

Significant water management issues: techniques, methods and results gained in the Danube River Basin District, Slovenia

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Abstract

The paper presents and explains the methods, approaches and procedures in the process of recognition of environmental protection issues of surface waters. For the river basins in the Danube River Basin District, it provides comprehensive results in terms of hydromorphological pressures and water pollution. Significant water management issues based on the technique of risk assessment and baseline scenario that includes the national action plans were prepared for each of the three river basins in the Danube River Basin District separately. They form the basis for the formation of cost effective programme of measures to achieve goods status, as a central part of river basin management plans. Summary of recognized significant water management issues in terms of hydromorphological pressures and water pollution is presented.

Keywords

Danube River Basin District, hydromorphological pressures, significant water management issues, Water Framework Directive, water pollution

INTRODUCTION

The proposal of significant water management issues (hereinafter called SWMIs) was prepared in the implementation process of the EU Directive 2000/60/EC (Water Framework Directive, hereinafter called WFD). In the final proposal also other EU directives listed in Annex VI (Part A) of the WFD were included as well as the Slovenian legislative documents. In this phase of preparing the river basin management plan for the Danube River Basin District, SWMIs are prepared similarly as in other EU Member States, on the basis of risk assessment of achieving good status and not on the basis of the ecological status of water bodies (hereinafter called WBs), as it is still under development. In the current risk assessment, the hydromorphological and chemical elements are mostly considered while in the ecological status the emphasis will be on biological and physico-chemical elements.

Risk assessment method applied in Slovenia has two main components that define the final risk class: hydromorphological pressures and water pollution with dangerous priority substances. The results of risk assessment were delineated into 4 classes, ranking of the risk for failing of the environmental objectives. The first two classes represent WBs that will or will probably achieve good status while the third and fourth classes represent WBs that will or will probably not achieve good ecological and chemical status. The latter were used as a starting point for the preparation of SWMIs.

SWMIs for hydromorphological pressures were defined with consideration of alteration of different hydrological and morphological elements as well as interrupted river continuity, while the SWMIs for water pollution were based upon water quality assessment from monitoring the results and on the basis of the information acquired regarding the high

amounts of hazardous pollutants that were sold or nutrients that were used in the catchment areas of WBs.

METHODOLOGY

For WBs that will probably not achieve good status a detailed survey of pressures was applied. Pressures on water environment, in individual RB frequently recognised as the cause for not achieving good status, were defined as significant problems. These recognized problems were correlated with different sectors and activities as well as linked to the existing national action plans. For WBs in the Mura, Drava and Sava River basins (hereinafter called RBs) with problems that were not covered with national legislation and which represent environmental pressures that pose the greatest risk to water bodies in the RB, SWMIs were prepared.

