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Flood issues and climate changes

Country Report
Serbia

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DANUBE REGION strategy

Acknowledgements

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Chapter 1 Introduction

Flood risk management issues in Serbia are regulated by the Water Law. The institutions involved in flood risk management are:

- Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia - Republic Directorate for Water – Belgrade (national level);
- Provincial Secretariat for Agriculture, Water Management and Forestry - Novi Sad (provincial – regional level);
- Public Water Management Company "Vode Vojvodine" - Novi Sad (provincial - regional level);
- Local water management companies (local level);
- Republic Hydrometerological Service of Serbia (national level); and
- Municipalities (local level).

Responsibilities of all participants in flood defense activities are determined by Water Law, General Flood Defence Plans and Annual Plans for Flood Defense. These plans are prepared separately for: (1) main rivers (as the Tisza River) where the flood protection structures are already existing and (2) smaller watercourses, where floods are endangering the local communities.
Flood risk management in line with EU Flood directive is going through its first cycle. The Preliminary flood risk assessment for the territory of Republic was finished in 2012, flood hazard and flood risk maps are prepared only for some rivers (none of them in the Tisza river basin) and the Flood risk management plan for the territory of the Republic of Serbia is under development (1st phase was finished in 2015, including Catalogue of measures).

Chapter 2 General description of the Tisza River Basin

Relief

The Tisza River Basin (TRB) in Serbia is a part of Pannonian lowlands (Figure 1). There are different geomorphological elements in relief (as alluvial plains, loess plateaus, sandy areas), with elevation 74-143 m above Adriatic sea level.

The Tisa River course in Serbia is 164 km long and divides the province of Vojvodina in two regions: the Bačka on the west and the Banat region on the east.

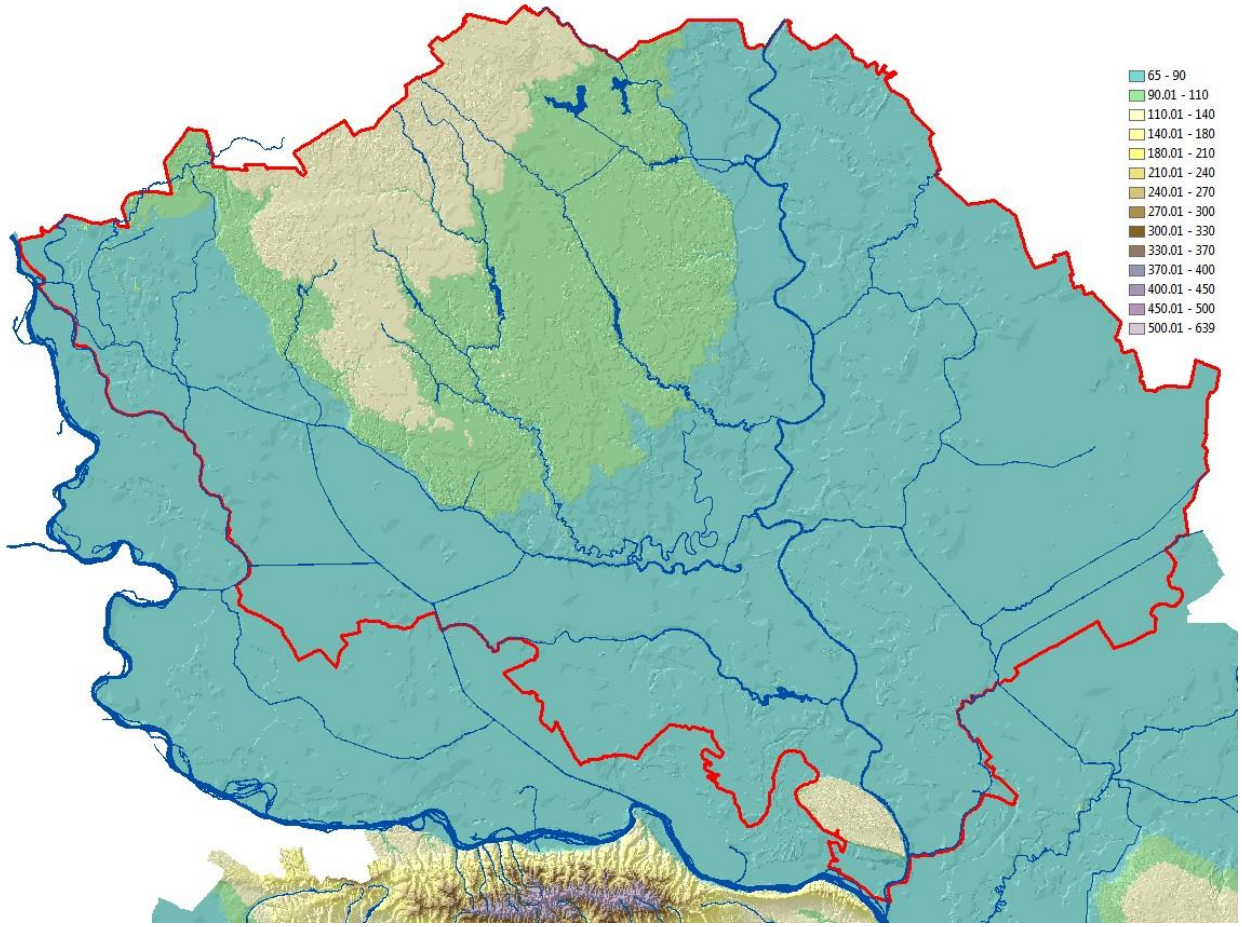

Figure 2.1 Hypsometric map of the TRB in Serbia

Geology

According to the Basic Geological Map of the Republic of Serbia in the scale of 1: 300.000, north and central part of Bačka the mainly dominated by loess and eolian sands, while the southern part of Bačka are dominated by loesses -terrestrial sediments and alluvial sediments. Alluvial sediments dominate in the wider zone of the Tisza River, while the central part of Banat is dominated by loesses - terrestrial sediments. Salinated land covers small areas mainly in alluvial terrace in wider zone of TRB in Banat and small isolated areas in zone of loesses - terrestrial sediments in Bačka.

