METHODOLOGY FOR ASSESSING ENVIRONMENTAL IMPACTS OF FLOOD PROTECTION OBJECTS

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Abstract

In the European Region, floods are the most common disasters, causing extensive damage and disruption. Flood mitigation measures are being undertaken throughout the centuries to reduce flood damages and losses. The paper at first introduces the environmental impact assessment process in Slovakia and involvement of risk analysis in environmental impact assessment. Risk analysis is an appropriate tool to determine the level of the risk of the proposed flood mitigation measures and through which it is possible to choose the alternative with the lowest level of risk for the environment. The objective of the paper is to propose a methodology for assessing environmental impact of flood protection objects. It offers some recommendations and conclusions with the aim of providing valuable insights for decision makers, planners and policy makers for the improvement of the environmental impact assessment practice.

Key words

decision making; environmental impact assessment; flood protection; risk analysis

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1 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]. EIA is 45 years old (beginning on 1 January 1970 when President Richard Nixon signed the National Environmental Policy Act in the USA). EIA, in principle, is the systematic approach used in the identification and evaluation of beneficial and harmful impacts on the physical, biological and socio-economic components of the environment.

EIA procedures for public and private projects that are likely to have significant effects on the environment in the Slovak Republic have been in place since the adoption of the EIA Act in 1994. In 2006, a new EIA Act in Slovakia was approved, and EIA procedures began to be applied to proposed activities under the 2006 Planning Act. The 2006 EIA Act introduced no major changes in EIA procedures but it tightened certain procedural time limits and better delineated EIA responsibilities between the Ministry of Environment (MoE) and the regional and district environment offices. It also harmonised the Slovak EIA legislation with three EU directives (Directive 97/11/EC, Directive 2003/35/EC, Directive 2009/31/EC, Directive 2014/52/EC) and put preconditions on the accession of Slovakia to the UNECE Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (the Aarhus Convention). The adoption of the EIA Act provided a firm basis for assessing forthcoming projects to be financed from EU Structural and Cohesion Funds [3].

The number of EIA procedures in Slovakia was low (30 to 70 a year) until 2000, but increased to around 200 in 2001 after the scope of projects subject to EIA was extended. Greater involvement by subnational environmental bodies after 2000 was also a factor. The number of EIAs increased further during the review period, reaching nearly 900 cases in 2008 [4]. Documentation from the assessment process is available to the public in electronic form on the MoE website. The complete documentation from 20 years of experience with EIA is archived in the EIA Documentation Centre at the Slovak Environmental Agency in Banská Bystrica. Figure 1 summarises the number of completed assessments of the proposed activities (EIA) and strategic documents (SEA) in Slovakia in 1994 – 2014.

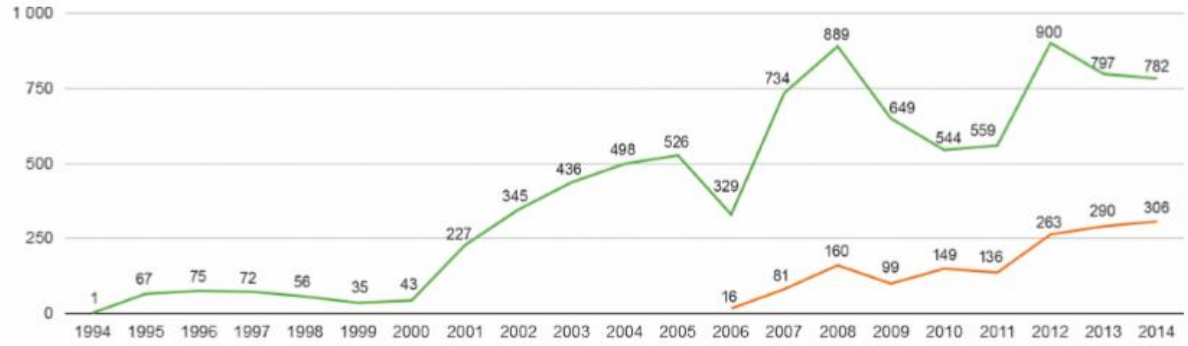

Figure 1. Number of completed assessments of proposed activities (EIA) in Slovakia in 1994 – 2014 (green – EIA; red – SEA) [4]

The National Council of the Slovak Republic on 1 January 2015 approved Law no. 314/2014 Coll., amending and supplementing Law no. 24/2006 Coll. on the assessment of impacts on the environment and on amendments to certain laws, as amended, and on amendments to certain laws.