Hydromorphological pressures

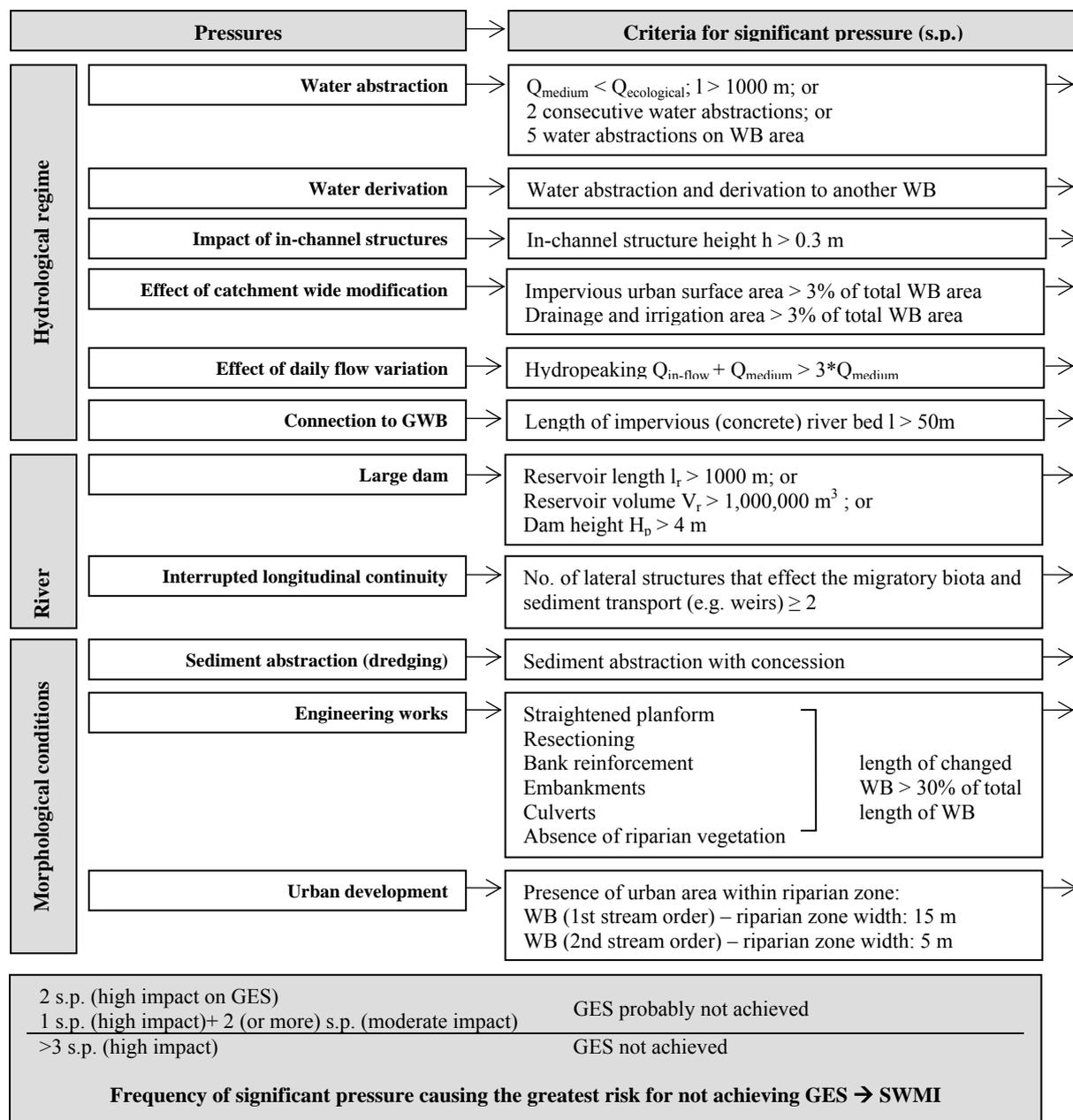


Figure 1: Hydromorphological pressures and criteria for significant pressures

For all of the three supporting hydromorphological elements as defined in WFD (e.g. hydrological regime, river continuity and morphological conditions) different related pressures were recognized and collected from various databases (e.g. concessions and water rights for water use), expert evidences (e.g. list of large dams), researches (e.g. degree of modifications of river morphology) and, last but not least, expert knowledge based on field investigations.

Since the impact of each hydromorphological pressure on biological elements and consequently on ecological status is not yet clear and defined, the criteria for significant pressures that may have a negative impact on the ecological status were defined based on the expert judgement (Figure 1). The magnitude of the negative impact of each pressure and combination of different pressures present on each WB defines also the final score of the hydromorphological risk assessment.

Water pollution

The assessment of different pressures causing significant water pollution includes three steps. First the concentrations of organic, nutrient, dangerous and dangerous priority substances in rivers and lakes obtained from monitoring data were considered. In the second step pressures on the environment from different sources were addressed in the following order:

1. Point source emission from industry, traffic, tourism and urbanization (releases of sewage that does not end in waste water treatment plants – hereinafter called WWTP)
2. Diffuse source pollution from agriculture and urbanization (organic pollution which originates from settlements not equipped with WWTP).

