Analysis of the Tisza River Basin 2007

Technical Summary

//// Deutschland //// Österreich //// Česká republika //// Slovensko //// Magyarország //// Slovenija //// Hrvatska //// Bosna i Hercegovina //// Srbija //// Crna Gora //// România //// България //// Moldova //// Україна ///

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1 Introduction

The Tisza[1] River Basin is one of the most picturesque territories of Europe. Mountain streams, meandering rivers, diverse floodplains are characteristic of this region – home to the unique mayfly species called the Tisza Flower (*Palingenia longicauda),* which is only found in the rivers of the plains of the Carpathian Basin.

Ukraine, Romania, the Slovak Republic, Hungary and Serbia share not only the beauties of the Tisza River Basin but also the area's problems related to water supply, severe flooding, droughts, landslides and erosion, accidental pollution by industrial and mining activities as well as pollution from agricultural sources. The whole document "Analysis of the Tisza River Basin 2007" presents the issues together with the facts from the Tisza River Basin that will enable an integrated river basin management plan to be developed which will meet the needs of the EU Water Framework Directive and the Flood Directive and which will enable the countries of the basin to manage their land and water to the benefit of the people and environment as well.

The Tisza Group under the ICPDR was responsible for this Analysis Report.

This Analysis is an intermediate step between the WFD Article 5. report submitted in March 2005 (prepared at both the Danube River Basin level, 'Roof Report' and national reports) and the River Basin Management Plan to be submitted in 2009. This report is presented in four main sections:

- Part 1 presents the overall characteristics of the basin including, geography, climate, hydrology, land use, basic socio-economic information, etc.
- Part 2 presents the detailed characterisation of the water **quality** of the basin and expands the information collected for the WFD Article 5. report submitted in 2005 – Danube Roof Report
- Part 3 presents the detailed characterisation of the water **quantity** of the basin. This represents significant new information of the impacts of floods and droughts, use of water, etc.
- Part 4 *integrates* the issues in the basin, specifically on how water quantity impacts water quality.

The Tisza River Basin Analysis Report gives an overview of the following waters:

- the Tisza River and its tributaries with a catchment size of >1 000 km^2 ;
- natural lakes >10 km^2
- reservoirs
- main canals
- groundwater bodies >1,000km^2

This technical summary is a shortened version of the whole Tisza River Basin analysis report (`*Analysis of the Tisza River Basin – 2007*`). The purpose of this summary is to serve as a reference/ guidebook to the main report, therefore the main figures and tables as well as the structure of the main report are preserved.

It is expected that this summary will be translated and further disseminated in national languages and will call for the interest to the main report.

[1] The spelling of the river name differs from country to country (UA: Tysa; RO: Tisa; SK: Tisa, HU: Tisza; RS: Tisa; UK: Tisza) In the context of this report, the English spelling **`TISZA`** will be used.

Part I - Characterisation

2 Tisza River Basin overview

The Tisza River Basin (see **MAP 1**) is the largest sub-basin in the Danube River Basin, covering 157,186 km² or 19.5% of the Danube Basin. Together with its tributaries, the Tisza River drains the largest catchment area in the Carpathian Mountains before flowing through the Great Hungarian Plain and joining the Danube River.

The Tisza River Basin is home to some 14 million people.

With a strongly meandering riverbed, the original length of the Tisza River was 1,400 km from its spring in the northeastern Carpathian Mountains in Ukraine to its mouth at the Danube. During the second half of the 19th century, extensive measures of river training and flood control were undertaken along the river. As a result of these works, the river's total length was shortened by approximately 30% and it is today 966 km. However, it is still the longest tributary of the Danube River with the second largest discharge after the Sava River.

The Tisza River Basin can be divided into two main parts:

- the mountainous Upper Tisza and the tributaries in Ukraine, Romania and the eastern part of the Slovak Republic and
- the lowland parts mainly in Hungary and in Serbia surrounded by the East-Slovak Plain, the Transcarpathian lowland (Ukraine), and the plains on the western fringes of Romania.

The Tisza itself can be divided into three parts:

- the Upper Tisza upstream from the confluence of the Somes/Szamos River,
- the Middle Tisza in Hungary which receives the largest right hand tributaries: the Bodrog and Slaná/Sajó Rivers together with the Hornád/Hernád River collect water from the Carpathian Mountains in the Slovak Republic and Ukraine, and the Zagyva River drains the Mátra and Bükk, as well as the largest left hand tributaries: the Szamos/Somes River, the Körös/Criş River System and Maros/Mures River draining Transylvania in Romania and
- the Lower Tisza (downstream from the mouth of the Maros/Mureş River where it receives the Bega /Begej River and other tributaries indirectly through the Danube – Tisza – Danube Canal System.

The Tisza River Basin has significant flood protection and land drainage systems.

Accidental pollution and nutrient pollution can directly influence aquatic ecosystems and drinking water utilisation, while large-scale land reclamation can damage wetland ecosystems and intensified flooding problems in other areas.

Five states share territories in the Tisza River Basin District: Ukraine, Romania, the Slovak Republic, Hungary and Serbia. The coverage of the states in the Tisza River Basin as well as the status of the countries in the EU is provided in **Table 1.**

Table 1: Coverage of the states in the Tisza River Basin as well as the status of the countries in the EU

Country	ISO-Code	Tisza River Basin area in the country (km^2)	Percentage of Tisza River Basin (%)	Percentage of Tisza River Basin area of the whole country area (%)	Status in the European Union
Ukraine	UA	12,732	8.1	2.1	-
Romania	RO	72,620	46.2	30.5	Member State
Slovak Republic	SK	15,247	9.7	31.1	Member State
Hungary	HU	46,213	29.4	49.7	Member State
Serbia	RS	10,374	6.6	11.7	Initiation in Octover 2005

Although Ukraine and Serbia are not EU Member States and non-EU States have no implementing and reporting obligations under the EU Water Framework Directive (WFD) they are cooperating in the frame of the ICPDR to implement the necessary WFD steps, including the development of a Tisza (and Danube) joint river basin management plans.

3 General characterisation of the Tisza River Basin

3.1. Geographic characterisation, climate and precipitation

The Tisza River Basin, the largest sub-basin of the Danube River, is shown in **MAP 1.**

The drainage basins of the tributaries of the Tisza River differ from each other in topography, soil composition, land use and hydrological characteristics.(**MAP 2** shows the topography and relief of the Tisza River Basin.) The 1800-2500 m high ridge of the Carpathian Mountains create in a semi-circle the northern, eastern and southeastern boundary of the Tisza catchment. The western – southwestern reach of the watershed is comparatively low in some places – on its Hungarian and Serbian reaches it is almost flat.

The Tisza River Basin is influenced by the Atlantic, Mediterranean and Continental climates, which impact regional precipitation. About 60% of the Upper Tisza River Basin gets more than 1000 mm of precipitation annually. Warm air masses from the Mediterranean Sea and the Atlantic Ocean cause cyclones with heavy rainfall on the southern and western slopes. In general, two-thirds of the precipitation occurs in the warm half of the year. Furthermore, land surface is subdivided into the Carpathian Mountains (70 % of catchment area) and the wide Tisza Lowlands. (See **MAP 3** and **MAP 7** – Precipitation).

The surface soils in the Tisza Basin have been grouped according to permeability in **MAP 4**.

3.2. The main water bodies in the Tisza River Basin

The Tisza River rises in the southeastern part of the Carpathian Mountains and is a result of confluence of the Bila and Chorna Tisza Rivers.

The tributaries of the Tisza include Vişeu, Iza, Terešva, Tereblya and Rika, Borzhava and Tur/Túr, Someş/Szamos, Crasna/Kraszna, Bodrog, Sajó/Slaná, Zagyva River, Hármas-Körös and Mures/Maros, Aranca/Zlatica and Bega/Begej Rivers.

There are two natural lakes greater than 10 km^2 in the Tisza River Basin, the Szegedi Fehér Lake and the Füred-Kócsi Reservoir.

Artificial water bodies and reservoirs:

1. The Danube-Tisza-Danube Canal System (DTD): is situated in the Vojvodina province of the Republic of Serbia.
2. The Eastern and Western Main Canals: are located in Hungary and are mainly used to assist water resource distribution.
3. Reservoirs: more than 60 reservoirs were built during the last century for various purposes.

Groundwater bodies are important sources for drinking water, industry and agriculture in the Tisza River Basin. There are seven transboundary groundwater bodies in the Tisza River Basin.

3.3. Main National parks, protected areas and Ramsar sites in the Tisza River Basin

The Tisza River Basin countries have a great number of protected areas and Ramsar designated sites. (see **Table 2 and MAP5**)

Table 2: The main national parks, nature and biosphere reserves in the Tisza River Basin

Name	Surface (ha)	Location
Carpathians Biosphere Reserve	53,630	Ukraine: Zakkarpattia Oblast
Synevyr	40,400	Ukraine: Zakkarpattia Oblast
Uzhanskyi	39,158	Ukraine: Zakkarpattia Oblast
Cãlimani	24,041	Romania: Part of Bistrita-Nasaud, Harghita, Mures and Suceava Counties
Grãdistea Muncelului - Cioclovina	10,000	Romania: All in Hunedoara County
Muntii Apuseni	75,784	Romania: Part of Alba, Bihor and Cluj Counties
Retezat	38,047	Romania: All in Hunedoara County
Rodna	46,399	Romania: Part of Bistrita-Nasaud, Maramures and Suceava Counties
Maramures Mountains National Park	148,850	Romania; Maramures County
Slovak karst – National Park	34,611	Slovak – Hungarian border
Latorica - landscape protected area (LPA)	15,620	East of Slovakia – Bodrog River Basin
Slovak paradise – National Park	19,763	Upper part of Hornad and Slana River Basin
Muránska planina – National Park	34,611	Part of Slana River Basin
Hortobágyi – National Park	52,173	Hungary: Middle Tisza region
Kiskunsági – National Park	22,095	Hungary: Middle Tisza region
Aggteleki – National Park	19,247	Hungary: Middle-Upper Tisza region

Name	Surface (ha)	Location
Bükki – National Park	40,263	Hungary: North west - Middle-Upper Tisza region
Körös-Maros – National Park	800,000	Hungary: Lower Tisza region
Ludasko Lake	593	Serbia: Backa region
Slano Kopovo	976	Serbia: Banat region
Stari Begej (Old Bega) – Carska Bara	1,767	Serbia: Banat region

All five countries of the Tisza River Basin are Contracting Parties to the Convention on Wetlands. The main Ramsar sites in the Tisza River Basin are shown in **Table 3**.

Table 3: The main Ramsar sites in the Tisza River Basin

Name	Surface (ha)	Location
Latorica - landscape protected area (LPA)	15,620	East of Slovakia: Bodrog River Basin
Domice	622	Slovakia: Kosice Region
Tisza River - Kosice	735	Slovakia: Kosice Region
Senné-rybníky (Senné fishponds	425	Slovakia
Hortobágy	52,173	Hungary: Middle Tisza region
Felső Tisza	22,311	Hungary: Szabolcs - Szatmár - Bereg County
Pusztaszer	5,000	Hungary: Csongrád County
Bodrogzug	3,782	Hungary: Borsod – Abaúj – Zemplén County
Mártély	2,232	Hungary: Csongrád County
Ludasko Lake	593	Serbia: Backa region
Slano Kopovo	976	Serbia: Banat region
Stari Begej (Old Bega) – Carka Bara	1,767	Serbia: Banat region

3.4. Summary of socio-economic aspects

All the Tisza River Basin countries have undergone a significant political, economic, social and environmental transformation in the past 15 years. In most countries, radical political changes occurred in 1989 to 1991 that resulted in free elections in various forms and the establishment of pluralistic, multi-party democracies and separated branches of power.

Table 4 presents the basic socio-economic data covering all five countries in the Tisza River Basin. The Gross Domestic Product (GDP) and population figures presented are normalised using the population equivalent. In this case, the considerable difference in the GDP per capita figures can shows a significant disparity in wealth. This big gap between the countries is reduced when GDP per capita figures are expressed in Purchase Power Parities (PPP).

Table 4: General socio-economic indicators (data source: Competent authorities in the Tisza River Basin unless marked otherwise)

Country	Number of inhabitants in the Tisza River Basin***	GDP	Total population	GDP per capita	GDP per capita
		(in million EUR)	(million)	(in EUR per capita)	(in PPP EUR per capita)
Ukraine *	1,2400,000	70,381	47,1	1,494	Not available
Romania****	6,095,000	38,908	21.7	1,795	5,264
Slovak Republic**	1,670,000	33,1	5.4	6,15	14,35
Hungary	4,126,000	50,663	10.1	5,016	11,243
Serbia	810,000	8,628	9.0	959	not available

*1 date for year 2005
*** SK Source – Statistical Yearbook 2005. Data represent the year 2004 and are from preliminary quarterly accounts (at current prices).*
*****Romania – source of information is 2004*
***UNEP Rapid Assessment figures

Land use overview

Land in the Tisza River Basin is mainly used for agriculture, forestry, pastures (grassland), nature reserves, as well as urbanised areas. (See **MAP 6** on land uses)

The higher parts of the catchment, particularly in the Slovak Republic and Ukraine and the higher altitudes in Romania, are covered with (mainly deciduous) forest. The lower parts and floodplains are used for intensive agriculture, except where larger wetlands and traditional grazing areas exist.

The urban environment and related issues are gaining importance in the Tisza River Basin. National statistics show that approximately 65% of the population in Hungary, and 60% in the Slovak Republic, currently live in an urban setting. In Romania the urban population was slightly lower at more than 50% of the total population.

The biggest cities in the Tisza River Basin are Timisoara (304 000), Cluj- Napoca (320 000) and Oradea (206 000) in Romania; Debrecen (205 000) and Miskolc (180 000) in Hungary; Kosice (234 000) in the Slovak Republic; Subotica (147 000) in Serbia and Uzhgorod (118 000) and Mukachevo (82 000) in Ukraine.

