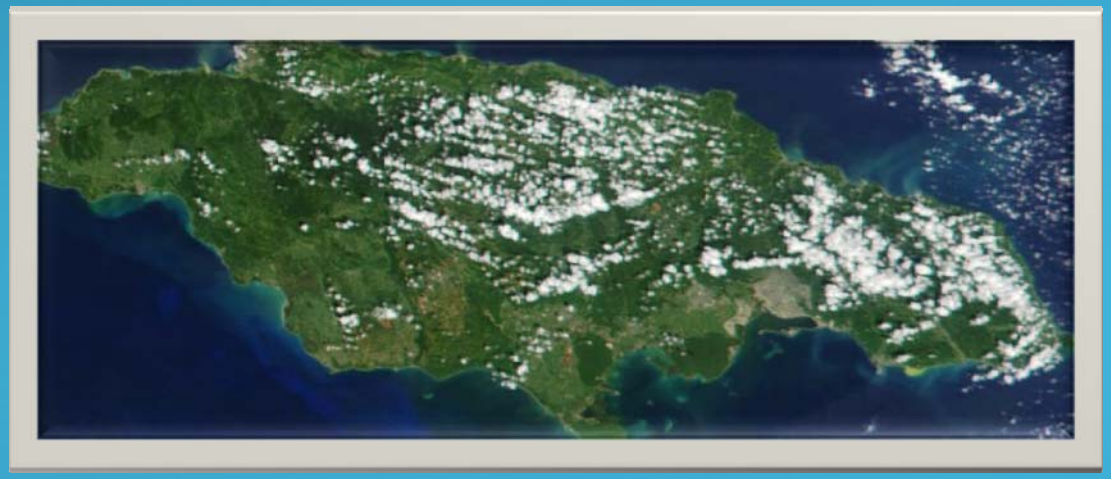
Hazard and Risk Geospatial Data Requirements : A Case Study of Urban Areas in Jamaica



Chengdu Forum on UN-GGIM, Global Map for Sustainable Development: Development and Application in Urban Hazard Mapping
15 -17 October 2013

Presented by Mark Codling, Jamaica

Presentation Outline

- Jamaica's Susceptibility to Hazards
- Situational Analysis of Jamaica Hazard Management (Urban Areas)
- Geospatial Data Requirements
- Challenges and Opportunities for Geospatial Requirements

Urban Settlement in St. Andrew, Jamaica

Jamaica
Geographic Location & Climate

- Size:~ 11,000 sq. km
- Latitude 18°15′ N and Longitude 77°20′ W)
- Tropical maritime climate, with the island experiencing tropical storms and hurricanes during the period July To November.
- Small island developing State
- Population: 2.89 (July 2012 est.) - urban population: 52% of total population

Jamaica's Susceptibility to Hazards

- Hurricanes
- Flooding (coastal & riverine)
- Landslide
- Drought
- Earthquakes

Jamaica's Susceptibility to Hazards

- Between 2004- 2012 the country experienced 8 major hurricane events.

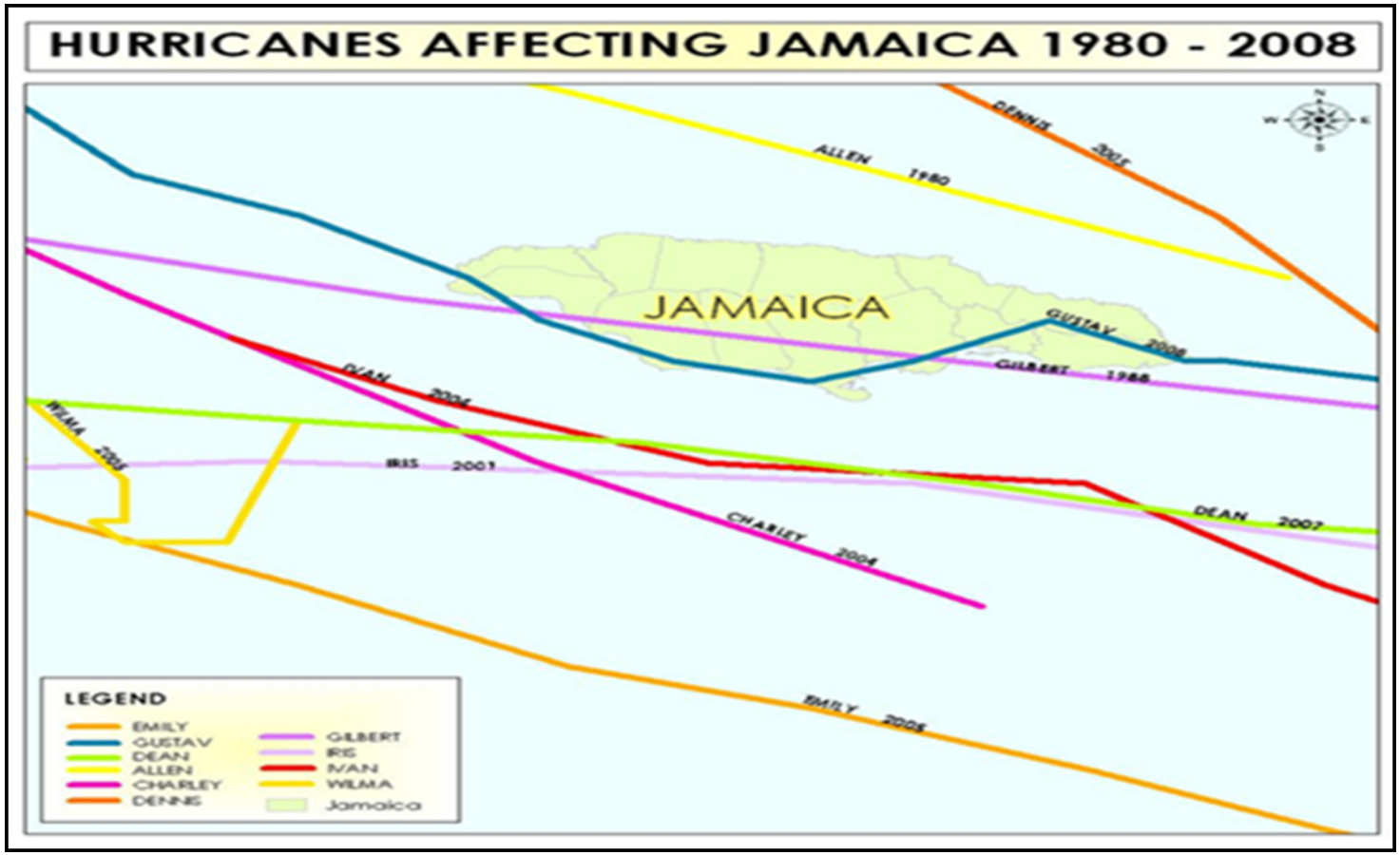
- Over 400 of the island's 900 communities ranked high or moderately high to natural hazards.

Jamaica's Susceptibility to Hazards

Overview of Climate Related Risk (10yr period) in Jamaica

Nature of Event	Year	Cost of Damage (JA$)	# Roads Affected	# Communities Affected	Casualties
Tropical Depression Nicole	2010	20,573,500.00	189	130	48
Tropical Storm Gustav	2008	15,051,000,000.00	151	76	12
Hurricane Dean	2007	23,000,000,000.00	269	169	4
Port Maria Rains	2006	48,862,500.00	9	24	-
November Rains	2006	533,200,108.00	17	93	-
Hurricane Emily & Dennis	2005	5,976,910,000.00	14	15	1
Hurricane Wilma	2005	3,419,202,845.40	90	106	1
Hurricane Ivan	2004	35,900,000,000.00	111	177	17
Hurricane Charlie	2004	248,912,460.00	-	-	1
May – June Rains	2003	203,347,750.00	-	27	-
Tropical Storm Lili & Isidore	2002	840,394,883.00	-	185	0
TOTAL		85,242,404,046.40	850	1002	84