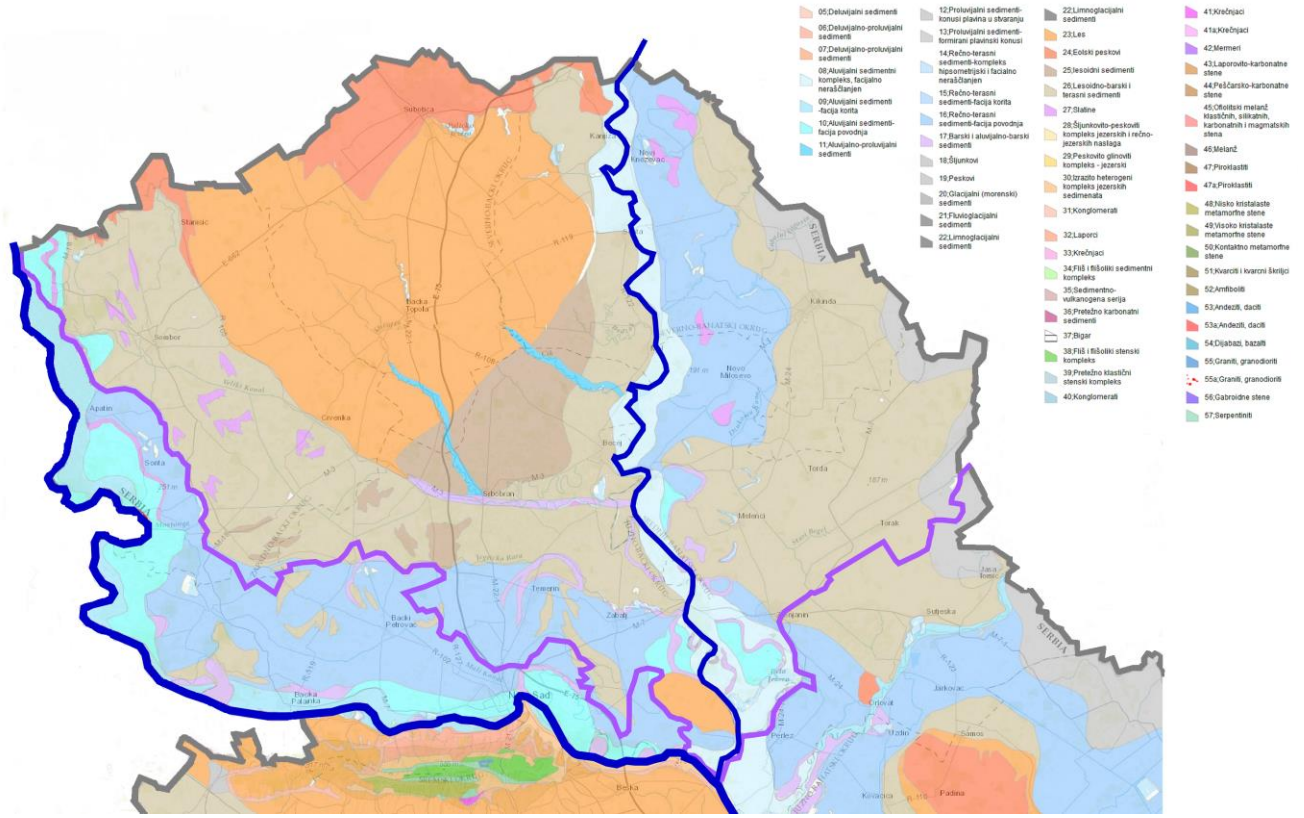

Figure 2.2 Basic geological map of the TRB in Serbia

Climate

The climate in the Serbian part of the TRB is moderate continental. It is apparent from the Table 2.1 (exhibiting mean monthly and annual air temperatures) that the highest temperatures occur in July, and the lowest in January.

Table 2.1: Average monthly and annual air temperatures (°C)

Weather station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year
Sombor	-1.2	1.0	5.7	11.2	16.3	19.5	21.1	20.4	16.6	10.8	5.5	1.2	10.7
Kikinda	-1.3	0.8	5.8	11.5	16.6	19.7	21.4	20.8	17.1	11.1	5.7	1.2	10.9
Zrenjanin	-1.1	1.0	5.8	11.5	16.6	19.7	21.4	21.0	17.4	11.4	5.8	1.3	11.0
Novi Sad	0.1	2.1	6.8	12.1	17.0	19.9	22.0	21.6	18.2	12.5	6.8	2.4	11.8

The intra-annual distribution of precipitation (Table 2.2) indicates) that the most rain falls in the May to July period, and the least in the January to March period. Generally, the month with the highest precipitation is June, and the lowest February/March. As presented in table bellow average yearly precipitation within the TRB in Serbia is lower than country average (730 mm).

Table 2.2: Total average monthly and annual precipitation levels (mm)

Weather station	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year
Sombor	35.4	33.5	33.0	48.7	60.0	76.3	60.9	48.8	35.8	40.6	53.4	44.7	571
Kikinda	33.5	34.7	32.3	44.8	53.0	74.1	52.9	50.2	36.4	35.1	48.0	46.3	541
Zrenjanin	35.2	36.3	36.1	45.7	62.4	83.9	58.8	47.7	36.0	35.1	47.8	47.3	571
Novi Sad	43.6	43.4	43.8	52.0	62.5	85.9	67.5	54.0	38.4	41.6	54.4	56.6	643

Water resources

Only 6.4 % of the TRB area belongs to Serbia (10,056 km^2). In Serbia, at the Senta hydrological station, Tisza River average (Q_{avg}), maximum ($Q_{1\%}$) and minimum ($Q_{95\%}$) flows are 802 m^3/s, 4, 222 m^3/s and 135 m^3/s, in a given order.

The major left tributary is the Begej River, with a mouth 10 km upstream of the Danube and Tisa confluence. The Begej River originates from the Old Begej and the Begej Channel, both coming to RS from RO. Right tributaries of the Tisa River in the Bačka region are small, and almost all incorporated in the Danube-Tisza-Danube Channel System (DTD).

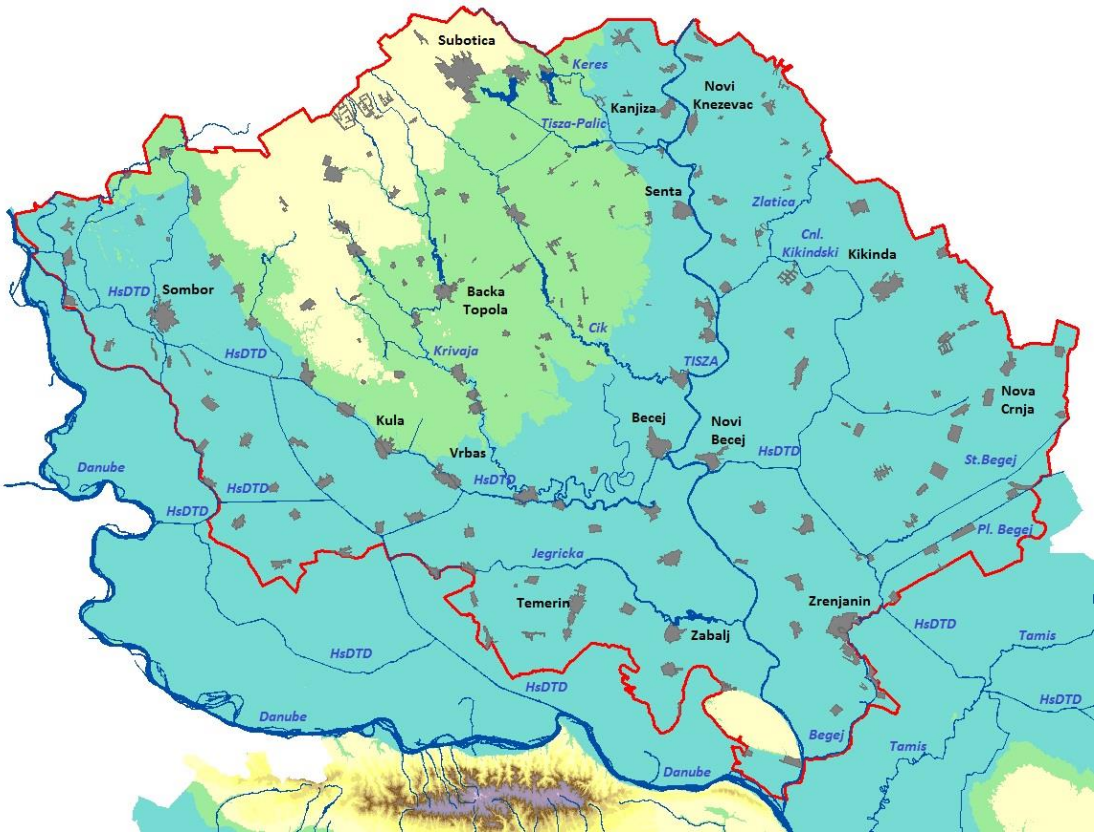

Figure 2.3 River Network in the Serbian part of TRB

The water level regime of the Tisza River is very complex:

(a) The lowest part of the Tisza River (downstream of the Dam near Novi Bečej) is under the influence of the "Iron Gate 1" HPP (built on km 943 of the Danube River in 1972). The height and extent of its backwater zone depend on the power-plant operation regime and hydrological conditions on the Danube River. At the time of low and average waters, the backwater extents to the profile of the Dam on the Tisza River. During high flows of the Danube, this influence may be prolonged up to the HU-RS border.

