

CGEO UNAM 2017

Curso de sismología ambiental

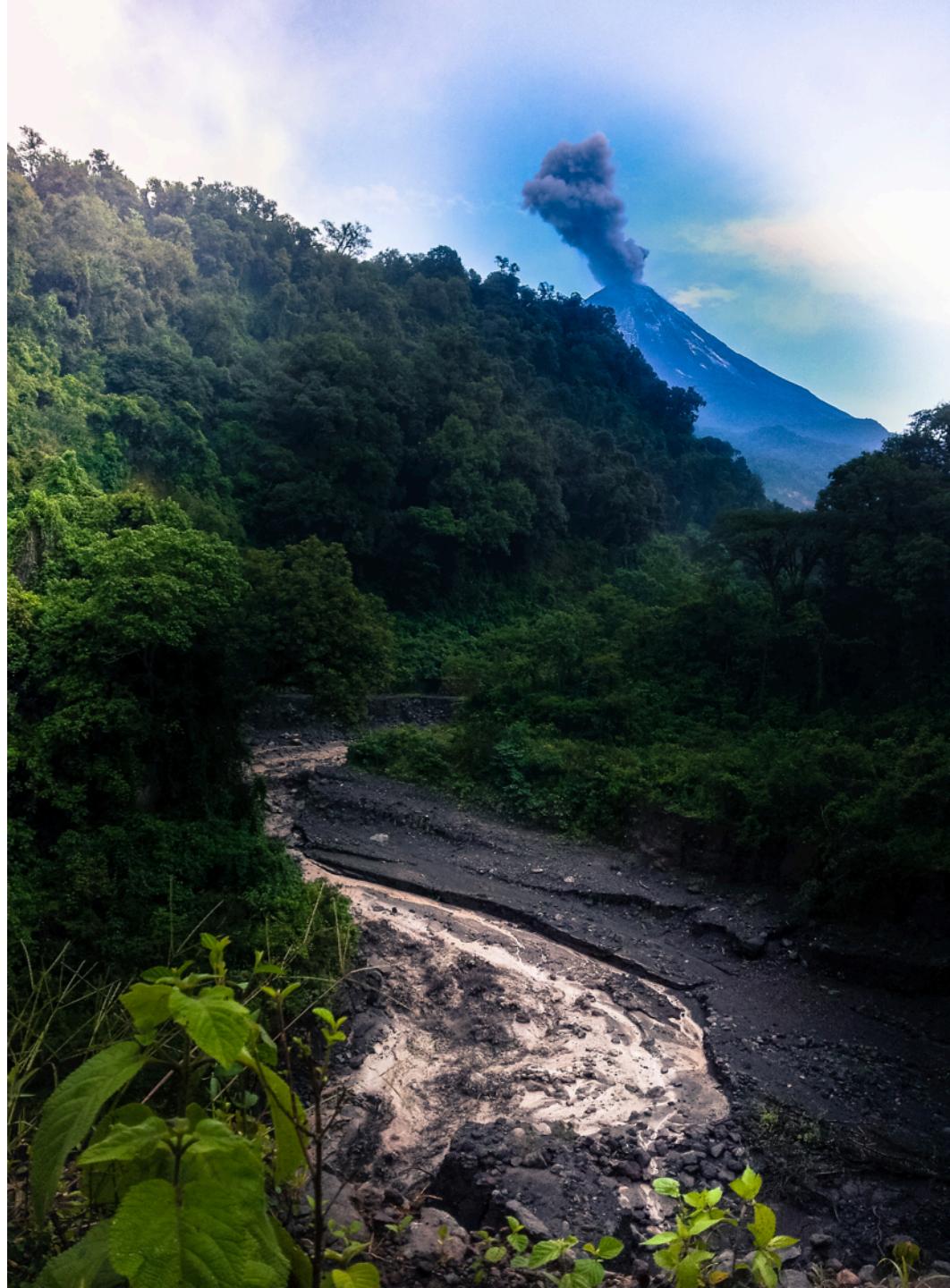
3 – Natural hazards and disaster risk reduction

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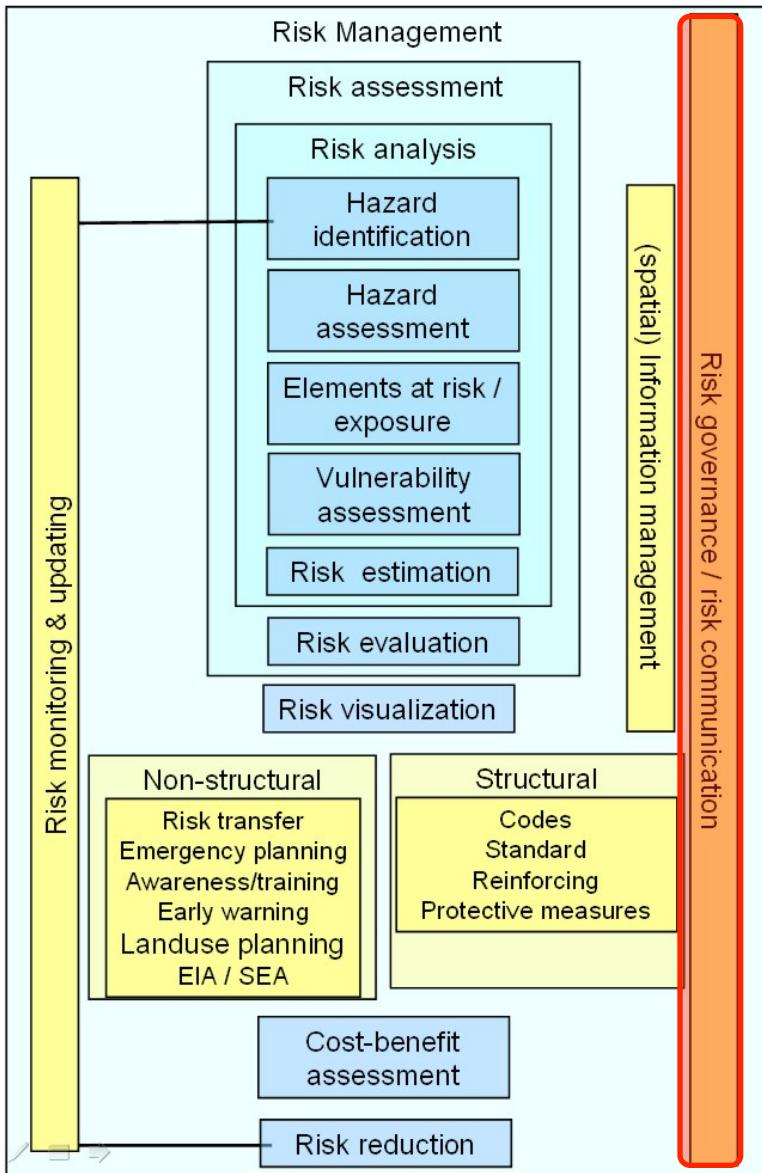
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Cees van Westen (ITC-UN)



Disaster Risk Management



Term	Definition
Risk analysis	The use of available information to estimate the risk to individuals or populations, property, or the environment, from hazards. Risk analysis generally contains the following steps: hazard identification, hazard assessment, elements at risk/exposure analysis, vulnerability assessment and risk estimation.
Risk evaluation	The stage at which values and judgements enter the decision process, explicitly or implicitly, by including consideration of the importance of the estimated risks and the associated social, environmental, and economic consequences, in order to identify a range of alternatives for managing the risks.
Risk assessment	The process of risk analysis and risks evaluation
Risk control or risk treatment	The process of decision making for managing risks, and the implementation, or enforcement of risk mitigation measures and the re-evaluation of its effectiveness from time to time, using the results of risk assessment as one input.
Risk management	The complete process of risk assessment and risk control (or risk treatment).

