RiskCity

Training package on the

Application of GIS for multi-hazard risk assessment in an urban environment.

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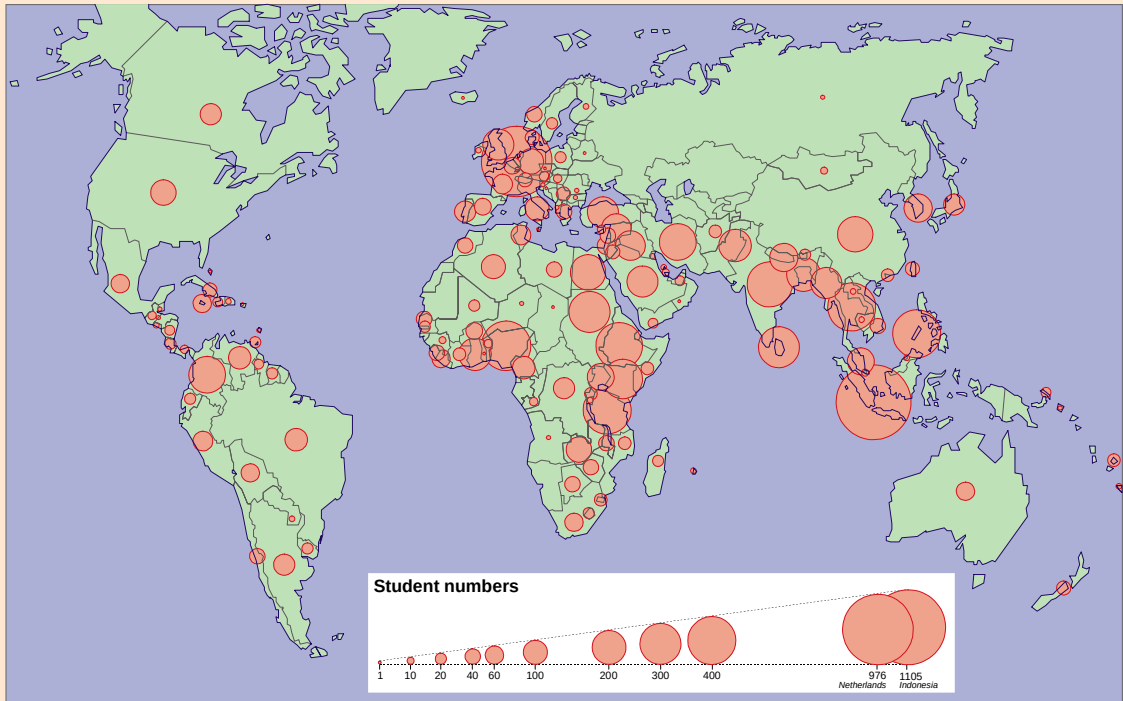
ITC: Training & Research for developing countries on spatial information.

- Our aim is to provide international postgraduate education through knowledge exchange directed primarily at capacity building and institutional development for and in countries that are economically and technologically less developed (LCDs).

- Our knowledge field is centred on geo-information science and earth observation.
- We work with partner organisations in Africa, Asia and Latin America



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DGIM - School for Disaster Geo-Information Management

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According to the Agreement between United Nations University (UNU) and ITC, the long-term objective is "to strengthen the capacity of institutions at national and local level in developing countries to reduce the vulnerability to natural hazards".

The overall objective of the School for Disaster Geo-Information Management is to support capacity building of organizations in developing countries through training of individuals in the collection, management, analysis and dissemination of spatial information before, during and after disaster events, in order to reduce the impacts of natural and related environmental and technological hazards.

Activities related to training, education and curriculum development

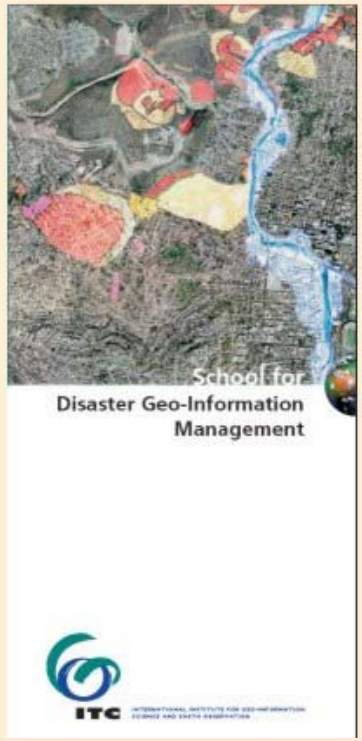
- Joint educational programmes
- Short courses and workshops
- Distance education courses
- University Networks
- Fellowship opportunities

Activities related to knowledge development and research collaboration

- Research projects
- PhD research
- Visiting scientists
- Small grants

Activities related to provision of project services

- Disaster Information Analysis Group (DIAG)
  - Damage assessment in Yogyakarta, Indonesia.
  - Production of base maps for earthquake affected areas in Pakistan.
  - Tsunami disaster information.



