

Thank You

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General: Information needs?

- Population data
- Past disaster data
- Settlement data

Risk Mapping

Risk = Exposure × Vulnerability

Exposure: Physical Assets, Human Factor.

Vulnerability: The vulnerability function is a graph or any combination of graphs or tables that depicts the loss caused by a hazard of a given intensity.

Exposure: Information needs?

Exposure data means physical assets that may be damaged if a natural event occurs. Exposure data also encompasses all aspects of the "human environment".

- Road & Bridge (all type)
- Water/generation/irrigation
- Power Supply
- Communication
- Infrastructure
- Temple/building/house
- School/hospital/others

Hazard Map: Information needs?

"A hazard map depicts areas at risk from natural hazards at a given time"

- Base Digital Map
- Geological Map
- Land Use Cover Map
- Vegetation/soil Map
- Rainfall and river discharge
- Topography map and Digital Elevation Model (DEM)
- Hydro-meteorological data

Disaster Management in Bhutan: "The Demand for INFORMATION"

United Nations/Germany International Conference on Earth Observation

"Global Solutions for the Challenges of Sustainable Development in Societies at Risk"

May 26-28, 2015
Bonn, Germany

"Disaster Risk Management
can be more efficaciously
addressed with the support of
Geo-spatial technologies and
Spatial Decision Support
System"

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Response and Relief Division
Department of Disaster Management
Ministry of Home and Cultural Affairs
Royal Government of Bhutan

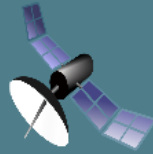
Hazard Map

Vulnerability
Map/Atlas

Exposure
Information



Hazard Map



Vulnerability Map/Atlas



Exposure Information

Multi-hazard Risk Assessment

Four important components for Disaster Risk Management

1. Risk Identification

- Which is the worst possible disaster scenario in a country?
- How much is the economic exposure?
- How much would be the maximum economic losses expected and with what frequency will they occur?
- How much is the expected annual loss?
- Where does the risk concentrates?

2. Risk Reduction

Visualization of hazard and risk (maps)

Land Planning

Damage scenarios to be prepare for emergency response

3. Risk Retention and Transfer

Resilient Economy

4. Disaster Management

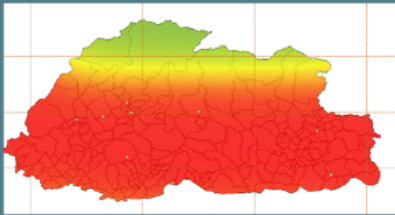
Cost/Benefit relationship to justify measures oriented to risk reduction

Financial protection by risk transfer mechanisms

Multi-hazard Risk Assessment

$$\text{Risk} = f(\text{Hazard}, \text{Vulnerability})$$

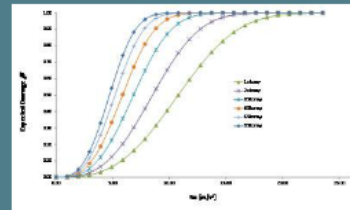
Hazard



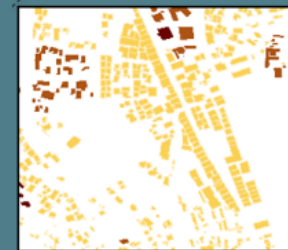
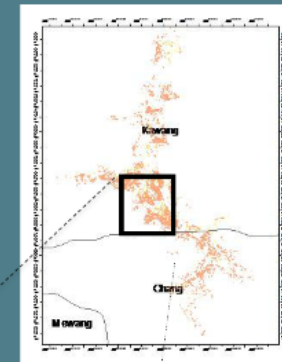
Exposure



Vulnerability



Expected Damage



Losses



Hazard Map: Information needs?

"A hazard map depicts areas at risk from natural hazards at a given time"

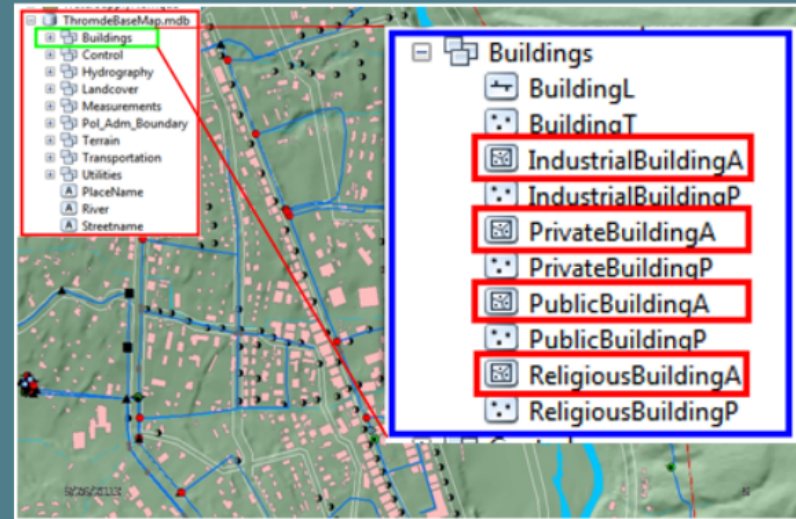
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Risk Mapping

