



MS Frontier Re Modeling Research Pte. Ltd.

Catastrophic Risk – A Flood Perspective

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02 Jun 2011



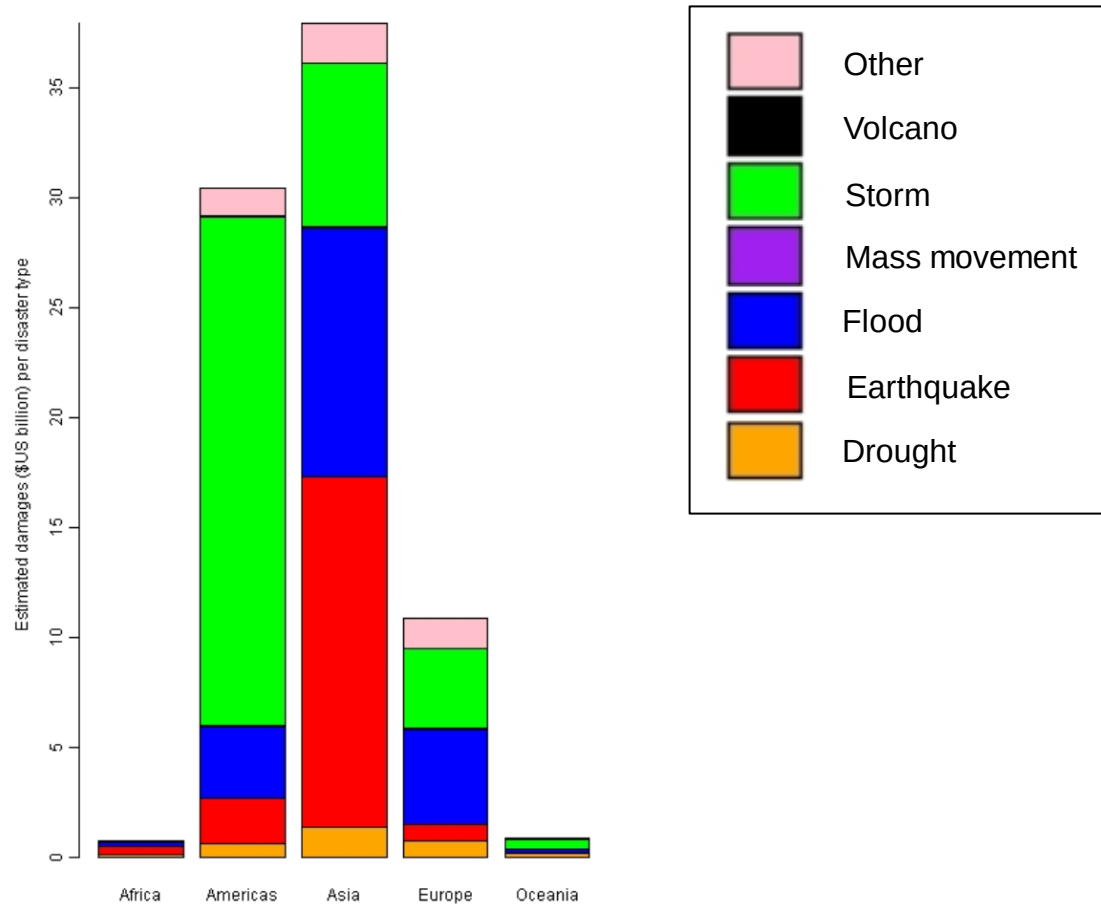
MSIG | MS Frontier Re

Agenda

- **Overview of natural disasters**
- **What if it happens again?**
- **What has 2010 brought?**
- **Flood risk assessment methodology**
- **Types of flood**
- **Uncertainty in flood modeling**
- **Flood Profile – Asia**
- **Summary**

Overview of natural disaster

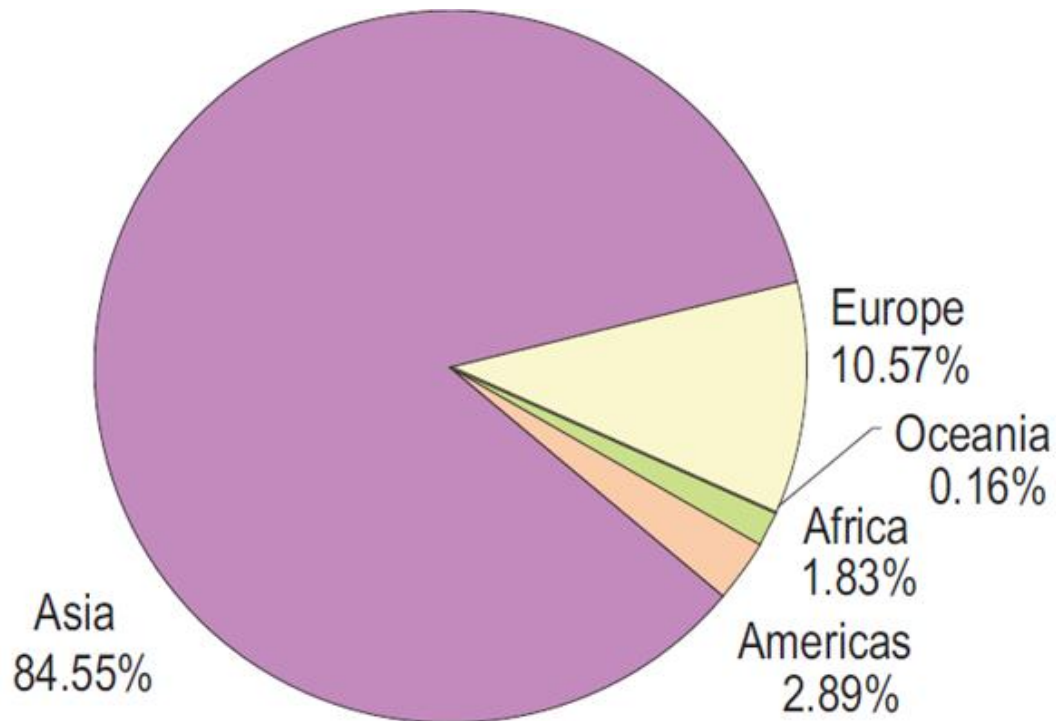
Annual Average Damage (\$US billion): 1990-2009



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

Overview of natural disaster

Percentage of people killed by natural disasters by region: Average 2000-2009



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

What has 2010 brought!



- **2nd Highest-number of loss related events since 1980!**
 - 950 events (785 average for last 10 years) – with 9/10th weather related
- **2nd Deadliest year in last three decades!**
 - 295,000 deaths (222,570 from Haiti Earthquake)
- **5th Highest losses since 1980!**
 - Approx USD 150bn losses (Insured losses around USD 37bn)
- **5 “Great Natural Catastrophes” by UN**
 - Haiti Earthquake (12th January 2010)
 - Chile Earthquake (27th February 2010)
 - Central China Earthquake (13th April 2010)
 - Russia – Heat wave (July to September 2010)
 - Pakistan Floods (July to September 2010)



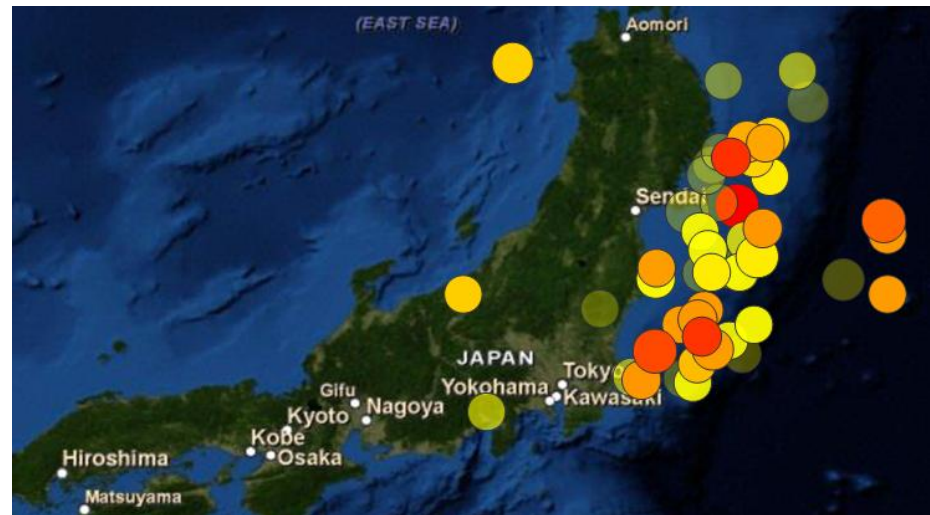
What has 2011 brought till now....

