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Article

Environmental Impact of Small Hydro Power Plant—A Case Study

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Abstract: Currently an international topic—not only among the members of the European Union—is the use of renewable energy, such as hydro power. The subject of this paper is the environmental impact assessment of the small hydropower (SHP) plant. The paper identifies the environmental impacts of an SHP plant in Spišské Bystré, Slovakia. It also assesses the alternatives to a specific hydraulic structure by quantitative evaluation from the point of view of character of the impacts, their significance, and their duration. The conclusion of the work includes the selection of the optimal alternative of the assessed construction and proposes measurements to reduce the negative impacts. The benefit of this paper is in highlighting 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 assess at the planning phase how the construction and operation of the proposed activities impact the environment.

Keywords: environmental impact assessment; hydro power plant; matrix of impacts

1. Introduction

Like the power industry, water management is not a sector per se, but it does secure access to water for all other sectors and for society as a whole according to need. However, unlike energy there are no alternative sources of water, and that is why for several years now water has been considered as a strategic raw material. The assessment of water resources involves establishing the amount, quality, and availability by evaluation of the possibilities of sustaining their development, management, and control. Water is used for cooling, shipping, and washing as a solvent, and also sometimes is found in the ingredients of finished products. A large amount of water is needed for refrigeration equipment. Volumes of industrial water are completely different in individual industrial sectors and also in different types of production, depending on the technology of the production process. Again, this depends on the climatic conditions, because the use of industrial water usually seems to be significantly smaller in northern areas than in southern regions, where the air temperature is higher. Developing the use of industrial water is one of the main reasons for water pollution in the world today. This is explained by the fact that in various countries, industrial growth has greatly increased and exaggerated the proportions of waste being released as waste water into watercourses, predominately untreated or only partially purified. In the battle with such pollution problems, many countries have approved energy measures for reducing the use and release of industrial waters. Since the 1970s and 1980s, a tendency towards stabilization and even a drop in the demand for industrial waters has been seen. It is expected that in many countries in the future, the trend will be a downward one due to a larger use of systems for supplying circulating water, and many industrial branches will aim at dry technologies without water usage.

The issue of greenhouse gas emissions in Europe is becoming important. European Union countries are continuously working to reduce these emissions. They have created a program for the use of renewable energy sources, committing to a 20% reduction of emissions by 2020. Working towards such a goal means that it is necessary to avoid deforestation, use new technologies, and use renewable energy sources—either geothermal, solar, wind, or hydropower [1]. In Slovakia, hydropower is the most common source of renewable energy used to produce electricity. Based on hydropower potential available for electricity generation at 7361 GWh per year, the current use is 57.5%. The share of larger hydropower for electricity produced in 2002 was 92% and the proportion of small hydropower (SHP) only 8%. The utilization of hydro power plants—particularly SHPs—in Slovakia for electricity generation is of prime importance to the economy. Small hydropower plants' utilization of the total available potential is 16% (1220 GWh), while the current total utilization is 24.5% (284.1 GWh) of the total available potential of SHP in Slovakia [2]. Small hydropower (SHP) plants have an installed capacity of 1–10 MW, and their impact on the environment is subject to assessment under Annex 1 of Act no. 24/2006 Coll. the impact assessment on the environment, as amended in the Slovak Republic. Installations for hydroelectric energy production are also subject to an environmental impact assessment under the European Directive 2014/52/EC. The necessity of more comprehensive standards for the impact assessment and the governance of small hydropower projects was proved, for example, by Kibler and Tullos [3]. They investigated the cumulative biophysical effects of small and large hydropower dams in China's Nu River, and they revealed that biophysical impacts of small hydropower may exceed those of large hydropower—particularly with regard to habitat and hydrologic change. Standards for SHP plants' impact assessment are necessary to encourage low-impact energy development. This is also a contribution of the presented paper. The environmental implications of small and large hydropower projects were also studied by Henning et al. [4,5] and Ferreira et al. [6]. Mayor et al. [7] assessed the differential contributions to the regional energy and water security of large- and small-scale hydropower deployment in the Spanish Duero basin. Results of their study showed greater impacts of SHP, mainly as a result of cumulative effects cascading along the rivers system.

