

# **Risk Models and Applications**

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# **Report**

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The Risk Management International Workshop, "Risk Models and Applications 2010", was held in Berlin on August 26-27, 2010. It was organized by CODATA-Germany in cooperation with GI TC 4.6 Environmental Informatics Working Group on Risk Management and with CODATA Working Group on "Documentation, Archiving and Open Access to Disaster Information".

The workshop enabled sharing best practices in risk models applications, implementation, and integration on an interdisciplinary level, and highlighted methodological dilemmas in risk modeling from the information systems point of view.

**Keywords:** Environment, hazard cartography, vulnerability analysis, risk assessment, risk models, risk communication

## **1 Introduction**

Objectives and focus of the workshop:

Due to increasing need for preparedness to disaster risks and development of policy response on a regional, national and international levels [1], extensive research has been done world-wide to model the risks and improve the underlying infrastructure.

Key to the workshop was having multidisciplinary experts to provide alternative views and approaches to risk analysis. The discussions and presentations provided an overview of risk assessment and disaster management related to socio-economic consequences, climate change and industrial hazards. Visualization and GIS representation of integrated risk information, development of specialized tools, databases, and their optimization tests were discussed.

## 2 Contributions

### **The following contributions were presented and discussed on the first day of the workshop:**

Horst Kremers and Alberto Susini: Introduction, scope, and objectives of the workshop  
The overall context of the presentations was given (planning policies with risks, biological and industrial risks, disaster management, emergency planning related to cartography, climate change).

Alberto Susini: Risk mapping of technological risks (chemical, biological and aircraft) by means of GIS Risk-Register, the examples of Geneva, "Geneva Risk" Swiss Government endorsed and commissioned a decision-making tool to address industrial risks arising from different activities, estimate the risks and related costs, as well as evaluate the data capacity and assess cumulative risks. The actors, methodology, dilemmas and links between major hazards and land use planning practices were discussed.

Diana Dushkova and Alexander Evseev: Russian North: environmental and human health risks assessment Importance on the Russian North as the country's largest supply of natural resources and a unique bioserve was emphasised Rapid industrial development of the region resulted in ecosystems disruptions and heavy pollution loads. "Hot spots", or the cities with the highest level of impact were targeted. For each city anthropogenic impact and ecological risks were assessed, and linked to human morbidity. Main types of economic activities causing high ecological risks, or "main destruction centers were identified. Recommendations on possible measures to correct the existing situation were suggested.

Jie-Ying Wu: The Disaster Risk Assessment System under Climate Change in Taiwan  
The disaster risk assessment system (DRAS) for Taiwan was formulated and built based on an extensive expert analysis. The key themes and indicators were selected by experts, scored using Fuzzy Delphi Method and Fuzzy Analytic Hierarchy Process (FAHP), and subsequently ranked. 349 Townships were analyzed. Effects of climate change, environment conditions, and socio-economic situation were incorporated to evaluate disaster risk for each township.

Mulyanto Darmawan and Ferrari Pinem: Forest Degradation Assessment in Kalimantan Tropical Rain Forest (KTRF) using Phenological and Geometrical shape analysis

The study elaborated the methodology of tropical rain forest structure assessment. The key element of research was analysis of forest geometric shape measured from phenological analysis in relation to ecological landscape and landcover mapping One important application on this research is development of a forest degradation model over Kalimantan Island and its interpretation.

G. Barinova, Yu. Koroleva, E. Krasnov: Indicative Modeling and Spatial Evaluation of Air Pollution Risk

Evaluation of air pollution risk in Kaliningrad region was performed based on monitoring of heavy metals concentration in two types of mosses during the period 1994-2005. Using regression analysis, it was shown that the concentrations of the metals depend on annual atmospheric precipitation. Sources of air pollution were identified and classified. Sites delineation was suggested to be incorporated into the further research.

Jianping Yan: Disaster Risk Assessments: GRIP's solution for public sectors Sponsored by the UN, global risk identification program (GRIP), provides a methodology to evaluating earthquake, flood and drought risks, and suggests the response which allows to reduce impact of hazards in high risk areas. Brief history of the project, methodology, and related coordination of country activities was presented. Currently disaster related data on 66 nationalities are being interpreted, and comprehensive disaster risk profiles on a country level are analysed to be reflected in the national disaster risk reduction strategies.

Carmen Diego Gonçalves, Antonio Possolo: Physical and Social Aspects of Seismic Risk

Physical and social aspects of seismic risk were measured and modeled jointly. It was shown that physical and social aspects, although very different in nature, are intertwined and share striking similarities. Seismic risk is assessed via the model, using the judgments on impact and magnitude of the hazard. Models for physical and social impacts all involve considerations of resilience: material in one case, psychological and social in the other.

