



STATUS OF HAZARD MAPS VULNERABILITY ASSESSMENTS AND DIGITAL MAPS

ST. KITTS REPORT

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

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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; 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 St. Kitts

1.0 Introduction

1.1 Physical and socio-economic background

St. Kitts is the larger island of the twin island federation of St. Kitts and Nevis. St. Kitts has a total area of 168 sq km. The island is shaped like a baseball bat and separated from Nevis by a three-km-wide channel called The Narrows. St. Kitts has a rugged topography with large areas of the island being inaccessible. These uninhabitable areas include mountain ranges, water bodies and rocky bluffs. The island's topography is dominated by Mount Liamuiga, a live volcano, which rises to a height of 1,156 m.

The population of St. Kitts was estimated to be 34,930 by the population census of 2001. This represented an increase of 3,106 persons from the 1991 population. The population is projected to grow 6.3% by 2021. Younger age groups dominate the demographic structure and this has resulted in a high fertility rate. The population of the island is heavily concentrated on the capital of Basseterre and its environs. In 2001, 37.9% of the island's population lived within this region.

Until the 1970s sugar was the main economic activity. While the crop still dominates the agricultural sector, activities such as tourism, manufacturing and offshore banking have developed. The economy of St. Kitts is dominated by the tertiary sector, which accounts for approximately 50% of the work force. The OAS Labour Force Survey of 1994 indicated that the main sectors of employment were business and general service (24.6%), government services (15.3%) and sugar cane production/manufacturing (12.2%). Other significant employers were manufacturing (9.9%), tourism (9.7%) and construction (9.6%). Tourism is the main earner of foreign exchange.

1.2 Major disaster issues confronting the country

The survey revealed that there are three major disaster issues confronting St. Kitts. These issues are: hurricanes; flooding; coastal erosion and slope instability.

Hurricanes are considered to be the major issue facing the country. This perception is due to the severe damage caused by hurricanes on the island over the last decade. Hurricane Georges, a category 3 storm struck St. Kitts on the 20-22nd September 1998. The hurricane caused severe damage to the island's infrastructure and the economy. In St. Kitts and Nevis, the hurricane affected 85 percent of the housing stock, most schools and the general hospital.

Flooding is a major issue especially within the capital of Basseterre. Basseterre is prone to flash flooding which has caused extensive damage to the port area.

The most recent flooding of Basseterre occurred along the College Ghaut system on Sunday 29th November 1998. The danger from flash flooding is increased because of the practice of locating development and roads along the "ghauts". In this regard, the National Emergency Management Agency (NEMA) in St. Kitts has stressed the need for use of early warning systems.

Coastal erosion and slope instability are of great concern. In the past, tropical storms and hurricanes have damaged major arterials along the coast and resulted in the isolation of sections of the island. Old Road was severely damaged by Hurricane Lenny in 1999. In the New Guinea area, Brimstone Hill Road has had to be rerouted because of coastal erosion.

It is interesting to note that although St. Kitts is a volcanic island with a live volcano, this risk did not seem to be of a high priority.

2.0 Hazard Mapping Initiatives

St. Kitts 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, inland erosion 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 (1998). 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 St. Kitts. The maps were all produced from the 1: 25,000 map base dated 1983. All the hazard maps, with the exception of coastal erosion, cover the entire island. The coastal erosion map dealt with beach erosion on specific beaches monitored by the Fisheries Department. The base map datum is Clarke 1880 modified and the projection is Transverse Mercator British West Indies.