Main economic sectors in the Tisza River Basin

Agriculture

During the last 10-15 years, agricultural production, including plant production and animal husbandry, has decreased in the Tisza River Basin and huge areas became fallow land. Also, there has been a general decline in the livestock, particularly in cattle and sheep stocks. In the Ukrainian part of the Tisza River Basin, agriculture has limited importance owing to unsuitable natural conditions, producing only small amounts of grain, meat and milk for domestic needs. Livestock breeding (based on seasonal pasturing of mountain meadows) is well preserved in the Carpathians, although the cattle and sheep stock decreased significantly during the past decade. In the southern part of the Slovak Republic, there is intense agriculture on the lowlands at the edge of the Hungarian Lowlands. Since 1990, livestock breeding has significantly decreased in the Slovak Republic (cattle by 41%, pigs – 43%, sheep – 20%, poultry – 4%). In Romania, big livestock farms closed down in the 1990s. In 2002, the Hungarian pig and poultry stock decreased by 63 and 60%, respectively, compared to the

1980 stock. In **Serbia**, fishponds and pig and cattle farming are still important for the local economy. (**Table 5.**)

Table 5. – Tisza River Basin agricultural area (ha) and livestock breeding

Country	Agricultural area				
	Arable land (ha)	Fruit trees, berries plantations (ha)	Grassland, Pasture (ha)	Vineyard (ha)	Heterogeneous Agricultural areas (ha)
Ukraine****	200400 (16%)	14100 (1%)	231000 (18%)	4800 (>1%)	8300 (>1%)
Romania	1475848	102718	126232	50598	1452310
Slovak Republic***	489650	2658	96508	3926	145983
Hungary	2 614 400	38 901	527 905	47 987	250 129
Serbia	791.000	9.000	54.500	5.500	35

Country	Livestock	
	Livestock (thousands/year)	Livestock density (Livestock per hundred hectares of agricultural area)
Ukraine****	194600 (3755)	42400 (819)
Romania	1740.4*	135.1**
Slovak Republic***	106*	14,35**
Hungary	1 675/30 724*	48/883
Serbia	865,5	96,70

* Cattle, pig, sheep/poultry
** All data from year 2002. Livestock in MEC (mature equivalent cow) units.
*** Areas in ha
**** UA comments: All data for year 2004, Agricultural area: in brackets % from total square in UA part of Tisza; Livestock: cows, pigs, sheep and goats (in brackets – poultry only)

Industry and mining

Industrial production has also dropped drastically since the 1990s. In the Tisza River Basin, the main industrial regions are located in Romania and Hungary, although there are also some important industrial facilities in Ukraine, the Slovak Republic and Serbia. Currently, the mining and metallurgical industries have an important share in the regional economy of the Tisza River Basin, as well as chemical, petrochemical, cellulose and paper, food, textile, and furniture industries.

Navigation

The Tisza River is used as a waterway from the Ukrainian-Hungarian border to the confluence with the Danube – over 70% of the river's total length. Some Tisza tributaries are navigable on shorter sections: the Bodrog River (along Hungarian stretch and 15 km in the Slovak Republic), the Mures

River (25 km, or less than 5% of its total length), the Körös River (115 km in Hungary) and the Bega/Begej River (presently 75 km in Serbia and 45 km in Romania before 1967).[2]

Hydropower generation in the Tisza River Basin

There are about 35 hydropower stations within the Tisza River Basin with an output of greater than 10 MW.

Table 6. The Installed capacity and discharges of the hydropower stations

Country	Installed capacity (MW)	Installed discharge (m^3/s)	% of the total power generation in the country
UA	32	50	0.05
RO	1535.8	2020	34.01
SK*	96.4	193	15
HU	39.5	860	0.5
RS	0	0	0
Total	1703-	3123	N/A

* Comment : SK - % of the total power generation represents year 2005. Hydro Power generation decreased from 20% in 1995 up to 15% in 2005

Two hydropower plants are planned in the Tisza River Basin on the border section between Romania and Ukraine. No development of new hydropower plants were mentioned in the Slovak Republic, Hungary, Serbia or Ukraine.

Forestry

Forestry is an important economic sector in the uplands of the Tisza River Basin, particularly in the Slovak Republic, Romania and Ukraine (see **MAP 7.**).

Table 7. Forested area of the Tisza River Basin

Country	Tisza River Basin area (ha) /country	Forested area in the Tisza River Basin (ha)/country	Deciduous forests (ha)	Coniferous forests (ha)	Country forested area share of country Tisza River Basin area (%)	Countries forested area share of total forested area of Tisza River Basin (%)
UA	1 273 200	694 000	467 200	180 800	54.5	16.1
RO	7 262 000	2 294 919	1 685 385	368 888	31.6	53.2
SK*	1 524 700	622 940	475 662	147 279	40.8	15.5
HU	4 621 300	683 025	No data	No data	14.8	15.8
RS	1 037 400	17 460	No data	No data	1.7	0.4
Total	15,718, 600	4,312,344	N/A	N/A	-	100

** - size of deciduous forest in SK comprises deciduous and mixed

[2] Roof Report 2004

Part II – Water Quality

4 Characterisation of surface water bodies

4.1 Identification of surface water categories

The following surface waters have been selected for the basin-wide overview:

- all rivers, heavily modified waters with a catchment size grater than 1 000 km²
- all natural lakes with an area greater than 10 km²
- artificial water bodies, which are mainly canals

4.2 Surface water types and reference conditions

The Tisza River Basin covers two ecoregions:the Carpathians and Hungarian Lowland. Ukraine, Romania and the Slovak Republic have territories in both ecoregions. The Hungarian and Serbian parts of the Tisza River Basin belong to ecoregion 11 (Hungarian Lowland).

In three countries – Hungary. Ukraine and Romania – ecoregions were divided into smaller geographical regions to address differences in river types based on diverse landscape features or variation in the natural vegetation or aquatic communities.

Table 8 Sub-ecoregions or bio-ecoregions in the Tisza River Basin

Ecoregion	Country	Sub-ecoregions or bio-ecoregions
10	**Ukraine**	Ukrainian Carpathians physical-geographical province ; Vododilno-Verkhovynsky, Polonynsko- Chornogorsky, Rakhivsko-Chivchinsky and Volcanic Intermountain physical-geographical regions
	Romania	Carpathian Intramountain area
11	**Ukraine**	Ukrainian Carpathians physical-geographical province ;Zakkarpattia lowlands physical-geographical region
	Hungary	Mountainous regions with calcareous character
		Mountainous regions with siliceous character
		Hilly regions with calcareous covering layers
		Plains with calcareous covering layers
		Peaty areas

Typology Systems used in the Tisza River Basin

Most countries in the Tisza River Basin (Ukraine, Romania, Hungary and Serbia) applied System B according to Annex II of the Water Framework Directive (WFD). Only the Slovak Republic used System A.

The common factors used in all Tisza River Basin typologies are the obligatory factors of System A: ecoregion, altitude, catchment area and geology (see **Table 9**). But most of the countries amended the classification according to their national requirements.

Table 9 Obligatory factors used in river typologies

<table>
<tr><th>Descriptor</th><th>Country</th><th colspan="8">Class boundaries</th></tr>
<tr><td rowspan="6">altitude</td><td>WFD</td><td colspan="2">0-200 m</td><td colspan="5">200-800 m</td><td>>800 m</td></tr>
<tr><td>Ukraine</td><td colspan="2">0-200 m</td><td colspan="5">200-800 m</td><td>>800 m</td></tr>
<tr><td>Romania</td><td colspan="2">0-200 m</td><td colspan="3">200-500 m</td><td colspan="2">500-800 m</td><td>>800 m</td></tr>
<tr><td>Hungary</td><td colspan="2">0-100 m</td><td colspan="3">100-200 m</td><td colspan="2">200-500 m</td><td>>500 m</td></tr>
<tr><td>Slovak Republic</td><td colspan="2">0-200 m</td><td colspan="3">200-500 m</td><td colspan="2">500-800 m</td><td>>800 m</td></tr>
<tr><td>Serbia</td><td colspan="2">0-200 m</td><td colspan="3">200-500 m</td><td colspan="2">500-800 m</td><td>>800 m</td></tr>
<tr><td rowspan="6">catchment area</td><td>WFD</td><td colspan="2">10-100 km²</td><td colspan="3">100-1,000 km²</td><td colspan="2">1,000-10,000 km²</td><td>>10,000 km²</td></tr>
<tr><td>Ukraine</td><td colspan="2">10-100 km²</td><td colspan="3">100-1,000 km²</td><td colspan="2">1,000-10,000 km²</td><td>>10,000 km²</td></tr>
<tr><td>Romania</td><td colspan="2">10-100 km²</td><td colspan="3">100-1,000 km²</td><td colspan="2">1,000-10,000 km²</td><td>>10,000 km²</td></tr>
<tr><td>Hungary</td><td colspan="2">10-200 km²</td><td colspan="3">100-2,000 km²</td><td colspan="2">1000 -12,000 km²</td><td>>10,000 km²</td></tr>
<tr><td>Slovak Republic</td><td colspan="2">10-100 km²</td><td colspan="3">100-1,000 km²</td><td colspan="3">>1,000 km²</td></tr>
<tr><td>Serbia</td><td>10-100 km²</td><td colspan="2">100-1,000 km²</td><td colspan="3">1,000-4,000 km²</td><td>4,000-10,000 km²</td><td>>10,000 km²</td></tr>
<tr><td rowspan="6">geology</td><td>WFD</td><td colspan="4">siliceous</td><td colspan="3">calcareous</td><td>organic</td></tr>
<tr><td>Ukraine</td><td colspan="4">siliceous</td><td colspan="3">calcareous</td><td>organic</td></tr>
<tr><td>Romania</td><td colspan="4">siliceous</td><td colspan="3">calcareous</td><td>organic</td></tr>
<tr><td>Hungary</td><td colspan="4">siliceous</td><td colspan="3">calcareous</td><td>organic</td></tr>
<tr><td>Slovak Republic</td><td colspan="8">mixed</td></tr>
<tr><td>Serbia</td><td colspan="4">siliceous</td><td colspan="3">calcareous</td><td>organic</td></tr>
</table>

Countries using **System B** used different optional factors to further describe the river types. With six descriptors Romania employed the highest number of optional factors (mean water slope, river discharge category, mean substratum composition, mean air temperature, precipitation and yearly minimum specific monthly flow with 95% probability). All other countries used mean substrate composition as the only optional factor within their System B typology (see **Table I0**).

Table 10 Optional factors used in the river typologies by countries using System B

Descriptor	Country	Class boundaries		
mean water slope	Romania	<10 p.m.	10-40 p.m.	>40 p.m.
river discharge[3]	Romania	high: >30 l/s km²	average: 3-30 l/s km²	minimum: <3 l/s km²

[3] In case of RO - the multiannual mean specific flow

mean substratum composition	Ukraine	gravel-pebble		pebble-boulder		boulder	
	Romania	blocks	boulders	gravel	sand	silt	clay
	Hungary	coarse		medium		fine	
	Serbia	coarse		medium		fine	
mean air temperature	Romania	high: >8 °C		average: 0-8 °C		low: <0 °C	
precipitation	Romania	abundant: >800 mm		average: 500-800 mm		reduced: <500 mm	
yearly minimum specific monthly flow with 95% probability	Romania	high: >2 l/s km²		average: 0.3-2 l/s km²		minimum: <1 l/s km²	

The Tisza flows through or borders on the territories of five countries: Ukraine, Romania, Hungary, the Slovak Republic and Serbia. These countries divided the Tisza River into eight types (see **Table 11**) and the typologies of the Tisza River were individually developed by the countries. Adjustment or harmonisation on the international level has not yet been completed. Therefore, five types were identified for the Upper Tisza: Ukraine delineated three types and both Romania and the Slovak Republic one type. For the Middle Tisza two types were delineated by Hungary, and for the Lower Tisza one type was delineated by Serbia.

Table 11 **Stream types defined for the Tisza River**

Country	**Name of the types**
Ukraine	UA_2C: Large rivers, low mountains, calcareous
	UA_1C: Large rivers, lowland
	UA_1D: Very large river, lowland
Romania	RO_06: Stream sector with wetlands in hilly or plateau area
Hungary	HU_14: Very large calcareous lowland stream
	HU_20: Very large calcareous lowland river
Slovak Republic	P1V_B1Large streams in Hungarian lowland
Serbia	RS_Typ1.1: Very large rivers, lowland, siliceous, fine sediments

In total, 40 stream types have been defined at relevant rivers of the Tisza River Basin with catchment greater than1,000 km² (see **Table 12**).

Table 12. **Number of stream types defined in the Tisza River Basin**

Country	Number of stream types defined for the relevant rivers in the Tisza River Basin
Ukraine	7
Romania	12
Hungary	11
Slovak Republic	7

Serbia	3
Total number of types	40

The Danube River Basin countries agreed on general criteria as a common base for the definition of reference conditions. These have then been further developed by the countries of the Tisza River Basin on the national level into type-specific reference conditions.

Spatially based reference conditions and expert judgement were the two methods predominantly used in the Tisza River Basin. Methods were also combined to derive reference conditions.

The Tisza River Basin countries defined reference conditions for all relevant biological quality elements, however 'macrophytes and phytobenthos' were not described by Ukraine (**Table 13**).

Table 13 **Definition of reference conditions for different indicative parameters of biological quality elements (x – parameter applies to quality element)**

		taxonomic composition	abundance	diversity	sensitive to insensitive taxa	age structure	biomass
Ukraine	Phytoplankton	x			x		
	Macrophytes and Phytobenthos						
	Benthic Invertebrates	x	x	x	x		
	Fish Fauna	x			x		
Romania	Phytoplankton	x	x				
	Macrophytes and Phytobenthos	x	x				
	Benthic Invertebrates	x	x	x	x		
	Fish Fauna	x	x		x	x	
Hungary	Phytoplankton	x	x				
	Macrophytes and Phytobenthos	x	x[1]				
	Benthic Invertebrates	x	x	x			
	Fish Fauna	x	x			x	
Slovak Republic	Phytoplankton	x	x	x	x		x
	Macrophytes and Phytobenthos	x	x	x	x		
	Benthic Invertebrates	x	x	x	x		
	Fish Fauna	x	x				
Serbia	Phytoplankton	x	x	x			
	Macrophytes and Phytobenthos	x	x[1]	x			
	Benthic Invertebrates	x	x	x			
	Fish Fauna	x	x	x		x	

[1] only Macrophytes

4.3 Identification of surface water bodies

Some 16 water bodies were identified on the Tisza River. The number of water bodies on the Tisza varied per country – seven delineated on the Hungarian part of the Tisza and only one on the Romanian and Slovakian part. This means that the size of the water bodies also varies significantly. The smallest water body on the Tisza is only 5 km long (Slovak Republic) and the longest is 159 km

(Hungary). **Table 14** and **II.15** give an overview of the number of water bodies identified on rivers. So far, 203 water bodies have been identified on the tributaries on the overview scale. Romania has the largest number of water bodies but also the largest part of the basin. The mean length of water bodies is 37 km on the tributaries and 62 km on the Tisza.

Table 14 **Number and lengths of water bodies at the Tisza River**

Country	number	mean length [km]	min [km]	max [km]
Ukraine	5	35.5	13	75
Romania	1	61	-	-
Hungary	7	83.5	21	159
Slovak Republic	1	5	-	-
Serbia	2	80.5	63	98
	Σ 16			

Table 15 **Number and lengths of water bodies at tributaries of the Tisza River Basin**

Country	number	mean length [km]	min [km]	max [km]
Ukraine	17	34	6	65
Romania	100	38.5	1	142
Hungary	43	39.5	7	94
Slovak Republic	30	34	5	91
Serbia	13	39.5	13	81
	Σ 203			

Two natural lakes greater than 10 km^2 were identified on Tisza Basin wide level: the Szegedi Fehér Lake and the Füred-Kócsi Reservoir.

MAP 8 shows the surface water bodies identified in the Tisza River Basin.

