MS Frontier Re Modeling Research Pte. Ltd.

Catastrophic Risk – A Flood Perspective

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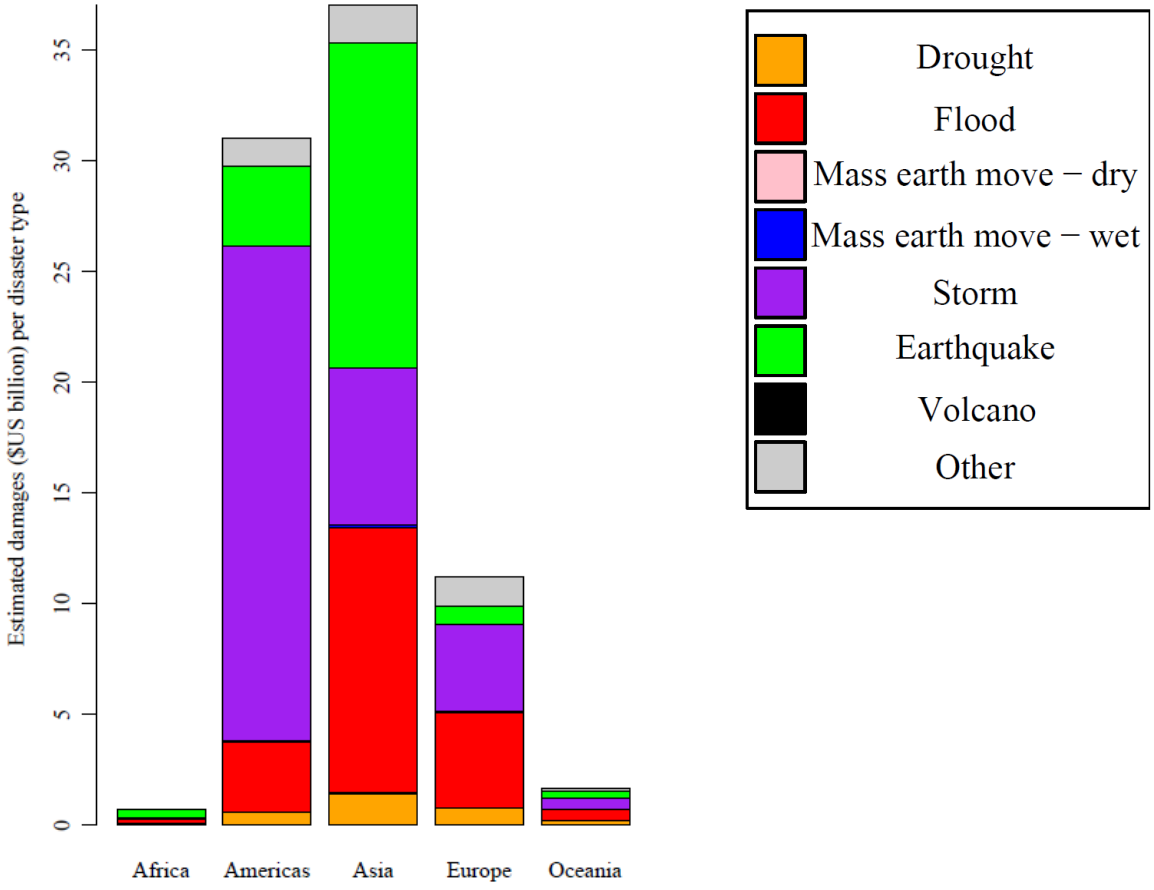
MSIG | MS Frontier Re

Agenda

- **Overview of natural disasters**
- **Flood risk assessment methodology**
- **Uncertainty in flood modeling**
- **Flood Profile – Asia & Pakistan**
- **Summary**

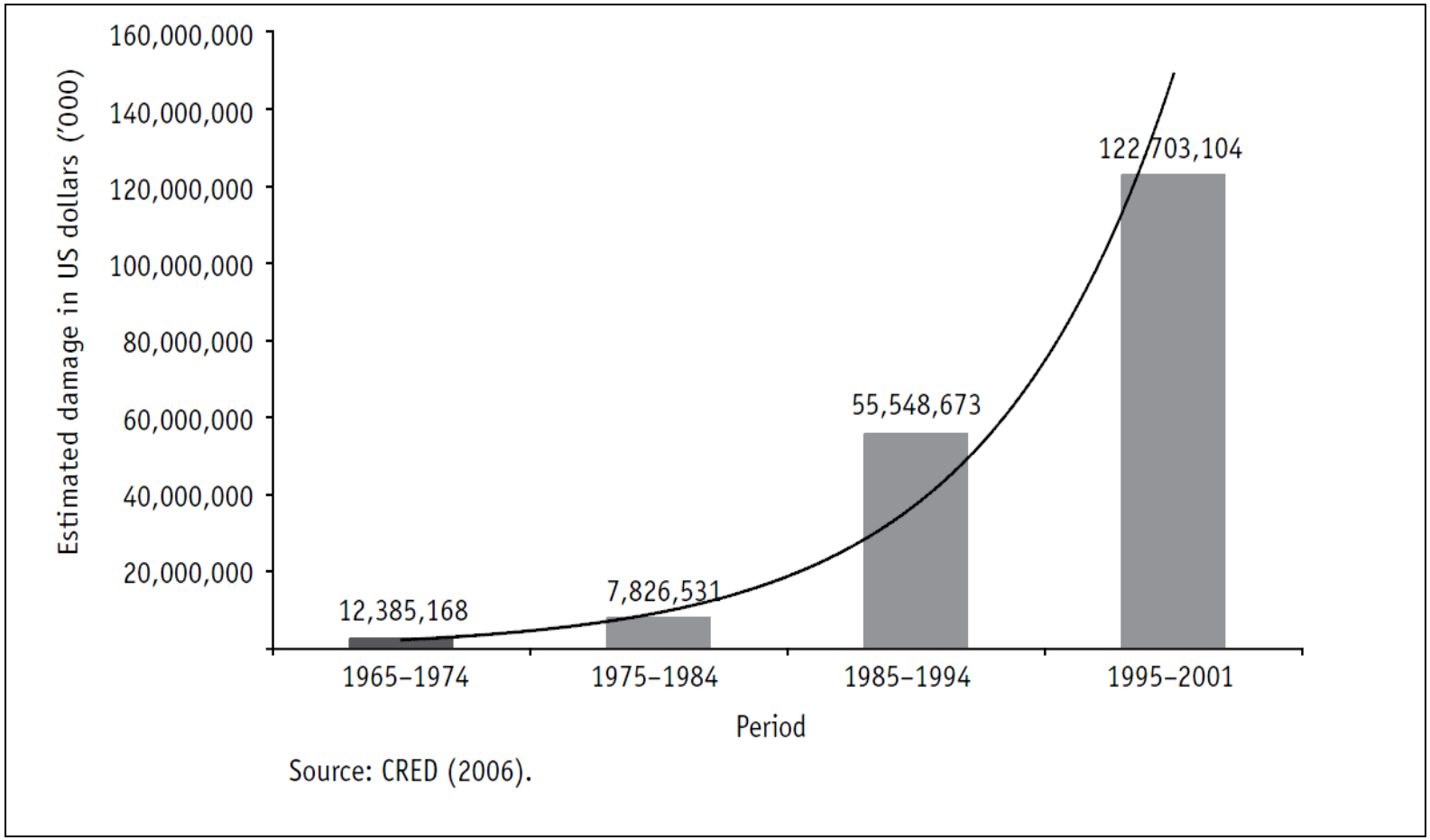
Overview of natural disaster

Annual Average Damage ($US billion): 1990-2010



Source:"EM-DAT: The OFDA/CRED International Disaster Database, Universite catholique de Louvain, Brussels, Belgium"