Experience with the implementation of the Law on Environmental Impact Assessment confirmed that the technical and urban development of Slovakia must go hand in hand from the beginning with knowledge of how much influence new activity will have in a particular area, and how potential negative impact on the environment will be minimized [5], [6] and [7].

From the methodological point of view, in the recent years much attention has been paid to the quality of preliminary environmental study and environmental impact statement. The quality of both needs to be constantly improved [6], [7].

The Conclusions and Recommendations of the second International Conference SEA/EIA 2014 in Slovakia, which among other things pay attention to the methodological manuals and guidelines, include for example the following:

- To revise current guidance materials in connection with the development of new techniques and methodologies as well as the practical experience of EIA/SEA in Slovakia and abroad (especially in the UK, the Netherlands, Sweden, Germany, Austria and the Czech Republic);
- To develop guidance materials or procedures and guidelines for issues which have not yet been solved, to take into account current knowledge and methods (e.g. risk analysis, guidance on the issue of reasonable alternatives and the method of their choice).

This need is confirmed by the results of a questionnaire survey conducted within the project "*Assessment of the quality of the environment in the V4 countries*". The objective of the project was to facilitate and promote the development of closer cooperation among V4 countries in the field of environmental assessment. Within this project implementation current methodologies were reviewed in relation to the development of new methodologies as well as practical experience with the process of evaluating the impacts of proposed activities on the environment [1].

According to the project's results – questionnaire survey [1] – eighteen percent of the respondents considered the methodological handbooks for the EIA process as sufficient, while 34 % of respondents considered them to be insufficient and 44 % of respondents thought that they were partially sufficient.

The key findings from empirical research from [8] are:

- No specific guidance on how to apply risk assessment in EIA exists.
- Literature on the linkage between risk assessment and EIA is rare, and few empirical evaluations of EIA have dealt with the issue up to now; those that did yielded evidence that EIA performance in terms of risk assessment is rather modest.
- Most practical applications of risk assessment in EIA are human health risk assessments and technological safety risk assessments. Adverse effects on non-human

biotic receptors and ecosystem wellbeing and integrity are seldom assessed, as well as the environmental consequences of accidents in general.

- Risk assessment in EIA is often hazard-based and oriented on a risk management approach. It often lacks systematic and deliberate approaches, methodical coherency, and completeness in terms of analytical key steps.
- Numerous and diversified barriers to more coverage and deeper integration of risk assessment in EIA were identified. Barriers most frequently named by experts include, amongst others:
    - lack of specific technical guidance, know-how, expertise, and training;
    - missing legal requirements;
    - missing definition of the concept of risk in the context of EIA;
    - lack of adequate methods;
    - deficits in coordination with other procedures;
    - difficulties in integrating outcomes of risk assessment in decision-making processes, in particular with regard to evaluating acceptability of risk;
    - difficulties in communicating risk issues and handling them in public participation;
    - fears about overburdening EIA, increase in duration and cost of procedures;
    - lack of awareness for significance or probabilistic nature of many hazards.

A risk-based approach is capable of being applied to key stages of the EIA process from scoping to mitigation. The application of a risk-based approach early in the process should contribute to early identification of key issues which would become the focus of subsequent detailed assessment phases. This approach recognizes that the level of information and knowledge regarding risks would increase during the environmental impact assessment process [9].

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 as can be seen from the various country papers, there is still a noticeable lack of capacity and resources for environmental assessment and management of water structures. The status of current practices is summarized as follows.

The use of risk-based methods in environmental impact assessment is limited. Only in Australia (and possibly New Zealand) is risk analysis now starting to be used as a methodology for environmental impact assessment [10]. The wider use of risk-based approaches is recognized as potentially helpful to define more precisely the environmental risks and enabling focus in key issues in environmental management and monitoring. A more explicit emphasis on risk analysis at all levels of assessment, and particularly in screening and scoping, should improve focus and administrative efficiency.

2 METHODOLOGY

Natural disasters have marked human existence throughout history [11], and leave a trail of deaths, destroyed homes, shattered communities and far-reaching damage to national economies. But in recent times, the scale and scope of these events have increased markedly. Since 1990, natural disasters have affected about 217 million people every year [12]. Natural disasters are broadly classified as biologic, climate-related (hydro-meteorologic), or geophysical (Table 1). The selection of optimal risk protection measures is a central task in many fields of human activity including natural hazard mitigation.

