

ENVIRONMENTAL IMPACT STUDY IN BODVA RIVER BASIN

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Abstract

The paper is devoted to environmental impact assessment and risk analysis of the floods in Slovak part of Bodva river basin. The paper studies the impact of the flooding water on environment – water bodies, soil and other endangered values. The proposal of flood environmental impact and risk assessment index calculation includes state of environment and environmental hazards in the chosen area.

Keywords: Environmental impact assessment, risk analysis, Bodva river basin, Slovakia, flood risk, sources of pollution

1 INTRODUCTION

Year 2010 was in terms of precipitation extremely above average and with significantly unequal in distribution of rainfall in each month in all regions of Slovakia. These rainfall conditions had a significant impact on the environment, catchment saturation and hence the overall flood situation on extreme flows in Slovakia, also a significant increase in groundwater levels, which flooded buildings.

During May and early June 2010 was abundant rainfall in many regions of Slovakia. Sub-basin Bodva struck during May and early June 2010 several waves of precipitation. On 16th May 2010 rainfall affected the entire sub-basin, gauging station Buzica referred the high of 49.1 mm. On 27th May 2010 was maximum rainfall of 44.0 mm measured in Turňa nad Bodvou. On 1st June 2010 Štós measured daily sum of 51.1 mm, in Turňa nad Bodvou 39.6 mm, in Moldava nad Bodvou 36.5 mm and in Buzica 35.0 mm. The culmination took place on 17th May and 4th June 2010 in the majority of streams of Bodva sub-basin. Nearly in all gauging stations have been exceeded water levels, which are intended to 3rd degree of flood activity. Culmination discharges ranged in water flow, which can be reached or exceeded once every 2-5 years.

Preliminary flood risk assessment identified the geographical areas with potentially significant flood risk. In the sub-basin Bodva were identified two geographical areas with existing potentially significant risk – Medzev and Jasov and three geographical areas with probably potentially significant risk – Košice-Šaca, Veľká Ida and Moldava nad Bodvou.

In the case of flood the main damages on the environment may occur as a consequence of accidents at sources of pollution. The issue of pollution sources is a key area of environmental protection. While pollution from point sources can be disposed by suitable technology, for diffuse pollution are essential proposals of preventive measures, that creating conditions to prevent contamination.

The paper studies the impact of the sources of pollution and flooding water on the environment. Environmental impact study in Bodva river basin includes the natural condition identification as well as human activity identification which may cause environmental damages in case of floods in the river basin.

2 METHODS

The main source of information for this study was: Implementation of the European Parliament and of the Council 2007/60/EC of 23 October 2007 on the assessment and management of flood risks – preliminary flood risk assessment in the sub-basin Bodva published by Ministry of the Environment in 2011.

2.1 Study area

The river basin Bodva belongs to an international Danube river basin. Slovak part of the river basin Bodva (figure 1) is defined on the north and east by border with Hornád river basin. From the south the Slovak part of the catchment Bodva is bounded by the border with Hungary and on the west by Slaná river basin.

