

# Analysis and assessment of environmental impacts of small hydro power plant in Slovakia

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**Abstract.** Environmental impact assessment (EIA) is an important process that, prior to approval of the investment plan, can provide a detailed examination of the likely and foreseeable impacts of proposed construction activity on the environment. The objective of this paper is to apply a specific methodology for the analysis and evaluation of the environmental impacts of selected constructions, namely, small hydro power plant, using matrix of impacts. This analysis method is intended not only to increase the clarity and precision of the evaluation process, but also to align it with the requirements of the environmental impact assessment system. This modification should improve the reliability of the environmental impact assessment, and could moreover also be applied to other infrastructure projects. Comparison of alternatives and designation of the optimal variant are implemented based on selected criteria that objectively describe the characteristic lines of the planned alternatives of activity and their impact on the environment. The use of proper EIA procedures can help the decision-makers to formulate proper activities based on qualified decisions. The designed project in Spišské Bystré, Slovakia is used as a case study to clarify and exemplify the methodology and techniques.

## 1. Introduction

The issue of greenhouse gas emissions in Europe is becoming more relevant. European Union countries, is continuously working to reduce these emissions. They have created a program on the use of renewable energy sources, which are committed to reducing the emissions by 20% to 2020. Work towards such a goal means that it is necessary to avoid deforestation, use of new technologies and use of renewable energy sources, either geothermal, solar, wind, or hydropower [1]. In Slovakia, hydropower is considered as the most common use of renewable energy to produce electricity. Based hydropower potential available for electricity generation is 7,361 GWh per year, currently is used at 57.5%. The share of large hydropower for electricity produced in 2002 was 92%, the proportion of small hydropower (SHP) only 8%. In Slovakia is a function of SHP large in addition to utilize primary hydropower potential for electricity generation. Small hydropower plants are involved in the utilization of the total available potential of 16% (1,220 GWh). Currently is used 24.5% (284.1 GWh) of the total available potential of SHP in Slovakia [2]. Small hydropower (SHP) are plants with an installed capacity of 1 MW to 10 MW and its impact on the environment is subject to assessment under Annex 1 of the Act no. 24/2006 Coll. the impact assessment on the environment, as amended in the Slovak Republic.

Assessment of the impact of the project on the environment is considered as a tool that minimizes the implementation of activities which could in any way negatively interfere with the environment and



at the same time allows choosing the optimal solution from the proposed alternatives of the project implementation; the alternative with the smallest negative impact of a proposed activity on the environment. At present, several authors devote to the issue of environmental impact assessment in Slovakia particular [3,4,5,6]; in the Czech Republic [7]; in Poland [8]; in Romania [9,10].

Law no. 24/2006 Coll. on the assessment of impacts on the environment and on amendments to certain laws, which entered into force on 1 February 2006 in regulate all EIA process in the Slovak Republic. It implements Directive 2014/52/EC of the European Parliament and the Council amending the previous Directive 2011/92/EC on the assessment of the effects of certain public and private projects on the environment. EIA is inevitable tool for decision making with final aim of sustainable development of the society. According to Law no. 24/2006 Coll. the assessment of impacts on the environment and on amendments in the Slovak Republic the "Industrial installations for the production of electricity from water power" hydropower plants from 5 MW to 50 MW are under screening procedure and hydropower plants producing more than 50 MW are under compulsory assessment. In this paper the impact matrix has been used for environmental impact assessment of small hydropower plant.

## 2. Materials and methods

A lot of methods (tools) have been utilized over the last decades to meet the different actions required in the conduction of impact studies. These methods are describe for example in [11] or [12]. There is a need for a general and thorough approach to justifying, explaining, demonstrating, implementing, sampling, using, and creating real skills in analysis in any area of the human society. Such a need is embedded in human evolution, and its importance is evident every time one needs to develop forecasts of future courses of action [13,14]. All management decisions are concerned with the future, and everything about the future is, to a greater or lesser extent, uncertain [15,16]. The uses of risk identification, analysis and assessment in relation to the environment have broadened considerably in recent years.

Guidelines of European Commission [17] provide information on methods and tools that were selected from case studies and literature research. These generally fall into two groups:

- Scoping and impact identification techniques - these identify how and where an indirect or cumulative impact or impact interaction would occur.
- Evaluation techniques - these quantify and predict the magnitude and significance of impacts based on their context and intensity.

Potential (probable) impacts have to be assessed in terms of their fundamental nature, i.e., whether the impacts are:

- positive (useful), or negative (adverse);
- direct or indirect, or potentially related to that effect (primary, secondary, tertiary);
- in real time or delayed time;
- short term or long term;
- reversible or irreversible;
- local or strategic;
- physical, chemical, biological, microbiological, biochemical.

It is expected that EIA will continue to act as an effective tool to prevent the application of investments not only in Slovakia which by their degree of environmental damage many times outweigh their benefits [18,19]. 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 use of proper EIA methodologies and procedures can help the decision-makers to manage proper activities based on qualified decisions [20].

In the following the case study is presented.