Jamaica's Susceptibility to Hazards



Jamaica's Susceptibility to Hazards

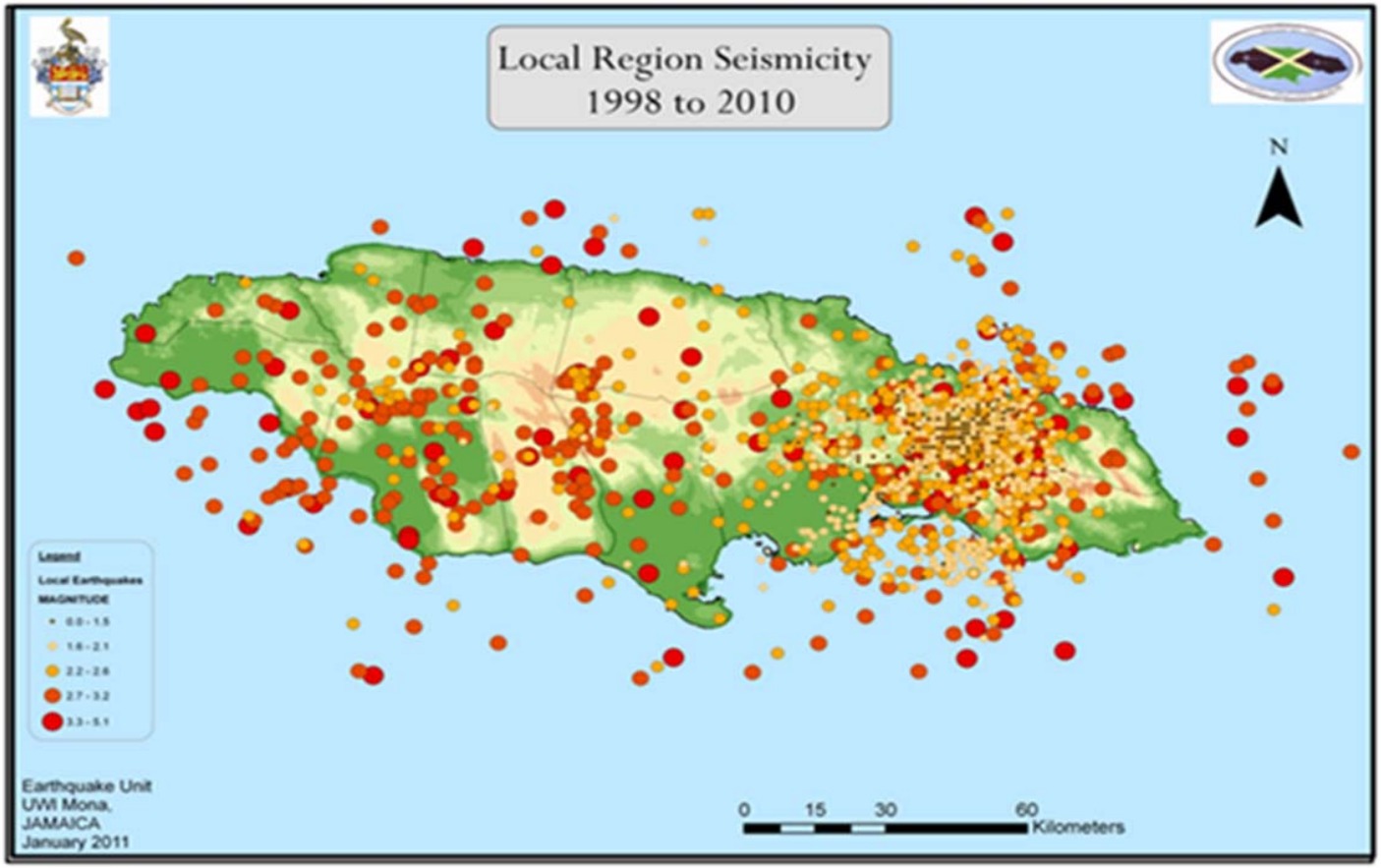
Earthquakes

- History of seismic activity. Experience on average 200 earthquakes per year

- Major earthquakes affected Montego Bay and Kingston in **1958,** and Kingston in **1907** & **1993**.

- Kingston, the most densely populated area is also the most active seismic zone. Landslides have resulted in deaths and disrupted major transportation networks.

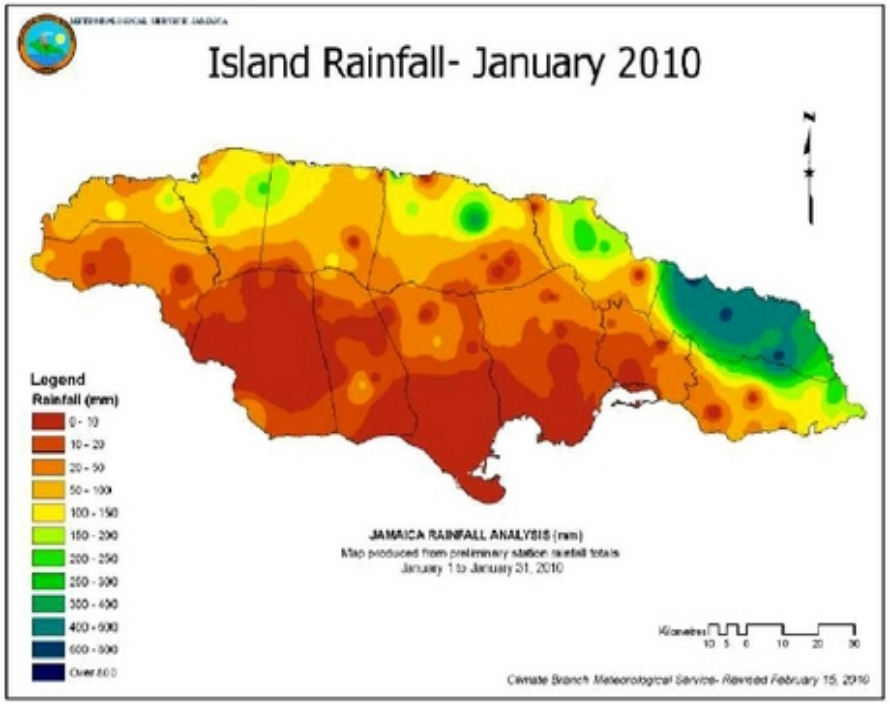
Jamaica's Susceptibility to Hazards



Jamaica's Susceptibility to Hazards

Drought

- Jamaica vulnerable to the drought hazard.
- Country lies within the tropics and so is dependent on more than one rainy seasons. A deficiency in any season can produce a damaging drought.
- The increase in Jamaica's population due to urbanization, has led to increased demand for an already limited supply of water.



Factors Contributing to Jamaica's Susceptibility to Hazards

- Improper Land Use for Urban Areas
- Lack of adherence to building codes
- Squatting (~754 informal communities scattered across the island, comprising 0.6 -0.9 million people (25% to 33% of the population) - Ministry of Housing Survey 2008
- Development in high-risk areas (along gully courses, on steep hillsides, and on road and railway line reserves).
- Environmental degradation.

Hazard Management in Jamaica

- Jamaica's Office of Disaster Preparedness and Emergency Management is responsible for coordinating the response to emergencies, with coordination being carried out from the National emergency operations Centre (NeoC).

- ODPEM is a statutory body created under the provisions of Section 15 of the Disaster Preparedness and Emergency Management Act .

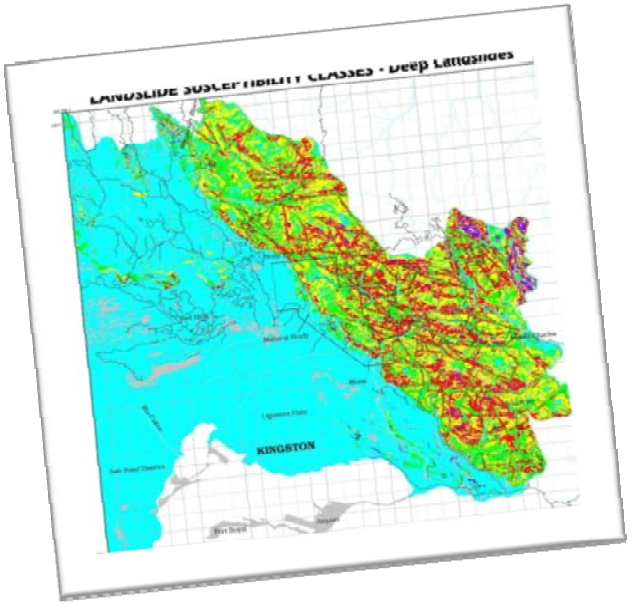
- Under the post-impact conditions, ODPEM coordinates the relief efforts with the input of the international community. (Source :National Disaster Action Plan for Jamaica 1997)

Hazard Management in Jamaica

Hazard Data Availability

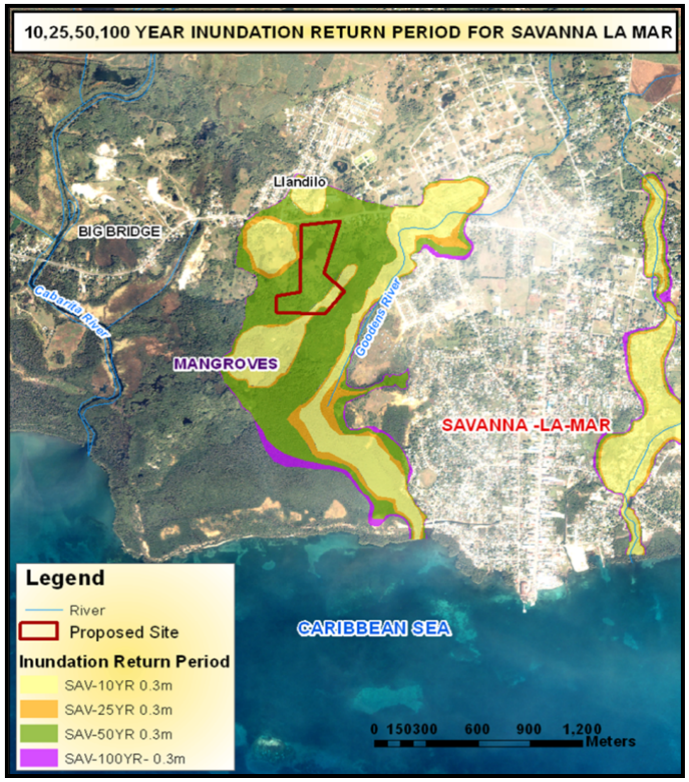
- Several Hazard Maps have been developed.
- These maps have been compiled and by the ODPEM for stakeholders to ensure that they are used effectively.
- National and local risk assessments are based on hazard data. Vulnerability information are available and include risk assessments for key hazards (Floods, Droughts and Landslides).