- **Christchurch Earthquake, New Zealand**

- *Magnitude : Mw 6.3*
- *Casualty: Death Toll - 181*
- *Second deadliest natural disaster in New Zealand (After 1931 Haeke's Bay Earthquake)*
- *Insured Loss: USD 7-10bn* (source www.rms.com)

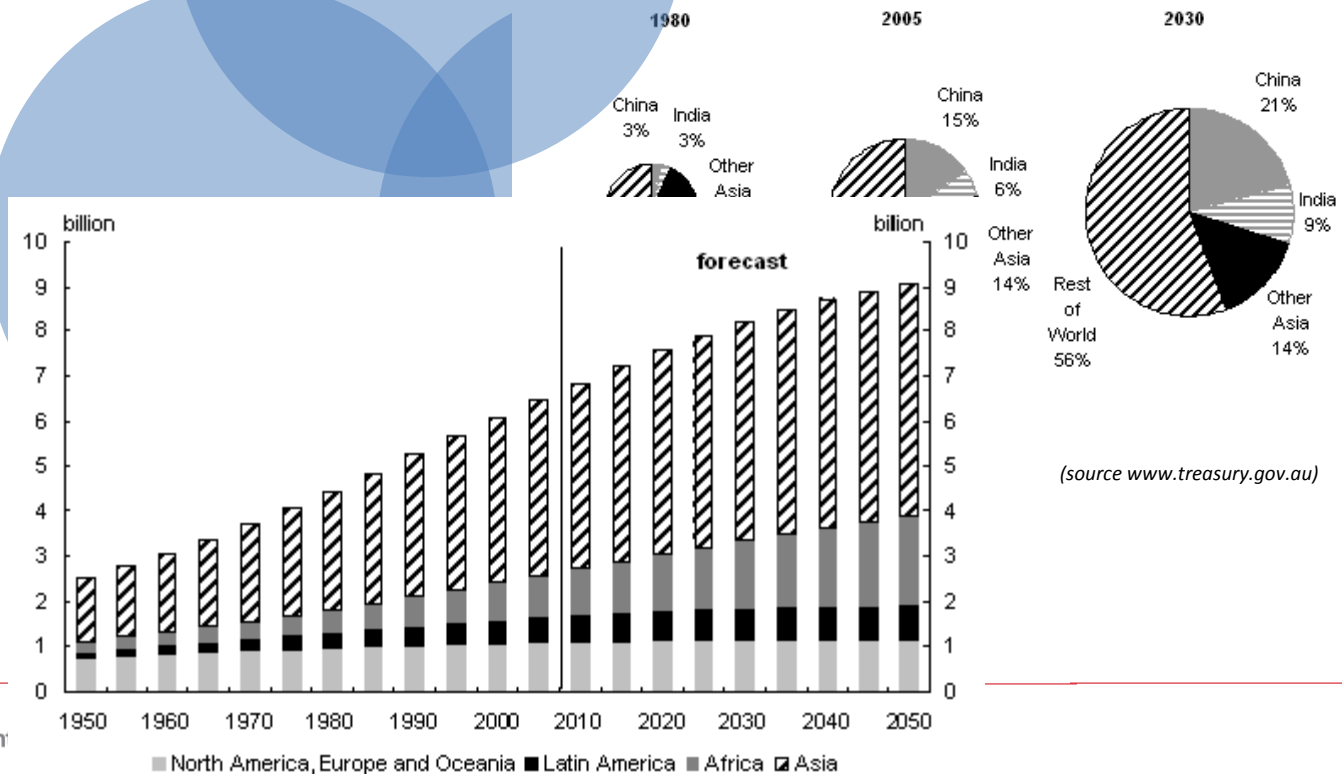
- **Tohoku, Japan Earthquake**

- *Magnitude : Mw 9.0*
- *Tsunami: Up to 37.9 m (124 ft)*
- *Casualty: 13,948 deaths, 4,916 injured and 14,734 missing*
(source: USGS)
- *Economic Loss Estimate: USD 200-300bn* (source www.rms.com)
- *Insured Loss Estimate: USD 21-34bn* (source www.rms.com)



Why are the numbers are bigger now?

Population



What is available?

Country	AIR		EQECAT			RMS		Risk Frontiers	
	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		✓		✓			✓		

