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# **STATUS OF HAZARD MAPS VULNERABILITY ASSESSMENTS AND DIGITAL MAPS**

## **NEVIS REPORT**

**THE CARIBBEAN DISASTER EMERGENCY  
RESPONSE AGENCY (CDERA)**

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## Table of Contents

Page	
	Preface 3
	1.0 Introduction 4
	1.1 Physical and socio-economic background 4
	1.2 Major disaster issues confronting the country 4
	2.0 Hazard mapping initiatives 4
	2.1 Methods of preparation and distribution 5
	2.2 Users and uses 6
	2.3 Current condition and limitations 6
	2.4 Respondents 7
	3.0 Vulnerability Assessment Studies 7
	3.1 Methods of preparation and distribution 8
	3.2 Users and uses 9
	3.3 Current condition and limitations 9
	4.0 Digital Maps 9
	5.0 Conclusions and Remarks 10

## Preface

From 2002 – 2005, the Caribbean Disaster Emergency Response Agency (CDERA) is implementing two major regional initiatives which are designed to reduce vulnerability to natural and technological hazards. These are the Japanese International Cooperation Agency (JICA) supported Caribbean Disaster Management (CADM) Project and the Canadian International Development Agency (CIDA) supported and Organization of American States executed Caribbean Hazard Mitigation Capacity Building Programme (CHAMP). The hazard mitigation planning component of the latter is being implemented in close collaboration with the Caribbean Development Bank's Disaster Mitigation Facility for the Caribbean. Hazard maps, vulnerability assessment studies, and digital maps are critical inputs to both initiatives.

This survey reviewed the status of these thematic activities in sixteen (16) CDERA Participating States, Haiti, Martinique, Suriname and Puerto Rico over the period August – October 2003. The objectives of the Survey were as follows:

1. To determine the status of hazard maps and vulnerability assessment studies and their use in the socio-economic planning and management of the Caribbean.
2. To determine critical success factors, gaps and best practices in the preparation and use of hazard maps and vulnerability assessment studies in the Caribbean.
3. To compile a database of hazard maps, vulnerability assessment reports, and digital maps available in the Caribbean.

Hazards considered under the survey included natural hazards such as floods, hurricanes, landslides, coastal disasters (surge, wave, and erosion), earthquakes, and volcanic eruptions as well as technological hazards. The types of vulnerability assessment considered were structural, economic, and human assessments.

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## **Status of Hazard Map, Vulnerability Assessments and Digital Maps in the Caribbean: Island of Nevis**

### **1.0 Introduction**

#### **1.1 Physical and Socio-economic Background**

Nevis is the smaller island of the twin island federation of St. Kitts and Nevis. Nevis operates under a system of self-government administered by the Nevis Island Administration. The island is located in the northeastern Caribbean and is 3 km to the south east of St. Kitts. It is separated from St. Kitts by a channel called The Narrows. Nevis is 93 sq km square, has a round shape with an average radius of 5.5 km. The island of Nevis is a single volcano. Nevis Peak sits in the center of the almost circular island and rises to 985m.

In 1991 the population was 8,794 that represented a 6.7% decrease from the 1980 census. However, a 1998 estimate puts the island at 10,080. Population is distributed around the island and concentrated on the coast and particularly on the capital Charlestown.

The economy developed on sugarcane and cotton production until the 1960s. It is now largely service oriented and based on tourism and off-shore financial services. The island has a stable economic environment and low unemployment.

#### **1.2 Major Disaster Issues Confronting the Country**

Hurricanes and wind damage specifically, are generally considered to be the major issues facing the country. This perception is probably due to the severe damage caused by hurricanes on the island over the last decade. Hurricane Georges, a category 3 storm struck the Eastern Caribbean islands, St. Kitts and Nevis on the 20-22<sup>nd</sup> September 1998 causing severe damage to infrastructure and the islands' economies. In St. Kitts and Nevis, the hurricane affected 85% of the housing stock, most schools and the Long Point Port.

It should be noted that although the island of Nevis is composed of a single active volcano and is subject to earthquakes, the perception is that these are few and far between and that the risk is manageable.

### **2.0 HAZARD MAPPING INITIATIVES**

Nevis has had one major hazard mapping initiative conducted as part of the Post Georges Disaster Mitigation (PGDM) Project. The PGDM project produced categorized hazard zone maps for volcanic activity, wind, waves, storm surge, coastal erosion, drought and flooding.

The goal of the PGDM project was to reduce the vulnerability of population, economic activities and resources to natural hazard through enhanced capacity

for hazard mitigation. The project was developed as a response to Hurricane Georges. The United States Agency for International Development-Jamaica/Caribbean Regional Program (USAID-J/CAR), established a program entitled Hurricane Georges Reconstruction and Recovery and the Organization of American States' Unit for Sustainable Development and Environment (OAS/USDE) implemented the disaster mitigation capacity building component for USAID-J/CAR, under the PGDM project. The project extended from January 2000 to July 2001.

