Implementing a National Disaster Risk Assessment under the Sendai Framework of DRR

Manzul K. Hazarika, Ph.D.

Director, Geoinformatics Center
Asian Institute of Technology (AIT), Thailand
manzul@ait.asia

Sendai Framework: Priorities for Action

1. Understanding disaster risk:
2. Strengthening disaster risk governance to manage disaster risk;
3. Investing in disaster risk reduction for resilience; and
4. Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction.

Priority 1 - Understanding disaster risk:

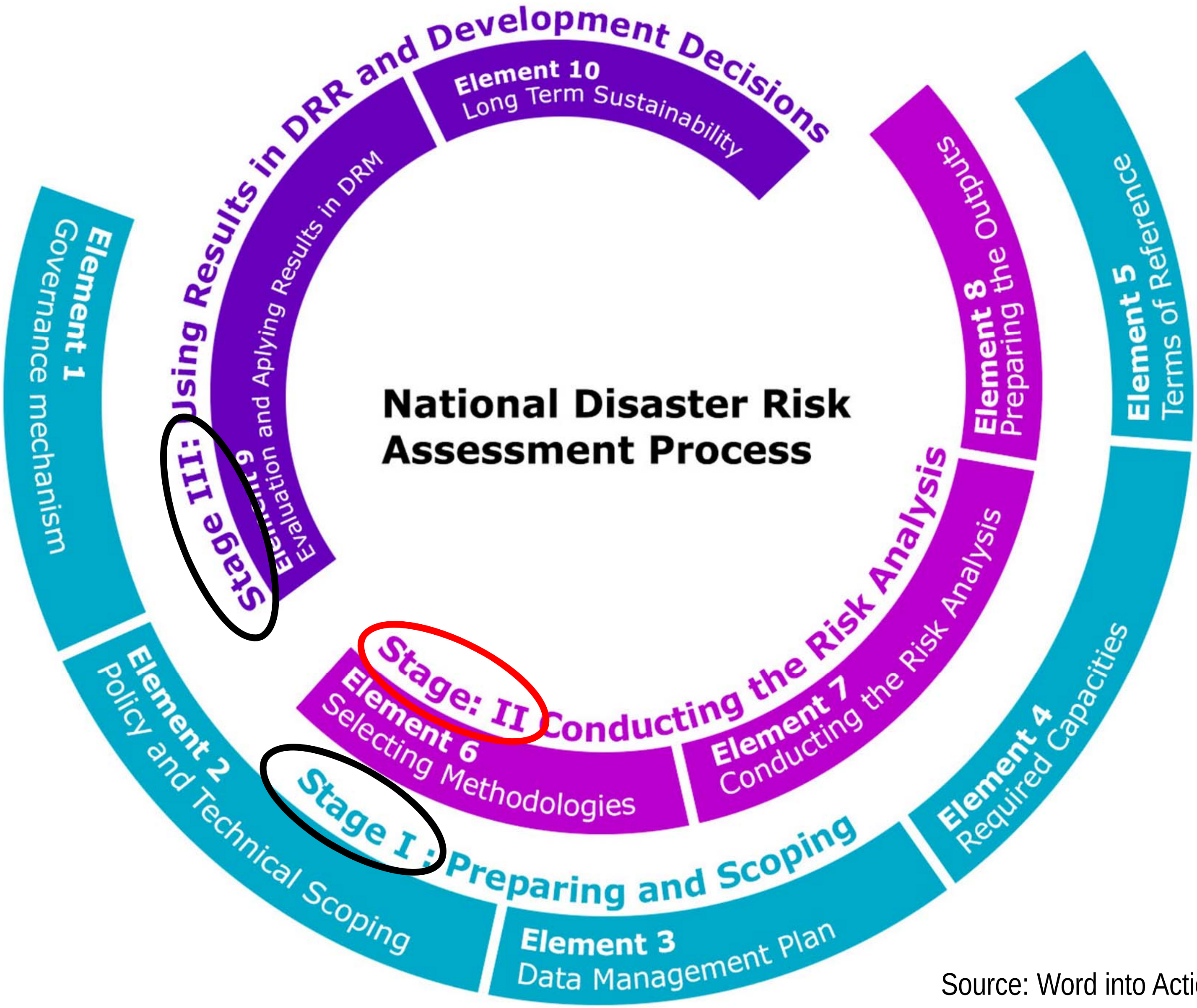
Disaster risk management should be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure, hazard characteristics and the environment.

Sendai Framework: Guiding Principles Relevant to Priority Action 1

1. Decision-making to be inclusive and risk-informed while using a multi-hazard approach;
2. Accounting of local and specific characteristics of disaster risks when determining measures to reduce risk.

Published on 23 Oct. 2017

Ten Elements for Successful Disaster Risk Assessment



Source: Word into Action Guidelines – National DRA, UNISDR, 2017.

Element 6: Utilizing Various Risk Analysis Methodologies

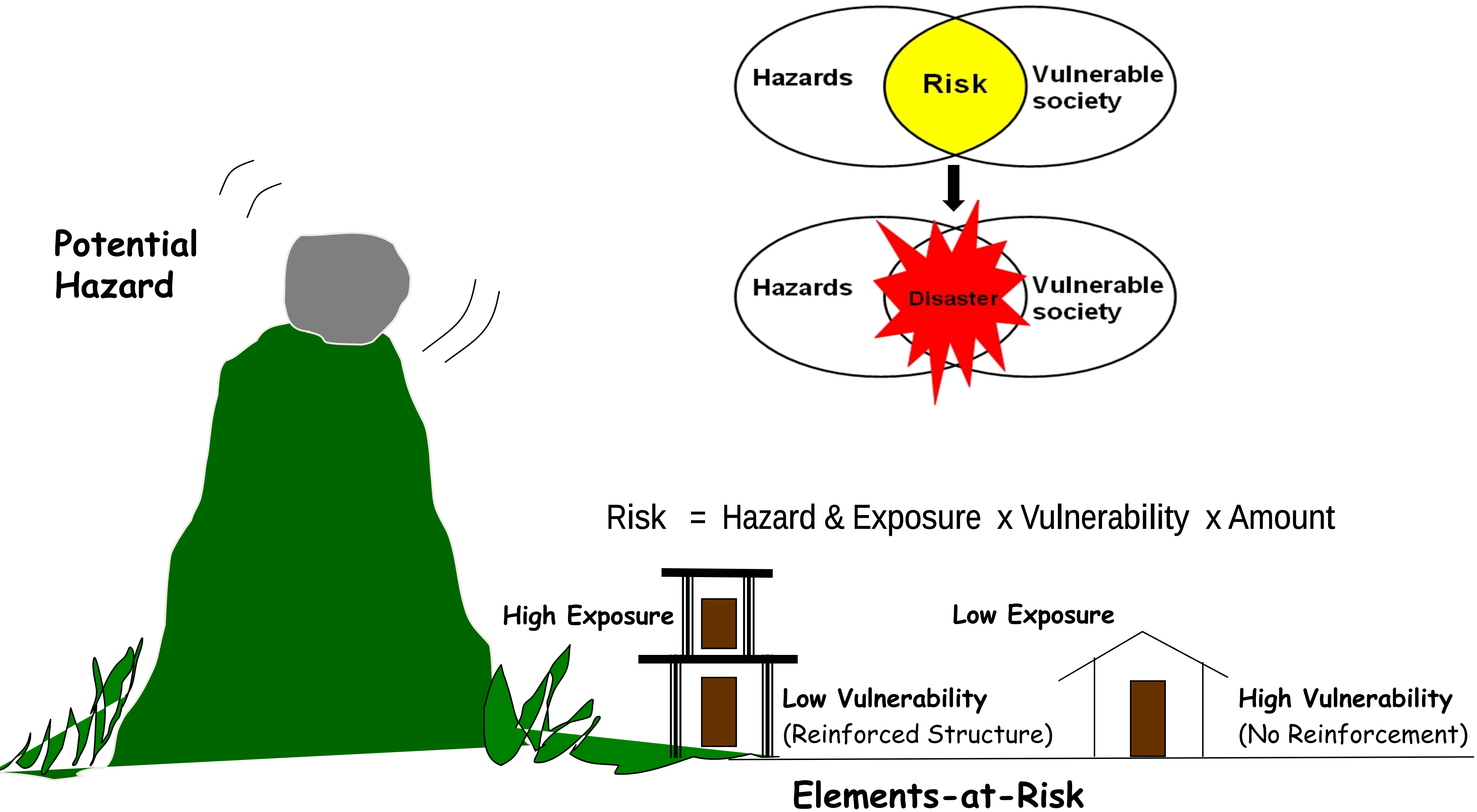
(i) Quantitative methods

Express the risk in quantitative terms either as probabilities, or expected losses. They can be deterministic/scenario-based (looking at a particular scenario) or probabilistic (taking into account the effect of all possible scenarios).