National Progress Report On The Implementation Of The Hyogo Framework: (2007-2009)



Hazard and Risk Management
Geospatial Data Requirements

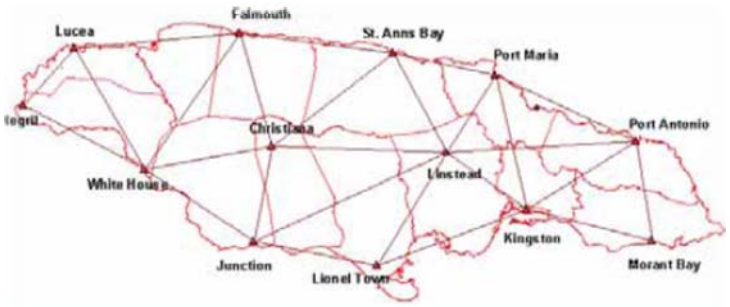
The importance of knowledge of the hazards and physical, social, economic and environmental vulnerabilities to disasters that most societies face, and of the ways in which hazards and vulnerabilities are changing in both the short and the long term, so that action can be taken on the basis of that knowledge.



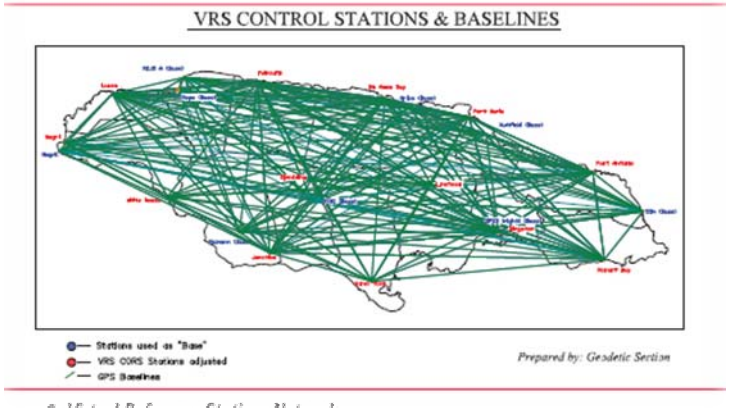
Hazard and Risk Management Geospatial Data Requirements

Critical Success Factors

1. Data Collection – GPS/GNSS and Voluntary geospatial information
2. Data Quality and Standards
3. Effective Spatial Data Analysis



igure 2: Virtual Reference Stations across Jamaica



Hazard and Risk Management Geospatial Data Requirements

Critical Success Factors

4. Spaced Based Data combined with other fundamental geospatial datasets –data within Government Agencies

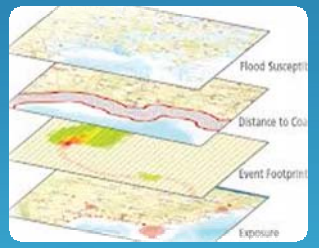
5. Spatial data infrastructure to facilitate the exchange of geospatial data for risk and hazards assessment

6. Common operational picture – urban hazard and risk assessment process

7. Understanding and mapping the hazard (Implementation of Early warning systems)

1 m color IKONOS High Resolution Satellite Imagery 2001

Hazard and Risk Management Geospatial Data Requirements



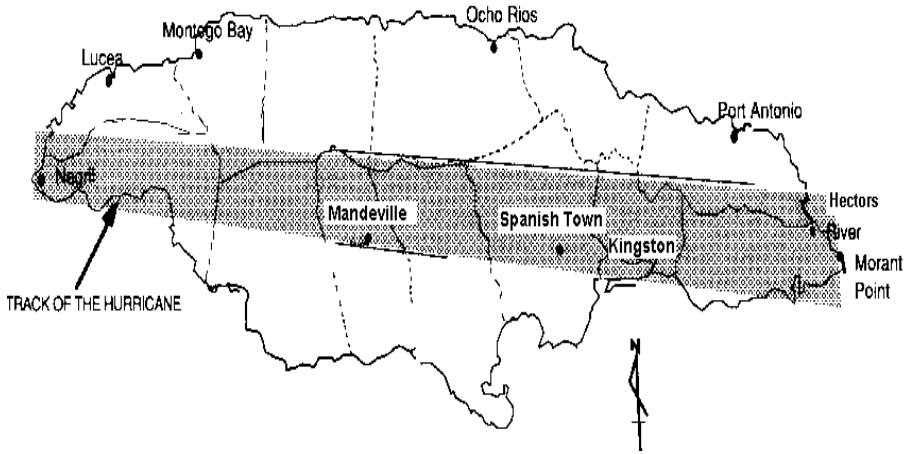
Categories	Geospatial Data
Physical Infrastructure	Roads, Telecommunication, Electricity, Building Foot Prints
Socio economic	Distribution of settlements, demographic and socio-economic data (population distribution by age, sex, income, education
Administrative Boundaries	Communities, Parishes, County
Cadastral	Parcel, Property Information, Tax Map
Social Facilities	School,emergency shelters, evacuation locations and critical facilities)
Land use	Forestry Reserves, Protected Areas
Geology	Faults, Stratigraphy, Soils
Base Map	Satellite Imagery, DEM,Topographic Map

Integration of Datasets

Hazard Related Datasets	
Geospatial Data Collected on Hazard Events	Hazard Models created for events
Flood	Storm Surge
Landslides	Wind
Earthquake Events	Flood
Landslides	Landslide
Wind	Earthquake

Hazard and Risk Geospatial Data Requirements - Case Study #1 Hurricane Gilbert

- Damage was estimated at US$4 billion, with the damage to agriculture accounting for over 40 percent of this total.
- 95 % of all health facilities suffered damage. Of the 25 public hospitals only two escaped with minimal damage.
- The disaster plans were never implemented. "The impact of the hurricane overwhelmed many sectors"
- Lessons Learnt : Demand for Geospatial Information to support disaster planning and response



Hazard and Risk Geospatial Data Requirements - Case Study #2– Earthquake 1993 and 1907

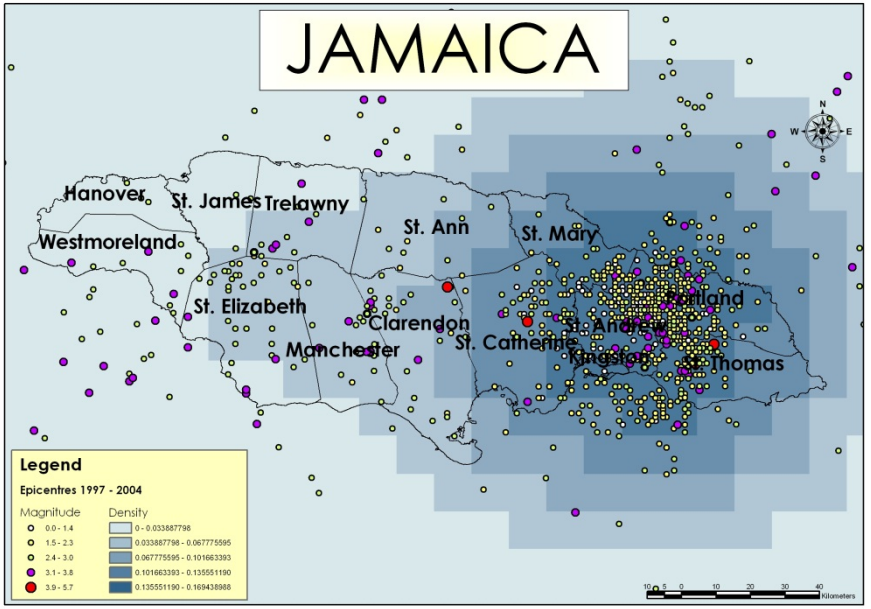
1907

- 1907 Kingston earthquake - magnitude of 6.5 on the moment magnitude scale
- one of the world's deadliest earthquakes recorded in history.
- every building in Kingston was damaged by the earthquake and subsequent fires, which lasted for three hours before any efforts were made to check them
- culminated in the death of 800 to 1,000 people, and left approximately 10,000 homeless .

