Risk Analysis for Comparison of the Proposed Activity Alternatives for the Purposes of Environmental Impacts Assessment

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Abstract: Environmental impact assessment (EIA) offers an appropriate legal and procedural framework for the integration of Risk analysis (RA). However, up to now risk analysis has not been widely used in European EIA practice. This paper proposes a model for procedural and methodological integration of EIA and RA based on reported best practice approaches. The proposed model stipulates embedding RA into EIA and is organized in accordance with the generic stages of the EIA process. The objective of the paper is to propose a methodology for assessing the activities, which will allow impacts assessment mainly in the field of water management (it has been applied in this field) on the environment and hence select the best option for the permission process. The paper presents a system of environmental impact assessment using risk analysis, the result of which should lead to the selection of future activity quantified with minimum risk to the environment. Comparison of the variants and designation of the optimal alternative will be implemented based on probabilities and consequences which objectively describe the characteristic lines of the planned variants and their impact on the environment.

Key words: Alternatives of the Activity · Degree of Risk · Environmental Impact Assessment (EIA) · Flood Protection Measure · Risk Analysis (RA) · Risk Index

INTRODUCTION

The process of the environmental impact assessment (EIA) is one of the most important instruments applied for environmental management [1] firmly embedded in domestic and international environmental law [2]. Despite the different legal prescriptions around the world, EIA consists of a rather standard set of logically organized stages (Figure 1-left section) [3, 4, 5]. A number of specific procedural issues were emerged in several of the special edition papers. These are: cumulative effects; public participation and different systematic methods which can be used for comparing and evaluating alternatives [4, 6].

Successful implementation of EIA requires skilled people, access to assessment and monitoring methods, financial and institutional support and monitoring and enforcement powers, amongst others. The availability of such resources across the region has improved significantly over the past decade, but there is still a noticeable lack of capacity and resources for environmental assessment and management. The use of risk-based methods in environmental impact assessment is limited. Risk analysis can offer many benefits as both a supporting and complementary technique in EIA and risk-based considerations may in many cases even be required to fulfil the substantive objectives of EIA as an instrument for precautionary and preventive environmental protection.
Fig. 1: Flow chart of the EIA process [12] and proposal methodology [10]-integration risk analysis (RA) into environmental impact assessment (EIA) process

The aim of the paper is to develop general methodology for the analysis and evaluation of environmental impacts of proposed activities on the environment by using risk analysis. The proposed methodology was applied for flood protection measures [7]. The application of developed methodology for the EIA process will developed assumptions for further improvements respectively more effective implementation and performance of EIA process.

MATERIALS AND METHODS

The paper presents the new scientific approach of using the risk analysis in the performance of impact assessment. The basic principle of the proposed action is to calculate the risk index—an estimation of the level of risk posed by the proposed activity on the environment. RA is based on the principle that the proposed activity is related to stressors that present the risk for the environment. This can be quantified by calculating of the individual risk for each identified stressor effects on components of the environment. Totally is possible to calculate the overall risk, which proposed activity poses to the environment and human health. The proposal methodology is illustrated in Figure 1 (right section).

Process of the risk analysis according the proposed methodology consists of three steps: identification of impacts, prediction of impacts-determination of
probability and consequence levels and evaluation of impact within each is necessary to perform several important tasks [7]. For identification the environmental impacts of stressors-sources of risks is used Universal matrix of risk analysis (UMRA). There are identified several major stressors like emission, flood, drought, sediments, pollutants, erosion, landslides, noise, vibrations, waste and radiation which have an impacts to population, climatic conditions, water environment and landscape.

Four levels of probability (0-1) and consequence (0-1) are proposed based on the literature studied, such as by [8] or [9] etc.

There are proposed four levels of risk-negligible, low, middle and high.

Assessment of the probability and consequence are combined in order to set individual risk of stressor to environmental components. Risk index \( IR_j \) reflects what risk posed the alternative of the proposed action for the environment. Index of risk \( IR_j \) is calculated using the following equation (2):

\[
IR_j = \sum_{i=1}^{n} P_i \cdot C_i,
\]

where IR-risk index; \( P \)-probability; \( C \)-consequence; \( j \)-rank of the alternative; \( n \)-number of considered impacts of stressors to environmental components (\( n = 1, 2, 3, 70 \)); \( i \)-rank of probability and consequences.

RESULTS AND DISCUSSION

The proposal of this procedure using risk analysis for determining the risk is used for choosing the best alternative of the proposed action of flood protection measure proposal in the village of Kru-lov. Slatvinec water stream in the village presents a constant threat of flooding there. Therefore it is inevitable to drainage areas as care and protection of the environment and people. Proposed alternatives for proposed activity, flood protection measure in Kru-lov village are [7, 10]:

- **Alternative 0 (\( A_0 \)): The current state** - stream bed will not be regulated;
- **Alternative I (\( A_1 \)): The polder construction** - stream bed will be regulated and the polder will be constructed above the village;
- **Alternative II (\( A_2 \)): The stream bed regulation** - stream bed in the village will be regulated for \( Q_{100} \).

On the basis of this assessment we may justify the proposal as follows: A comparison of alternatives for the proposed action-flood protection facilities in the village Kru-lov at the stream Slatvinec all three considered alternatives \( (A_0, A_1, A_2) \) presents on the basis of the calculated risk index \( IR_j \) middle and high level of environmental risk. Based on the risk index \( IR_j \) we can state that Alternative I \( (A_1) \) is in the light of expected environmental impacts optimal and therefore it is recommended to regulate the watercourse Slatvinec in the village Kru-lov and build the polder above the village. The object of flood protection according to [10] is assigned to middle level of risk, which was designed based on the calculated risk index and presents optimal alternative for the environment.

CONCLUSION

Risks \( R \) are calculated individually for each stressor which have impact on the components of the environment for each considered variant for determination of risk index \( IR_j \). Calculation of the risk index \( IR_j \) determines the risk posed by activity for environment. It is directly related to the environmental impact assessment of activities under Law No. 24/2006 Coll. in Slovakia. Under this law it is necessary to compare alternatives for the proposed activity and produce a proposal for the optimal alternative.

The current paper proposes a model of integrating RA into EIA which may be considered as a framework for risk based evaluation of environmental impacts of flood mitigation measures which are part of water management.

ACKNOWLEDGEMENTS

The contribution is written thanks to support of project VEGA 1/0609/14.

REFERENCES