Directive 2001/77/EC of the European Parliament and of the Council on the promotion of electricity produced from renewable energy sources in the internal electricity market and Directive 2003/54/EC of the European Parliament and of the Council have stability rules commune in terms of obtaining and distributing electricity. The Commission Communication of 10 January 2007 entitled *"Roadmap for renewable energy—Renewable energies in the 21st century: building a more sustainable future"* has demonstrated that a 20% target for the global share of renewable energy would be an achievable target and that a framework that includes binding targets should provide the business community with the long-term stability needed to make rational and sustainable renewable energy investments to reduce dependence on imported fossil fuels and increase the use of new energy technologies. The Framework Directive 2009/28/EC on the promotion of the use of energy from renewable sources aims at developing the local and regional electricity market in order to reduce greenhouse gas emissions. The Renewable Energy Directive establishes an overall policy for the production and promotion of energy from renewable sources in the EU Member States. It requires the EU to fulfil at least 20% of its total energy needs with renewables by 2020—to be achieved through the attainment of individual national targets. On 30 November 2016, the Commission published a proposal for a revised Renewable Energy Directive to ensure that the target of at least 27% renewables in the final energy consumption in the EU by 2030 is met. The Directive specifies national renewable energy targets for each country (from a low of 10% in Malta to a high of 49% in Sweden), taking into account its starting point and overall potential for renewables.

However, all of these initiatives are in conflict with the provisions of the Framework Directive 2000/60/EC, according to which strict rules are imposed to reduce the hydromorphological alteration of watercourses, but also the evaluation of eco-systems. In Romania, the development of investments in micro-hydro power plants was supported, but in contradiction the environmental provisions were enforced, imposing major restrictions. So, in 2015, the European Commission launched the infringement procedure against Romania due to micro-hydropower projects in the Fagaras Mountains. A similar situation has occurred in Slovakia.

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 are devoted to the issue of environmental impact assessment in Slovakia [8–11]; in the Czech Republic [12]; in Poland [13]; and in Romania [14,15].

Environmental impact assessment (EIA) procedures for public and private projects that are likely to have significant effects on the environment in Slovakia have been in place since the adoption of the EIA Act in 1994. In 2006, a new EIA Act was approved, and EIA procedures began to be applied to buildings under the 2006 Planning Act. 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 to 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 a tool for decision making, with the final aim of the sustainable development of 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 a screening procedure, and hydropower plants producing more than 50 MW are under compulsory assessment.

This paper also briefly presents a case study: technical and technological solutions of three variants of the selected engineering construction of a small hydroelectric power plant situated in Spišské Bystré, in Slovakia. The assessment was devoted to direct impacts of the proposed activity, characteristic of the current state of the environment in the affected area, the assessment of the expected impacts of the proposed activity on the environment, and estimation of their importance using the point method. For comparison of the variants of small hydroelectric power plants, the matrix method is applied. The purpose of this comparison is to select the optimal variant of the proposed action, and proposes measures to prevent, eliminate, minimize, and offset the impacts of the proposed activity on the environment.

2. Materials and Methods

Many methods have been introduced over the last 50 years to meet the different requirements of environmental impact assessment studies. Mentioned methods are explained, for example, in [16,17]. 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 human society [18,19]. Most management decisions are concerned with the future; however, the future is usually uncertain [20–25]. The uses of risk identification, analysis, and assessment in relation to the environment have broadened considerably in recent years.

Guidelines of the European Commission [22] provide information on approaches that were selected from case studies and literature survey. These include scoping and screening techniques which predict the magnitude and significance of impacts and attempt to quantify them based on their intensity, frequency, duration, and character. Scoping and impact identification methods include:

- Network and analysis
- Consultation and questionnaires
- Checklists

Evaluation and screening methods include:

- Modeling
- Comparative methods

Techniques include:

- Matrices
- Expert opinion.