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RiskCity training package

- **A training package on the use of GIS for multi-hazard risk assessment in an urban setting in developing countries.**
- **A series of exercises, presentations, lectures, data and software.**
- **The basis for courses with duration of 2 days to 3 months.**
- **Distance education course.**

Exercise 3: Generating a database of elements at risk

Exercise 8. Spatial Multi Criteria Evaluation for vulnerability assessment.

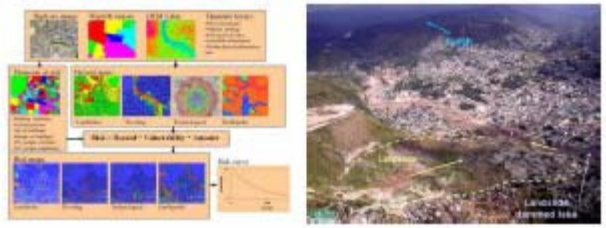
Exercise 11. Analysis of costs & benefits of risk reduction scenarios.

Expected time:	3 hours
Data:	data from subdirectory:\exercise11
Objectives:	After calculating the expected losses for the different return periods, and the average annual risk, we would now like to analyze the various options that the municipality has to mitigate the risk, using a basic cost/benefit analysis.

GIS case study exercise materials

RiskCity

Application of GIS for multi-hazard risk assessment in an urban environment.



Version: June 2008
Cees Van Westen

UNU – ITC School for Disaster Geo-Information Management
http://www.itc.nl/unu/dgim

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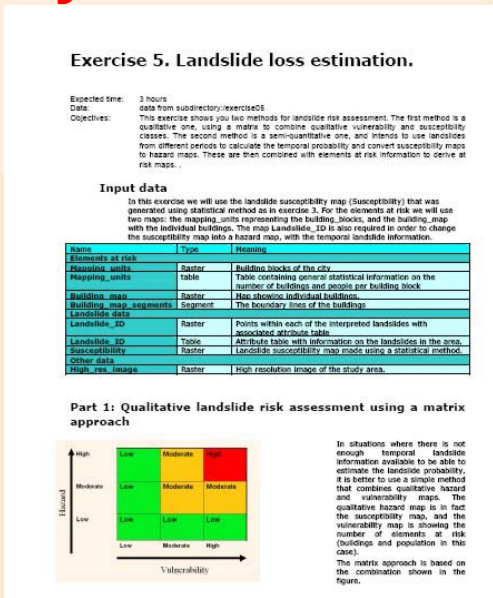
Objectives of RiskCity

- **The objective of this training package is to demonstrate the concepts of the use of GIS for susceptibility, hazard, vulnerability, capacity and risk assessment in an urban setting.**

- **It deals with the following questions**
  - Which spatial data are important?
  - How to get spatial data?
  - How to do hazard assessment?
  - How to generate an elements at risk database?
  - How to estimate vulnerability?
  - How to make a qualitative and quantitative loss estimation?
  - How to do a cost-benefit analysis for disaster reduction options?
  - How to use risk information in spatial planning and disaster preparedness?



Exercise 5. Landslide loss estimation.

Expected time: 3 hours
Data: data from subdirectory:\exercise05
Objectives: This exercise shows you two methods for landslide risk assessment. The first method is a qualitative one, using a matrix to combine qualitative vulnerability and susceptibility classes. The second method is a semi-quantitative one, and intends to use landslides from different periods to calculate the temporal probability and convert susceptibility maps to hazard maps. These are then combined with elements at risk information to derive at risk maps. .

Input data

In this exercise we will use the landslide susceptibility map (Susceptibility) that was generated using statistical method as in exercise 3. For the elements at risk we will use two maps: the mapping_units representing the building_blocks, and the building_map with the individual buildings. The map Landslide_ID is also required in order to change the susceptibility map into a hazard map, with the temporal landslide information.

Name	Type	Meaning
Elements at risk		
Mapping_units	Raster	Building blocks of the city
Mapping_units	table	Table containing general statistical information on the number of buildings and people per building block
Building_map	Raster	Map showing individual buildings.
Building_map_segments	Segment	The boundary lines of the buildings
Landslide data		
Landslide_ID	Raster	Points within each of the interpreted landslides with associated attribute table
Landslide_ID	Table	Attribute table with information on the landslides in the area.
Susceptibility	Raster	Landslide susceptibility map made using a statistical method.
Other data		
High_res_image	Raster	High resolution image of the study area.