(ii) Qualitative methods

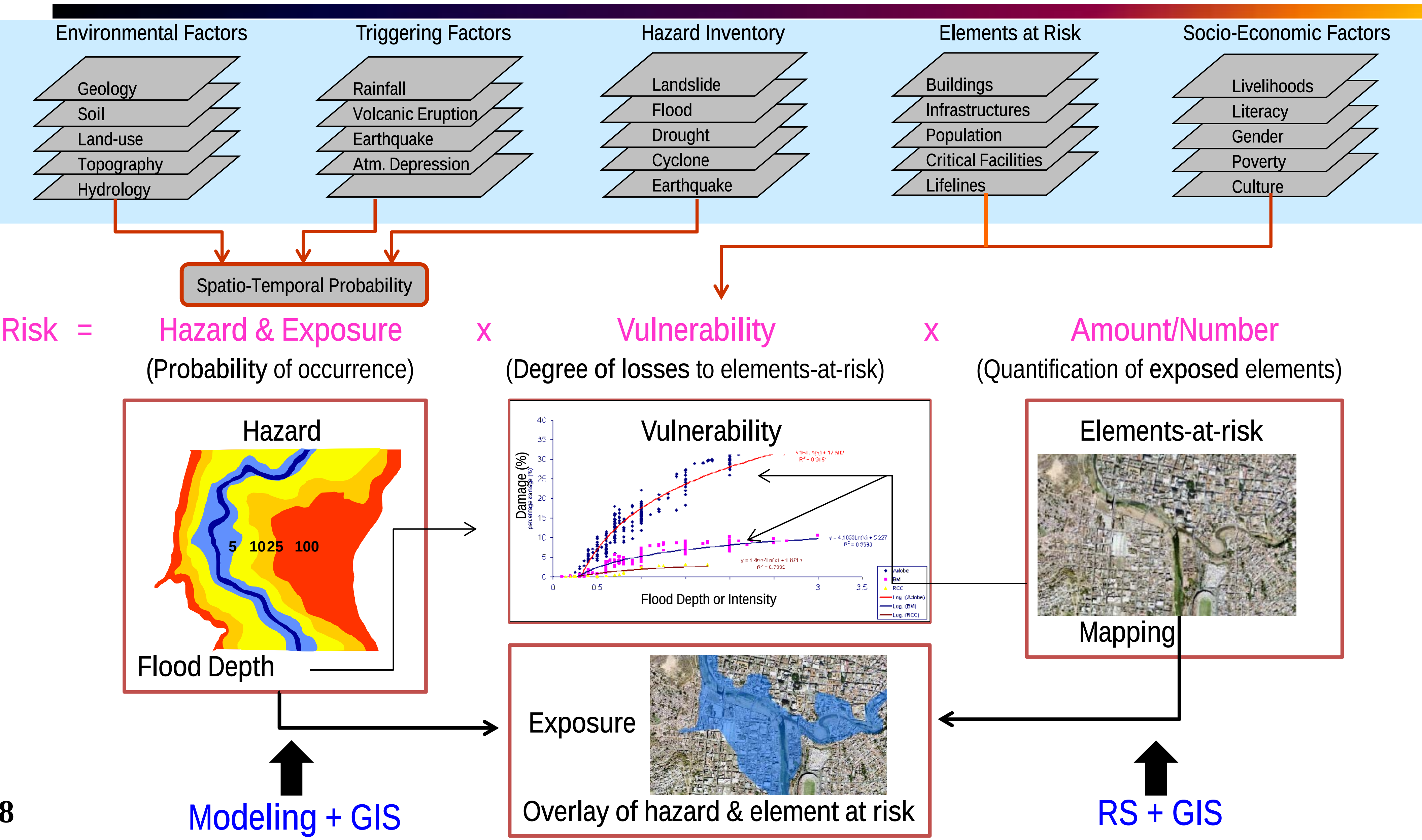
Risk expressed in terms of high, moderate and low.

(i) Quantitative Method - Defining the 'Risk'



Risk = Hazard & Exposure x Vulnerability x Amount

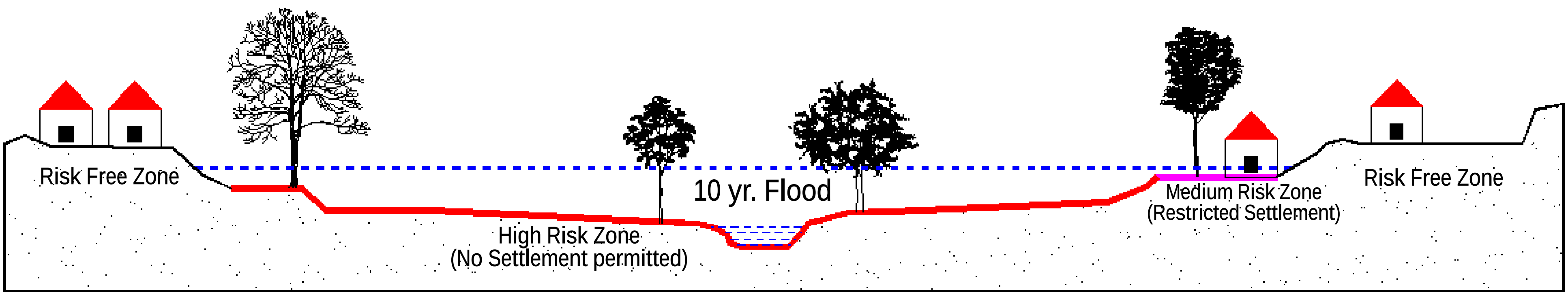
Spatial Representation of the Risk



Quantitative Risk - Deterministic (Scenario-based)

What is the cost for risk zoning and relocation?

What is the insurance premium in different risk zones?



Risk	= Hazard	x Vulnerability	x Amount (Asset)	
$Risk_{Lt}$	= 0.1	x 0.5	x 100,000	= 5,000 US$
$Risk_{Mid}$	= 0.1	x 1.0	x 100,000	= 10,000 US$
$Risk_{Rt}$	= 0.1	x 0.2	x 100,000	= 2,000 US$
$Risk_{Total}$				= 17,000 US$

Quantitative Risk - Deterministic (Scenario-based)

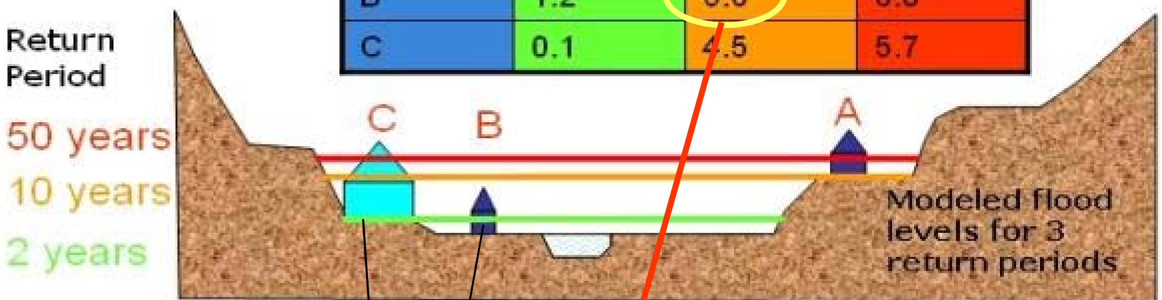
It is worth to note that scenario-based approach tend to drift towards “known” and experienced risks, often leading to an underestimation of actual risk.

Quantitative Risk – Probabilistic

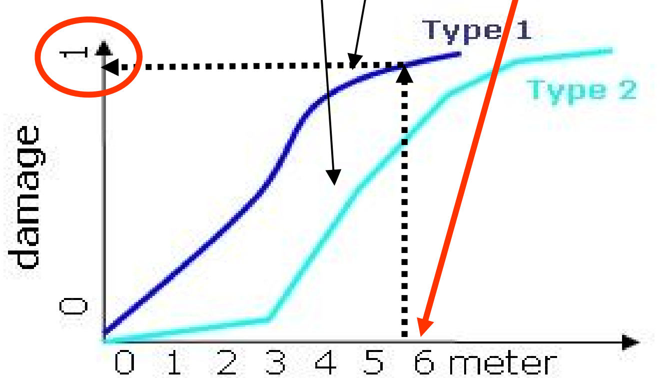
Hazard

Water depth per return period

House	2 years	10 years	50 years
A	0	0.8	2.0
B	1.2	5.6	6.8
C	0.1	4.5	5.7



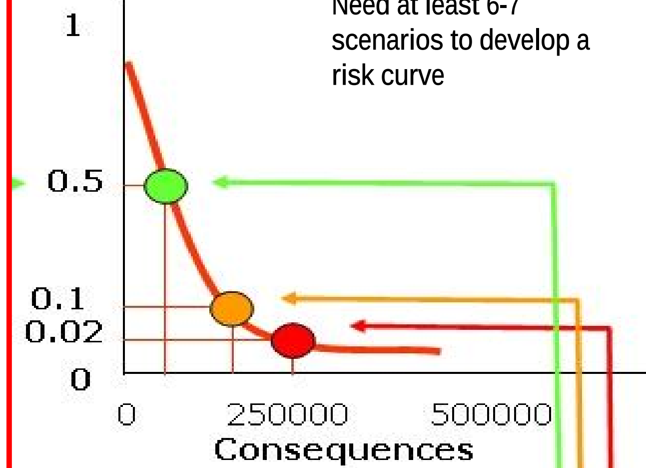
Vulnerability curve



	RP	PT	A	V	V*A	ΣV*A
A	2	0.5	100000	0	0	20000
B	2	0.5	50000	0.2	10000	
C	2	0.5	200000	0.05	10000	
A	10	0.1	100000	0.1	10000	160000
B	10	0.1	50000	1	50000	
C	10	0.1	200000	0.5	100000	
A	50	0.02	100000	0.4	40000	250000
B	50	0.02	50000	1	50000	
C	50	0.02	200000	0.8	160000	

Risk curve

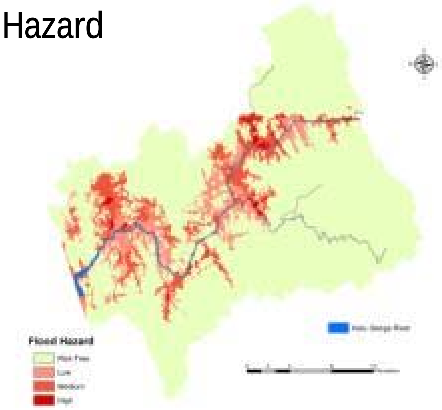
Need at least 6-7 scenarios to develop a risk curve



