



STATUS OF HAZARD MAPS VULNERABILITY ASSESSMENTS AND DIGITAL MAPS

COMMONWEALTH OF BAHAMAS COUNTRY 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 Maps, Vulnerability Assessments and Digital Maps in the Caribbean: THE BAHAMAS

1.0 Introduction

1.1 Physical and socio-economic background

The Commonwealth of Bahamas, located roughly at 24° 15' N and 76° 00' W, comprises an archipelago of 700 low-lying islands trending in a northwestern to southeastern direction over 100,000 square miles in the Atlantic Ocean from the coast of Southeast Florida to 50 miles north of Haiti. The Bahamas has a total area of 13,940 km² with 3,542km of coastline. The islands and cays are made of limestone greater than 5000m in depth, sitting on the Bahamas Platform, a geologically stable structure. Many of the islands are long, flat coral formations just 3-4m above mean sea level with low rounded hills having a maximum height of 100 feet. The highest point in The Bahamas is Mt. Alvernia, 63m (206 feet) high on Cat Island. There are no rivers or streams on any island. A fresh water lens overlying the salt water provides the inhabitants with fresh water, most of which comes from the island of Andros. There are 13 major islands, one of which is New Providence, just 80 square miles in area, being the most populated.

The Bahamas experiences a tropical marine type of climate with maximum temperatures ranging from 25° C to 30° C and high humidity throughout the year. The North Atlantic Southeast Trade winds are felt in the summer and the North American high pressure system in the winter. Average rainfall varies from 600mm in the dry southeastern islands to more than 1600mm in the northwestern islands. The rainy season is from May to October, with hurricane activity increasing from August to October. 49 hurricanes passed near The Bahamas between 1886 and 1990. An analysis of hurricane activity by the Meteorological Department revealed that the country experiences an average of 0.9 to 1.4 hurricanes each year for intense periods of hurricane activity.

The vegetation of The Bahamas varies from north to south. The northern islands have pine forests in their interior, and mangroves in tidal flat areas. The islands of central Bahamas have broad-leaved vegetation in the central areas, with mangroves on the flat coastal areas. More drought-resistant species are found in the southern islands, with mangroves on the flat coastal areas.

The estimated population of The Bahamas is 297,477 (July 2003) with the island of New Providence being the most populated island having 222,200 people, most of whom live in the capital city of Nassau (2003). The next important town is Freeport on the island of Grand Bahama with 15% of the population. 28.8% of the population is below the age of 14 years, and 65.4% between 15-64 years. The population growth rate is an estimated 0.77% with a net migration rate of -2.21 migrants per 1000 population. Internal migration takes place from the central and southern islands to Nassau and

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Freeport for employment and better services. The natural resources of The Bahamas are salt, aragonite, timber and arable land. The economy is heavily based on tourism, offshore banking and international shipping. The service industry accounts for 90% of the GDP, with tourism alone accounting for 60% of that industry, and employing 50% of the labour force. Manufacturing and agriculture contribute only 10% of the GDP. Per capita GDP is \$US17,000 (2002). (Source of statistics: Central Intelligence Agency (CIA) Fact Book, 2003) found at: <http://www.cia.gov/cia/publications/factbook/geos/gj.html>.

1.2 Major disaster issues confronting the country

Major hazards affecting The Bahamas are coastal inundation due storm surges and localized flooding which are often associated with tropical storms and hurricanes; hurricane-force winds; contamination of aquifers and the threat of sea level rise. Hurricane winds are known to damage buildings and infrastructure of the built environment. Contamination of aquifers is a serious concern for Bahamians. This can come about due to the movement of sewage, pesticides and seawater into the soil and aquifers as a result of localized flooding and storm surges. Coastal flooding of low-lying areas, unrelated to the passage of a tropical storm or hurricane, can also occur from a combination of high winds, spring tides and coastal bathymetry, especially around tidal creeks and sounds. Another concern is anticipated sea level rise that makes the coastal zone particularly vulnerable to beach erosion, loss of habitat for marine life, loss of fresh water aquifers, and damage to coastal infrastructure. Oil spills in coastal waters and in ports are hazards that the country is likely to face.