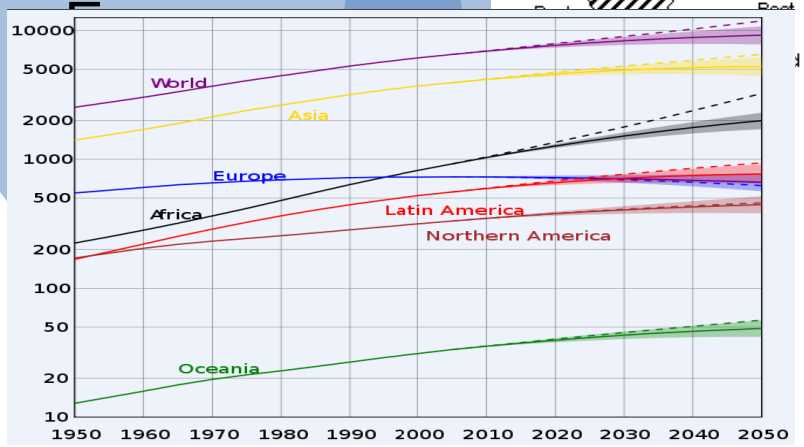
Economic Losses due to Flood – Asia 1965 - 2004

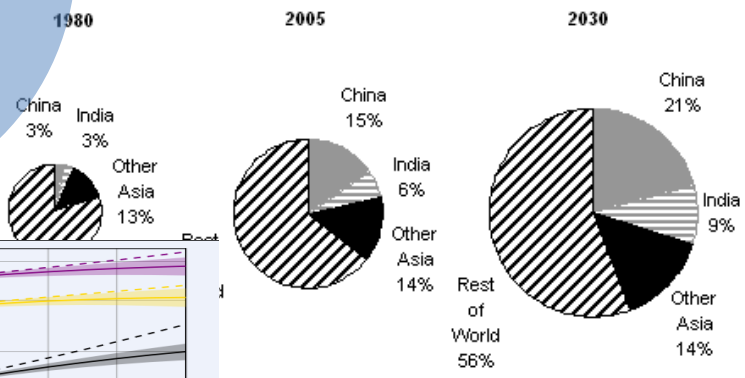


Source: CRED (2006).

Why are the numbers are bigger now?

Population





(source www.treasury.gov.au)

What is available?

	AIR		EQECAT			RMS		Risk Frontiers	
Country	Tropical Cyclone	Earthquake	Tropical Cyclone	Earthquake	Typhoon rainfall – flooding	Tropical Cyclone	Earthquake	Riverine Flood	Hail
China	✔	✔	✔	✔	✔		✔		
Guam						✔	✔		
Hong Kong*	✔		✔	✔		✔	✔		
India			✔	✔			✔		
Indonesia		✔		✔			✔		
Japan	✔	✔	✔	✔	✔	✔	✔		
Macau*							✔		
Malaysia			✔	✔	✔				
Pakistan			✔	✔					
Philippines	✔	✔	✔	✔	✔		✔		
Saipan**							✔		
Singapore				✔					
South Korea	✔		✔	✔	✔				
Taiwan	✔	✔	✔	✔	✔		✔		
Thailand			✔	✔	✔				
Australia	✔	✔	✔	✔		✔	✔	✔	✔
New Zealand		✔		✔			✔		