Courtesy: ITC

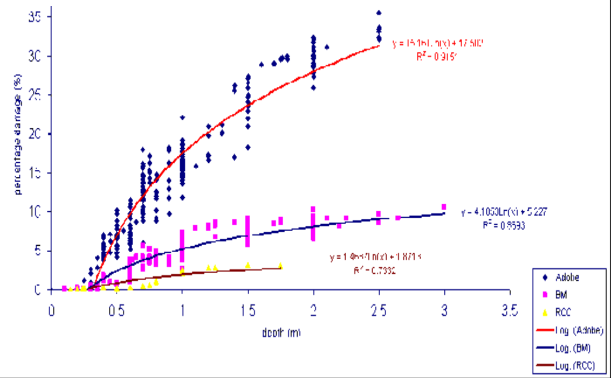
Quantitative Risk Map for Flood in Sri Lanka

Hazard



X

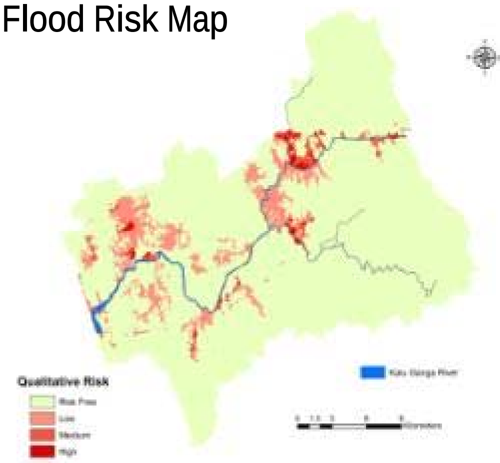
Quantitative Vulnerability



X

Amount of loss for various types of buildings

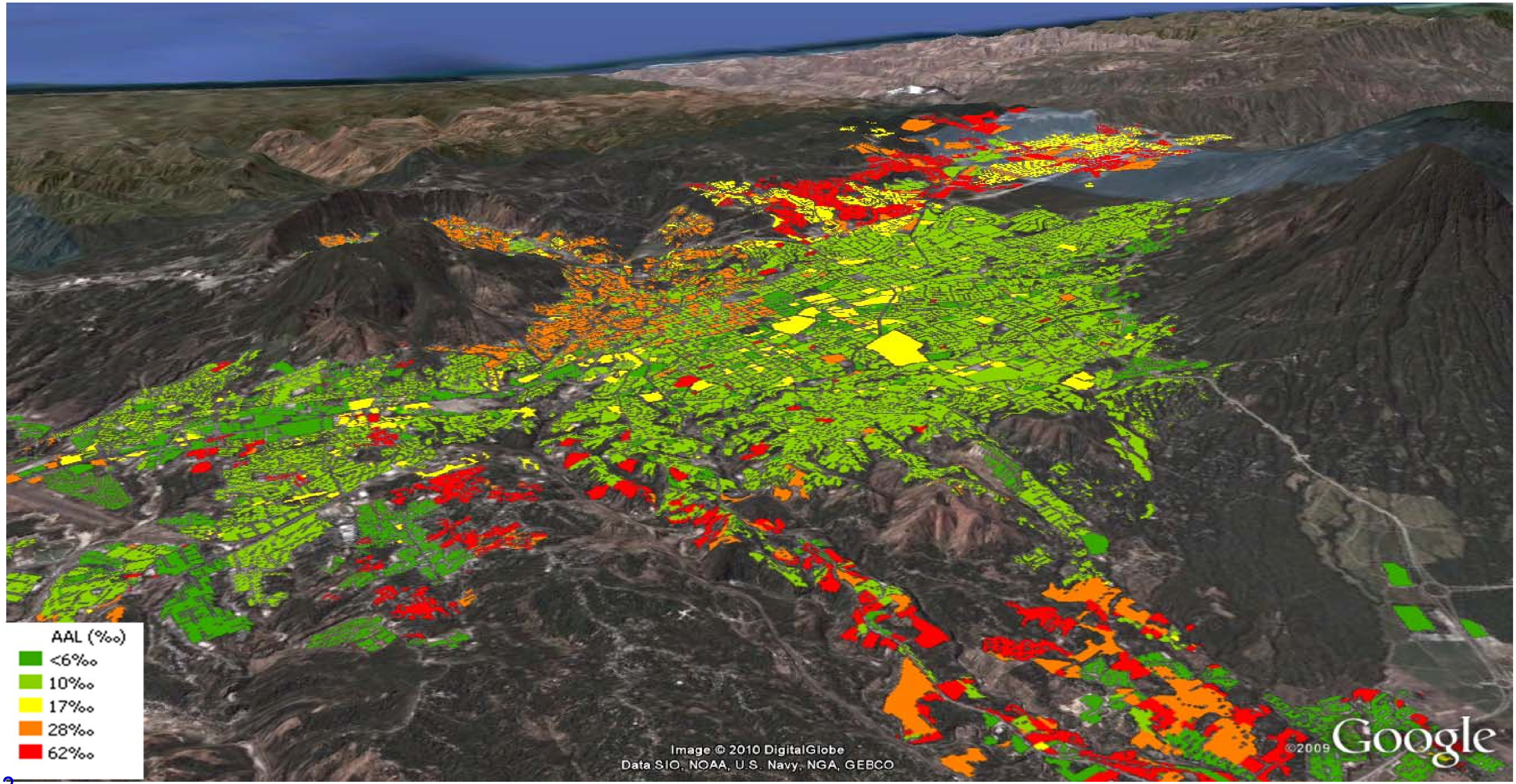
Flood Risk Map



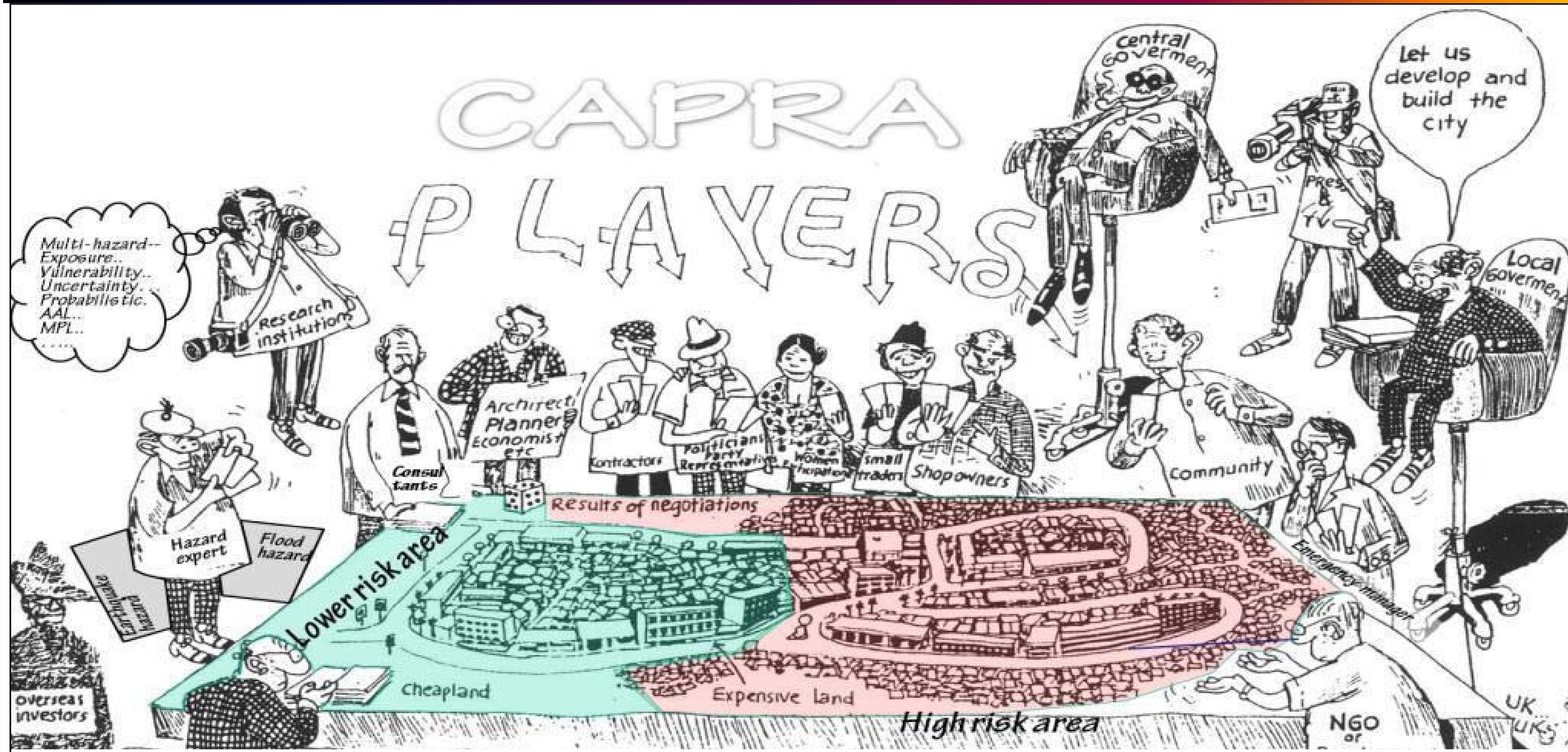
Results for El Salvador

San Salvador multi-hazard risk

Annual average loss (relative). Probabilistic analysis (earthquake and hurricane)