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2.0 Hazard Mapping Initiatives

Hazard maps were prepared for storm surge and seismic hazards for the Bahamas. The survey revealed that a Storm Surge Atlas for the Northern and Central Bahamas was produced using the SLOSH model, which was developed in 1990 and tested in 1992, using data from Hurricanes Andrew and Floyd and found to be effective. The study is used to assess storm surge development on the islands likely to be hit by a hurricane.

Two sets of seismic hazard maps were prepared for the Bahamas by the Seismic Research Unit, one, done in 1999, as part of the regular dissemination of information that the Unit routinely performs and the other for the Caribbean Disaster Mitigation Project (CDMP) in 1999.

Table 1 shows the details of hazard mapping in The Bahamas.

Table 1 – Hazard Mapping in The Bahamas

Type	Purpose	Coverage	Scale	Date produced	Primary sources	Author
Storm surge	To map storm surge and inundation resulting from hypothetical hurricanes using the SLOSH model	Northern and Central Bahamas	A grid of a telescoping system with 90 arc lengths and 104 radials	2000	National Weather Service of the Bahamas P.O. Box N-8330, Nassau, Bahamas	Arthur Rolle, National Weather Service of the Bahamas and National Hurricane Centre, Florida, US.
Seismic	To map Horizontal Ground Acceleration; Expected Maximum Mercalli Intensity; and Horizontal Ground Velocity	Entire country	0.25° grid resolution	1999	OAS/CDMP http://www.oas.org/en/cdmp/hazmap.htm	Seismic Research Unit, UWI, Trinidad.
Seismic	To map general level of earthquake hazard in the Caribbean in the terms of the Modified Mercalli Scale and PGA and SGA values	Extreme Southern Bahamas	0.25° grid resolution	1999	Seismic Research Unit http://www.uwiseismic.com/SRU_Site01/Earthquakes/eq_ec_seismicity_hazmm.html	Seismic Research Unit, UWI, Trinidad.

2.1 Methods of preparation and distribution

2.1.1 Storm surge

The Storm Surge Atlas for the Northern and Central Bahamas (New Providence and Vicinity) contains maps of storm surge heights and expected inundation produced from

a numerical storm surge model, SLOSH (sea, lake, overland surges from hurricane) developed by Jeleznianski *et al.* (1984). It has two components: a Hurricane Model and a Storm Surge Model. Using data from the Weather Service of the Bahamas and NOAA's National Hurricane Centre in Florida, US, thirteen hurricanes of various strengths and direction were modeled and results input in the storm surge model. The maps show the highest water levels with respect to mean sea level, but not for any specific point of time. The accompanying document entitled *A Storm Surge Atlas for the Northern and Central Bahamas (New Providence and Vicinity)* contains greater detail on the methodology used.

2.1.2 Seismic hazard maps

The first set of seismic hazard maps, produced by the Seismic Research Unit, showed levels of ground shaking using the Modified Mercalli (MM) scale of earthquake intensities and Peak Ground Acceleration (PGA) with 10% probability of exceedance in any 50-year period and One-Second Spectral Ground Acceleration (SGA) for the same probability. The southern extremity of The Bahamas falls into the Moderate Hazard category of earthquake intensity using the MM scale. This area has the lowest level of seismicity in the Caribbean. The Seismic Research Unit will update the MM maps, and the PGA and SGA maps in the near future. The maps can be viewed at the

URL: http://www.uwiseismic.com/SRU_Site01/Earthquakes/eq_ecseis_bahaz.html

The methodology for arriving at the Seismic Hazard maps for The Bahamas, showing PGA and SGA values, is given at:

URL: <http://seismo.ethz.ch/gshap/northam/report.html>

The second set of seismic hazard maps was prepared for the CDMP Hazard Mapping and Vulnerability Assessment workshop in 1999. These maps showed seismic hazard maps of Horizontal Ground Acceleration, Expected Maximum Mercalli Intensity and Horizontal Ground Velocity for The Bahamas. The maps were prepared using types and intensities of earthquakes, distribution of faults, thrusts and volcanoes in the region. Recurrence models were used to determine how future earthquakes would occur. All this information was combined to produce expected earthquake spectra that showed how amplitude would vary with frequency. Maps of ground acceleration, ground velocity and Modified Mercalli Intensities for the Leeward Islands, done at a scale of 0.1° grid resolution, are posted at:

URL: http://www.oas.org/en/cdmp/document/seismap/bah_tci.htm

Source of this information:

URL: <http://www.oas.org/en/cdmp/hazmap/Grenada/atwell.htm#Introduction>

The methodology for arriving at the *Eastern Caribbean Seismicity* seismic hazard maps for The Bahamas, showing PGA and SGA values, produced by the SRU, is given at:

URL: <http://seismo.ethz.ch/gshap/northam/report.html>

2.2 Users and uses

The storm surge study is used by the National Disaster committee to assist in planning evacuations in the event of a hurricane; by engineers for construction purposes; the insurance industry; Ministry of Works and Utilities; and the BEST (Bahamas Environmental, Science and Technology) Commission.

No information is available on the users and use of the seismic hazard maps.

2.3 Current condition and limitations

Limitations of the storm surge study were: outdated maps, low resolution of final maps, anomalous water heights, exclusion of local wave, tides, rainfall, and flooding data from the model. There were also problems in determining maximum wind speed. The technical jargon used in the atlas plus its limited distribution prevented its wide use and circulation. Also, the atlas does not apply to the entire country.

2.4 Critical success factors

No information was provided on the critical success factors in the preparation, maintenance, and use of the storm surge study.

2.5 Respondents

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Please see Appendix I for a list of persons interviewed.

3.0 Vulnerability Assessment Studies

No vulnerability assessment reports were identified during the survey visit.

4.0 Digital Maps

Every effort made to obtain this information from the relevant person/agency has proved futile at the time of the submission of this report. The report will be updated as soon as this information becomes available.

5.0 Conclusions and Remarks

The only hazard maps that appear to be produced for The Bahamas were those in the atlas *A Storm Surge Atlas for the Northern and Central Bahamas (New Providence and Vicinity)*. A search on the Internet located a report on the *Impact of Severe Weather Events on Tourism in the Bahamas* prepared by consultant, Ivor Jackson for CDERA, 2003. Section 3.1 of the report dealt with vulnerability to climate change and severe weather events for the Bahamas. Internet search also indicated that hazard maps were prepared for seismic hazards for the Bahamas.

The study concludes that there is the need to produce coastal inundation maps at a larger scale for use in disaster preparedness and evacuation planning in the populated islands of The Bahamas.

References

BEST Commission. 2001. **The Bahamas National Report: Integrating Management of Watersheds and Coastal areas in Small Island Developing States (SIDS) of the Caribbean**. URL: www.cehi.org.lc/water_resources/projects/iwcam/national_reports/bahamas/bahamas_national_report.pdf

Jackson, Ivor. 2003. **Impact of Severe Weather Events on Tourism in the Bahamas**. Paper presented at a CDERA and Asian Disaster Preparedness Centre Seminar on Climate Change and Severe Weather Events in Asia and the Caribbean, at Grand Barbados Beach Resort, Barbados, July 24-25, 2003.

Rolle, Arthur, W. (No date given). **A Storm Surge Atlas for the Northern and Central Bahamas (New Providence and Vicinity)**. Prepared by the national Weather Service of the Bahamas and the Storm Surge Group of the National Hurricane Centre, National Oceanic and Atmospheric Administration, Coral Gables, Florida, US.

Appendix 1: Persons interviewed on 23-25 September 2003, Bahamas

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