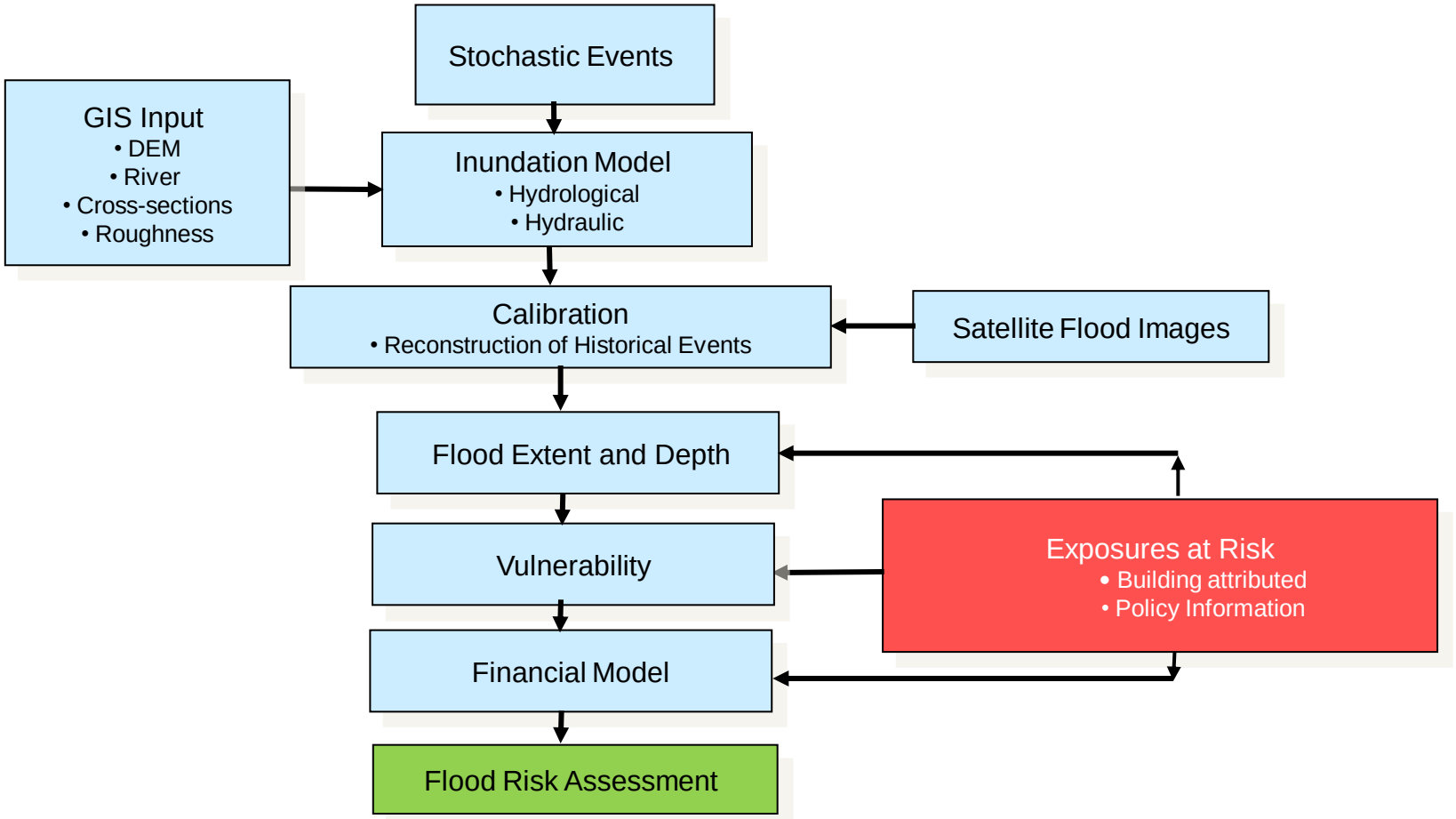
* Included in China EQ

** Included in Guam EQ

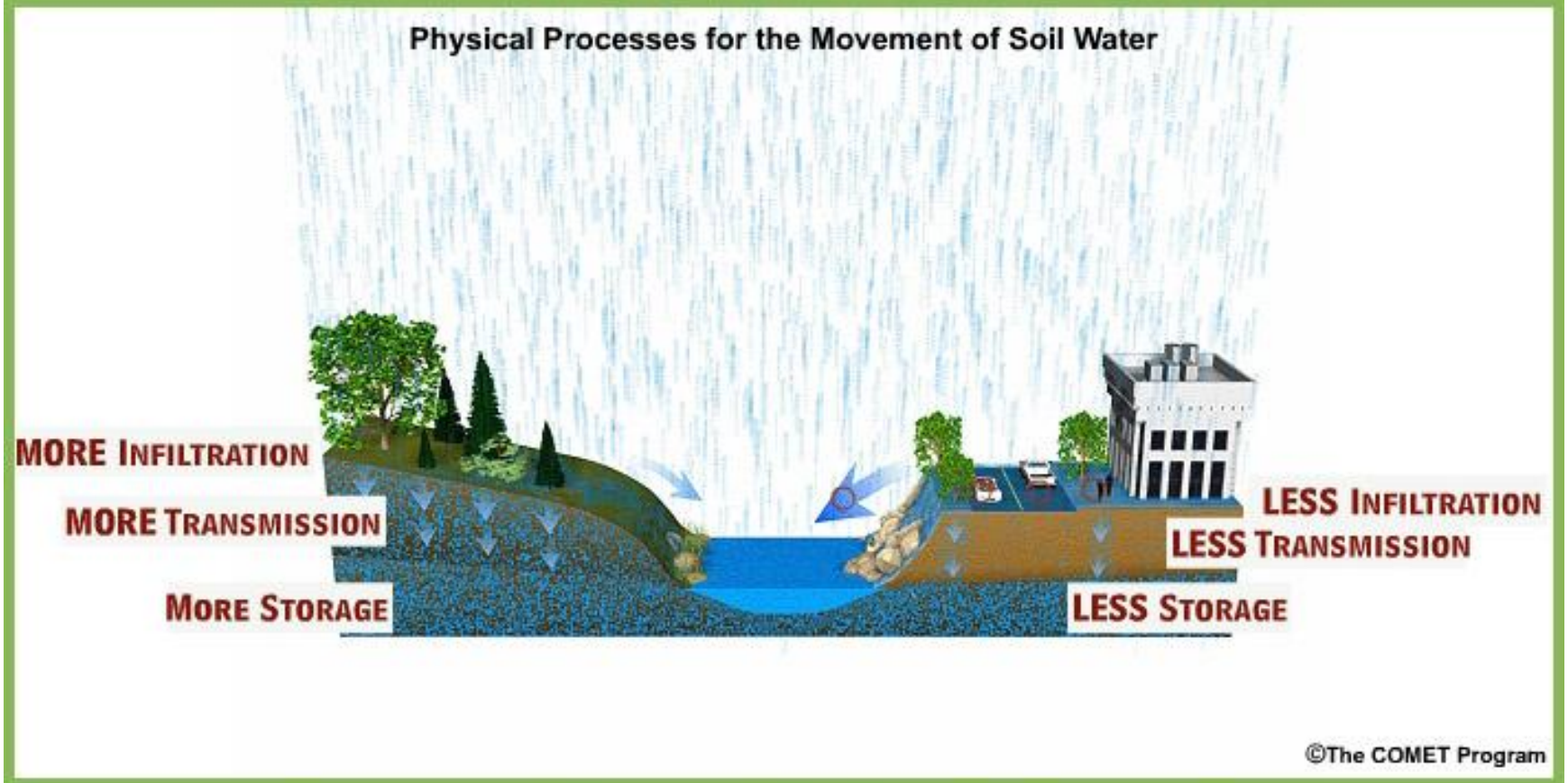
Flood risk assessment methodology

Probabilistic Risk Model

Rainfall/Runoff based

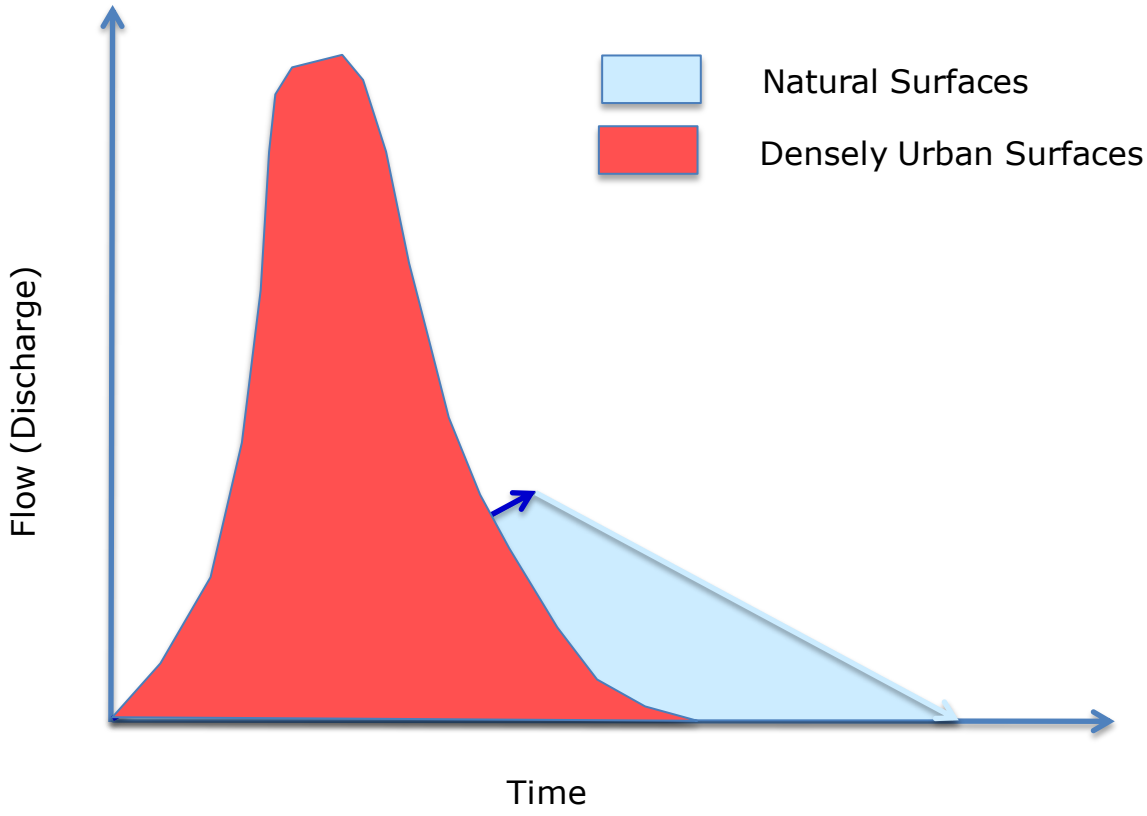


Hydrology



» Natural groundcover slows the speed of surface runoff, keeping water in contact with the ground surface for a longer time. This increases infiltration, transmission, and storage.

Hydrology – Rainfall Runoff relationship in different conditions



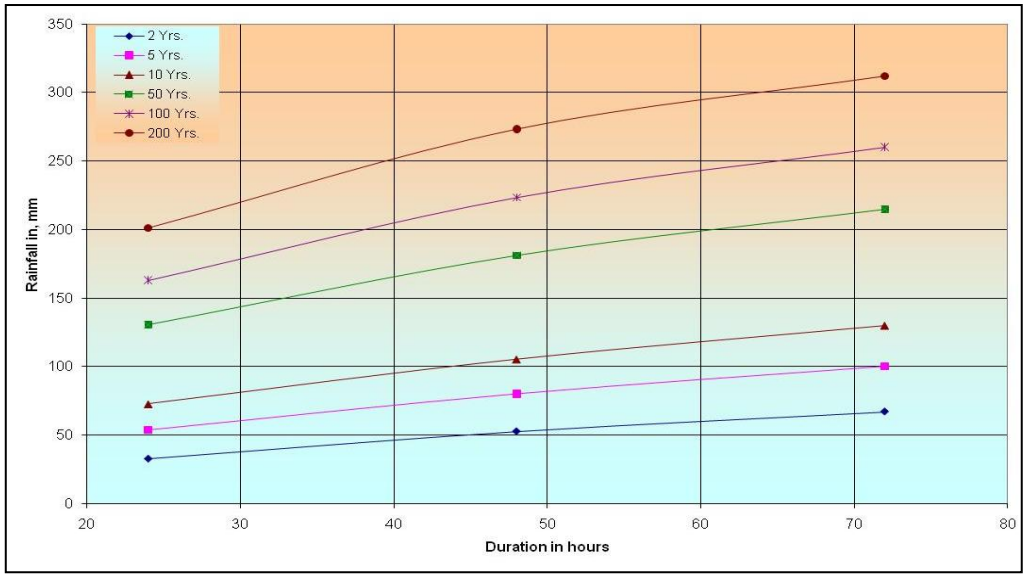
Stochastic Module

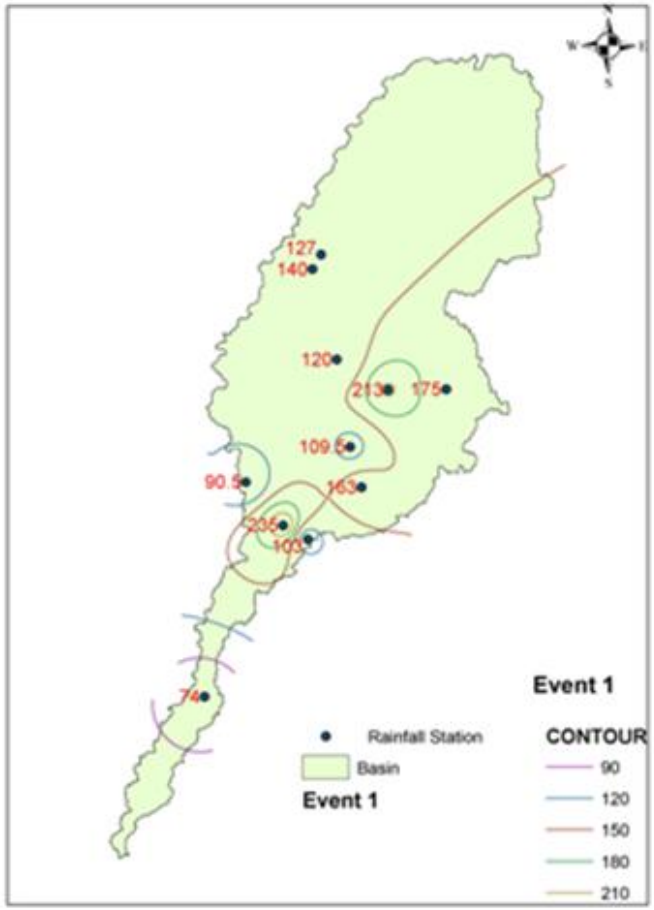
The stochastic event module generates stochastic events from the characteristics of historical events using simulation techniques.