Part 1: Qualitative landslide risk assessment using a matrix approach

In situations where there is not enough temporal landslide information available to be able to estimate the landslide probability, it is better to use a simple method that combines qualitative hazard and vulnerability maps. The qualitative hazard map is in fact the susceptibility map, and the vulnerability map is showing the number of elements at risk (buildings and population in this case).

The matrix approach is based on the combination shown in the figure.

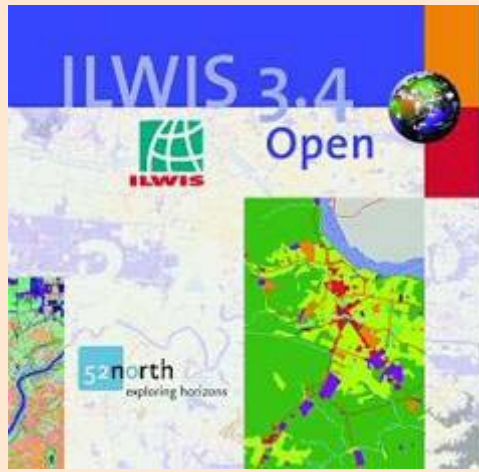
Open-Source software: ILWIS

Open Source software, so no restrictions for use.
Complete stand-alone software that can be used by NGO's , Universities and Government organizations working with spatial information.

Some key features

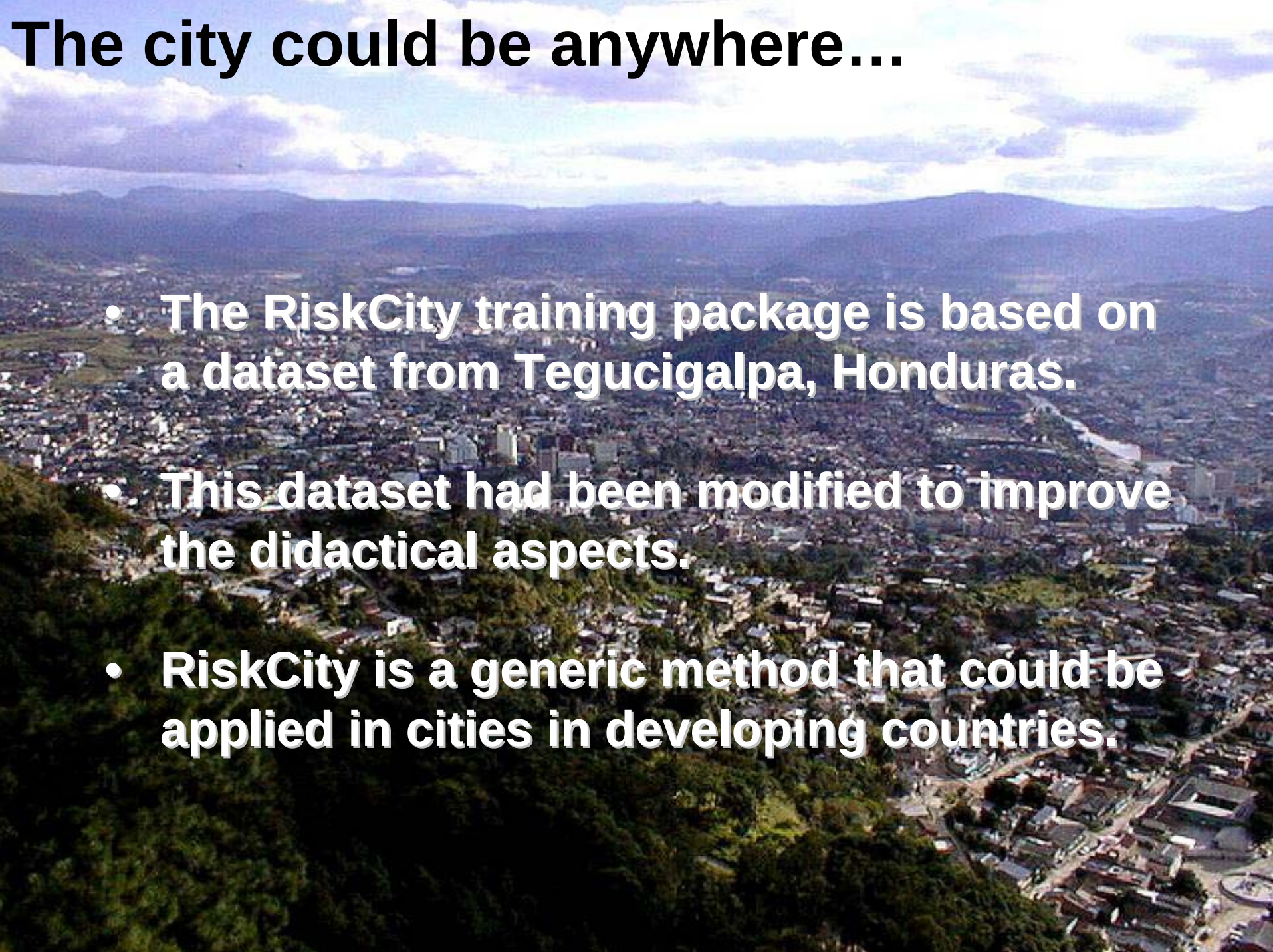
- Import and export of widely used data formats;
- On-screen and tablet digitizing;
- Comprehensive set of image processing tools;
- Orthophoto, image georeferencing, transformation and mosaicing;
- Advanced modeling and spatial data analysis;
- 3D visualization with interactive editing for optimal view findings;
- Rich projection and coordinate system library;
- Geo-statistical analyses, with Kriging for improved interpolation;
- Production and visualization of stereo image pairs;
- Spatial Multiple Criteria Evaluation.