Table 1 summarises the hazard maps that exist for the island of Nevis. The maps were all produced from the 1:25,000 map dated 1983. All the hazard maps, with the exception of the coastal erosion map, cover the entire island. Coastal erosion data was collected only for specific beaches. The base map datum is Clarke 1880 modified and the projection is Transverse Mercator British West Indies. The maps were produced as an input to disaster planning and hazard mitigation plan development.

**Table 1 – Hazard Mapping of Nevis**

Type <sup>1</sup>	Purpose	Date Produced	Primary Sources	Author
Volcanic	Disaster planning	2002	Seismic Research Unit, UWI	Seismic Research Unit, UWI
Wind	Hazard mitigation plan development	2001	Department of Physical Planning Natural Resources & Environment (DPPNRE)	Department of Physical Planning Natural Resources & Environment
Waves				
Storm surge				
Coastal erosion				
Drought				
Flooding				

*Note 1: The scale of the base maps used in all these hazard maps is 1:25,000*

## 2.1 Methods of Preparation and Distribution

The PGDM project provided a geographic information system (GIS) consultant to improve the GIS capacity of the Government of Nevis. The capacity of the Nevis Island Administration and specifically the Department of Physical Planning Natural Resources & Environment (DPPNRE) was expanded under the project. Base map information was digitized, an inventory of critical facilities was conducted and the facilities were mapped. This data and the summary hazard

layers from each of the PGDM hazard assessments were incorporated into a GIS database for Nevis. Table 2 provides the categories used for the wind, surge, and wave hazard maps.

**Table 2: Categories used for the wind, surge, and wave hazard maps**

Hazard level	Description	Wind speed in metres/sec		Surge height in metres		Wave height in metres	
		<i>Lower bound</i>	<i>Upper bound</i>	<i>Lower bound</i>	<i>Upper bound</i>	<i>Lower bound</i>	<i>Upper bound</i>
0	None	0	17	0.0	0.1	0.0	0.1
1	Low	17	43	0.1	0.5	0.1	1.0
2	Moderate	43	50	0.5	1.5	1.0	1.5
3	High	50	59	1.5	3.0	1.5	2.0
4	Very high	59	100	3.0	100.0	2.0	100.0

The volcanic hazard map was one output of the volcanic hazard assessment project for Nevis. The map was generated on the basis of monitored seismic activity, “past eruptive products” and previous research. Wind, storm surge and waves are caused by hurricane and tropical storm activity and are closely related. The Arbitrator of Storms (TAOS) model was used to generate the vulnerability maps. Drought was analyzed on the basis of watersheds and considered environmental, meteorological, hydrological, infrastructural, human and land use factors. Flooding considered factors such as slopes, drainage, ratio of watershed area to flood plain and run-off rates and potential. The Hurricane Lenny rainfall event (1999) was used as the basis for classification of flood hazards. Inland erosion examined sheet and rill erosion, gullying and landslides. Coastal Erosion (‘coastal erosion’ refers to beach erosion in this assessment) considered only those beaches that are monitored by The Fisheries Division of St. Kitts and Nevis, the DPPNRE. Specific details for the preparation of each hazard map can be accessed in the OAS consultant reports on PGDM web site at [www.oas.org/pgdm](http://www.oas.org/pgdm). All hazard maps exist primarily in ArcView shapefile digital format. Maps are available on the PGDM web site for free download.

## 2.2 Users and Uses

The DPPNRE and the Disaster Coordinator use the hazard maps to support their activities. Physical Planning uses the maps as inputs into development planning. The Disaster Coordinator uses the maps to support contingency planning for disasters. Individuals interviewed were not aware of any other users of the maps.

## 2.3 Current Condition and Limitations

The hazard maps have not been updated and there are no immediate plans to do so. The maps are in ArcView 8.2 shapefile digital format. The DPPNRE indicated

that the scale of mapping did not support local area planning. For example, individual streets in Charlestown that are prone to flooding were not identified, rather the entire town was zoned as prone to flooding.

The preparation of several hazard maps suffered from a lack of current digital data. The absence of settlement data, a current road network, and detailed elevation data were some of the data issues indicated. The period of data collection limited the amount of data available for analysis. In particular, the models used to predict flooding and beach erosion were forced to make assumptions and use mean values. The use of mean values reduced the impact of extreme events in the results of the studies. Data issues impacted on the models used and the quality of the results.

## 2.4 RESPONDENTS

Two interviews were conducted in Nevis on August 5<sup>th</sup> 2003. The interviews were with representatives of the Department of Physical Planning, Natural Resources and Environment and the Nevis Island Administration. Personal and contact information is listed below:

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In addition, information was sourced from the Seismic Research Unit at the University of the West Indies and the Organization of American States (OAS) Unit for Sustainable Development and Environment (USDE) to complete the data required on the hazard mapping and vulnerability assessment studies executed in Nevis.