- Duration
- Intensity
- Spatial pattern
- Initial loss

Return Period Rainfall in mm

RP	1 Day	2 Day	3 Day
2	32.6	37.6	42.0
5	53.6	65.1	75.4
10	72.6	90.2	104.7
20	95.0	119.5	138.2
50	130.6	166.2	189.9
100	163.0	208.6	235.3
200	201.1	258.3	287.2
500	261.6	337.4	367.1

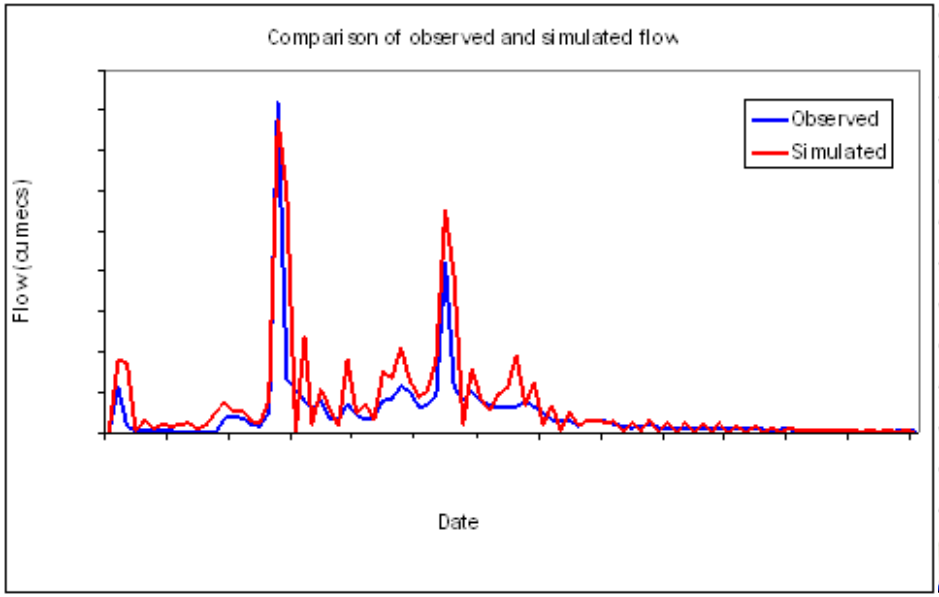


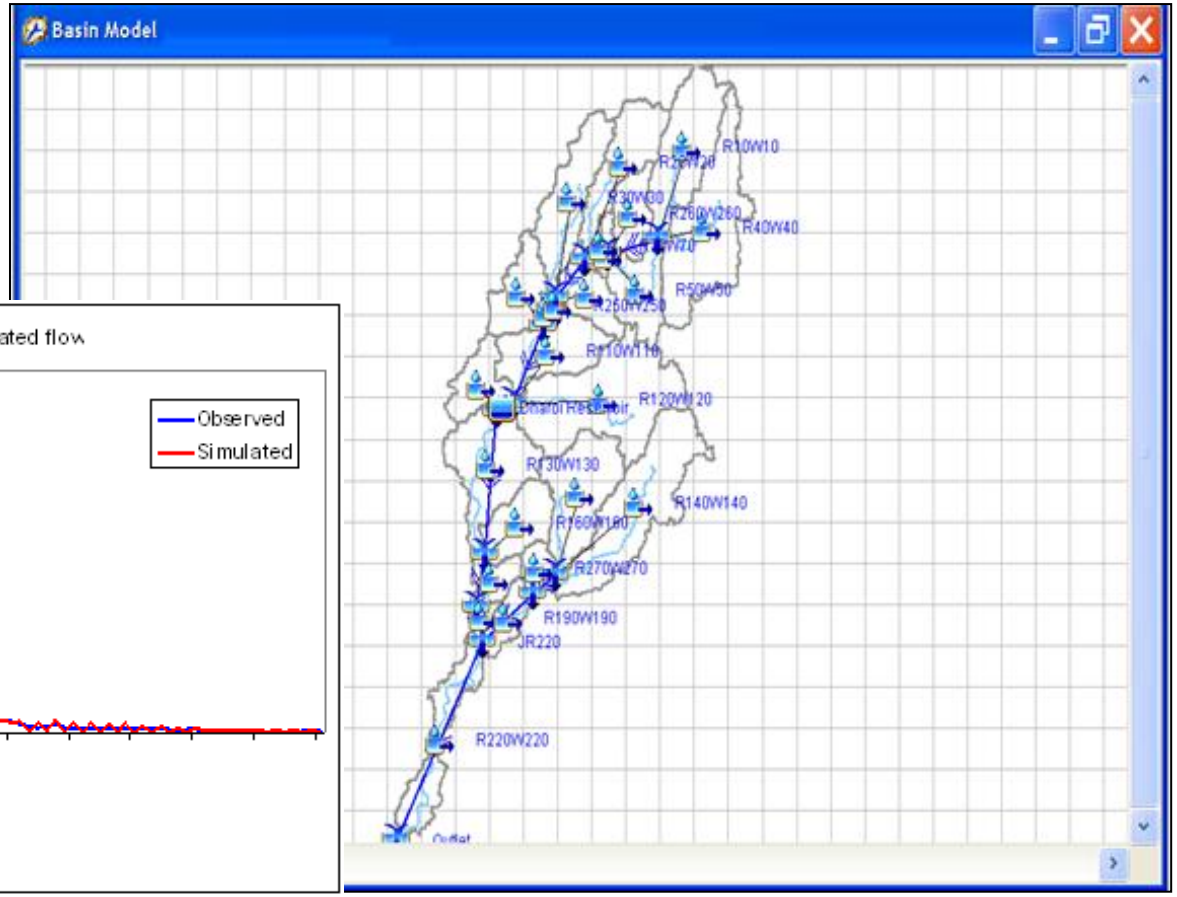


Hazard Module – Hydrologic modeling

Input for hydrological model

- Digital Elevation model – Ground surface elevation data
- River Network
- Soil Map
- Land-use
- Rainfall
- Observed flow data