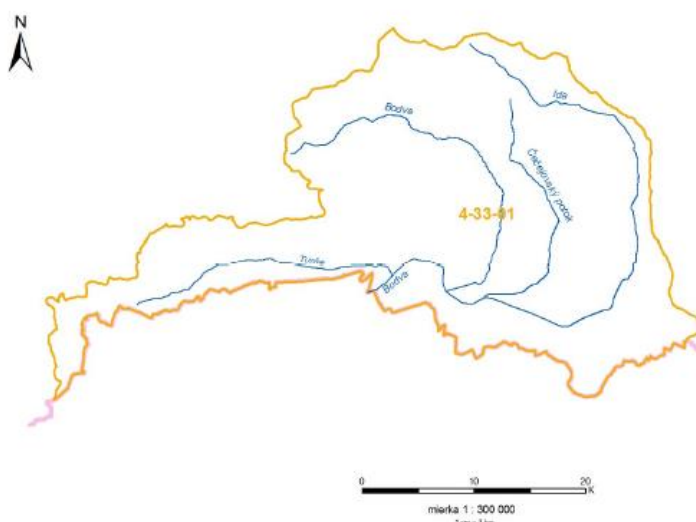


Figure 1. Slovak part of Bodva river basin

Bodva river Basin is situated in the southwestern part of the Kosice region. The river Bodva rises in the mountains Volovske hills, on the northeastern slope of the hill Osadník (1186 m asl.). The whole area of Kosice region belongs into the zones of Inner Western Carpathians. Geological structure of the area forms the hydrogeological conditions of the sub-basin Bodva. Older Paleozoic rocks whose original character before metamorphosis was volcanic with intergranular permeability are characteristic by fissure permeability. Basic characteristics of the river basin Bodva contains table 1.

Table 1. Basic characteristics of the river basin Bodva

Area of the Danube river basin	807 827 km ²
Area of the Bodva river basin (in the Slovak republic)	858 km ²
Bordered places of the Bodva river basin in Slovakia:	
– the westernest point	Kamenec (západný svah) 48° 33' N 20° 27' E
– the easternest point	Milhost' 48° 33' N 21° 15' E
– the northeast point	Kloptaň 48° 47' N 20° 52' E
– the southeast point	Kečovo 48° 27' N 20° 28' E
– the highest point	Osadník 1186 m asl.
– the lowest point	Host'ovce 168 m asl.
The total length of the river Bodva in the Slovak republic	48 km
Long-term average flow of Bodva in Host'ovce	4.48 m ³ .s ⁻¹
The catchment area of Bodva extends into states	Maďarsko
Region	Košice
District	Košice II, Košice – okolie, Rožňava
Number of villages in the basin area	45
Ppulation	56 245 (year 2009)
<i>Land use:</i>	
Urban areas	1.6 %
Agricultural areas	47.1 %
Forest areas	46.8 %
Water areas	1.6 %
Other (industry etc.)	3.4 %

From the morphological point of view is a sub-basin Bodva considerably diverse area with a different relief (table 2). Central and eastern part of the basin consists of slightly wavy Košice basin, which is concluded in the north by Volovske hills. From the west part the basin is bordered by Slovak Karst and in the south it is bordered by Bodva upland (Mazúr&Lukniš, 1980).

Table 2. Geomorphological units of sub-basin Bodva

Subprovince	Area	Part
Inner Western Carpathians	Slovak Ore Mountains	Slovak Karst
		Volovske hills
	Lučenec-Košice depressions plane	Košice plane
		Bodva upland

Sub-basin Bodva regarding the complex orographic ratio ranges into several climatic zones. South and east part – the largest part of basin belongs to the district of the climate, which is warm and slightly damp with cold winters. Long-term average annual air temperature is 5 ° C to 8 ° C. Long-term average rainfall in the basin range from 600 to 1,000 mm.r⁻¹.

Height and slope conditions affect climatic conditions, especially the size and distribution of rainfall, the air temperature and thus on the overall water balance and runoff regime. They are one of the determinants of erosion. The basic morfological characteristics of Bodva sub-basins (Bodva river and its tributaries) are presented in table 3 (SWME, 2012).

Table 3. Morfological characteristics of Bodva sub-basins

Stream - profil	Area of the sub-basin	Length of the valley	The highest point	Height of the source	The lowest point	Difference in the height	Slope
	km ²	km	m asl.	m asl.	m asl.	m	%
Bodva - Nižný Medzev	90.20	14.2	1186	900	320	580	4.08
Bodva - above Ida	202.90	38.2	1186	900	180	720	1.88
Ida - mouth	380.70	56.6	1210	850	180	670	1.18
Bodva - above Turniansky stream	663.90	47.2	1210	900	170	730	1.55
Turniansky stream - mouth	179.30	32.0	1186	520	170	350	1.09
Bodva – state border	865.50	48.4	1210	900	169	731	1.51

One of the first steps of the characterization of the river basin under the Water Framework Directive (WFD) is to break down the surface water categories (rivers, lakes, transitional and coastal waters, artificial or heavily modified water bodies) and then the distribution of water bodies in each category to the types. In total, in the Slovak republic was identified 22 types of surface water flows to the catchment area above 10 km². There are 3 types of these in the sub-basin Bodva, the report shows the table 4. Into the natural lakes category were included 23 water reservoirs in Slovakia, identified as water bodies with altered category. In Bodva River Basin is one water body – reservoir Bukovec.

