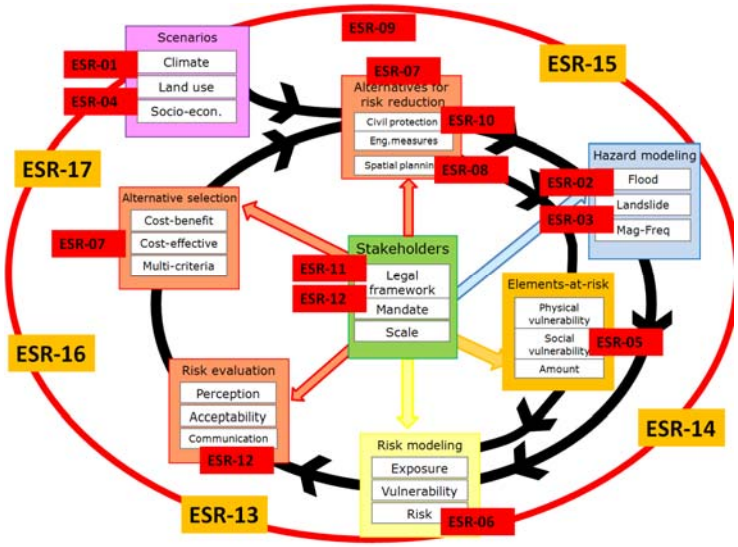
DESIGN OF SPATIAL DECISION SUPPORT SYSTEM FOR ANALYZING CHANGES IN HYDRO-METEOROLOGICAL RISK

Cees Van Westen (ITC)

Zar Chi Aye (ESR-09, UNIL)

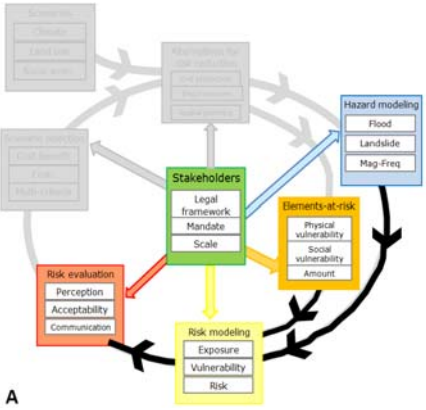
INTRODUCTION



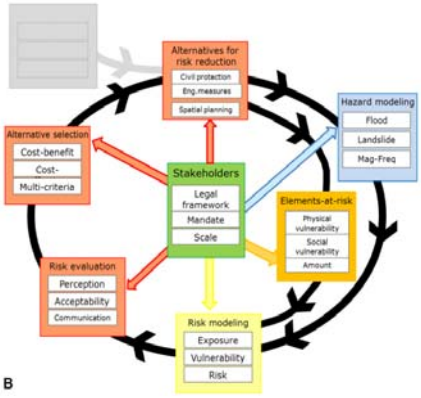
Main aspects

- To develop an open-source tool that is:
  - Generic
  - Scale independent
  - Allows different types of hazard. On the other hand, it also hazard independent.
  - Allows different types of risk analysis
  - Allows to compare alternatives for risk reduction
  - Allows to compare future scenarios

Use of the system (1,2)

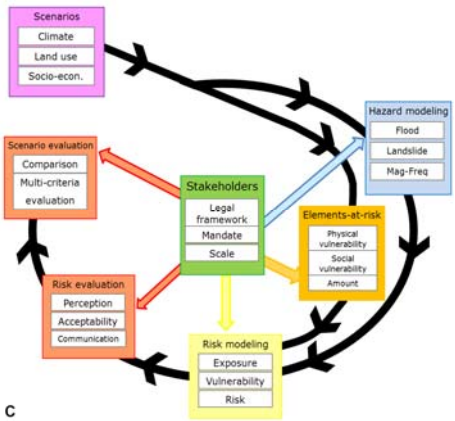


Analyzing the current level of risk



Analyzing the best alternatives for risk reduction

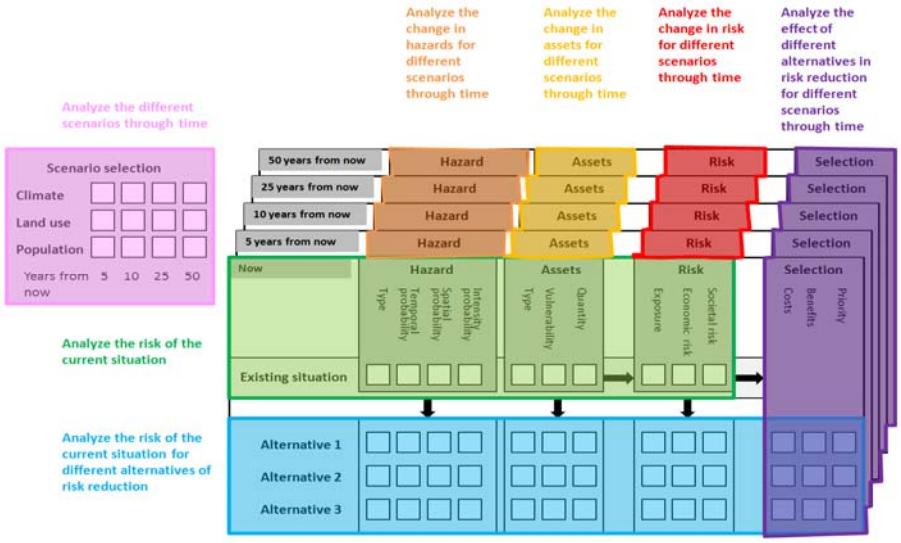
Use of the system (3,4)