The EIA process involves a combination of approaches [12]:

- Identification and definition of the impact;
- Analysis of the impact associated;
- Determining the significance of the impact.

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 vastly outweigh their benefits [23–25].

In this paper, the impact matrix has been used for the environmental impact assessment of small hydropower plants, and presents an overview, distribution, and classification of the impact of the projects on the environment by different criteria for the purposes of the evaluation. In addition, it also highlights the identification and assessment of the expected impacts of the construction on the environment. The presented impact matrix combines qualitative and quantitative methods: verbal statements which were transformed into the numerical values presented in Table 1. This assessment requires special attention and sensitive work with verbal and numerical scales. It used indicator values. This method consists of only a very approximate method, where by its value an indicator may represent a description of the analyzed problem.

The assessment was done by seven experts—the authors and three more people—the experts working in the field of SHP plant design and/or the assessment of environmental impacts of SHP plants, and one of them is working in the landscape ecology—the nature protection. They used the brainstorming method. They consulted the selection of the criteria and their impacts at the personal meetings as well as by e-mail communication.

The proposed EIA methodology involves a combination of approaches:

- Establishing the context
    - Characteristics of the current state of the environment in the affected area
    - Brief description of alternatives of the proposed activity ($A0$, $A1$, $A2$)
- Evaluation of impacts
    - The character of the impacts
    - The significance of the impacts
    - The duration of the impacts
- Quantification of impacts and
- Comparison of alternatives.

The use of proper EIA methodologies and procedures can help the decision-makers to manage proper activities based on qualified decisions [26].

In the following, the case study is presented.

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 inundation	−1	2	1	−2	1	3	1	3	1	3	1	3
ground water in protected area	−1	2	1	−2	1	2	1	2	1	2	1	2
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-ichthyofauna	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 site	0			0	−1	3	0.5	−1.5	−1	2	0.5	−1
flora-at backwater	0			0	−1	2	1	−2	−1	1	1	−1
landscape:												
structure	0			0	−1	1	1	−1	−1	1	1	−1
using	0			0	1	2	1	2	1	2	1	2
scenery	0			0	−1	1	1	−1	−1	1	1	−1
the protected areas and their protective zones:												
protected areas	0			0	−1	1	1	−1	−1	1	1	−1
water protected areas	0			0	−1	1	1	−1	−1	1	1	−1
the territorial system of ecological stability	0			0	−1	3	1	−3	−1	2	1	−2
urban areas, land use:												
urban areas	0			0	1	3	1	3	1	3	1	3
land use	0			0	1	3	1	3	1	3	1	3
air:												
air quality	0			0	−1	1	1					
concentrations of emissions	0			0	−1	1	1					
SUM				**−7**				**1**				**7.5**

Study Area

The selected site for the proposed activity—construction of small hydropower plant—is located in the village Spišské Bystré, district of Poprad, Eastern Slovakia (see Figure 1). The study area is close to the High Tatras Mountains, where the High Tatras National Park is located (20 km) and near the Slovak Paradise protection area (10 km), but the selected site is actually out of any protected area. The municipality is located at an altitude of 674 m, has a population of 2394 and an area of 3787 ha. Bystrá creek is a right-bank tributary of the Hornád, which belongs to Danube River Basin and has a length of 17 km. The proposed SHP plant is designed as a run-of-river plant in river kilometer 4.0. The annual discharge of Bystrá creek is 0.42 m^3/s. The discharge of 100-years return period in the site is 60 m^3/s. Currently, the creek in that area has the 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 a small hydropower plant includes a regulation of the river bed, which consists mainly of fortifications of the channel cross-section.

Three alternatives of the proposed activity were assessed (Figure 2):

- 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 fish pass.

