware of the possibility that more slides could occur. One of these was Mr. Bertie Cox who worked heroically to help the injured.

The direction of operations was eventually taken over by the colony's Administrator, Mr. A A Wright, who introduced a measure of order and organized workers into gangs so as to dig out the bodies of the victims. A morgue was established near the site and the dead was placed there for identification. By nightfall, nearly fifty bodies had been recovered, with an estimated one hundred more presumed still missing.

The following day, November 22nd, at about 4 a.m., another landslide struck the Ravine Poisson area. This one claimed another two lives, in addition to reburying many of the dead bodies that were unearthed on the previous afternoon. As a result of this second slide, an order was issued by the Administrator to have the entire area evacuated. Police then proceeded to coordinate the movement of refugees to Castries and adjoining villages. Later, the government dispensed relief to the sufferers from the floods and landslides, and to persons who had to be evacuated from the dangerous areas.

The Report of Inquiry into the disaster sited its cause as follows, "it would appear that heavy accretions of rain water on the summit of the watershed percolated through and entered faults in the strata of the hills thus causing what is believed to be a burst in the hillside."

The final death toll was put at 99.

Once again we see how with heavy rains the water soaked through the earth and this brought about a massive landslide. Nature provides trees to anchor the earth and minimize landslides. Let us protect ourselves by leaving our hillsides covered with trees.

~*~*~*~*~

FOND ST JACQUES

Hurricane Abby - Landslide [July 10, 1960] - 6 Dead - EC$4 million damage

> The tropical depression that became Hurricane Abby developed east of the Lesser Antilles on July 10 ... As it crossed the islands; it rapidly strengthened into a hurricane that night.
>
> The name Abby has been used for three tropical cyclones in the Atlantic Ocean, 1960, 1964 and 1968. The 1960 Hurricane Abby was a Category 1 hurricane that crossed the Caribbean before hitting Belize [then British Honduras]. It killed six people in St. Lucia. [SOURCE: Wikipedia]

Tropical Storm Debbie – Mudslide [September 10, 1994] – 3 Dead - EC$250 million damage

> This was described by Klohn Cripman, Hydrologist as "*the 1000 year*" storm.
>
> On the night of Sept. 10 1994, the system which would later be identified as tropical storm "Debby" unleashed more than 10 inches of rain on the island of St. Lucia, leaving in its wake four [4] dead, a number of injuries, and millions of dollars worth of damage to key physical infrastructure.
>
> The most immediate impact… was the loss of four lives, three at Fond St Jacques and one at Vanard.
>
> [Source: Extract from An Evaluation of Tropical Storm Debby – Its impact on St. Lucia and Resultant Response – February 1995]

~*~*~*~*~

BLACK MALLET / MAYNARD HILL [*SLOW*] LANDSLIDE [1999]

The problem of the stability of the slope at Black Mallet/Maynard Hill in the southeast of Castries was brought to public attention with dramatic force in early October, 1999 when approximately 80,000 cubic metres of colluvial material 'flowed' downslope toward the Marchand River, resulting in the destruction of several concrete structures and ruptured public utilities serving the community. Residents of thle community reported that minor cracks were observed developing on masonry walls and concrete floor slabs during the last week of September, 1999. On October 5, the Ministry of Communications, Works & Public Utilities were notified of these disturbing developments by a resident.

Over the weeks that followed another slide scrap developed south ("uphill) of the first encompassing an additional 0.6Ha. This scrap crossed Maynard Hill Road at approximately 70 m from the top of the original scrap and aligned eastward along a paved stepped walkway that ascends toward Parker Hill.

As far back as June/July 1999 cracking was reported in a building at the corner of Black Mallet Road and Mauricette Gap. What could have been interpreted as local settlement of the corner column of this reinforced concrete and blockwork structure eventually developed into the scrap of a full-scale landslide, currently referred to as the Black Mallet Landslide. However, it was only around September 17th 1999 that reports of significant damage to buildings were received and structural damage consistent with mass movement on slopes became evident.