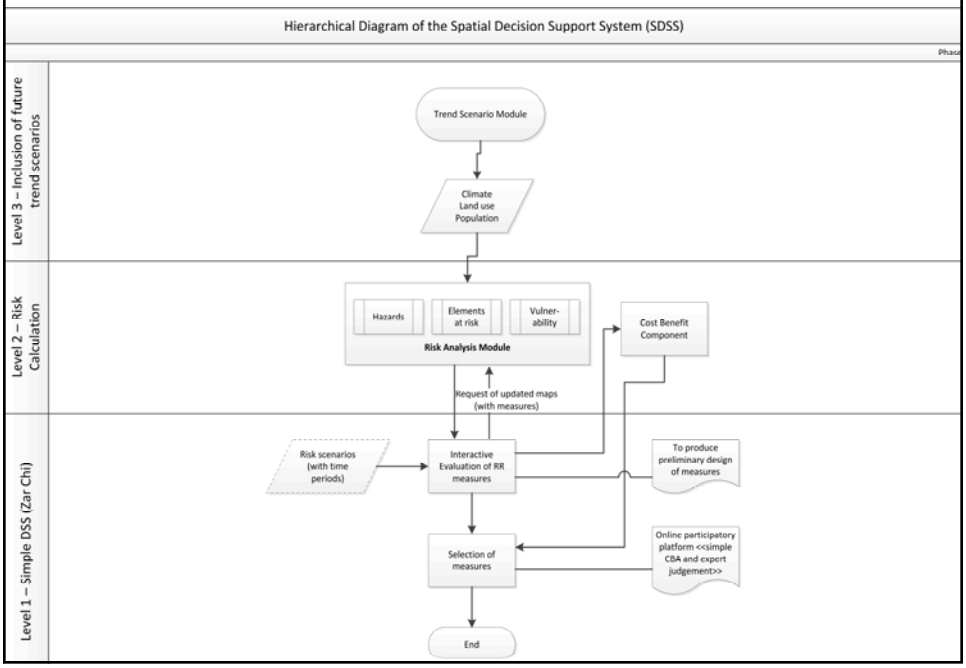


Evaluation of the consequences of scenarios to the risk levels

Evaluation of different risk reduction alternatives under future scenarios

Cube visualization of analysis



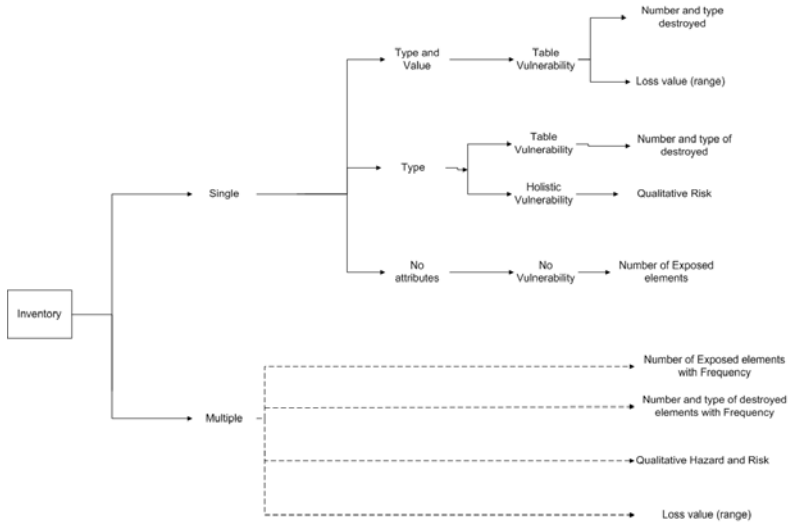


RISK ANALYSIS

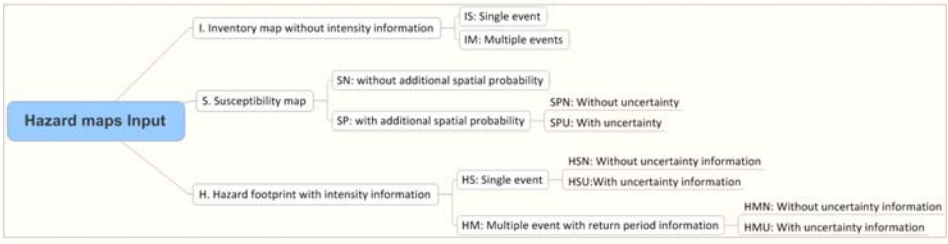
Type of risk analysis

- Number of EaR exposed
- Number of EaR destroyed
- Risk curve
  - With uncertainty
  - Without uncertainty
- Qualitative risk index