RiskCity training package is currently also being developed for use with ARCGIS



ILWIS is an Open source GIS and Image Processing software
Can be downloaded from: http://52north.org/

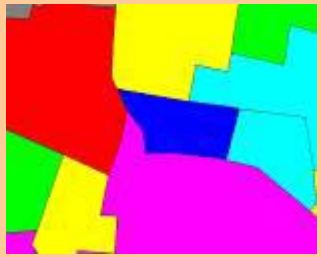
The city could be anywhere…



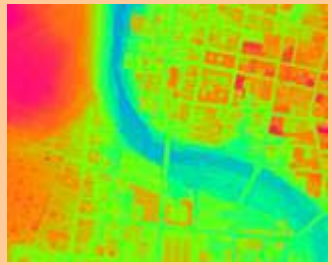
- The RiskCity training package is based on a dataset from Tegucigalpa, Honduras.
- This dataset had been modified to improve the didactical aspects.
- RiskCity is a generic method that could be applied in cities in developing countries.

High res image

Ward & census



DEM Lidar



Thematic layers:

- Flood discharges
- Seismic catalogs
- Soil and rock data
- Landslide information
- Technological information
- etc.

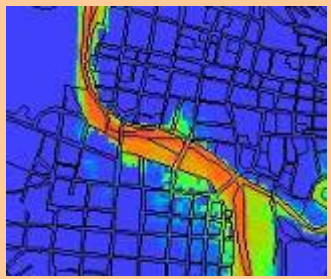
Elements at risk

Building Attributes:

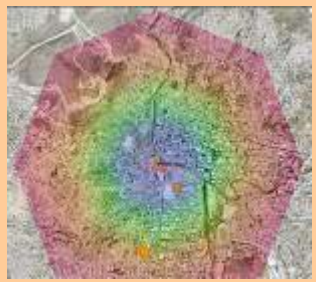
- Urban land use
- Nr of buildings
- Height of buildings
- Nr. people (daytime)
- Nr. people (nighttime)