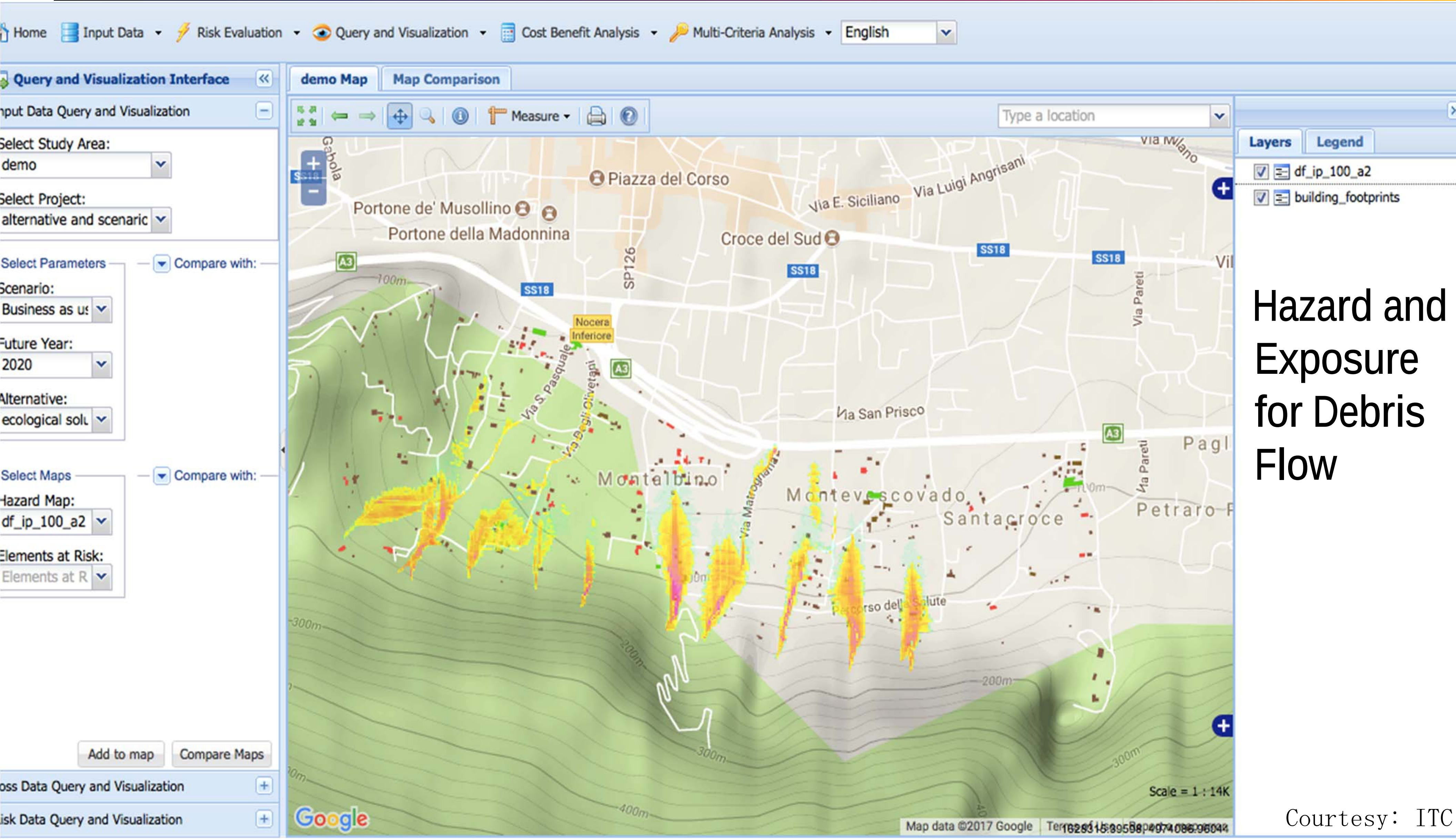
Probabilistic Risk Assessment Initiative – CAPRA (WB)



CAPRA Features (www.ecapra.org)

- Multi-hazard (Six Hazards - Earthquake, Flood, Hurricane, Landslide, Tsunami and Volcano)
- Probabilistic approach with possibility of integrating Climate Change information
- Informed decision making on basis of scientific risk assessment

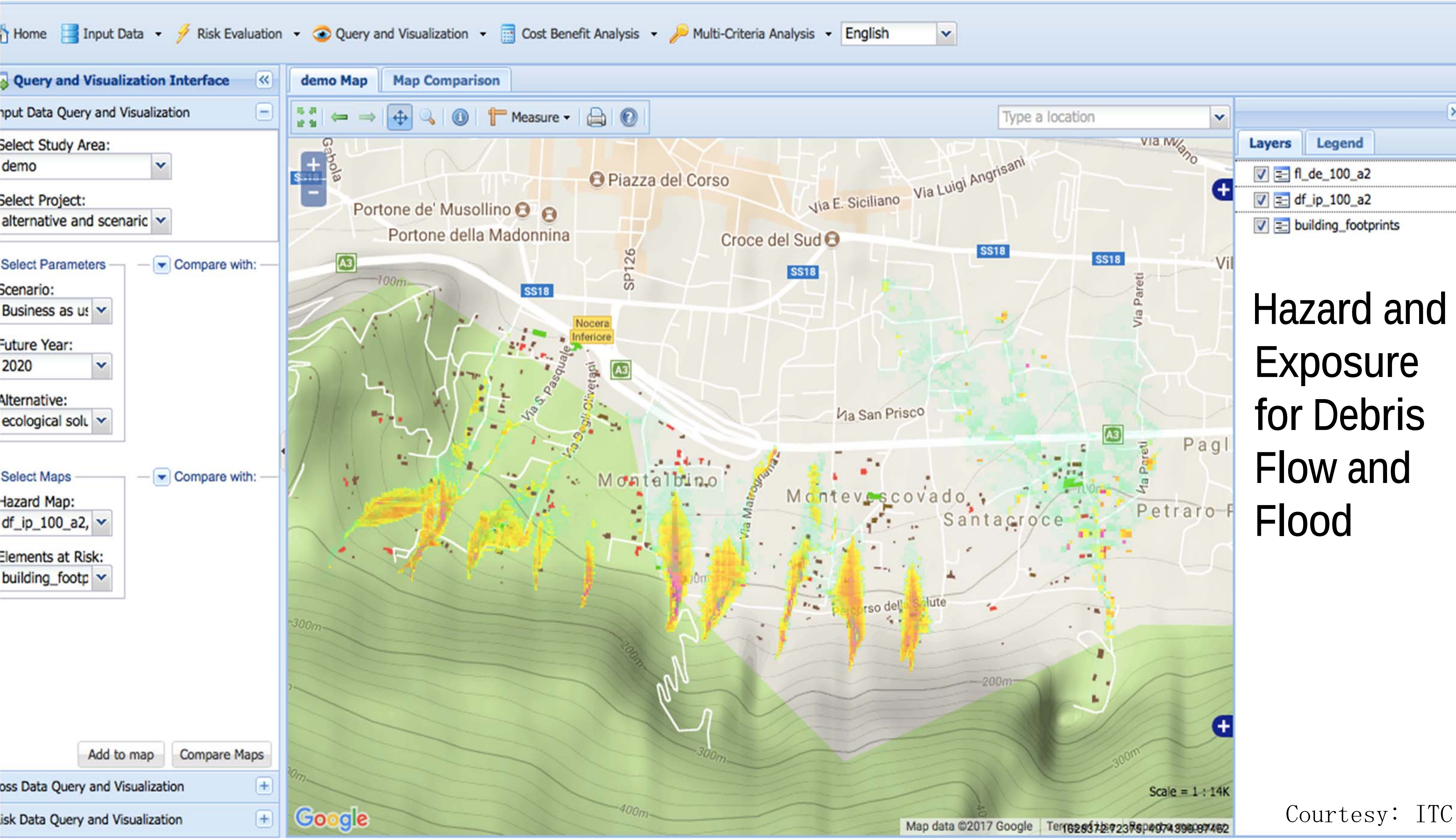
Probabilistic Risk Assessment Initiative - RISK CHANGES