(b) The water level regime upstream from the Dam near Novi Bečej is under its influence. The Dam, located on the 63rd km of the Tisza River, is the major structure of the DTD.

Soil

Analysis of soil types in TRB in Serbia is based on the Digital Soil Map of Autonomous Province of Vojvodina (APV) in 1:50.000 scale, which provides unification of more-less similar types of soil (84 different types) into 12 separated soil groups with similar characteristics.

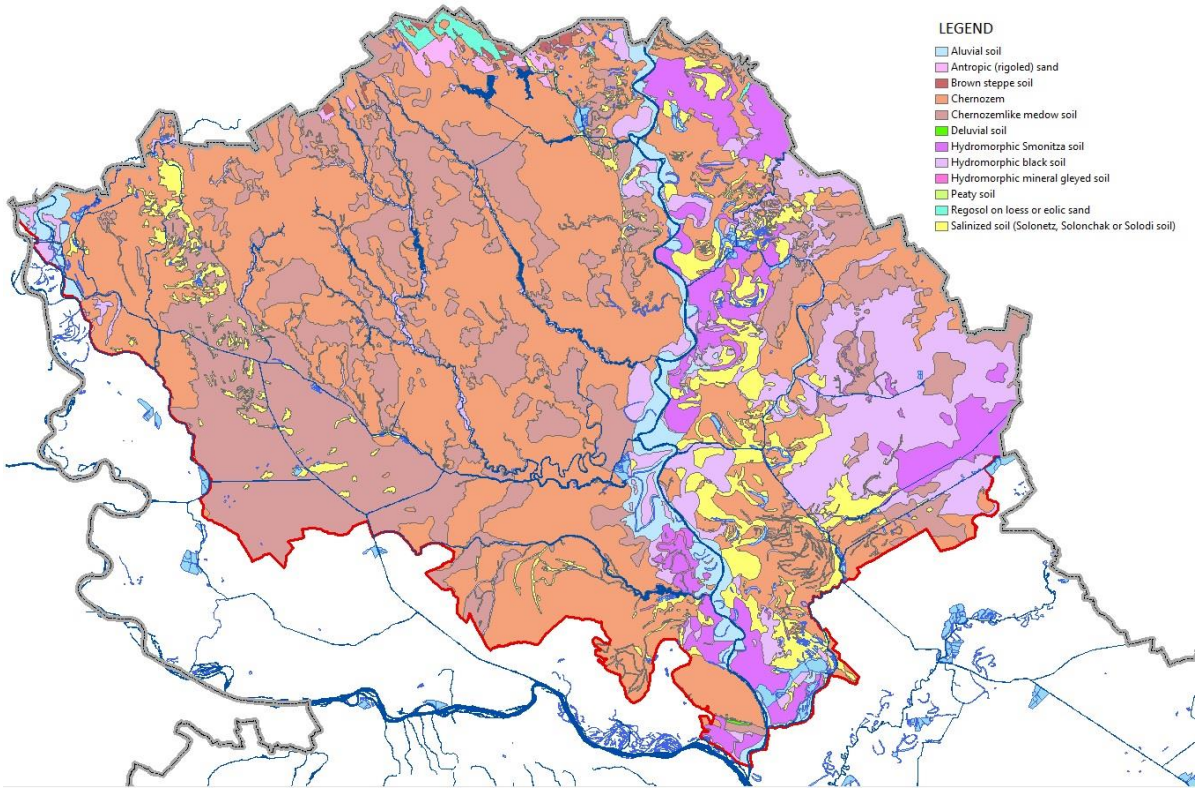

Figure 2.4 Soil types in TRB in Serbia

The dominant types of soil in TRB are groups of chernozems and cherzonem-like medow soils with over the 700 thousands of hectares. All other soil types, like alluvial soil, antropic soil, deluvial soil, regosol, brown steppe soil, salinized soil, peaty soli, hydromorphic mineral gleyed soil, hydromorphic black soil and hydromorphic smonitza soil covers about 315 thousands of hectares. The distribution of different soil groups is presented on Fig. 2.5.

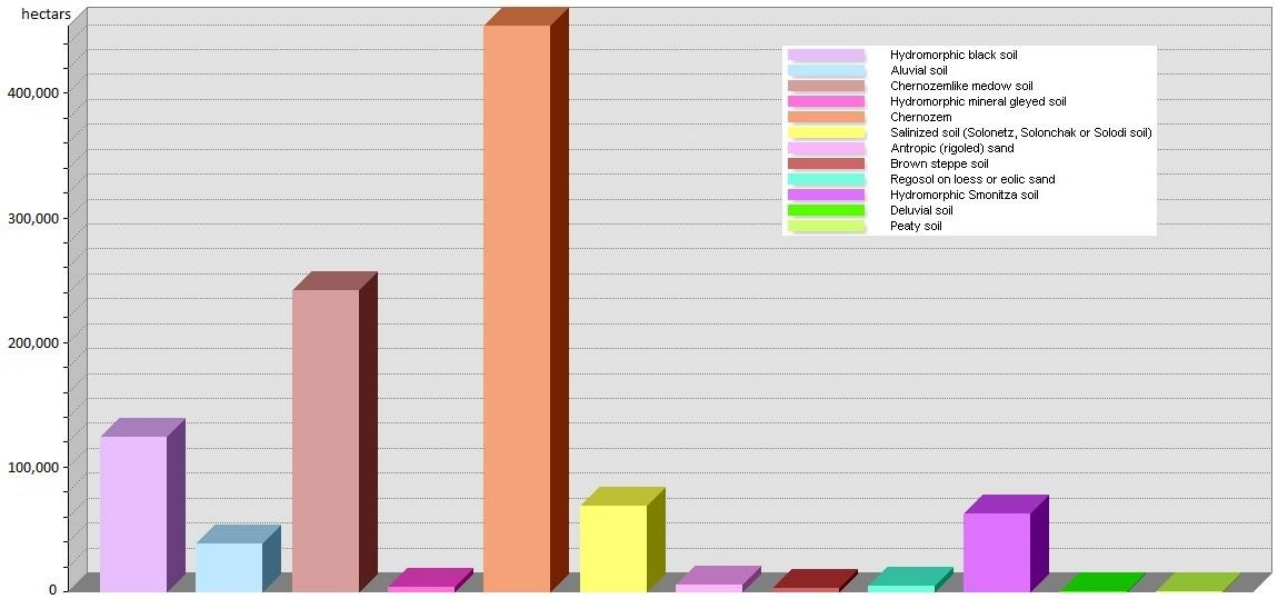

Figure 2. 5 Graph of soil types in TRB in Serbia

Population and human settlements

2011 census shows that the TRB in Serbia is the home of approximately 780,935 inhabitants. Settlements with less than 5,000 inhabitants are dominant. The largest towns are Subotica (97,910 inhabitants), Zrenjanin (76,511), Sombor (47,623) and Kikinda (38,065).

Land use

The land in the Serbian part of the TRB is predominantly used for agriculture (Figure 2.6). According to the CORINE Land Cover (European Environmental Agency (EEA), 2012) agricultural areas cover 84% of the TRB in Serbia, artificial surfaces (including urban fabric and industrial or commercial units), forests and semi natural areas (mainly natural grasslands and broad-leaved forests) and water bodies, each cover 5%, and the remaining 1% is under wetlands (inland marshes).