Hazard maps

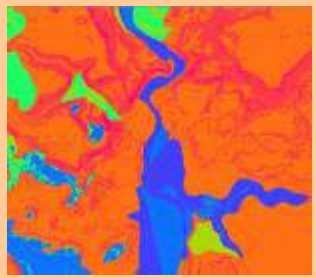
Landslides



Flooding



Technological



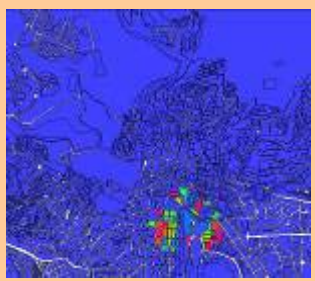
Earthquake

Risk = Hazard * Vulnerability * Amount

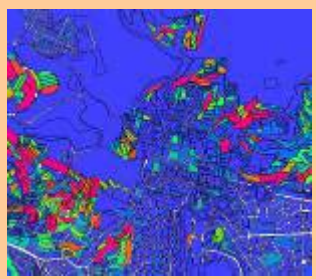
Risk maps

Landslides

Flooding

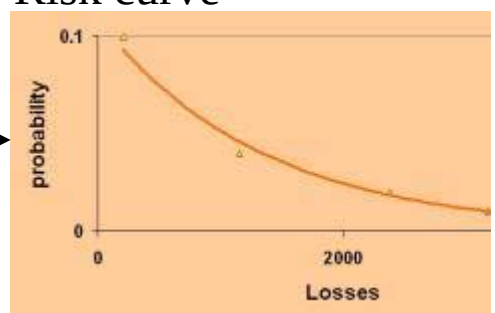


Technological



Earthquake

Risk curve



RiskCity exercises

- **Introduction to data and software,**
- **Obtaining image data and image interpretation;**
  - Downloading Google Earth data and referencing
- **Remote sensing**
- **Hazard assessment:**
  - Landslides, Earthquakes, Flooding, Technological
  - Additional: coastal, tsunami, forest fire, drought, volcanic
- **Elements at risk**
  - Assuming new data is available: start from Google Earth
  - Assuming more data available (cadastral, census, DEM)
- **Loss estimation**
  - Annual loss estimation using risk curves
  - Qualitative loss estimation using matrices
- **Spatial Multi Criteria Evaluation**
  - Using indicators for social, physical, economical, environmental vulnerability, and for capacity
- **Annual loss estimation**
- **Cost benefit analysis**
- **Using risk information in spatial planning**

Planning

- **Available in English, Spanish and Chinese.**
- **Distance education course planned for spring 2009.**
- **Used as basis for courses with different duration**
- **Short courses annually in various locations:**
  - Netherlands (ITC: July)
  - Central America (Mexico: June)
  - South America (Bolivia: September)
  - China (Chengdu: November)
  - SE-Asia (Bangkok: May and October)

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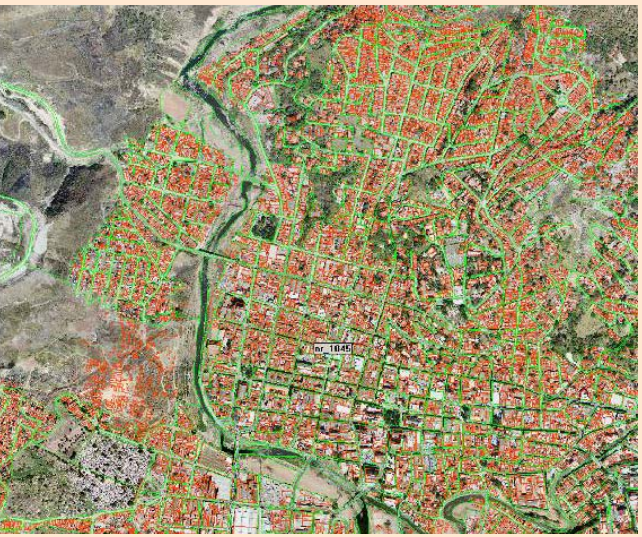
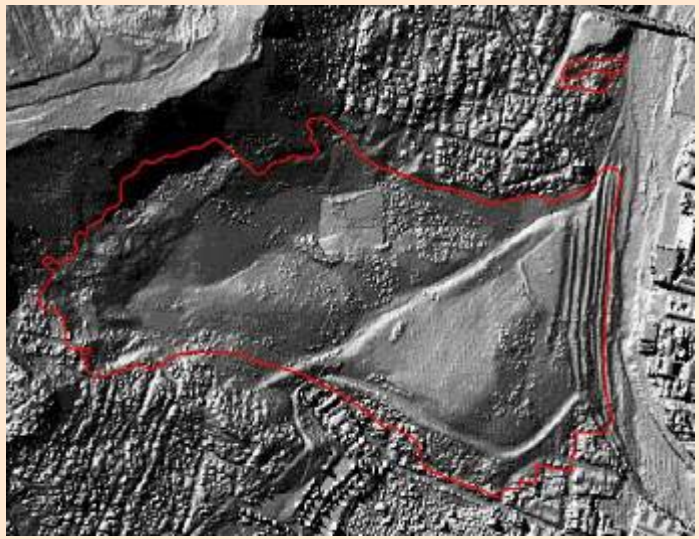
clas