### 3. Study area

The chosen site for the construction of small hydropower plant is located in the municipality Spišské Bystré (figure 1). The village is located at an altitude of 674 m, has a population of 2,394 and an area of 3,787 ha. Bystrá creek is a stream in the district of Poprad; it is right-hand tributary of the Hornád and has a length of 17 km. Currently, the creek in that area has character of unregulated water flow with an irregular trapezoidal profile width from 2.0 m to 6.0 m in the bottom and from 5.0 m to 10.0 m in water level. The proposal of small hydropower plant includes a modification of the bed of the watercourse, which consists mainly of fortifications of the channel cross section.



**Figure 1.** Location of the study area.

Three alternatives figure 2 of the proposed activity were assessed:

- Alternative 0 – the present state of the environment, no SHP plant will be constructed;
- Alternative 1 – construction of SHP plant;
- Alternative 2 – construction of SHP plant with bypass fishpass.

Assessment of the expected impacts of the proposed activity on the environment is presented in the following.

### 4. Results

The first step of the impact assessment of the proposed activity on the environment is the identification of the impacts on the partial components of the environment. When developing criteria and determine their importance we have placed emphasis on the nature, extent and duration of the effects. We have assigned values to individual consequences according to the proposed scale:

- The character of the impacts (CH): - negative, 0 no impact, + positive,
- The significance of the impacts (S): 1 insignificant, 2 significant, 3 very significant,
- The duration of the impacts (D): **0.5** short-term, **1** long-term.

In table 1 are identified the impacts on individual components of the environment. The values of the nature of the impacts are added according to the above proposed scale. We have assessed only impacts that are supposed to be occurring during the construction and operation of SHP plant.

The next step in EIA process is the selection of the optimal alternative by assessing the character, significance and duration of the impacts done by quantitative method (table 1). Multiplied values of impacts nature have been counted separately for each alternative of the proposed activity. The alternative that has reached the highest positive value can be considered as optimum.

**Table 1.** Quantification of impacts and comparison of alternatives.

Impact on	Alternative 0				Alternative 1				Alternative 2			
	CH0	S0	D0	CH0 *S0 *D0	CH1	S1	D1	CH1 *S1 *D1	CH2	S2	D2	CH2 *S2 *D2
population:												
noise	0			0	-1	2	1	-2	-1	2	1	-2
vibrations	0			0	-1	2	0.5	-1	-1	2	0.5	-1
dust	0			0	-1	3	0.5	-1.5	-1	3	0.5	-1.5
quality of life	0			0	-1	2	0.5	-1	-1	2	0.5	-1
economy	-1	2	1	-2	1	3	1	3	1	2	1	2
tourism, recreation	0			0	1	2	1	2	1	2	1	2
sport activities	0			0	1	2	0.5	1	1	2	0.5	1
water conditions:												
surface water flowing	-1	2	1	-2	1	2	1	2	1	2	1	2
surface water standing	-1	2	1	-2	1	3	1	3	1	3	1	3
ground water in	-1	2	1	-2	1	3	1	3	1	3	1	3
inundation	-1	2	1	-2	1	2	1	2	1	2	1	2
ground water in protected area												
soil:												
land occupation	0			0	-1	1	1	-1	-1	1	1	-1
water regime of soil	-1	2	1	-2	1	2	1	2	1	2	1	2
soil erosion	-1	2	1	-2	1	3	1	3	1	3	1	3
fauna and flora and their biotopes:												
fauna-mammals	1	2	1	2	-1	2	1	-2	-1	2	1	-2
fauna-birds	1	1	1	1	-1	1	1	-1	-1	1	1	-1
fauna-ichtyofauna	1	2	1	2	-1	3	1	-3	-1	1	1	-1
fauna-amphibians	1	2	1	2	-1	3	1	-3	-1	1	1	-1
flora-at construction	0			0	-1	3	0.5	-1.5	-1	2	0.5	-1
site	0			0	-1	2	1	-2	-1	1	1	-1
flora-at backwater												
SUM				-7				3				4,5

The highest value 7.5 has reached Alternative 2: SHP plant Spišské Bystré with bypass fish pass, therefore it can be considered from a comprehensive assessment of the environmental impact as optimal variant, with the less negative impacts to the environment (although this Alternative is the most costly). During construction is necessary to pay attention to the measures that reduce, respectively mitigate the adverse impact on the environment, including health of population. Measures need to be designed to prevent, eliminate, minimize and compensate the negative impacts.

## 5. Conclusion

In the paper knowledge on techniques and methods to assessment of interaction between humans, natural resources, and water projects are developed, distributed and used with aim to mitigate adverse impact and remediate the environment. The approach has a clearly defined methodology and original concept of solution.

The benefit of this paper is to highlight the importance of assessing the impact of construction on the environment in the planning phase. Eliminating the negative impacts of the construction on the environment is much more challenging than the implementation of preventive measures, and it is therefore necessary to consider and assess how the construction and operation of the proposed activities impact the environment in the planning phase of this activity.

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