Table 4. Number of types of water bodies

Code of the type	Name of the type	Number of water bodies
K2M	Small streams at an altitude of 200-500 m in the Carpathians -	27
K3M	Small streams at an altitude of 500-800 m in the Carpathians	5
K2S	Medium-sized streams at an altitude of 200-500 m in the Carpathians	3
K232	Water body, with modified category, deep with medium surface area at an altitude of 200-500 m in the Carpathians	1

In the sub-basin Bodva was identified 36 water bodies (including body with modified category) with a total length of 345.05 km, which represents about 2.0% of the total number of bodies of the Slovak Republic. Overview of the number of water bodies in the basin under different types of documents tab. 4.

There are 101 groundwater bodies in Slovakia. To the sub-basin Bodva was attached 1 groundwater body - it's a body of water in the pre-quaternary rocks – SK2005200P – intergranular groundwater of Abov upland with area 73.779 km² – brackish to freshwater clays with sand and gravel positions, siltstones pore.

Land resources are mainly located in the flat part of the basin, but also to undulating hilly terrain Medzev, it also occurs on the steep slopes of the Slovak Karst (MŽP SR&SAŽP, 2002).

There is a predominance of heavy loamy soils that occupy contiguous area of Košice basin. Lighter soils – sandy-loam occupy forests in the mountains Volovske hills and partially Slovak Karst. These soils have a large admixture of the skeleton.

Table 5. Soil types

Soils types in km ² / % of total area					
Clay	Clay-loam	Loam-sand	Sand-loam	Cliffs	Skeleton above 50 %
524/59	155/17.3	22/2.4	173/19.4	17.3/1.9	128/14.3

There are two phytogeographical regions in Košice region: region of western Carpathian flora (Carpaticum occidental) and Pannonian flora (Pannonicum) in terms of phytogeographical division. Colorful natural conditions make in the area a considerable diversity of fauna. As with plant species there are represented species of lowland, upland, but also mountain and more of them are among the important and rare species of fauna in Slovakia (Futák, 1980).

2.2 Protected areas of the Slovak part of the Bodva river basin

The principle of territorial nature and landscape protection are included in Slovakia in Law no. 543 dated on 25th of June 2002 on the protection of nature and landscape. According to this law, significant or endangered nature and landscape can be declared as protected area in the definition of mentioned categories. In the river basin Bodva includes the following (SEPA, 2013):

- Protected landscape area - Slovak Karst, included on the UNESCO world heritage list as a natural biosphere reserve;

- National park – Aggtelek;

- Protected areas - Perín ponds and Slaná;

- Natural reservations – Havrania skala, Hrušovská lesostep, Jasovské dubiny, Kečovské škrapy, Drieňovec, Turniansky hradný vrch, Zádielska tiesňava, Kloptaň, Kráľova studňa, Pod Fabiankou, Sokolia skala;

- Natural monuments - Drienovská jaskyňa, Hrušovská jaskyňa, Jasovská jaskyňa, Kunia priepasť, Milada, Obrovská priepasť, Silická ľadnica, Skalísty potok, Snežná diera, Stratenská jaskyňa, Zvonivá jama.

The European network of protected areas in the Slovak part of the basin Bodva include protected bird areas and areas of European importance NATURA 2000, with aim of the protection of rare and endangered plant and animal species and their habitats.

There are three protected bird areas (PBA) and nine protected areas of European importance (SKUEV), listed in table 6.

