Disaster Risk Assessment: Opportunities for GIS and data management with Open DRI

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OUR VULNERABLE LAND MASS

• Housing developments on drainage channels and steep slopes
• Unapproved development and land squatting
• Voluntary approach to the use of building codes
• Active seismic activities with geological faults
• Low level of awareness on the impact of natural hazards
• Low level of real estate insurance
Social Factors

- Poverty – settlement location and housing quality, slow rehabilitation/recovery.
- Access to Resources – land ownership, employment, social infrastructure, education, public awareness.
- Cultural practices – agricultural methods, perceived unreliability of scientific forecasts.
- Stagnant or declining economies
Physical and Environmental Factors

Geological structure – contributes to active seismicity
Steep topography – contributes to mass wasting and high velocity runoff
Low-lying coastal plains – increasing susceptibility to inland and coastal floods
Tropical maritime climate – with associated high magnitude rainfall and other tropical phenomenon.
PHYSICAL LOCATION- HYDRO-METEOROLOGY.


Atlantic Tropical Storm/Hurricane Track 1990-1999

Source: Caribbean Hurricane Network: Climatology of Caribbean Hurricanes. www.stormCARIB.com
Atlantic Tropical Storm/Hurricane Paths 2000-2005
THE CONSEQUENCES
Damage to homes in Jamaica due to Hurricane Ivan 2004

Homeowner surveying the damage.
Risk and Vulnerability (inundation)

Risk is high for inundation in low lying riverine areas and coastal areas.

Belize city June 2008  Georgetown January 2005
Risk and Vulnerability (landslides, debris flows)

Risk is high for flash floods and landslides (including debris flows) in small islands of volcanic origin. They are caused by localized heavy rainfall over small and steep river catchments.

Damage to Buildings in Haiti due to the Earthquake of 2010
Loss/ damage of homes: Some Statistics

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Event</th>
<th>Housing loss/damage(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominica</td>
<td>1979</td>
<td>Hurricane David</td>
<td>60</td>
</tr>
<tr>
<td>St. Lucia</td>
<td>1980</td>
<td>Hurricane Allen</td>
<td>30</td>
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<tr>
<td>Jamaica</td>
<td>1988</td>
<td>Hurricane Gilbert</td>
<td>25</td>
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<td>Montserrat</td>
<td>1989</td>
<td>Hurricane Hugo</td>
<td>90</td>
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<td>Anguilla</td>
<td>1995</td>
<td>Hurricane Luis</td>
<td>41</td>
</tr>
<tr>
<td>St.Kitts &amp; Nevis</td>
<td>1998</td>
<td>Hurricane Georges</td>
<td>85</td>
</tr>
<tr>
<td>Jamaica</td>
<td>2004</td>
<td>Hurricane Ivan</td>
<td>14</td>
</tr>
<tr>
<td>Grenada</td>
<td>2004</td>
<td>Hurricane Ivan</td>
<td>90</td>
</tr>
<tr>
<td>Cayman Islands</td>
<td>2004</td>
<td>Hurricane Ivan</td>
<td>50 (estimated)</td>
</tr>
</tbody>
</table>
Risk and Vulnerability

Caribbean Region is one of disaster hot spots in the world.
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Antigua and Barbuda</td>
<td>7</td>
<td>7</td>
<td>105.7</td>
<td>18.1</td>
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<td>Bahamas</td>
<td>4</td>
<td>5</td>
<td>209.4</td>
<td>9.5</td>
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<td>Barbados</td>
<td>5</td>
<td>3</td>
<td>148.4</td>
<td>6.3</td>
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<td>6</td>
<td>5</td>
<td>33.8</td>
<td>5.4</td>
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<tr>
<td>Dominica</td>
<td>7</td>
<td>43</td>
<td>133.4</td>
<td>55</td>
</tr>
<tr>
<td>Grenada</td>
<td>4</td>
<td>0</td>
<td>30.1</td>
<td>9.5</td>
</tr>
</tbody>
</table>
What is Risk?
Risks are an integral part of life and since risk cannot be completely eliminated, the only possible option is to assess and manage it.