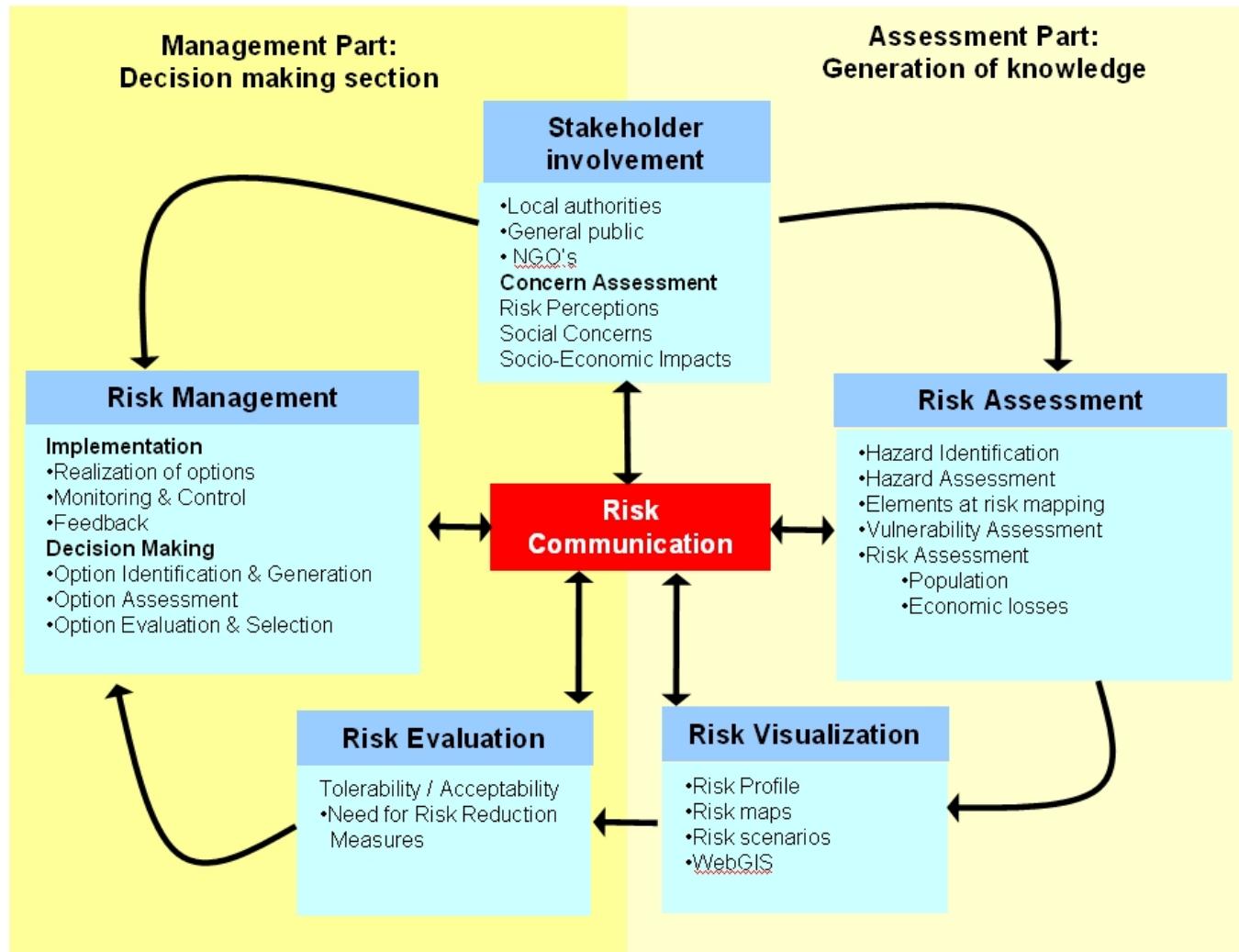
Disaster Risk Management

Pre-disaster activities				Post-disaster activities	
Risk identification	Mitigation	Risk transfer	Preparedness	Emergency response	Rehabilitation-reconstruction
Hazard assessment (frequency, magnitude, location)	Structural and non-structural works and actions	Insurance, reinsurance of public infrastructure and private assets Financial market instruments (catastrophe bonds, weather-indexed hedge funds)	Warning systems, communication systems, protocols	Humanitarian assistance	Rehabilitation, reconstruction of damaged critical infrastructure
Vulnerability assessment (population and assets exposed)	Land-use planning and building codes	Public services with safety regulations (e.g. energy, water, transportation)	Contingency planning (utility companies, public services)	Clean-up, temporary repairs and restoration of services	Macroeconomic and budget management (stabilization, protection of social expenditures)
Risk assessment (function of hazards and vulnerability)	Financial incentives for preventive behavior		Networks of emergency responders (local, national)	Damage assessment and identification of priorities for recovery	Revitalization of affected sectors (e.g. exports, tourism, agriculture)
Hazard monitoring and forecasting (space-time modeling, scenario building)	Education, training and awareness about risks and prevention	Financial protection strategies	Shelter facilities, evacuation plans	Mobilization of recovery resources (public-multilateral, insurance)	Incorporation of risk management in reconstruction processes

Risk Governance Framework

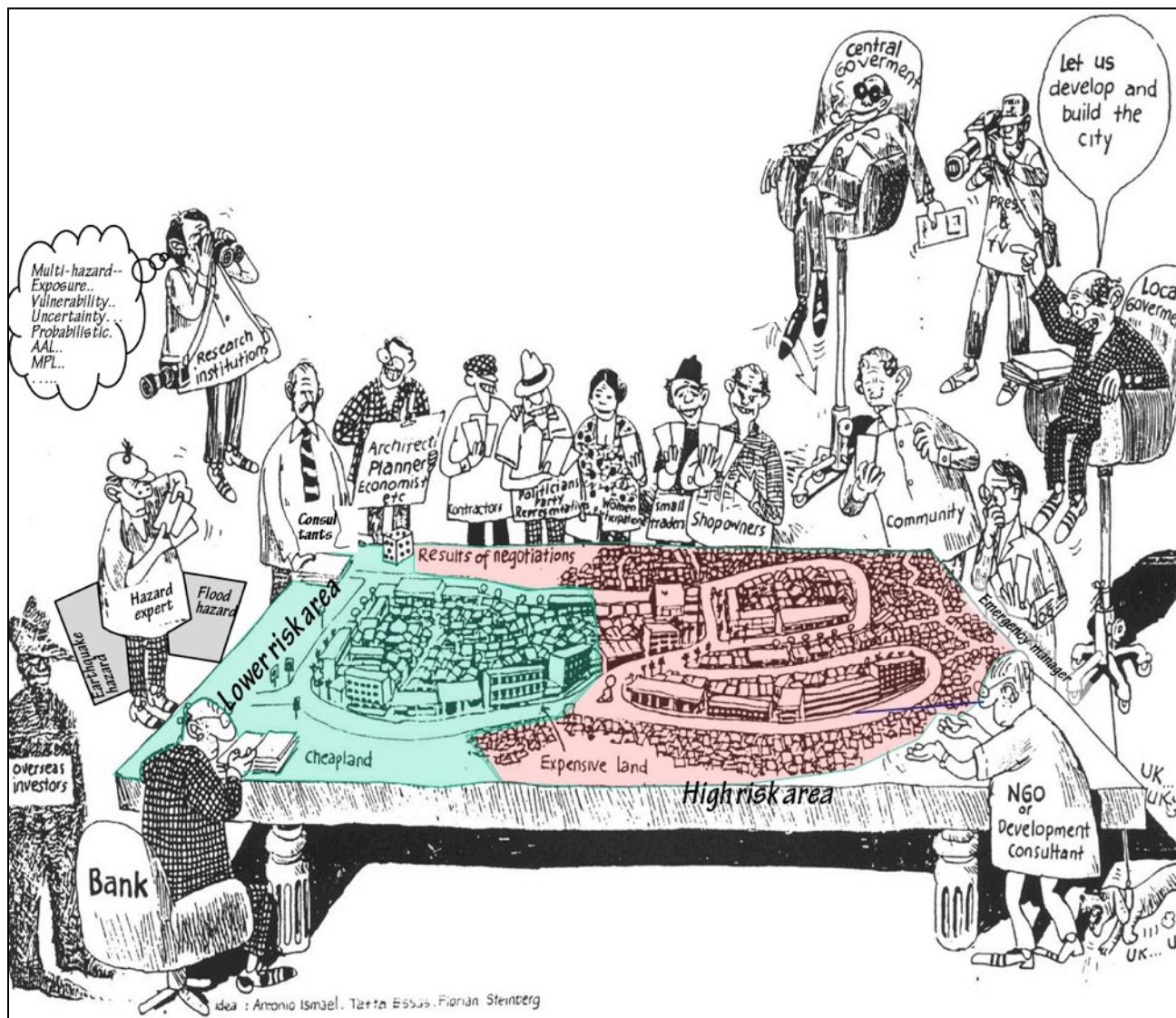
The aim of Risk governance is to involve the various stakeholders within all aspects of risk management.

