WP6 Analysis of Latent Risk Factors (Value-at-risk) for Extreme Phenomena in Coastal Zones

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Moscow – 14.05.2011

Outline

- Loss, essential natural disasters, risks.
- Peculiarity of geophysical data.
- Suggestions for initial data structure, two categories for objects description, their parameters and data matrix.
- Problem statement on developing latent risk factors.
- Probabilities for risk assessment.

Loss, essential natural disasters, risks.

- **Loss** could be regarded in relation to:
  a) gross national product (ВНП);
  b) number of suffering people as related to total population on the territory;
  c) number of human losses.
- Criteria for classification of extreme natural phenomena (EPH)
  i) loss evaluated more than 1% of ВНП;
  ii) number of injured people more than 1%;
  iii) number of human losses more than 100 people.

An event satisfying at least one of the above criteria is referred to as natural disaster.

- Statistical data analysis provided by МЧС shows that dynamics for the loss growth is different for different types of natural disasters.
- **Value-at-Risk (VaR)** in accordance with adopted economical models is **maximal optional loss during natural disaster with probability *p* .**

Value-at-Risk for complex phenomenon is determined by the risks for its structural elements.

Peculiarity of geophysical data

- There does not exist any general unified data base on EPH.
- For most data there does not exist description of measurement technique and accuracy.
- There does not exist any standard for EPH description.

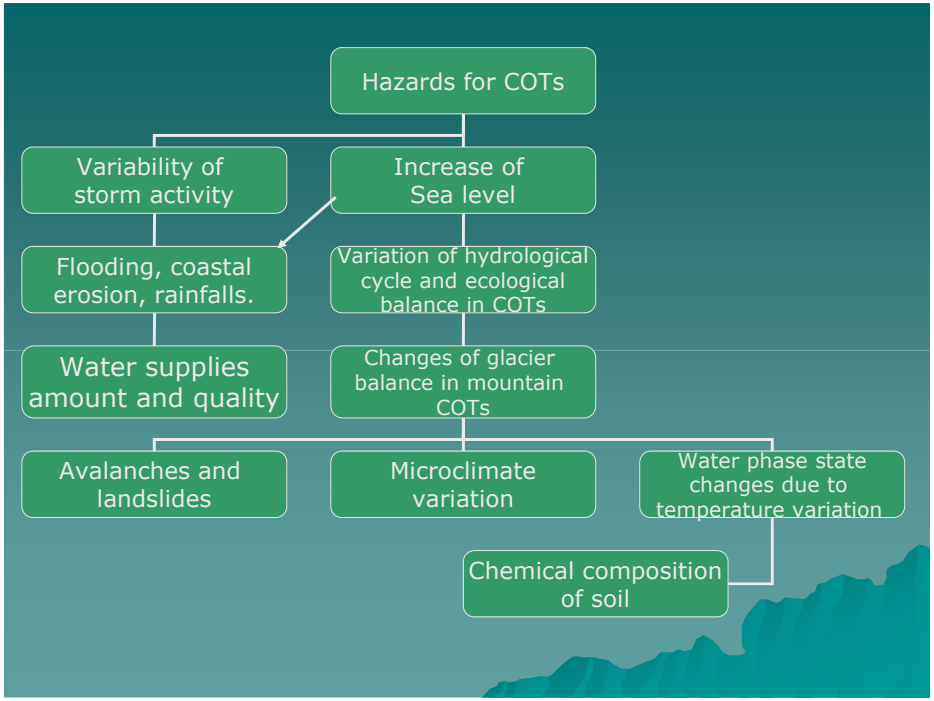
Suggestions for initial data structure, two categories for objects description, their parameters and data matrix.

- Two categories of objects are distinguished to build the data matrix

Coastal territories (COT)

Extreme natural phenomena (EPH)

- Each category could be described by a set of properties, which values could be presented in the form of data matrix.
- Properties could be measured in different scales: quantitative, ordinal, nominative. Each scale limits the set of data analysis methods.



EPH characteristics

- Energetic class of phenomena (*E*)
- Impact (*I*)=(amplitude of effect)/(regular amplitude)
- Loss vector $L=(L_1 , L_2)$
- L_1 – value of economical loss
- L_2 – value characterizing humanitarian loss
- A source of EPH (*S*) (seismic, wind, flooding, storm, rainfalls, mudflows, thermohaline effects, soil contamination, etc.)
- *I* and *S* are measured in nominal scales

COT characteristics

- Population density (y_1) and season variation (y_2)
- Average ВНП for the region (y_3)
- Length of coastline (y_4)
- Fractal dimension of coastline (y_5)
- River delta presence (y_6)
- Mountains (y_7)
- Potential hazard index (y_8)

The list is assembled according to our understanding. It could be increased in case of anything essential missing.

Data Matrix

- For all EPH observed there should be developed a matrix, which rows numbers correspond to EPH and columns – properties. $M_1 = \left(m_{ij}^1\right), i - EPH\ number, j - property\ number$
- For all COTs of interest there should be developed a matrix, which rows numbers correspond to COT and columns – properties. $M_2 = \left(m_{ij}^2\right), i - COT\ number, j - property\ number$
- Both matrixes could be unified.
- There exists a bank of natural disasters from МЧС, which incorporates description of 5200 natural phenomena.

Cluster anallysis

- Clusterization of extreme phenomena (EPH) and coastal territories (COT)
- Based on results of this analysis the most dangerous territories will be distinguished.
- The values of properties for most dangerous territories will be developed.

Problem statement on developing latent risk factors

- The contribution to Value-at-Risk could be made not by each parameter (property) independently, but by some combination (group) of dependent parameters.
- **These groups are named latent risk factors (f_i).**
- Determining of these factors presents a mathematical problem relevant to data matrix distinguishing by means of factor analysis.

Our suggestions

- Define risk as weighted sum of latent factors.

$$VaR = \sum_k w_k f_k$$

- Weight (w_k) of each factor is determined by its loss value.
- Based on physical sources of EPH it is possible to determine natural precursors for this factor.

Probabilities for risk assessment

- Probability distribution function for risk could be determined by a linear combination of probability distribution functions of latent factors.
- Each latent factor has a succession of its natural precursors, which have their own probability $\{A_1, A_2, ..., A_n\}$
- The probability of latent factor could be evaluated by formula

$$p(A_1, A_2, ..., A_n) = p(A_1) \cdot p(A_2 \mid A_1) \cdot ... \cdot p(A_n \mid A_1, ..., A_{n-1})$$

Thank you for attention !