**No FLOOD
Model in
Asia**

* Included in China EQ

** Included in Guam EQ

Flood risk assessment Approach



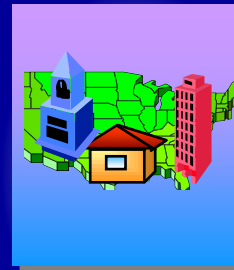
Stochastic Module



Hazard Module



Vulnerability
Module

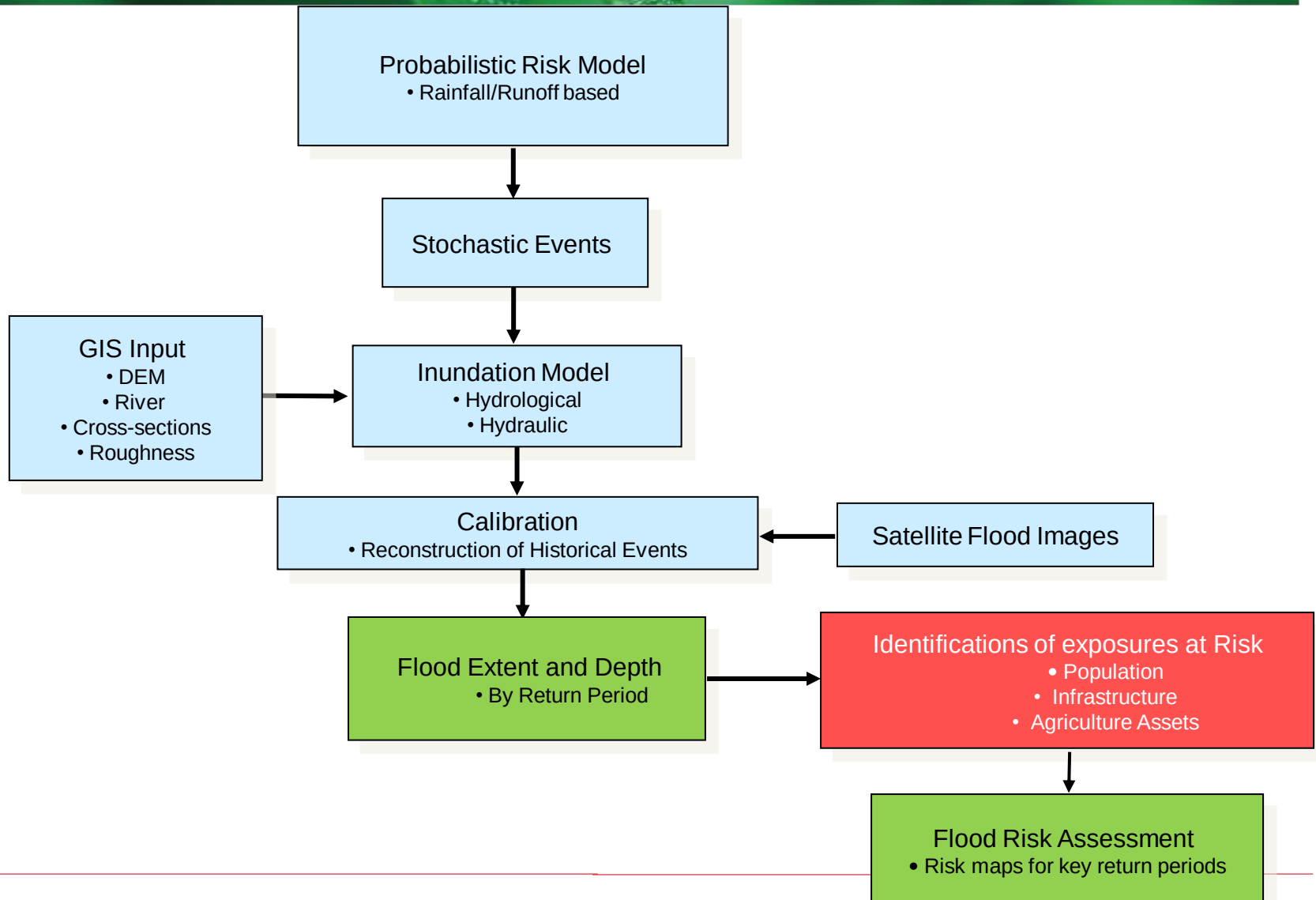


Exposure Module

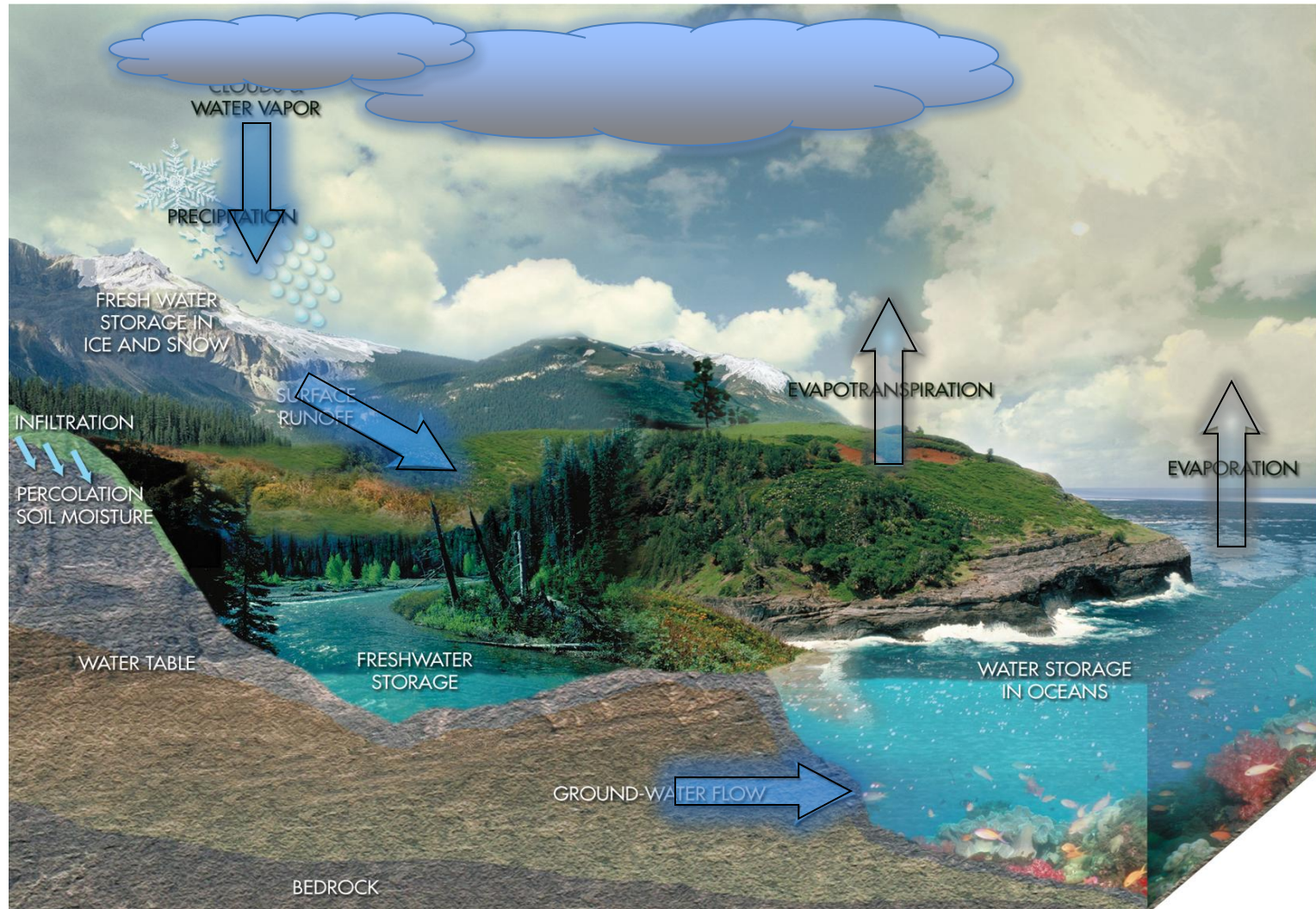


Financial Module

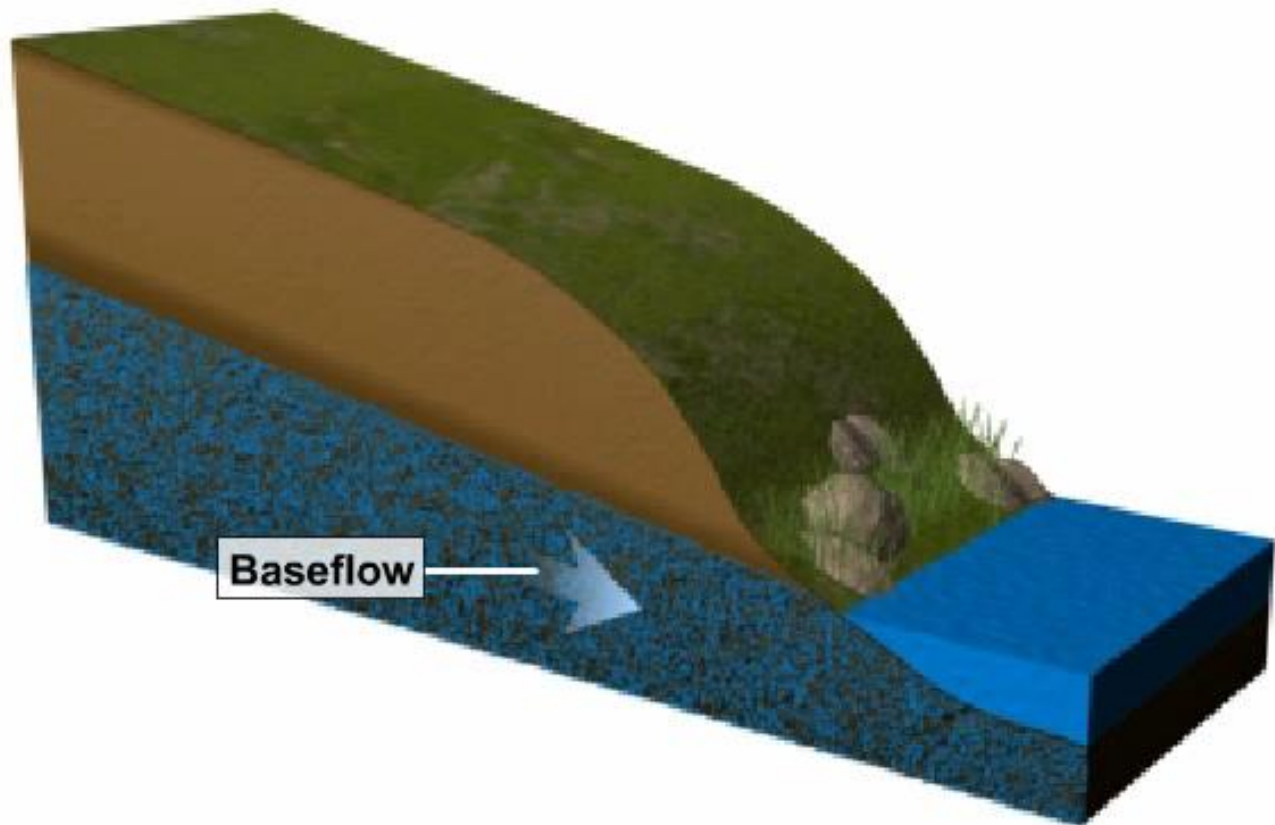