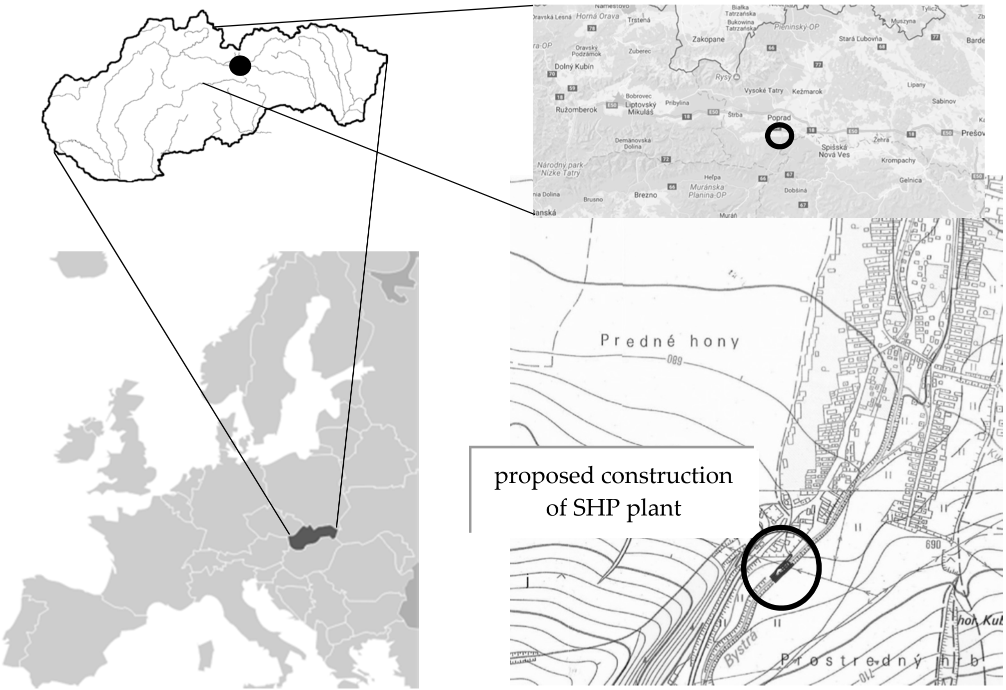

Figure 1. Location of the study area. SHP: small hydropower.