Hazard and Risk Geospatial Data Requirements - Case Study #2 – Earthquake 1993 and 1907

1993

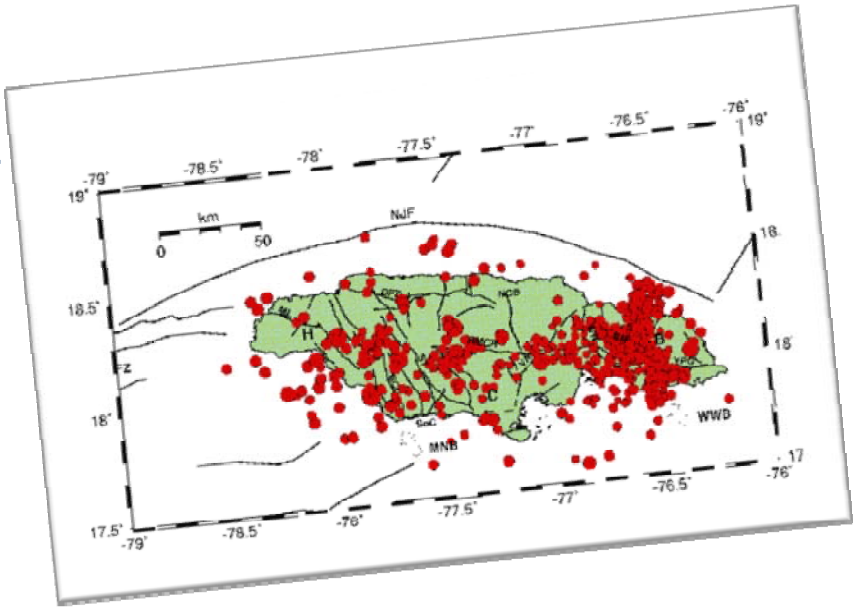
- The pattern of damage and geologic effects observed in 1993 are very similar to those reported in 1907.
- The sites of ground failures were related to landslides, liquefaction, and ground cracks and fissures and the associated damage.



Hazard and Risk Geospatial Data Requirements - Case Study #2 – Earthquake 1993 and 1907

Lessons Learnt : Geospatial Requirements

Need for State-of-the-art, GIS-based hazard maps dealing with landslides, earthquakes, flooding, storm surge for following urban areas Kingston and St.Andrew, Clarendon and St.Catherine, South Coast of Jamaica, Portland, and Montego Bay areas. (Source: Rafi Ahmad 2001)



Hazard and Risk Management Geospatial Data Requirements - Case Study # 3: Portmore Urban Area Hazard Assessment

Portmore, St Catherine, Jamaica

- Located 17.9°N, 76.87°W
- Accounts for 31 percent of total population of St. Catherine
- Fastest growing city in Jamaica - 4% growth rate
- The area suffered in the past from earthquake and urban flooding

Hazard and Risk Geospatial Data Requirements - Case Study #3: Portmore Urban Area Hazard Assessment

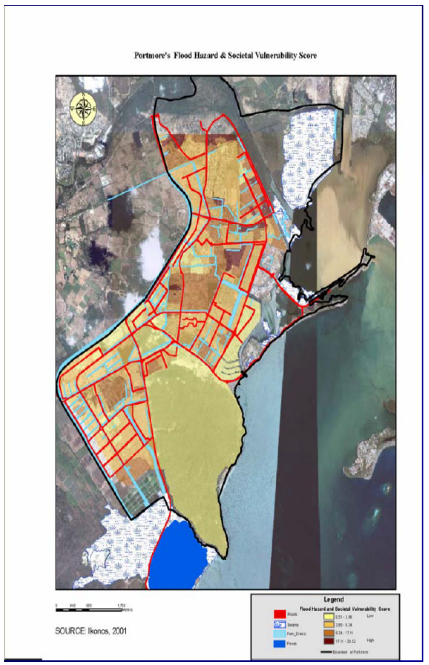
The Portmore Urban Area Hazard Assessment Project, 2007 (UNDP)

Objective: To conduct hazard mapping for Inland Flooding , Earthquake Storm Surge for the Portmore Community.

Output: Recommendations to improve/update The Portmore Evacuation Plan

Recommended Geospatial Data Requirements

- Identification of the Critical Facilities
- The Commercial and Residential Built Environment
- Population
- Data from Hurricanes Ivan (2004) and Dean (2007) used to generate flood incident map
- Earthquake related data
- Storm Surge related data



Hazard and Risk Geospatial Data Requirements - Case Study #3: Portmore Urban Area Hazard Assessment

The Portmore Evacuation Plan

Priority Zones:
Those areas in Portmore which are most vulnerable to meteorologically induced events, such as hurricanes and tropical storms.

Secondary Zones:
Those areas which are less vulnerable and less prone to meteorologically induced events.

Assembly Points:
Places where persons relying on public transportation to the designated shelters should gather.

Shelters:
Temporary locations of safety for those evacuees who are evacuating their homes as a result of disasters of a destructive nature.

Evacuation Routes:
Safe routes to be taken from the area at risk.

Spatial Information on the Hazards Assessment properly Informs the plan

ZONES	COMMUNITIES	ASSEMBLY POINTS	ROUTES
Priority Zone 1	Waterford	**1)**Waterford Infant School **2)**Waterford Primary School **3)**Waterford Comprehensive High School	Route 1 North to Kingston (R1NKgn)
	Caymanas Gardens Site A	**4)**Caymanas Race Track Parking Lot	Route 7 North to Kingston (R7NKgn)
	Portsmouth	**5)**Portsmouth Primary School	Route 1 North to Kingston (R1NKgn)

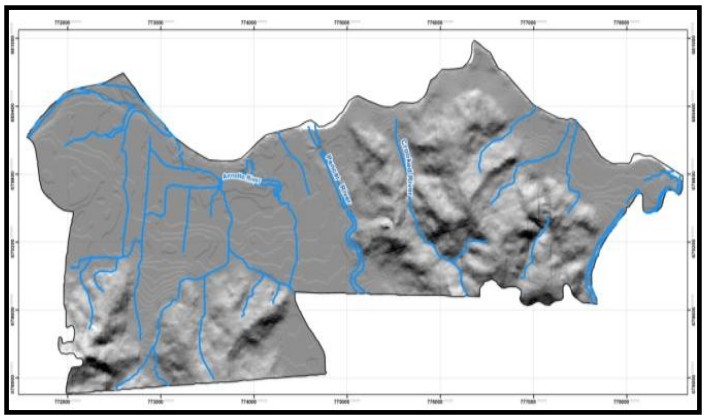
Hazard and Risk Geospatial Data Management Requirements - Case Study # 4: Annotto Bay Urban Area Hazard Assessment

Annotto Bay, St. Mary

•Coastal town located on Jamaica's NE coast.

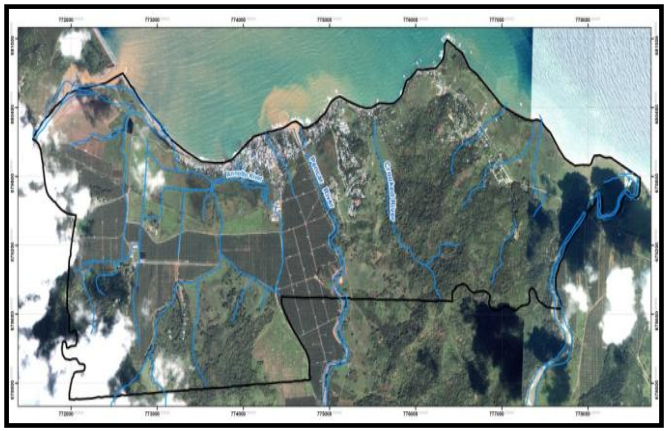
•Low lying – elevations of 1-3m above sea level

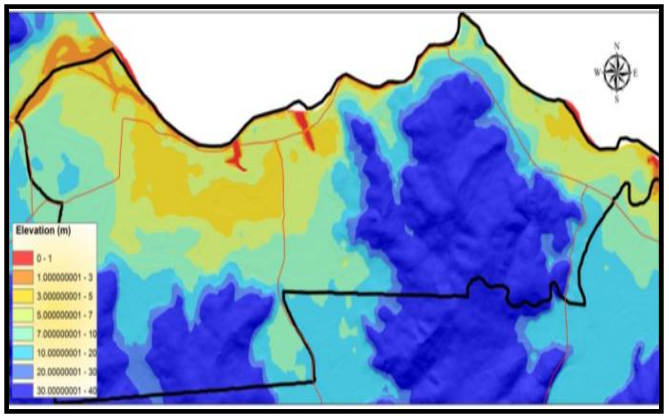
•Community is traversed by 4 rivers- Annotto, Pencar, Mother Ford Drain, Crooked Rivers.



Hazard and Risk Geospatial Data Requirements - Case Study # 4 Annotto Bay Urban Area Hazard Assessment

- The town is repeatedly affected by storm surge and riverine flooding.
- Urbanization has led to encroachment of development at high water mark ~18 from foreshore.
- Population of 5,400





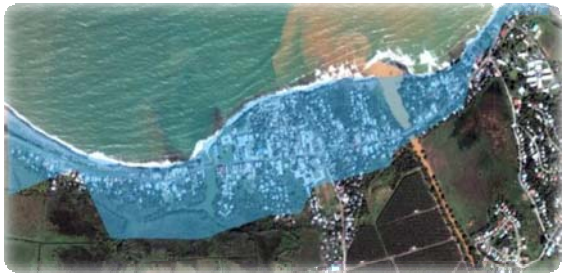
Hazard and Risk Geospatial Data Management Requirements - Case Study # 4: Annotto Bay Urban Area Hazard Assessment

The Annotto Bay Urban Area Hazard Assessment Project, 2012

Objective: Multi hazard Risk assessment for the Annotto Bay .