Flood risk assessment methodology



Hydrology - Hydrological Cycle



Basic Soil Water and Runoff Terms



Hydrology

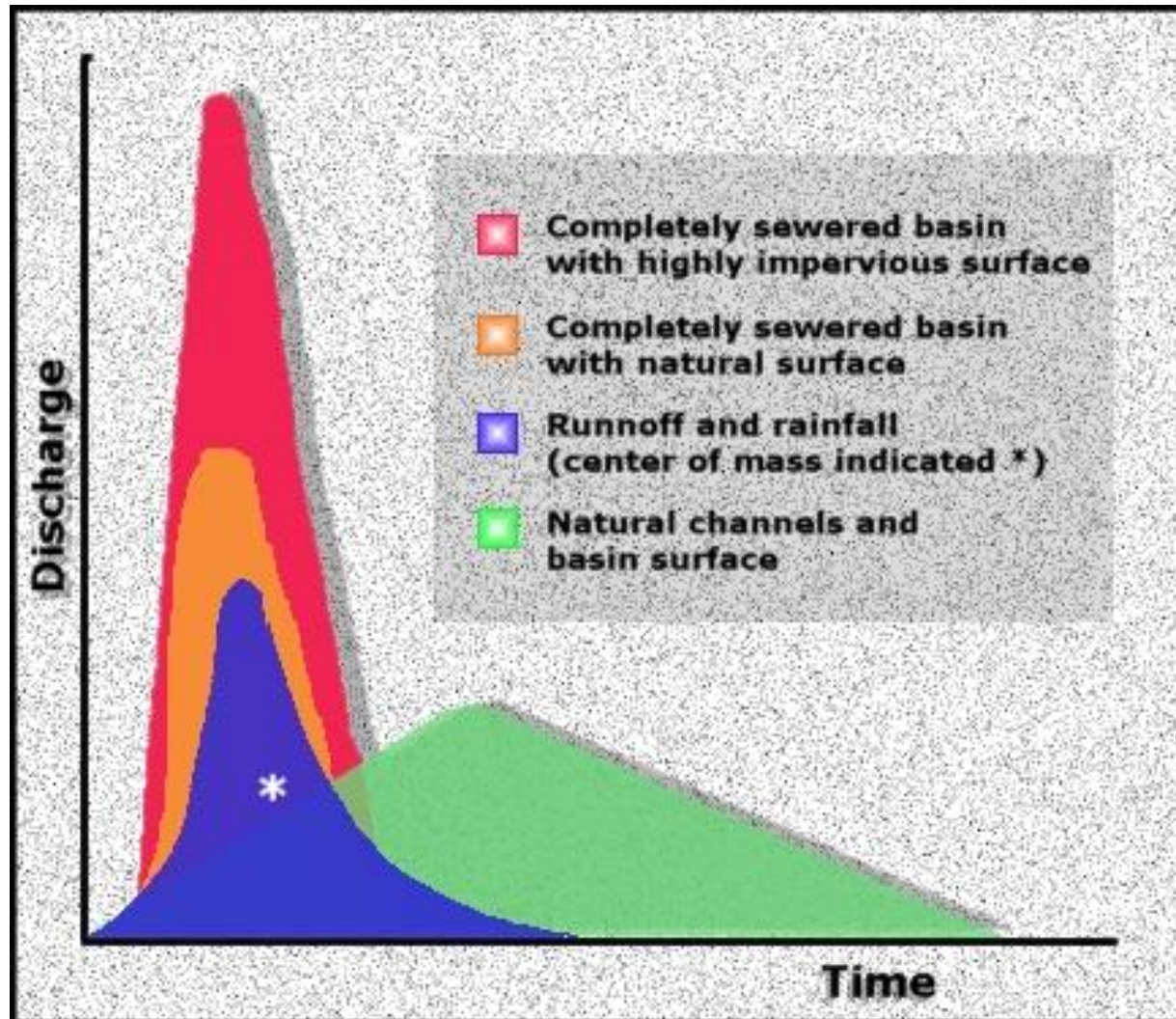
Physical Processes for the Movement of Soil Water



©The COMET Program

» 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

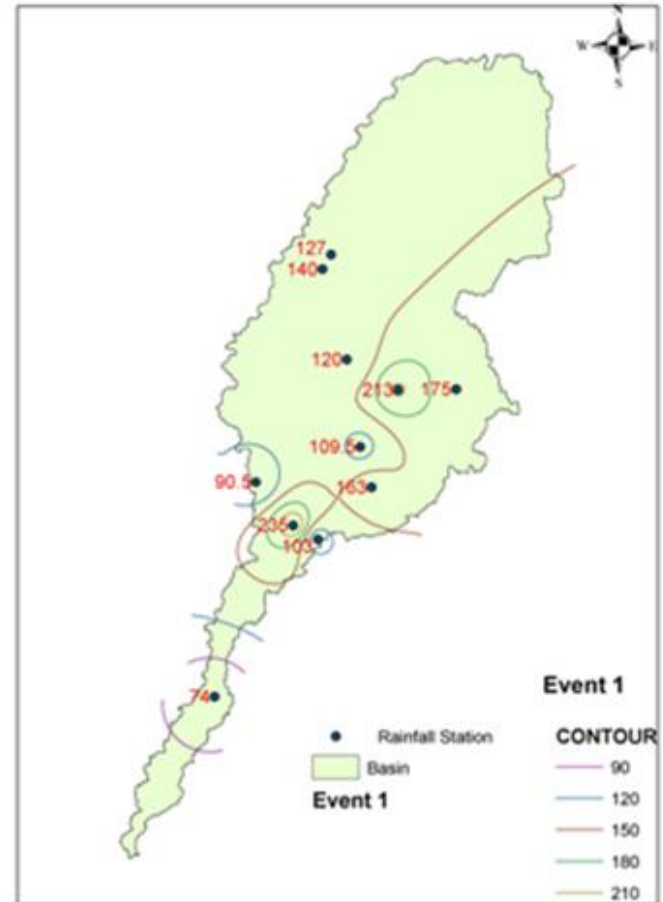
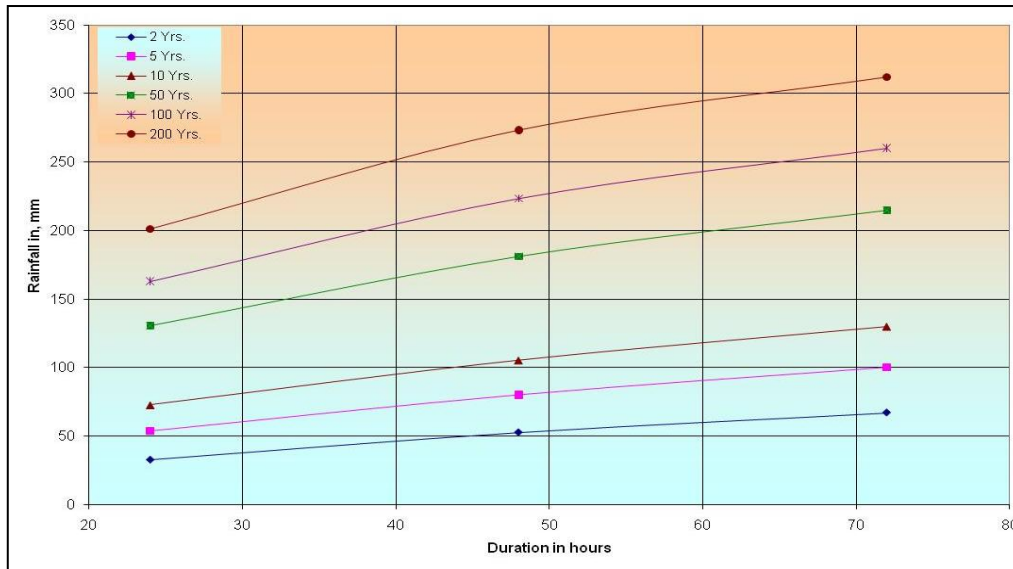