Risk communication is central.



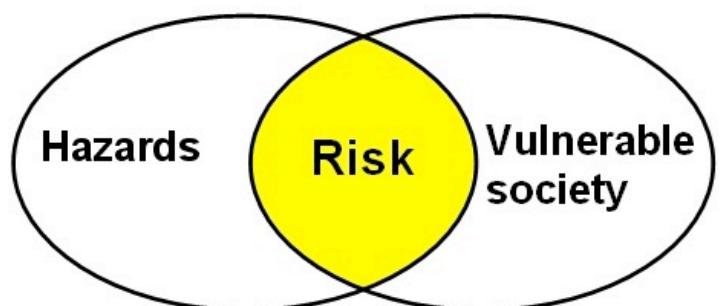
The International Risk Governance Council Risk Governance Framework
(Source: IRGC, 2006)

Stakeholders

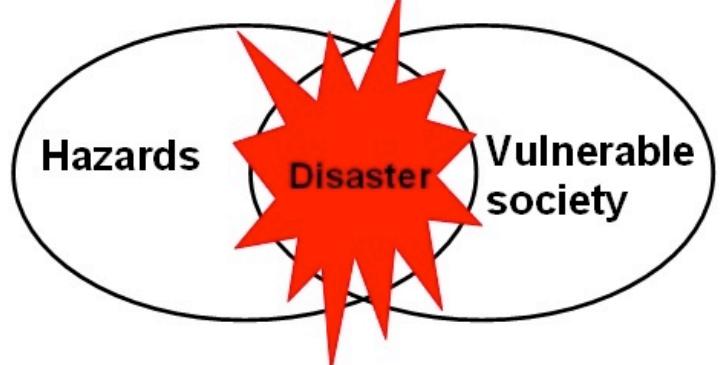


Aspects in stakeholder involvement

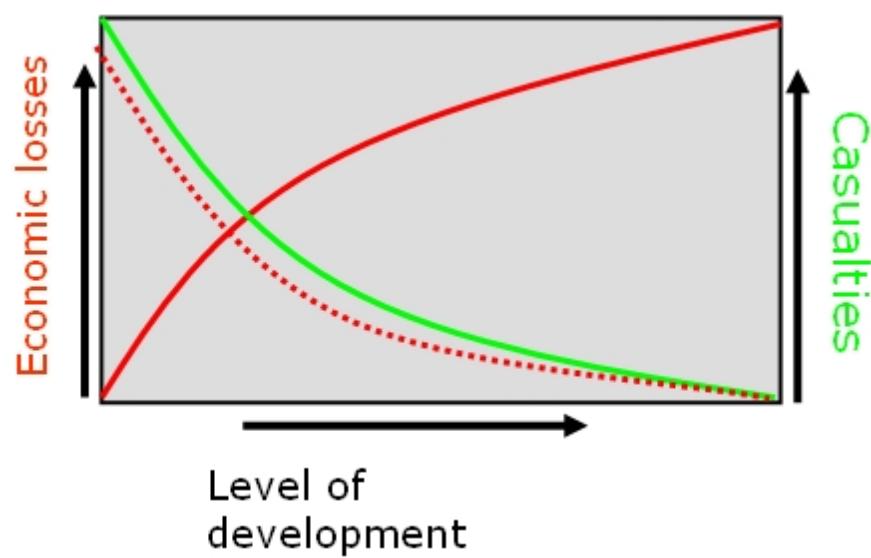
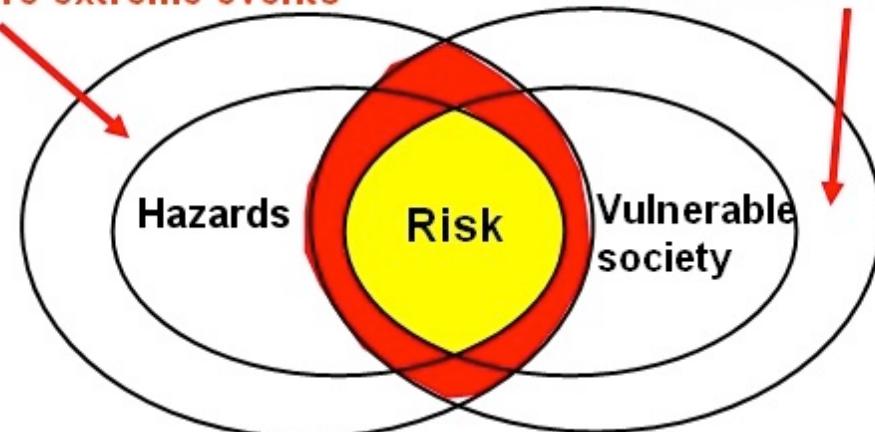
Aspect	Question
Identification	Are stakeholders identified (through a proper process - including prioritisation)?
Representation	Are all relevant social groups represented?
Engagement	Are all relevant social groups motivated to engagement?
Access to Information	Share of stakeholders that regularly take part in information meetings
Interest	Are the stakeholders interested in having information, in the outcome?
Trust	Do the stakeholders trust the decision makers, institutions and information available?
Acceptance - Process	Do the stakeholders accept the process?
Acceptance - Outcome	Do the stakeholders accept the outcome?
Dialogue	Are stakeholders engaged in dialogue with listening and mutual understanding?
Financial	Do the financial resources available meet the needs of the governance process defined?
Personnel	Do the personnel resources available in expertise and capacity meet the needs of the governance process defined?
Time	Is there calendar time to meet the governance process defined?