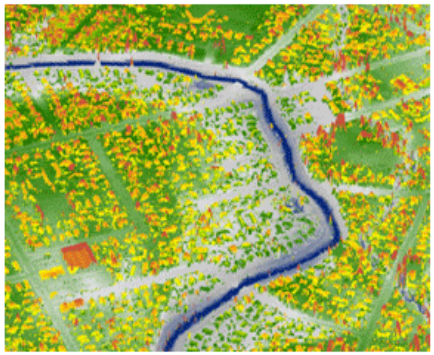




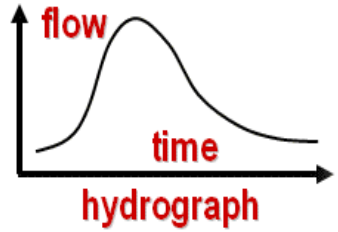
Hazard Module – Hydraulic modeling

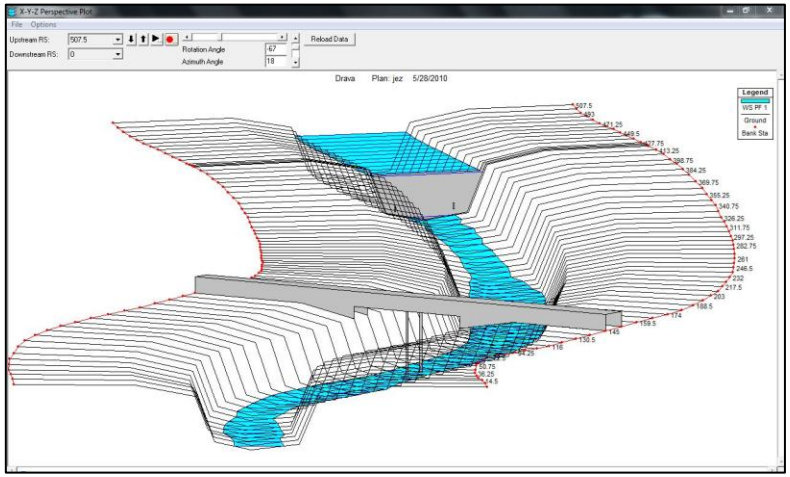
Input for hydraulic model

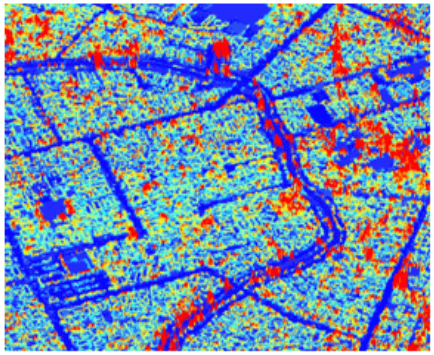
- River cross section
- Flow hydrograph
- Surface roughness
- Satellite imagery



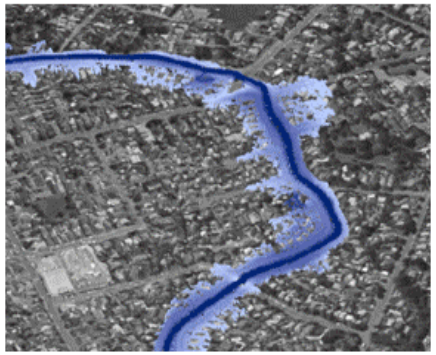
elevation model







surface roughness model



flood depths & extent

http://www.riskscape.org.nz/structure/modelling

Types of Floods

Type	Cause	Areas Affected	Loss Agents	Damage - Frequency and Severity	Loss Prevention
Storm Surge	High level of water due to wind set-up, high waves	-Coastal areas -Areas near big lakes	-Wave force -Salt water	-Low frequency -Very high losses	-Early warning -Dykes -Evacuation
River Flooding	Intense and/or persistent rain for longer period	Areas near river	-Prolonged impact of water -Water contamination	-Low frequency -High loss potential	-Early Warning -Structural flood control -Temporary protection of property -Putting movable objects somewhere else Evacuation
Flash Flood	Intense rainfall; mostly locally	Practically anywhere	-Mechanical impact of fast flowing water -Large amount of sediments	-High frequency Relatively minor losses	-Adequate drainage

Vulnerability Module

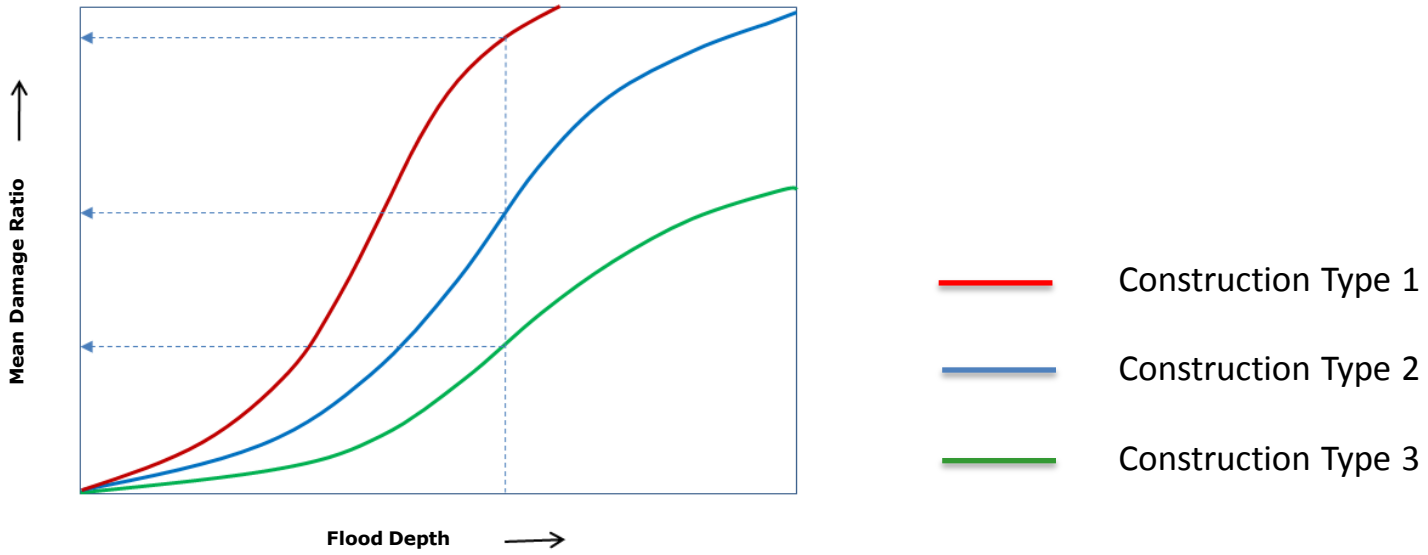
The vulnerability is the expected degree of loss, which can be expressed as a damage ratio.

- magnitude of the hazard (e.g. flood depth, flow velocity)

&

- the characteristics (attributes) of the asset (e.g. structural strength of a building)

Physical Characteristics



Exposure Module

Exposure data development

- LOB
  - Residential
  - Commercial
  - Industrial
  - Agricultural

  etc.

- Structural details
  - Construction type and material
  - Wall and flooring material etc
  - Age and height

  etc.

- Location

- Data Resolution

India: Summary

Table S00-008: DISTRIBUTION OF HOUSEHOLDS LIVING IN CENSUS HOUSES BY PREDOMINANT MATERIAL OF WALL

		Total	%	Rural	%	Urban	%
	Total number of households	191,963,935	100.0	138,271,559	72.0	53,692,376	28.0
I	Material of wall:						
I.1	Grass, Thatch, Bamboo, Wood, etc.	19,592,950	10.2	17,486,115	12.6	2,106,835	3.9
I.2	Plastic, Polythene	552,263	0.3	363,671	0.3	188,592	0.4
I.3	Mud, Unburnt Brick	61,792,142	32.2	54,928,309	39.7	6,863,833	12.8
I.4	Wood	1,762,822	0.9	1,288,987	0.9	473,835	0.9
I.5	G.I., Metal, Asbestos sheets	1,238,588	0.6	511,566	0.4	727,022	1.4
I.6	Burnt Brick	83,825,466	43.7	47,305,200	34.2	36,520,266	68.0
I.7	Stone	18,072,903	9.4	14,457,490	10.5	3,615,413	6.7
I.8	Concrete	4,680,000	2.4	1,609,316	1.2	3,070,684	5.7
I.9	Any other material	446,801	0.2	320,905	0.2	125,896	0.2