Stochastic Module

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

- Duration
- Intensity
- Temporal pattern
- Initial loss

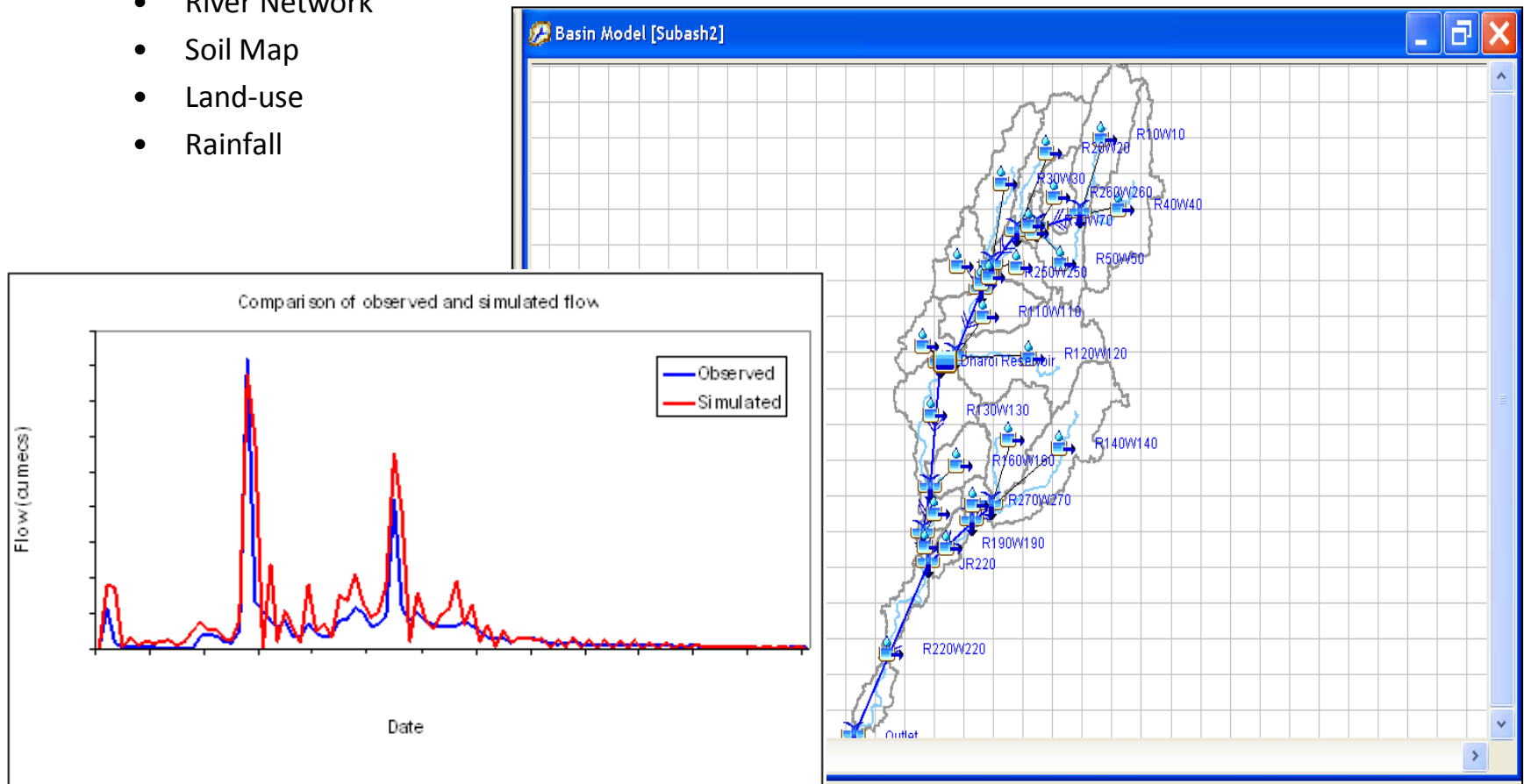
RP	1 Day	2 Day	3 Day
2	32.6	37.6	42.0
5	53.6	65.1	75.4
10	72.6	90.2	104.7
20	95.0	119.5	138.2
50	130.6	166.2	189.9
100	163.0	208.6	235.3
200	201.1	258.3	287.2
500	261.6	337.4	367.1



Hazard Module – Hydrologic modeling

Input for hydrological model

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



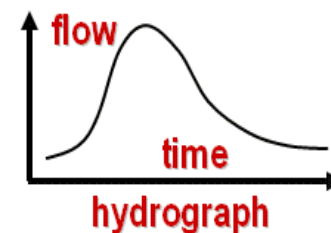
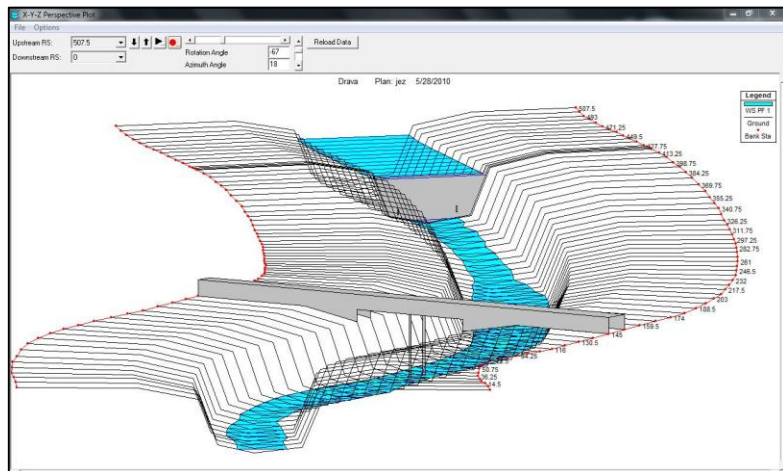
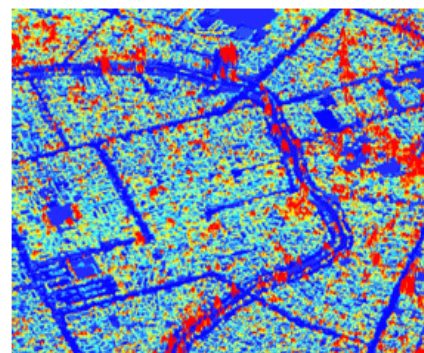
Hazard Module – Hydraulic modeling

Input for hydrological model

- River cross section
- Flow hydrograph
- Surface roughness
- Satellite imagery
- Observed flow data



elevation model



surface roughness model



flood depths & extent



Types of Floods

Riverine flood

- Heavy rains or rapid snowmelt cause rivers to rise

Flash Floods

- Intense storms dropping large amounts of rain within a brief period

Dam Failure

- Earthquake
- Heavy rainfall

Coastal Floods

- Tidal surges and flash flooding

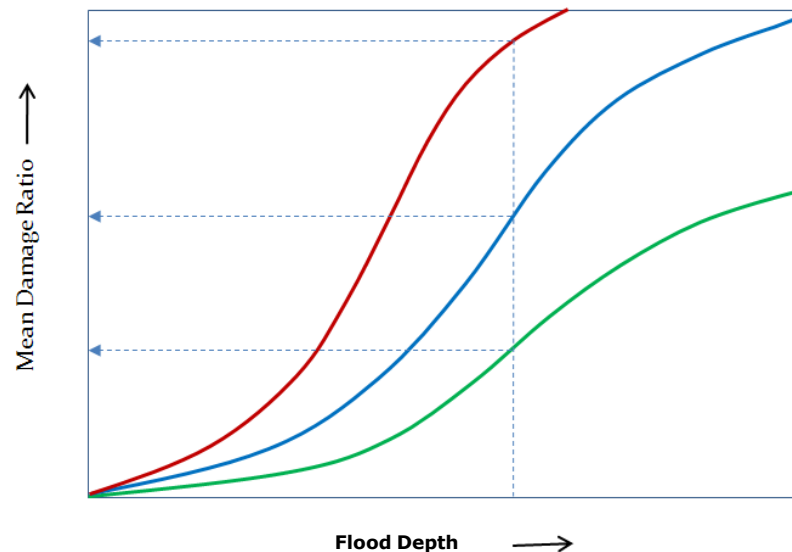
Vulnerability Module

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 Characteristic



Exposure Module

Exposure data development

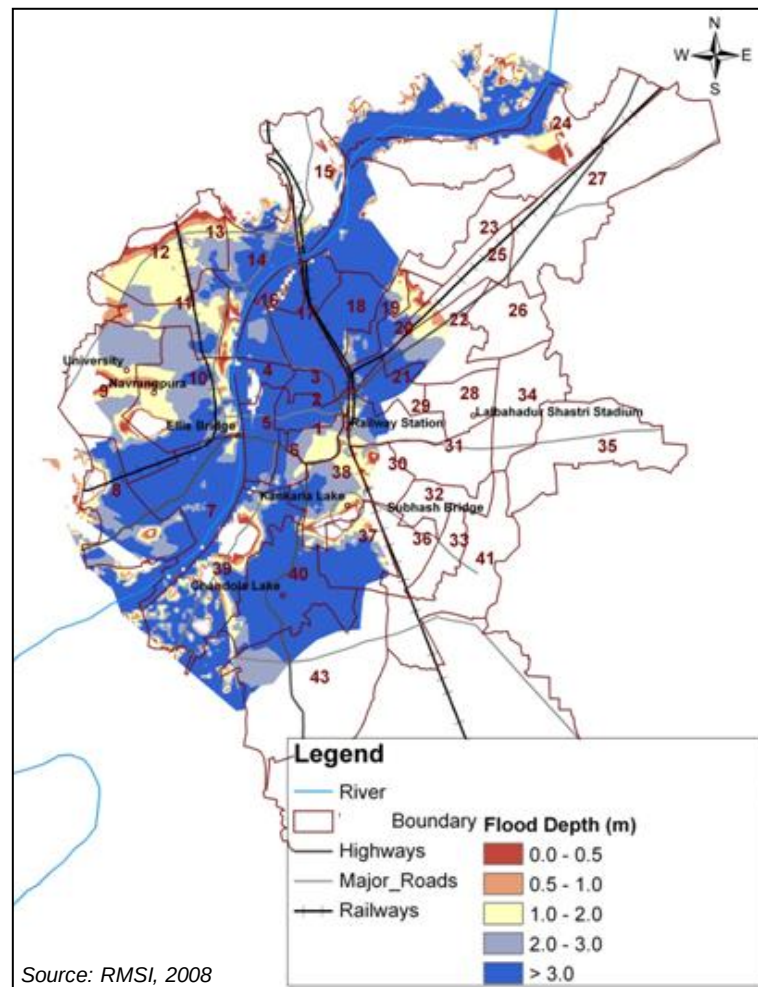
- LOB
 - Residential
 - Commercial
 - Industrial
 - Agricultural
- Structural details
 - Construction type and material
 - wall and flooring material etc
 - Age and height
- Location
- Data Resolution