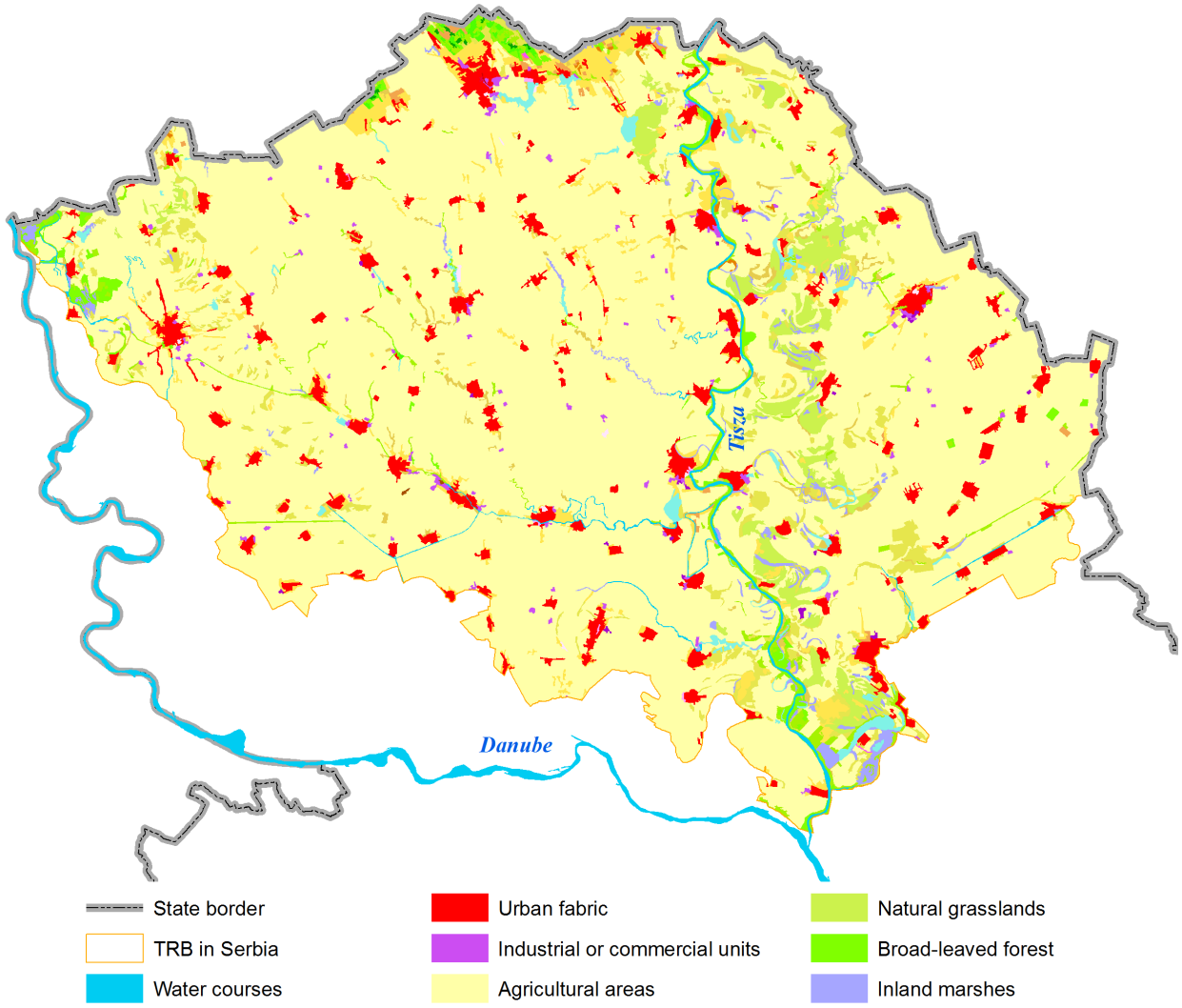

Figure 2.6 Land use in Tisza River Basin in Serbia (EEA, 2012)

Economic activity

Due to the natural features, the main economic activity within the Tisza River Basin in Serbia is agriculture, followed by food industry. Also, fish farming and livestock farms are present. The oil and natural gas reserves are mainly located in North East region - Banat (Mokrin, Kikinda, Elemir, etc) and their extraction is significant economic activity in this part of TRB.

Biodiversity and Protected areas

Based on the current Environmental Protection Act of the Republic of Serbia (RS Official Journal, Issue 66/91), protected natural resources are classified into 5 categories: National Parks, Nature Parks, Areas of Exceptional Features and Beauty, Nature Reserves (general and specific), and Natural Monuments. In addition to the national classification of protected natural resources, each natural resource has been assigned a specific international status or category (like IUCN Classification, Ramsar Convention, IBA List). The list of areas in TRB, protected pursuant to these documents is given in Table 2.3.

Table 2.3: Protected areas in the TRB in Serbia

Site	National status	International status	Description	Surface area (ha)	Area of wetland (%)
Slano Kopovo	Special Nature Reserve	IUCN - IV	A saline lake surrounded by seasonally wet halophytic meadows.	976	70
Stari Begej - Carska Bara	Special Nature Reserve	IUCN - IV	Floodplain between the Tisza and the Begej holding widely distributed native ecosystems	1676	65
Ludaško jezero (Lake Ludaš)	Special Nature Reserve	IUCN - IV Ramsar site 137	The lake and its surroundings are home to diverse habitats (aquatic, swamp, meadow and steppe), with a number of plant and animal species	387	95
Stara Tisa kod Bisernog Ostrva	Nature Park	-	Disconnected river meander	392	95
Jegrička	Nature Park	IBA	Former floodplain	1145	
Palić	National Park	IUCN - V		713	90
Subotička Peščara	Area of Exceptional Features	IUCN - IV		5370	10
Selevenjske Pustare	Special Nature Reserve	IUCN IV IBA SER002 (area 677 ha)		677	16.07
Pašnjaci velike droplje (Pastures of the Great Bustard)	Special Nature Reserve	IUCN IV		979	n/a

Cultural heritage

Based on data and information from the Provincial Institute for the Protection of Cultural Monuments, numerous protected cultural sites exist in the TRB in Serbia. The protection program includes 266 monuments of culture, 5 spatial cultural and historical units, 11 archaeological sites and 5 famous sites. All of them are categorized according to the significance, and given in the table 2.4.

Table 2.4: Cultural heritage in the TRB in Serbia

	Of exceptional significance	Of great significance	Of significance	Total
Monuments of culture	13	105	148	**266**
Spatial cultural and historical units	0	3	2	**5**
Archaeological sites	1	5	5	**11**
Famous sites	1	4	0	**5**

Chapter 3 Flood risk at Tisza River Basin Level

Flood protection infrastructure

System of flood protection levees along the Serbian section of the Tisza River is built along both river banks, in a total length of 314.8 km. Levees were built in XVIII century, and heightened and improved after every large flood. After a long-lasting, hard and costly flood defense in 1970, a systematic approach was applied to resolve the problem. Reconstruction of the existing and building of some new, reallocated levees were grounded on equal standard - to enable the protection from the floods with hundred year return period (4,100 m^3/s), with 1m additional freeboard above the design flood level. Reconstruction of the last remaining old levee on the right bank (between km 21 and km 36) started after 2006 flood, and recently finished. The Table 3-1 synthesises information and data with respect to hundred year flood events dikes within the TRB in Serbia. Only D.16.1.2 in Đala is designed based on 25 year return period since it is "summer dike". The additional "summer dikes" located within the TRB floodplains in Serbia are designed based on 10 year return period.

The DTD, one of the biggest multi-purpose systems in Europe, interconnects the rivers in Vojvodina. The concept of DTD was finalized after the 2nd World War. DTD enables management of waters within the Bačka and the Banat region, encompassing the following tasks: flood protection, drainage of excess interior waters, convey of water for the irrigation of agricultural land; water supply for industry, farms and fisheries; navigation; receiving and convey of waste waters, with protection of water quality; recreation, sports and tourism. All rivers in north and middle Banat region are incorporated into eastern part of DTD, while watercourses in the Bačka region are incorporated in its western part.