Table 1 – Hazard Maps in St. Kitts

Type ¹	Purpose	Coverage	Primary Sources	Author
Volcanic	Development of hazard mitigation plan	Entire island	Seismic Research Unit, UWI	Seismic Research Unit, UWI
Wind	Development of hazard mitigation plan	Entire island	Physical Planning Unit, St. Kitts	Physical Planning Unit, St. Kitts
Waves	Development of hazard mitigation plan	Entire island	Physical Planning Unit, St. Kitts	Physical Planning Unit, St. Kitts
Storm surge	Development of hazard mitigation plan	Entire island	Physical Planning Unit, St. Kitts	Physical Planning Unit, St. Kitts
Coastal erosion	Development of hazard mitigation plan	Monitored beaches	Physical Planning Unit, St. Kitts	Physical Planning Unit, St. Kitts
Inland erosion	Development of hazard mitigation plan	Entire island	Physical Planning Unit, St. Kitts	Physical Planning Unit, St. Kitts
Flooding	Development of hazard mitigation plan	Entire island	Physical Planning Unit, St. Kitts	Physical Planning Unit, St. Kitts

Note 1: The year of production of all these maps is 2001

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 St. Kitts. 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 national GIS database for St. Kitts. 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 St. Kitts. 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 Arbiter of Storms (TAOS) model was used to generate the hazard maps. Flooding considered factors such as slopes, drainage, ratio of watershed area to flood plain and run-off rates and potential.

The Hurricane Lenny (1999) rainfall event was used as the basis for classification of flood hazards. Inland erosion examined sheet and rill erosion, gullying and landslides. Coastal erosion considered only those beaches that are monitored by The Fisheries Division of St. Kitts and Nevis, the Department of Environment and the Physical Planning Division. Specific details for the preparation of each hazard map can be accessed in the OAS consultant reports on the PGDM web site 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. They have been incorporated into the St. Kitts Atlas that is available in CD-ROM format for EC\$200. The Volcanic hazard map is distributed in published format.

2.2 Users and uses

The main user of the hazard maps is the Physical Planning Unit that uses the maps for policy development and development control. Other government agencies, such as Works and Housing, use the maps to inform infrastructure and housing developments. NEMA has integrated the hazard maps into its contingency planning. Foreign investors have used the hazard maps for feasibility studies.

2.3 Current condition and limitations

None of the hazard maps has been updated and there are no immediate plans to do so.

The Physical Planning Unit indicated that the map scale is too small to be useful for local area planning. The Unit also expressed concern as to the statistical value of the baseline data used for the preparation of the hazard maps. It was felt that the maps would have benefited from a longer data collection period.

NEMA indicated that errors were found on the flood hazard map and expressed the view that more local knowledge should have been incorporated into the data used for modeling. They also indicated that there is a constraint to the use of the maps at the community level of disaster management because of a lack of training in map reading.

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 Critical success factors

Respondents indicated two factors that contributed to the success of the project:

- a. The PGDM consultant worked full time in St. Kitts with the Physical Planning Unit.
- b. The mapping of hazards and vulnerability allowed for easy dissemination of information.

2.5 Respondents

← Formatted: Bullets and Numbering

Two interviews were conducted in St. Kitts on August 6th 2003. The interviews were with representatives of the Physical Planning Division and the National Emergency Management Agency. Personal and contact information is listed below:

Mr. Ellis Hazel,
Chief Physical Planner,
Planning Unit, Physical Planning Division,
Church Street, Development Bank Building, Basseterre, St. Kitts.
Telephone: 1-869-465-2277;
Email: phyplskb@caribsurf.com

Mr. Carl Herbert,
Disaster Coordinator,
National Emergency Management Agency (NEMA),
Taylor's, Basseterre, St. Kitts.
Telephone: 1-869-466-5521;
Fax: 1-869-466-5310;
Email: nemaskb@thecable.net

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 St. Kitts.

3.0 Vulnerability Assessment Studies

The PGDM hazard vulnerability project is the only vulnerability assessment conducted for the island of St. Kitts. It is a structural, economic and human assessment of the impact of hurricanes, coastal / inland erosion and flooding. It specifically assessed the elements of critical facilities and resources. The study was used as an input to the preparation of a disaster mitigation plan. It is owned by the Physical Planning Unit of the Government of St. Kitts and was prepared with support from the OAS (USDE) and USAID. The study was prepared over the period 2000 to 2001.

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 the St. Kitts/Nevis Hazard Vulnerability Assessment on the PGDM web site www.oas.org/pgdm.

3.1 Methods of Preparation and Distribution

The vulnerability assessment methodology consists 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.