Output:

- Development/update land use plans based on risk assessments
  - Using plans to prevent/control development in risk areas
  - Prescribing restrictions on building type, use, occupancy and density in high risk areas.
  - Population vulnerability



Hazard and Risk Geospatial Data Requirements - Case Study # 4: Annotto Bay Urban Area Hazard Assessment

Geospatial Data Requirements/Input- Hazard Assessment

•Topographic data - Digital Elevation Model

•Bathymetric data- mapping of offshore shelf to max. depth of 18m.

•Space-based data (2001 IKONOS Satellite Imagery)

•Socio-economic data

•Physical Infrastructure and Critical facilities

•Historical storm tracks - NOAA

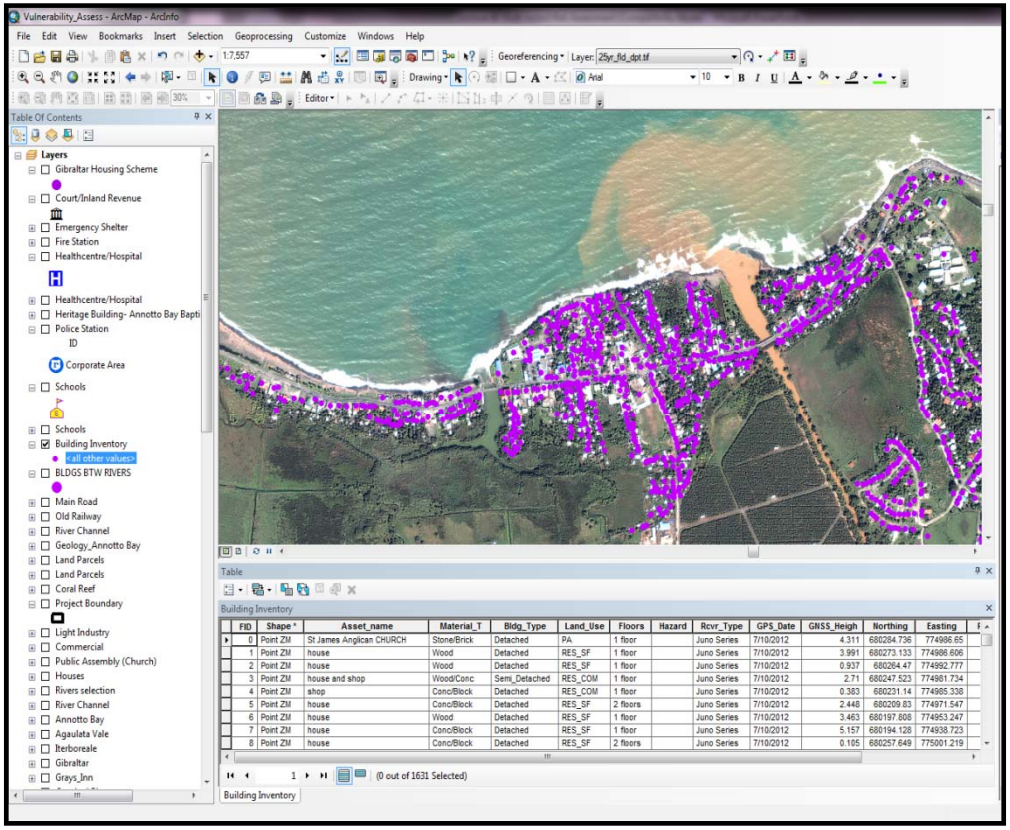
•JONSWAP Wind-Wave model – determine wave conditions generated at site

•Anecdotal evidence of storm surge

Hazard and Risk Geospatial Data Requirements - Case Study # 4: Annotto Bay Urban Area Hazard Assessment

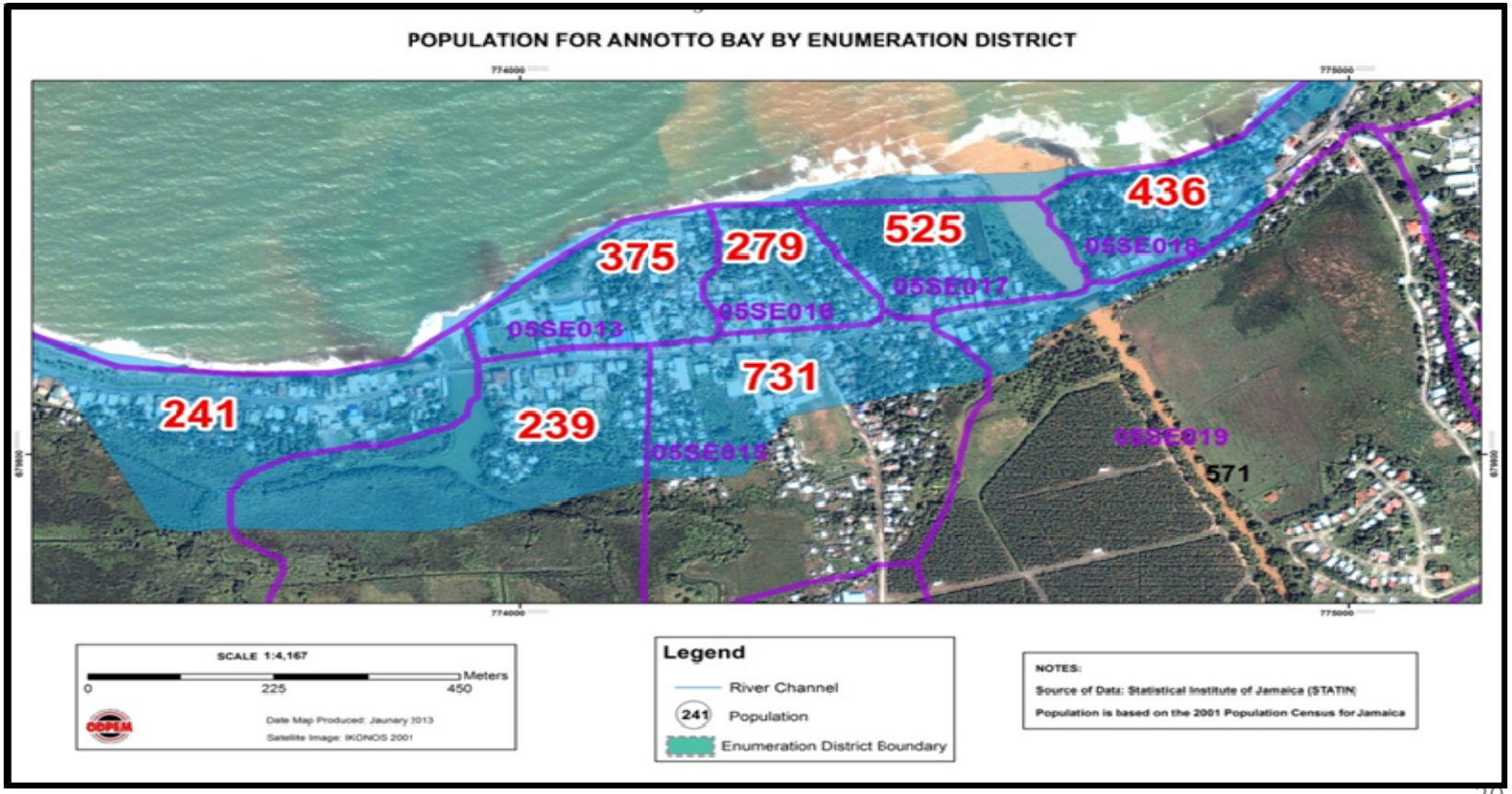
Geospatial Data Requirements/Input- Hazard Assessment

- 1632 assets mapped.
- The following attributes were described:
  - ✓ Land use
  - ✓ # of floors
  - ✓ Materialof construction
  - ✓ Replacement cost for buildings
  - ✓ Finished floor level



Hazard and Risk Geospatial Data Management Requirements - Case Study # 4: Annotto Bay Urban Area Hazard Assessment

Population Vulnerability



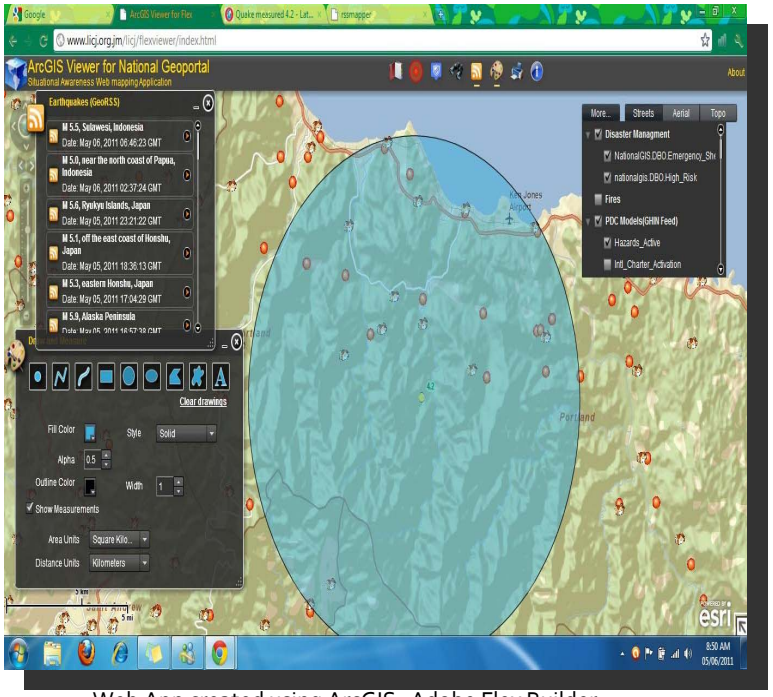
Hazard and Risk Geospatial Data Requirements Establishment of a NSDI

Access Mechanisms

•The National Geospatial Portal was used to develop a disaster situational awareness application to evaluate spatially a seismic activity in the eastern part of Jamaica.