Hazard and Exposure for Debris Flow

Courtesy: ITC

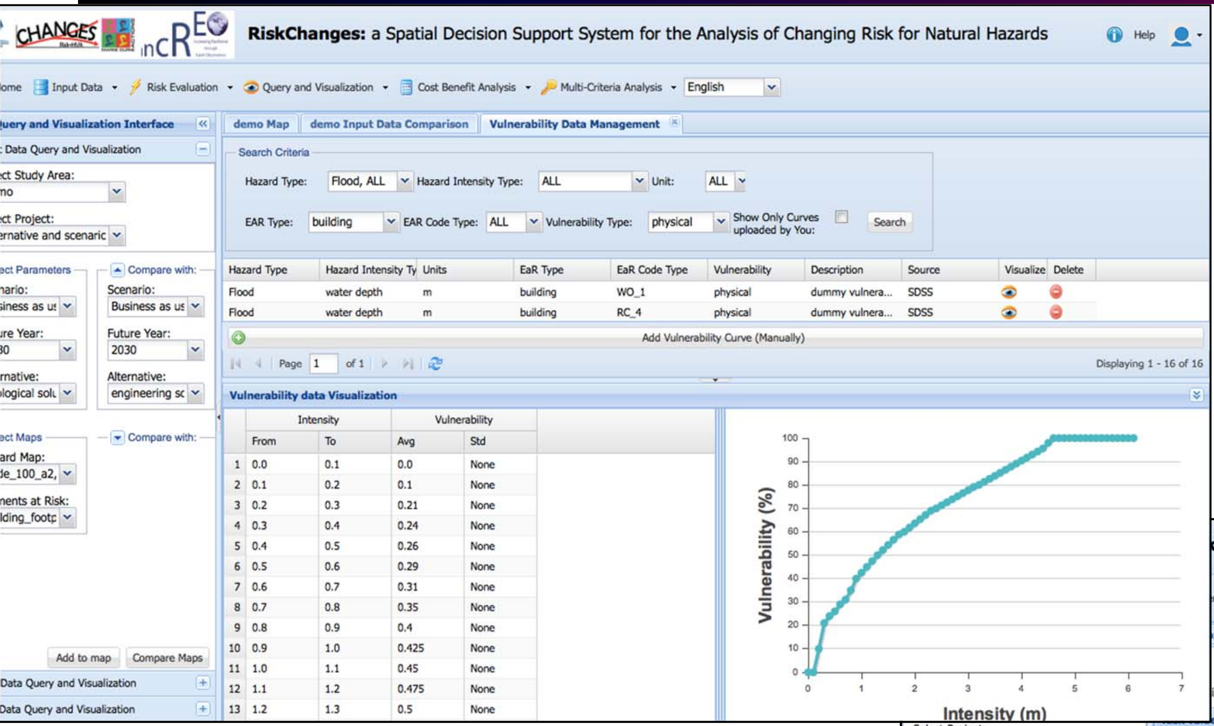
Probabilistic Risk Assessment Initiative - RISK CHANGES



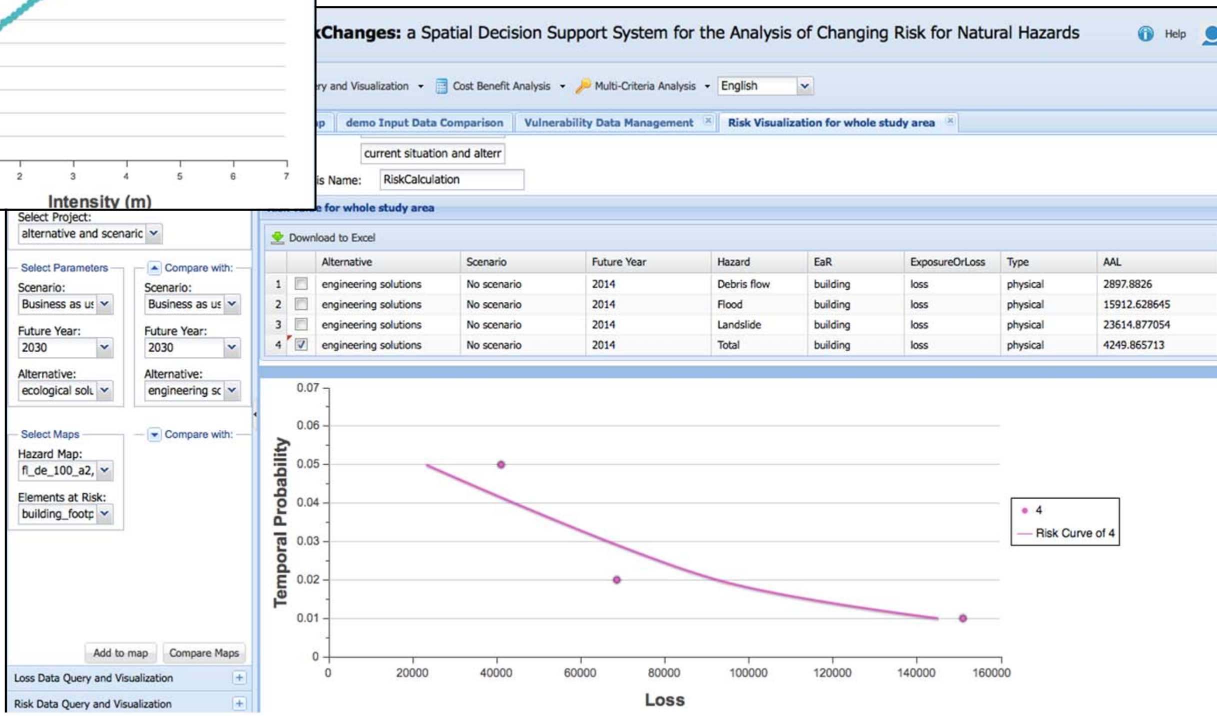
Hazard and Exposure for Debris Flow and Flood