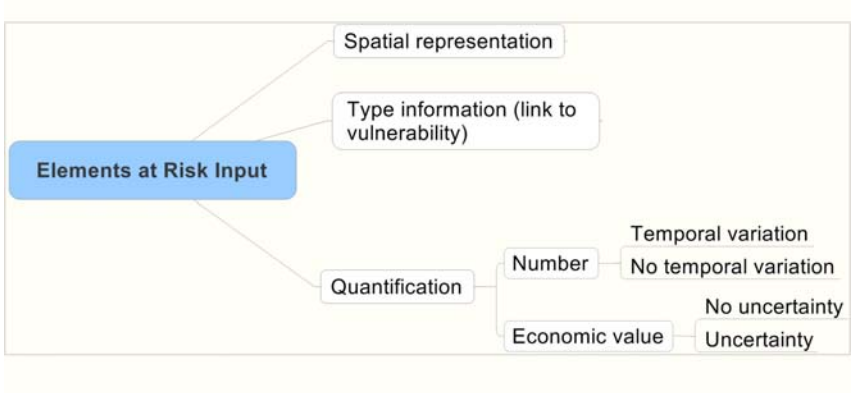
Mapping Tree (table)



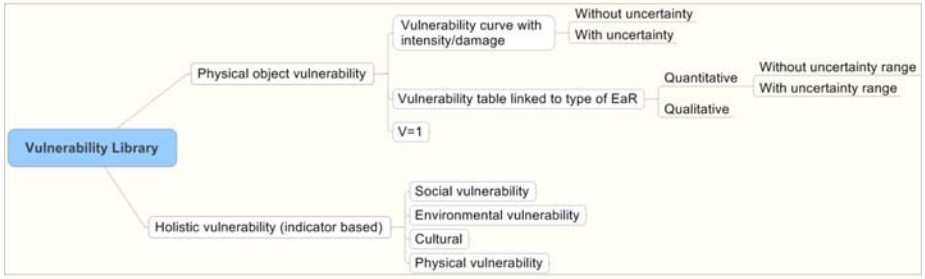
Hazards

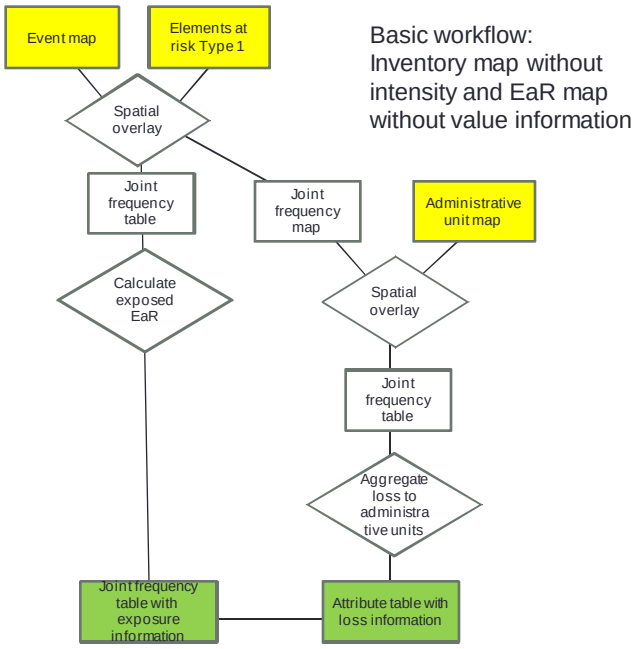


Elements at Risk

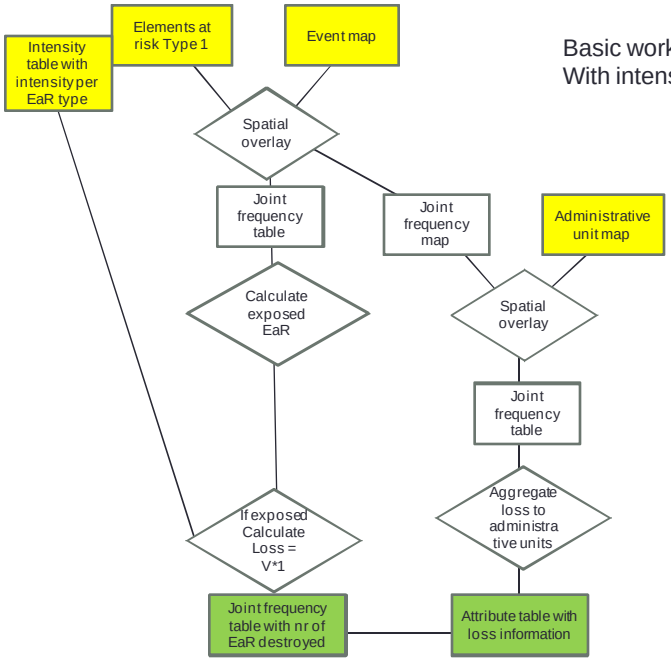


Vulnerability data

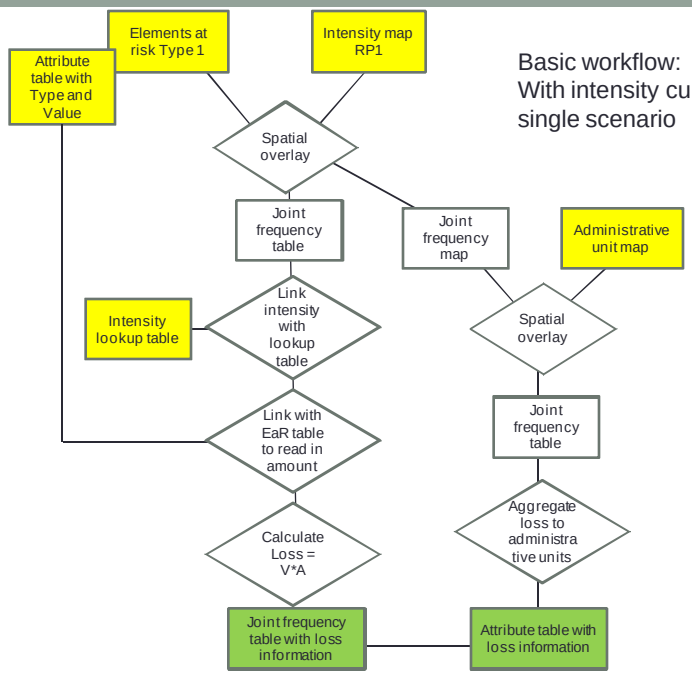




Basic workflow:
Inventory map without intensity and EaR map without value information

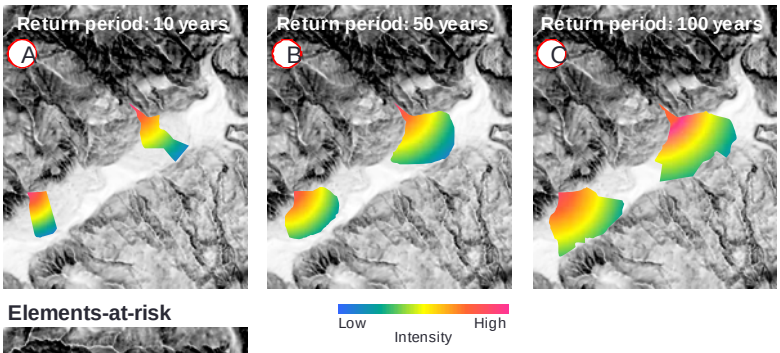


Basic workflow:
With intensity tables