•The earthquake struck eastern Jamaica about 4:29am (May 06, 2011)

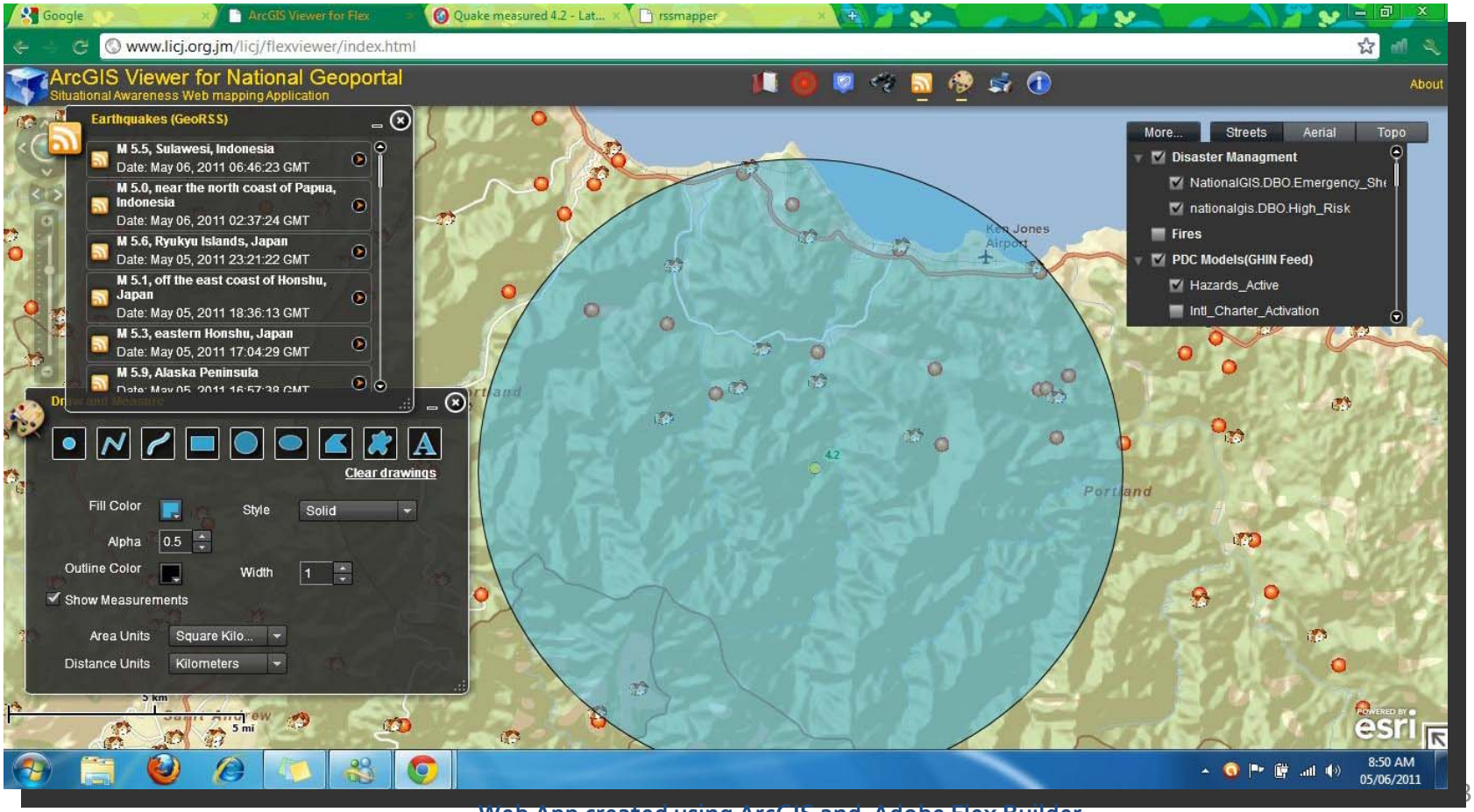
- magnitude of 4.2 on the Richter scale, (USGS).
- epicentre 26 kilometers from Kingston
- depth of 20.3 km



Web App created using ArcGIS Adobe Flex Builder

Hazard and Risk Geospatial Data Requirements - Establishment of a NSDI

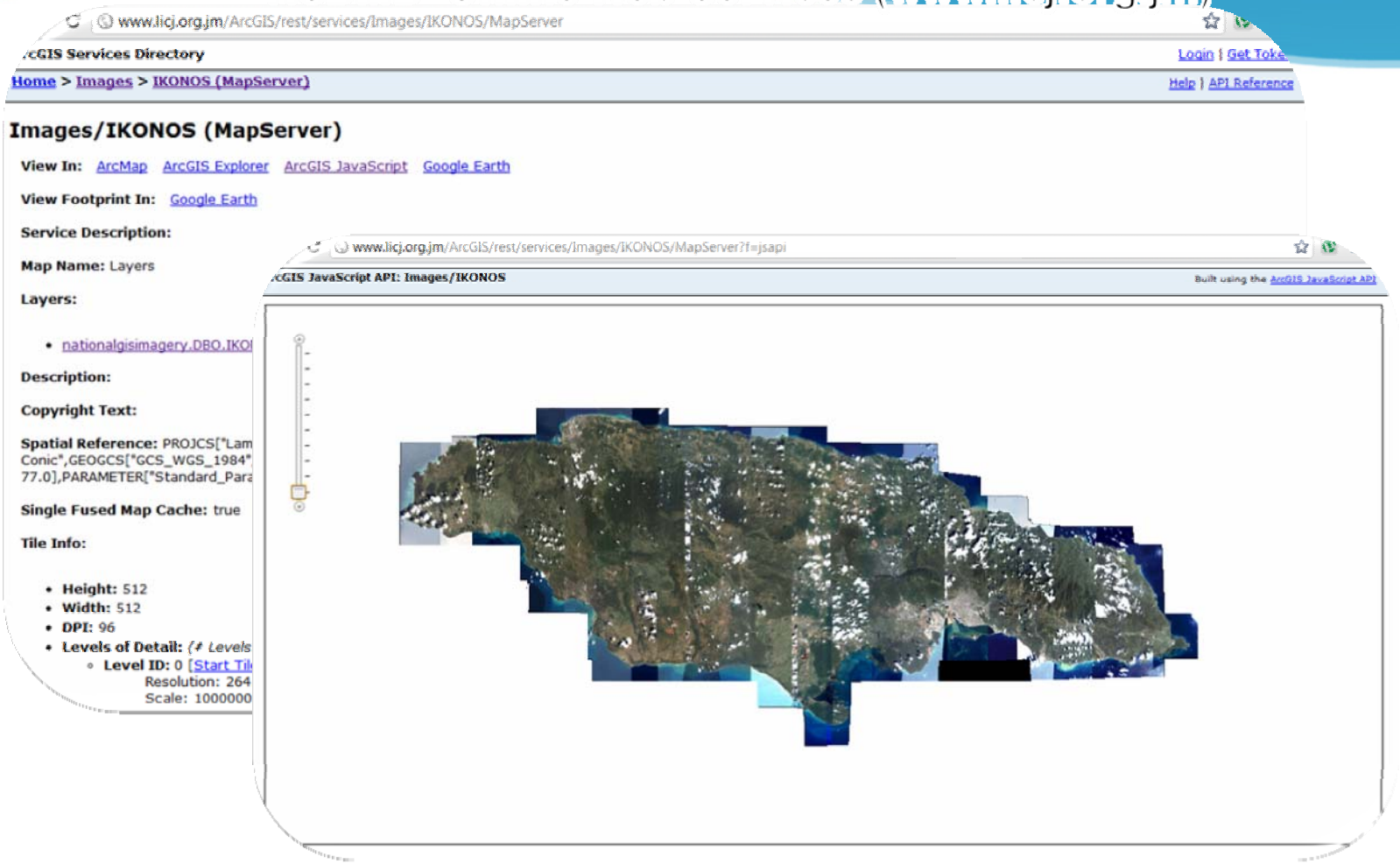
Disaster Situational Awareness Application