Figure 2. *Cont.*

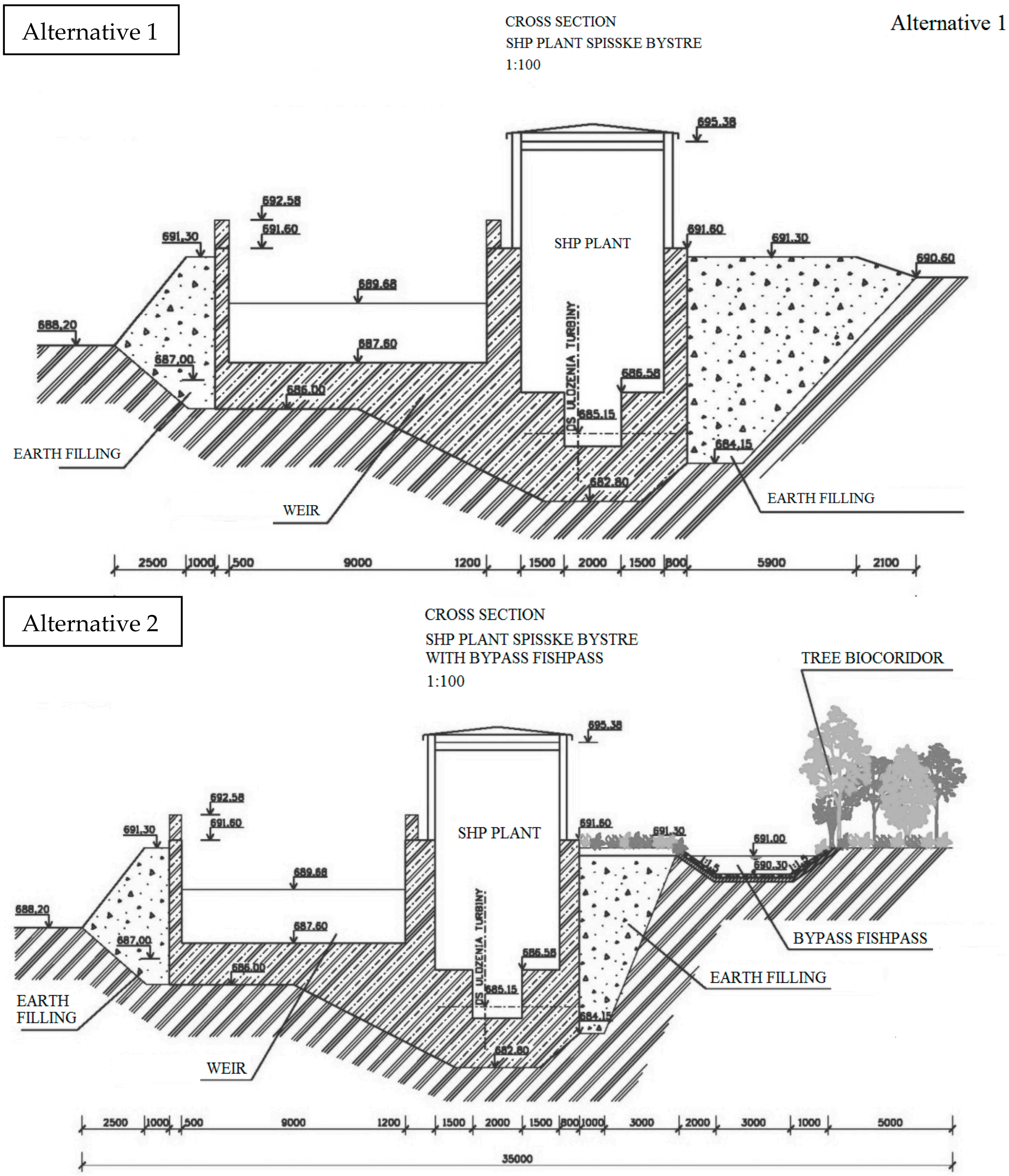

Figure 2. Alternatives of the proposed activity.

Impacts on the environment are reflected by the effects of the water project, which in this case is the small hydro power plant. From the identification of impacts and their influence on individual components of the environment of the study area by the detection matrix, it is obvious that the most significant negative impacts during the construction activity will be from construction machinery, accompanied by noise, emissions, and dust. These stressors negatively affect habitats, climate, population and other components of the environment. The construction will also affect the soil layers as well as the quality of surface water. Direct negative impact on the environment during the operation of the SHP plant is not expected. For a comprehensive assessment of the expected impact in terms of its significance, nature, and duration, it is recommended to use the quantitative evaluation method. The assessment of the expected impacts of the proposed activity on the environment is presented as follows.

3. Results

This chapter includes the comparison of alternatives of the proposed activity (SHP plant in Spišské Bystré) and the selection of the optimal alternative, including a comparison with zero alternative (Alternative 0, Alternative 1, Alternative 2). 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 determining their importance, we 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.

Table 1 identifies 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 the impacts envisaged occurring during the construction and operation of the SHP plant.

The next step in the EIA process is the selection of the optimal alternative by assessing the character, significance, and duration of the impacts undertaken by quantitative method (Table 1). Impacts' nature have been counted separately for each alternative of the proposed activity as a sum of points that are product of multiplying the character, the significance, and the duration of the impacts. The alternative that reached the highest positive value can be considered as optimal.

