RISK CHANGES: SPATIAL DECISION SUPPORT SYSTEM FOR THE ANALYSIS OF CHANGING MULTI-HAZARD RISK

CEES VAN WESTEN

Building resilient communities through urban planning and the integration of the Natural Sciences:
QUESTION BY THE ORGANIZERS

- What relevant information of your subject-matter expertise can be provided to urban planning and policy making at local and regional level for planning more resilient cities and human settlements?
  - Introduce a system that supports planners to integrate multi-hazard data;
  - Show examples from different parts of the world (China, Africa, Eastern Europe, Caribbean)
RiskChanges: a Spatial Decision Support System for the analysis of changing multi-hazard risk, based on possible future scenarios and risk reduction alternatives to analyse the effect of risk reduction planning alternatives on reducing the risk now and in the future, and support decision makers in selecting the best alternatives.

Users:
- Civil protection organizations.
- Organizations with the mandate to design structural risk reduction measures
- Planning organizations
Debrisflow (DF) hazard
Return period: 20 years

Flashflood (FL) hazard
Return period: 20 years

Landslide (LS) hazard
Return period: 20 years
Use of possible future scenarios: climate change & land use change

No risk reduction

Alternative 1: Engineering solutions

Alternative 2: Ecological solutions

Alternative 3: Relocation

2014

2020

2030

2040
Loss and risk assessment

Loss calculation for each combination of:
- Hazard type
- Return period
- Elements-at-risk

Select the type of risk analysis:
- Administrative units
- Hazard types
- Elements-at-risk
- Alternatives
- Scenario/future years
- Economic/population
Alternatives for risk reduction

Alternative 1: Engineering solutions

Alternative 2: Ecological solutions

Alternative 3: Relocation

Scenario: Risk-informed planning

<table>
<thead>
<tr>
<th></th>
<th>2014 Annualized Risk</th>
<th>Risk Reduction</th>
<th>2020 Annualized Risk</th>
<th>Risk Reduction</th>
<th>2030 Annualized Risk</th>
<th>Risk Reduction</th>
<th>2040 Annualized Risk</th>
<th>Risk Reduction</th>
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<tbody>
<tr>
<td>Existing</td>
<td>379138</td>
<td></td>
<td>338875</td>
<td></td>
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<td>Alternative 1</td>
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<td>680278</td>
<td>69162</td>
<td>1928873</td>
<td>149170</td>
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</tbody>
</table>

The graphs show the annualized risk and risk reduction over the years 2014 to 2040 for each alternative.
Cost-benefit analysis

- Use results of the risk calculation (AAL) as input;
- Determine investment costs, maintenance costs, and costs
- Project lifetime. Investment period
- Calculate indicators: Cost Benefit Ration, Net Present Value, Internal Rate of Return
Multi-criteria evaluation

- Use risk indicators: AAL, % risk reduction
- Use cost-benefit indicators: CBR, NPV, IRR
- Define other indicators: social, economic, environmental
- Standardization
- Weighting
- Ranking
- Compare ranking of different stakeholders
Visualization options

Single Map Visualization

<table>
<thead>
<tr>
<th>Web-GIS: Single Map Visualization</th>
<th>Functionalities</th>
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<tbody>
<tr>
<td><img src="image" alt="Web-GIS Map" /></td>
<td>• Basic GIS tools (navigation, geo-location, measurement tool etc.)</td>
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<tr>
<td></td>
<td>• Feature Info</td>
</tr>
<tr>
<td></td>
<td>• Layer tree</td>
</tr>
<tr>
<td></td>
<td>• Context Menu</td>
</tr>
<tr>
<td></td>
<td>• Map Legend</td>
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Data Comparison

<table>
<thead>
<tr>
<th>Swiping tool</th>
<th>Linked views</th>
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<td><img src="image" alt="Swiping tool" /></td>
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</table>
http://changes.itc.utwente.nl/RiskCHANGES/
EXAMPLES OF APPLICATIONS WORLDWIDE