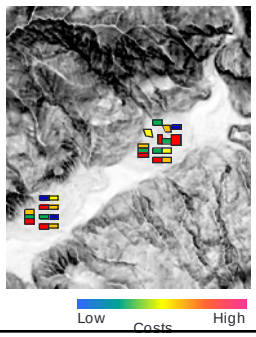


Basic workflow:
With intensity curves:
single scenario

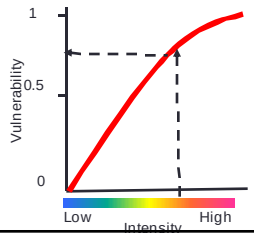
Hazard scenarios



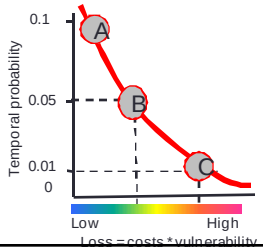
Elements-at-risk

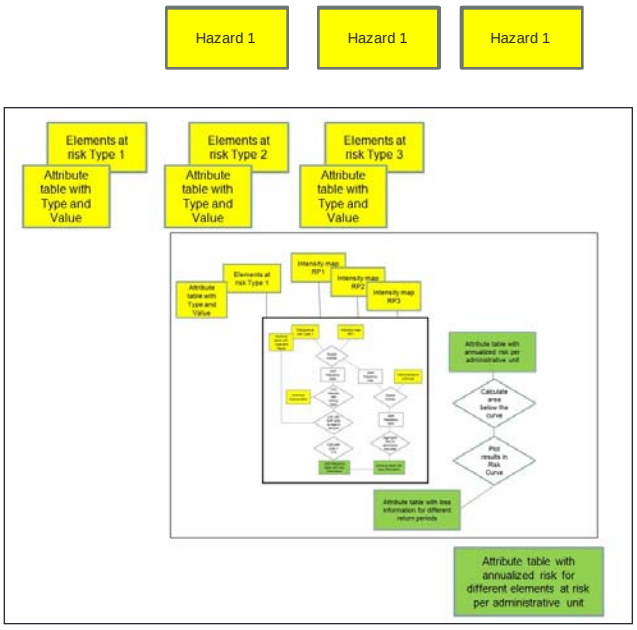


Vulnerability



Risk curve





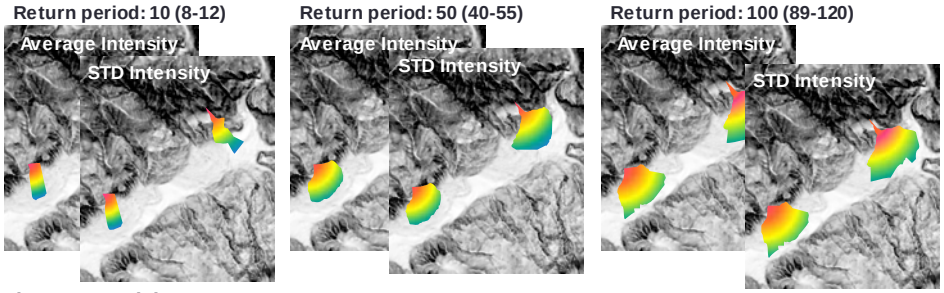
Basic workflow:
With intensity curves:
Different hazards
Multiple scenarios
Multiple elements at risk