Web App created using ArcGIS and Adobe Flex Builder

Hazard and Risk Geospatial Data Requirements Establishment of a NSDI

NSDMD- Online Web Services (www.licj.org.jm)



Hazard and Risk Geospatial Data Requirements -NSDI

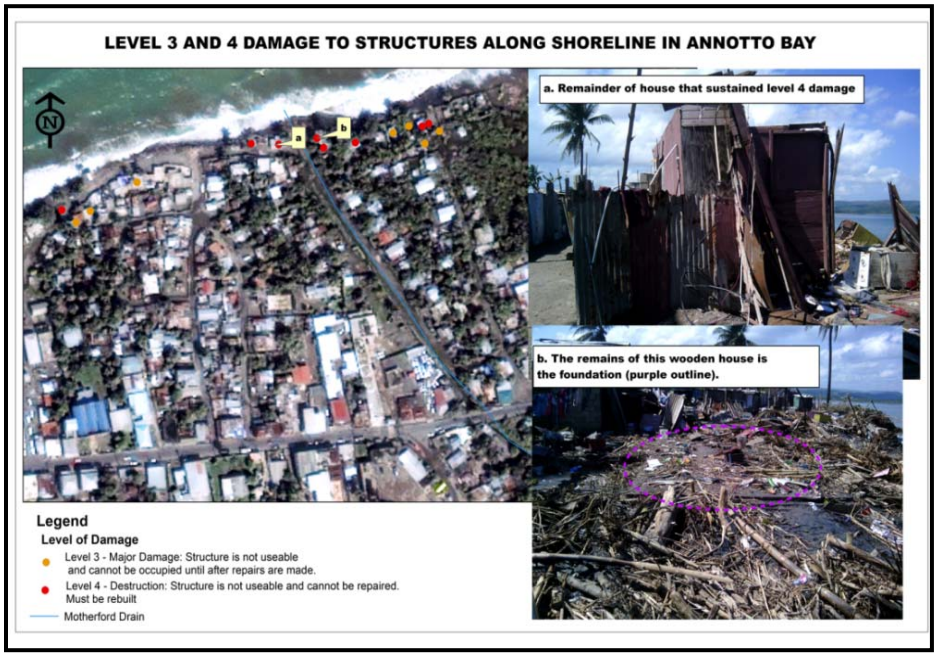
Information is needed about the hazards that are likely to occur including:

•their location

•the elements that are at risk when hazards materialize into disaster events,

•the vulnerability of society and the critical infrastructure that will be exposed to the consequences of the disaster.

The data required thus concern the geographical distribution of hazards and the specific characteristics of hazard-prone area(s). Therefore, there is a need for this data to be collected.



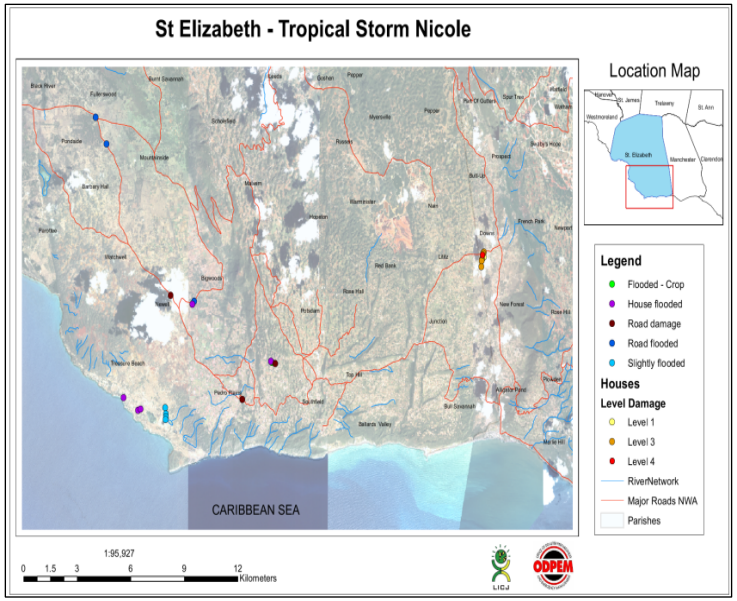
Damage sustained in Annotto Bay during the passage of Hurricane Sandy, 2012

Hazard and Risk Geospatial Data Requirements -NSDI

National Emergency Response GIS Team Case Study – Geospatial Information Collection & Analysis

- NERGIST consists of GIS technical specialists from multiple government agencies, private sector organizations, tertiary education institutions and communities who **undertake geospatial analysis, scenario modeling, image interpretation and analysis, data collection and damage assessment** prior to, during and post meteorological, geological and man made disaster events.

- The data and mapping products created are used to support disaster response and recovery efforts island wide.



Hazard and Risk Geospatial Data Requirements -NSDI

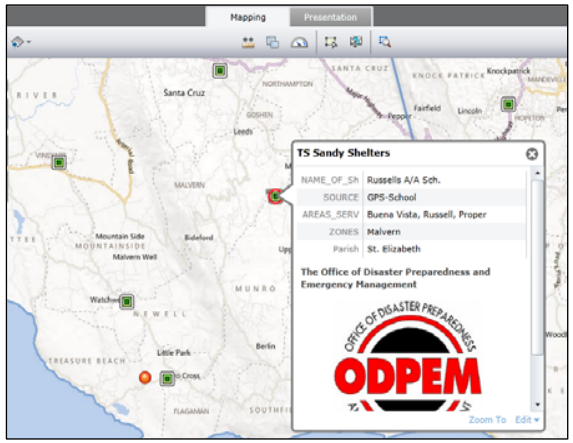
Initial Damage Assessment

An Incidence Map was generated in Google maps from information received from the public .**Crowdsourcing** enabled the information-sharing among teams of responders. Hazards were identified, evaluated and prioritized.

Tropical Storm 2010 ,Crowd sourced Hazard Map

Hazard and Risk Geospatial Data Requirements -NSDI

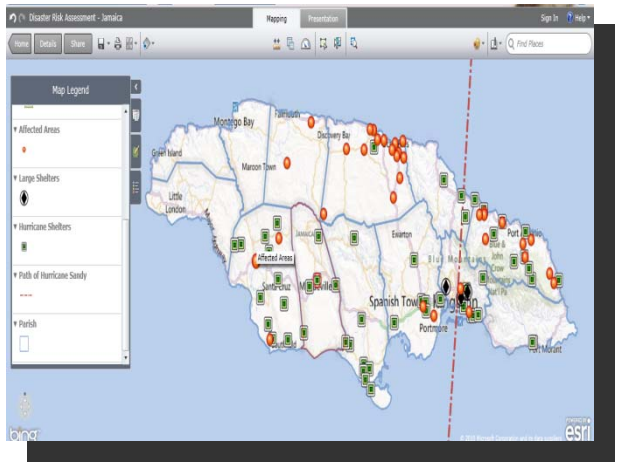
In 2012, NERGIST activities were centred primarily on Government's response to the effects of Hurricane Sandy by providing technical assistance in conducting damage assessment .The data captured during the exercise is available in the NSDMD central data repository. The following tasks were undertaken:



1.Risks were identified, evaluated and prioritized

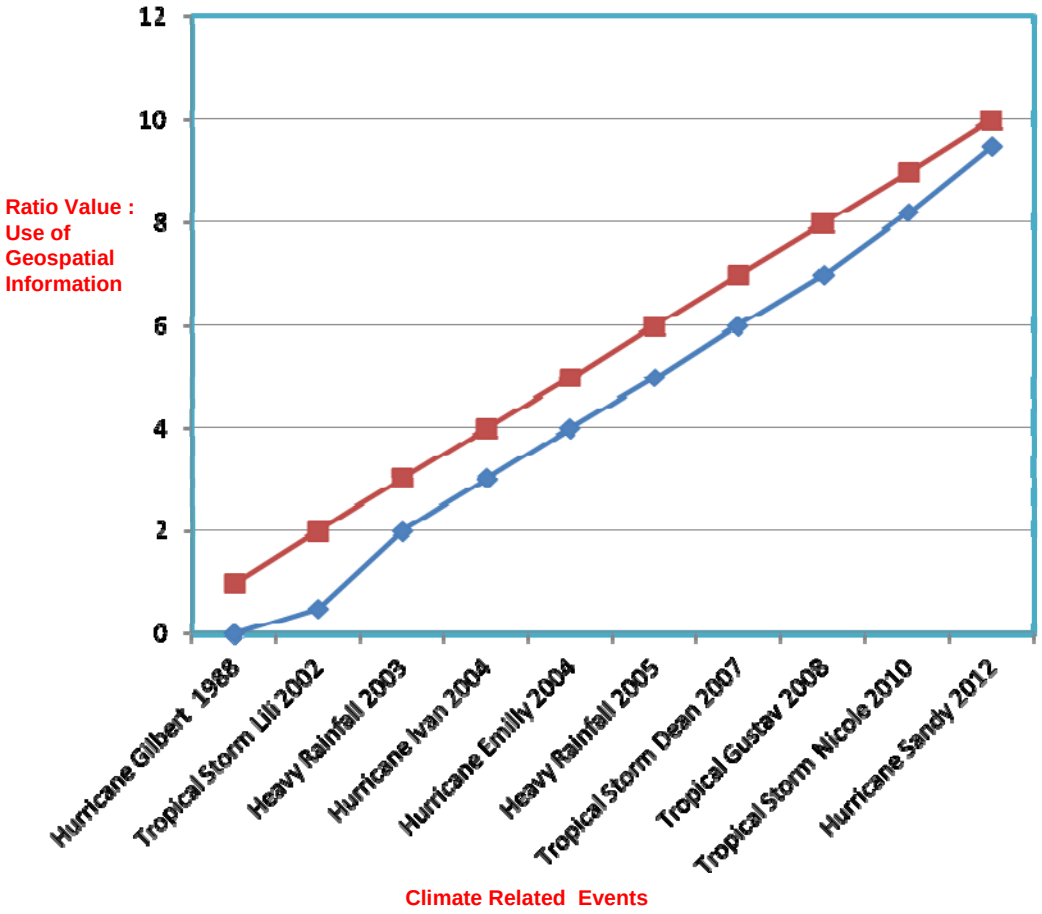
2.The path of the hurricane was mapped in relation to critical assets