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

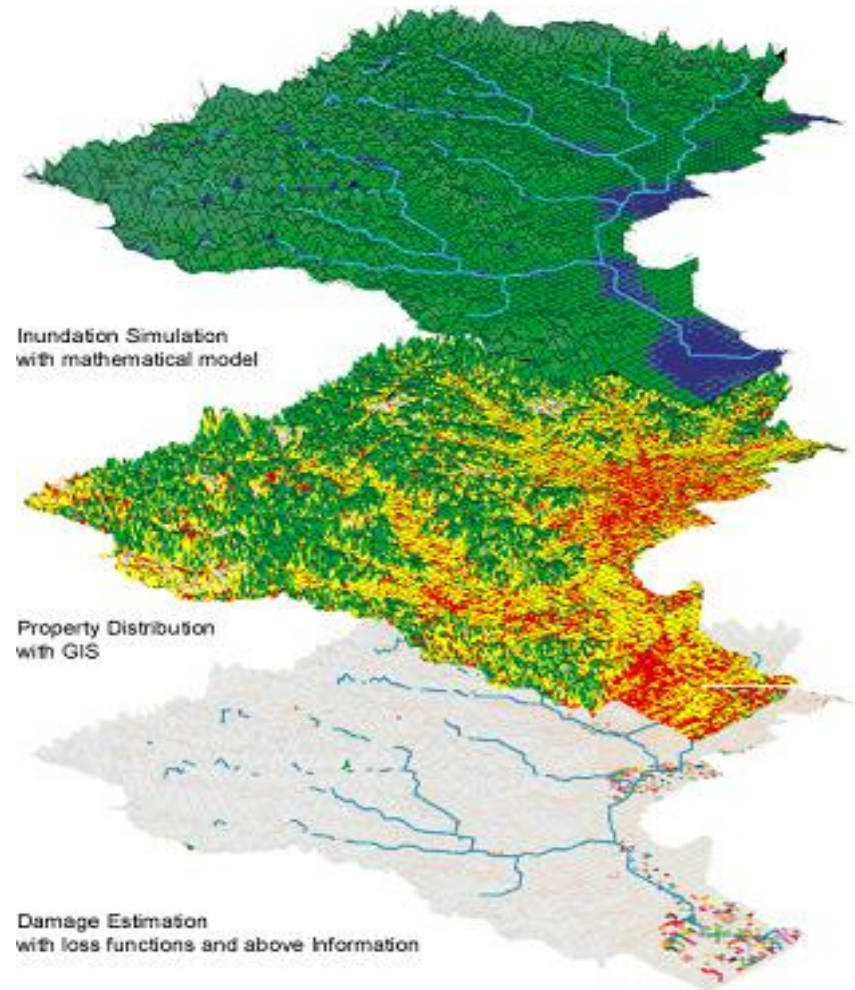
Importance of High Resolution Exposure Data



Detailed Data / Aggregate Data

Loss Module

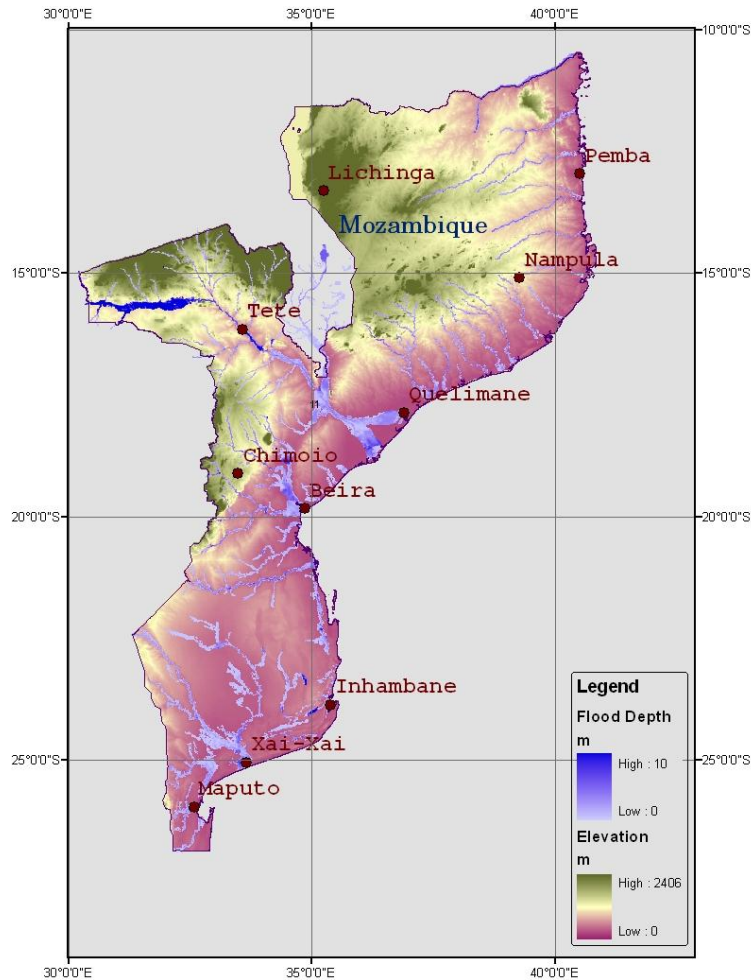
**Loss = Average flood depth * MDR
* area affected * replacement
cost per unit area**



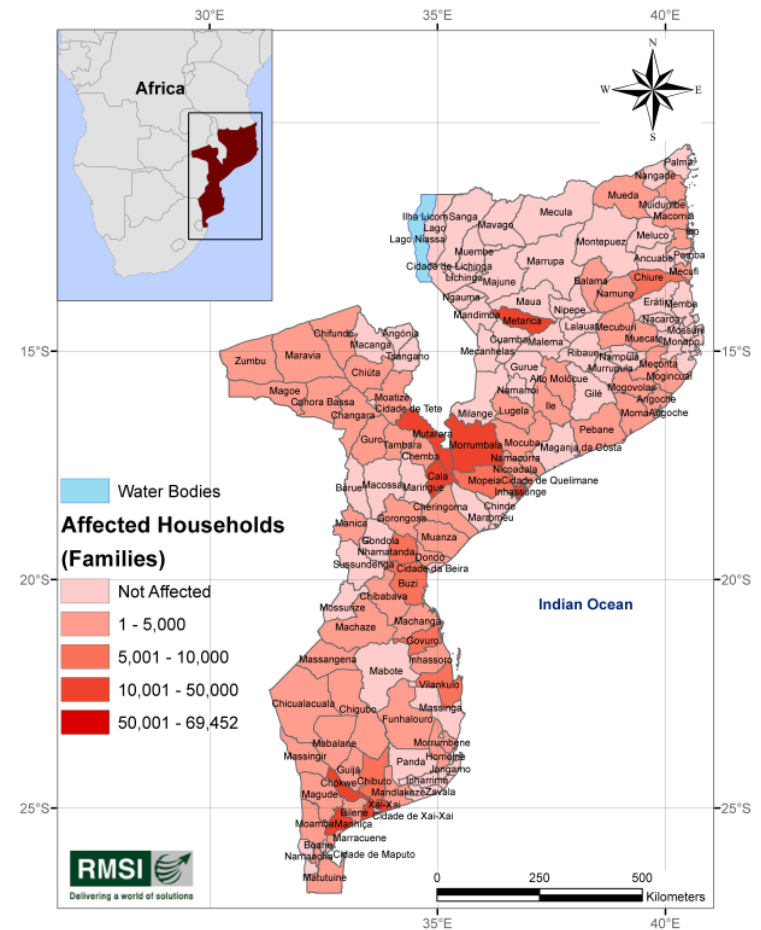
Source : [http://www.adrc.asia/publications/Venten/HP/Paper\(Herath\).htm](http://www.adrc.asia/publications/Venten/HP/Paper(Herath).htm)