Oral history suggests that damage to buildings and infrastructure in the Black Mallet area has been occurring for many years (Henry, 1999) although not to the degree of that currently experienced. This was corroborated during the reconnaissance survey by the authors, as "aged" settlement related cracks were in evidence in many older buildings, which appeared.

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TAPION SUBSISTENCE [2004] [SOURCE: Star Newspaper and Strata Engineering Report]

The problem of stability at Tapion located to the west of the City of Castries was brought to public attention on the morning of September 26, 2004 when approximately 1,800 cubic of colluvial material “flowed” downslope, resulting in the destabilization of two [2] concrete structures and ruptured public utilities serving the community.

At the time of the site visit on September 26th, 2004 the tension cracks observed on the upper access road were up to 450mm in width and extended over a distance of approximately 13.0 m. Some ground displacement of about 450 mm was prevalent on the upper access road due to differential movement within the area.

Service at the private Tapion Hospital was disrupted and resumed in full on four days after land slippage in the area had made the road to the hospital impassible. Access was re-routed via the coastal road behind the School of Music. A neighboring two-bedroom house was severely damaged but remained intact for three days after the slippage then fell apart.

It is believed the slide was caused by excessive water in the soil. Investigators hope to discover the source of the water, how deep the slide extends and how long the solid mass will keep sliding.

Dr Kannan, a consultant anesthetist at the Victoria Hospital, recounted his experience.

> *"Upon returning home on September 11 from a month's vacation in India I noticed that the pillars were bent. There was also a crack in the driveway. I immediately informed my landlord. She sent a contractor to assess the building,"* Dr Kannan said.
>
> *"The contractor said there was no cause for panic, but I had a feeling that something was wrong—something was pushing my house. I immediately began looking for an apartment. I found one in Goodlands and two Saturdays ago I moved my family to that house. I was very busy at Tapion and Victoria hospitals so I didn't move right away. Whenever I got time I moved slowly."*

Dr Kannan stared wide-eyed at the damage done to the house he'd called home for five years.

"I was really supposed to move the rest of my things on Sunday," he went on, amazed at his narrow escape. *"But when I got here at 4:30pm on Saturday I noticed another crack—about two inches long. I told my helper that there was no need to wait until Sunday...* "

~*~*~*~*~

Others

1994: September 9

> The most significant natural disturbances in recent years have been caused by a number of storms and hurricanes in 1994 and 1995. Tropical Storm Debbie in 1994 was one of the wettest to hit St. Lucia this century and caused landslides and erosion that resulted in heavy siltation from runoff. A study of three reefs on the southwest coast shortly after the storm revealed considerable damage, with coral mortality as high as 50% at the most heavily impacted site. Sediment depth and the proportion of bleached corals were highest at sites near river mouths (Nowlis et al. in press). In 1995, the heavy seas that accompanied Hurricanes Luis and Marilyn caused severe damage to reefs on the west coast, particularly to shallow stands of Porites porites but there are no quantitative data available on destruction or recovery. [SOURCE: www.canari.org/status_west.pdf]

1988: September 17

> The consequences of altering the vegetation on a steep slope were demonstrated to a farmer in St. Lucia (The Weekend Voice, September 17, 1988). He maintained a banana field on a 90 to 100 percent sloped cleared of forest vegetation. On September 11, 1988 following a tropical

storm which drenched the island he was an eyewitness to destruction of his field by a landslide. About 3:30 p.m., the farmer observed the slope begin to move starting very slowly at the bottom and followed by the upper slope as it accelerated. Nearly 5 hectares including his entire field was carried away leaving a 1.5-kilometer long swath of exposed soil. Chief Forestry Officer Gabriel Charles and his fellow rangers inspected the site and unanimously attributed the disaster to deforestation and a slope too steep to be used for banana cultivation. Even the farmer concluded, "I think it was the absence of trees with firm roots which caused the slide. I also think the squatting and cutting of trees on the hills should be stopped...". [SOURCE: http://isis.uwimona.edu.jm/uds/Land_St_Lucia.html]