4.4 Identification of significant pressures

Significant point sources of pollution

Table 16: **Significant pressures(point sources) in the Tisza River Basin (based on the agreed ICPDR criteria)**

Countries	Municipal	Industrial	Agricultural
Ukraine	1	0	0
Romania	22	25	2
Slovak Republic	1	1	0
Hungary	11	7	0
Serbia*	16	6	0
Total	**51**	**39**	**2**

* Municipal and industrial point sources discharges for Tisza River Basin in Serbia are only estimated

Significant point source pollution from organic substances and nutrients

Table 17: **Municipal point source discharges of COD, BOD, total nitrogen and phosphorus in the TRB (based on ICPDR Emission Inventory data of 2005)**

Point Source discharges from Municipal sources				
Country	**BOD(t/a)**	**COD(t/a)**	**N(t/a)**	**P(t/a)**
Ukraine	558	820	145	117
Romania	12275	30092	5094	685
Slovakia	230	667	401	64
Hungary	6896	13507	2501	311
Serbia*	660	1198	15	5
Totals	**21,285**	**48,234**	**8,821**	**1,264**

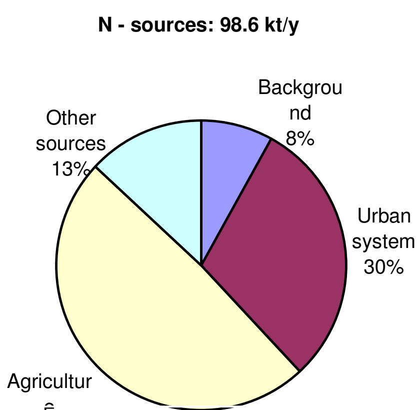
* Municipal and industrial point sources discharges for Tisza River Basin in Serbia are only estimated

Significant sources of nutrients (point and diffuse)

The specific P point discharges reflect, not only the state of the P elimination in wastewater treatment plants, but also the existing use of phosphorus in detergents, and discharges from direct industrial sources, as well as the amount of the population connected to wastewater treatment plants.

Table 18: **National average nutrient inputs by countries in the period 2002-2004**

Country	P specific emissions from point sources	P – point sources	Tot P	N specific emission from point sources	N - point sources	Tot N
	g/(inh.d) P	t/y	t/y	g/(inh.d) N	t/y	t/y
Ukraine	0.26	121	684	1.06	499	14467
Romania	0.63	1171	3222	4.82	8995	46647
SlovakRepublic	0.27	142	698	1.86	969	12058
Hungary	0.59	1194	3147	1.74	3520	22738
Serbia	0.02	8	463	0.17	63	2689



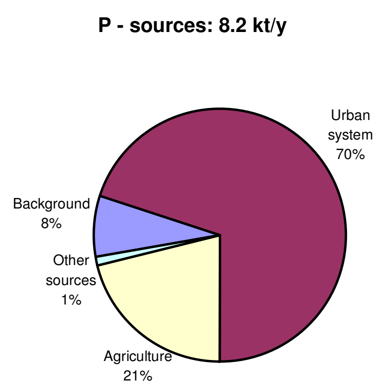


Figure 1. Estimation of the origins of nutrient pollution after recalculations from MONERIS (2007) based on reference year 2004

Table 19: **Sum of total nutrient emissions into country parts of the Tisza River Basin in the period 2002-2004 (MONERIS)**

Country	P sum specific emission	N sum specific emission
	g/ha a P	kg/ha a N
Ukraine	536	11.33
Romania	451	6.53
Slovak Republic	441	7.63
Hungary	694	5.01
Serbia	426	2.47

Other significant anthropogenic pressures in the Tisza River Basin

Accident Emergency Warining Systsem of the Danube River Basin

The general objective of the Accident Emergency Warning System (AEWS) is to increase public safety and protect the environment in the event of accidental pollution by providing early information for affected riparian countries. Participating countries established Principal International Alert Centres (PIACs) to distribute the warning message at the international level.

Mining activities in the Tisza River Basin

There is considerable diversity among sites in the types of problems they present. Sites may have a variety of physical, environmental and public safety concerns. In countries with a long mining history the magnitude of these impacts is often considerable and the cost of 'cleaning up' these sites are daunting. The largest environmental impact of mining activities is mine waters, a lasting remnant of historical and past mine activities. The amount of water and its chemical composition, particularly with a content of heavy metals and low pH, can vary in dependence from hydrogeological and hydrogeochemical situation of concrete region and system of drainage. In many cases it is not possible to measure its quantity and quality, or diffuse outflow.

The environmental impact of abandoned mines may cause significant pressures on the environment, which can dramatically increase after the mine closes. Often, the impact of the mines starts immediately after the closure of the mine and cessation of the mining activities. The impacts can be extremely difficult to control, often because they are a function of depositing very larger amounts of waste in ways that may not meet modern best practices. Mining produces a large volume of waste than any other industry; there are individual waste sites involving deposits of hundreds of millions or even billions of tons of material

The mining industry is well developed in the Tisza River Basin. Among the riparian countries, Romania has the most developed mining and ore processing industry due to its significant deposits of copper, lead, zinc, gold, silver, bauxite, manganese and iron ore.

Small-scale mining also occurs in the Ukrainian section of the basin, with the extraction of salt, kaolin, mercury, gold, complex ores, zeolites and rocks used as construction material

Mining of polymetalic ore and its processing was active in the Slovak Republic in the middle part of the Hornad River Basin watershed – above the Ružín Reservoir (Smolník, Rudňany, Slovinky) and the upper part of the Slaná River Basin. In the beginning of 1990s these activities were terminated, and only two remain active at the present time:Rudňany (Markusovce) and Nižná Slaná.

At present, the Hungarian mining industry in the Tisza River Basin produces hydrocarbons, coals, industrial minerals and construction materials. Locations of mining activities are quite evenly distributed in the territory. The Tisza alluvial provides an opportunity for a great number of permitted and illegal gravel pits.

There are no significant mining activities in the Serbian part of the Tisza River Basin, except the extraction of clay and sand for construction.

Significant hydromorphological alterations

The hydromorphological drivers relevant on the Tisza basin-wide scale are: hydropower generation, flood defence, navigation as well as water transfer, diversion and water abstraction.

4.5 Artificial and heavily modified water bodies (provisional identification)

A considerable part of the Tisza River and of numerous Tisza tributaries were assessed as significantly affected by hydromorphological alterations and were identified as provisional HMWBs. (**MAP 9** shows HMWBs of the Tisza River Basin.). In total, 21 AWBs were identified on tributaries of the Tisza River Basin in Romania, Hungary and Serbia. No AWBs were identified in Ukraine and the Slovak Republic. The identified AWBs amount to 10% of the total identified tributary water bodies in the Tisza Basin and have a total length of around 772 km. Serbia identified the majority of its tributary water bodies as AWBs (≈85%), due to the significant presence of canals in this lower part of the Tisza River Basin. The Serbian AWBs mainly used for navigation and flood protection. In other parts of the basin, such as Romania, AWBs are also used for hydropower.

Main Tisza River

Eight provisional HMWBs were identified on the main Tisza River of 540 km length. The provisional HMWBs identified are equivalent to 56% of the total length of the Tisza River (of 966 km) and to 50% of the total Tisza water bodies. The provisional HMWBs on the Tisza River are concentrated in Hungary and Serbia (the middle and lower part of Tisza).

It must also be mentioned that preliminary designation of the HMWBs is higher in the Tisza River than the European average.

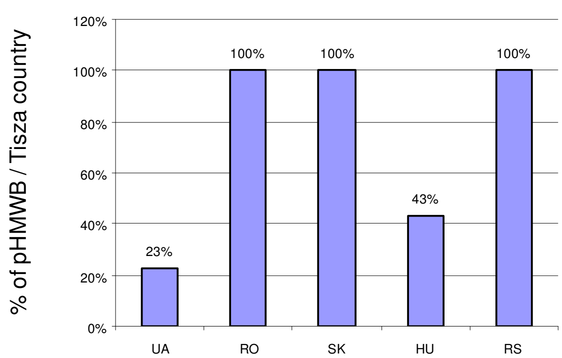


Figure 2 Percentage of provisional HMWBs on the national Tisza water bodies in the Tisza Countries

Tisza tributaries

The 77 provisional HMWBs identified on the tributaries of the Tisza River are 2,431.77 km long. Most of the tributary provisional HMWBs lie in Romania, the Slovak Republic and Hungary. The provisional HMWBs identified are equivalent to ≈38% of the total tributary water bodies of the basin.

From a cross-country perspective, it is interesting to note that the Slovak Republic identified up to ≈83% of its total tributary water bodies as provisional HMWBs. The high percentage of provisional HMWBs within the Slovak Republic can be explained by the fact that the main Slovakian rivers were regulated after World War II. Regulation served to provide enough water for economic development (as reservoirs for industry and hydropower generation) and for flood protection of inhabited areas. On the other hand, Ukraine identified only ≈6% of its tributary water bodies as provisional HMWBs (see **Figure 3**). The low percentage of provisional HMWBs on the Ukrainian tributaries of the Tisza is due to the fact that rivers in Ukraine have not been very developed and are thus not significantly modified yet in their hydromorphology.

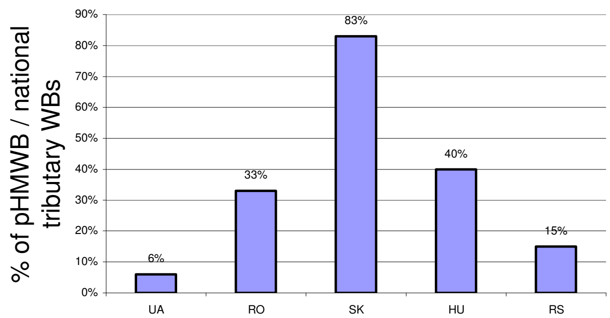


Figure 3. Percentage of provisional HMWBs related to national tributary water bodies of the Tisza River in the Tisza countries

Uses affecting provisional HMWBs

According to Figure II.4., flood protection and navigation appear to affect almost the entire length of provisional HMWBs on the Tisza River, while hydropower and urbanisation are not linked to any of the provisional HMWBs. In Serbia and Hungary, the entire length of the Tisza provisional HMWBs are used for navigation and flood protection and, in Romania, flood protection.

On the tributaries, the main use affecting the greatest length of provisional HMWBs (see **Figure 5.)** is flood protection, followed by urbanisation, hydropower and navigation. In Ukraine, the only provisional HMWB tributary identified is used for flood protection. In Romania and in the Slovak Republic, the greatest length of tributary pHMWBs serves flood protection, hydropower and urbanisation. In Hungary, all tributary provisional HMWBs are used for flood protection. Finally in Serbia, tributary provisional HMWBs are used mainly for flood protection and navigation and urbanisation to a lesser extent.

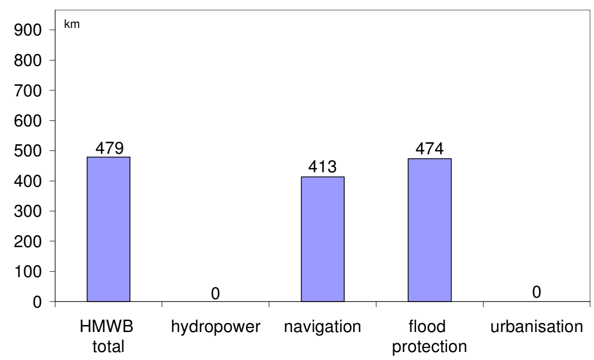


Figure 4 Main uses/measures of provisional HMWBs on the **Tisza** River

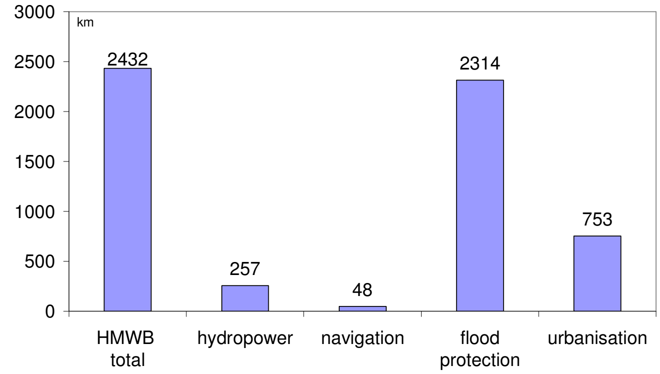


Figure 5 Main uses/measures of provisional HMWBs on the **tributaries** of the Tisza River

Significant physical alterations affecting provisional HMWBs

The main significant physical alterations affecting provisional HMWBs on the Tisza River are bank reinforcement/fixation and dams/weirs (see **Figure 6.**). In the case of the tributaries, dams/weirs are the main significant physical alterations affecting the greatest length of provisional HMWB, followed by bank reinforcement/fixation and by channelisation/straightening (see **Figure 7.**). Ukraine's single tributary provisional HMWB is affected by channelisation/straightening. In Romania, tributary provisional HMWBs are affected to their greatest length by channelisation/straightening, followed by bank reinforcement/fixation and last by dams/weirs. In the Slovak Republic, the greatest length of tributary pHMWBs is affected by bank reinforcement/fixation, dams/weirs and finally by channelisation. Hungary's tributary pHMWBs are mainly affected by dams/weirs. Finally, Serbia's tributary pHMWBs are affected mainly by channelisation/straightening and bank reinforcement/fixation.

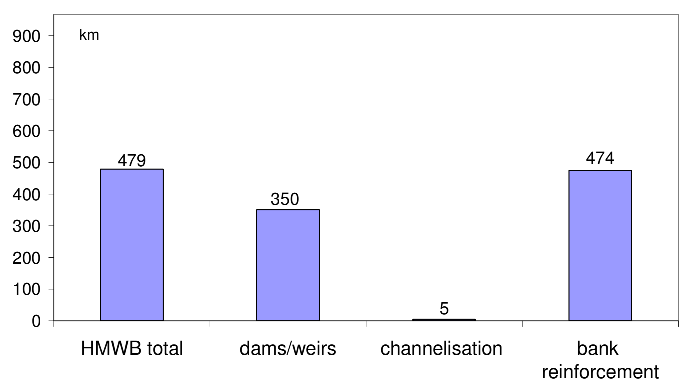


Figure 6 Physical alterations of pHMWBs on the **Tisza** River

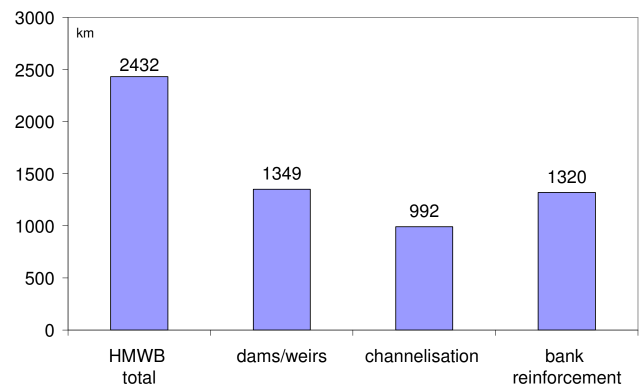


Figure 7 Physical alterations of pHMWBs on **tributaries** of the Tisza River

4.6 Monitoring

Water quality monitoring in surface waters

MAP 10 a [4] of this report includes the surveillance monitoring I (SM 1 – based on the national surveillance monitoring networks), surveillance monitoring II (SM 2 - supplementary to SM I and aims at the long-term monitoring of specific pressures of basin-wide importance) and operational monitoring stations of surface waters, which are operating in the Tisza River Basin since January 2007. Operational monitoring will be undertaken in order to establish the status of those bodies identified as being at risk of failing to meet their environmental objectives, and assess any changes in the status of such bodies resulting from the programmes of measures.