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

4. Discussion

The objective of this paper is the analysis and evaluation of the environmental impacts of small hydro power plants by use of the matrix of impacts. The identification and evaluation of the environmental impacts include the health and social impacts to the population in the study area. The aim is the selection of the optimal variant of the proposed activity, using quantitative evaluation. In practice, there are many procedures and methods which can be used to identify and evaluate these impacts. In order to identify environmental impacts of the water structure, in accordance with valid legislation, we used a survey matrix method by which we specified the impacts of the activity on the components of the environment. This method increases the transparency and precision of the evaluation process, and also satisfies the requirements of the environmental impact assessment procedure. This approach can be applied to other infrastructure projects. Comparison of alternatives and selection of the optimal variant are implemented based on selected criteria and foreseen impacts of the activity on the environment. This method is adequate for the assessment of the proposed environmental impacts of SHP plants, although to confirm the results, the other (the alternative) method could be also used. Comparison of the variants revealed that Alternative 2—construction of SHP plant with bypass fishpass can be considered as an optimal variant because it reached the highest positive values. Not only from an economic point of view (which is the use of renewable energy sources), but also from an ecological point of view that involves the reduction of greenhouse gas emissions, the proposal of the optimal variant is beneficial to the concerned area. The benefit of the study is in pointing out the importance of environmental impact assessment of the construction before requesting a permit for the construction. Eliminating the negative effects of construction on the environment is far more demanding than the implementation of preventive measures, and it is therefore necessary to assess how the construction will affect operation of the proposed activity in the area. The use of the EIA process can help the decision-makers to select proper mitigation measures based on qualified decisions. The proposed activity in Spišské Bystré, Slovakia is used as a case study to exemplify the methodology.

5. Conclusions

Environmental impact assessment (EIA) is an important process prior to approval of the proposed activity. It can provide essential information about the foreseeable impacts of the investment plan on the environment. The assessment of the potential impacts on the environment is the most important stage in the EIA process. Environmental assessment is based on the technical description of the project, as well as prediction and evaluation of the impacts on the environmental components. From the point of view of environmental requirements for construction, the negative impact on the environment is minimized in the preparatory phase of the project by analyzing and assessing the impact of the construction on the environment, thus avoiding an increase in costs due to unforeseen impacts during the construction phase.

The knowledge of tools to assess interaction between humans, natural resources, and water projects is developed, distributed, and used with the aim of mitigating adverse impacts and remediating the environment. The approach has an original solution concept.

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References

1. European Commission—Renewable Resources of Energy. Available online: http://www.ec.europa.eu/news/energy/120608_sk.htm (accessed on 2 March 2015).
2. Hydropower Energy. Available online: http://www.oze.stuba.sk/oze/vodna-energia/ (accessed on 2 March 2015).
3. Kibler, K.K.; Tullos, D.D. Cumulative biophysical impact of small and large hydropower development in Nu River, China. *Water Resour. Res.* **2013**, *49*, 3104–3118. [CrossRef]
4. Mayor, B.; Rodríguez-Muñoz, I.; Villarroya, F.; Montero, E.; López-Gunn, E. The role of large and small scale hydropower for energy and water security in the Spanish Duero Basin. *Sustainability* **2017**, *9*, 1807. [CrossRef]