India : Summary

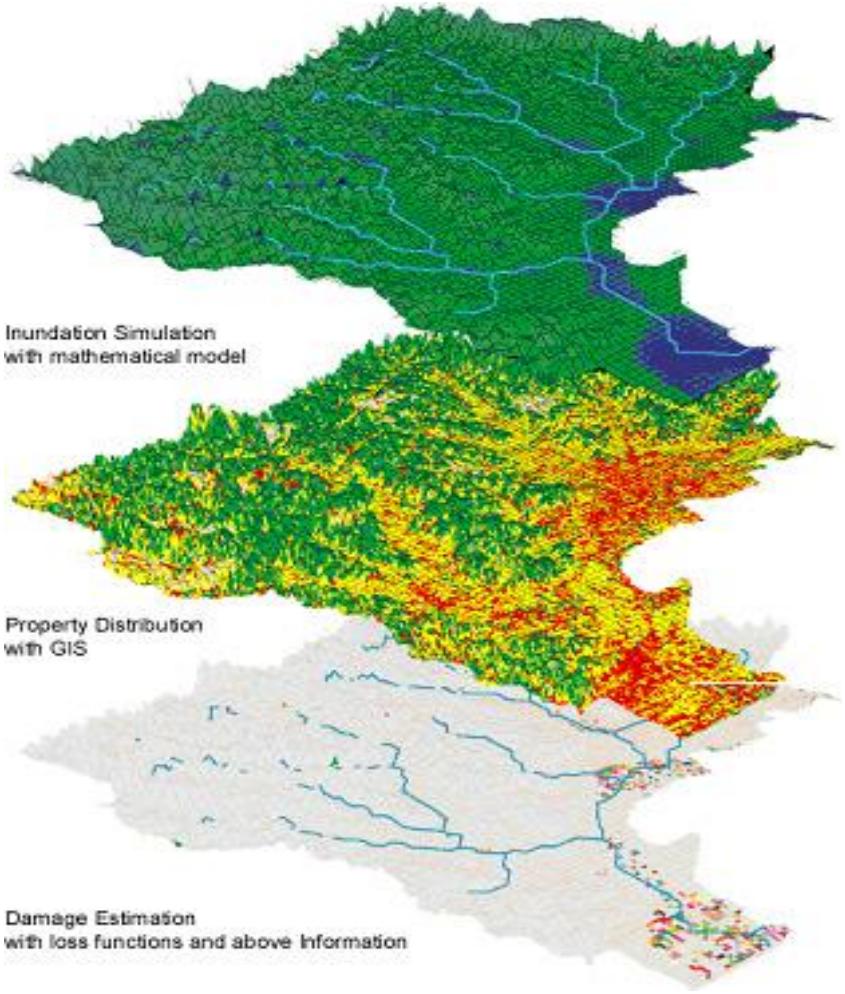
Table S00-006: DISTRIBUTION OF CENSUS HOUSES BY PREDOMINANT MATERIAL OF FLOOR

		Total	%	Rural	%	Urban	%
	Total number of census houses	249,095,869	100.0	177,537,513	71.3	71,558,356	28.7
G	Material of floor:						
G.1	Mud	136,779,853	54.9	124,855,981	70.3	11,923,872	16.7
G.2	Wood, Bamboo	2,286,504	0.9	1,822,348	1.0	464,156	0.6
G.3	Brick	6,287,685	2.5	4,030,993	2.3	2,256,692	3.2
G.4	Stone	14,507,423	5.8	8,119,872	4.6	6,387,551	8.9
G.5	Cement	69,712,015	28.0	34,235,926	19.3	35,476,089	49.6
G.6	Mosaic, Floor Tiles	18,544,232	7.4	4,010,786	2.3	14,533,446	20.3
G.7	Any other material	978,157	0.4	461,607	0.3	516,550	0.7