In 2005 five Transnational Monitoring Network (TNMN) stations were operating in the Tisza River Basin in Sajópüspök, Tiszasziget, Martonos, Novi Becej and Titel.

Regarding national monitoring stations in 2005 there were a total of 204 water quality monitoring stations on rivers larger than 1000 km^2 catchment area in the Tisza River Basin.

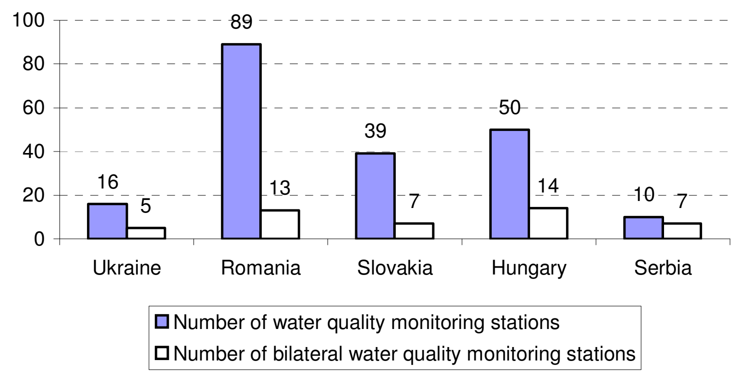


Figure 8 Water quality monitoring stations for rivers larger than 1000 km^2 in the Tisza River Basin

Water quantity monitoring

There were a total of 255 water quantity monitoring stations on the surface waters of the Tisza River Basin in 2005. All the stations measure water level (gauging stations). Additionally some other parameters, such as discharge or water temperature, are regularly measured at some of the water quantity monitoring stations.

[4] Summary Report to EU on monitoring programmes in the Danube River Basin District designed under Article 8 – Part I. WFD Roof report on Monitoring - Part I: Development of WFD compliant monitoring programmes for the Danube River Basin District, 2007

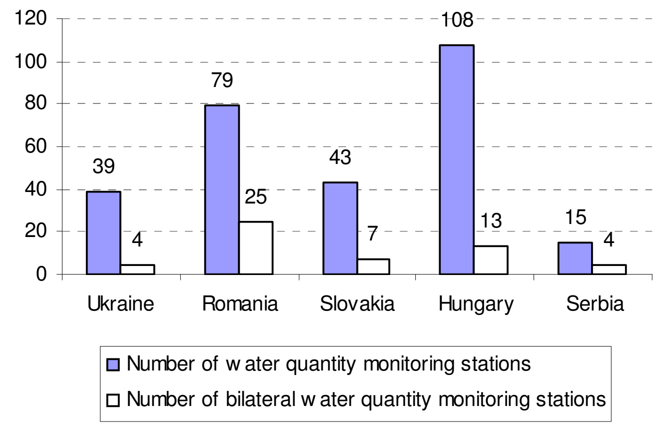


Figure 9. Distribution of the water quantity monitoring stations among the Tisza River Basin countries

Groundwater monitoring

MAP 10 b [5] introduces the chemical and quantity groundwater monitoring stations. The groundwater network design is based on existing national monitoring programmes which were adapted to the requirements of Article 8 of the WFD in EU Countries.

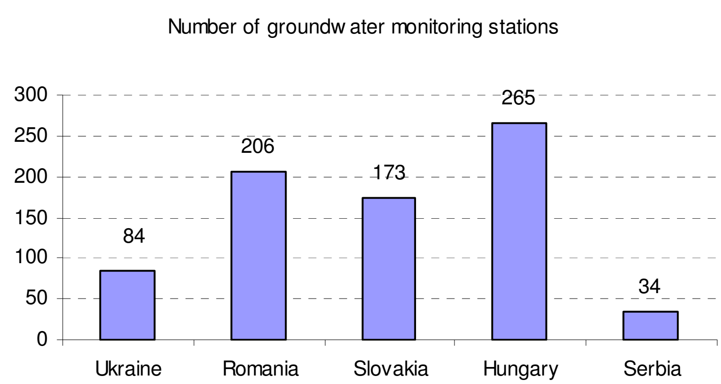


Figure 10. Number of groundwater monitoring stations

4.7 Assessment of impacts

For the purposes of this report water quality was assessed by Romanian experts based on *National Romanian Norm for surface water classification (1146/2002)*, which represents the transposition of the TNMN assessment system into Romanian legislation.

The *target objectives* are represented by the values of the second class of the *Norm 1146/2002*, the analysis of the water status is based on the mean annual concentrations.

[5] Summary Report to EU on monitoring programmes in the Danube River Basin District designed under Article 8 – WFD Roof report on Monitoring - Part II: Status report: Towards the development of groundwater monitoring in the Danube River Basin, 2007

Data are based on the period of 2001 to 2003 and in case of Tiszasziget,Martonos, Novi Becej, Titel period of 2004 – 2005.

For the water quality assessment the following data were used:

- data provided by the TNMN
- data provided by the Romanian National Monitoring Network
- data provided by the Joint Danube Survey-Investigation of the Tisza River 2001 (JDS-ITR)

Organic substances

The representative parameters of water status characterisation for organic substance are: dissolved oxygen, BOD_5 and COD-Mn.

The results for the period of 2001 to 2003 show:

- the values of the dissolved oxygen concentrations (7,40 – 11,50 mg/l) and BOD_5 concentrations (1,73 – 2,8 mg/l) have classified the **Tisza River** in the first class for the all monitoring sites;
- the values of COD-Mn (2,10 – 5,10 mg/l) have classified the **Tisza River mainly** in the first class for all the monitoring sites between 2001 and 2003 and in the second class in 2004 and 2005.

Similar results have been also recorded for the **Tisza tributaries**, values which belong to the first and second class, the only exception being the Dara monitoring site (on the Somes River) for which the value of the COD-Mn concentration belongs to the third quality class.

Nutrients

The representative parameters for water quality characterisation are: $N\text{-}NH_4^+$, $N\text{-}NO_2^-$, $N\text{-}NO_3^-$ $P\text{-}PO_4^{3-}$ and Ptot.

The nutrient concentrations for 2001 to 2003 have been characterised through the following values:

- 0,081 – 0,405 mg/l for $N\text{-}NH_4^+$. The monitoring sites Teceu (2001, 2002), Martonos (2003), Novi Becej (2002, 2003) and Titel (2001 – 2003) recorded that the target objectives were exceeded, with the indicator $N\text{-}NH_4^+$ belonging to the third class. According to the data from JDS-ITR, there were no exceedings recorded to the first class in the Novi Becej si Titel monitoring sections.
- 0,009 – 0,057 mg/l for $N\text{-}NO_2^-$. All the monitoring sites of the Tisza River recorded that the values for indicator $N\text{-}NO_2^-$ were in the second class in most cases, with the remaining sites belonging to the first class. Similar results were also recorded in the JDS-ITR.
- 0,15 – 1,19 mg/l for $N\text{-}NO_3^-$. For this indicator, the Tisza River is classified in the first class for Valea Viseu and Teceu (2001-2003), and in the second class for the remaining monitoring sites. For the two sections of JDS - ITR (Novi Becej and Titel) the values of $N\text{-}NO_3^-$ concentrations belonged to the first class.
- 0,027 – 0,086 mg/l for $P\text{-}PO_4^{3-}$ For this indicator the Tisza has been classified in the second class in general, with the remaining monitoring sites belonging to the first class. Similar results have also been recorded in the JDS-ITR.
- 0.011 – 0.23 mg/l for P total. For this indicator the Tisza belonged to the second class in general, with the exception of the Tiszasziget monitoring site (2001, 2002) which belonged to the third class.

Regarding the **Tisza tributaries**, the values of the nutrient concentrations belonged to the first and second class, with the exception of the Dara (Somes) monitoring site for which the value of $N – NH_4^+$

belonged to the fourth class for the entire period of time and sections Sajopuspoki (Sajo) and Cheresig (Crisul Repede) belonged to the third class for the indicator P–PO_4^{3-} for 2003.

As a general trend for the period of 2001 to 2003, the values of nutrient concentrations on the Tisza River were not high, ranging within the 'target objectives' class, with the exception of the indicator N – NH_4^+ which had a random variation: high values in the Upper Tisza monitoring sites and a rapid decrease in the Tiszasziget monitoring site (very high dilution), followed by a similar increase to that of Upper Tisza for the Lower Tisza.

Heavy metals

The evolution of heavy metals from 2001 to 2003 was the following:

- Cu concentration has been between 6.34 – 25 µg/l which classified most of the Tisza River monitoring sites in the first and second class, with the exception of Valea Viseului (2002) and Teceu (2002) which belonged to the third class.
- Cr concentration values (1 – 7.32 µg/l) corresponded to first class for the entire period of time and for all the monitoring sites.
- Pb concentration values (2.1 – 21 µg/l) classified the Tisza River in the fourth class in general, with the exception of the Tiszasziget site for which the values corresponded to the first and second class.
- Cd concentration values (0.13 – 2 µg/l) classified the Tisza River in the first and second classes in general, with the exception of the Valea Viseu (2002) site which corresponded to the third class.
- Ni concentration values (3.66 – 27 µg/l) corresponded to the first class, with few exceptions (Valea Viseului, 2002, 2004 – second class)

Referring to the **Tisza tributaries**, the values of the heavy metal concentrations belonged to the first and second classes with few exceptions: the monitoring site Dara (Somes) for which the value of Zn concentration for 2001 belonged to the third class, the value of Pb concentration for 2002 and 2003 belonged to the third and fifth classes and the value of Cd for 2002 and 2003 belonged to the fourth class.

According to the results of the heavy metals from JDS-ITR, the values for both monitoring sites (Novi Becej si Titel) were under '*target values'*.

Regarding **heavy metals** Cu, Pb and Cd exceed the II-nd class and are considered toxic substances, Pb and Cd being very toxic for water resources, especially for the biota.

High heavy metals concentrations show the pollution of the area with heavy metals (mining area) only in the monitoring sites of the Upper Tisza.

The Tisza River flowing from Ukraine at entrance in Romania has altered chemical characteristics through constantly exceeding the second class quality (Target Values) of the TNMN Water Quality Classification System for Pb, Cd and Cu.

Organic toxic substances

Of the organic toxic substances, only phenolic index and detergents were analysed. There is not enough data for the remaining substances (AOX, oil products, lindane, DDT, atrazine, chloroform, carbon tetrachloride, trichloroethan, tetrachlorethan).

The evolution of the toxic substances concentrations values on the Tisza River from 2001 to 2003 has been the following:

- the values of the phenolic index concentrations ranged between 1.0 – 5.0 µg/l which determined the classification of the Tisza River in the third class, with the exception of Valea Viseului (2003) which belonged to the second class.

- the values of the anionic detergent concentrations were between 11.0 – 42.0 µg/l, the Tisza River classified accordingly to the first class.

For the Tisza tributaries the values of the phenolic index concentrations belonged to the third class for all the monitoring sites.

Of the two classes of analysed pollutants, it was noticed that the detergents do not pose pollution problems as they are all well under the target objectives, but the same is not true for the phenolic index. Phenols are known as substances with toxic effects on aquatic organisms. They can appear in water through accidental pollution, and in general their trend is decreasing however values are enough high in comparison to target objectives.

4.8 Risk of failure to reach environmental objectives

The risk assessment is based on a combined evaluation approach considering both significant pressures and in-stream quality data. The risk analysis is a stepwise approach from disaggregated information to the aggregated analysis of risk. The pressures and their relating impacts are disaggregated into the following risk categories:

- Organic pollution,
- Hazardous substances,
- Nutrient pollution and
- Hydromorphological alterations.

Results on the Tisza River

On the Tisza River , 11 water bodies (668 km long) were assessed as ‘at risk’. This is equivalent to 69% of the total Tisza water bodies (see **Figure 11**.) and of the total length of the Tisza River. The main part of water bodies ‘at risk’ lies in Hungary and Serbia. Tisza water bodies possibly at risk (25% of the total) were reported only by Ukraine and Hungary, while the only Tisza section not at risk (6% of the total) lies in Ukraine.[6]

Figure 11 reflects national ‘risk assessment’ differences between the five Tisza countries. Three Tisza countries (the Slovak Republic, Romania and Serbia) classified up to 100% of their national share of Tisza WBs as at risk. In Ukraine, only 20% of its national Tisza water bodies were classified as at risk but 60% were classified as possibly at risk.

[6] Ukraine classified one stretch of its Tisza as ‘not at risk’, although it considered this stretch as ‘possibly at risk’ for hydromorphology.

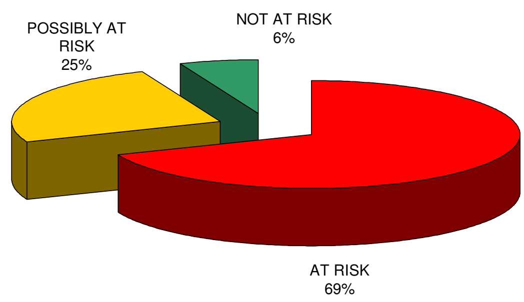


Figure 11 Surface Water Bodies at risk/possibly at risk/not at risk on the Tisza River

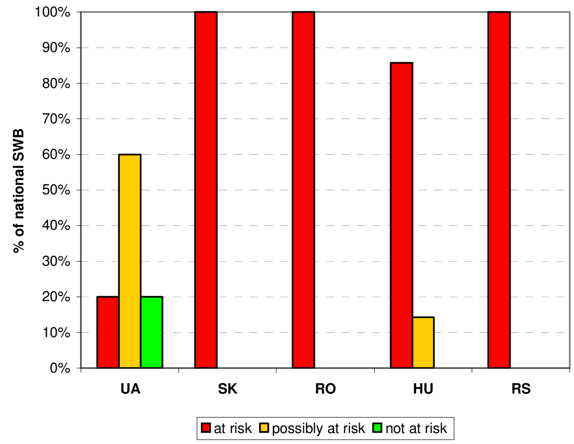


Figure 12 Surface Water Bodies at risk/possibly at risk/not at risk in the 5 countries sharing the Tisza River

Data on risk assessment were available for most of the Tisza River. The few data gaps and uncertainties could be overcome through future harmonisation of river kilometres and risk assessment results for transboundary Tisza sections shared by Ukraine/Romania, Ukraine/Hungary and the Slovak Republic/Hungary**. Figure 13.** illustrates the reasons for which water bodies are at risk (nutrient pollution, hazardous substances, organic pollution or hydromorphological alterations).