adpc 20 years of reducing disaster risks in Asia and the Pacific

Input data

- **Image data**
- **Hazard data**
- **Elements at risk**
- **Height data**

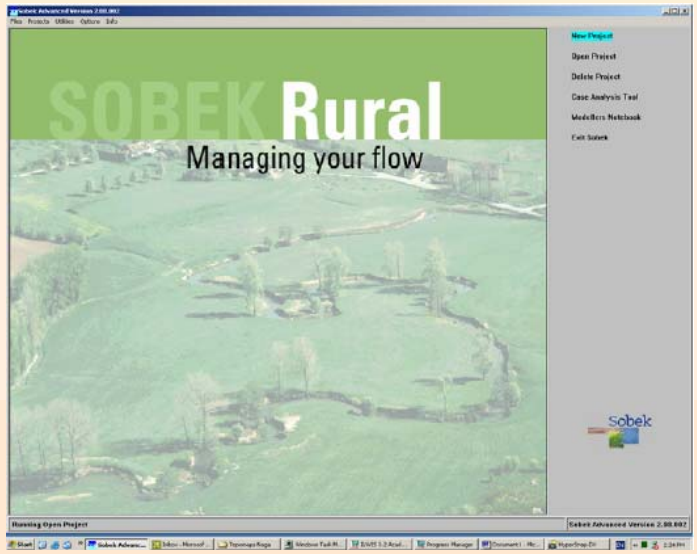


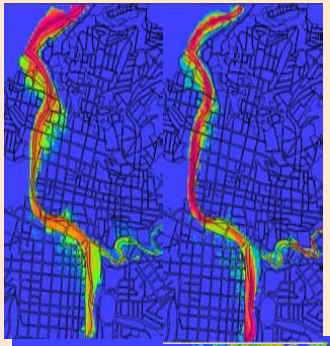


Name	Type
Image data	
High_res_image	Raster image
Elevation data	
LidarDEM	Raster map
Contours	Segment map
TopoDEM	Raster map
Elements at risk	
Wards	Polygon map
Mapping_units	Polygon map and table
Building_map	Raster map
Roads	Segment map
Hazard data	
Landslide_ID	Raster map
Flood_100_year	Polygon map
Rivers	Segment map

Flood hazard modeling

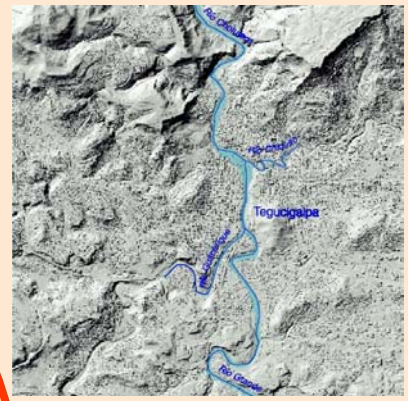
- Sobek: **a two dimensional hydraulic model.**
- Input:
  - **Digital Surface Model (Lidar)**
  - **Discharge data**
  - **Roughness data (landuse)**

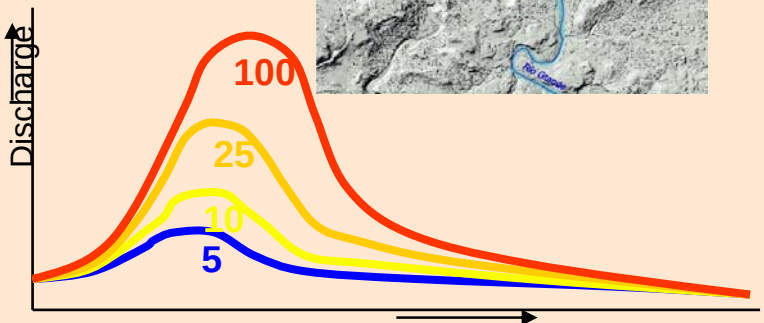




- Output:
  - **Flood depth**
  - **Flow velocity**

(Per time step)