Courtesy: ITC

Probabilistic Risk Assessment Initiative - RISK CHANGES

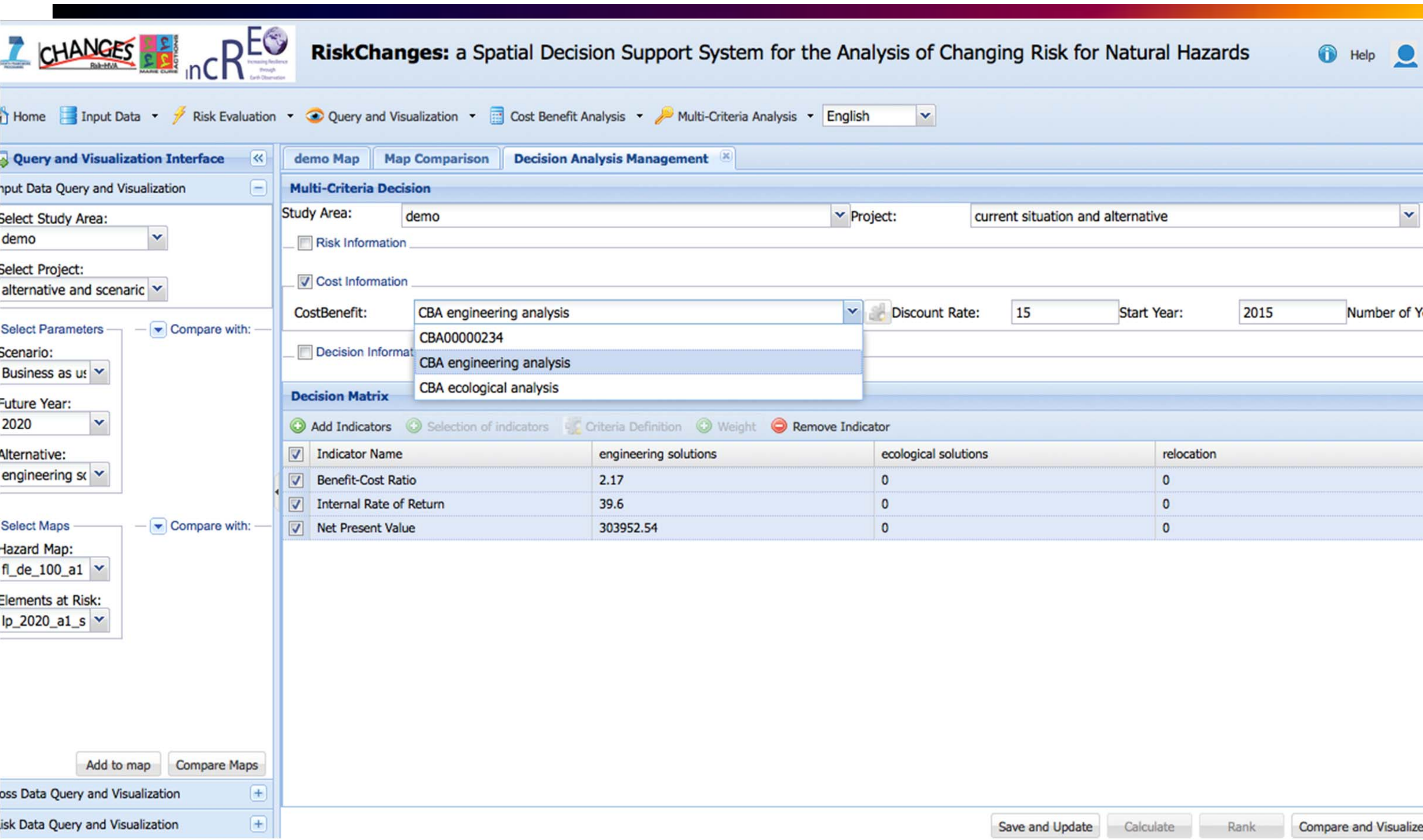


Vulnerability Curves for Flood

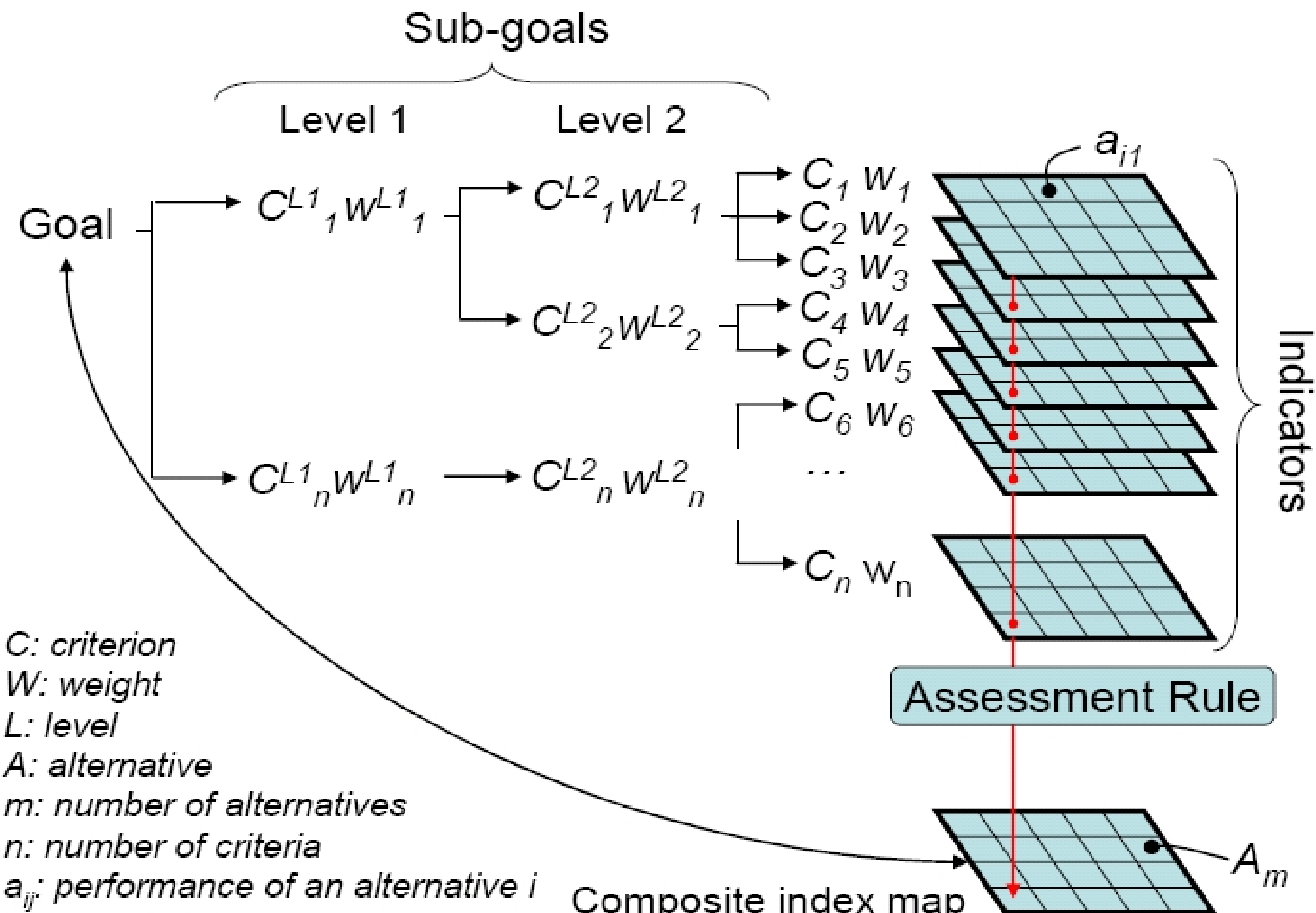


Risk Curves

Probabilistic Risk Assessment Initiative - RISK CHANGES



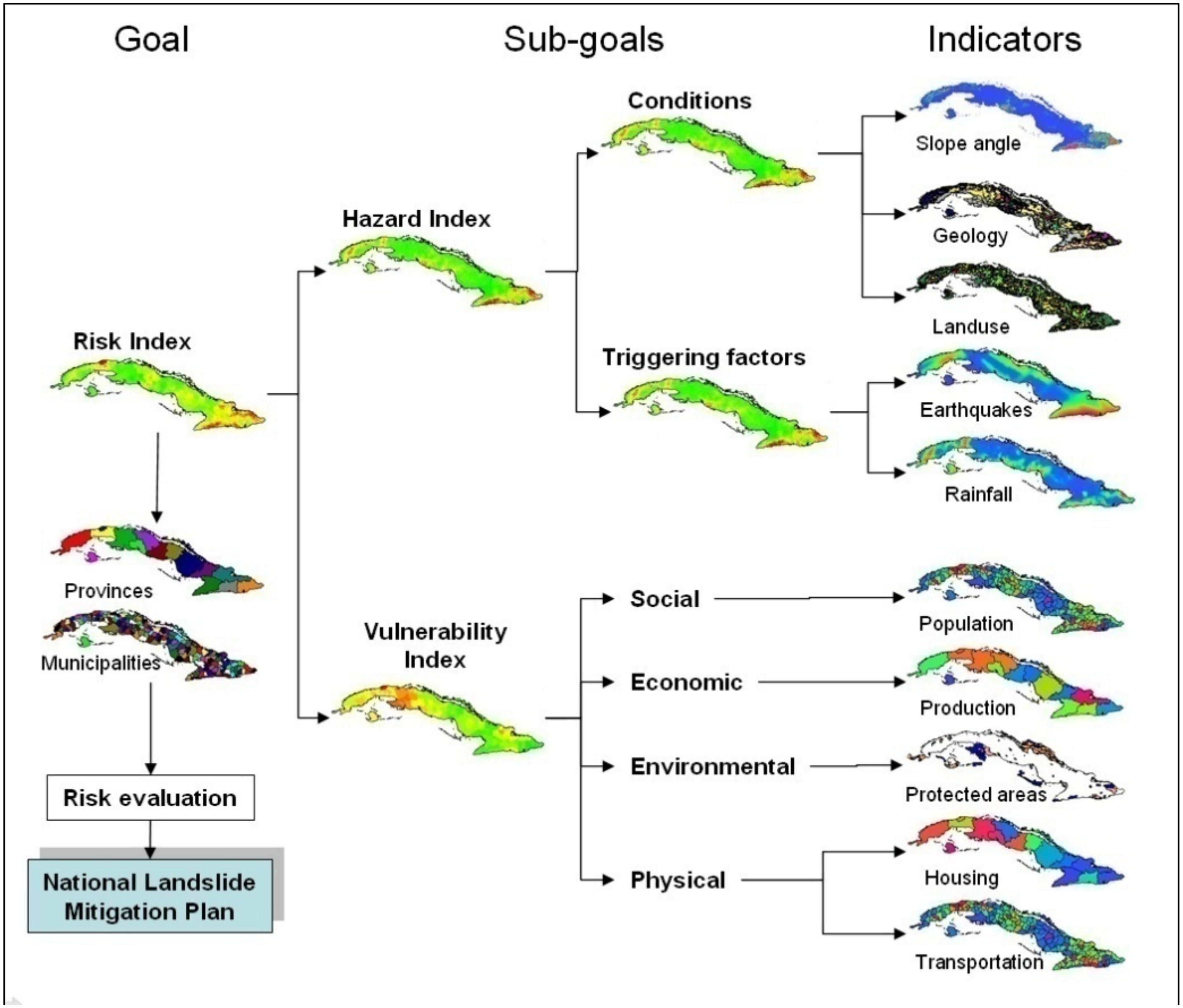
Qualitative Risk – Spatial Multi-Criteria Analysis



C: criterion
W: weight
L: level
A: alternative
m: number of alternatives
n: number of criteria
a_{ij}: performance of an alternative i and a criterion i

Courtesy: ITC

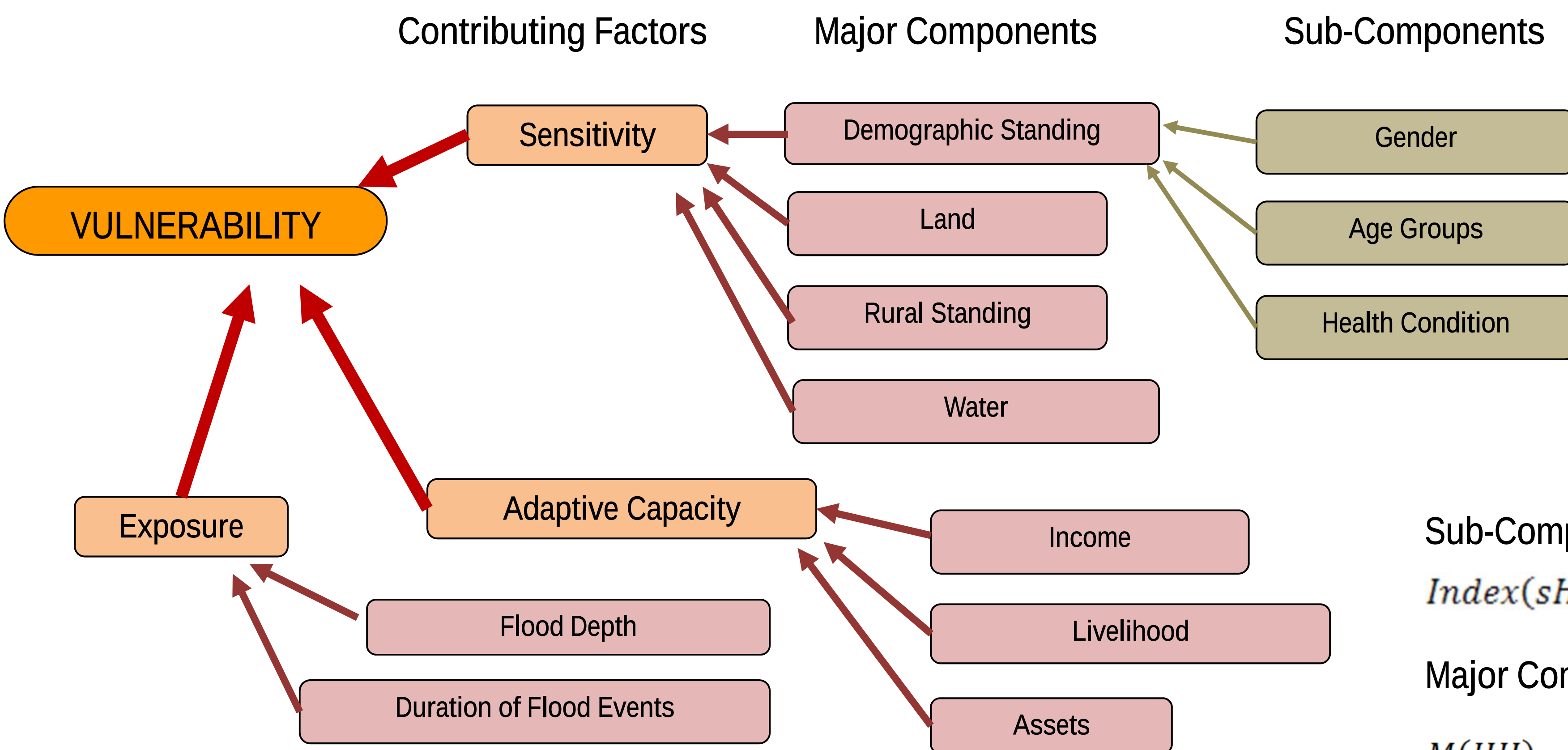
Probabilistic Risk Assessment Initiative - RISK CHANGES