Figure 13. is based on the information provided in the completed Risk Assessment Templates. To correctly interpret the information, it should be considered that in three transboundary Tisza sections, shared by Ukraine/Romania, Ukraine/Hungary and the Slovak Republic/Hungary, non-harmonised risk assessment results and river kilometres were reported by the riparian countries. In these cases, only the data of one riparian could be illustrated in the Figure. In the case of the Ukraine/Romania section, the figure illustrates only the Romanian data. The corresponding Ukrainian data, not shown in the figure, classified part of this section as 'at possible risk' due to hydromorphology, as 'possibly at risk' due to hazardous substances, as 'not at risk' for nutrients and 'possibly at risk' due to organic pollution. In the case of the Ukraine/Hungary section, the figure illustrates the Hungarian data. The corresponding Ukrainian data, not shown in the figure, classified this section as 'possibly at risk' instead of 'at risk' due to hazardous substances. In the Slovakia/Hungary section, the figure again illustrates the Hungarian data. The corresponding Slovakian data, not shown in the figure, classified this section as 'at risk' due to organic pollution, as 'at risk' due to nutrients, as 'possibly at risk' due to hazardous substances and as 'at risk' due to hydromorphology.

Based on the data shown in the Figure, 69 % of the Tisza was calculated as 'at risk' or 'possibly at risk' due to organic pollution, 65 % due to nutrient pollution, 92 % due to hazardous substances and 100% due to hydromorphological alterations.

The Upper Tisza in the mountainous area of Ukraine is classified as 'possibly at risk' due to hydromorphological alterations. In Romania, the Tisza is classified 'at risk' due to hazardous substances and possibly at risk for hydromorphological alterations, nutrient pollution and organic pollution. The Middle Tisza is partly classified as 'at risk' and partly as 'possibly at risk' due to hydromorphological alterations, hazardous substances and organic pollution. In this middle part, nutrient pollution is also as a reason for the possible risk of a significant part of the Tisza River. The

Lower Tisza is 'at risk' due to hydromorphological alterations, hazardous substances and nutrient pollution.

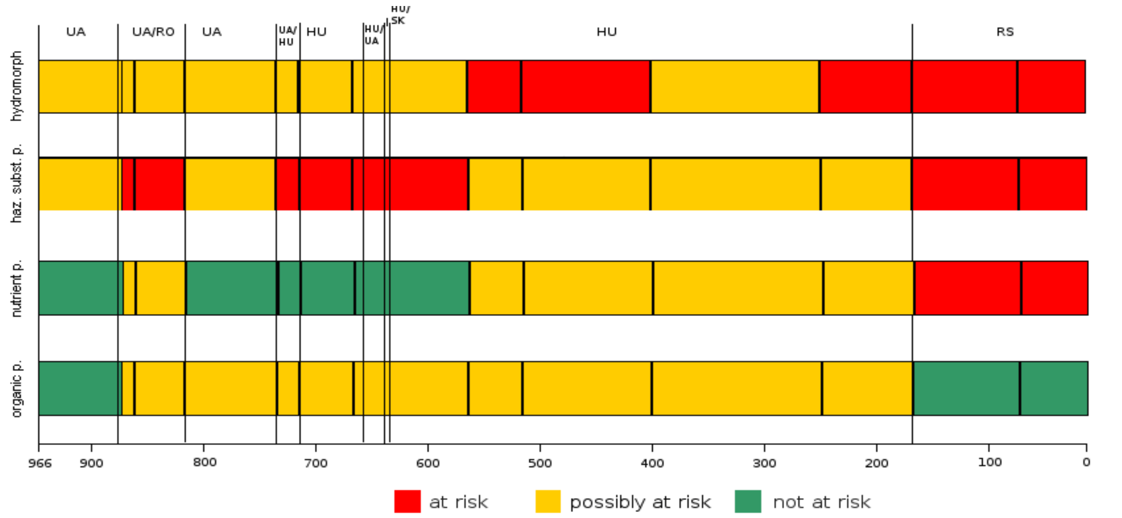


Figure 13[7] Risk classification of the Tisza, disaggregated into risk categories. Each full band represents the assessment for one risk category (hydromorphological alterations, hazardous substances, nutrient pollution, organic pollution). Colours indicate the risk classes

The high risk or possible risk due to hydromorphological alterations is related to the presence of physical pressures such as weirs, bank reinforcement, channelisation and river regulation, especially in the middle and lower parts of the Tisza. Hydromorphological risk is also linked to the identification of approximately 50% of the length of the Tisza as provisionally heavily modified in its middle and lower part.

The Tisza has also been classified to a substantial extent as 'at risk' or 'possibly at risk' due to the presence of hazardous substances. A major problem in assessing the results on hazardous substances is the limited data availability in the Tisza River Basin. In Ukraine, risk and possible risk were related mainly to heavy metals and cyanides from Romanian mines, chlorides from Ukrainian mines as well as mercury.

Romanian sections of the Tisza were also assessed as 'at risk' from hazardous substances coming from upstream in Ukraine. Specifically, the waters of the Romanian Tisza constantly exceeded second class limits (Target Values of the TNMN Water Quality Classification System) for heavy metals Pb, Cd and Cu at Valea Viseului, the entry of Tisza in Romania. At the exit of the Romanian/Ukrainan Tisza at Teceu/Tyacchiv, concentrations of heavy metals were lower in 2001 - 2003 than those for the entry and as the same as for the entry in 2005-2006.

In Hungary, heavy metals mainly of transboundary origin were reported as responsible hazardous substances for classifying water bodies on the Tisza River as 'at risk'. In Serbia, parameters such as mercury (Hg) and phenols exceeded the set thresholds of 0.1 µg/l and 1 µg/l respectively.

Tisza water bodies at risk due to nutrient pollution were classified mainly in Hungary and Serbia. The main reason for failing the WFD objectives for nutrient pollution is the incomplete implementation of the urban wastewater treatment directive and diffuse nutrient pollution from agriculture.

[7] Organic pollution is based on saprobic-index which is not used on Hungary

Results on the Tisza tributaries

On the Tisza tributaries, 144 water bodies were assessed as 'at risk'. This is equivalent to 71% of the total tributary water bodies in the Tisza River Basin. The main water bodies 'at risk' lie in Romania, the Slovak Republic, Hungary and Serbia. Tributary water bodies possibly at risk (15% of the total) were reported by all Tisza countries except for Serbia. Tributary water bodies not at risk (14% of the total) are found in Ukraine, the Slovak Republic and Romania.

Figure 15 reflects national 'risk assessment' differences between the five Tisza countries for their share of the Tisza tributaries. On one hand, Serbia, Hungary, Romania and the Slovak Republic classified the largest part of their tributary water bodies as 'at risk'. On the other hand, Ukraine classified 41% of its national share of Tisza tributary water bodies as 'possibly at risk' and 47% as 'not at risk'.

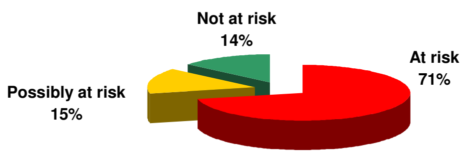


Figure 14 SWBs at risk/possibly at risk/not at risk on the Tisza tributaries

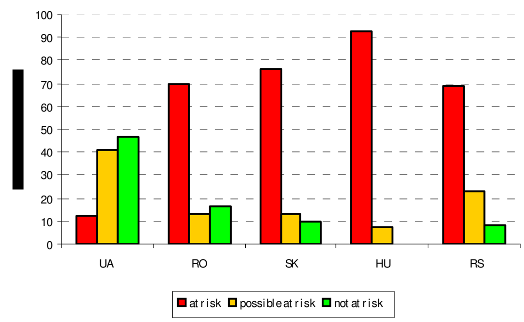


Figure 15 SWBs at risk/possibly at risk/not at risk in the five countries sharing the Tisza tributaries

Figures 14 and 15 illustrate the reasons tributary water bodies are at risk and possibly at risk in the Tisza Basin and in each country. The Tisza tributaries are at risk mainly due to hydromorphological alterations and nutrient pollution followed by organic pollution and hazardous substances. Hazardous substances, however, were the main reason for the classification of tributary water bodies as 'possibly at risk' (especially in Romania, Hungary and the Slovak Republic).

The high risk of tributary water bodies due to hydromorphological alterations is related to the frequent presence of bank reinforcements, channelisation and transverse river structures for flood protection and urbanisation (see also related information on the identification of pHMWBs on the Tisza tributaries)

The high risk from nutrient pollution in Romania is caused by diffuse pollution sources from human settlements, especially in rural areas where a small part of the population is connected to sewage systems and wastewater treatment plants. In Hungary and the Slovak Republic, the high risk from nutrient pollution can be explained by the incomplete implementation of the urban wastewater treatment directive and diffuse nutrient pollution from agriculture.

For the extended classification of water bodies as 'possibly at risk' and 'at risk' due to hazardous substances, several tributaries in Romania exceeded second class limits for heavy metals. These rivers were thus classified as at risk due to natural background and discharges (direct or by tributaries) from mining pollution sources. In Hungary, the presence of heavy metals is mainly responsible for the classification of water bodies as at risk or possibly at risk due to hazardous substances. In the Slovak Republic, hazardous substances such as mercury (HG), zinc (Zn), trichlormethane, trichlorethane-1,1,2 and Polychlorinated Biphenyls (PCBs) are responsible for the water bodies being at risk. Serbia reported mercury (Hg) and phenols as reasons for the risk of water bodies due to hazardous substances.

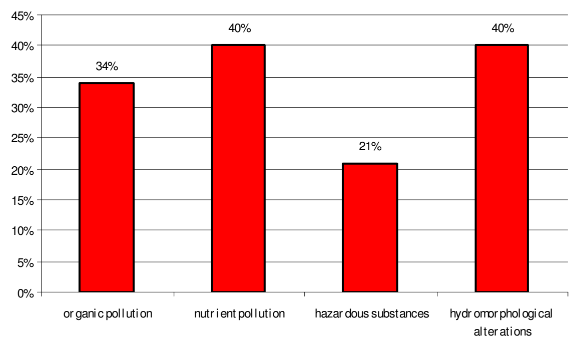


Figure 16 SWBs **at risk** from different pressures on the Tisza tributaries

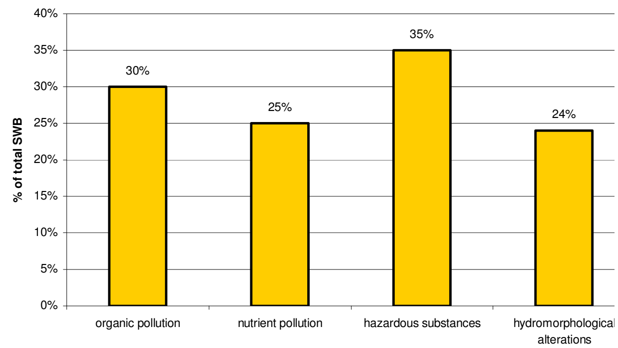


Figure 17 SWBs **possibly at risk** from different pressures on the Tisza tributaries

MAP 11 – 14 includes information on risk assessment related to hydromorphological alteration, nutrient, organic pollution and hazardous substances.

4.9 Data gaps and uncertainties

There is still need for cross-border harmonisation on certain transboundary pHMWBs, and the main uncertainties are:

- A water body on the common Tisza River border of the Slovak Republic/Hungary was identified as a pHMWB by the Slovak Republic but not by Hungary.
- A water body on the common Mures River border of Romania/Hungary was identified as a pHMWB by Romania but not by Hungary.

However, follow-up risk assessment activities are needed to fill in data gaps, especially concerning the numerous water bodies which were classified as ‘possibly at risk’ due to the current lack of data.

Additionally, there is need for further bilateral exchange concerning risk assessment. Several uncertainties in the data evaluation were related to the lack of harmonisation of river kilometres and of risk assessment results for common transboundary water bodies on the main Tisza (especially for sections shared by Ukraine/Romania, Ukraine/Hungary and the Slovak Republic/Hungary) and some of its tributaries. In several cases, the same river sections were included in the Risk Assessment Templates of neighbouring countries indicating non-matching river kilometres and risk classification results.

5 Characterisation of groundwater quality

This chapter provides an overview characterisation of important transboundary groundwater bodies (GWBs) in the Tisza River Basin. A size threshold of more than 1,000 km² was defined to select important transboundary GWBs to be included in this Tisza Analysis Report. Transboundary GWBs were additionally selected on the basis of several other criteria used by the Tisza countries: use of the GWB as a source of drinking water, water for agriculture and industry, the GWBs' contamination threat, the GWBs' link to important ecosystems, such as protected areas or national parks, and the presence of transboundary impacts.

Despite its focus on important transboundary GWBs, this chapter also summarises information on important national GWBs of the Tisza Basin larger than 1,000 km².

MAP 10b shows the Groundwater bodies in the Tisza River Basin.

5.1. Important transboundary groundwater bodies in the Tisza River Basin

In total, 33 important transboundary GWBs were identified. **Figures 18 and 19** indicate the national breakdown of these transboundary GWBs with regard to the size and the number of GWBs.

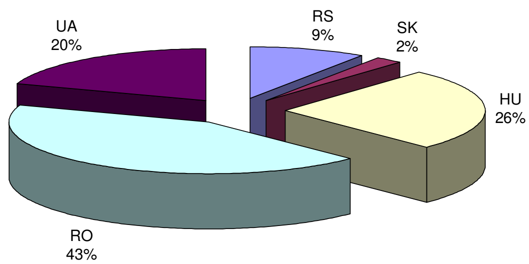


Figure 18 Country repartition of transboundary GWBs (related to size/Km²)

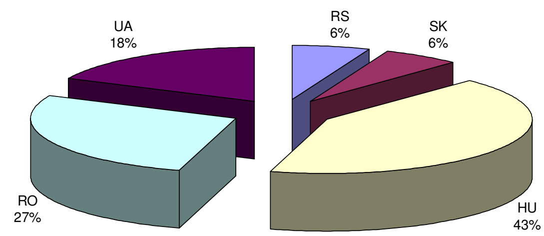


Figure 19 Country repartition of transboundary GWBs (related to numbers of GWBs)

Table 24. gives an overview of the common borders between countries in the Tisza River Basin (white cells). Numbers in the cells indicate the number of transboundary GWBs reported as bilaterally agreed upon. The numbers in brackets indicate GWBs where bilateral (or trilateral) agreements are still missing or need to be renewed or need to be further clarified.

Table 20: Matrix of transboundary groundwater bodies

	RS	HU	RO	SK	UA
RS		(5) / (1)	(1) / (1)		
HU	(1) / (5)		8 / 6	2 / 3	(5) / 0
RO	(1) / (1)	6 / 4(4)			(5) / 0
SK		3 / 2			(6) / 0
UA		0 / (5)	0 / (5)	0 / (6)	

	B
A	2 (1) / 2

Country A reported 2 transboundary GWB bilaterally agreed with country B

Country B reported 2 transboundary GWB bilaterally agreed with country A and 1 transboundary GWB where bilateral agreement is pending, needs to be further clarified or renewed with country A

Data source: Groundwater Templates submitted by the Tisza countries.

Note 1: The matrix should be considered as preliminary until further harmonisation of transboundary GWB data between the Tisza countries.