Table 6. Protected areas

Identification number	Name of protected area	Area (ha)	Percentage of basin area (%)
PBA1	Slovenský kras	24 338	28,4
PBA2	Košická kotlina	29 610	34,5
PBA3	Volovské vrchy		
SKUEV0340	Český závrť	3,930	0,00
SKUEV0341	Dolný vrch	1528,090	1,78
SKUEV0345	Kečovské škrapy	354,500	0,41
SKUEV0347	Domické škrapy	12,750	0,01
SKUEV0348	Dolina Čiernej Moldavy	1896,840	2,21
SKUEV0349	Jasovské dubiny	36,250	0,04
SKUEV0352	Hrušovská lesostep	40,850	0,05
SKUEV0355	Fabiánka	92,020	0,11
SKUEV0356	Horný vrch	5447,079	6,35

2.3 Settlement of the Slovak part of the basin Bodva

Under the current territorial and administrative division sub-basin Bodva falls within the scope of the Košice region and touches the districts of Košice - surroundings, Košice II and Rožňava. The largest part of the catchment is situated in the district of Košice - surroundings (691 km²), located in the district of Rožňava 181.2 km² and a small part of the area 19.1 square kilometers located in the district of Košice II. According the information from 2010 the population in the area is 56 140; 27 067 in the towns through which flows Bodva river and 29 073 through which flows its main tributary Ida (SO, 2013).

3 RESULTS

3.1 Sources of pollution in the study area

Potential sources of water contamination are all activities in the catchment, all contaminated sites and landfills, industrial activities, agricultural activities, and other. Point sources of pollution i.e. potentially also found recorded through three dedicated databases:

– KV-ENVIRO (WRI, 2008), which contains more than 13 004 potential point sources of pollution. The basis of this database is a database GeoEnviron, which contains 9177 potential point sources of pollution. These are 2 279 sites, 6 938 landfills and other sources of pollution.

– Register of contaminated sites (REZ), which is part of the Information System (www.enviroportal.sk) was built under the project Systematic identification of contaminated sites in the Slovak Republic (www.sazp.sk). It contains 1 819 sites, which are divided into 3 parts: likely environmental burdens (Part A) - 878 sites, environmental burdens (Part B) - 257 sites rehabilitated and reclaimed environmental burdens (Part C).

– Database: Integrated monitoring of pollution sources (IMMZ), which contains sources of pollution of hazardous substances, which the State Water Authority ordered a duty to monitor their impact on groundwater. This database currently contains more than 310 sources of pollution, mainly landfills (WRI, 2008).

Flooding of mentioned sources of pollution as well as from diffuse sources of pollution may leak out pollutants and thus deteriorate the quality of surface water, groundwater, and soils, which can lead to environmental disasters, such as damage of habitats, fauna and flora as well as diseases and epidemics occurrence.

Table 7 gives information source of pollution and their classification according the degree of danger for environment, stated by authors. Each source was divided into categories according different criteria based on literature studying, consultation and experiences. The more dangerous source of pollution has the higher point classification.

Table 7. Classification of sources of pollution

Source of pollution	Characteristic	Criteria	Point classification
<i>Point sources of pollution</i>			
Industrial enterprises	Category of enterprise	unclassified	2
		A	3
		B	4
Sewage treatment plants	Number of equivalent inhabitants	< 2000	1
		2000 – 10 000	2
		10 000 – 100 000	3
		100 000 and more	4
Petrol stations	-	-	4
<i>Diffuse sources of pollution</i>			
Landfills	Type of landfill	for inert waste	1
		for non-hazardous waste	2
		for hazardous waste	3
Impoundments	-	-	1

Mine activities	Type	underground	1
		surface	2
Population in urban areas	Percentage of population without sewerage	0 – 40	1
		40 – 60	2
		60 – 100	3
Agricultural areas	Percentage of potentially flooded area	0 – 40	1
		40 – 60	2
		60 – 100	3
Environmental burden	-	is reclaimed	1
		is likely	2
		is confirmed	3