Hazard & risk materialize



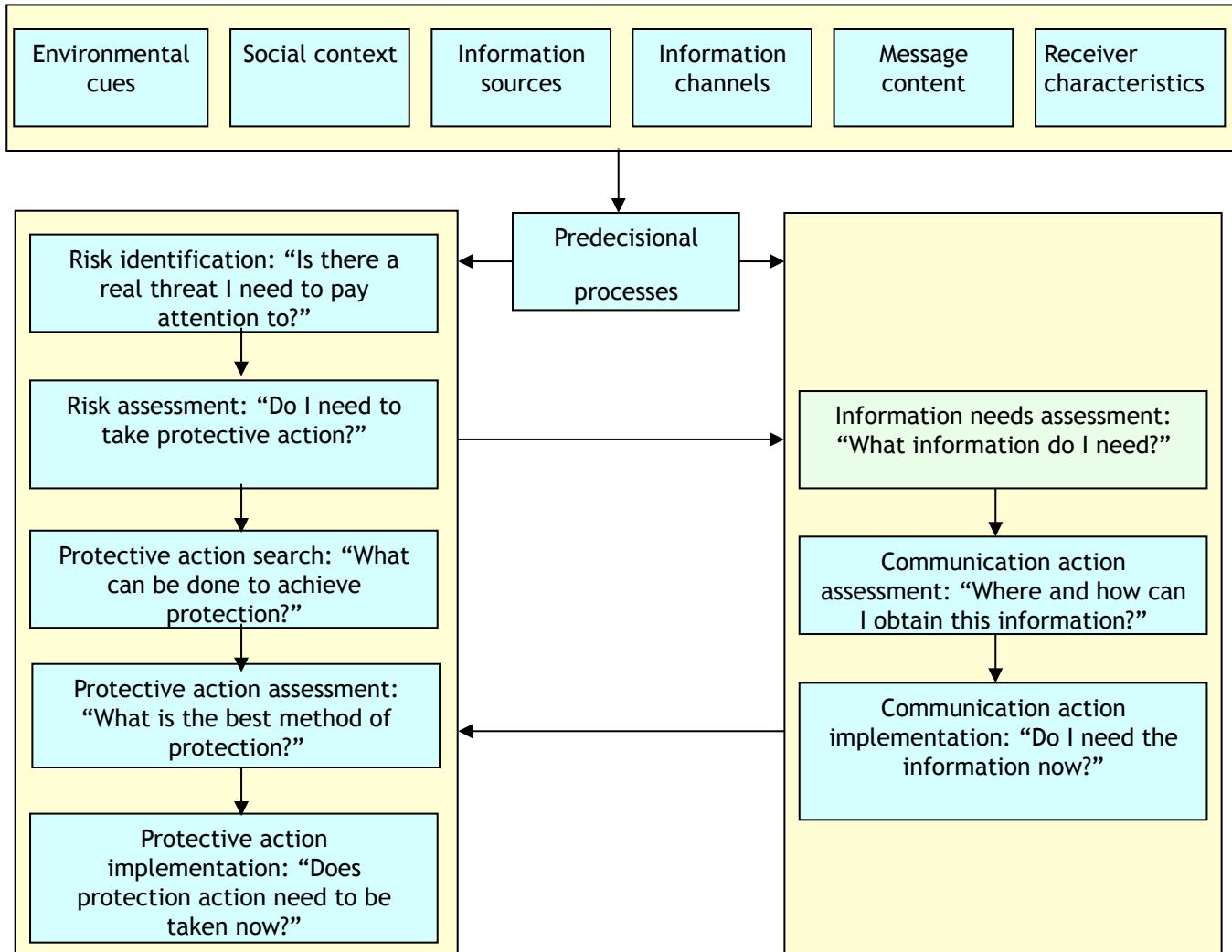
Climate change
More extreme events



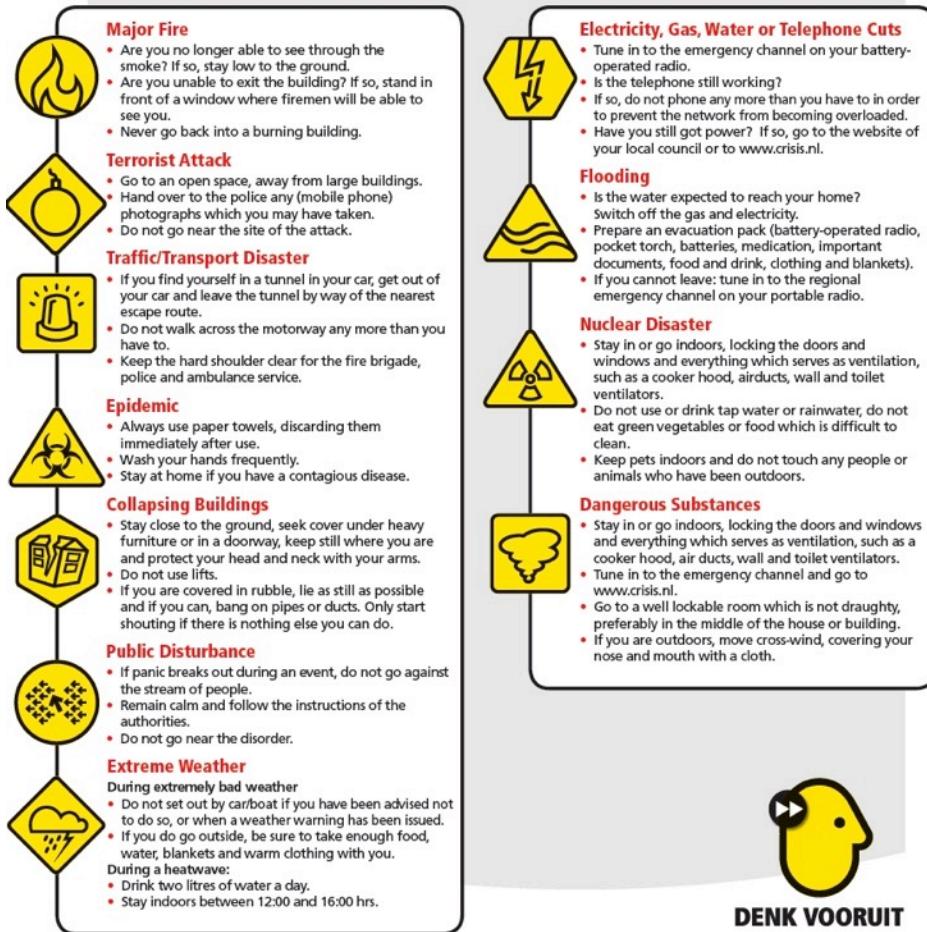
Risk communication

Risk communication is the interactive exchange of information about risks among risk assessors, managers, news media, interested groups and the general public.

- who (**Source**)
- says what (**Message**)
- via what medium (**Channel**)
- to whom (**Receiver**)
- and directed at what kind of change (**Effect**).



Risk communication: Netherlands

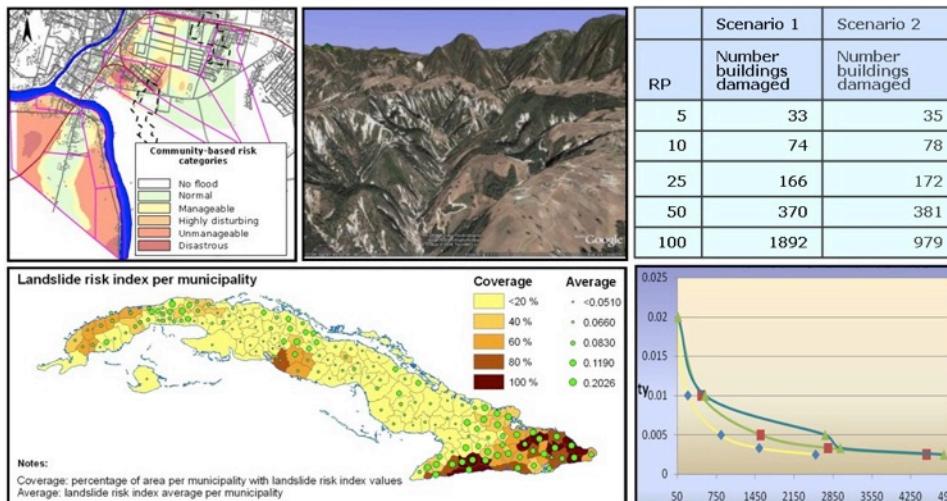


Information and communication



Risk visualization

- Statistical information per administrative unit (country, province, municipality, or neighborhood)
- Risk curves
- Maps which shows the spatial variation of risk over an area
- WebGIS applications that allow the user to combine different types of information, and display information such as:
- Spatial Data Infrastructure / Clearinghouses, where through internet basic GIS data can be shared among different technical and scientific organizations involved in hazard and risk assessment.
- Animations showing the spatial and temporal distribution of hazards and risk



What to visualize for whom?