Note 2: The matrix indications on the 'not bilaterally agreed' status of Ukraine's transboundary GWBs with reference to specific neighbouring countries is based solely on Ukraine's submitted groundwater maps and was not provided as such in Ukraine's Groundwater Template.

The following gives a summary of the information provided by the countries on their transboundary GWBs concerning their delineation criteria, their uses, main pressures and impacts.

Criteria for delineation: The GWBs were generally delineated according to a combination of criteria including the geological type and the borders of the surface catchment areas. Thermal water bodies were sometimes additionally separated on the basis of their temperature.

Geological overview: Sand, gravel, silt, clay and boulder are the main components of the aquifers of the important transboundary GWBs. Hydraulic conductivity varies.

Groundwater use: Groundwater in the Tisza River Basin is used mostly for drinking water purposes (91% of the transboundary GWBs). It also supplies water for industry (58% of the GWBs) and agriculture (mainly irrigation, in 48% of the GWBs). In some cases, groundwater is also used in balneology, for industrial bottling and geothermal purposes.

The chemical pressures on groundwaters most often named were from agriculture (use of fertilisers) and settlements (absence of wastewater services). Overabstraction of groundwater in some parts of the Tisza River Basin is recognised as a possible cause for the unbalance between abstraction and recharge of groundwater.

5.2. Results of the risk assessment on groundwater

The risk classification distinguished between three classes: GWBs 'at risk', GWBs 'possibly at risk' and GWBs 'not at risk'. A GWB is classified as being 'at risk', if the nationally applied risk criteria are fulfilled. In cases of insufficient data, GWBs were classified as being ‘possibly at risk’ until more detailed information becomes available.

(Quality) chemical status

The majority (88%) of the transboundary GWBs was reported as not at risk in terms of (quality) **chemical status** (see **Figure 20**). Transboundary GWBs at qualitative risk (12%) were reported by the Slovak Republic, Romania and Ukraine.

Concerning the important national GWBs, 12% was reported as being at risk in terms of (quality) **chemical status** and another 16% as possibly at risk.

Quantity status

Of the nominated transboundary GWBs, 85% were assessed as ‘not at risk’ in terms of quantity status (see **Figure 21**). Transboundary GWBs at quantitative risk were reported by Hungary (3%) and GWBs possibly at risk were reported by Serbia and Ukraine(12%).

As concerns the nominated important national GWBs, 7% were assessed as ‘at risk’ in terms of quantity and another 5% as ‘possibly at risk’.

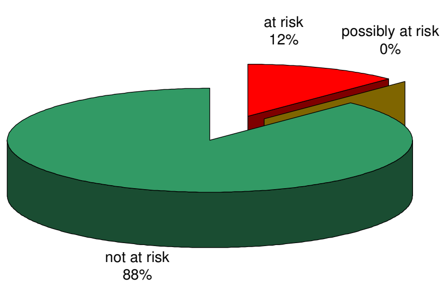


Figure 20 Transboundary GWBs at risk/ possibly at risk/ not at risk in terms of quality – chemical status

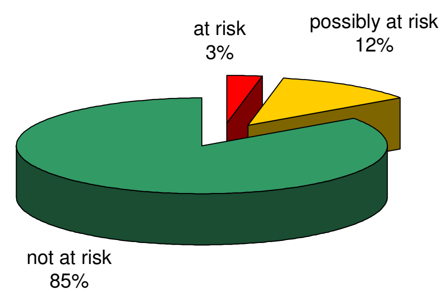


Figure 21 Transboundary GWBs at risk/ possibly at risk/ not at risk in terms of quantity

Part III - Water Quantity

6 Water resources and uses

6.1 Water resources

The Tisza River ranks as the longest tributary (966 km) and the second largest tributary of the Danube River by flow volume, with an average discharge of about 830 m^3/sec. The basin drains an area of 157,186 km^2 and is the main water source for Hungary, a significant source for Serbia and an important source for western Romania and southeastern the Slovak Republic.

The multi-annual area mean values of the main balance elements of the Tisza River Basin[8] are:

- precipitation 744 mm/a,
- evapotranspiration 560 mm/a,
- runoff 177 mm/a (= 830 m^3/s).

The isoline map of runoff (**MAP 15**) shows the variation of runoff within the Tisza River Basin between 10-20 mm/a (along the middle reach of the Tisza River) and more than 1,000 mm/a (in the northeastern Carpathians and the Apuseni Mountains).

The total reservoir capacity is about 2.7 billion m^3 and this amount represents about 10% of the average annual flow for the Tisza. There are 7 reservoirs larger than 100 million m^3 which were built for a variety of purposes (**See Table 21).**

Table 21: Reservoirs in the Tisza River Basin larger than 100 million m³

Category (capacity range)	Location			Reservoir				
	Country	River Basin	River	Name	Catchment upstream of reservoir	Volume	Surface	Purpose
Mm^3					km^2	Mm^3	ha	
100-200	RO	Crisuri	Dragan	Dragan	159	112	292	multipurpose
		Mures	Sebes	Oasa	187	136	401	multipurpose
	SK	Bodrog	Ondava	VD Veľká Domaša a Malá Domaša	827	178.28	1,510	electricity production, recreation, fishing, flood protection, industry water supply, irrigation
	RS	Tisa	Tisa	Tisa	na	160	na	irrigation, flood protection

[8] Detailed information about the main components of the multi-annual water balance in the Tisza River Basin, based on measurements from 1931 to 1970, is given in the monograph 'Hydrology of the River Danube', published in 1986 in Munich.

Category (capacity range)	Location			Reservoir				
	Country	River Basin	River	Name	Catchment upstream of reservoir	Volume	Surface	Purpose
Mm^3					km^2	Mm^3	ha	
200-500	**RO**	Somes	Somes Cald	Fantanele	325	225	826	hydropower, flood protection
	RO	Mures	Raul Mare	Gura Apelor	235	210	411	hydropower
	HU	Tisza	Tisza	Kisköre	65,670	253	12,700	Multipurpose
	SK	Bodrog	Laborec-bočná nádrž	VN Zemplínska Šírava	1,567	297	3,280	recreation, fishing, irrigation, industry water supply, flood production

6.2 Water uses

The water resources of the Tisza River Basin are mainly used for public water supply, irrigation and industrial purposes, but also for other agricultural uses, such as fishery, and recreation.

The overall estimation of consumptive use between water users is given in **Figure 22.**

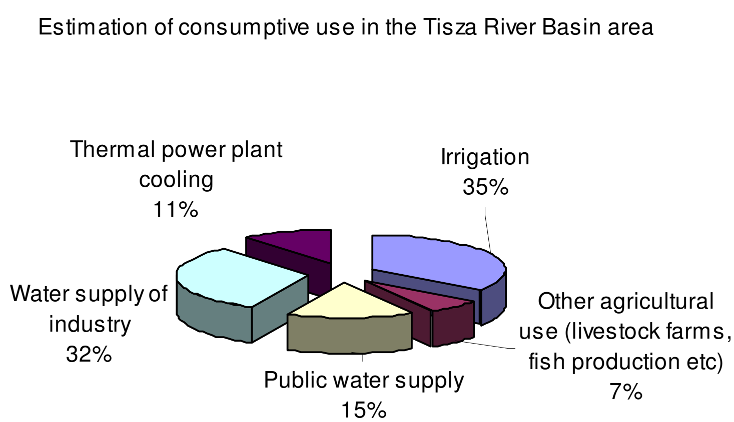


Figure 22 Estimation of consumptive use between water users in the Tisza River Basin

The total annual water consumption in the Tisza River Basin is estimated at about 700 million m^3, or about 2-3% of the total annual flow. About 20% of this consumption comes from deeper aquifers.

As further analysis of the ICPDR Tisza Group, detailed information was collected on the average total water quantities used annually for various water uses in the last three years (2002-2004) which also illustrates the major sources of water for the water users.

Irrigation represents the major consumptive use of water in the Tisza River Basin. Many older irrigation systems are temporarily out of operation due to reasons that may include the economic situation in countries or change of ownership, among others. The total annual consumptive use of water for irrigation is about 250 million m^3, or about 8 m^3 per second, representing about 1% of the annual flow.

The use of water for other **agricultural uses** (livestock farms, fish production or other uses) is relatively low due to the reduced number of livestock lately also resulting from the economic situation in countries or change of ownership. The use of water for livestock is highest in Serbia and Hungary, and the use of water for fish production is significant in most of the countries, especially in Serbia, Romania and Hungary. The total annual consumptive use is relatively small - about 50 million m^3.

Total annual consumptive use of water for **public water supply** is about 110 million m^3, while for **industrial water supply** the total annual consumptive use of water is about 200 million m^3. There are no thermal power plants in Ukraine and Serbia and the total annual consumptive use of water for **cooling of the thermal power plants** is about 80 million m^3, required by Romania, Hungary and the Slovak Republic.

Altogether 34 hydropower plants were identified by the countries, and out of these, 28 with the highest installed capacity are in Romania.

As the Tisza River is established as a class IV international waterway by an AGN agreement, the required navigation conditions should be available at low flow of 95% duration, or approximately 175 m^3/s. The minimum discharge in the Tisza River required for safe navigation on the selected profiles in Hungary is 120 m^3/s between Kisköre and Szolnok.

6.3 Scenario for 2015 – water demand

Based on the `*average total water quantities annually used by the given users*` and the `*percentage of the estimated consumptive use*` (see Annex 11), a scenario for 2015 was created giving the estimated consumptive uses by various water users (million m^3).

This overall estimation of consumptive use between water users for 2015 is given in **Figure 23.**

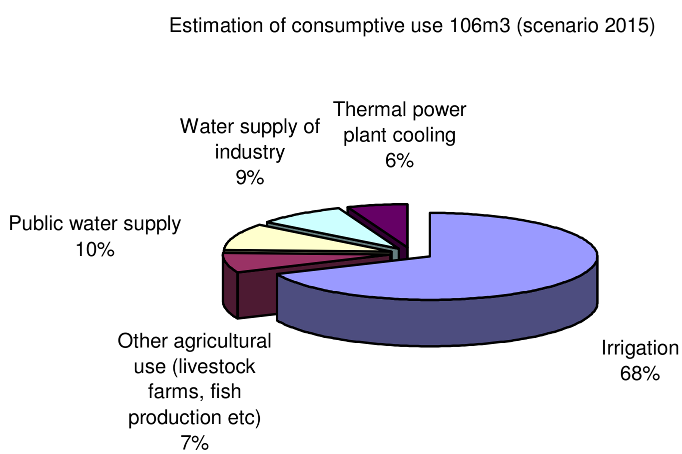


Figure 23 Estimation of consumptive use between water users for 2015 in the Tisza River Basin

Data on planned water uses were collected and water demand in the Tisza River Basin was analysed for the year 2015. The total water demand is given for: irrigation, other agricultural uses (such as livestock farms or fish production), municipal and industrial water supply, hydropower, navigation, preservation of water regimes and ecological requirements.

It is likely that the total annual water demand in the Tisza River Basin will be about 1.5 billion m^3 in 2015, or 5.5-6% of the total annual runoff. Deeper aquifers are planned as a supply source for approximately 20% of the expected water demand.

A significant increase in water use for **irrigation** is planned for 2015. All countries plan to upgrade their existing irrigation systems or build new ones. Irrigated areas will increase from about 500,000 ha to about 625,000 ha, and annual quantities of water for irrigation will increase from about 250 million m^3 to about 1,300 million m^3. Areas and water quantities needed for irrigation in 2015 are given in Annex 11. The total annual consumptive use of water for irrigation is predicted to be about 950 million m^3 or about 35 m^3 per second, representing about 4,2% of the mean annual flow. Future augmentation of water use for irrigation, where consumptive use is a major component, will be an additional pressure in the Tisza River Basin. Aquatic ecosystems already vulnerable will be particularly endangered in the summer, when planned irrigation can go beyond available water quantities.

Other water uses (municipal and industrial water supply, other agricultural uses - livestock farms, fish production, hydropower or navigation) will not significantly increase by 2015.

For other **agricultural uses** it is estimated that the total consumptive use will be around 100 million m^3.

Estimations related to the water quantities planned for **public water supply** by 2015 indicate a 25% increase by 2015. The total consumptive use will be relatively low – about 140 million m^3 – and will not be a key pressure if adequate treatment of municipal wastewater can be provided.

On the other hand, a significant portion of water for municipal water supply originates from slowly renewable deep aquifers, and the sustainability of the water supply from these aquifers must be ensured.

An increase in water use for **industrial water supply** is not planned. However it is important to note that some industries require large water quantities, while untreated wastewater may be polluted in some cases.

No new hydropower plants are planned in the Slovak Republic, Hungary, Serbia or Ukraine, but one on the border between Romania and Ukraine. The future increase of **hydropower** capacities in the Tisza River Basin should be through the reconstruction and upgrade of the existing infrastructure to minimise the need for development of new structures. New developments or reconstruction/upgrade of existing facilities should be in line with EU environment protection standards (i.e. new hydropower plants should have fish passages and respect requirements for minimum environmental flow) to lessen the impact on water quality.

Low water flows needed for **navigation** will remain the same in 2015.

5 Floods

Floods in the Tisza River Basin can form at any season as a result of rainstorm, snowmelt or the combination of the two. Snowmelt without rainfall rarely occurs in the Tisza Basin and floods resulting from this account for no more than 10-12% of the total amount. The rise in temperature is almost always accompanied or introduced by some rain. Thus large flood waves are generated more frequently in late winter and early spring.

The warm period from May to October accounts for nearly 65% of total floods, and the cold period from November to April accounts for only 35%. However maximum discharges and the volume of restricted flow of floods in the cold period generally exceed those observed in warm period.

The floods generated in Ukraine, Romania and the Slovak Republic are mainly flash floods and last from 2-20 days. Large floods on the Tisza in Hungary and in Serbia, in contrast, can last for as long as 100 days or more (the 1970 flood lasted for 180 days). This is due to the very flat characteristic of the river in this region and multi-peak waves which may catch up on the Middle Tisza causing long flood situations. Also characteristic of the Middle Tisza region is that the Tisza floods often coincide with floods on the tributaries, which is especially dangerous in the case of the Somes/Szamos, Crasna/Kraszna Bodrog, Cris/Körös and Mures/Maros Rivers.

Following a relatively dry decade, a succession of abnormal floods has annually set new record water levels on several gauges over the last four years. Over 28 months between November 1998 and March 2001, four extreme floods travelled down the Tisza River. Large areas were simultaneously inundated by runoff and flash floods of abnormal height on several minor streams. The extreme Tisza flood in April 2006 was preceded by several floods in February and March generated by melting snow and precipitation.

In the Tisza Valley, organised, systematic flood protection started in the mid 19th century. The backbones of these works are the flood protection dikes along the main river, but also include river training works, bank protections, flood retention reservoirs and polders. At this time drainage systems with pumping stations were also built.