Matrix showing losses for the hazards versus elements at risk

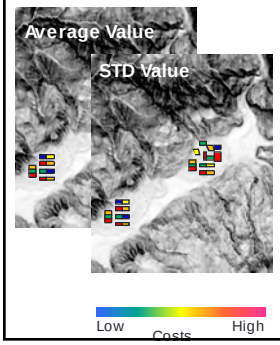
Attribute table with annualized risk for different hazards and elements at risk per administrative unit

Risk curves for different hazards and different elements at risk per administrative unit

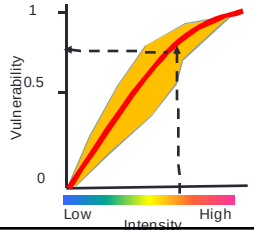
Hazard scenarios



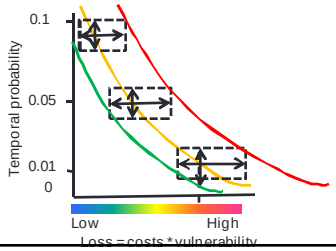
Elements-at-risk

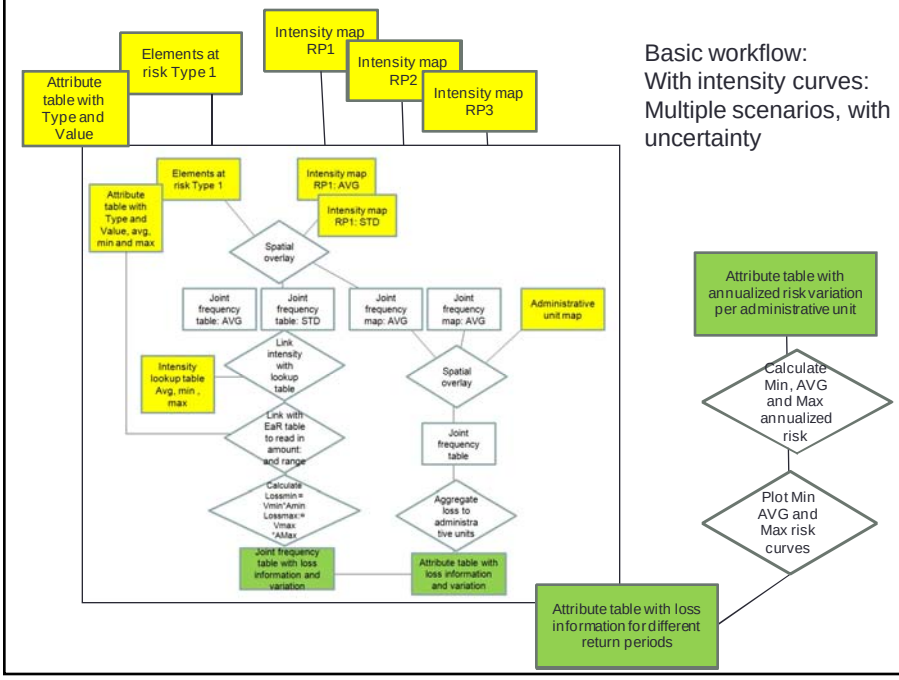


Vulnerability with uncertainty



Risk curves: minimum, avergae and maximum





Basic workflow:
With intensity curves:
Multiple scenarios, with uncertainty

DECISION MAKING

Definitions

- Alternatives:

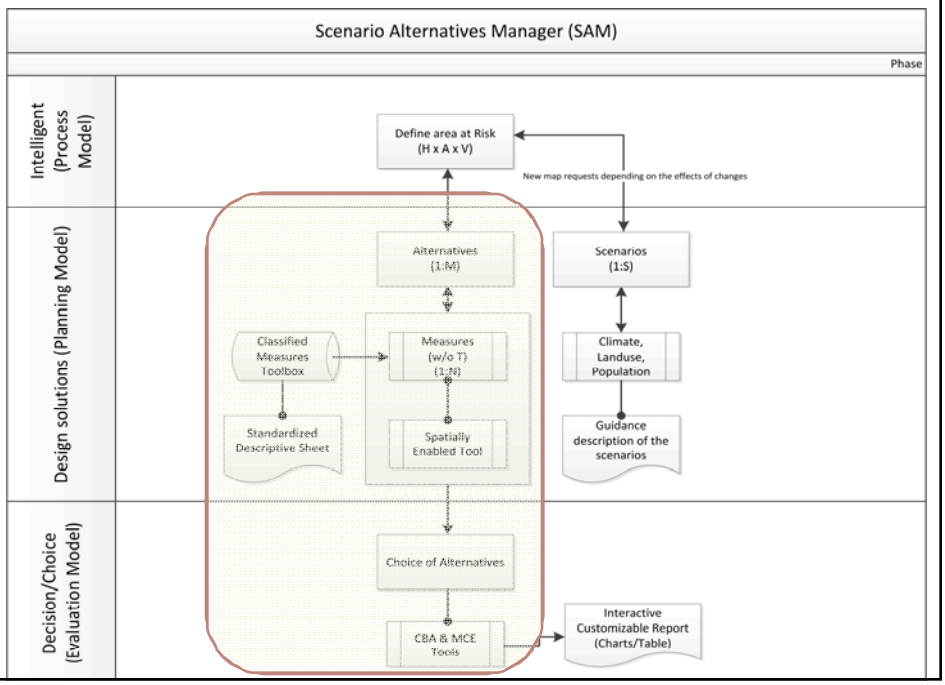
  "A design of measures (nested choices of measures)"