1985

It does not require a large landslide to block or interfere with traffic for short periods. A landslide occurred in 1981 on St. Lucia's principal west coast road between Castries and Soufriere. About 765 cubic meters of debris from the cutslope late on Friday afternoon blocked the road. It was removed by Sunday (M. Henry, Personal Comm., 1985). During that time, people traveling to work between Castries and Soufriere or transporting perishable agricultural products for shipping from Castries were forced to wait or drive additional miles via the main east coast road to reach their destinations. [SOURCE: http://isis.uwimona.edu.jm/uds/Land_St_Lucia.html]

Management of Slope Stability in Communities [MoSSaiC]

[SOURCE: http://www.mossaicstlucia.com/index.htm]

Landslides can be a major hazard in Tropical areas. Here landslide hazard prediction is just as important for existing roads, urban and agricultural areas as it is for those areas subjected to new construction or newly changed agricultural practices.

The Mossaic vision seeks to......

.... [achieve] local capacity-build in the broad area of slope stability whilst simultaneously seeking to minimise resource expenditure

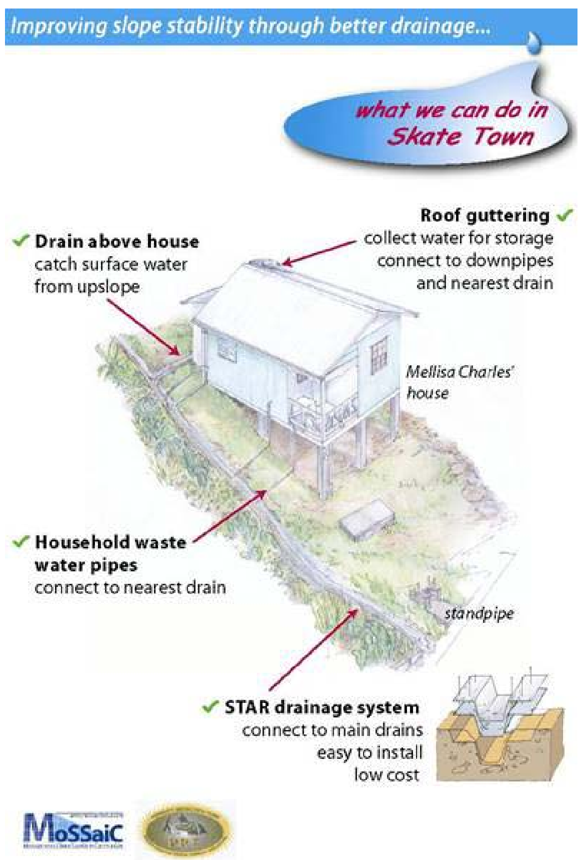
.... achieve the vision by identifying key environmental project foci that can be undertaken by existing government-based staff and local communities