## 3.0 VULNERABILITY ASSESSMENT STUDIES

To assess the vulnerability of critical facilities to natural hazards, the priority categories of facilities were identified and mapped. These categories included any facilities that functioned as a shelter; hospitals and clinics; government administrative buildings; airports and seaports; power, water and telecommunication installations; oil and gas companies; protective services and

the road network. Using the hazard GIS layers, those facilities that are at the highest risk to each of the mapped natural hazards were identified. For additional details please refer to St. Kitts/Nevis Hazard Vulnerability Assessment on the PGDM web site [www.oas.org/pgdm](http://www.oas.org/pgdm) .

### 3.1 Methods of Preparation and Distribution

The vulnerability assessment methodology used by the PGDM project consisted of the following steps:

- a. Identification and prioritization of hazards
- b. Creation of an inventory of critical facilities
- c. Assessment of each facility in terms of damage history, structural vulnerability and operational vulnerability for each hazard identified
- d. The creation of hazard specific vulnerability zone maps
- e. The locational assessment of facilities within hazard zones
- f. The calculation of a total facility vulnerability score (FVS) for each facility and each hazard.

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The vulnerability assessment process is defined by the formula:  $FVS = (L+V)HPS$ ; Where "FVS" is the Facility Vulnerability score, "L" is the Locational Vulnerability, "V" is defined as the total of the damage history, structural vulnerability and operational vulnerability scores and "HPS" is the Hazard Priority Score.

A weighted, priority listing of hazards was used to generate the Hazard Priority Score (HPS) as listed in Table 3.

**Table 3 – Hazard Priority Scores (HPS)**

Hazard	HPS
Winds / Hurricanes	5
Drought	1
Storm Surge	2
Floods	3
Coastal Erosion	4

The Vulnerability Assessment process was automated within a GIS environment to allow for the integration and analysis of data with hazard mapping. The system was designed within Microsoft Access™ and ArcView 3.2™ and consists of a Microsoft Access™ database and an ArcView 3.2™ project. The Microsoft Access™ database stores the critical facility data and calculates the "V" of each facility for each hazard. A table consisting of the hazard specific "V" scores is linked to each ArcView 3.2™ project. The ArcView 3.2™ project consists of digital maps and linked data tables.

Maps on the following features were integrated into the project to identify the features vulnerable to hazards: critical facilities; roads; settlements; corals; topography; drainage; landuse/landcover.

The GIS facilitated the overlay of hazard maps on the location of features and critical facilities. Visual interpretation determined which features were located in the various hazard zones. Spatial and tabular manipulations in the GIS identified facilities in each hazard zone and calculated the "FVS" of each facility.

### **3.2 Users and Uses**

The DPPNRE uses the Vulnerability Assessment study as inputs into development planning and particularly for the execution of environmental impact assessments. The department indicated that the document is not in public domain and is not widely circulated.

### **3.3 Current Conditions and Limitations**

The Assessment study has not been updated and there are no plans to do so. The coastal erosion research was conducted of specific beaches and is therefore of limited utility. Generally, more detailed mapping is required to support local area planning.

### **4.0 DIGITAL MAPS**

On the island of Nevis digital mapping is conducted in the GIS Unit of the DPPNRE. This unit is working towards establishing a national GIS and has created a number of digital map layers. Table 4 indicates the digital map layers that exist for the island of Nevis. All layers cover the entire island and are in ArcView 8.2 shapefile format. All layers were produced from 1:25,000 scale maps.

**Table 4 – Digital Maps Available in Nevis**

<b>Data Theme</b>	<b>Year input map was produced<sup>1</sup></b>	<b>Primary Source [Name of Agency]</b>
Wind Hazards	2000	OAS / USDE
Surge Hazards		
Wave Hazards		
Contours	1987	GIS Unit
Land use		
Vegetation		
Soils		
Geology		
Roads		
Rivers		
Rainfalls	1991	
Schools / churches	2001	OAS / USDE
Hotels		
Shelters		
DEM	2000	

*Note 1: The datum and projection of all the input maps are Clarke 1880 Modified and TM BWI Grid respectively*

**5.0 Conclusions and Remarks**

Nevis is an active volcanic island. The island is conical in shape and is made up of a single volcano. The population is distributed along the coast and concentrated on the main town of Charlestown. The economy is heavily dependent on the tertiary sector and in particular tourism. Sugar is the main agricultural crop.

The island is prone to hurricanes, seismic activity and flooding. Hurricanes are considered to be the major threat, as over the last decade they have caused significant structural and economic losses. Hazard mapping has been conducted for volcanic, hurricane, coastal erosion, drought, and flooding hazards. A vulnerability assessment has been conducted of critical facilities and resources by the PGDM project for hurricanes, coastal erosion, drought and flooding.

Hazard maps and the Vulnerability Assessment are used most by the DPPNRE. This Department uses the information to strengthen its development planning function. The Disaster Coordinator uses the hazard maps as an input to disaster contingency planning to a limited extent. The Vulnerability assessment does not appear to be widely used.

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