The concentrations of pollutants obtained from monitoring results and calculated from point sources were compared with the criterion presented in Table 1, while the diffuse pollution sources from agriculture were evaluated using different criteria. They were evaluated on the basis of agricultural land use and data showing the amounts of active substances sold in different RB districts (Peterlin et al., 2007). In the third and final step the WBs with significant pressures were identified as WBs in which the concentrations of different pollutants were higher than $0.8 \cdot LV$ (class 3) or LV (class 4) and where the analysis showed high inputs of nutrients and pesticides from diffuse sources. These WBs will probably not achieve good ecological and chemical status as required by the WFD.

Table 1: Criteria for identification of significant pressures – water pollution

	1 – irrelevant pressure	2 – low level of pressure	3 – medium level of pressure	4 – significant pressures
Organic pollution and nutrient enrichment	$C < 0.5LV$	$0.5LV \leq C \leq 0.8LV$	$0.8LV < C \leq LV$	$C > LV$
Dangerous and dangerous priority substances pollution	$C < 0.3LV$	$0.3LV \leq C \leq 0.8LV$	$0.8LV < C \leq LV$	$C > LV$

LV – limit value from Ur. L. RS, 11/02

RESULTS AND DISCUSSION

For the recognition of significant pressures in Slovenia a generic list of sectors and activities with impacts on the water environment was prepared (Table 2). SWMIs were then prepared by linking the results of risk assessment, which were delineated on two major areas of interest, i.e. to hydromorphological pressures and water pollution, and the as-prepared list.

Table 2: The sectors and activities used for the preparation of SWMIs

Sectors	Activities
Energetics	Water abstraction (water derivation) for hydropower plants and small hydropower plants, Sediment abstraction (dredging), River engineering works, Hydropeaking
Industry	Water abstraction for technological purposes, Impervious urban surface area, Sediment abstraction (dredging), River engineering works, Point source releases from industry
Agriculture	Water abstraction for irrigation, Water abstractions for fish farming, Drainage and irrigation area, Different river engineering works, Releases from farms, Rinsing and drifting of nutrients and pesticide
Urbanization	Impervious urban surface area, Water abstraction for water supply, Sediment abstraction (dredging), River engineering works, Releases from waste water treatment plants (WWTP)
Traffic	River engineering works
Tourism	River engineering works, Riverside resorts and baths

Further results are presented separately for two main fields of work for the three river basins on the Danube RB district – Mura, Drava and Sava. The Danube RBD covers 16,422 km², which represents 81% of the total area of the Republic of Slovenia. The greater part belongs to the Sava RB (72% of Danube RBD), followed by the Drava RB (20%) and the least belongs to the Mura RB (8%). Proportionally to the area the number of WB is distributed. On the Danube RBD there are 114 WBs (Bizjak et al., 2005) on the rivers and 76 WBs will probably not achieve good status until 2015.

Hydromorphological pressures

Eight pressures were analysed in detail for each RB district. On Figure 2 the number and percentage of WBs with a particular significant pressure is presented. Because of the differences in relief, natural resources and consequently land use in the RB districts, the structure of pressures is very heterogeneous. The relief on the Mura RB is mostly plain and from that very reason the main sectors causing the hydromorphological pressures are urban development and agriculture. The most productive agricultural land is alongside the rivers that were straightened and resectioned in the past. These regulations are still maintained and are in contradistinction to the dynamic self-maintaining morphological conditions that enable good conditions for biological elements. The Mura RB was also drained to a great extent in the former times. It has the largest drained area of all RBs in Slovenia.

The Drava RB has more diverse relief than Mura and consequently many sectors causing significant pressures. Beside agriculture, urban development and transport, energetics is the main pressure. The chain of hydropower plants and numerous water abstractions for small hydropower plants denote this RB mostly in the mountainous and hilly relief. In the lower, plain relief, regulations, derivation channels, land drainage and water abstractions for fish farms play a major role.