Flood Hazard Map

Flood Extent Map - 100 Year Return Period



FLOOD AFFECTED EXPOSURE
100 Year Return Period



Source : RMSI, 2009

Uncertainties and challenges in flood modeling

Data

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

Flood Profile - Asia

Absolute human exposure				Absolute economic exposure			
Average people exposed per year			Country	Average GDP ¹ exposed per year			Country
1		19,279,960	Bangladesh	1		21.86	United States of America
2		15,859,640	India	2		12.58	China
3		3,972,502	China	3		9.74	Bangladesh
4		3,403,041	Viet Nam	4		9.39	India
5		1,765,674	Cambodia	5		4.72	Germany
6		1,101,507	Indonesia	6		4.56	Japan
7		819,822	Thailand	7		4.17	France
8		788,572	Philippines	8		3.09	Thailand
9		579,732	Pakistan	9		2.57	Philippines
10		444,450	Myanmar	10		2.21	Viet Nam
11		390,594	United States of America	11		2.18	Argentina
12		333,224	Nepal	12		1.98	United Kingdom
13		265,260	Brazil	13		1.84	Spain
14		233,320	Russian Federation	14		1.82	Netherlands
15		226,622	Nigeria	15		1.76	Canada

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

¹: In billions US\$

Flood Profile - Asia

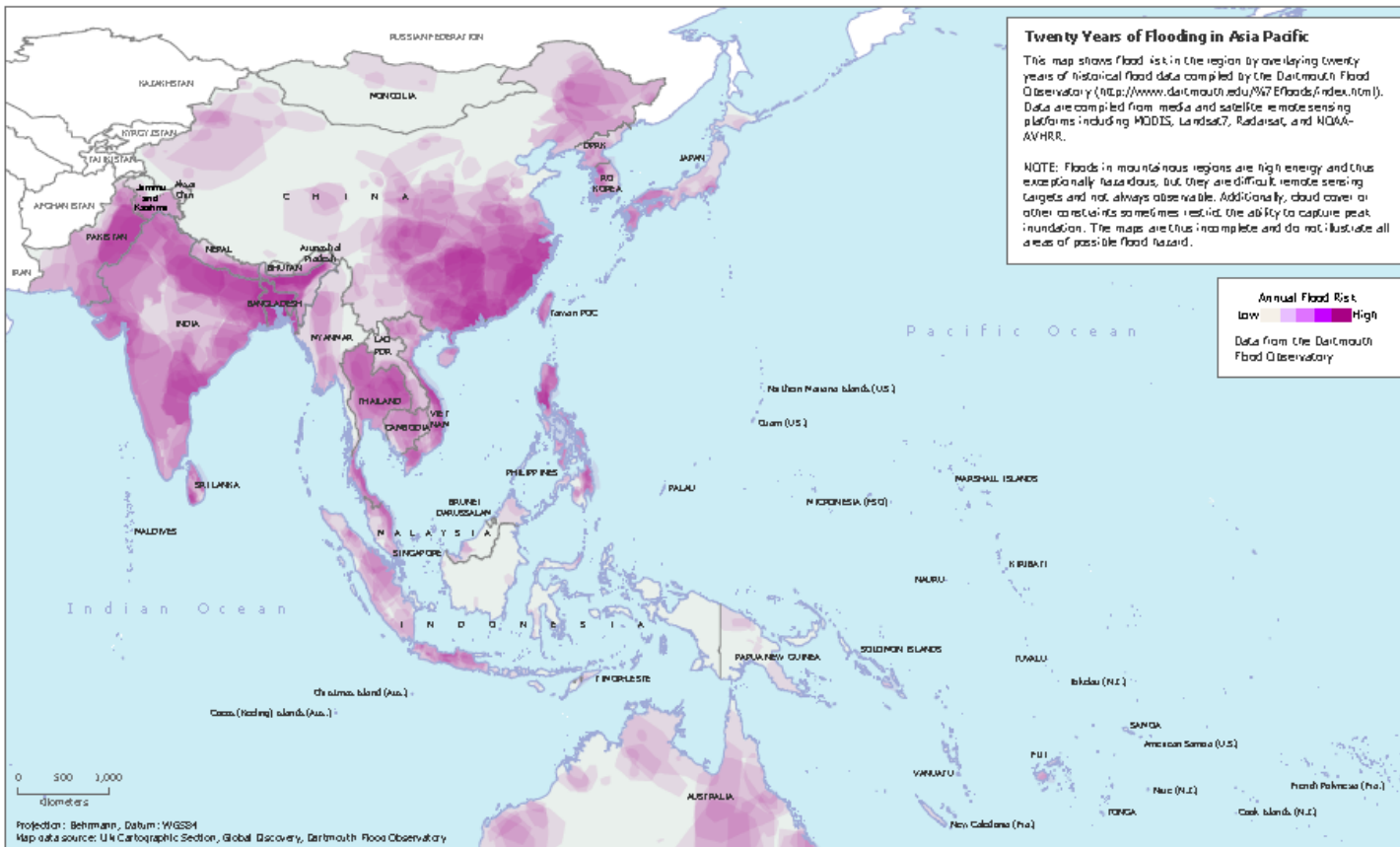


OCHA Regional Office for Asia Pacific

Flooding in Asia Pacific: 1985 - 2005

Issued: 16 August 2006

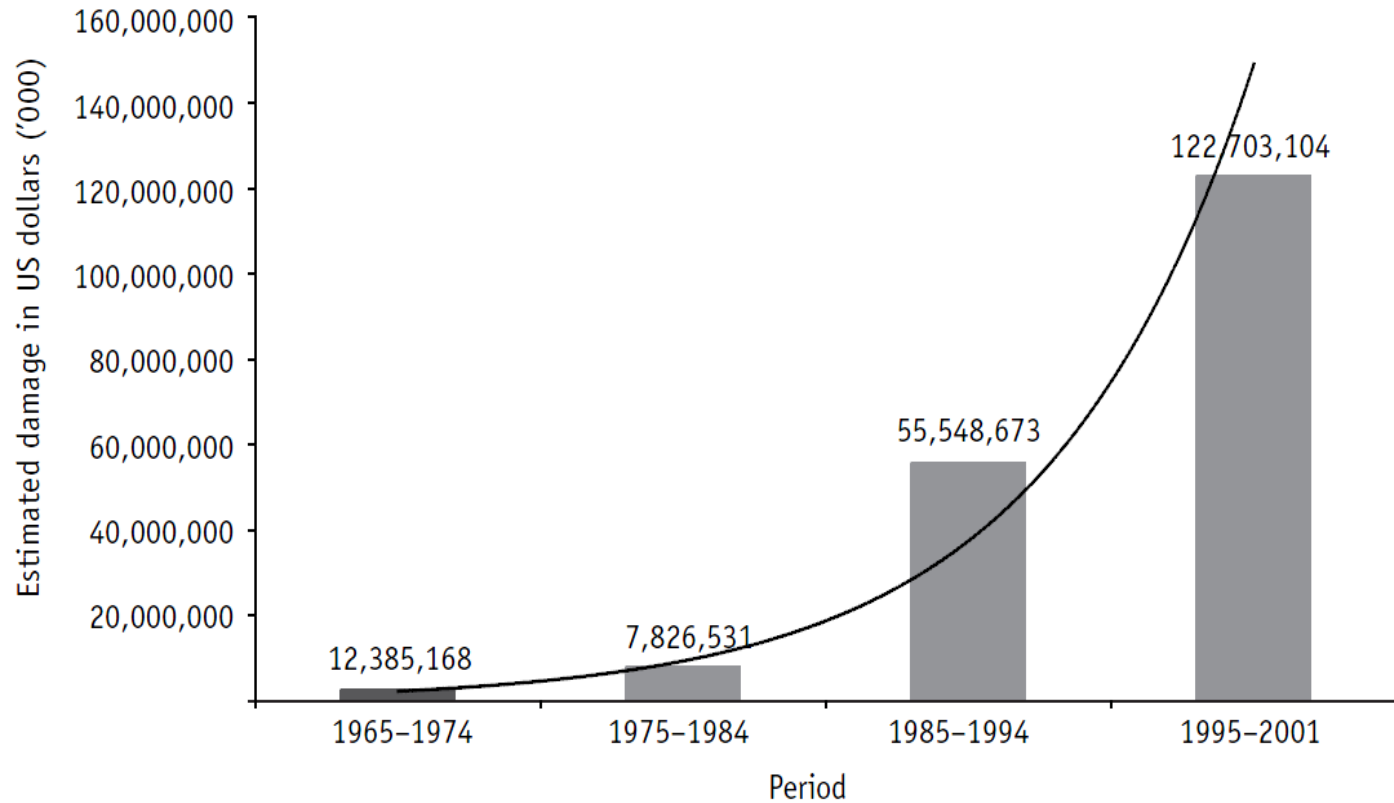
United Nations Office for the Coordination of Humanitarian Affairs (OCHA)
Regional Office for Asia Pacific (ROAP)
Executive Suite, 2nd Floor, U.N. Building,
Rajamannin Road, Bangkok 10200, Thailand
<http://www.ochaonline.un.org/roap>