Stakeholder	Purpose	Type of risk visualization
General public	General information on risks over large areas	Basic WebGIS applications in which they can overlay the location of major hazard types with high resolution imagery or topographic maps.
	Awareness raising	Animations (what if scenarios)
	Community-based DRR projects	Simple maps of the neighborhood with risk class, buildings and other features
Businesses	Investment policies, and location planning	General information about hazards and risks in both graphical and map format.
Technical staff of (local) authorities	Land use regulation / zoning	Map with simple legend in three classes: construction restricted, construction allowed, further investigation required.
	Building codes	Maps indicating the types of building allowed (building type, number of floors)
	Spatial planning	Hazard maps, with simple legends related to probabilities and possible consequences
	Environmental Impact Assessment	Maps and possible loss figures for future scenarios
	Disaster preparedness	Real time simple and concise Web-based information in both map and graphical forms
Decision makers / local authorities	Decision making on risk reduction measures	Statistical information, loss exceedance curves, F-N curves, maps.
	Investments	Economic losses, projected economic losses for future scenarios.
	Strategic Environmental Assessment	General statistical information for administrative units.
NGO's	Influence political decisions in favor of environment and sustainable development	This can vary from simple maps to Web-based applications, depending on the objectives of the NGO
Scientists / technical staff of hazard data producers	Hazard information exchange to public and other agencies	WebGIS applications where they can access the basic information
	Exchange of basic information for hazard and risk assessment	Spatial Data Infrastructure / Clearinghouse for exchanging information
Insurance industry	Development of insurance policy	Loss Exceedance Curves of economic losses, F-N curves
Media	Risk communication to public,	Animations of hazard phenomena that clearly illustrate the problems.

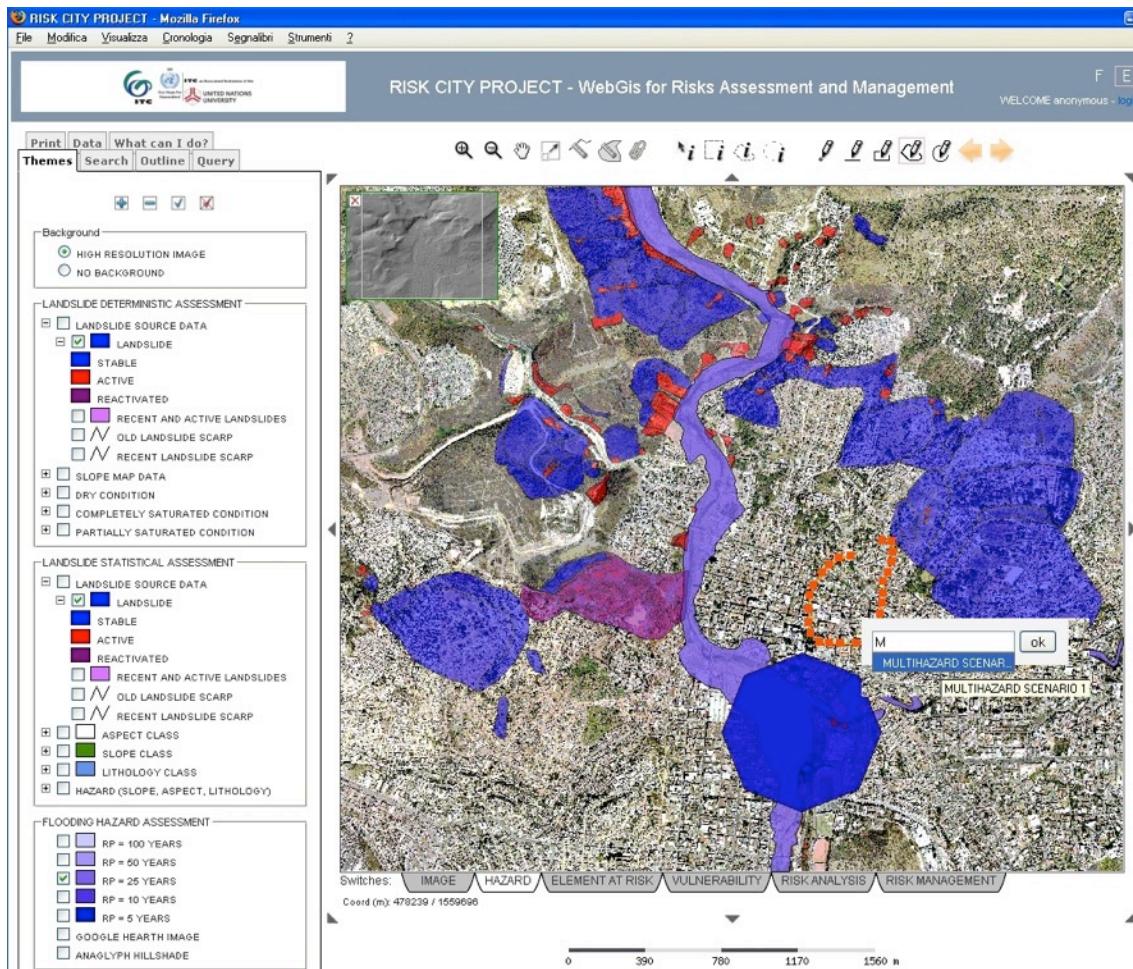
Risk visualization: example 1

<http://www.grid.unep.ch/activities/earlywarning/preview/index.php>



Web-GIS – RiskCity: example 2

<http://geoserver.itc.nl:8181/cartoweb3/WebRiskCity/WebRiskCity.html>



Risk atlas: example 3

Andean countries

<http://www.comunidadandina.org/predecan/atlasweb/index.html>

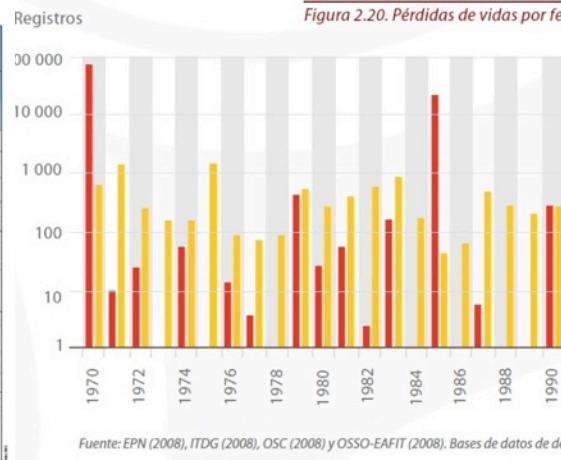
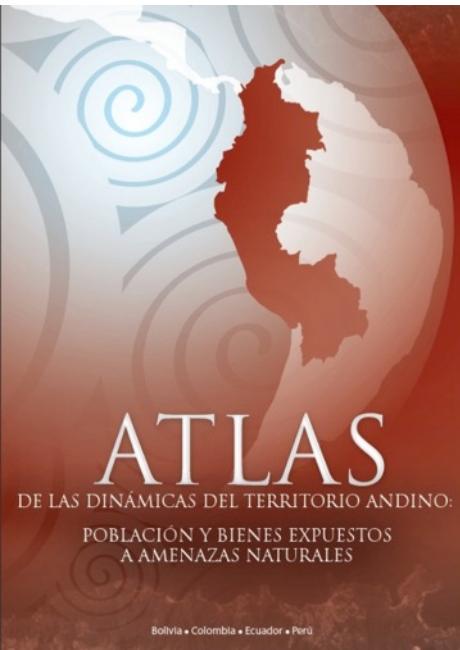
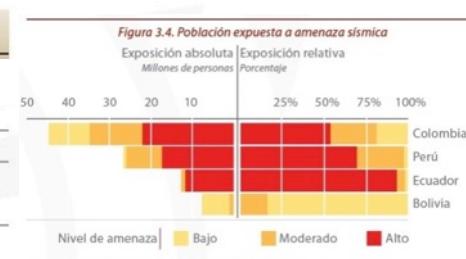


Figura 2.20. Pérdidas de vidas por fenómenos geológicos e hidrometeorológicos, 1970-2007



Fuente: Elaboración propia a partir de los mapas 17 y 7. Ver memoria técnica.