Qualitative Risk – Spatial Multi-Criteria Analysis

Courtesy: ITC

Regrouping of Socio-Economic Indicators for Qualitative Risk Assessment



Sub-Components

$$Index(sHH) = \frac{Shh - Smin}{Smax - Smin}$$

Major Components

$$M(HH) = \frac{\sum_{i=1}^{n} Index(sHH)i}{n}$$

Contributing Factors

$$CF(HH) = \frac{\sum_{i=1}^{n} Wi\ M(HH)i}{\sum_{i=1}^{n} Wi}$$

Exposure: Intensity (depth) and duration of flood events

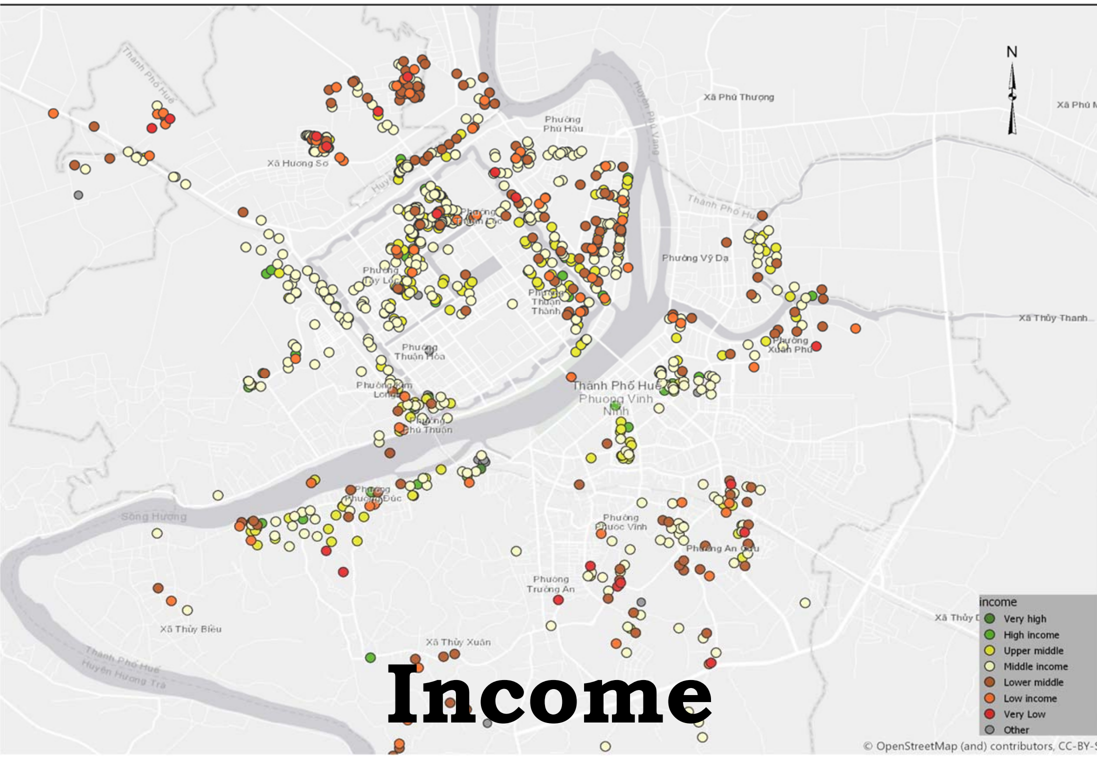
Adaptive Capacity: Community'd ability to withstand or recover from flood events

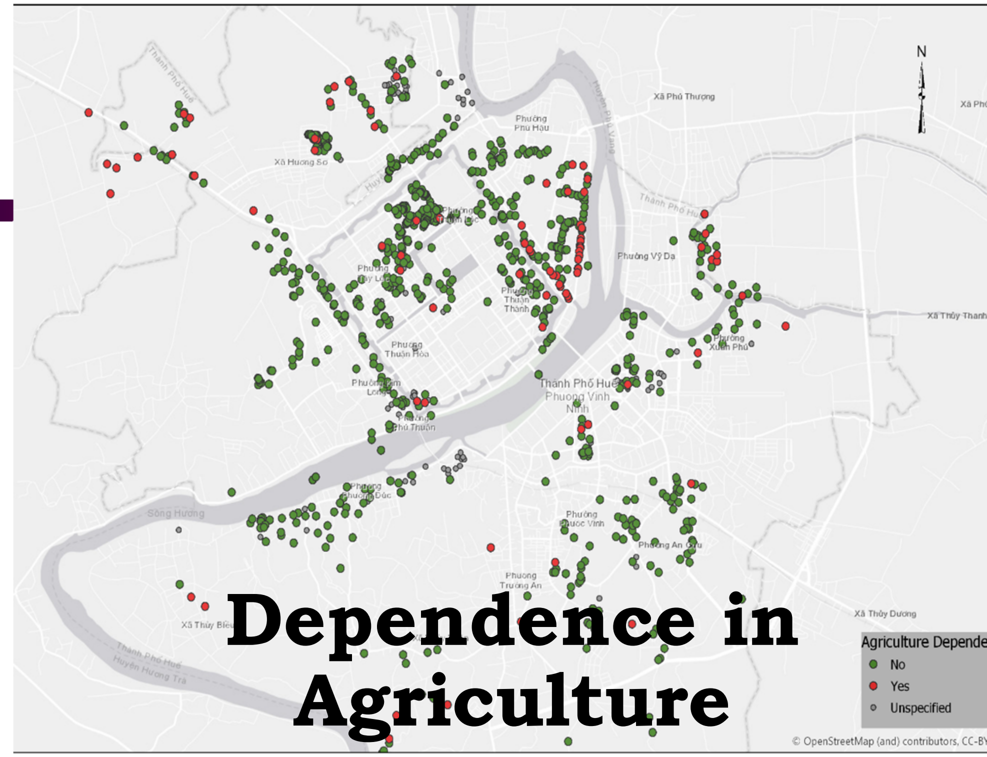
Sensitivity: Degree to which the community is affected by flood events.

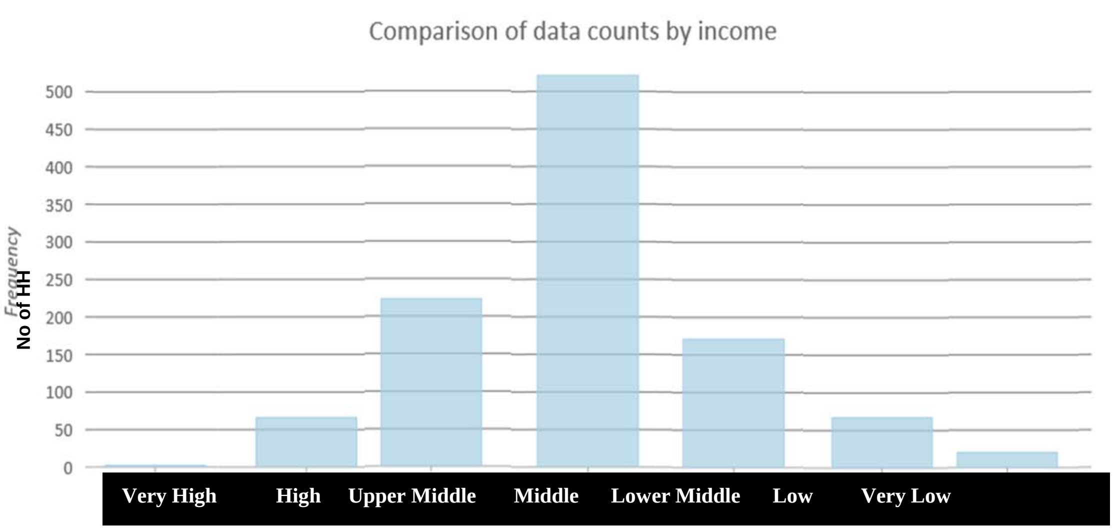
Hanh et al., 2009

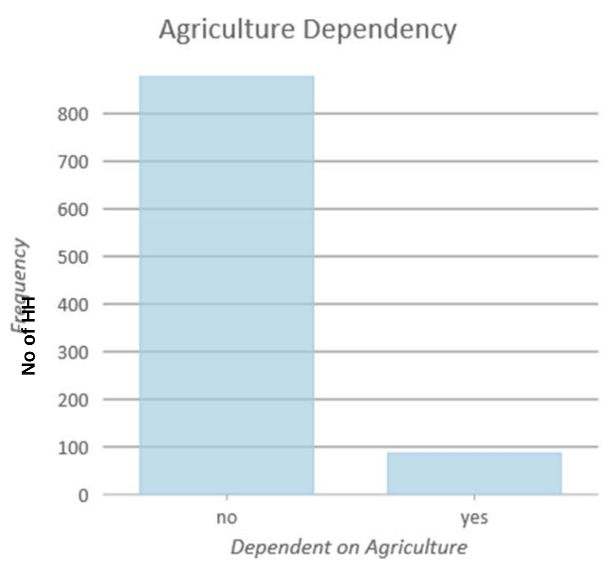
Field Data Collection for Qualitative Vulnerability Assessment