The first step in risk assessment is to find out what the problems are. This involves evaluating the significance of a given quantitative measure of risk in an integrated way.
Disaster Risk Management Framework

- Description of intention
- Hazard mapping
- Vulnerability assessment
- Estimation of probability of consequences
- Estimation of magnitude of consequences
- Risk estimation
- Risk evaluation
- Risk management
Earthquake Risk Assessment Methods

4 major steps (Batuk et al 2005)

1. **Hazard Analysis** – quantifies the physical characteristics of a hazard, including probability of occurrence, magnitude, intensity, location, influence of geological factors

2. **Exposure Analysis** – identifies and maps underlying elements at risk or exposures, including the built environment and socioeconomic factors such as population and economic activity

3. **Vulnerability Analysis**: Assesses the degree of susceptibility to which elements at risk are exposed to the hazard. A common form of vulnerability analysis uses historical damage records to prescribe relationships between damage to dwellings and hazard intensity, for example different buildings and construction types will have distinct vulnerability curves, and finally

4. **Risk analysis** synthesizes the above three components and determines the resulting losses as a function of return period or as an exceedance probability
Uses of Earthquake Risk Assessment

(C. Benson and J. Twigg, 2004)

• Predicting the expected impact of earthquake of projects
• Identification of appropriate risk management strategies
• Predicting the impact a project would have on forms and level of vulnerability in the wider community
• Help to formulate national policy objectives such as land use planning and building codes
• It provides cost efficient decision support on how to optimize investments into risk reducing measures in three situations, namely, prior, during and after an earthquake.
Data Required for Earthquake Risk Assessment

A. Baseline data

- Administrative boundary
- Land cover, roads, streams etc.
- Transportation and utility system
- Facility and building structures
- Demography (census, population distribution, density)
- Economic value of asset of various sectors
B. Hazard data

- Historical records (time, place, extent, magnitude / intensity) of earthquake hazard
- Geology, lithology, soil, and slope, water table
- Faults location, length, and depth
- Site condition, ground motion
- Existing method in hazard & risk assessment methodology
C. Vulnerability data

- Proximity of assets to active and inactive fault lines
- Age of structures
- Population and development density
- Value of assets
- Location of critical facilities: Hospitals, Schools, Prisons, Banks, Public offices
- Construction materials used in buildings
- Location of lifelines: telecommunication, water, gas, power, transport systems
What is Risk Management?
Risk management means reducing the threats to life, property and the environment posed by the hazard whilst simultaneously accepting unmanageable risks and maximizing any associated benefits (Smith, 1996.)

Risk management involves the efforts of a variety of sectors and series of actions.

In the case of earthquakes, risk management describes the role of seismic monitoring in developing alternative strategies for reducing future losses and aiding the recovery process.
Earthquake Risk Management Measures

- National risk reduction program
- Disaster preparedness and response plans
- Disaster recovery plans (National and sectoral)
- Earthquake hazard maps
- Earthquake early warning systems
- Landuse planning
- Building codes and development regulations
- Insurance schemes
- Development incentive programmes
- Efficient risk communication strategies
- Public education (use of simulators)
- Research and development programmes
- Earthquake risk policy and legislation
Existing and Planned Land Use Map of Metro Manila
Peak Ground Acceleration Map and Commercial & Industrial Areas Subject to Heavy Shaking
What are the Challenges facing the Development of Risk Assessment and Management in the Caribbean?

- Lack of a consistent data collection programme for risk assessment and management.
- Lack of an active public education programme.
- Capacity development and enhancement
- Review of relationship with related agencies
- Lack of a database on building structures
- Vulnerability assessment of communities
- Obtaining political support
The way forward:

Development of a roadmap and procurement plan for a National GIS infrastructure for data integration, data sharing, data analysis, data dissemination for all stakeholders in Grenada.

What do we need?

- Data
- Tools
- Policy
- Human capacity