Table 1. Classification of natural disasters [12]

Disaster subgroup	Disaster main types
Geophysical	Earthquake Volcano Mass movement (dry): rockfall, landslide, avalanche, subsidence
Meteorological	Storm: tropical cyclone, extratropical cyclone, local storm
Hydrological	Flood: general flood, flash flood, storm surge or coastal flood Mass movement (wet): rockfall, landslide, avalanche, subsidence
Climatological	Extreme temperature: heat wave, cold wave, extreme winter condition Drought Wildfire: forest fire, land fire
Biological	Epidemic infectious disease: viral, bacterial, parasitic, fungal, prion Insect infestation Animal stampede

Authors have proved that a risk-based approach may be applied in the EIA process. It is assumed that this could be applied during the scoping phases of the EIA and includes the consideration of potential impacts of developments to environment and humans.

It is appropriate that the criteria used within the EIA risk-based approach are consistent with the terminology and understandings used within the water management sector by integration the risk analysis within EIA.

This paper provides a framework for the risk analysis component of the scoping phase within the EIA process, Figure 2. The process outlined in this paper will assist with determination of an estimation of risks to environmental and health of proposed activities.

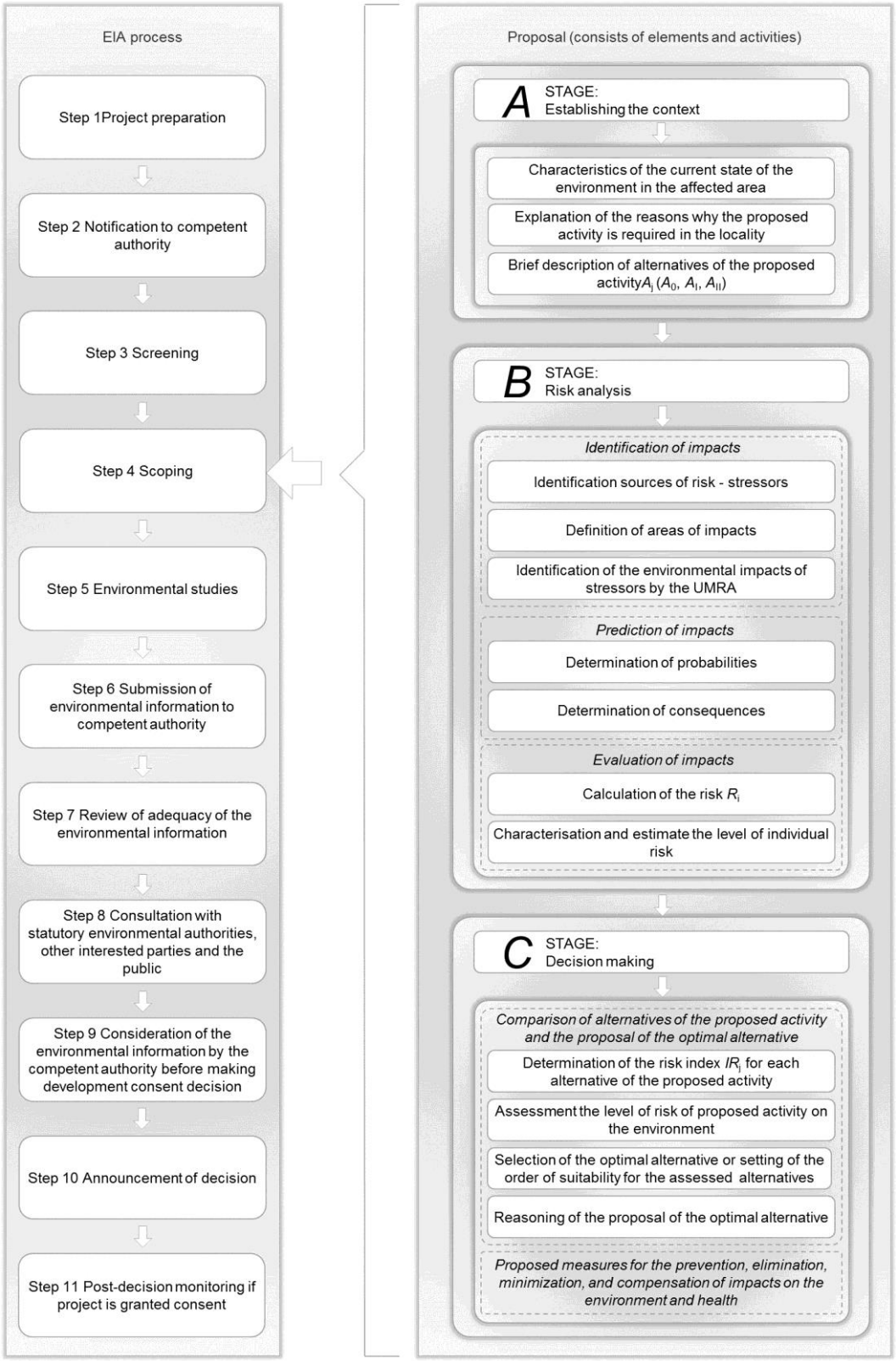

Figure 2. Flow chart of the EIA process and proposal methodology – integration risk analysis (RA) into environmental impact assessment (EIA) process based on UMRA

The proposed methodology consists of three stages, which includes a number of key elements and activities. In this section methodological approach to flood direct intangible damage (negative effects on environment) assessment is presented. Overall, an accurate estimation of negative effects on environment is important in order to be able to determine the environmental flood risk level in a system and the effects of risk reducing measures.