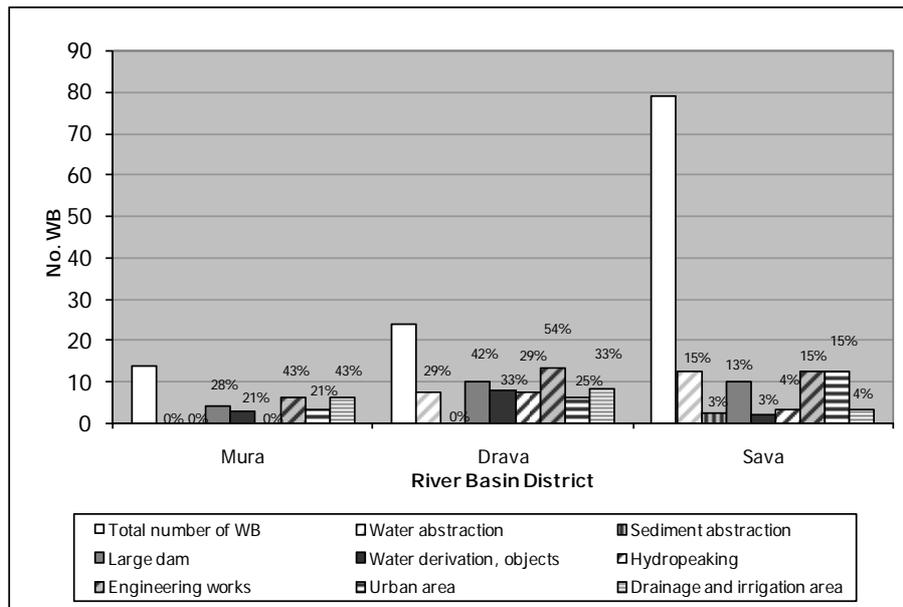


Figure 2: Hydromorphological pressures on the Mura, Drava and Sava river basin

The most diverse RB, which is also the largest, is the Sava RB. The upper part of this RB is characterised by the high mountainous relief which then passes over the hilly and undulating relief to the plain terrain and then back to the hilly and undulating one. This is why all the possible sectors and pressures are present in this RB. In the middle part with flat terrain, urban development, agriculture, industry and tourism are the cause of the significant pressures. Out of all sectors considered in the preparation of SWMIs the energetics as well as urban development is present in all parts of Sava RB. Main urban centres located in this RB are causing that the Sava RB has the largest percentage of urban impervious surface areas. In these centres and in their vicinity the morphological conditions of the rivers are altered extensively. Numerous flood protection reservoirs and by-pass channels were built for the protection of urban and industrial areas. Beside the permanent concession for sediment abstraction, given to all RB water management concerns, on the Sava RB additional sediment abstractions are identified, especially in the upper mountainous part.

Table 3: Number or percentage of individual pressures on each RB

Pressure		Mura	Drava	Sava
Water abstraction (No.)	Small HPP	0	46	59
	Fish farming	0	28	37
	Irrigation	0	0	0
	Water supply	0	1	1
	Industry	0	1	1
Changed morphological conditions (%)	Slightly–moderately changed	5.1	42.2	46.3
	Extensively changed	82.1	42.2	34.2
	Severely changed	1.8	13.9	11.2
Sediment abstraction (No.)		0	0	5
Large dam (No.)		6	18	13
Derivation channel (No.)		3	8	2
HPP (No.)		0	8	5
Urban area (%)		4.6	3.5	5.2
Drainage and irrigation area (%)		12.3	2.8	1.3

Water pollution

In the assessment of water pollution we considered organic pollution as BOD₅ and saprobe index, nutrient enrichment as total phosphorous, ammonium, nitrite, nitrate, dangerous substances as detergents, phenol substances, AOX, mineral oils, copper, zinc, cobalt and several pesticides and dangerous priority (hereinafter call hazardous) substances as cadmium, nickel, lead, mercury and different pesticides from priority list presented in the preparatory document for Environmental Quality Standards (COM, 2006).