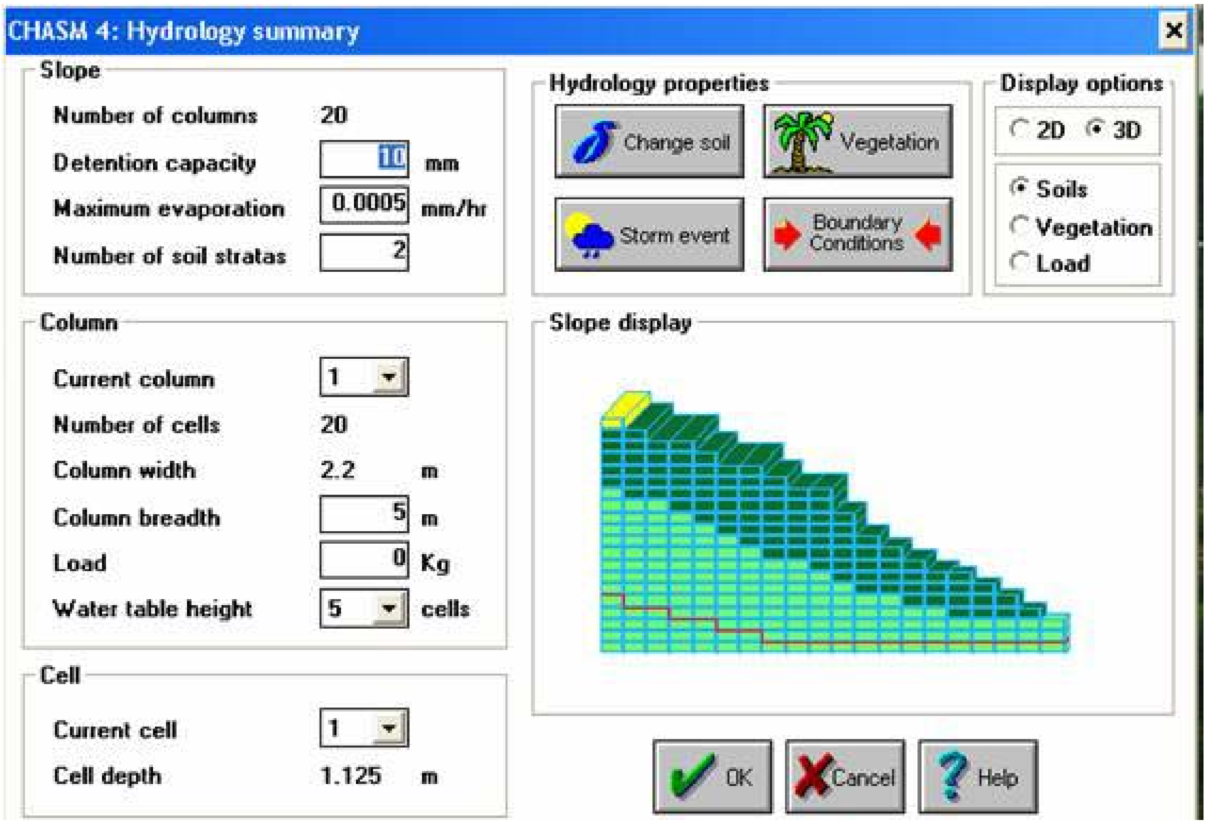
.... establish team structures that are key to delivering the vision - a **management team** that develops and communicates the vision; **field teams** that develop project strategies and implement specific project plans.

The project framework has three objectives:

- to control water on cultivated slopes in order to reduce soil erosion and landslide risk
- to establish a trial site at which low-cost, appropriate drains could be installed
- to develop a integrated drainage plan involving perhaps as many as 15 farmers

Slope stability assessment is a core element of the MoSSaiC vision. Field evidence shows the complex relationships between precipitation, soil properties, vegetation and slope geometries in respect of potential failure.





It is appropriate therefore to use a software package that allows for the assessment of process controls on slope instability that includes the provision for unsaturated soil water conditions, bioengineering, and dynamic pore pressure modeling. CHASM TM has been installed on selected St Lucian government machines for dedicated use on the MoSSaiC programme.

Public awareness is an important aspect of improving slope stability conditions. Recognizing the needs of Communities and individuals such that they can understand and participate in both planning processes and decisions in respect of slope stability improvement measures is very important.

Public awareness poster designed for Sakte Twon Community, Castries , St Lucia West Indies

MoSSaiC is involved with document design for individuals, delivery of courses to Communities and the provision and design of low cost slope stability measures for such groups.

SECTION 5: Response

SECONDARY DISASTERS

A specific disaster may spawn secondary disaster that increases the impact, a classic example, is an earthquake that can cause a tsunami, which in turn results in coastal flooding.