Table 22 Flood protection structures in the Tisza River Basin

Country	Length of the dike km	Reservoir and/or polders[9] $10^6 m^3$
Ukraine		
Tisza River Basin	726 (embankments) + 276 (bank protecting and training structures)	65,8 in 9 reservoirs an 59 ponds
Romania		
Tisa	5.56	-
Viseu	7.85	-
Iza	13.53	-
Tur	77.12	28.09 in 4 reservoirs
Somes	1198.00	557.0 in 35 reservoirs
Crasna	163.39	28.79 in 1 reservoir and 1 polder
Barcau	336.00	
Crisul Alb	210.19	
Crisul Negru	378.10	45.50 in 2 polders
Crisul Repede	55.40	117.25 in 3 reservoirs
Mures	825.00	524 in 31 reservoirs and polders
Bega-Veche	104.30	46.94 in 9 reservoirs and polders
Bega	115.40	65.43 in 15 reservoirs and polders
Slovak Republic[10]		

[9] Total storage

[10] Note: Total reservoir volumes in the text and table taken from Abaffy, D., Lukáč, M., Liška, M.: Dams in Slovakia. T.R.T. Medium, Bratislava 1995. The actual volumes are changed due to sedimentation, wind wave

Country	Length of the dike km	Reservoir and/or polders[11] $10^6 m^3$
Tisza	6	-
Slana	5.7	-
Tributaries of Slana	107.8	14.1 in 4 reservoirs
Bodva	28.6	
Tributary of Bodva	41.0	25.6 in 2 reservoirs
Hornad	34.2	62.7 in 2 reservoirs
Tributaries of Hornad		11.5 in 1 reservoir
Bodrog	22.12	-
Tributaries of Bodrog	230.87	631.9 in 3 reservoirs and 1 polder
Hungary		
Tisza	1 064.1	-
Túr	75.7	-
Szamos	93.0	-
Kraszna	62.3	-
Lónyay Main Canal	102.8	-
Bodrog	57.9	-
Sajó (incl. Takta)	119.6	-
Hernád	62.0	-
Zagyva-Tarna	389.0	46.0 in 3 reservoirs and 2 flood detention basins
Körösök (incl. Berettyó, Hortobágy-Berettyó)	747.9	295.0 in 6 flood detention basins
Maros	95.1	-
Tisza River Basin in Hungary	2 869.3 (primary defences) and 407.6 (confinement structures)	326.0 in 3 reservoirs and 8 flood detention basins
Serbia		
Tisza	314.8	-
Old Bega	71.5	-
Bega	62	-

abrasion of reservoir banks and revisions (sediment removal). Updated reservoir volumes for selected reservoirs are available, but from different time moments.

[11] Total storage

MAP 16 shows the flood defences in the Tisza River Basin in Hungary.

7.1 Drainage systems

Characteristics of lowland drainage

The total area covered by lowland drainage networks in the Tisza Valley is 56,789,37 km^2.

Table 23. The area and the numbers of the sub-drainage systems

Country	Number of sub-drainage systems	Total areas [km2]
Ukraine	5	109.70
Romania	273	10 964.37
Slovakia	12	1 205.30
Hungary	64	33 765.00
Serbia	10	10 745.00
Sum	*364*	*56 78. 37*

The length of the canals in these areas is 63,937 km in the following distribution.

Table 24. Length of the drainage channels

Country	Lengths of canals [km]
Ukraine	1 296
Romania	16 409
Slovakia	633
Hungary	37 083
Serbia	8 515

The average discharge of these systems per total area is 145 l/s/km^2, which is detailed in the **Table 25**:

Table 25. Average discharges from drainage channels

Country	Average discharges [l/s/km2]
Ukraine	384
Romania	138
Slovakia	115
Hungary	31
Serbia	59

In connection with these systems, 860 pumping stations operate with 2,050.73 [m^3/s] total flow at the mouth of the canals

7.2 National long-term flood plans (Action Plans)

Ukraine

In 1998 and 2001, catastrophic floods occurred in Zakarpattia and led to significant material and social damage in the region. To avoid such damage in the future, the State Committee for Water Management developed the **'Scheme on Complex Flood Protection in the Tisza River Basin in Zakarpattia'.** It also developed the corresponding **'Programme for integrated flood protection in the Tisza River Basin in Zakarpattia oblast on 2002-2006 and forecast until 2015'** to realise flood protection measures provided by the Scheme. It was approved on 24 October 2001 by the Cabinet of Ministers of Ukraine № 1388.

The Programme realisation was set up in **three stages**: The first stage from 2002 to 2006 envisaged implementation of urgent measures with a total budget of 441 million UAH, the second stage for the period of 2007 to 2011 with a total budget of 423 million UAH, and the third for the period of 2012 to 2015 with a total budget of 569 million UAH.

The Scheme 2001 recommends a comprehensive approach to:

- control flood runoff through the construction of 42 unregulated, flow-through flood retention reservoirs and additional polders with regulated outflow in the flatland to reduce the flood discharge from Q1% to Q10%
- erection of regulating hydrotechnical constructions (weirs and semi-weirs)
- strengthening of the system of flood protection dikes
- forest protection, antierosive and mudflow protection measures in the mountainous area
- local versions of the protection of certain settlements or for their proposals.

Having analysed the programme implementation in detail and considering the urgent necessity of flood protection measures, theZakkarpattia State regional administration, State Committee for Water Management, Government and Verhovna Rada of Ukraine developed the new version of the *Programme of integrated flood protection in the Tisza River Basin in Zakarpattia oblast on 2006-2015***.** It was approved on 13 February 2006 by the Cabinet of Ministers of Ukraine №130.

MAP 17 introduces the national flood defence improvement scheme in Transcarpathia in Ukraine.

In Slovakia Long-term flood protection plan is oriented predominantly at water retention measures (mainly construction of polders (dry reservoirs) with the aim to decrease surface runoff and maximum discharges.

In the field of new river engineering works or reconstruction of existing regulations the following criteria are taking into account:

- inside residential area - the water management purpose of measures on rivers is balanced with ecological requirements. Attention is paid mainly to shape of cross section and longitudinal slope.
- outside residential area – aim is to retain existing course of the river and stabile part of cross sections as much as possible. The water courses are shortened in exceptional cases only and cut meanders are let opened - not filed up.

By means of previously built up flood protection measures the adequate land protection against high floods was provided. However at present, from capacity point of view many of the river regulation works do not secure adequate flood protection. This situation is caused by following factors:

- natural decrease of rivers discharge capacity due to growing of vegetations and silt sedimentation.
- change of hydrological conditions (increase in maximum discharge values)

- o water management measures realized in neighbouring countries (e.g. at Bodrog river in Hungary – with the backwater effect in Slovak territory).

In **Hungary** the national policy objectives are twofold: As a *general aim* the Government of the Hungarian Republic in its *Government Resolution 2005/2000. (I. 18.) on the revised development plan of flood defence* confirms that the issue and the tasks of flood protection are considered part of the security policy of the country in the field of disaster management and the maintenance and development of those structural flood defences which are the property of the state has to be done accordingly.

Regarding *quantitative targets*, the followings can be summarised :
Lessons learnt from the series of extraordinary floods from 1998 to 2001 revealed that the former strategy to prevent floods by heightening and strengthening dikes should be reconsidered. As a result of studies, a new strategy called `*Update of the Vásárhelyi*[12] *Plan*` (Hungarian abbreviation: *VTT*) was developed aiming to reduce flood hazards by decreasing flood crests. This goal will be achieved by a 'room for rivers'-type project, the VTT, in the frame of which there are three main elements concerning flood hazard reduction:

- development (heightening and strengthening) of the existing dikes where they do not comply with the 1 in 100 year floods;
- improvement of the flood conveyance capacity of the river by setting back the dikes at bottlenecks, creating a hydraulic corridor in the floodway with low resistance by minimising obstacles of flow (opening sand bars, reducing the height or even demolishing summer dikes and rehabilitating pastures and mosaic-type forests instead of the existing unmaintained forests of invasive species with dense undergrowth in the hydraulic corridor) (**MAP 18** shows the improvement of flood conveyance capacity of the Tisza River in Hungary);
- reactivation of protected floodplains with controlled inundation by creating flood detention basins to cut the flood peaks (**MAP 19** shows the planned flood detention basins along the Tisza River in Hungary)

Based on the experiences of the extraordinary flood emergency in 2006 as well as due to changes in the financial conditions the VTT programme will be modified and the implementation will be adjusted to the financial cycles of the EU.

From the six detention basins planned to be built in Phase I, the construction of the Cigánd-Tiszakarád and Tiszaroff basins is significant and they will be finished in 2007. The licensing procedure of the Nagykunsági and Hanyi-Tiszasülyi detention basins is finished, and is in progress for the Szamos-Kraszna Basin.

The proposed sequence of implementation of the detention basins is as follows:

- first the six detention basins planned in Phase I are to be finished (Cigánd-Tiszakarádi, Tiszaroffi, Szamos-Kraszna közi, Hanyi-Tiszasülyi, Nagykunsági, Nagykörüi), no changes in the planned sequence are needed;
- the Szeged detention Basin is proposed as the seventh, because the flood crest depression effect of the first six basins is minimal for the Tisza River downstream from Csongrád, while the coincidence of significant floods on the Tisza and Maros Rivers may create extraordinary flood hazards;
- either the Bereg or the Szamosköz are proposed as the eighth detention basin, as the Upper Tisza reach in the vicinity of Tivadar remains vulnerable, despite the dike reinforcements and the positive effect of the Szamos-Krasznaközi detention basin,;
- the further sequence is determined by the relative lack of detention capacity along the Tokaj-Kisköre reach, therefore the ninth detention basin can be selected from among the Dél-Borsodi, the Hortobágy central or the Körös-zugi;

[12] Pál Vásárhelyi was a hydraulic engineer who developed the conceptual flood alleviation and river training plan of the Tisza River Basin in the middle of the 19th century.

- the rest of the sequence including the Hanyi-Jászsági, the Csanyteleki and the Tiszakarádi, further the Csongrád Nagyréti are to be determined according to their hydraulic efficiency and specific costs.

In Romania the National Institute of Hydrology and Water Management is in charge with the elaboration of the River Basin Development and Management Schemes , which are the instruments for planning at basin level and are composed of two parts: the River Basin Development Plan and the River Basin Management Plan.

Romania signed an agreement in 2004 with the International Bank for Reconstruction and Development to finance a project on 'Risk mitigation in case of natural calamities and preparation for emergency situations'. The project covers rehabilitation and safety improvement of the flood defence infrastructure for rivers (Tarna Mare, Tarnava Mica, Cibin and Bega), for large dams (Berdu, Varsolt and Lesu) and for small dams (Sanmihaiul Roman and Taria).

One of the beneficiaries is the Ministry of Environment and Sustainable Development which is also responsible for the implementation of the project.

In Serbia levees along the Serbian section of the Tisza River enable the protection from the flood with return period once in 100 years (4 100 m^3/s), with one meter additional freeboard above the design flood level. Presently, protection lines on 90% of their total length meet this standard. The quality of executed works was in general justified in 2000 and 2006, when large flood waves occurred.

Only two levee sections remained, which has to be reconstructed in the same manner: one at the right bank and one at the left bank, both at the most downstream section of the Tisza River. During spring time in 2006, the necessity and urgency of these works was proven, because these levees were seriously endangered due to concurrent extreme floods on the Danube and the Tisza rivers.

The reconstruction of Tisza levees on the most downstream sector is an urgent task in Serbia. The main design for reconstruction works is ready, and financing will probably ensured from the Investment plan for Vojvodina. It is expected that reconstruction works will start in 2008.

7.3 Assessment of risks - flood risk mapping

The only comprehensive flood map covering the entire Tisza River Basin and showing the extension of the floodplains is the one compiled in 1938 in Hungary on the scale of 1:5.000.000, and summarising historic inundations before river training and flood alleviation works started (see **MAP 20** – Historic flood map of permanently and temporarily inundated areas before the flood alleviation and drainage works). Romania compiled historic flood maps of the Someş and Crisuri floodplains in 1996 (1:25.000), but no historic flood maps have been reported for the territory of the Tisza Basin in the Slovak Republic and Serbia.

A map of flooded areas in the Tisza River Basin during 1998 – 2006 was created by the Dartmouth Flood Observatory (USA) by merging satellite images, showing the inundations of 1998 and 2006 in the Upper Tisza and the 2005 flood in the Banat region (see **MAP 21**)[13].

General inundation maps are available for floodplains in Hungary, compiled in 1977 in scales of 1:100,000; 1:50,000, indicating the flood extent of 1% and 0,1% probability (see **MAP 19**). General inundation maps have also been created covering the Tisza Basin in Serbia. The maps compiled in 2002 are in scales 1:20,000. The maps are available in both countries in paper format for restricted use. No such maps have been reported for the territory of the Tisza Basin in Romania, the Slovak Republic and Ukraine.

[13] This satellite image does not give information on the extension of floodplains in the Tisza River Basin, only the actual flooding of the referred years. Furthermore, the inundations can be seen between the dikes and on the land due to undrained runoff (excess water).

A flood hazard map was developed in 2005 in the Slovak Republic for the 56 km long stretch of Topľa River, between Prešov and the Topľa River mouth to the Hornád River. Initial efforts in the recent past to develop digitised flood hazard maps resulted in 5% coverage of the Tisza River Basin floodplains in Hungary. In the frame of TACIS and other projects, initial steps to provide flood hazard maps were made in Ukraine in recent years, however flood risk maps are not yet available in any of the Tisza River Basin countries.

8 Drought

The Tisza River Basin runoff is highly variable – there are alternate periods of drought and flooding that are difficult to forecast and manage effectively. The droughts of recent years, such as the drought of August 2003, had severe effects in the region, particularly on the Hungarian Plain where agriculture was extremely affected. The lack of water reduces not only agricultural activity, but also the development of industry and urbanisation. Cities and other communities demand more water than the quantity available from rainfall, and it has always been difficult to get enough water for settlements far away from rivers.

There is no general definition of drought, but it is commonly understood to be a less than usual natural water supply.

In **Ukraine** the term 'Drought management' has never been applied to the Ukrainian part of the Upper Tisza River Basin due to the fact that in Transcarpathia the annual surface water resources potential per capita (3130 m^3) is three times as much as the same index for the whole country (1000 m^3). In this case the only terms which fit are 'Water scarcity' or 'Water deficit'. In the set of observations available there were examples of dry years (1961, 1963) but which didn't result in water shortage.

In **Serbia** drought has been the object of much research and investigation by a number of Serbian authors. This research and investigation encompasses all aspects of drought: from global and regional problems, environmental impacts, morphological, physiological and biochemical aspects of plant resistance to drought, to irrigation problems. Some of the drought indices or indicators (such as the deviation from average precipitation levels, seasonal fluctuations of precipitation, relationship between precipitation and potential evapotranspiration, water balance, occurrence of dry periods or development of semi-arid areas in Serbia) are being used in regional drought assessments from the hydro-meteorological perspective.