Sichuan, China
60,104 landslides

828 individual points in the initiation part of landslides,

586 caused completely damming of rivers;

242 caused partially damming;
Model for the near real-time prediction of earthquake-induced landslide distributions.
Model for the near real-time prediction of earthquake-induced landslide distributions
Multi-hazards: Beichuan town, Sichuan, China
Multi-hazards: Beichuan town, Sichuan, China

Earthquake → Landslide → flood
POST-EARTHQUAKE DEBRIS FLOWS
Debris flow modelling for the design of risk reduction measures
Multi-hazard risk maps

Vulnerability curves

Exposure results: Debrisflows

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<tr>
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<th>Area</th>
<th>Min</th>
<th>Max</th>
<th>percentage</th>
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Exposure results: Floods

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Population Vulnerability Floods

Physical Vulnerability Floods

Population Vulnerability Debrisflows

Physical Vulnerability Debrisflows

Risk results

Economic value of exposed buildings

Estimated economic building losses

Detail (Scale 1:10,000)

The risk assessment was carried out only for floods and debris flows. Due to lack of data, flash floods were not taken into account. The building inventory of the current situation was used. Only building risk was assessed. Risk to transportation and other infrastructure as well as building contents are not included. The impact pressure resulting from the FLOW-R modelling procedure is probably too low. This is why the calculated losses are smaller than the losses reported for the 2004 event. In this regional analysis it was difficult to incorporate the effect of the recent risk mitigation measures. For a full scale analysis would be required.
EXAMPLES OF APPLICATIONS WORLDWIDE

Flood hazard in Kampala, Uganda
Example: Flood management for slums in Kampala
EXAMPLES OF APPLICATIONS WORLDWIDE

5 Caribbean countries
Caribbean Handbook on Risk Information Management

1. Create a methodological framework to incorporate hazard and risk information into planning processes
2. Train technicians and decision-makers to use it
3. Assess and improve upon hazard and risk data availability
Handbook on the generation of hazard and risk data and its use in planning

Methodology “book”
- Analyzing triggers
- Flood hazard assessment
- Landslide hazard Assessment
- Loss estimation
- Evaluating different planning alternatives
- Land use planning and management
- Critical infrastructure
- Writing TORs

Use case “book”
- Land use planning and management
- Critical infrastructure
- Evaluating different planning alternatives
- Disaster preparedness planning
- Loss estimation
- Hazard assessment
- Data management

Data management “book”
- Data requirements
- Data collection: Base data
- Data collection: Hazard data
- Data collection: Assets data
- Managing Geospatial data
- Sharing Geospatial data

www.CHARIM.net
National scale flood and landslide hazard maps
Generation of geographic base data

Landslide maps

Belize, Dominica, Saint Lucia, Saint Vincent and the Grenadines and Grenada

Flood maps
EXAMPLES OF APPLICATIONS WORLDWIDE

Georgia, Caucasus
The project “Institutional building for natural disaster risk reduction (DRR) in Georgia”, aimed to:

- Generate capacity on multi-hazard risk assessment & planning;
- Create a national scale multi-hazard risk atlas for Georgia;
- Train people in new technology;
- Develop guidelines

http://drm.cenn.org
Atlas Flipbook
NATIONAL-SCALE MULTI-HAZARD RISK ASSESSMENT
Atlas of Natural Hazards and Risks in Georgia

Map of Public reporting

Exposure of Population (in %) to Hazard and Risk, aggregated on Region level

Legend
- Region
- District
- Community

Base Layer
- Google Streets
- Google Hybrid
- Google Satellite

Overlays
- Exposure on Region level

Please choose the level at which to generate Exposure maps:
- Region
- District
- Community

Please select the Disaster type:
- Earthquake

Please select the Risk level:
- High

Please select the Exposure element:
- Population

[Generate map] [Reset]
UNIVERSITY OF TWENTE.

THANK YOU

INTERNATIONAL POSTGRADUATE TRAINING, RESEARCH AND PROJECTS