Raushan Mamyrova: Landslides in loess deposits

Characteristics of loess landslides and their peculiarities for Kyrgyzstan were presented. Based on analysis of historical seismic data and precipitation statistics, it was concluded that thin loess layer can cause catastrophic earth flows, loess failure occurs at gentle slopes, and tension cracks can contribute to water infiltration

The following presentation was handed to the workshop participants:

Robert Dixon-Gough, Józef Hernick, Krzysztof Gawroński : Analysis and Evaluation of the Anthropogenic Morphology of Small Upland Catchments

### **The role of indicators and statistical methods in Risk Models**

At the end of the first day of the workshop, participants discussed the role of indicators and statistical methods in Risk Models.

Disaster Risk Management area is rapidly growing and there is a substantial need for improved statistical data, related indicators, and application of advanced mathematical methods to process the information and build functional and practical models. Special focus has to be placed on methodological issues, standardization and enhancing of data collection, and vulnerability risk indicators.

Before the statistical analysis is performed, we have to define what we are assessing and what are our basic hypothesis on which we are going to build the model. Is it damage? Probability of loss? In disaster risk management we assess the extent of damage, probability, uncertainty and vulnerability. Choosing the model, one has to ask, if the assumptions are applicable for a particular type of analysis and modeling of natural or industrial phenomena. Thorough analysis of the underlying data, and distribution assessment is required (data variability, skewness, normality tests, etc.). For example, if the risk event is defined as a heavy rainfall, with all its negative consequences, risk manager has to assess the probability of the rainfall, the robustness of the estimate, extent of damage and stability of the solution. The input information would be the historical occurrences of the rain, historical damage, and losses. The output should ideally give the tool to cover the potential damage, and define the magnitude of the preventive measures to protect against the hazard effects.

In the field of industrial accidents, there is a substantial need for standardization of plant data, along with generalization and simplification of the major risks and accidents' scenarios. With the formatted data, it will be possible to use models on a regional scale to assign risk damage related to land use management practices.

Simulations and scenario analysis are broadly accepted tools for hazard risks modeling and prediction of risk events. The robustness of the model results can be assessed separately to understand the effects of the parameter fluctuations on the model results. The problems linked to assessing the models uncertainty with clear calculated values, must be better addressed in future.

For any model, specific risk factors, capable of assessment, have to be defined, and classified. Often there is a shortage of usable numerical data for risk parameters. Access to standardized industrial frequency failure data of industrial equipment is of a great help for allowing large scale calculations. It significantly restraints development and validation of the disaster risk models. To address the issue, models for analysis with parameter uncertainty shall be utilized. The magnitude of uncertainty and level of confidence of the model results can be estimated. Improving data quality linked to higher standardization and access, expanding coverage, and choosing most appropriate model, may significantly reduce uncertainty, providing for robust tools for future disaster risk modeling.

**The following presentations were presented on the second day of the workshop:**

Shih-Liang Chan: On the Vulnerability Assessment of Typhoon Disaster of the Taipei Metropolitan Areas

Framework and tools for typhoon disaster vulnerability assessment in Taipei Metropolitan Areas were developed based on the three main components: exposure, sensitivity and resilience. Recursive model developed by Prof. Vester utilizing criteria and impact matrices was applied to simulate effects and create scenario analysis. The inputs included biophysical, socio-economic, and stakeholders involvement measures.

It is planned to extend the research to other metropolitan areas, used different spatial scale application, and apply the results to the spatial planning practice.

Anandita Sengupta: Applying Consequence Modeling Scenarios to Factor Technological Risk into Land Use Planning

The research illustrates the risk zonation of industry approach for India. Master plan of Indian Government is to separate industry clusters, and classify the clusters in terms of industrial risk. Environment risk reporting and information system (ERRIS) is utilized to collect and process information on hazards in residential areas.

Parameters on 100-500 buildings are carefully analyzed, and each area is mapped based on vulnerability assessment. Analysis of combined hazards is proposed for the methodology adjustment.

Jose Manuel Mendes: The Importance of Scale in Social Vulnerability Assessment: The Portuguese Case

A theoretical background on social vulnerability assessment is given. A new measure of social vulnerability based on Susan Cutter's SOVI index, is created, and applied to municipal level with a national framework, and parish level supported by a sample of seven municipalities in the Centre Region of Portugal. Social Vulnerability is considered as a function of Criticality and Support Capabilities. Challenges of data standardization, calibration, and analysis were highlighted.

Biswajeet Pradhan: Manifestation of RS and GIS data for landslide hazard and risk analyses using WoE based geospatial model: Balik Pulau catchments, Malaysia

Landsides lithology, structure, inventory, and detection methods are provided. The Bayesian probability model, known as the likelihood ratio and weights-of-evidence model, is applied to landslide hazard analysis, using spatial databases. Landslides susceptibility maps were created for Malaysia, and subsequently validated using ROC method. The produced landslide hazard map showed 91% prediction.

Risk analysis was performed on the hazard map using the socio-economic parameters and found that a significant portion of the study area is falling under the „high risk zone“ where it poses threat to lives, property and infrastructure.

