



Holistic and multifactorial methodology for natural disaster risk assessment

Холистична и мултифакторна методология за оценка на риска от природни бедствия

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Introduction

The risk assessment (analysis) of natural hazards is a disaster preparedness activity including pre-disaster risk reduction phase of the risk management process. Risk analysis is a base for decision making and the main tool for the risk management and scenarios development about the risk reduction. UN terms and definition are accepted and approved among risk management specialists. According to these terms, risk assessment includes three main components: vulnerability, hazard and coping capacity assessment.

Risk – the probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disruption or environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions. The term risk refers to the expected losses from a given hazard to a given element at risk, over a specified future time period. The first definition is given by (Blaikie et al., 1994).

Risk = Hazard potential x Vulnerability, or

Risk = Hazard x Vulnerability/Coping capacity
(UNISDR, 2002; UNDP, 2004).

It must be mentioned that these are not algebraic equations and they only show the interactions between risk, hazard and vulnerability.

Methodology

There are many models and methods for disaster and damage assessment caused by particular natural hazards. Each method or model has its own specific features. The differences in models very often lead

to some disadvantages like: different results, different scenarios with various initial and final data and results, incompatibility, inappropriateness, etc. That's why during the last years the efforts are directed to search complex methods including all factors and parameters concerning risk assessment and analysis.

Basic methods and methodologies about the risk and multi-risk assessment are developed by: United nations programs – ISDR, UNDP; Inter-American Development Bank and Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (GTZ); ESPON 3.1.3...(2004); Joint Research Centre (JRC), EC.

The main components of multifactorial methodology (called risk factors) values are determined as follows:

$$H = w(H1) \times H1 + w(H2) \times H2 + w(H3) \times H3 + \dots + w(Hn) \times Hn,$$

$$E = w(E1) \times E1 + w(E2) \times E2 + w(E3) \times E3 + \dots + w(En) \times En,$$

$$V = w(V1) \times V1 + w(V2) \times V2 + w(V3) \times V3 + \dots + w(Vn) \times Vn,$$

$$C = w(C1) \times C1 + w(C2) \times C2 + w(C3) \times C3 + \dots + w(Cn) \times Cn,$$

where H, E, V and C are the values of the Hazard, Exposure, Vulnerability and Capacity & Measures, respectively; H1, H2...E1, E2...V1, V2...C1, C2... refer to the scaled values of the indicators, and w_i are the weights. A total sum of the weighting coefficients must be equal to 100.

The risk profile for the given selected area is expressed as:

$$R = (wH + wE + wV) - wC,$$

where R is the overall risk index, H, E, V and C are the factors value of the Hazard, Exposure, Vulnerability and Coping capacity, respectively and w_i is the weighting coefficient.

Discussion

The new holistic approach for multifactorial methodology includes (Frantsova, 2017):

- *Risk perception as a part of the risk assessment.*

This is an attempt to quantify psychological factors as a source of increasing risk and vulnerability. Considering the models and research, risk perception can be accepted as a root foundation related to the risk management. Therefore, the inclusion in the risk assessment is imperative. The psychological variable “It won’t happen to me” is associated with personal decisions. But the analogous psychological factors are the base of the human behavior and decisions. Risk perception as a key factor may become the main reason for maximize vulnerability or respectively its reduction.

Thereby, the risk profile for the given selected area is expressed as:

$$R = wH + wE + wV + wRP - wC,$$

where H, E, V, C and PR are the values of the Hazard, Exposure, Vulnerability, Coping Capacity and Risk Perception, respectively; H1, H2...E1, E2...V1, V2...C1, C2... refer to the scaled values of the indicators, and w_i are the weights.

Thus, we can accept the “risk perception” as the one of the core factors with the highest “weight” in the establishment of the risk profile for the given phenomenon. The statement “It won’t happen to me” lead to “I won’t take any measures because it merely won’t happen to me”.