The analysis of the three RBs in the Danube river district points out to large problems with the presence of nutrients in WBs (Figure 3) with the emphasis on the Mura and Drava RBs. The identified significant pressures were associated with a high percentage of agricultural areas as well as with unregulated sewage systems and wide distribution of settlements, particularly in the Mura RB. Pollution with dangerous substances is a consequence of the presence of industry, urbanisation and tourism in all three RBs.

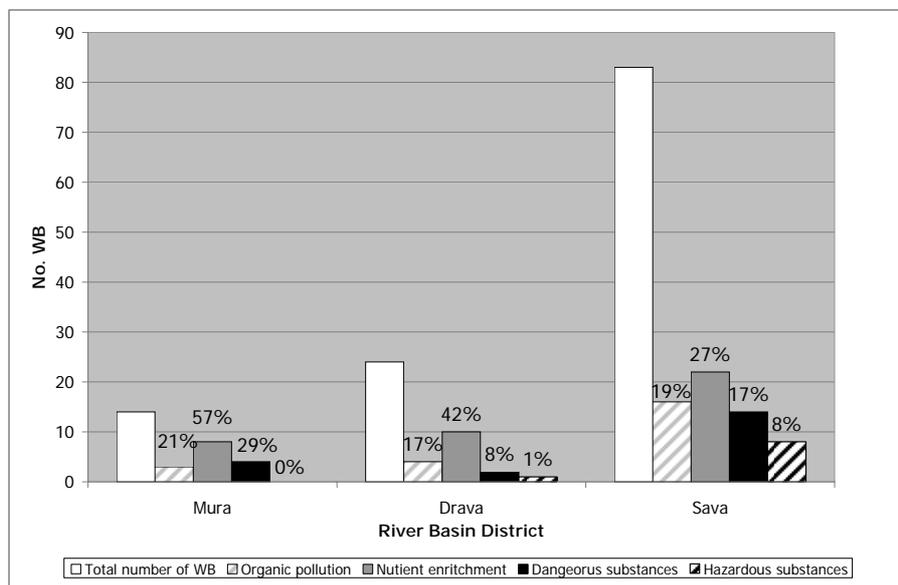


Figure 3: Number of WBs at risk because of organic pollution, nutrient enrichment, dangerous and hazardous substances

From risk assessment of hazardous substances we identified 9 WBs in the Danube Basin District with significant pressures from hazardous substances pollution. The monitoring data showed high concentrations of two different hazardous substances i.e. cadmium and lead, in two different WBs located in the Sava RB. The subsequent analysis of the area polluted with lead showed that the emission limit values (hereinafter call ELV) of this substance is exceeded because of point sources pollution from non-metallic mineral production. For an additional 6 WBs in the Sava RB and 1 WB in the Drava RB we also identified significant pressures from diffuse source pollution on the basis of information regarding pesticides that were sold in the catchment area in quantities greater than 50 tons/year.

Point source pollution exceeding emissions limit values. Point source emissions from different sectors and activities were analysed (Table 2) for the purpose of identification of the pollution recognized from monitoring data. The sectors and activities that were identified as exceeding ELV in the Danube basin district are listed in Table 4. Approximately 49% of total amount of point source releases are emitted directly into water or into the sewage system which does not end with WWTP. Out of this high percentage of releases there are 146 composed of organic

and nutrient substances and 182 of dangerous and hazardous pollutants for which ELV according to the Slovenian legislation (Ur. L. RS, 47/05) are exceeded. The analysis of these sources showed that out of all activities considered (Table 4) the highest portion of emissions exceeding ELV comes from food industry, wood processing industry, paper processing industry and publishing, manufacture of metal and metal fabricated products and from dumping grounds. The highest density (No. of releases exceeding ELV / total area of RB) of these releases is in the Drava RB.