Zbyněk Sterba, Cenek Sasinka: Evaluation of Maps for Crisis Management in the Context of User's Cognitive Features From Data to Mental Process

The research is a part of an extensive project: “Dynamic Geovisualization in Risk Management” funded by the Ministry of Education, Youth and Sports of Czech Republic. Integrated rescue system uses different GIS and data from different sources. Maps for crisis management must be intelligible and enable quick and effective decision making. MULTivariate TESTING Programme (MUTEP) was developed to enable precise and objective evaluation of cartographic products and perform testing of related attributes. As an experiment, cartographic and psychological tests were applied online. 110 students were tested. As expected, color was a factor which made the information retrieval more complex. Statistical tests on discrimination did not provide pertinent results. Therefore, an important task for the team is to find better psychological models that would test cartographic processes in more suitable way.

Horst Kremers: Elements of RISK Communication

RISK Communication, Actor Situation, Decisionmaking, Strategy and Action Control, Archiving Communication Information, Standards, Multi-Cultural RISK Information.

Alexandre O. Tavares, José M. Mendes, Eduardo Basto, Susana Freiria :

Public Perception and Public Policies on Natural Hazards. The Unconformities in the Portuguese Case

Public awareness is one of the key aspects emphasized by public authorities in Portugal, and incorporated into operational policies. The key natural hazards defined for Portugal generally differ from the ones traditionally looked at by international agencies due to country specifics (wildfires prevail). Analysis of local and national risk perception for Portugal was performed, along with the review of confidence in risk information source. Results clearly differed on regional and organizational level. Further work needed in promoting public awareness to contribute to proper recognition of risk.

Debanjan Bandyopadhyay: Integrating Technological Risk Modeling with Distributed Geoinformation System

High impact industrial risks were assessed based on the review a ghastly accident in Bhopal, in 1984. The main reasons of high impact were: absence of information, public unawareness, unadequacy of health programs, no emergency response structure in place. The need of an integrated information system to help decision making process was emphasized. The system should consolidate the info on hazards, vulnerability, quantitative risk analysis, provide spatial analysis, and be owned by the state. The specific tool for India was developed and is available online. The system has a query capability, evaluates and predicts damage, is easily updateable by actors. The summary impact and the hazard footprint are provided.

Jianping Yan: Disaster Risk Modeling for Public Decision Making – Conceptual Framework

The presenter contrasted his understanding of risk with the alternative definitions, and emphasized the importance of monetary losses equivalent for each assessed case. Examples of catastrophic risk models providing vulnerability assessment in terms of hazard severity and damage exposure were reviewed.

### 3 Open Forum - Discussion, Research and Development Deficits

The discussion following each presentation was of great value to all workshop participants.

Among the discussion items, the following aspects were highlighted as most important topics for further research:

- Social influences, including perception of risk by public, niche:
  - Roles of survey, and cognition aspects integration into risk framework
- Narratives and their role.
  - Definitions of risk situations.
  - Experts and nomenclature, risk vocabulary.
- Building structured methodology to assess risk.
- Incorporation of public opinion into disaster risk assessment in a comprehensive way
  - Public vision and fears
- Continuing problem of syntax , semantics and pragmatics
- Text-oriented risk disaster messages utilization in Risk Management and their impact
  - Newspaper, TV, multimedia
  - Heterogeneous stream of information
- Info-mining messaging and test info-mining further development.
- Information accessibility, communication to public, and impact on policy and regulation
- Creation of easily understandable indicative maps, showing the disaster consequences
- Utilization of risk maps in land use planning
- Hazard and risk mapping and their translation and recognition on public policies
- Data and models validation and the case studies generalization into the general modeling
- Data access and the scalar scope
- Social vulnerability and institutional confidence.

Another comprehensive issue is control. What if the forecast is available? How to minimize the consequences of the approaching disaster? For example: what are the remedies to minimize health risks based on the forecast?

The presenters demonstrated how to integrate environmental and health risks, how to use social traits in conjunction with the seismic and typhoon risks, suggested an integrated framework to assess the hazards holistically. Often many subject matter experts are used to weight the risk elements. Assessment of consistency among the experts is of a major importance. Methodology standardization from local to national level is and reliability can also be a challenge.

Some of the discussions involved the definition of models and methodologies, but also the building and use of data and the reproducibility of results.

Interdisciplinary approach to risk management, including the recognition by the different actors, including politicians, planners and citizens.

Vision of the international organizations responsible for building large platforms and tools for risk management with the vision of case studies with established methodologies to local/regional scales.

Emerged as a relevant topic to the analysis and risk management: the assessment of social vulnerability, which reflects a broad set of indicators and indices, some accepted at global level and with other with specific local definition and expression.

The development deficits and main issues highlighted in "Risk Models and Applications, Selected Papers, CODATA –Germany 2010" special edition are also compelling today.

[1] CODATA-Germany Lecture Notes in Information Sciences, "Risk Models and Applications, 2010" ISBN 978-3-00-030278-7