Variables Socioeconómicas	Amenazas, susceptibilidades o potencial de ocurrencia a los fenómenos naturales							
	Earthquake	Volcanoes	Landslides	Debrisflow	Flooding	Cold	Drought	Tsunami
Population	■	■	■	■	■	■	■	■
Roads	■	■	■	■	■	—	—	■
Electrical energy system	■	■	■	■	■	■	■	■
Oil infrastructure	■	■	■	■	■	—	—	■
Harbours	■	■	■	■	■	■	■	■
Airports	■	■	■	■	■	■	■	■
Agriculture	—	■	■	■	■	■	■	■

■ Cruce realizado

■ Cruce realizado, presentado en textos y gráficos ya que a la escala 1:11 millones el producto cartográfico es ilegible.

■ Cruce realizado, los mapas de amenaza volcánica tienen una escala con mayor detalle, lo que permitió que las variables socioeconómicas expuestas se representaran en un solo mapa.

■ Para el cruce Tsunami y puertos se hizo un análisis más integral, que incluyó, además de los puertos importantes, ciudades costeras y puertos de importancia muy local. Para ello se utilizaron datos de las poblaciones costeras.

■ Aunque el cruce de las variables es factible no es posible realizarlo a la escala de trabajo de 1:11 millones, ya que resulta muy general. El cruce es necesario y posible para estudios detallados o de caso.

— No aplica

Risk reduction

$$R = f(H, V, C)$$

R = Risk

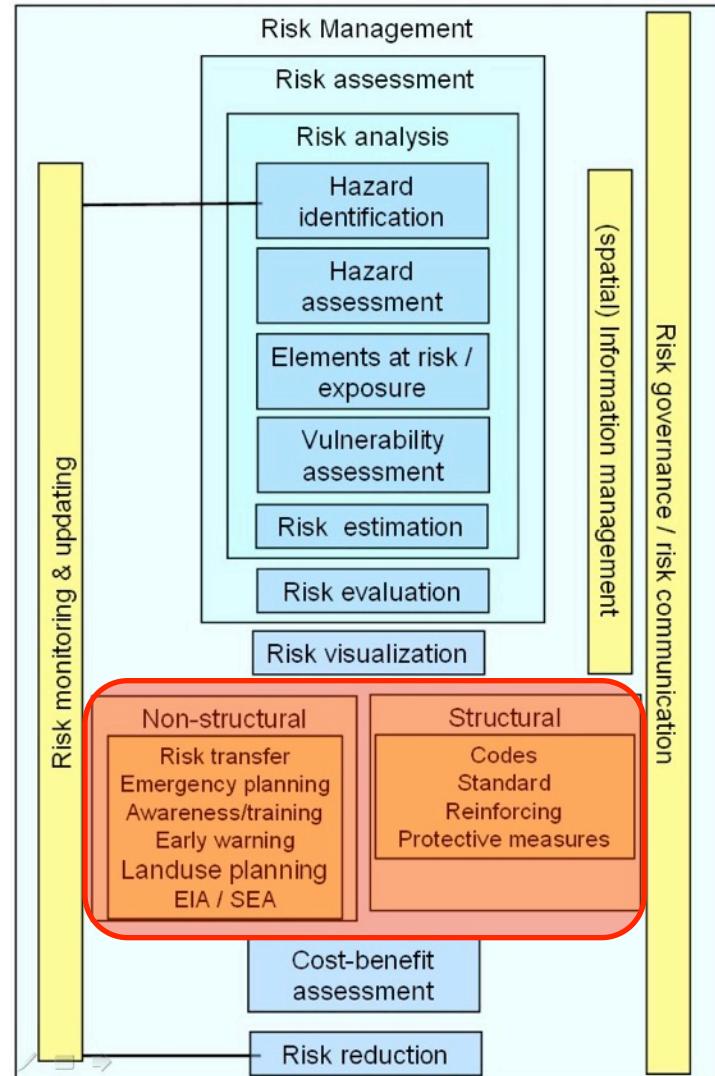
H = Hazard

V = Vulnerability

C = Coping capacity

Risk can be reduced by:

- Reducing the hazard
- Reducing the vulnerability of the elements at risk
- Reducing the amount of the elements at risk
- Increasing the coping capacity



Risk reduction strategies

- **Structural measures:**

refer to any physical construction to reduce or avoid possible impacts of hazards, which include engineering measures and construction of hazard-resistant and protective structures and infrastructure

- **Non-Structural measures:**

refer to policies, awareness, knowledge development, public commitment, and methods and operating practices, monitoring and early warning systems, including participatory mechanisms and the provision of information, which can reduce risk and related impacts.

Risk reduction strategies

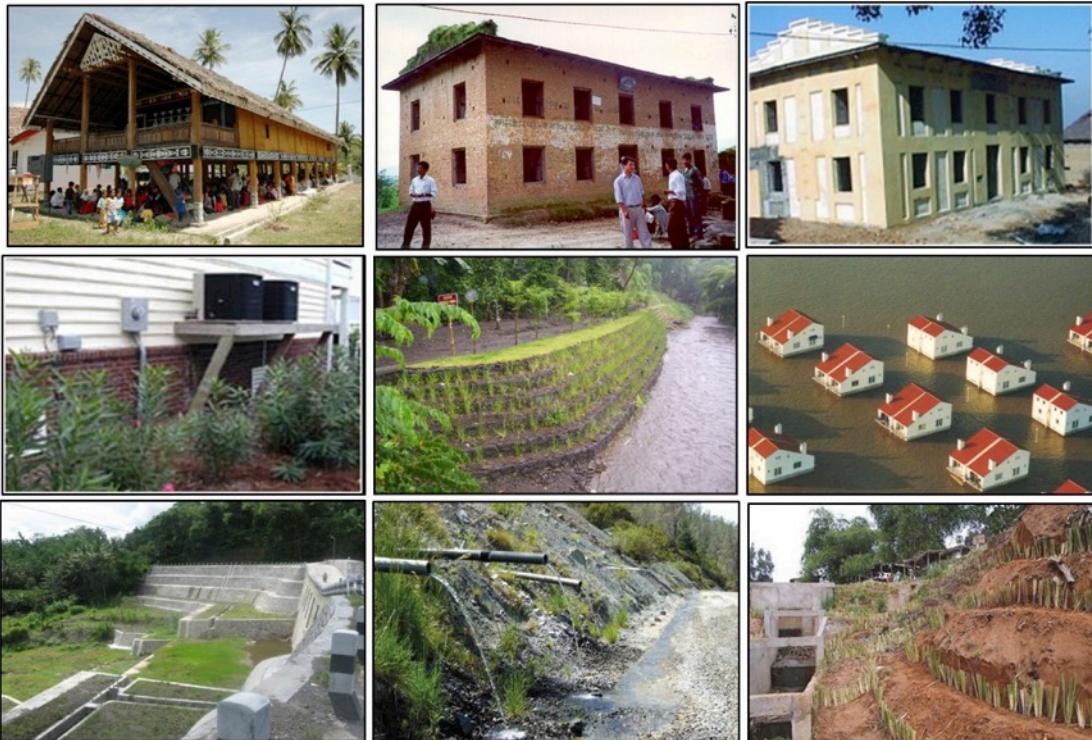
- **Avoidance** (eliminate) i.e. modify the hazard
- **Reduction** (mitigate) i.e. modify the susceptibility of hazard damage and disruption.
- **Transference** (outsource or insure) i.e. modify the impact of hazards on individuals and the community.
- **Retention** (accept and budget)

Risk reducing measures

Structural measures

Any physical construction to reduce or avoid possible impacts of hazards

- engineering measures
- construction of hazard-resistant and protective structures and infrastructure
- retrofitting