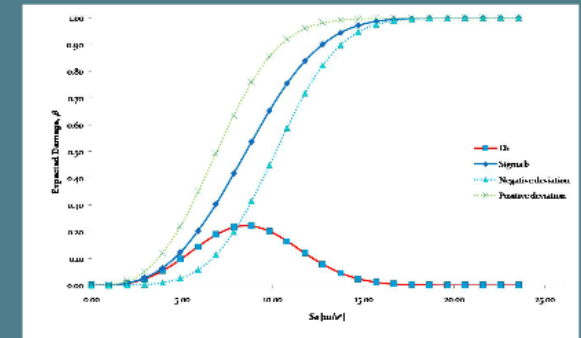
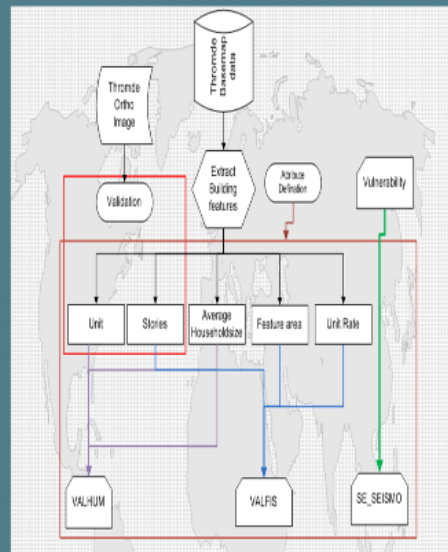
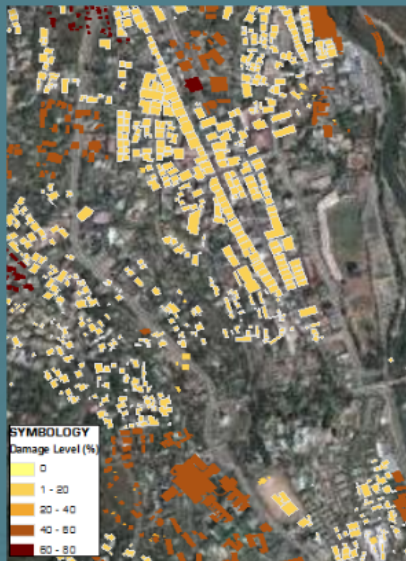
Risk = **Exposure**
Financial Value



Human Value



* **Vulnerability**



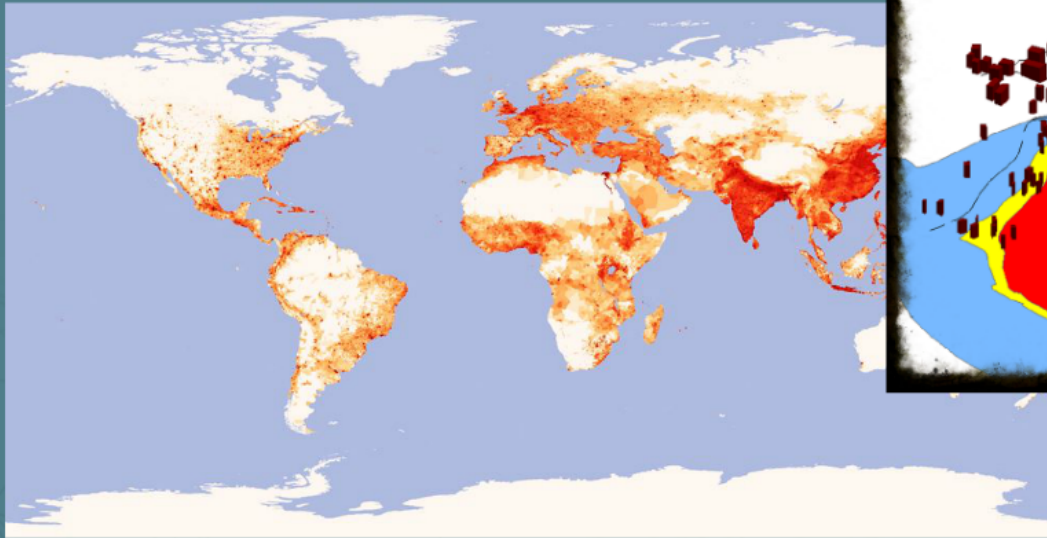
- The vulnerability functions developed are very preliminary.
- The parameters on which the function depends has been mostly adopted from Mexico.
- Good approximate but requires more work to be put to practical use.

General: Information needs?

Population data

Past disaster data

Settlement data



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