The Dam on the Tisza River is the key structure in DTD, as it enables the gravitational entry of 120 m^3/s of water into the channel network which may be used for the irrigation of agricultural land in the Banat and the northern part of the Bačka region. Useful volume of the lake at the normal water stage is about 50 x $10^6 m^3$. The dam is 520 m long. The main flood protection facilities within the TRB are listed in tables below.

Table 3- 1 Dikes

Crt. nr.	Dike name	Water course	Dike position[1]	Locality name	Length (m)	Medium high (m)	YCO[2]	Normal operating conditions		Status[3]
								Probability of exceeding (pc%)	Q (m^3/s)	
1	D.10.1.2	Tisza	RB	Titel	7710	5.00		1		satisfying
2	D.12.3.3	Bajski kanal	LB	Bački Breg	530	6.00		1		satisfying
3	D.13.1.1	Tisza	RB	Horgoš	5200	5.50		1		satisfying
4	D.13.1.2	Tisza	RB	Martonoš	8680	5.50		1		satisfying
5	D.13.1.3	Horgoš-Martonoš channel	LB	Martonoš	4500	5.50		1		satisfying
6	D.13.1.4	Horgoš-Martonoš channel	RB	Martonoš	4500	6.00		1		satisfying

7	D.13.1.5	Tisza	RB	Kanjiža	13300	5.50		1		satisfying
8	D.13.1.6	Kereš	LB	Adorjan	7500	2.50		1		satisfying
9	D.13.2.1	Kereš	RB	Adorjan	7500	2.50		1		satisfying
10	D.13.2.2	Tisa	RB	Senta	22820	5.00		1		satisfying
11	D.13.3.1	Tisa	RB	Ada	21800	6.00		1		satisfying
12	D.14.1.1	Tisa	RB	Bečej	31580	4.70		1		satisfying
13	D.15.1.1	Tisa	RB	Čurug	18540	6.00		1		satisfying
14	D.15.2.1	Tisa	RB	Mošorin	16970	5.00	2008	1		satisfying
15	D.15.2.2	Tisa	RB	Mošorin II line	12500	3.00	2009	1		satisfying
16	D.16.1.1	Tisa	LB	Novi Kneževac	24990	5.00		1		satisfying
17	D.16.1.2	Tisa	LB	Đala	6210	5.00		4		satisfying
18	D.16.1.3	Tisa	LB	Đala II line	7580	1.50		1		satisfying
19	D.16.1.4	Tisa	LB	Čoka	30500	5.00		1		satisfying
20	D.16.2.1	Tisa	LB	Padej	4950	5.00		1		satisfying
21	D.16.2.2	Tisa	LB	Novo Miloševo	14700	5.00		1		satisfying
22	D.16.2.3	Tisa	LB	Novi Bečej	11280	5.00		1		satisfying
23	D.17.1.1	Tisa	LB	Sokolac	11140	5.00		1		satisfying
24	D.17.1.2	Tisa	LB	Taraš-Elemir	29570	6.00	2010	1		satisfying
25	D.17.1.3	Tisa	LB	Belo Blato	12100	6.00	2010	1		satisfying
26	D.17.1.4	Begej	RB	Perlez	8850	3.00	2010	1		satisfying
27	D.17.2.1	Begej	LB	Perlez	3910	4.50	2010	1		satisfying
28	D.17.2.2	Tisa	LB	Knićanin	9450	6.00	2010	1		satisfying
29	D.19.1.3	Vrbas-Bezdan channel	RB	Bački Monoštor	18400	4.00		1		satisfying
30	D.19.2.1	Vrbas-Bezdan channel	RB	Bezdan	18200	4.50		1		satisfying
31	D.19.2.4	Bajski channel	LB/RB	Bezdan-Bački Breg	14640	4.00		1		satisfying
32	D.19.4.1	Kosančić-Mali Stapar	RB	Bački Gračac	7000	2.00		1		satisfying

		channel.								
33	D.19.4.2	Kosančić-Mali Stapar channel	LB	Kruščić-Ruski Krstur	7000	2.00		1		satisfying
34	D.19.4.4	Vrbas-Bezdan channel	RB	Vrbas-Kula	6000	3.00		1		satisfying
35	D.19.4.5	Vrbas-Bezdan channel	LB	Vrbas-Kula	6000	3.00		1		satisfying
36	D.19.6.2	Zlatica	RB	Padej	900	2.50		1		satisfying
37	D.19.6.3	Zlatica	RB	Jazovo-Banatski Monoštor	9970	3.00		1		satisfying
38	D.19.6.5	Zlatica	RB	Vrbica-Granični	4380	1.50		1		satisfying
39	D.19.6.5	Zlatica	RB	Majdan-Granični	3640	1.50		1		satisfying
40	D.19.6.5	Zlatica	RB	Banantsko Arandjelovo-Granični	4020	1.50		1		satisfying
41	D.19.6.6	Zlatica	LB	Padej	10000	3.00		1		satisfying
42	D.19.6.7	Kikindski channel	RB	Kikindski kanal	19700	3.00		1		satisfying
43	D.19.6.8	Banatska Palanka-Novi Bečej channel.	LB	Novi Bečej	4430	3.00		1		satisfying
44	D.19.7.1	Zlatica	LB	Jazovo	8910	3.00		1		satisfying
45	D.19.7.3	Kikindski cnl	LB	Kikindski kanal	17600	3.00		1		satisfying
46	D.19.7.4	Zlatica	LB	Nakovo-Granični	12160	3.00		1		satisfying
47	D.19.8.1	Banatska Palanka-Novi Bečej	RB	Novi Bečej	9400	3.00		1		satisfying
48	D.20.1.1	Begej	RB	Zrenjanin	18550	3.00		1		satisfying
49	D.20.2.1	Stari Begej	RB	Stari Begej	37040	3.50		1		satisfying

50	D.20.3.1	Stari Begej	LB	Stari Begej	34690	3.00		1		satisfying
51	D.20.3.2	Plovni Begej	RB	Plovni Begej	27060	2.50		1		satisfying
52	D.20.3.3	Plovni Begej	RB	Itebej-Granični	3300	1.50		1		satisfying
53	D.20.4.1	Plovni Begej	LB	Plovni Begej	29000	2.70		1		satisfying

[1] left bank (LB) or right bank (RB)
[2] Year of Commissioning, [3] technical status: very good, satisfying, non-satisfying/bad.