The names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations

Map Ref: OCHA_ROAP_Flood_History_v1_060816

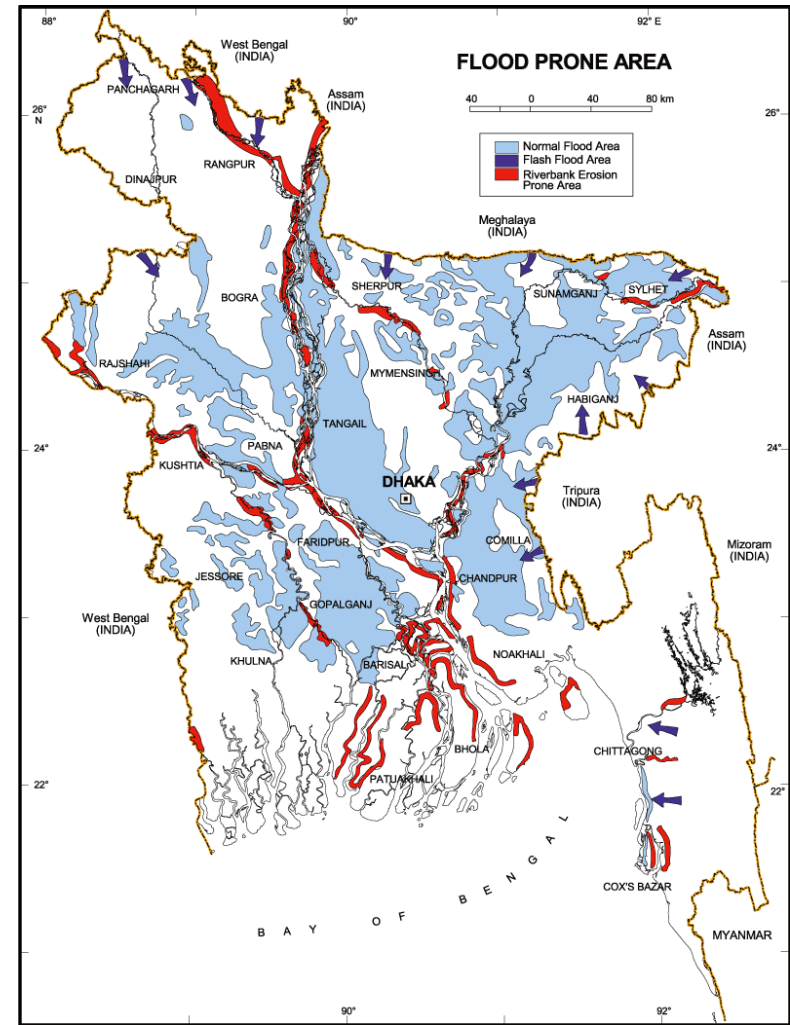
Economic Losses due to Flood – Asia 1965 - 2004



Source: CRED (2006).

Flood Profile - Bangladesh

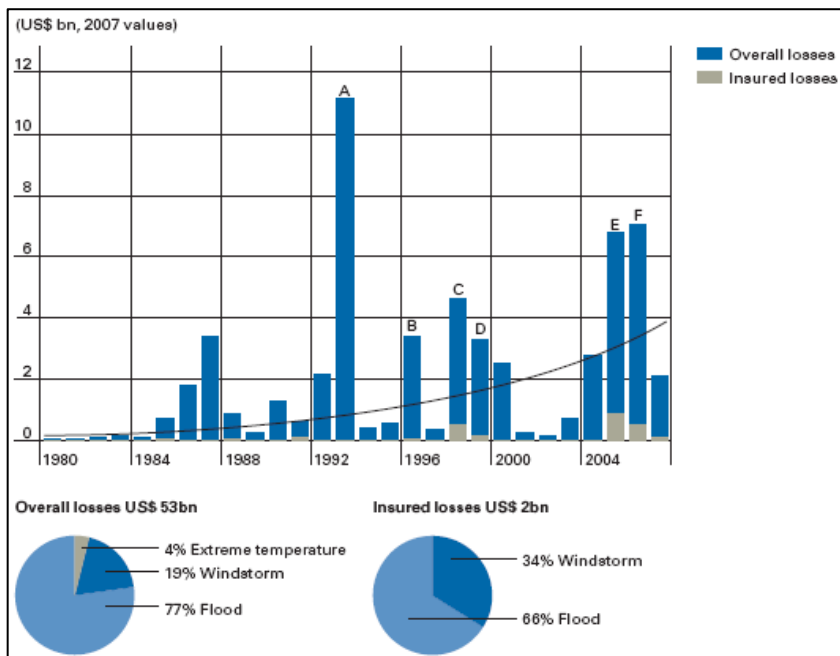
- Situated on the Ganges Delta and the many tributaries flowing into the Bay of Bengal.
- 75% of Bangladesh is less than 10m above sea level and 80% is flood plain
- Flash flood, local flood, monsoon flood and floods due to storm surge



Source : <http://www.banglapedia.org/httpdocs/>

Flood Profile - India

- Out of the country's total geographical area of 329 million hectares about 45 million hectares is flood prone.



Source: NatCatSERVICE, Geo Risks Research, Munich Re



Source : UNDP flood zone map

Flood Profile - China

Summarized Table of Floods in China P Rep from 1900 to 2011

Type of Flood	No. of Events	Killed	Total Affected	Damage (000 US\$)
Unspecified	50	2254492	165018799	16865744
Flash flood	20	2099	89073073	4493090
General flood	131	4340199	1584815300	137890499
Storm surge/coastal flood	5	391	1000015	-

Source: "EM-DAT: The OFDA/CRED International Disaster Database

China's ten largest flood events since 1980 accounted for overall losses of more than US\$ 135bn but, in contrast to the western industrialized nations with their high insurance penetration, insured losses amounted to only 1–2%. -Munich Re, February 2010

Summary

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



Questions?

Backup: What if *The History* repeats itself.....

- **1995 Kobe Earthquake - Japan**
 - *RMS Study (2007): Economic Loss – USD 57bn with Insured Loss of USD 2.6 bn*
- **1959 Typhoon Vera - Japan**
 - *RMS Study (2009): Insured Losses between USD 14.5 - 18 bn*
- **2011 Japan Earthquake**



Backup: Overview of natural disasters

Natural Disasters in Asia, 1900-2010

	No of Events	Killed	Total Affected	Damage (000 US\$)
Metrological (Storm, Tropical Cyclones, etc)	1,365	1,260,474	777,948,221	163,360,493
Average per event		923	569,925	119,678
Hydrological (Flood, Coastal Flood, Avalanches, Landslide, Subsidence, etc)	1,809	6,801,220	2,999,621,905	248,015,076
Average per event		3,760	1,658,166	137,101
Geophysical (Earthquake, Tsunami, Avalanche, Landslide, Volcano, etc)	711	1,817,824	129,833,966	320,341,925
Average per event		2,557	182,608	450,551

Backup: Importance of High Resolution Exposure Data

- Building Characteristics

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



- Exact Location

- Latitude
- Longitude