Flood risk

5 years

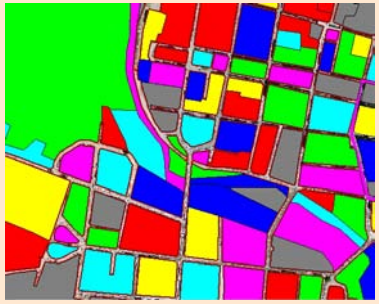
50 years

10 years

100 years

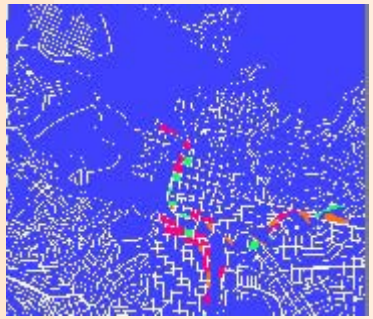
25 years

Mapping units

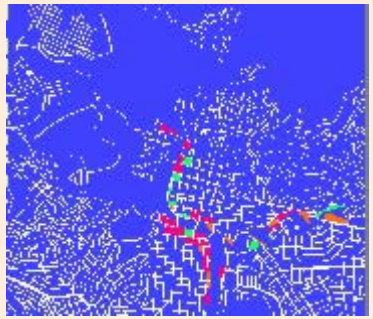


Hazard polygons

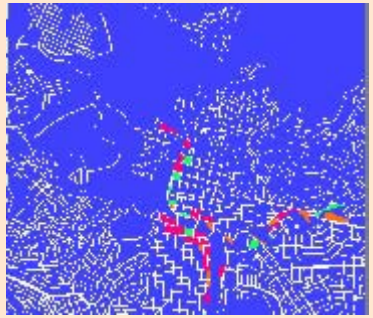
5 years



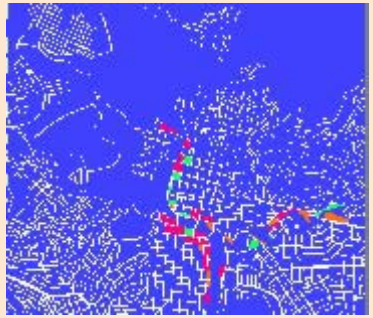