RESPONSIBILITIES MATRIX

BEFORE

ACTION	AGENCY	ROLE
Slope Stability	Ministry of Physical Development	Management of Slope Stability In Communities [MoSSaiC]
Hazard Maps	Ministry of Physical Development	Development Planning
Hazard Maps	Ministry of Works	On going
Co-ordinate government programmes for vulnerability reduction.	National Hazard Mitigation Council	Monitoring through technical working groups
Hazard Maps	National Hazard Mapping and Vulnerability Assessment Committee [HMVA].	On going
Hazard Mitigation Policy	NEMO – All Agencies	Approved by Cabinet in 2008
Hazard Mitigation Plan	NEMO Secretariat	Approved by Cabinet in 2008
Geology Map	OAS	Map – 1984
Debris Flow Map	Cassandra Rogers based on De Graff	Map
Landslide Map	Cassandra Rogers based on De Graff	Map
Evacuation Plans	NEMO – All Agencies	National Plan Community Plans

DURING

ACTION	AGENCY	PRODUCT
Landslide	NEMO – All Agencies	Landslide Response Plan
Flood	NEMO – All Agencies	Flood Response Plan
Earthquake	NEMO – All Agencies	Earthquake Response Plan
Volcanic Eruption	NEMO – All Agencies	Volcano Response Plan
Evacuation	NEMO – All Agencies	Safe Passage

AFTER

ACTION	AGENCY	PRODUCT
Search and Rescue	Fire Service	Urban Search and Rescue Plan
Evacuation	NEMO – All Agencies	Community Evacuation Plans
Security	Police Force	Response Plan
Coordination	NEMO Secretariat	EOC/SOPs
Coordination	Fire / Police	DRAFT National Incident Management System [NIMS]
Clean up	NEMO – All Agencies	Debris Management Guidelines
Medical	NEMO – All Agencies	Mass Causality Plan
Disposal of Bodies	NEMO – All Agencies	Mass Fatalities Plan
Shelter	NEMO – All Agencies	Emergency Shelter Policy
Shelter	NEMO – All Agencies	Emergency Housing Policy

ACTIVATING THE NATIONAL EMERGENCY RESPONSE MECHANISM

A major situation, which threatens population centres will require that the Incident Commander [IC] or Lead Agency receives support for its control and management. This will be coordinated by the National Emergency Operations Centre (NEOC). The decision to advise the NEMO Secretariat of the need for additional support will be made by the IC.

The IC, usually from the Fire Service or the Police Force, will complete a Situation Report Form for the Director NEMO. (Appendix 1)

The Director NEMO in consultation with the IC and the Cabinet Secretary, will decide on activation of the Plan and if necessary, the NEOC.

The NEOC, once activated, will coordinate response, request additional resources and ensure adequate support to all relevant functions. The IC will retain operational control of all operations.

If the NEOC is not activated, NEMO Secretariat will perform the coordination function.

Once the NEOC is activated all Standing Operating Procedures shall come into effect.

The lead agency for the SOPs for the EOC is the NEMO Secretariat. The Standing Operating Procedures for the National Emergency Operations Centre is a Document of the Saint Lucia National Emergency Management Plan and is a stand – alone Volume.

ACTIVATING THE REGIONAL RESPONSE MECHANISM

A major situation, which threatens population centres in Saint Lucia, may require that the Government of Saint Lucia receives support for its control and management. This will be coordinated by the Caribbean Disaster Emergency Response Agency [CDERA].

The decision to advise the CDERA Coordination of the need for additional support will be made by the Prime Minister, the Cabinet Secretary or the Director NEMO, based upon established response levels. (See Appendix 2)

The Director NEMO will complete a Situation Report Form for the Coordinator of CDERA. (See Appendix 1)

The Coordinator of CDERA in consultation with the Government of Saint Lucia will decide on activation of the Regional Response Plan.