3 RESULTS

In Slovakia, and not only here, there is significantly increasing climate variability, particularly total precipitation. There has been a very significant increase in the occurrence of extreme daily precipitation resulting in increased risk of local flooding in various areas of the Slovak Republic in the last 20 years.

The risk analysis according to the proposed methodology consists of three activities: identification, prediction and evaluation of impacts. The objective of risk analysis is to provide guidance to characterize the relationship between probabilities and consequences of individual risks. Assessments of probability and consequence are combined in order to set the risk of individual stressors to environmental components. The risk matrix is a tool for obtaining a risk assessment of the proposed activity on the environment. The final step is selection the best from the proposed alternatives for decision making – choosing the best option for flood protection in the study area.

3.1 Comparison of alternatives of the proposed activity and proposal of the optimum alternative

- Determination of risk index IR_j for each alternative of the proposed activity

Calculation of the risk index IR_j determines the risk for the environment posed by water structures. It is directly related to the environmental impact assessment of activities under Law No. 24/2006 Coll. Under this law it is necessary to compare alternatives for the proposed activity and produce a proposal for the optimum alternative. This proposal of the activity, which involves creating a set of criteria of risk factors to determine the assessment of each alternative, can be used as a reference element for selection of the optimum alternative, or to determine the suitability of the assessed alternative. It serves as a basis for justification of the optimum alternative.

- Selection of the optimum alternative or ranking of the alternatives assessed in order of suitability

The first place represents an alternative that is optimal in terms of the degree of risk posed to the environment. The second place is an alternative which is less acceptable and the third place is the alternative that is least acceptable and the most risky in terms of the level of risk to the environment.

3.2 Proposed measures for the prevention, elimination, minimization, and compensation of impacts on the environment and health

Implementation of the project will be prepared on the basis of project documentation in accordance with Law No. 50/1976 Coll. on Spatial Planning and Construction (Building Act), as amended, and subsequently a construction permit will be issued. Documentation of the flood protection object proposal must include all requirements for the adoption of such

measures in order to mitigate the negative impacts of the proposed activity on the environment or prevent, mitigate, minimize or compensate expected impacts of actions that may arise during its implementation. For construction of the flood protection objects (FPO) it is necessary to have in place the following precautions:

- zoning measures:
  - approve the proposed activity within the land use planning documentation;
- technical measures:
  - during the vegetation work, implement the adequate compensation of native plants in appropriate places providing channel flow capacity; etc.
- technological measures:
  - carry out the technological part of the work in accordance with the preparation of project documentation;
- organizational and operational measures:
  - implement safety measures at the construction site; etc.
- other measures:
  - the implementation company must ensure disposal of generated waste in accordance with applicable legislation; etc.

4 CONCLUSION

It is expected that EIA will continue to act as an effective tool to prevent the application of investments in Slovakia which by their degree of environmental damage many times outweigh their benefits. In some cases, EIA is understood only as a "mirror" to comply with legal or technical standards, which is not sufficient for modern environmental planning. The assessment process should take into account the emotions and feelings of the public, stress factors, fear of risk and criteria reducing the quality of life. Generally, we can say that impact assessment in Slovakia is still based on professional principles, as is evidenced by EIA documentation on a standard or even high level.

The weaknesses of the EIA process lie in the methods used within EIAs. The challenge for environmental research is to improve the guidance provided for impact analyses so as to encourage good practice within EIAs, and to eventually strengthen the consideration of environmental issues in the decision-making concerning new projects. To this end, the application of risk analysis to EIA has been chosen as the subject of this research.

This paper explores the benefits of using the risk assessment/analysis technique in the evaluation of proposed activities. The aim is to improve transparency and minimize subjectivity in the EIA process. This methodology is intended to streamline the process of environmental impact assessment of constructions, also in the field of the water management.

The work points out the possibility of improving existing methods of assessing the impacts of proposed activities by applying risk analysis in assessing the impact of water structures on the

environment. Utilizing the methods of risk analysis to assess the impact of activities on the environment and human health is an original proposal.

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