Source: India : Census of India 2001

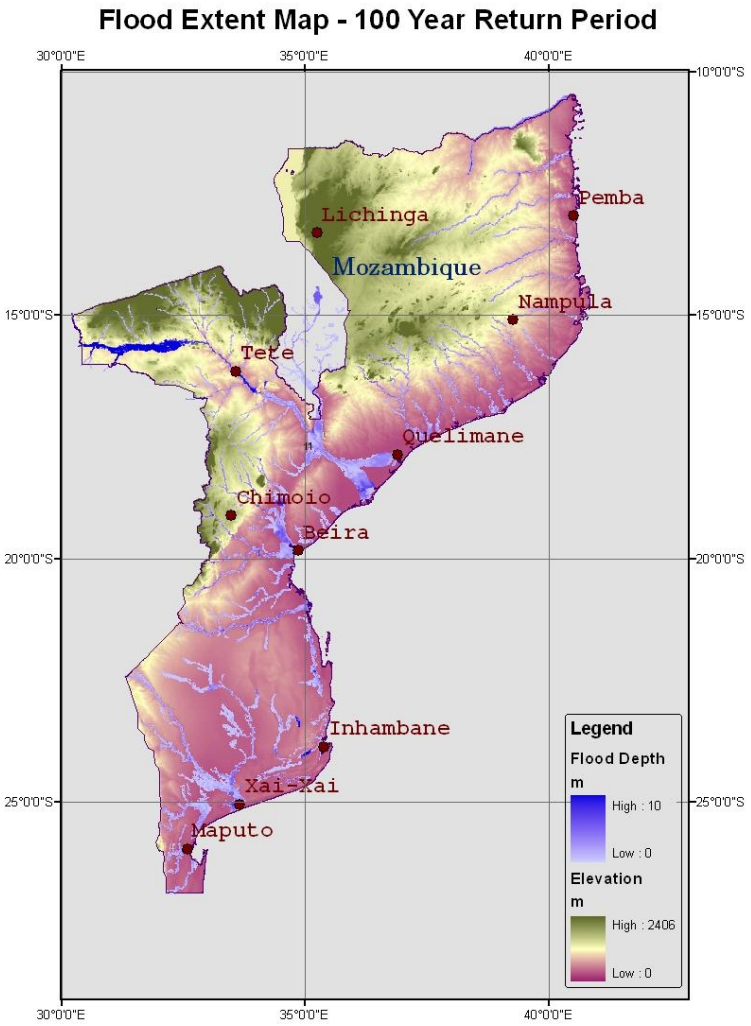
Loss Module

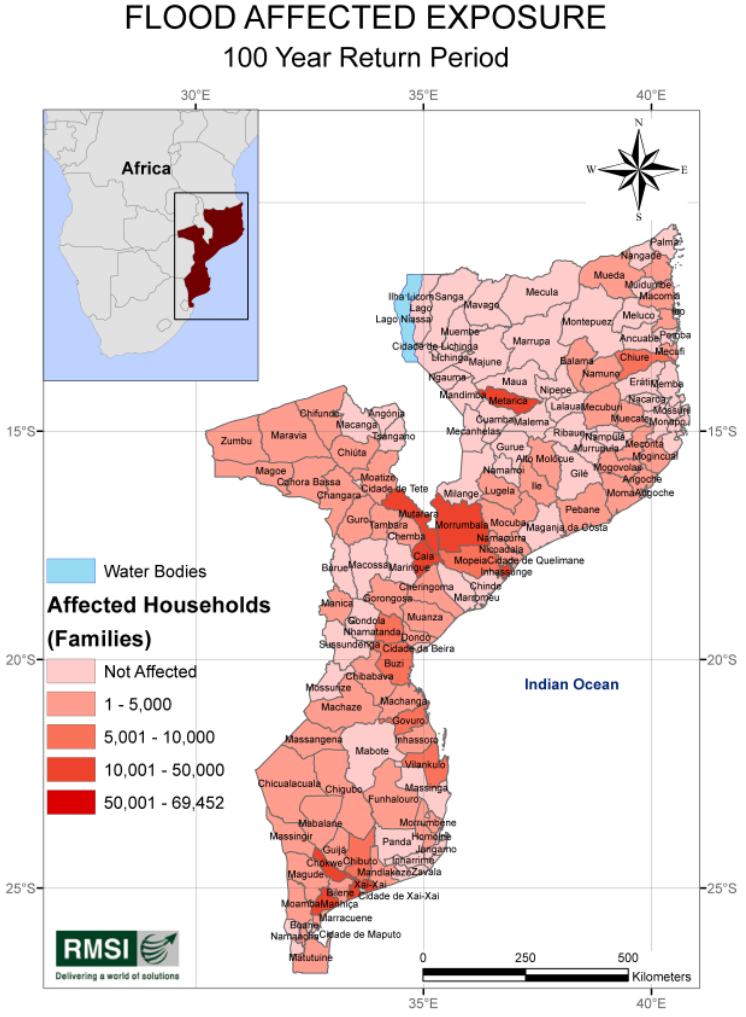
Loss = MDR * Replacement cost



Source : http://www.adrc.asia/publications/Venten/HP/Paper(Herath).htm

Flood Hazard Map

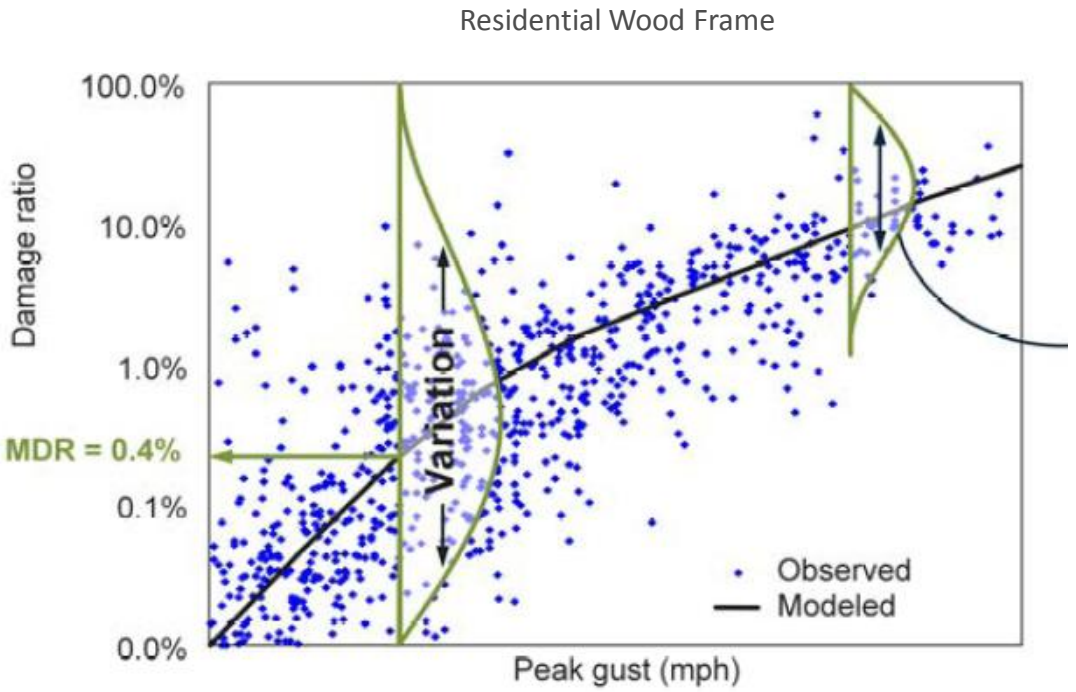




Source : RMSI, 2009

Modeling Uncertainties

- **Hazard**
- **Exposure**
- **Vulnerability**



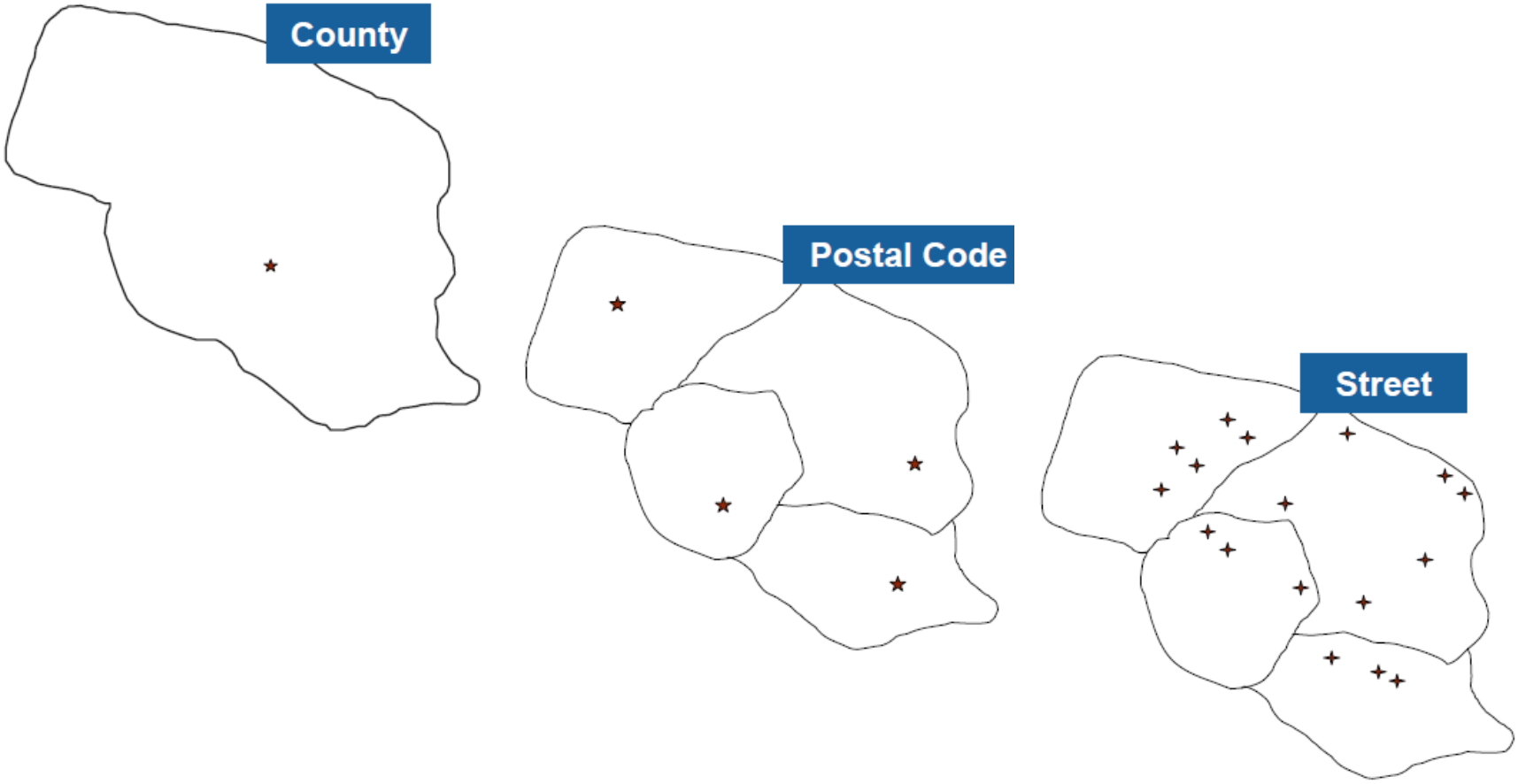
Other challenges in flood modeling

Data

- Meteorological and hydrological data - availability and gaps
- Large amount of data – heavy to process
- Resolution of data – Model Input Data
- Exposure data - resolution
- Loss data for historical events

Other challenges in flood modeling

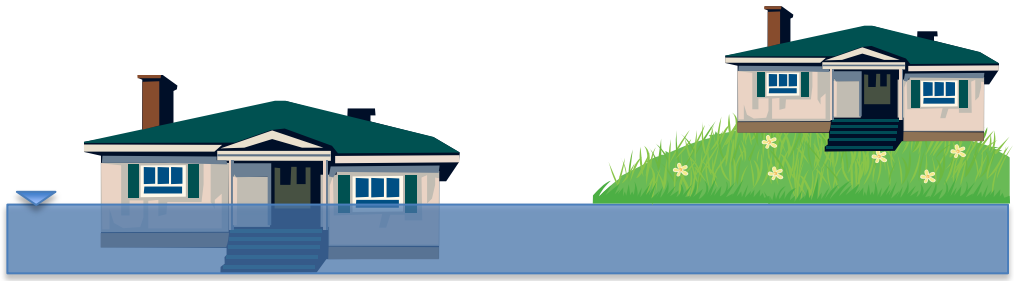
Exposure Data Resolution



Other challenges in flood modeling

- Building Attributes
  - Construction
  - Occupancy
  - Building Height
  - Year Built. etc

- Exact Location
  - **Address Information**



Flood Profile - Asia

Absolute human exposure

	Average people exposed per year	Country
1	19,279,960	Bangladesh
2	15,859,640	India
3	3,972,502	China
4	3,403,041	Viet Nam
5	1,765,674	Cambodia
6	1,101,507	Indonesia
7	819,822	Thailand
8	788,572	Philippines
9	579,732	Pakistan
10	444,450	Myanmar
11	390,594	United States of America
12	333,224	Nepal
13	265,260	Brazil
14	233,320	Russian Federation
15	226,622	Nigeria