Table 4: The sectors and activities for which the calculated concentrations of (A) organic and nutrient pollution, (B) dangerous and hazardous substances exceed ELV (Ur. L. RS, 47/05)

	Number of releases	Mura		Drava		Sava	
		A	B	A	B	A	B
Statistics	Total	49	53	156	172	506	561
	Directly into water	17	20	91	98	234	272
	Releases where C > ELM	9	11	41	48	96	123
Sectors	Activities	↓	↓	↓	↓	↓	↓
Industry	Food industry	●	●	●	●	●	●
	Textile industry					●	●
	Wood processing industry	●	●	●	●	●	●
	Paper processing industry and publishing, printing activities		●		●	●	●
	Chemical industry			●	●	●	●
	Manufacture of metal and metal fabricated products	●	●	●	●	●	●
	Manufacture of other non-metallic mineral products			●	●	●	●
	Electron and electrical industry					●	●
	Construction	●	●				
	Manufacture of machinery and equipment	●	●	●	●	●	●
	Laundry and chemical cleaning			●	●	●	●
Agriculture	Animal breeding	●	●	●	●	●	●
Urbanization	Trade and machinery repair			●	●	●	●
	Health and social security			●	●	●	●
	Dumping grounds	●	●	●	●	●	●
	Releases from WWTP	●		●		●	
Traffic	Traffic and storage			●	●	●	●
Tourism	Hotel trade and tourism	●	●	●	●	●	●

Diffuse source pollution. For the analysis of diffuse source pollution, the portions of different land uses were determined. The results showed that proportions of agricultural areas in Mura, Drava and Sava RB are 67%, 47% and 32%, respectively. The northeast part of Slovenia (the Mura RB) has the highest percent of agricultural land use where primarily the cultivation of land is performed. Risk analysis of nutrient enrichment and hazardous substances pollution established on the basis of this land use showed that 64% as well as 21% of total of WBs (14) in the Mura RB are at risk of failing good status because of high levels of phosphorus and nitrate as well as pesticides inputs, respectively. In the Sava RB, which has the lowest percent of agricultural area, around 32% (26.5 out of 83) of WBs is at risk because of intense animal breeding and vegetable production.

CONCLUSIONS

On the basis of risk assessment we established that 41% out of the total number of WBs are at risk because of hydromorphological pressures and 51% because of water pollution, while 27%

of WBs are under both hydromorphological and water pollution pressures. With the consideration of current and authoritative action plans originating from the Slovenian legislation, the SWMIs for these WBs are:

- for hydromorphological pressures:
 - o Many exceeded water abstractions for different purposes, especially in the summer time.
 - o Interrupted river longitudinal, lateral and vertical continuity as a consequence of diverse engineering works.
 - o Altered morphological conditions, above all the riparian zone (e.g. removed riparian vegetation) and prevented natural dynamic processes that are the essential component for biological elements.
 - o Non-sustainable land use in the river corridor vicinity and hinterland.
- for water pollution:
 - o Overloads of organic, nutrient, dangerous and hazardous pollutants in the period of lowest discharges in a water year and exceeded emission limit values from point source discharges.
 - o Water pollution of different pollutants from diffuse sources in the vicinity of settlements which are not included in the National Action Plan on the Urban Waste Water Treatment Directive.
 - o Additional SWMIs: Input of nutrients and hazardous substances (e.g. pesticides) from agricultural sources.

Our further work will be oriented in collecting new information's regarding different sectors as well as activities (e.g. sediment abstractions, industrial dumping grounds, water abstractions for hotel trade and tourism etc.) that were not evaluated during the preparation of presented SWMIs and analysis of their influence on the Slovenian water environment. SWMIs will be regarded in the process of determination of cost effective programme of measures as a basis for achieving good status of water in river basin management plans.

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