- Measures:

  "Structural or non-structural measures"

- Scenarios:

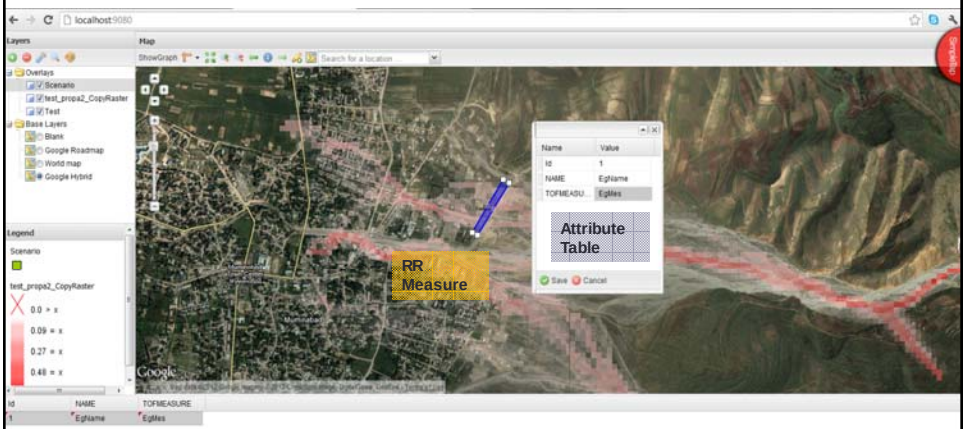
  "External influences which are beyond control"



Toolbox of measures

	Applicable?	Prevention (hazards)	Adaptation (assets)	Cost-Benefits	Example(s)
Structural					
1. ….					
2. ….					
3. ….					
…					
Non-structural					
1. …					
2. …					
3. …					
…					

Spatially enable tool



- Name of alternatives
  - Type of Measures
- No. of people/infrastructures (exposed/reduced)
- Damage cost
- CBA ratio

List of updated maps (for measures considered)
- Hazards?
- Assets?

Link with risk analysis module

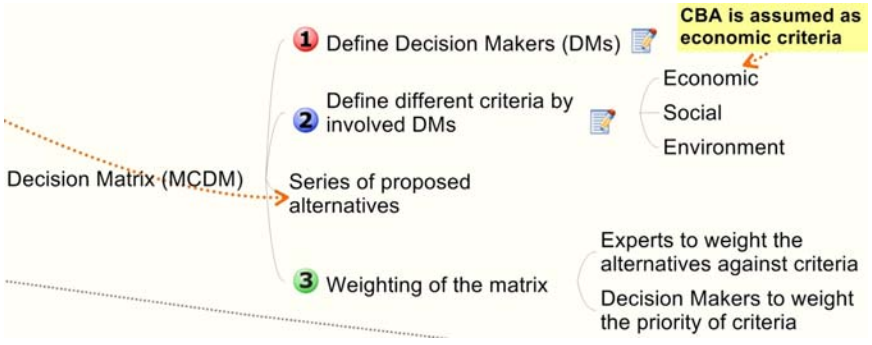
(simple) CBA for each RR scenarios

Cost Benefit Component

- Level 1:
  "Simple CBA with estimated (expert information)"
- Level 2 & 3:
  "Detailed CBA with complete information"

		CRITERIA			
ALTERNATIVES / SCENARIOS	PROBABILITY	COST (€)	CASUALTIES	BENEFITS	...
	0.1%	-RANGE-	...	...	
	5%	....	...	....	
	20%				

