TOWARD AN INTEGRATED SPATIAL DECISION SUPPORT SYSTEM TO IMPROVE COASTAL EROSION RISK ASSESSMENT: MODELING AND REPRESENTATION OF RISK ZONES

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Outline

- Introduction
  - Concepts: Risk, its components and Risk Assessment
  - Issues and needs
  - Main Objective
- Proposed solutions
- Achievements
- Conclusion and Future work
Concepts

a) Fishery Environment Agriculture Transport Urban planning and so on.

b) Risk Concept

Varnes 1984; Blong 1996; Cutter 1996; Cutter et al 2003; Boruff et al 2005; Biddie et al 1994; Dauli et al 2009

Coastal Risk Assessment

IPCC 2007; UNEP 2002; UNFCCC 1999; NOAA 2003; Mai and Leinberger 2002

Risk Concept = Hazard x Vulnerability

Nature of the risk

- Multidimensional: involves several elements that need to be analysed, synthesized, cross-tabulated and compared
- Multi-Scale (micro, meso, macro) and hierarchy
- Existence of uncertainty uncertainty propagation
- Modeling and representation of the risk (segmenting technique and attribution of risk value to each segment)
- Fuzzy nature of coastal Erosion

Prevents the elaboration of a coherent vision of the coastal risk for decision makers

Issues and Needs

- Multiple stakeholders under authority of different organizations in local, provincial and federal governments.
  - Huge amount of data from different sources
  - Multiple criteria and interests to evaluate the risk

- Nature of the risk
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Issues and Needs

Potential Technologies

Geospatial Business Intelligence System (GeoBI)
- Analytical system
- Fast synthesis over time
- Trend analysis
- Perform complex querying
- Aggregated Information
- Spatial comparison
- Interactive knowledge discovery

Main Objectives

Developing a Spatial Decision Support System to improve the assessment of coastal erosion risk using SOLAP approach
Proposed Methodology

Coastal Risk Assessment
- Coastal Hazard Identification
- Vulnerability Analysis
- Coastal Erosion
- Social
- Economical
- Environmental

Response Option Process
- Communicating Result to Decision Makers
- Retreat
- Adaptation
- Protection

Impact Analysis
- Communicating Results to Interested Communities
- Scenario Generation

Coastal Risk Zone Representation

SOLAP: Multi-Dimensional Representation
- 5 Dimensions: Spatial, Temporal, Social, Economical, Environmental

SOLAP Architecture
- Dimension
- Member
- Measure
- Fact

Spatial On-line Analytical Processing

SOLAP Data Structure
- Star
- Snowflake
- Mixed
Solution

- Spatial Decision Support System Based on Geospatial Business Intelligence Paradigm
  - Needs analysis
  - Data inventory
  - Coastal erosion risk parameters (hazards, targets, and vulnerability index)
    \[ R(T,i) = H(T,i) \times \sum_{i=1}^{N} \text{Rank}(v(i)) \times \omega(T,i) \]
  - Spatial multidimensional conceptual model (dimensions of analysis, measures to calculate, and SOLAP implementation model).

Solution (continued)

Elaborate an Adapted Vulnerability Index

<table>
<thead>
<tr>
<th>Category</th>
<th>Index parameter</th>
<th>Rank 1*</th>
<th>Rank 2*</th>
<th>Rank 3*</th>
<th>Rank 4*</th>
<th>Rank 5*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geology &amp; geomorphology (type of coast)</td>
<td>Crop, stable beach with vegetation</td>
<td>6-10m</td>
<td>5-9m</td>
<td>4-5m</td>
<td>3-4m</td>
<td>2-3m</td>
</tr>
<tr>
<td>Geology &amp; geomorphology (type of coast)</td>
<td>Crop, unstable beach without vegetation</td>
<td>2-3m</td>
<td>1-2m</td>
<td>0.5-1m</td>
<td>0-0.5m</td>
<td>2.5-3.5m</td>
</tr>
<tr>
<td>Coast Elevation (DEM)</td>
<td></td>
<td>&gt; 25m</td>
<td>17-24m</td>
<td>11-17m</td>
<td>4-10m</td>
<td>0-3m</td>
</tr>
<tr>
<td>Slope (average)</td>
<td></td>
<td>1-13%</td>
<td>14-20%</td>
<td>21-28%</td>
<td>29-35%</td>
<td>&gt; 36%</td>
</tr>
<tr>
<td>Tide variation (m/year)</td>
<td></td>
<td>&lt;-1</td>
<td>1-0.99</td>
<td>1-2</td>
<td>2.1-4</td>
<td>&gt; 4</td>
</tr>
<tr>
<td>Tide range (m)</td>
<td></td>
<td>&lt;1</td>
<td>1-1.9</td>
<td>2-4</td>
<td>4.1-6</td>
<td>&gt; 6</td>
</tr>
<tr>
<td>Wave height</td>
<td></td>
<td>0-2.9</td>
<td>3-4.9</td>
<td>5-5.9</td>
<td>6-6.9</td>
<td>&gt; 6.9</td>
</tr>
<tr>
<td>Hydrology and drainage network</td>
<td></td>
<td>Non-presence ---- ---- ---- Presence of faults, fractures or subsidence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance between shore and depth of 5m</td>
<td></td>
<td>1001-1200m</td>
<td>701-1000m</td>
<td>700-400m</td>
<td>301-400m</td>
<td>&lt; 300m</td>
</tr>
<tr>
<td>Distance between coastline and the vulnerable object</td>
<td></td>
<td>&gt; 61m</td>
<td>31-60m</td>
<td>21-30m</td>
<td>11-20m</td>
<td>0-10m</td>
</tr>
<tr>
<td>Weakness of geological structure</td>
<td></td>
<td>Absence of faults, fractures or subsidence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Key indicators:**
- People
- Infrastructures
- Building and built environment
- Topography
- Geology and geomorphology
- Hydrology network
- And so on
Achievement:
Spatial Multidimensional Conceptual Model

- Dimensions
  - Spatial
  - Temporal
  - Thematic

- Measures
  - Risk Equation

\[ R(T,t) = H(T,t) \times \sum_{i=1}^{N} \text{Rank}(v(i)) \times \omega_i(T,t) \]

SOLAP Interface
Conclusion

- **Geospatial Business Intelligence paradigm (GeoBI)** is a Fast and Efficient SDSS tool for coastal erosion risk assessment

- **Future work:** implementation of the idea is on the way

Comments or Advices are welcome!
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