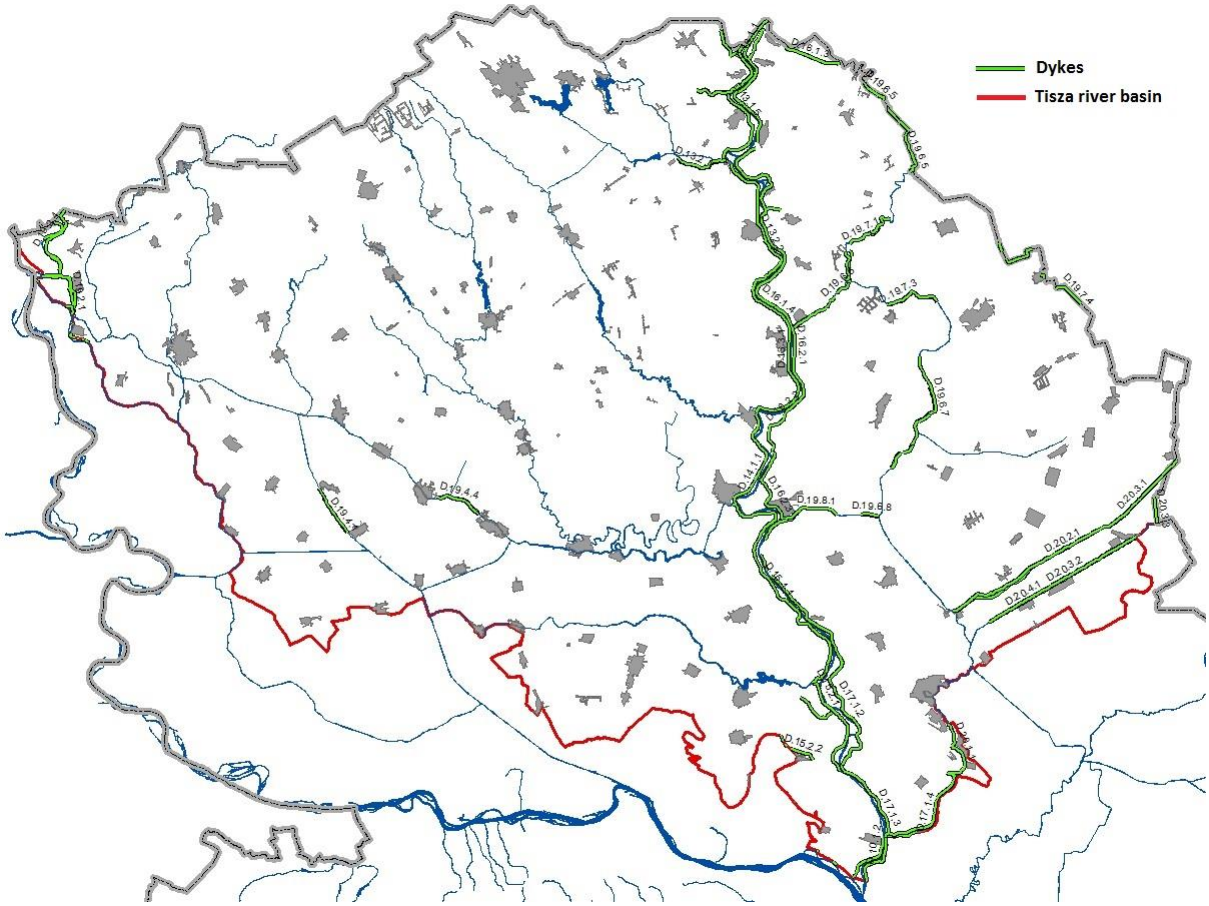

Figure 3.1 Dykes in TRB in Serbia

Table 3 - 2 Permanent reservoirs

Crt. nr.	Reservoir name	Water course	Nearest locality name	High dam (m)	Type of dam[1]	Volume at NRL (mn.m^3)	Volume at MEL[3] (mn.m^3)	Attenuation volume (mn.m^3)		Use[2]
1	Brana na Tisi	Tisza	Novi Bečej	0-9	Gravity from concrete		50,000			water supply

[1] – arch/gravity from concrete/earth/embankment, etc.
[2] – flood protection, water supply, industry, irrigation etc.
[3] Normal Retention Level
[4] Maximum Exploitation Level

Drainage systems

Within the drainage tasks, the DTD serves as a primary infrastructure system, on which local drainage systems rely on. Development of drainage systems on 762,000 ha (339,000 ha in the Bačka and 423,000 ha in the Banat region) and routing of drainage waters through main channels towards two main recipients - the Danube and the Tisza river was planned. Presently, there are 134 drainage systems with 82 pumping stations in operation, as well as about 460 km of primary and 9,019 km of secondary drainage channels (See Figure 3.2 and 3.3). Also, there are about 3,500 other water structures, as a sluices, ship-locks, bridges, cascades, siphons, etc.

Figure 3.2 Drainage systems and pumping stations in TRB in Serbia

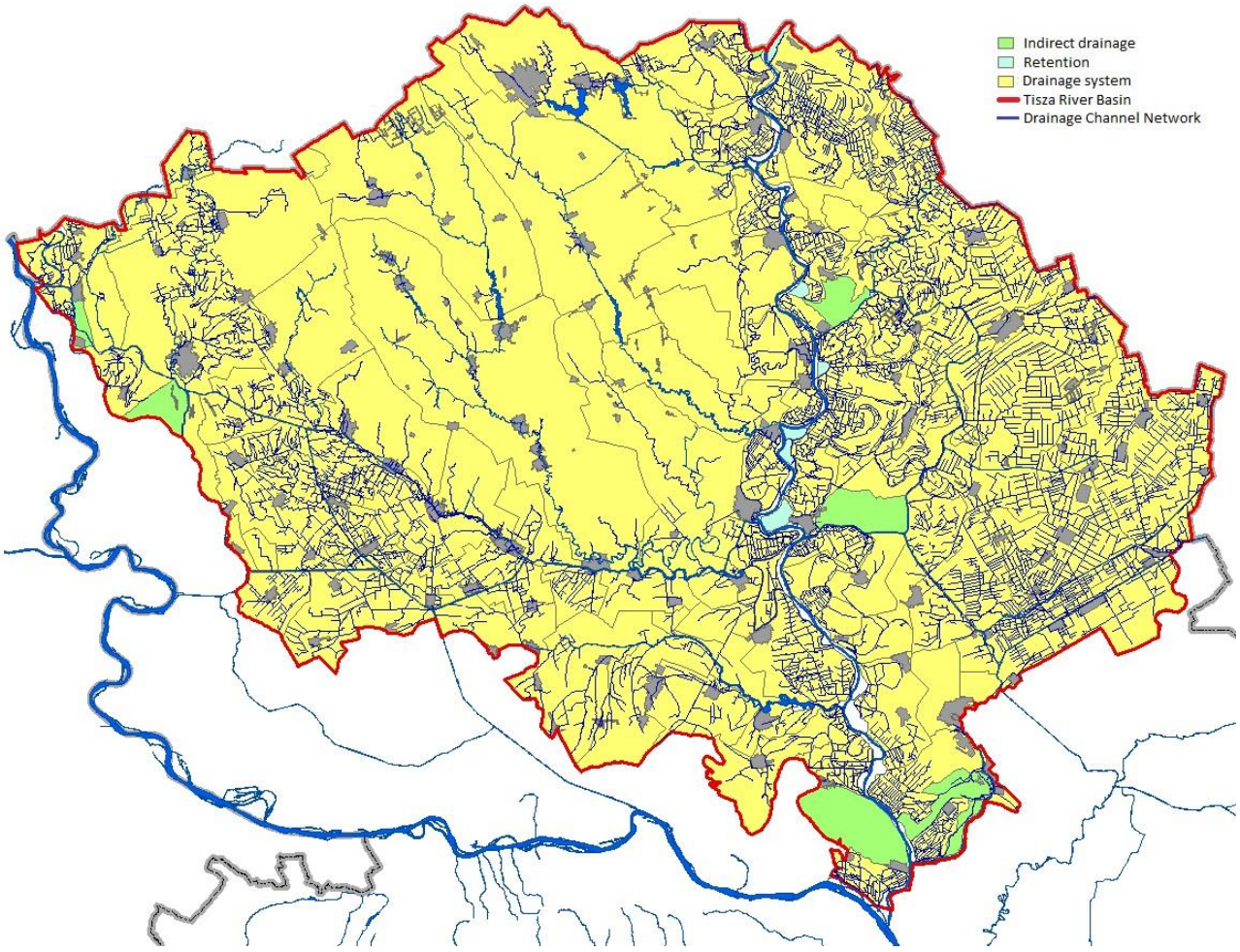

Figure 3.3 Drainage channel network in TRB in Serbia

Table 3- 3 Drainage systems

Crt. nr.	Name	Function	Drained area (km²)	Receiver / river
1	Kendjija	Drainage system	21.86	Hs DTD Vrbas - Bezdan
2	Bezdan-Bački Breg	Drainage system	40.06	Hs DTD Vrbas - Bezdan
3	Bezdan-Bački MonoItor I	Indirect Drainage	9.55	Hs DTD Vrbas - Bezdan
4	Severna Mostonga	Drainage system	530.76	Hs DTD Vrbas - Bezdan
5	Plazović	Drainage system	109.12	Hs DTD Vrbas - Bezdan
6	Horgoško-Martonoški rit sliv XII	Drainage system	36.3	Tisza
7	Horgoš-Martonoš sliv XI	Drainage system	90.84	Tisza
8	Stari Kereš sliv IX	Drainage	20.76	Tisza