Building design to withstand hazards in Mountain areas



- **Foundation**
 - Base plate foundation
- **Basement**
 - Waterproof concrete
 - Enhancement openings and sealing
 - Backflow flaps
- **First & second floor**
 - Reinforcement of supporting walls
- **Roof**
 - Reinforcement of roof
- **Building openings**
 - Decrease amount and area of windows in hazard direction
 - Avalanche shutters
 - Temporary preventive measures (to close openings)

Building design to withstand hazards in Mountain areas

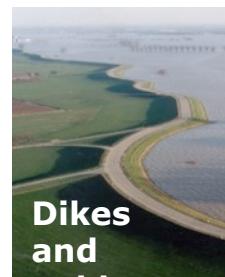
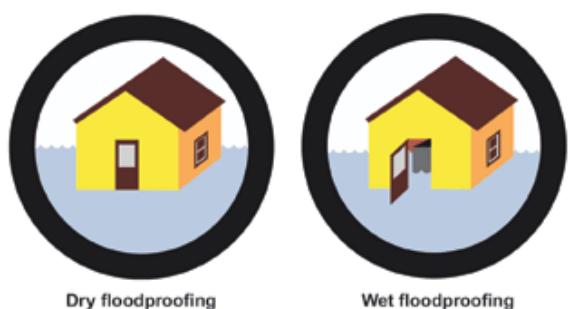
Measure	Increase in construction costs
Reinforcement of the hillside outer wall	17
Reinforcement of the structural slab	30
Reinforcement of the truss	10
Reduction of eaves (decrease in roof area)	-16
Avalanche-proof window and window shutters	67
Above flood-level light shafts +23	23
Total costs of the prototype reinforced building	8



Fuchs et al., 2011

Risk reducing measures - structural

Basic approaches to floodproofing



Dunes

Dams and barriers



Deepening of the forelands



Removal of obstacles



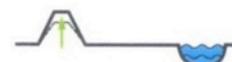
Lowering of groynes



Enlarging of summer beds



Flood channel



Strengthening of dikes

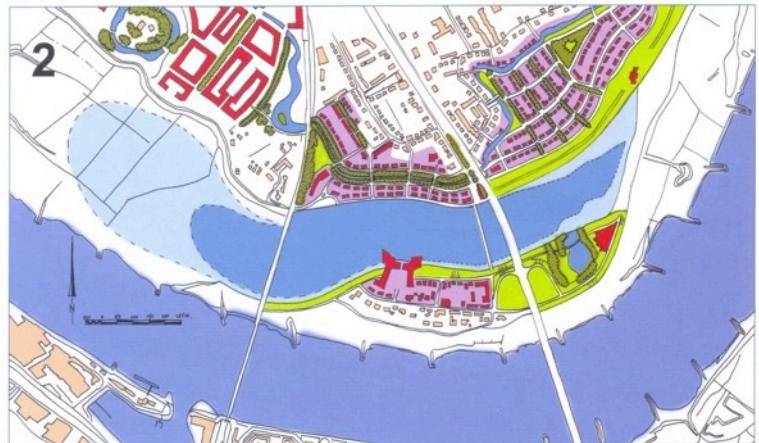


Displacement of dikes or
Depoldering

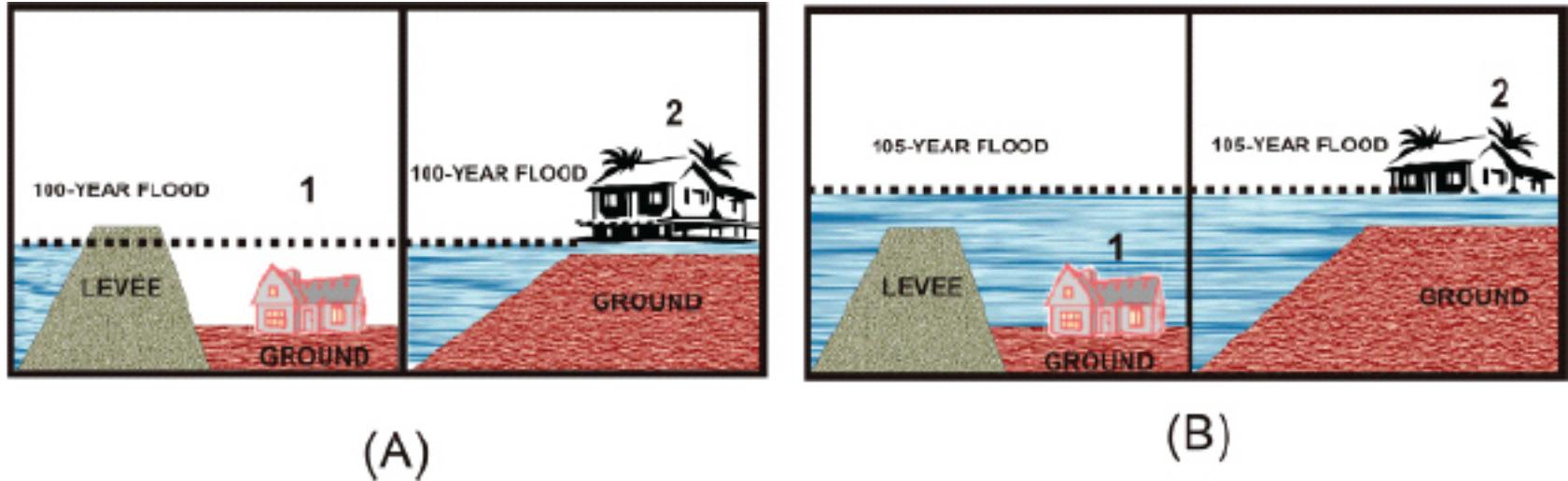
Example: the Netherlands



To avoid future flood losses a secondary channel and island are planned
Restrictive development and some removal of existing buildings



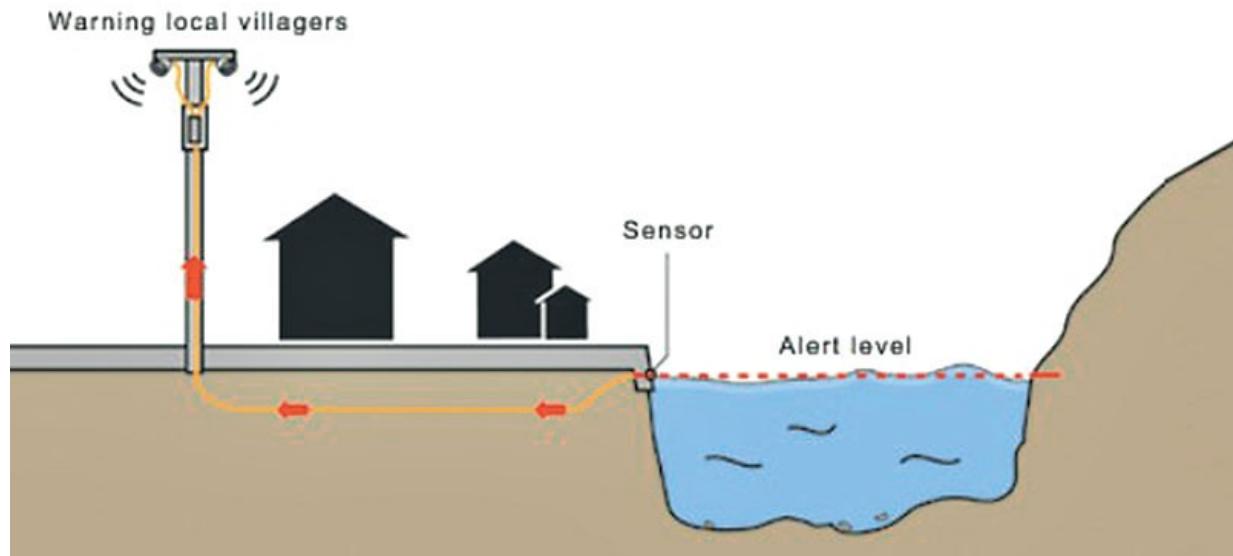
Levee effect!