The actual sources of pollution in the studied area, situated in the flooded area are marked in bold in table 7. It is resulted as follows:

- Agricultural area (1 544 701 m²) contains 49.83 % from whole the flooded area (3 099 950 m²) (by Q₁₀₀) – data from GIS (done by authors);
- Percentage of population without sewerage is 24.7 as from 29 390 of equivalent inhabitants 46.6 % is connected to sewerage systems and 28.7 has individual systems of wastewater treatment – data from Medzev Urban Plan (Medzev, 2013);
- Environmental burden – there is one confirmed burden in the study area “Strojsmatl”, storehouse of heavy oils and fuels, in Medzev (figure 2) – according the Register of contaminated sites (REZ);

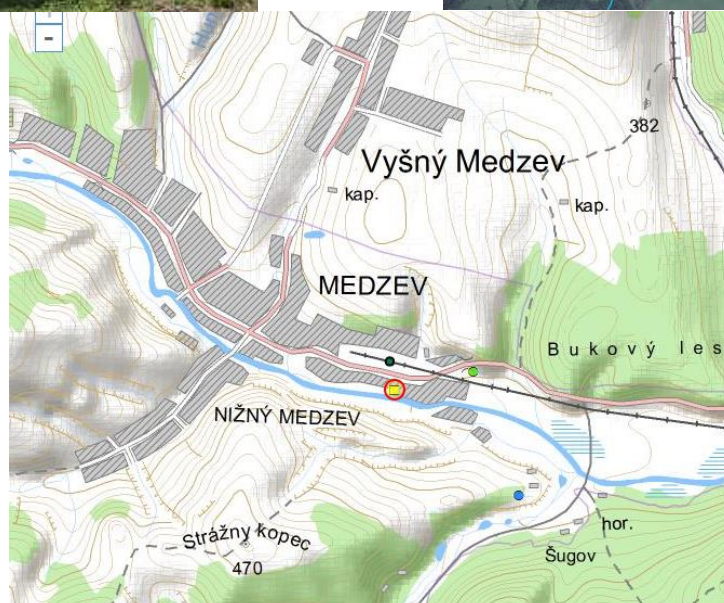
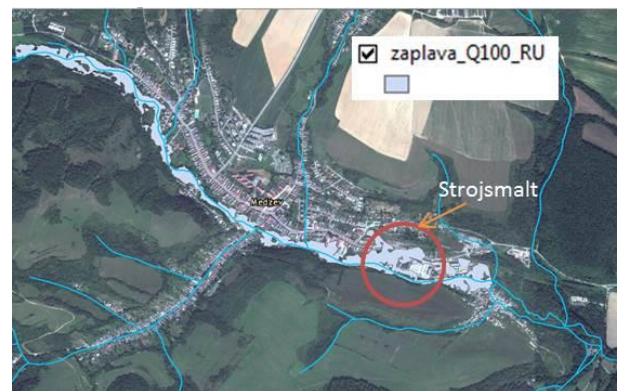


Figure 2. Strojsmatl in Medzev situated in flooded area

5 CONCLUSION

In general and as well for Bodva river basin, proposed measures to mitigate adverse environmental impacts of flood risk are as follows:

Urban measures:

– The proposed activity has been done along with the regulatory approval within the territorial planning documentation of municipalities;

Technical measures:

– Within the river stream regulations implement an adequate compensation plants rather native species in appropriate of places providing channel flow capacity;

– Within the vegetation by planting replacement trees to implement the preferential use of native tree species;

Technological measures:

– Technological part of the work carried out in accordance with the preparation of project documentation;

Organisational measures:

– Within the cutting of existing although worthless vegetation, minimize devastating interventions;

– For constructions to handle an emergency plan for the disposal of any environmental damage;

Other measures:

– Ensure appropriate monitoring regime and quality of surface and groundwater;

– Develop a plan of emergency measures for the disposal of any environmental damage, etc..

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