Drought is a recurrent feature of the **Hungarian** climate and can cause substantial damage to the nation's agriculture. Dunay and Czakó (1987) note that 36% of the overall agricultural loss originates from drought, followed by hail, floods and frosts, in order of importance. Each year from 1983 to 1995, with the exception of 1987, 1988 and 1991, were drought years. This long period of drought was unprecedented in the 20th century in the region and comparable in length only to the ten-year period from 1943 to 1952 or in severity to the 1779-1794 drought event (Gunst, 1993). Since eight of the twelve years were disastrous drought years, this series of dry years has increased the scientific and political interest in climate variability and climate change and the importance of drought as an extreme meteorological event. After a couple of normally wet years, Hungary experienced very dry years again in 2000 and 2003. (Szalai, S., Szinell, Cs., Zoboki, J. (2000)

In **Romania** the identification of high drought risk areas in the Tisza River Basin was made on the basis of the correlation of the aridity index calculated through the reporting of precipitations to the potential evapotranspiration with the one of the aridity index Palfay (PAI) which takes into consideration the frequency of the dry years. For the basins afferent to the Tisza River tributaries, the areas with PAI index values between 4 and 6 (moderate sensibility) and 6 and 8 (high sensibility) are only encountered in the Salaj Hills and in the Western Plain, at the border with Hungary and Serbia**.** The respective areas are fragmented and comprise a relatively small surface.

The obvious conclusion is that in the Romanian part of the Tisza River Basin, the intensity of the drought expressed through a high frequency of the dry years isn't a characteristic phenomenon, as the areas with high values of the Palfay index are small and discontinuous**.** This area is, to a great extent, classified as a dry/sub/humid area. In this region there are still dry years and even dry periods, the most important being the 1961 – 1973 period, but interrupted by excessively rainy years. Analyses emphasise that the driest season is autumn, especially in September and October.

For the **Slovak part** of the Tisza River Basin, the PAI index was used during the evaluation of drought**, and showed that** the most unfavourable year was 2003. Most of the Slovak part of the Tisza River Basin was classified as having 'moderate draught', with the exception of the Somotor station (in the vicinity of the Bodrog River), with value of 10.4 meaning 'severe draught', and the Michalovce station (Laborec Valley) with value of 8.41 as 'medium draught'. Return periods were not calculated.

The aridity factor – defined as the relation of annual potential evaporation to a mean annual precipitation – is below 0.2 at the eastern border of the Tisza Basin (in the Carpathian Mountains) and increases from northeast to southwest up to 1.4 in the middle of the Hungarian Plain (at the mouth of the Körös Rivers), as displayed in the **MAP 22.**

MAP 23 shows an example of deviation in Hungary between the annual depth of the groundwater table in 2003 and the annual mean for 1956-1960.

Part IV Cross Cutting Water Management Issues

9. Economy

9.1 Water tariffs and charges in Hungary

The system of water resource fees to be paid in proportion to water uses, has been introduced in order to regulate the utilisation of water resources based on the aim of the water use and the type of water used. Water resource fees account for a relatively small part of the total costs of abstraction, both in the industrial, agricultural and the public utility sector.

The obligation of paying a water load fee was introduced on 1 January 2004 for all polluters – including companies that operate water public utilities – who discharge their pollution into surface water, in proportion to the quantity of pollutants discharged. The obligation to pay a soil load fee was introduced on 1 July 2004 for all those who do not connect their facilities into the public sewage system (where such a system exists) and thereby pollute groundwater.

In Hungary there are two types of water price systems (price structures) for the basic services: a one-factor system based on unit price, block tariffs, fixed price and a two-factor system based on the basic price + service fee (variable part) abondement fee + service fee (variable part).

9.2 Water tariffs and charges in Romania

Water abstraction charges are the same all over Romania, but differ according to the source of water (inland rivers, the Danube and groundwater) and the category of user (industry, household, power plant, agriculture, fisheries). Prices of drinking water are set up at the municipality level taking into account the local conditions and costs associated with providing drinking water.

The effluent charges are levied on a set of pollutants and aimed at reducing their content in the rivers to within the limits set by the law. If limits are exceeded, fines or penalties are levied. Penalties are levied for non-compliance for both water intakes and discharges of wastewater. The penalties are used as income for the Water Fund, and the income from all water charges is used to cover operating costs.

The drinking water and sewage and wastewater treatment tariffs are based on the production and exploitation costs, maintenance costs, depreciation costs, loan rates according to the obligations of the loan contracts and credit reimbursement.

The income from all water charges is used to cover operating costs. The penalty revenues according to the Law 310/2005 are source of income for National Administration Apele Romane , and not funding the "Water Fund.

9.3 Water tariffs and charges in Serbia

The funding of water management at the national level is defined in the Water Law. The major sources are: the budget (including fees for the use and protection of water and charges for extraction of material) and revenues from fees assessed by public water companies (drainage fees, irrigation fees and fees for the use of the infrastructure). Additionally, local governments and utilities invest in the water sector through local activities (primarily municipal water supply and wastewater disposal), as do other legal entities and individuals to meet their needs or protect their property.

The basic problem associated with water sector funding arises from the fact that there is a large gap between needed funding and secured funding. Namely, 'user pays' and 'polluter pays' principles are not fully applied in water and service pricing, resulting in an extremely low level of self-funding and a major reliance on the budget. Further, fees for the use and protection of resources are far below required levels, and the management of accounting, invoicing and collection does not ensure full collection.

Current drinking water tariffs and removal of wastewater charges are well below economic levels.

9.4 Water tariffs and charges in the Slovak Republic

According to the 2004 Water Act, two categories of payments for water using exist in the Slovak Republic:

- (1) payment for water abstraction from water courses, utilisation of hydropower potential of water courses with install capacity, water abstraction from water courses for energy production, utilisation of hydropower potential of water coursers of water constructions according to the international agreement utilisation for navigation other services in the public interest
- (2) charges for groundwater abstraction, wastewater discharge

Most of the revenue from payments are income of the Slovak Water Management Enterprise (SWME) and are used to operate water courses and river basins. Charges are collected by SWME and they are a funding source of the Slovak Environmental Fund since 2004.

The household drinking water bill is calculated on a volumetric consumption of water (price multiplied by volume of delivered water). According to the 2004 Water Act, the polluter is obliged to treat wastewater according to the state-of-art technologies (that is secondary treatment at the minimum). The Water Act also requires treating wastewater to meet the emission limits. Therefore, there are cases where the polluter must add a tertiary step in order to meet the standards. According to the Regulation on Pollution Charges from 1979, each polluter must pay a water effluent charge.

9.5 Water tariffs and charges in Ukraine

Ukraine has several laws and other secondary laws regulating the issues of drinking water, water supply and sewage water. According to the 2002 Law of Ukraine 'On Drinking Water and Drinking Water use' communal enterprises of territorial communities (vodocanals) are those enterprises which provide central water supply services. These enterprises have their own property and are financially independent. Vodocanals make tariffs for water supply and sewage water by themselves and approve them in local village or city councils.

The tariffs do not take into account the source from which the water in-take is made (surface or groundwater).

Tariffs differ for various consumer groups: population, governmental organisations and industry. All water, supplied by Vodocanal is drinking (there is no technical water for industry). Tariffs increase from year to year for all groups of consumers, and they are the highest for industry.

According to the current legislation, all water users have to clean wastewaters. If a water user does not make direct discharge, it should discharge wastewaters to wastewater treatment facilities of Vodocanal. A separate agreement for subscriber service provision is made in this case.

The discharge of pollutants into surface waters by Vodocanal and by the water user with direct discharge is regulated by the 1999 Decree of Cabinet of Ministers of Ukraine 'About Approval of Order of Establishment of Charges for Pollution of Environment and Getting the Charges'.

10. Interaction between water quality and water quantity aspects

10.1. Relevance of integration of water quality and water quantity aspects in the Tisza River Basin area

The Tisza River Basin is one of the areas where the importance of the integration of water quality and water quantity management activities is apparent.

Part II (Water Quality) of this report introduced the main pressures in the Tisza River Basin as well as the main risks related to the water bodies. The subchapter on significant pressures introduced the main point and diffuse source pollutions and highlighted the important role of agriculture as a significant source of diffuse source pollution.

Part III gave an overview of the pressures related to floods and droughts, and introduced the historical floods and potential damage by flood events as well as facts related to drought events (including an assessment of low water flow and the signs of groundwater depletion).

Important issues are how the mentioned pressures impact the water ecosystems, and how the interactions between the related impacts should be analysed, as well as how the risks of floods and droughts to human health and life, environment and economy can be prevented and managed by integrated water and land use management.

An important discussion point in the frame of the Tisza Group work process was that `hydromorphological pressures can be reduced inter alia by appropriate use of the active, and where feasible, by partial reactivation of former floodplains`. Protecting nature and restoring wetlands will be significant future tasks in the Tisza River Basin; however, the ecologically important water needs of wetlands are not yet determined for the transboundary level. Ecologically important water needs are different for different parts of the Tisza River Basin and transboundary harmonization of water needs must be taken into account.

An inventory of water resources and uses is not currently available for the transboundary level, but inventories would be essential for further analysis as well as for planning future infrastructure projects, which have potential effects on the transboundary level.

It is important to note that wetlands play an important role in river basin functions. They are central components of the hydrological cycle, performing economically and environmentally valuable functions to regulate water quality and quantity and therefore contribute to reaching and maintaining 'good status'[14].

Finally, there are important actual or potential links between the purposes and methods of flood management and the achievement of water quality objectives. In particular, flood management has the potential to positively affect the risk of runoff and associated diffuse pollution from agricultural and rural areas. Flood management involves interventions to modify the conveyance and storage of surface waters, thereby affecting the hydromorphological characteristics of rivers and in turn their ecological status.

As a discussion point, the present extreme climate conditions can strongly influence the water quantity aspect of the Tisza River Basin and can have a secondary effect on the quality of water ecosystems. The following subchapter gives an overview of the possible impacts related to climate changes and highlights the possible effects on the Tisza River Basin.

10.2. Anticipated impacts due to climate changes

Climate variability and change in Europe over the next 50 years could severely impact the quality and quantity of aquatic resources for human consumption as drinking water and the availability of water in agriculture, increase the frequency of extreme events such as floods and droughts and make policy adaptation very challenging.

Significant impacts on the Tisza and Danube water systems are expected, in particular:

- Reduced average water flow
- Increase in extreme events
- Significant regional and local variations
- Impacts on water uses not known
- Changes is water quality and ecological status likely but not investigated

Practical research needs to prepare a River Basin Management Plan (scenarios):

- Quantify the impacts of climate change on water quality/classification of surface and groundwater
- Quantify the impacts of climate change on water quantity, its spatial-temporal distribution including extreme events such as floods and droughts
- Assess the availability of surface and groundwaters under different scenarios and for different uses
- Evaluate the associated costs of adaptation and the effectiveness of different protection/adaptation measures in transnational river basins
- Evaluate the impacts of climate change on the re-mobilisation and re-distribution of contaminants as a result of extreme events

Climate change is a new key challenge, but not the only one existing in water management. The EU Policy Frame with IWRM + ICZM is a sound basis for coordination across sectors, but further developments must involve all concerned to avoid conflicts among different users - prioritisation of uses, sharing of costs.

[14] Elements of Good Practice in Integrated River Basin Management, key issues, lessons learned and 'good practice' examples from the WWF/EC `Water Seminar Series` 2000/2001. pp. 35-36

11. Conclusions

The Tisza River Basin is one of the areas where the importance of the integration of water quality and water quantity management activities is apparent. The Tisza River Basin Management Plan will integrate issues of both water quality and water quantity in a combined approach for land and water management.

Action must be taken collectively to maintain and protect the ecosystem with an integrated river basin management approach combining land and water management, as well as balancing water quality and water quantity.

The threats to the Tisza River Basin must be addressed and managed through enhanced international planning and measures. The Tisza River Basin Analysis provides vital information to successfully develop the Integrated River Basin Management Plan.

The Tisza River Basin countries have collaboratively prepared this report which will be converted into a plan of action with support from the EU and other financing institutions. The Tisza countries will then implement the plan under their EU and ICPDR commitments.

Identifying the next steps

While the Tisza countries have undertaken much work, there are still many areas that need to be addressed to successfully develop a River Basin Management Plan for the Tisza Basin. The report has helped to identify the gaps in data and information that need to be delivered.

Based on the outputs of the analysis the following can be assessed:

Water quality evaluation must be improved by:

- Unifying the approaches of risk assessment between countries, as well as providing data (such as results from water quality monitoring) for impact assessment to validate risk estimation
- Refining the assessment of the risk of failing to meet Good Ecological Status
- Improving the monitoring of all parameters required by the WFD

Water quantity evaluation must be improved by:

- Improving data on water uses
- Developing flood maps including flood hazard and risk maps

Management of water quality and quantity must be better integrated by:

- Improving flood risk maps
- Improving inventories of pollution hot spots
- Collecting and organising information on planned infrastructure projects
- Improving assessments regarding excessive river engineering projects
- Defining minimum flows for ecological quality and pressure criteria

The Tisza River Basin Analysis, as a step towards the fulfilment of the WFD, is the analysis of the Tisza Basin environment and the impacts on it. As such, it is a major step by the Tisza countries to protect and maintain important resources in the river basin. This report characterises the Tisza River Basin by identifying key environmental and water management problems in relation to water quality and water quantity, and creates the basis for the development of the integrated Tisza River Basin Management Plan by 2009.

The Tisza River Basin Analysis, supported by an EU grant, has undergone the same process taken by the Danube countries to produce the Danube River Basin Analysis 2004 (Roof Report) at the Danube

River Basin level. However, the analysis for the Tisza went beyond the work of the Roof Report in several significant ways:

- The Tisza River Basin Analysis addresses issues specific to the sub-basin level, such as mining pollution.
- The analysis includes new data from Ukraine and Serbia, which was previously unavailable for the Roof Report.
- The analysis integrates management issues of both water quantity and water quality to manage jointly.

Integration of water quality and quantity in land and water planning will be essential. To achieve this success in the Tisza River Basin, countries must work together and with all other partners.

The results of the analysis will be used to develop the Tisza River Basin Management Plan and Programme of Measures for implementation by 2015. Although the analysis shows that there are still many areas where additional work is needed, the Tisza Group and the countries of the Tisza River Basin have achieved significant progress and serve as an outstanding example of cooperation.

Plan of Action recommended by The Tisza Group:

By the end of 2008, the plan calls for:

- Preparation of a draft Tisza River Basin Management Plan for public consultation
- Preparation of a 'Programme of Measures' to address the priority issues of organic, nutrient and hazardous substance pollution as well as the impacts of extensive river engineering
- Validation of risk assessment using the new WFD-compliant national monitoring data
- Compilation of a list of future infrastructure plans and projects

By the end of 2009, following the public consultation, the plan calls for Tisza countries to complete the final Integrated River Basin Management Plan, including flood-related aspects.

Long-term actions

It is critical to follow up on the work begun in the Tisza River Basin Analysis in order to protect the Tisza ecosystems from pollution as well as from floods and droughts. Success will depend on the dedicated cooperation from all countries and continuing work on long-term actions:

- Implementation of the measures of the Integrated River Basin Management Plan
- Developing strategies and implementing plans to adapt to climate change
- Improving flood risk management within the Tisza River Basin including the restoration of floodplains and wetlands
- Ensuring equitable balances of water resources between the needs of the countries and the environment