50 years



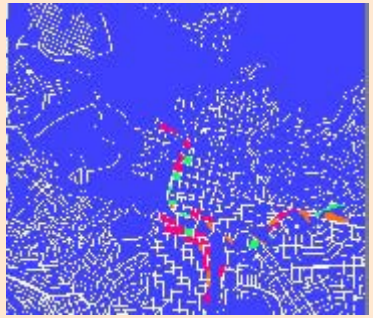
10 years



100 years

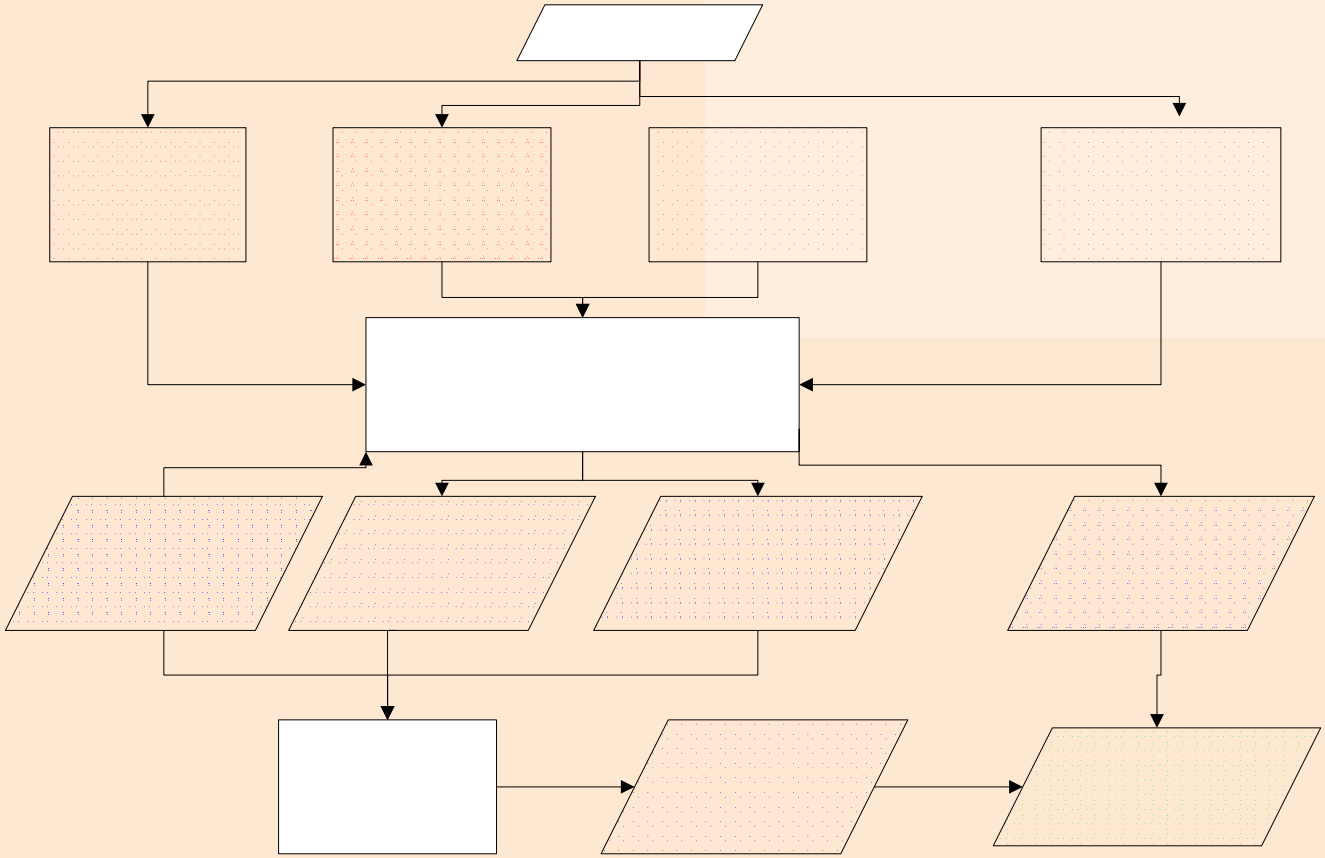


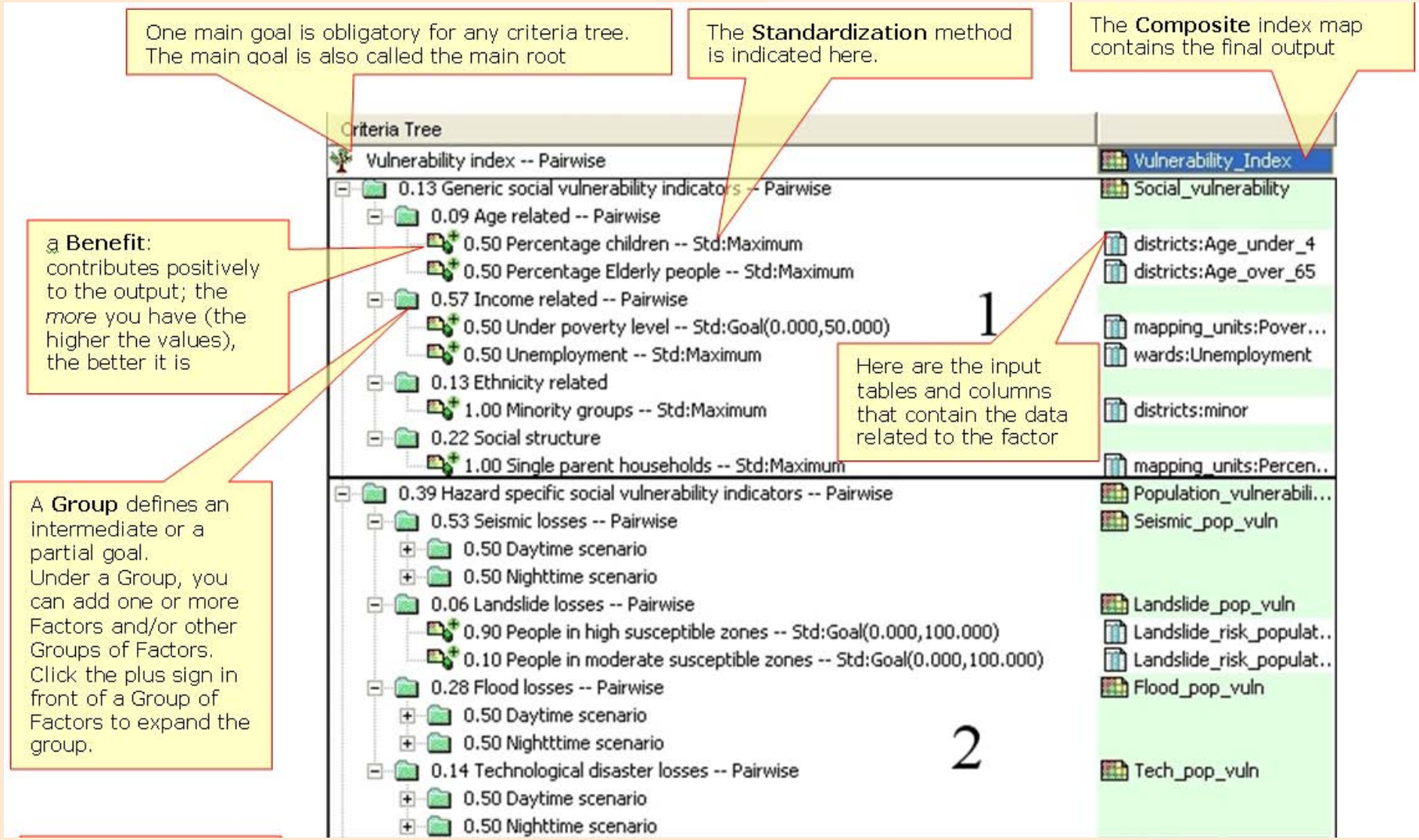
25 years



Buildings Affected

Vulnerability assessment using Spatial Multi-Criteria Evaluation



RISK = HAZARD * VULNERABILITY / CAPACITY

The criteria tree