Multi-criteria Evaluation Tool

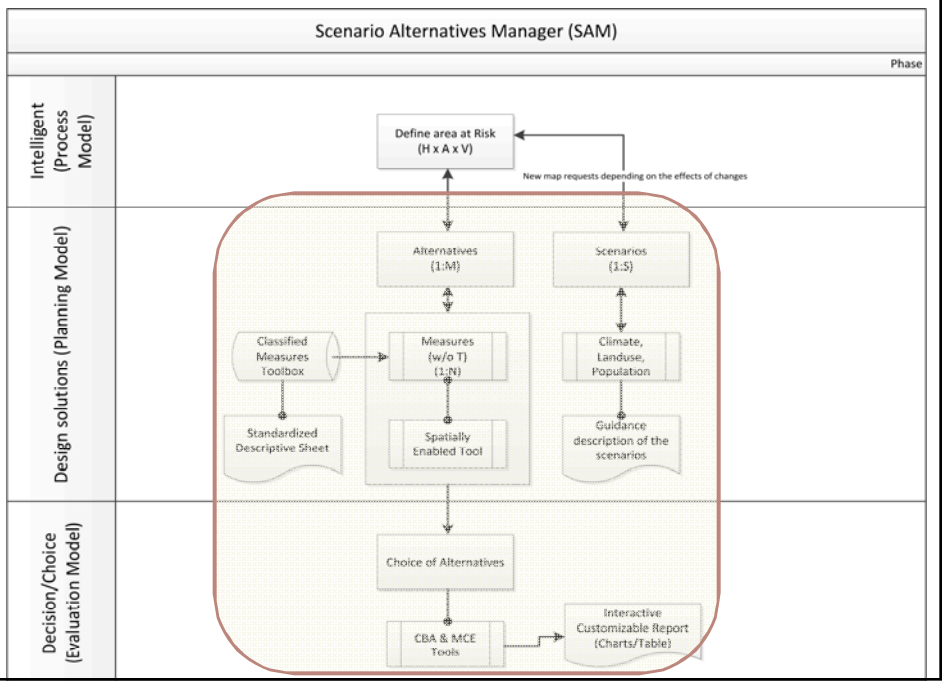


Decision Matrix

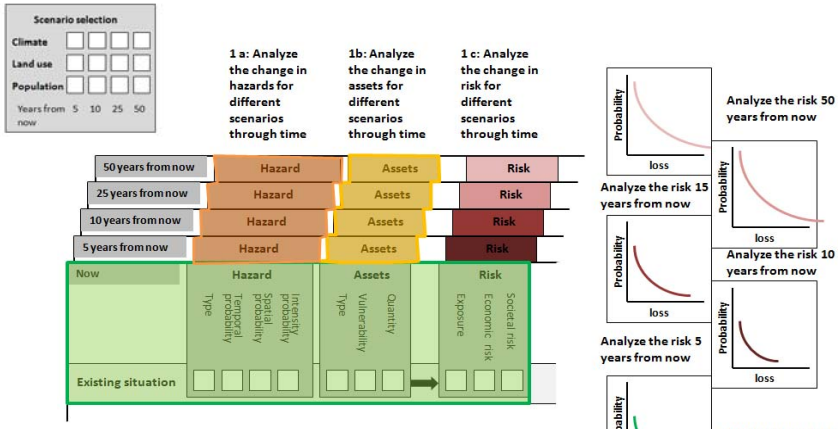
Criteria	Economic	Social	Environmental
Alternatives	1. … 2. … 3. …	4. … 5. … 6. …	7. … 8. … 9. …
I. …….			
II. …….			
III. …….			
IV. …….			

- Criteria and preferences to be defined by stakeholders
- Decision matrix to be prepared by experts

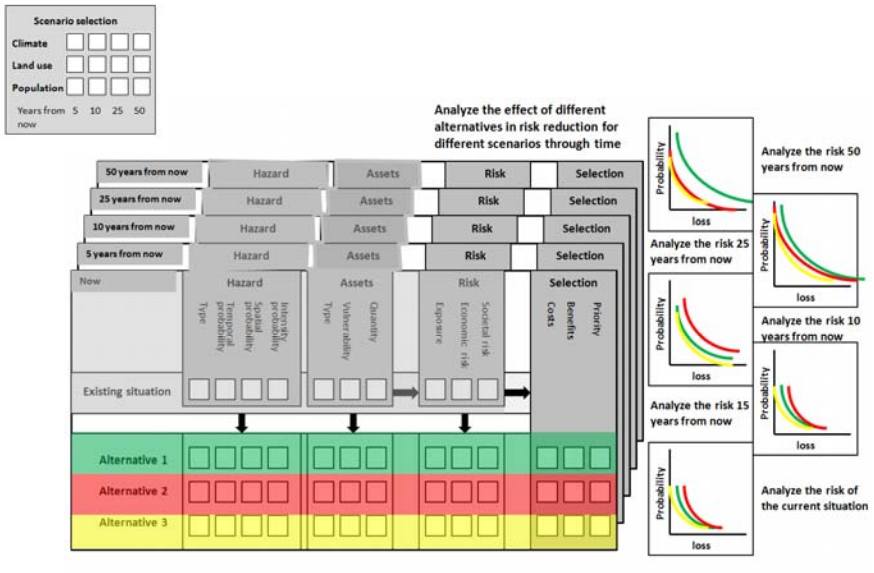
Pre-designed RR scenarios (Alternatives) to be designed by the local experts



Scenario evaluation component



Scenario Guidance and Translation:
Each of the scenarios should have a "narrative" explaining the scenario in words and in figures (e.g. percentage change of certain features)



SUMMARY OF SELECTED ALTERNATIVEs /SCENARIOs

DAMAGE MAP (e.g.)