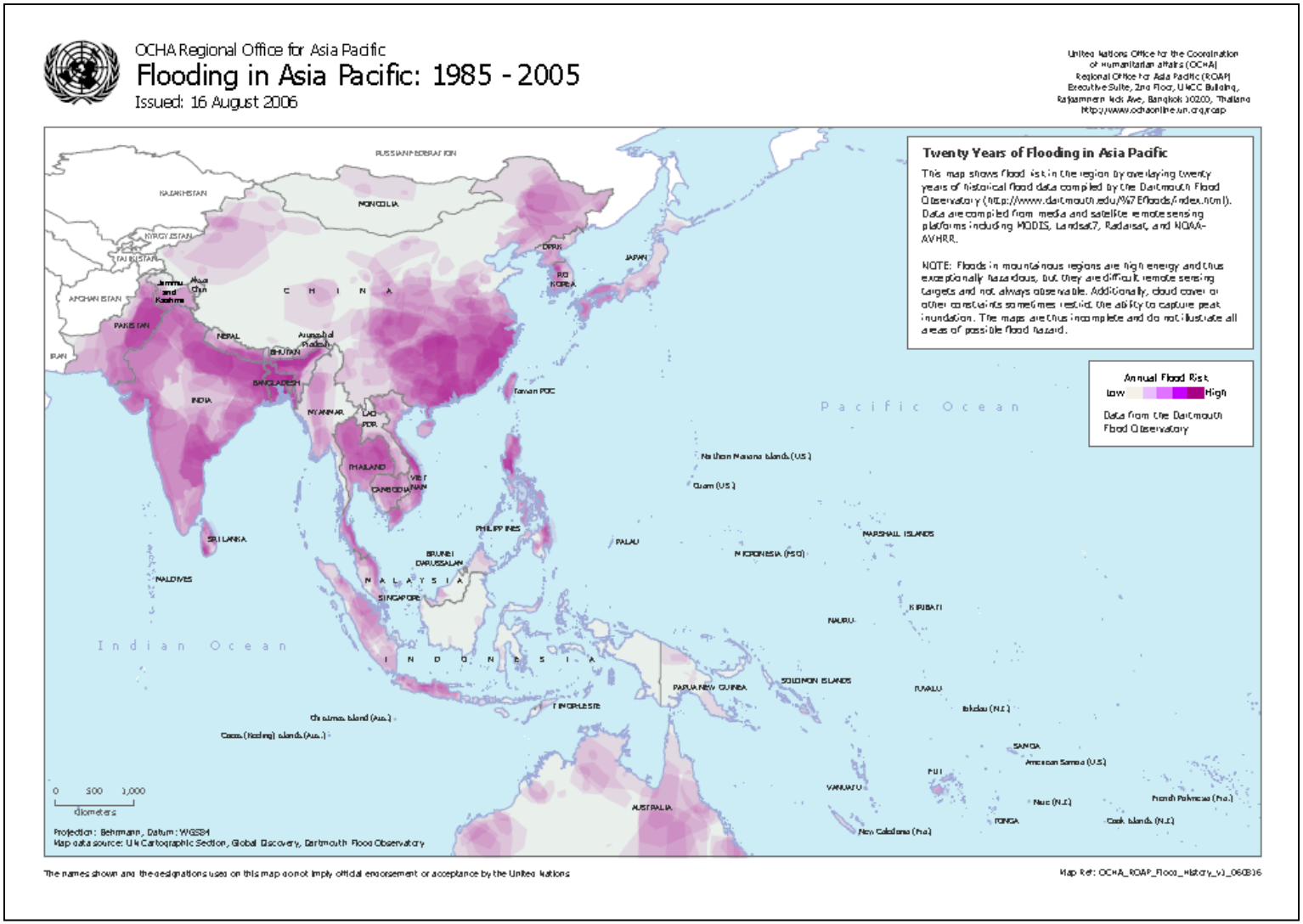
Absolute economic exposure

	Average GDP[1] exposed per year	Country
1	21.86	United States of America
2	12.58	China
3	9.74	Bangladesh
4	9.39	India
5	4.72	Germany
6	4.56	Japan
7	4.17	France
8	3.09	Thailand
9	2.57	Philippines
10	2.21	Viet Nam
11	2.18	Argentina
12	1.98	United Kingdom
13	1.84	Spain
14	1.82	Netherlands
15	1.76	Canada

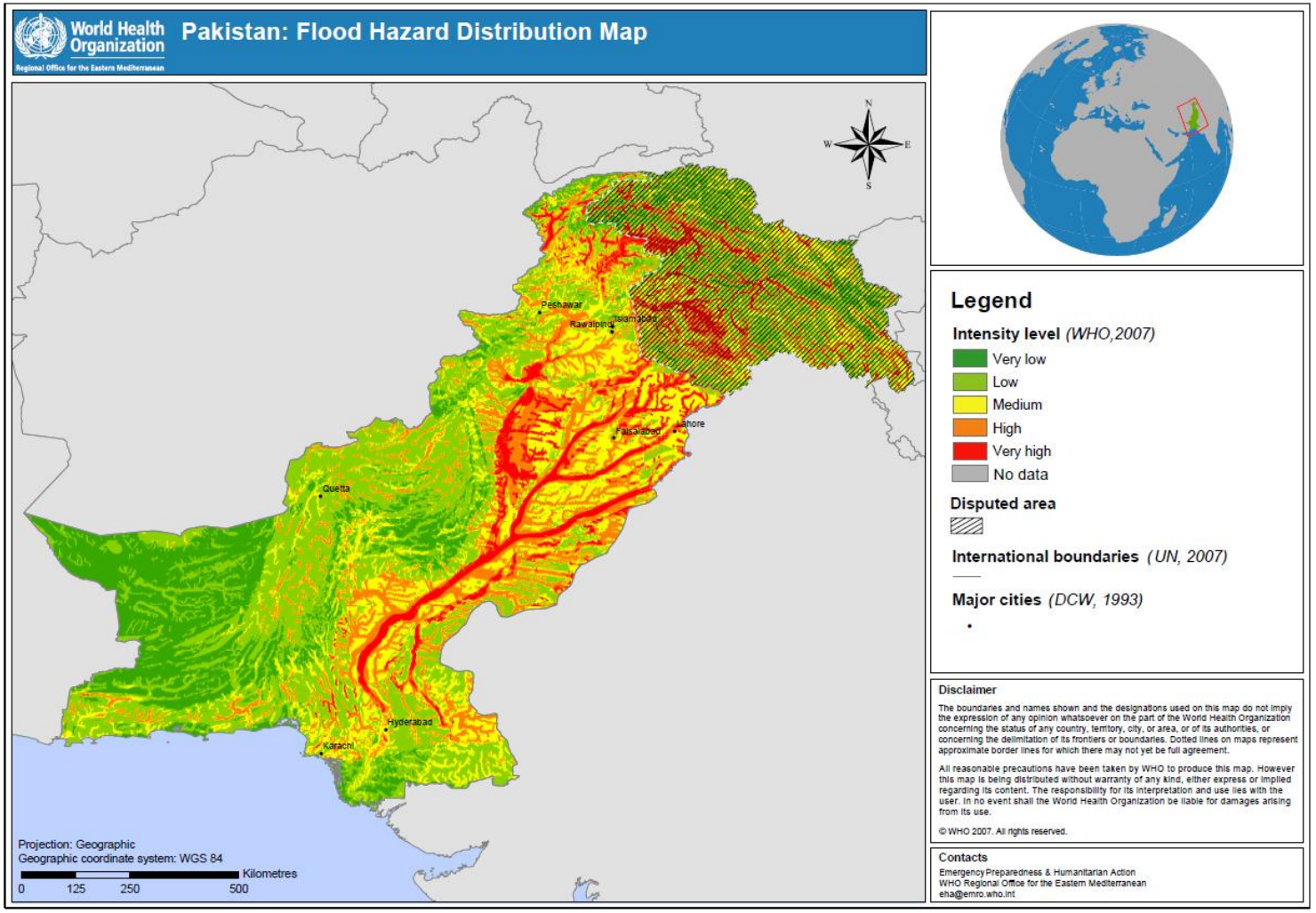
http://www.preventionweb.net/english/hazards/statistics/risk.php?hid=62

[1]: In billions US$

Flood Profile - Asia



Flood Profile - Pakistan



Summary

- **Asia's potential for large catastrophe losses is increasing due to**
  - **growing population**
  - **economic growth**
  - **increasing insurance penetration**
- **Flood models are the most complex models – large amounts of high resolution datasets are needed**
- **Currently no standalone Flood Model available in Asia**
- **Data quality : Garbage in – garbage out**


Thank You