		system		
9	Kanjiški rit sliv X	Drainage system	26.82	Tisza
10	Kereš	Drainage system	426.42	Tisza
11	Senćanski rit sliv VII	Drainage system	41.75	Tisza
12	Kaloča sliv V	Drainage system	185.95	Tisza
13	Makoš sliv VI	Drainage system	2.75	Tisza
14	Budžak sliv III	Drainage system	159.46	Tisza
15	Molski rit sliv II	Drainage system	22.09	Tisza
16	Čik 2	Drainage system	161.53	Tisza
17	Čik 1	Drainage system	496.31	Tisza
18	Perlek - Medenjača - Mali rit	Drainage system	46.02	Tisza
19	Ugarnice	Drainage system	14.37	Hs DTD Bečej - Bogojevo
20	Beljanska bara	Drainage system	335.23	Hs DTD Bečej - Bogojevo
21	Krivaja 2	Drainage system	735.35	Hs DTD Bečej - Bogojevo
22	Krivaja 1	Drainage system	423.49	Hs DTD Bečej - Bogojevo
23	Vrbas	Drainage system	58.71	Hs DTD Vrbas - Bezdan
24	Vrbas-Kula	Drainage system	97.34	Hs DTD Vrbas - Bezdan
25	Kula-Crvenka	Drainage system	157.66	Hs DTD Vrbas - Bezdan
26	Telečka-Istočna Gradina	Drainage system	246.71	Hs DTD Vrbas - Bezdan
27	Bezdan Ostrvo I	Drainage system	12.09	Hs DTD Vrbas - Bezdan
28	Bezdan-Bački Monoštor	Indirect Drainage	5.51	Hs DTD Vrbas - Bezdan
29	Kupusina 9-6	Drainage system	51.86	Hs DTD Prigrevica - Bezdan
30	DTD Bukovac	Indirect Drainage	28.28	Hs DTD Prigrevica - Bezdan
31	Miletić - Čičovi	Drainage system	42.33	Hs DTD Odžaci - Sombor
32	Žarkovac	Drainage	38.59	Hs DTD Vrbas - Bezdan

		system		
33	Stapar	Drainage system	39.62	Hs DTD Vrbas - Bezdan
34	Srpski Miletić	Drainage system	15.78	Hs DTD Bečej - Bogojevo
35	Severna Jegrička	Drainage system	158.53	Hs DTD Bečej - Bogojevo
36	Ruski Krstur	Drainage system	16.39	Hs DTD Bečej - Bogojevo
37	S-I	Drainage system	62.76	Hs DTD Vrbas - Bezdan
38	KK-II	Drainage system	20.62	Hs DTD Kosančić - Mali Stapar
39	KC-III	Drainage system	98.11	Hs DTD Vrbas - Bezdan
40	Ruski Krstur III-26	Drainage system	25.59	Hs DTD Kosančić - Mali Stapar
41	Kosančić III-23	Drainage system	16.71	Hs DTD Kosančić - Mali Stapar
42	Savino Selo K-IV	Drainage system	6.69	Hs DTD Bečej - Bogojevo
43	Kucura K-IV	Drainage system	57.85	Hs DTD Bečej - Bogojevo
44	Jegrička	Drainage system	72.49	Jegrička
45	Sistem SV	Drainage system	33.04	Hs DTD Bečej - Bogojevo
46	Jegrička 2	Drainage system	51.27	Jegrička
47	BB	Drainage system	43.2	Hs DTD Bečej - Bogojevo
48	Turija Nadalj I	Drainage system	59.14	Hs DTD Bečej - Bogojevo
49	Turija-Nadalj II	Drainage system	9.63	Jegrička
50	Stara Tisa - Bačkogradištanski rit	Drainage system	47.4	Tisza
51	Turija - Nadalj - Bačko Gradište	Drainage system	25.95	Hs DTD Bečej - Bogojevo
52	Jegrička 3	Drainage system	36.31	Jegrička
53	Koštanica	Drainage system	2.34	Hs DTD Bečej - Bogojevo
54	Bečejski Donji veliki rit	Drainage system	28.34	Tisza
55	Biserno Ostrvo	Drainage system	19.88	Tisza
56	Žabalj	Drainage	119.33	Tisza

		system		
57	Odžaci	Drainage system	54.78	Hs DTD Bečej - Bogojevo
58	Jegrička	Drainage system	139.04	Hs DTD Bečej - Bogojevo
59	Stepanovićevo-Jegrička	Drainage system	123.05	Jegrička
60	Temerin	Drainage system	127.88	Jegrička
61	Temerin - Gospođinci	Drainage system	96.93	Jegrička
62	Žabalj-mesto	Drainage system	34.03	Jegrička
63	Vrbica	Drainage system	114.12	Tisza
64	Đurđevo	Drainage system	21.14	Tisza
65	Titel	Drainage system	37.29	Tisza
66	Mošorin	Drainage system	15.24	Tisza
67	Titelski breg	Indirect Drainage	84.44	Tisza
68	Novi Kneževac	Drainage system	228.1	Tisza
69	Vok	Drainage system	11.5	Tisza
70	Crna Bara	Drainage system	44.4	Zlatica
71	Sanad-Budžak	Drainage system	6.8	Tisza
72	Kere bara-Đurđeva bara	Drainage system	52.65	Tisza
73	Pesir	Drainage system	15.68	Tisza
74	Zlatica II	Indirect Drainage	27.19	Zlatica
75	Jazovački	Drainage system	25.92	Zlatica
76	Čoka II	Drainage system	22.78	Tisza
77	Monoštorski	Drainage system	19.26	Zlatica
78	Vrbica	Drainage system	73.52	Zlatica
79	Graničar	Drainage system	9.11	Zlatica
80	retenzija Batka	Retention	3.45	Tisza
81	Retenzija Đala	Retention	3.85	Tisza

82	Šuljmoški	Drainage system	27.89	Zlatica
83	Kerekto-Bočar	Drainage system	161.91	Tisza
84	Burza	Drainage system	51.56	Tisza
85	Vranjevo	Drainage system	2.25	Tisza
86	Šušanj	Drainage system	3.19	Hs DTD Ban. Palanka - Novi Bečej
87	Kopovo	Indirect Drainage	50.49	Hs DTD Ban. Palanka - Novi Bečej
88	Bečejski	Drainage system	23.38	Hs DTD Kikindski kanal
89	Galadski	Drainage system	41.61	Hs DTD Kikindski kanal
90	Miloševački	Drainage system	22.15	Hs DTD Kikindski kanal
91	Bočarski	Drainage system	14.77	Hs DTD Kikindski kanal
92	Iđoski-Kindja	Drainage system	28.96	Hs DTD Kikindski kanal
93	Berski	Drainage system	12.67	Hs DTD Kikindski kanal
94	Katahat	Drainage system	51.95	Hs DTD Kikindski kanal
95	Retenzija Bočar	Retention	2.12	Tisza
96	Retenzija Libe	Retention	8.16	Tisza
97	retenzija Ljutovo	Retention	9.01	Tisza
98	Zlatički	Drainage system	109.78	Hs DTD Kikindski kanal
99	Sajanski	Drainage system	9.99	Hs DTD Kikindski kanal
100	Begejski	Drainage system	63.74	Zlatica
101	Mokrinski	Drainage system	80.68	Hs DTD Kikindski kanal
102	Sistem K- III	Drainage system	4.05	Hs DTD Kikindski kanal
103	Kindja	Drainage system	15.9	Hs DTD Kikindski kanal
104	Nakovski	Drainage system	104.74	Hs DTD Kikindski kanal
105	Glavni	Drainage system	211.92	Hs DTD Kikindski kanal
106	Tašfalski	Drainage system	6.1	Hs DTD Kikindski kanal
107	Bašaidsko-Molinski	Drainage system	81.29	Hs DTD Kikindski kanal