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 the total of the damage history, structural vulnerability and operational vulnerability scores and “HPS” is the Hazard Priority Score.

A priority listing of the hazards were weighted from 1 to 5 to generate a Hazard Priority Score (HPS) as listed in table 3. These are the values utilized in this assessment.

Table 3 – Hazard Priority Scores (HPS)

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

The Vulnerability Assessment process was automated within a GIS environment to allow for the integration and analysis of data with hazard mapping. The system is designed within Microsoft Access™ and ArcView 3.2™. It consists of a Microsoft Access™ database and an ArcView 3.2™ project for each island. The Microsoft Access™ database stores the facility data collected by PGDM Committee 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. These are: critical facilities; roads; settlements; corals; topography; drainage; and landuse / landcover.

The GIS facilitates the overlay of hazard maps on the location of features and critical facilities. Visual interpretation determines which features are located in the various hazard zones. Spatial and tabular manipulations in the GIS identify facilities in each hazard zone and calculate the FVS of each facility.

3.2 Users and uses

The Physical Planning Unit and NEMA use the Vulnerability Assessment study as inputs into their functions. Due mainly to the low level of distribution of the results of the study, its use by other agencies is quite limited.

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 limited to specific beaches therefore its results were of limited utility. The Physical Planning Unit indicated that detailed mapping was required to support local area planning. NEMA indicated that the format of the document limits the wide dissemination of the data. They felt that it was not intended for the layman and required interpretation before the information could be disseminated to communities.

4.0 DIGITAL MAPS

The St. Kitts government has made the decision to centralize GIS mapping within the Planning Unit of the Physical Planning Division. The primary source for all digital mapping is the Physical Planning Unit. All digital maps are stored in ArcView shapefile format and cover the entire island. The PGDM project created a number of digital map layers and assisted the unit to establish a national GIS. The layers were produced using the Clarke 1888 Modified datum and the Transverse Mercator British West Indies projection. Table 4 indicates the details of these map layers.

Subsequently, the Lands and Surveys Division produced 2001 mapping of St. Kitts and determined that the national datum and projection should be standardized to WGS84 Local Carib97 Geoid and Transverse Mercator. The mapping that exists in this format is indicated in Table 5.

Table 4 – Digital Mapping in Clarke 1888 Modified and British West Indies Transverse Mercator for St. Kitts

Theme	Scale of input map	Year produced
Wind Hazards	1:25000	2000
Surge Hazards	1:25000	2000
Wave Hazards	1:25000	2000
Contours	1:25000	1983
Land use	1:25000	1983
Vegetation	1:25000	1983
Soils	1:25000	1983
Geology	1:25000	1983
Roads	1:25000	1983
Rivers	1:25000	1983
Rainfalls	1:25000	1983
Population	1:25000	1983
DEM	1:25000	1983

Table 5 – Digital Mapping in WGS84 Local Carib97 Geoid and Transverse Mercator for St. Kitts

<i>Theme</i>	<i>Scale of input map</i>	<i>Year produced</i>
Contours	1:2500	2001
Roads	1:2500	2001
Rivers	1:2500	2001
Buildings	1:2500	2001
Bridges/Culverts	1:2500	2001
Electricity lines	1:2500	2001
Population	1:2500	2001

5.0 CONCLUSIONS AND REMARKS

St. Kitts is a volcanic island with rugged topography. Most of the population is located along the coast and concentrated in the capital city of Basseterre. 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, flooding and coastal erosion. Over the last decade hurricanes have caused significant structural and economic losses. Hazard mapping has been conducted for volcanic, hurricane, coastal erosion, inland erosion and flooding. A vulnerability assessment has been conducted of critical facilities and resources by the PGDM project for hurricanes, coastal and inland erosion and flooding.

Hazard maps and the Vulnerability Assessment are used most by the Physical Planning Unit and NEMA. The Physical Planning Unit uses the information to strengthen its development planning function. NEMA uses the information to improve disaster contingency plans. The hazard maps appear to be widely used at the national level. At the community level their use is constrained by the ability of the community to read maps. The Vulnerability Assessment does not appear to be widely used.

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