HAZARD MAP

INTERACTIVE CUSTOMIZABLE REPORT

1. *SELECTED ALTERNATIVES/SCENARIOS*
2. *EXPOSURE REPORT*
3. *COSTS*
4. *CONSEQUENCES*
5. *…..*

VISUALIZATION OF DIFFERENCES OF MAPS

ALTERNATIVE 0 (NO RISK REDUCTION)

ALTERNATIVE n (NO RISK REDUCTION)

Tn

ALTERNATIVE n (RISK REDUCTION)

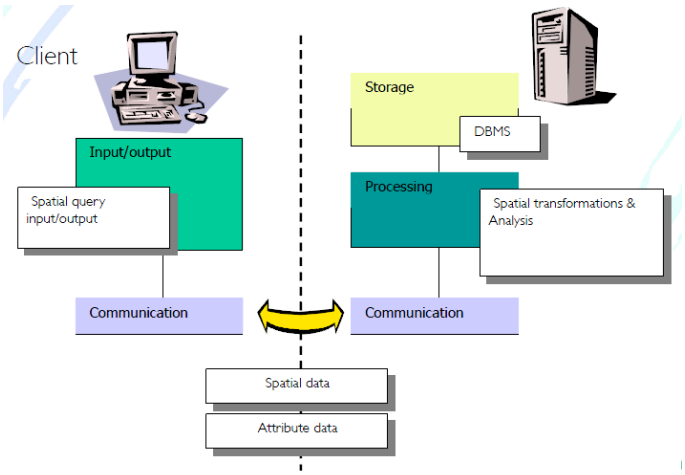
ALTERNATIVE n (RISK REDUCTION)

Tn + 1

(TIME BAR)

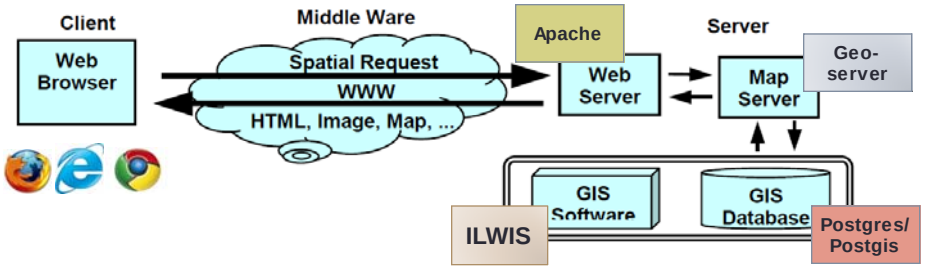
TECHNICAL ASPECTS

Example of server-side applications
(Source: Kobben et al, 2010)

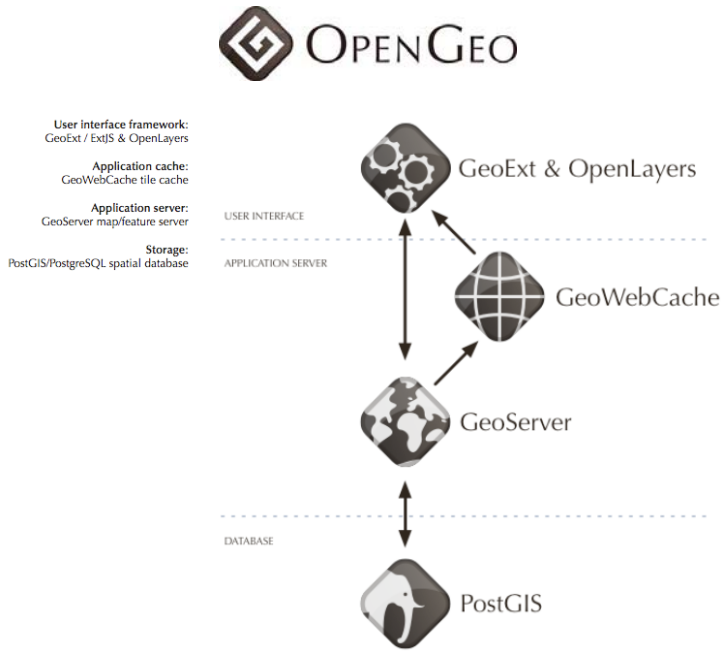


Kobben, B., Lemmens, R., & Husiman, O., 2010. 'Client Server Architectures' – Lecture note, GFM3-module 8, Dept of Geo-information Processing, ITC, University of Twente.

Typical web-GIS model
(Source: Helali, 2001)



Helali, H., 2001, 'Design and Implementation of a Web GIS for the City of Tehran', MSc thesis, Department of Geodesy and Geomatics Engineering K.N.Toosi, University of Technology, Tehran, Iran



Positions announced

NR	Title	With	Where
01	Development of the spatial data management of the SDSS	PLUS	Salzburg (Austria)
02	Development of the data analysis modules within the SDSS	ITC	Enschede (Netherlands)
03	Development of the Spatial Decision Support Framework	UNIL	Lausanne (Switzerland
04	Development of web-based risk communication and visualization methods of the SDSS	TUDO	Dortmund (Germany)
05	Development of the cost-benefit component of the SDSS	TUD	Delft (Netherlands)