- *Five classification characteristics associated with risk perception.*

These evaluation elements are derived from risk perception research. They have already been proposed as criteria for risk evaluation procedures in a number of countries such as Denmark, the Netherlands and Switzerland (WGBU, 1998). The following are particularly important:

- ubiquity – spatial distribution of damage or of damage potential;
- persistency – temporal scope of damage or damage potential;
- irreversibility – non-restorability of the state that prevailed prior to occurrence of damage. In the environmental context, this is primarily a matter of the restorability of processes of dynamic change

(such as reforestation or water treatment), not of the individual restoration of an original state (such as preserving an individual tree or extirpating non-native plant and animal species);

- delay effect – the possibility that there is a large latency between the cause and its consequential damage. Latency can be of physical (low reaction speed), chemical or biological nature (such as in many forms of cancer or mutagenic changes). It can also result from a long chain of variables (such as cessation of the Gulf Stream due to climatic changes);

- mobilization potential (refusal of acceptance) – the violation of individual, social or cultural interests and values that leads to a corresponding reaction on the part of those affected. Such reactions can include open protest, the withdrawal of trust in decision makers, covert acts of sabotage or other forms of resistance. Psychosomatic consequences can also be included in this category.

- *Global change syndromes.*

All syndromes must meet the following criteria, however:

- each syndrome relates directly or indirectly to the environment; exclusive reference to core problems within the anthroposphere is not permitted;

- the syndrome should occur as a visible or virulent cross-cutting problem in many regions of the world;

- the syndrome should describe non-sustainable development and/or significant environmental degradation.

Global change research must therefore deal with the diagnosis, prediction and assessment of global trends, the prevention of negative trends, “repairing” existing damage (rehabilitation and reconstruct) and adaptation to the unavoidable. Therefore, the primary interactions between these trends must be identified, described and explained.

The syndrome concept provides a new basis for global change research, the knowledge base of which continues to be split up according to the environmental media or core problems. This sectoral or disciplinary approach is certainly justified: without searching for a deeper understanding of the individual problem areas and their functional mechanisms, it is impossible to understand the specific aspects of environmental stress.

Conclusion. Why is the holistic approach so important?

The study of risk perception arose out of the observation that experts and people often disagreed about the risky various technologies and natural hazards. Three major families of theory have been developed: psychology approaches (heuristics and cogni-

tive), anthropology/sociology approaches (cultural theory) and interdisciplinary approaches (social amplification of risk framework). The earliest psychometric research was done by psychologists Daniel Kahneman and Amos Tversky, who performed a series of gambling experiments to see how people evaluated probabilities. Their major finding was that people use a number of heuristics to evaluate information.

Research within the psychometric paradigm turned to focus on the roles of affect, emotion, beliefs, etc., in influencing risk perception. Melissa Finucane and Paul Slovic have been the key researchers here.

Daniel Kahneman known for his work on the psychology of judgment and decision-making, as well as behavioral economics, for which he was awarded the 2002 Nobel Memorial Prize in Economic Sciences (shared with Vernon L. Smith).

Meanwhile, many different methods, methodologies and techniques have been developed to predict with the highest accuracy relative frequencies and magnitude of natural events and possible damage.

Risk perception, by contrast is based largely on personal experience, mediated information, intuitive estimations, cultural evolution, etc. As studies of risk perception have shown that people associate risks not only with physical damage, but also with violations of social and cultural values (Fischhoff et al., 1978; Slovic, 1987, 2000; Drottz-Sjöberg, 1991; Pidgeon et al., 1992; Jungermann, Slovic, 1993; Renn, 1998). The technical-scientific risk perspective has largely excluded this dimension of risk, restricting itself essentially to damage to property, health and the environment (WGBU, 1998). It was only psychological and sociological risk research that then created a basis for sufficiently characterizing and largely explaining societal risk experience. Besides underscoring non-physical risk dimensions, perception research has also shown that people base their evaluations of risks on a series of contextual risk properties in addition to the probability and severity of damage.

On the basis of the knowledge of non-physical dimensions and contextual risk properties we can understand the human behavior against natural events and threats. What a society defines or professes to perceive as risk is thus not necessarily in

any direct relation to the magnitude of risk as defined by the two components of probability of occurrence and extent of damage (Renn, 1998).

A comprehensive risk analysis should be based on a holistic approach and include not only rational techno-mathematical methods, but also psychological constructs that are part of the everyday life of every individual, depending on their environment, culture, society, psychology, beliefs, etc. The ways in which decisions are made are not rational and technical-mathematical, but intuitive, even mythological, and based on previous experience.

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