5. Hennig, T.; Wang, W.; Feng, Y.; Ou, X.; He, D. Review of Yunnan's hydropower development. Comparing small and large hydropower projects regarding their environmental implications and socio-economic consequences. *Renew. Sustain. Energy Rev.* **2013**, *27*, 585–595. [CrossRef]
6. Hennig, T.; Wang, W.; Magee, D.; He, D. Yunnan's fast-paced large hydropower development: A powershed-based approach to critically assessing generation and consumption paradigms. *Water* **2016**, *8*, 476. [CrossRef]
7. Ferreira, J.H.I.; Camacho, J.R.; Malagoli, J.A.; Camargo Guimarães, S., Jr. Assessment of the potential of small hydropower development in Brazil. *Renew. Sustain. Energy Rev.* **2016**, *56*, 380–387. [CrossRef]
8. Zeleňáková, M.; Zvijáková, L. *Using Risk Analysis for Flood Protection Assessment*; Springer: Cham, Switzerland, 2017; p. 128. ISBN 978-3-319-52150-3.
9. Pavlíčková, K.; Kozová, M.; Miklošovičová, A.; Zarnovičan, H.; Barancok, P.; Luciak, M. Environmental impact assessment. In *Textbook for Students of Master's Studies*, 1st ed.; Comenius University in Bratislava: Bratislava, Slovakia, 2009.
10. Kočická, E. Environmental Impact Assessment (in Term of Theory and Praxis). Available online: https://stary.tuzvo.sk/files/FEE/dekanat_fee/11_Kocicka_AFE.pdf (accessed on 30 November 2017).
11. Majerník, M.; Bosák, M. *Environmental Impact Assessment*; Technical University: Košice, Slovakia, 2003.
12. Říha, J. *Environmental Impact Assessment of Investments. Multicriteria Analysis and EIA*; Academia: Prague, Czech Republic, 2001.
13. Gałaś, S.; Gałaś, A.; Zeleňáková, M.; Zvijáková, l.; Fialová, J.; Kubíčková, H.; Házi, J. *Comparing the Phase of Screening in the Fields of Tourism and Recreation Water Management and Mining in the V4 Countries*; AGH University of Science and Technology Press: Krakow, Poland, 2014.
14. Rojanschi, V.; Bran, F.; Diaconu, G. *Protection and Environmental Engineering*; Editura Economică: Bucuresti, Romania, 1997; p. 368.
15. Iojă, I.C. *Analysis and Evaluation of the Environmental Situation*; Editura Economică: Bucuresti, Romania, 2013; p. 183.
16. Canter, L.W. Methods for effective environmental impact assessment. Environmental methods review. In *Retooling Impact Assessment for the New Century*; The Press Club: Fagro, ND, USA, 1998; pp. 58–68.
17. Canter, L.W. Environmental Impact Assessment. In *Environmental Engineers' Handbook*; CRC Press: Boca Raton, FL, USA, 1999.
18. Bujoreanu, I.N. Risk analysis series part one—Why risk analysis? *J. Def. Resour. Manag.* **2012**, *3*, 139–144.
19. Romanescu, G.; Miftode, D.; Mihu-Pintilie, A.; Stoleriu, C.C.; Sandu, I. Water quality analysis in mountain freshwater: Poiana Uzului reservoir in the eastern carpathians. *Rev. Chim.* **2016**, *67*, 2318–2326.
20. Costanza, R.; Daly, H.E. Natural capital and sustainable development. *Conserv. Biol.* **1992**, *6*, 37–46. [CrossRef]
21. Welsh, T. Full Monte—The Better Approach to Schedule Risk Analysis User Guide. Available online: http://www.barbecana.com/_downloads/Full%20Monte%202017%20User%20Guide.pdf (accessed on 2 December 2016).
22. Walker, L.J.; Johnston, J. Guidelines for the assessment of indirect and cumulative impacts as well as impact interactions. In *Environment, Nuclear Safety & Civil Protection*; The Publications Office of the European Union: Luxembourg, 1999; p. 170.
23. Zvijáková, L.; Zeleňáková, M.; Purcz, P. Evaluation of environmental impact assessment effectiveness in Slovakia. *Impact Assess. Proj. Apprais.* **2014**, *32*, 150–161. [CrossRef]
24. Zvijáková, L.; Zeleňáková, M. *Risk Analysis in the Process of Environmental Impact Assessment of Flood Protection Objects*; Leges: Prague, Czech Republic, 2015; p. 255.
25. Tkáč, Š.; Vranayová, Z. The use of the water element in the energetics of micro-urban development in Slovak Republic and Taiwan R.O.C. *Pollack Periodica* **2014**, *9*, 101–112. [CrossRef]
26. Shah, A.; Salimullah, K.; Sha, M.H.; Razaulkah, K.; Jan, I.F. Environmental impact assessment (EIA) of infrastructure development projects in developing countries. *Int. J. Sustain. Dev.* **2010**, *1*, 47–54.