- (A) Situation when the water level in the river is below the Base Flood Elevation (BFE). The levee protects the House 1 up to the 100-year level.
- (B) Situation when the water reaches the 105-year flood level and overtops the levee. House 1 is submerged and House 2 is subjected to minimal damage.

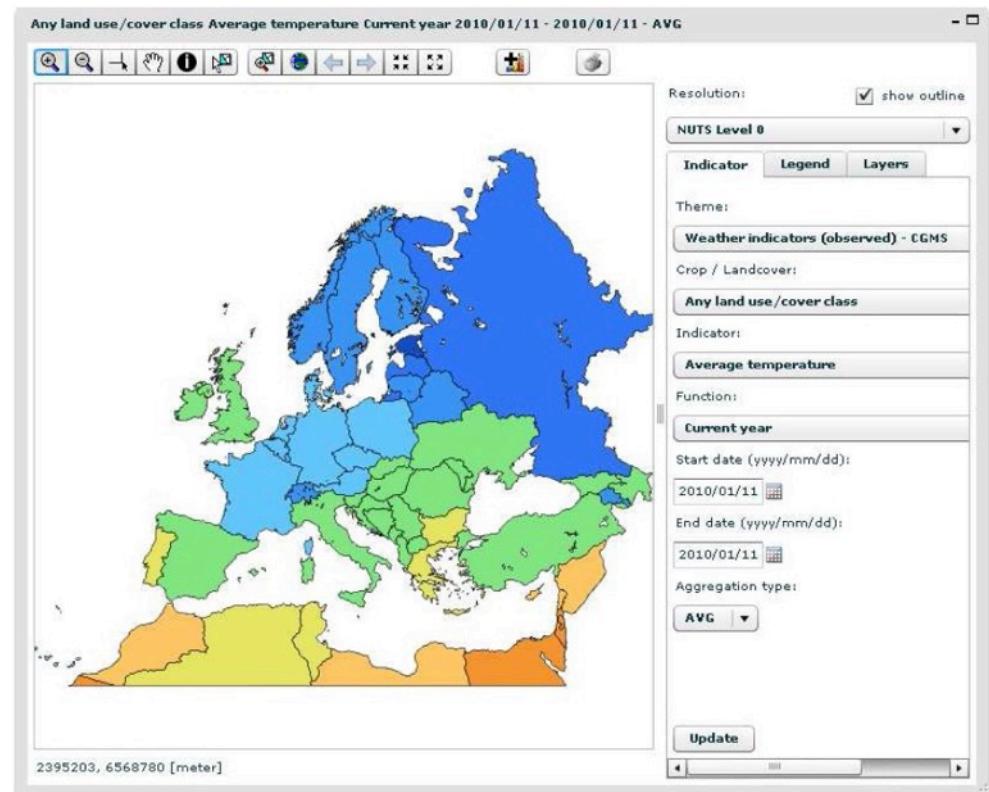
Risk reducing measures – non structural

- Early Warning
- Preparedness and contingency planning
- Emergency management (e.g. shelter facilities, evacuation plans)

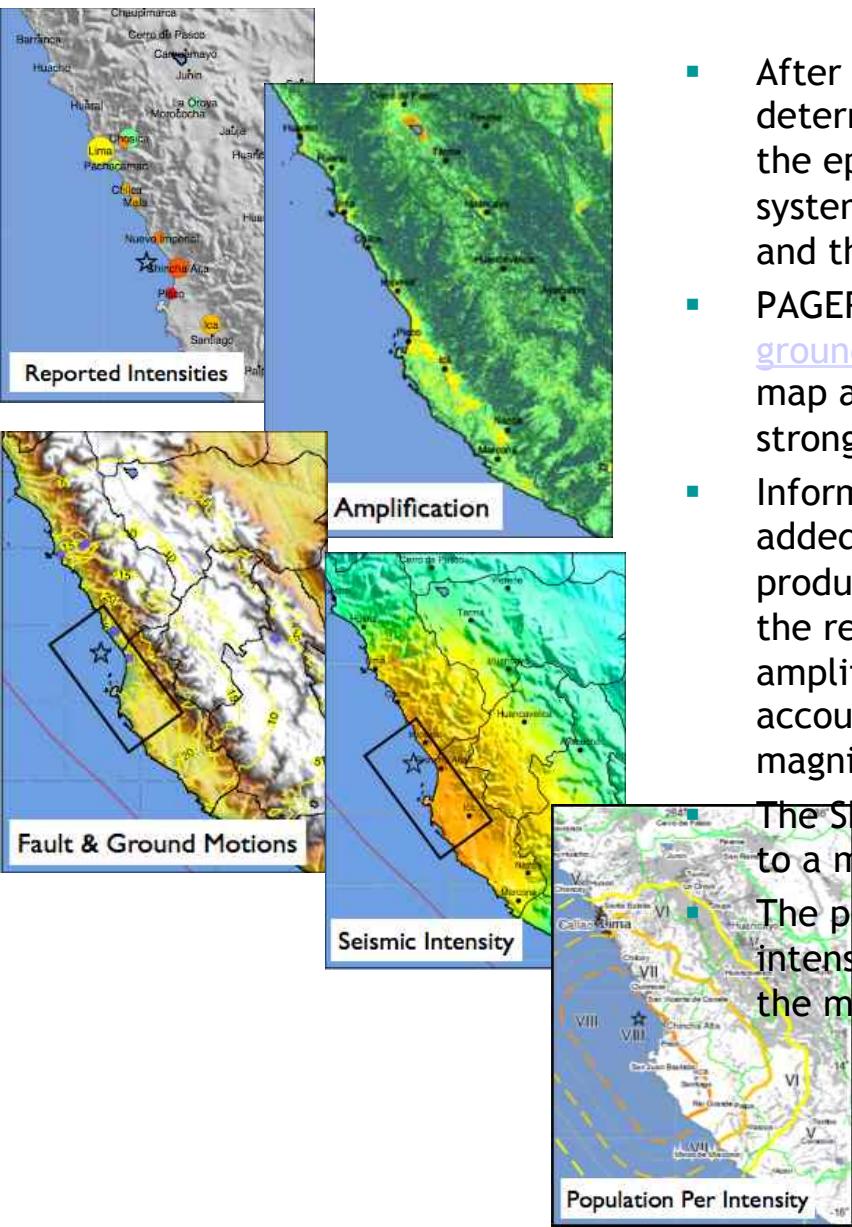


Example: MARSOP3

- Crop Yield Forecasting
- Joint Research Centre (JRC) of the EC, Alterra, VITO, Meteoconsult.
- This system includes:
 - management of a meteorological database,
 - an agro-meteorological model and database,
 - low resolution satellite information,
 - statistical analyses of data
 - crop yield forecasting
- publishing of bulletins containing analysis, forecasts and thematic maps on crop yield expectations using a Web-GIS application



USGS PAGER



- After the magnitude and hypocenter of an earthquake are determined, PAGER retrieves any intensities reported by people in the epicentral region via the online USGS "[Did You Feel It?](#)" system. The colored circles show the reported intensity at a city and the circle's size is proportional to population.
- PAGER generates a soil/rock site-specific [ground-motion amplification map based on topographic slope](#). This map accounts for the tendency of soft-soil sites to experience stronger ground motion amplification than rock sites.
- Information about the fault geometry and size (black rectangle) is added when it becomes available. The ShakeMap system then produces regional ground shaking estimates (yellow contours) using the reported intensities, the site-specific ground-motion amplification map, and seismic wave attenuation equations that account for the variation of seismic shaking intensity with magnitude, distance and depth.

The ShakeMap system then converts the estimated ground motions to a map of seismic intensity.

The population affected at each intensity level is computed and intensities and populations at nearby cities tabulated by combining the map of intensity with the Landscan population database.