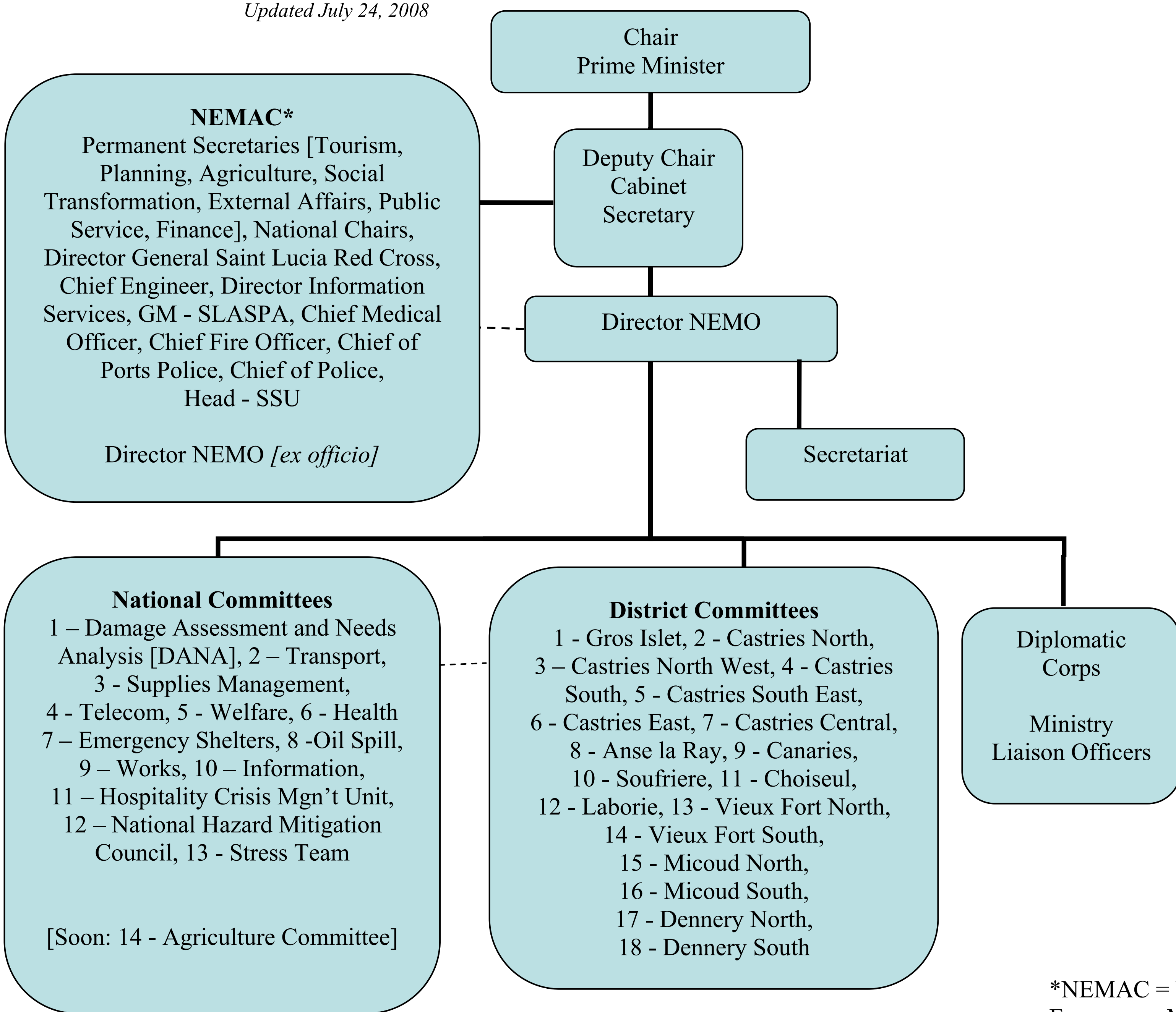
Once activated, CDERA Coordinating Unit will coordinate regional response, request additional resources and ensure adequate support to all relevant National functions. Once activated all Standard Operating Procedures shall come into effect.

The National Emergency Operations Centre [NEOC] shall retain operational control of all operations in Country.