Contributing Factor	Major Components	Sub-Components
Sensitivity (S)	Demographic standing	Gender, Age, Health
	Rural standing	Accessibility, proximity to market
	Water	Well, bore-well, tap water
	Land	Ownership, size, land-use
Adaptive Capacity (A)	Income	Amount, sources
	Assets	House types/size, vehicle
	Livelihoods	Agriculture, business, jobs
Exposure (E)	Past flood events	Flood frequency, flood depth


Income
N
income
Very high
High income
Upper middle
Middle income
Lower middle
Low income
Very Low
Other
© OpenStreetMap (and) contributors, CC-BY-S

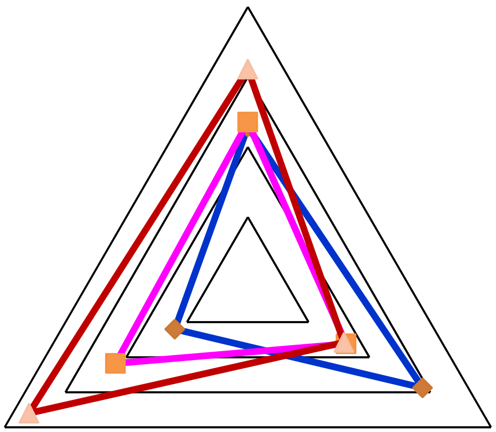

Dependence in Agriculture
N
Agriculture Depende
No
Yes
Unspecified


Comparison of data counts by income
500
450
400
350
300
250
200
150
100
50
0
Frequency
No of HH
Very High
High
Upper Middle
Middle
Lower Middle
Low
Very Low

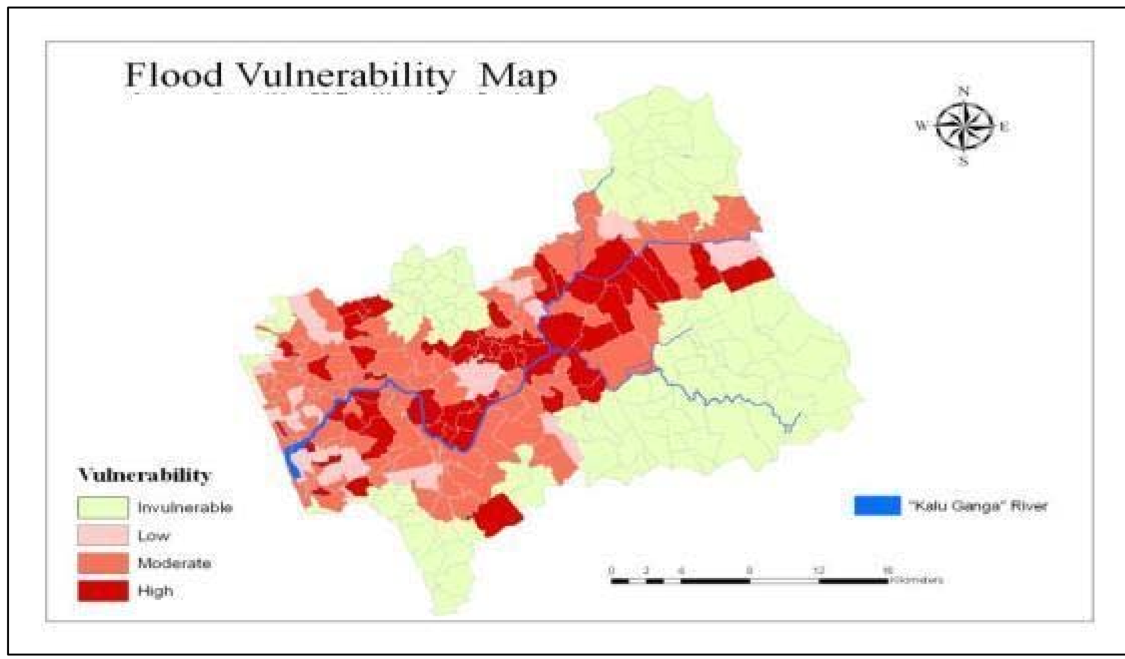

Agriculture Dependency
800
700
600
500
400
300
200
100
0
Frequency
No of HH
no
yes
Dependent on Agriculture

Example - Qualitative Vulnerability Analysis Using Socio-Economic Indicators

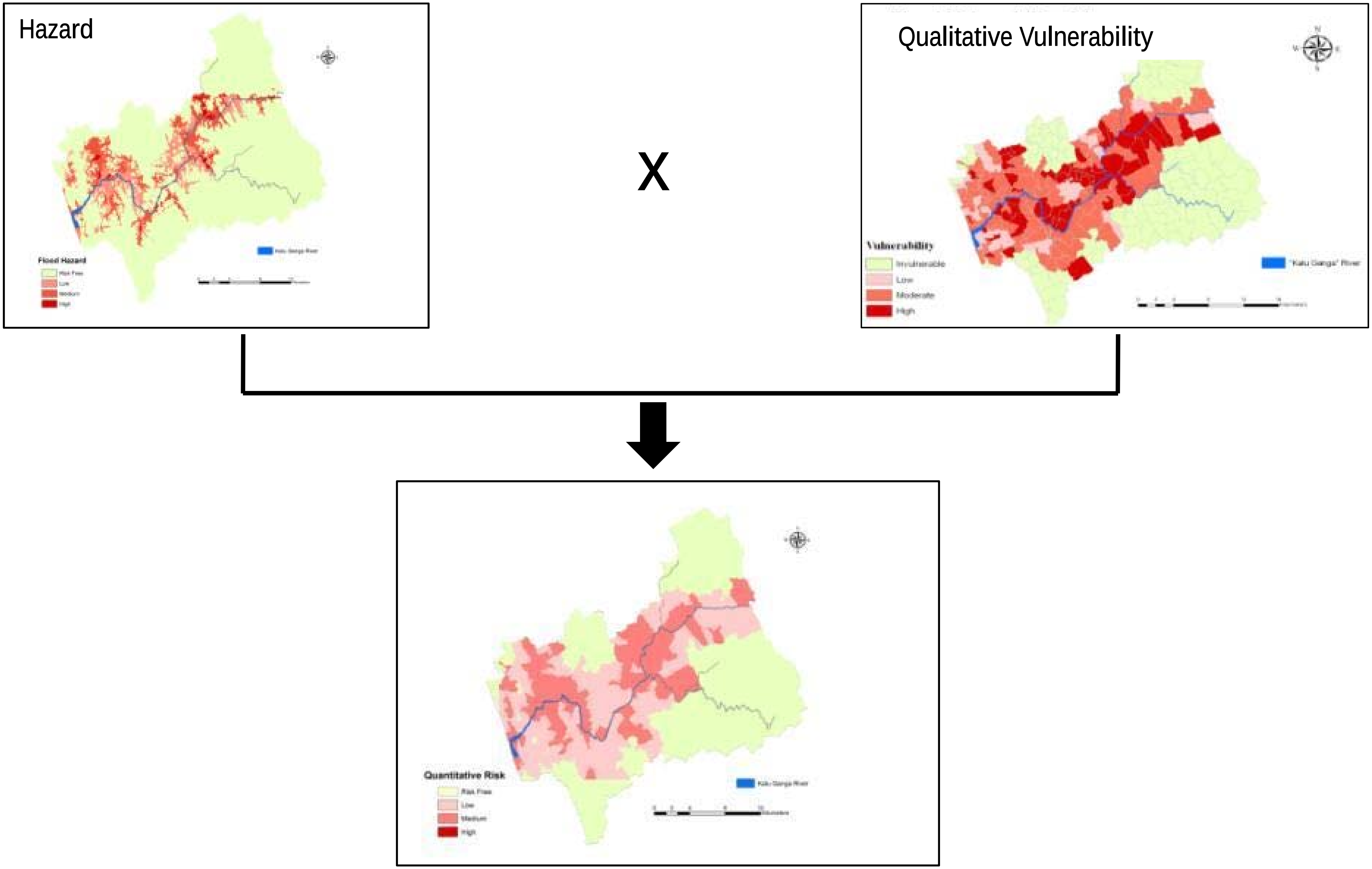
$$VI = [E(HH) - A(HH)] \times S(HH)$$



Flood Vulnerability Index	Sensitivity (S)	Adaptive Capacity (A)	Exposure (E)
FVI=0.1481	0.4575	0.5749	0.2402
FVI=0.5047	0.4711	0.3235	0.4355
FVI=0.8490	0.6222	0.3158	0.7201



Example of Qualitative Risk (Socio-Economic) Map and its Use



Selecting a Risk Analysis Methodology

Selecting an analysis methodology depends on:

1. Quality of the methodology and its appropriateness for the purpose it should serve.
2. Resources it requires: technical (including data, tools and expertise), financial and time.
3. Significance of the risk and level of investment for managing the risk.

For example, **probabilistic modelling**, can provide a comprehensive view of hazard, risk and uncertainties to the design of high-cost structural disaster risk reduction measures.

Thank you for your kind attention