3.A Risk Assessment Map was developed and shared with the ODPEM.



Challenges for Hazard and Risk Geospatial Requirements

Tracking the Use of Geospatial Data for Hazard and Risk Assessment



Tracking the changes related to the development and **provision of consistent geospatial information and modelling techniques for natural hazards** to enable better decision making for disaster preparedness and response.

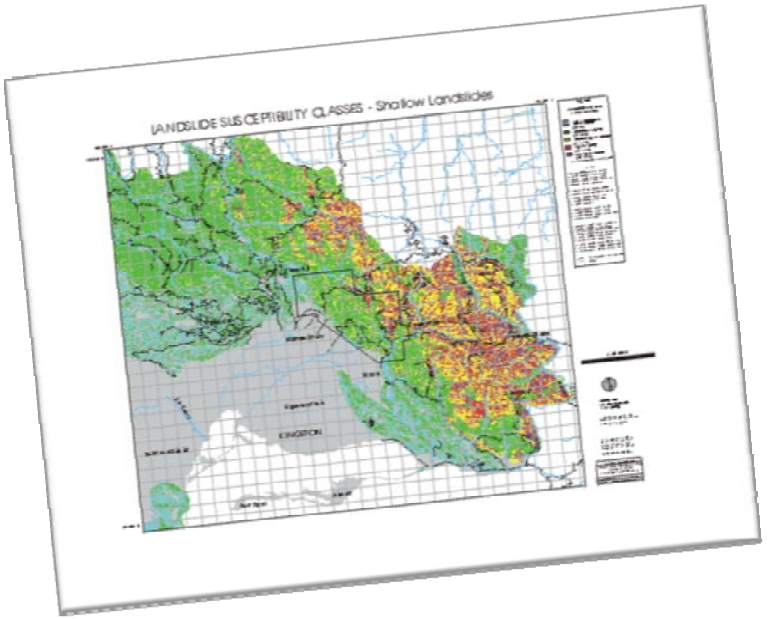
Challenges for Hazard and Risk Geospatial Requirements

Current condition and limitations for Hazard Maps

1.The hazard maps done for the Kingston Metropolitan Area had data deficiencies with respect to closer contours.

2.A contour interval was desired for slope angles and curvatures; surrogate variables, and deficiencies in the DeGraff method.

3.One major weakness of the Landslide Susceptibility Map for the Upper St. Andrew area was the small scale of aerial photos which obscured small slides in the analysis. (Source: Status of Hazard Maps, Vulnerability Assessments and Digital Maps in the Caribbean 2003)



Challenges for Hazard and Risk Geospatial Requirements

Current condition and limitations for Hazard Maps

4.The limitation of the Landslide Susceptibility Map of Rio Grande hazard map was **the arbitrary distance between the hazard zones**. However, they were chosen in order to highlight areas most prone to landslides in the Rio Grande Valley. Secondly, the hazard zones indicated an area's susceptibility to landslides.

5.The prediction was based on the analyses of previous landslide occurrences and other related factors, for example, geology and slope. The zones studied were not an ideal indication of the size, type of landslide or the distance that it may travel. (Source: Status of Hazard Maps, Vulnerability Assessments and Digital Maps in the Caribbean 2003)

Challenges for Hazard and Risk Geospatial Requirements

- **Sharing Available and Reliable Data**

Cooperation between the geospatial community and the science community is particularly important in studying natural hazards and risks, because observations from multiple disciplines and multiple data collection activities need to be considered together. Arguably, all disciplines that produce and use geospatial data have **a need for more data sharing and collaboration.**

Challenges for Hazard and Risk Geospatial Requirements

- **No national level policy on the use of geospatial information,** which would specify its usage, sharing, dissemination and accessibility.

- There is no formally established National Spatial Data Infrastructure policy or legislation which would dictate data sharing requirements use etc.

- There is a need for the development of **better use of space-based data to allow for effective analysis** and understanding of hazards and risk

- There is a **paucity of trained personnel in advanced remote sensing and hazard mapping .**

- Jamaica requires additional technical expertise in hazard mapping technology and its related fields.

Challenges and for Geospatial Requirements

Lack of Sufficient and Reliable Socio- Economic Data

- **Most socio- economic datasets exist in a non- spatial format** which makes it more challenging to be combine with hazard related dataset.

- To be more effective, socio –economic must exist in geospatial format and be combined with appropriate baseline fundamental datasets.

Recommendations

Spatial data infrastructures facilitates the exchange of geospatial data

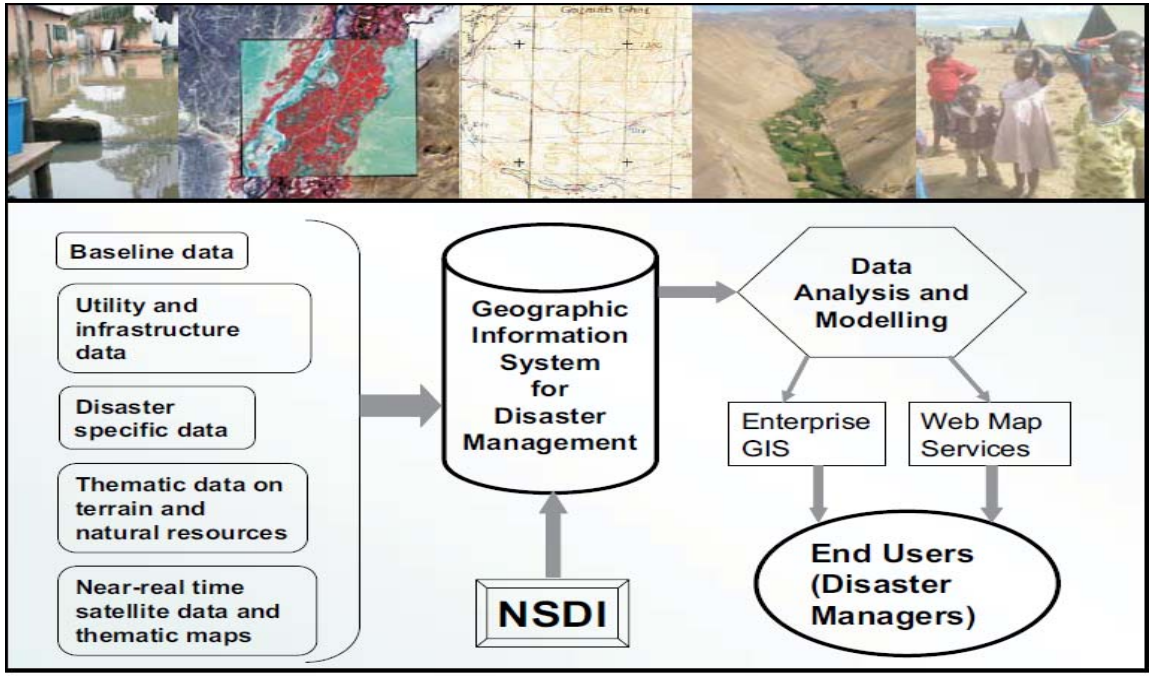


Figure 1: Conceptual framework - The Spatial Information for Disaster Management

Source : Geoinformation for Disaster and Risk Management Examples and Best Practices, 2010

Recommendations

1. Formal Establishment of an NSDI and effective data sharing policies

2. Jamaica can benefit from the effective utilization of integrated space-based data and technology to assist in hazard mapping, while at the same time developing an effective mechanism to ensure currency of satellite imagery at all times.

3. Need to use available methods – like remote sensing for assessing the **elements at risk in informal dwellings**

4. Build capacity country wide in disaster response and data collection agencies in data collection, analysis advanced remote sensing and hazard mapping

5. Universal access to data from specific agencies who collect, or have data collected and maybe analyzed for their use (at no cost for developing countries).

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