OF SPECIAL NOTE: ***Should the CDERA/CU receive a request for activation from an alternate source regardless of its apparent credibility, the CU is to confirm the request with the Prime Minister, the Cabinet Secretary or the Director NEMO.***

National Emergency Management Organisation

Updated July 24, 2008



*NEMAC = National Emergency Management Advisory Committee

National Hazard Mitigation Council

Of great importance is the fact that Saint Lucia has established the National Hazard Mitigation Council (NHMC), who will be key in the planning, implementation, monitoring and evaluation of Landslide management activities.

The objectives of the NHMC are:

1. To co-ordinate government programmes for vulnerability reduction.
2. To foster scientific and engineering endeavours aimed at closing gaps inn knowledge in order to reduce loss of life and property.
3. To develop measures for the assessment, prediction, prevention and mitigation of natural disasters through programmes of technical assistance and technology transfer, demonstration projects and education and training, tailored to specific hazards and locations and to evaluate the effectiveness of those programmes.
4. To prepare a National Mitigation Plan for Saint Lucia.

Additionally, at a meeting of governmental agencies held in November 19th, 1999, the following additional objectives were recommended:

1. That the disaster legislation be reviewed to include mitigation.
2. That the existing initiatives for the preparation of mitigation plans formulated by the FAO/CDERA and the Caribbean Hotel Association should be reviewed with a view to informing the requirements for carrying forward and co-ordinating work in hazard mapping and vulnerability assessments.
3. That a harmonized template be developed for data collection for mitigation.
4. That the technical requirements for the production of hazard maps needs to be comprehensively developed.

APPENDICES

Appendix 1 – Situation Report
Based on *Belize National Hazard Management Plan - Structural Fire Response Plan*

SITUATION REPORT SERIAL NO. NEMO 002

1. DATE: TIME:

2. EVENT:

3. DEATHS…………….. INJURIES……………. MISSING…………….

4. RESPONSE ACTIONS TAKEN:
(Since last report)

5. PERSONNEL, EQUIPMENT DEPLOYED:

6. POPULATION THEATENED:

7. THREAT OF HAZARDOUS MATERIALS IF ANY:

8. NEED FOR EVACUATION (Y) (N)

9. APPROXIMATE NO. OF PERSONS:

10. SPECIAL POPULATION NEEDS:

11. ADDITIONAL RESOURCES NEEDED IN PRIORITY ORDER:

12. COMMENTS on need for activating NEOC

SGD…………………………………… DATE……………….. TIME……………..

Appendix 2 – Levels of Regional Response

The extent of CDERA's involvement in disaster response operations in Participating States depends on the severity of the situation and the type of assistance required by affected States. Three levels of regional response have been defined:

LEVELS OF REGIONAL RESPONSE TO DISASTERS			
Level	**Description**	**Extent of Regional Involvement**	**Examples**
I	Local incidents within a Participating State are dealt with in the regular operating mode of the emergency services. The local national focal point is required to submit, on a timely basis, information on the emergency event for the purposes of consolidating regional disaster records.	No regional response required	Conway Fire [June 2004]
II	Disasters taking place at the national level which does not overwhelm the socio-economic structure or capacity to respond within the affected state. In such cases, the primary assistance at the regional level will be limited to providing technical expertise to National Disaster Organizations or facilitating their access to specific resources which may be required due to the particular disaster event. The whole operation is still managed by the national disaster focal point.	Limited or specialized	Tropical Storm Debby [September 1994] Gros Piton Fire [2002]
III	Disasters which overwhelm the capacity of the affected state(s) to respond. In such instances the Regional Response Mechanism is activated. This includes the activation of the Caribbean Disaster Relief Unit (CDRU) which is the operational arm of the Regional Response Mechanism. The CDRU comprises representatives from the military forces within CARICOM and its main responsibility is logistical support for the receipt and dispatch of relief supplies.	Full activation	Hurricane Ivan [September 2004]

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