108	Vincaidski	Drainage system	6.87	Hs DTD Kikindski kanal
109	Melenci I	Drainage system	54.19	Hs DTD
110	Turski Begej	Drainage system	98.57	Hs DTD
111	Banatski Dvor	Drainage system	20.7	Stari Begej
112	Karađorđevo-Molin	Drainage system	174.05	Stari Begej
113	Itebej-Crnja	Drainage system	292.82	Stari Begej
114	Sokolac	Drainage system	38.67	Hs DTD
115	Kumane	Drainage system	58.48	Tisza
116	Kumane II	Drainage system	57.02	Tisza
117	Melenci III	Drainage system	28.5	Hs DTD
118	Melenci II	Drainage system	49.85	Hs DTD
119	Babatov	Drainage system	37.57	Tisza
120	Elemir-Aradac	Drainage system	94.27	Tisza
121	Zrenjanin	Drainage system	62.14	Begej
122	Mihajlovo-DTD	Drainage system	20.64	Hs DTD
123	Mihajlovo-Begej	Drainage system	17.41	Begej
124	Mužlja-Lukino Selo	Drainage system	78.93	Tisza
125	Ribnjak	Indirect Drainage	36.11	Tisza
126	Belo Blato	Drainage system	28.28	Begej
127	Carska Bara	Indirect Drainage	11.15	Begej
128	Međurečje	Drainage system	46.61	Stari Begej
129	Jorgovan	Drainage system	39.95	Stari Begej
130	Stajićevo	Drainage system	10.93	Begej
131	Žitište-Klek	Drainage system	33.95	Plovni Begej
132	Begejci	Drainage	100.7	Plovni Begej

		system		
133	Mrtva Tisa naspram Đale	Indirect Drainage	2.47	Tisza
134	Molin - Šećeranski	Drainage system	23.07	Hs DTD Kikindski kanal

Significant historical floods and Areas with Potentially Significant Flood Risk

In XX century, many major floods occurred on the Serbian part of the TRB (1919, 1924, 1932, 1940, 1944, 1947, 1965 and 1970), but the protection system resisted. The first important flood after the major reconstruction of the levees was in 2000, also without any consequences. The most recent flood on the Tisa River occurred in 2006, almost simultaneously with the Danube flood. Water levels on the most downstream section of the Tisa River were very high, due to the influence of the Danube backwater. The flood protection unit, citizens and the Army made extreme efforts to prevent overtopping of the right levee, and levee breaching at the week points.

Areas with Potentially Significant Flood Risk (APSFR) in the TRB in Serbia were identified based on the potential adverse consequences which future floods may cause for human health, the environment, cultural heritage and economic activity. A table with APSFRs is given below:

Table 3- 4 Areas with Potentially Significant Flood Risk

APSFR name	Representation type	Length (km)
Tisza from the mouth to the state border with Hungary	line	164
Begej Channel (DTD) from the mouth to the Banatska Palanka – Novi Bečej Channel (DTD)	line	36
Stari Begej the mouth to the state border with Romania	line	38
Zlatica from the mouth to the state border with Romania	line	35
Plazović from the mouth to the state border with Hungary	line	44

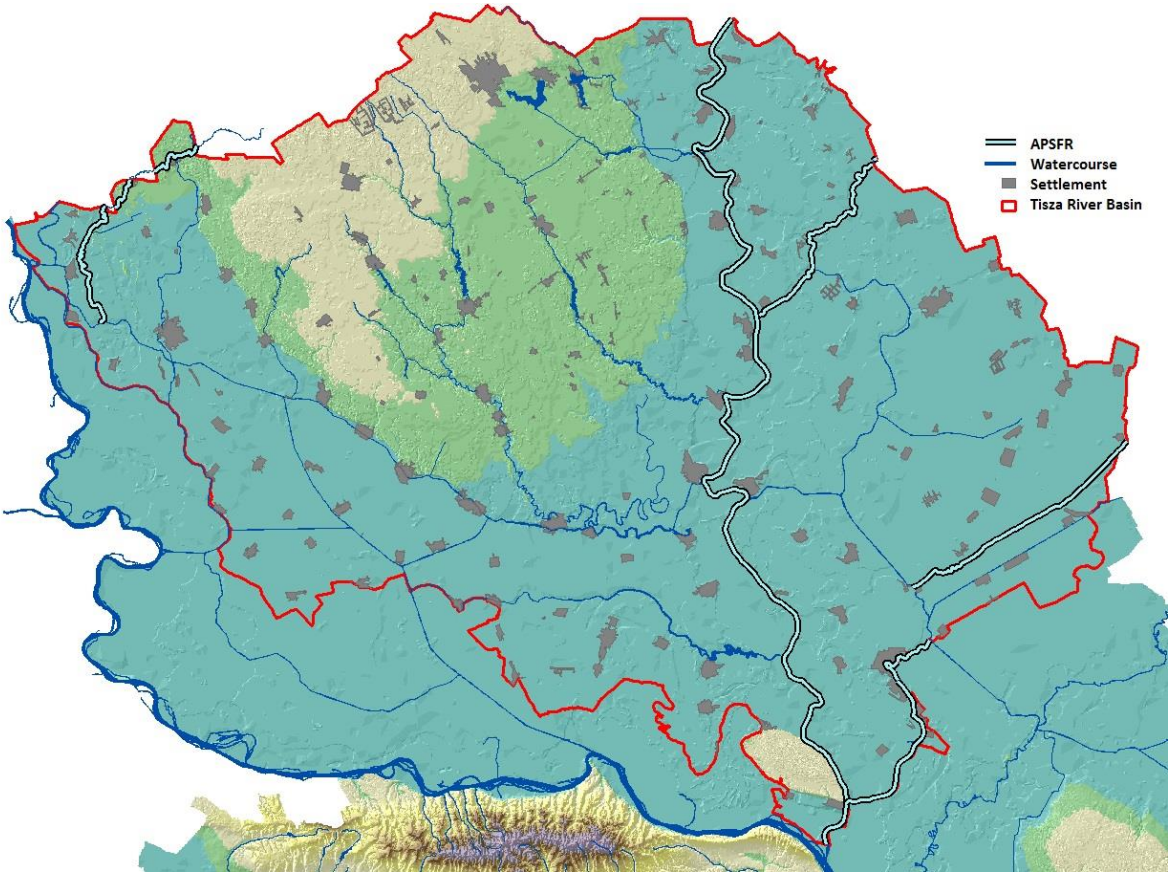

Figure 3.4 Map with APSFR in the TRB in Serbia

National Flood Hazard Maps and Flood Risk Maps for TRB

Flood hazard maps and flood risk maps for the APSFR in the TRB will be prepared by using an official national methodology within the Study of Flood Prone Areas in Serbia – Phase 2, which is in the initial stage of project preparation. For the time being, only indicative flood prone areas are available, obtained based on expert knowledge. It should be noticed that a part of TRB is also endangered by the Danube floods, due to very flat terrain.

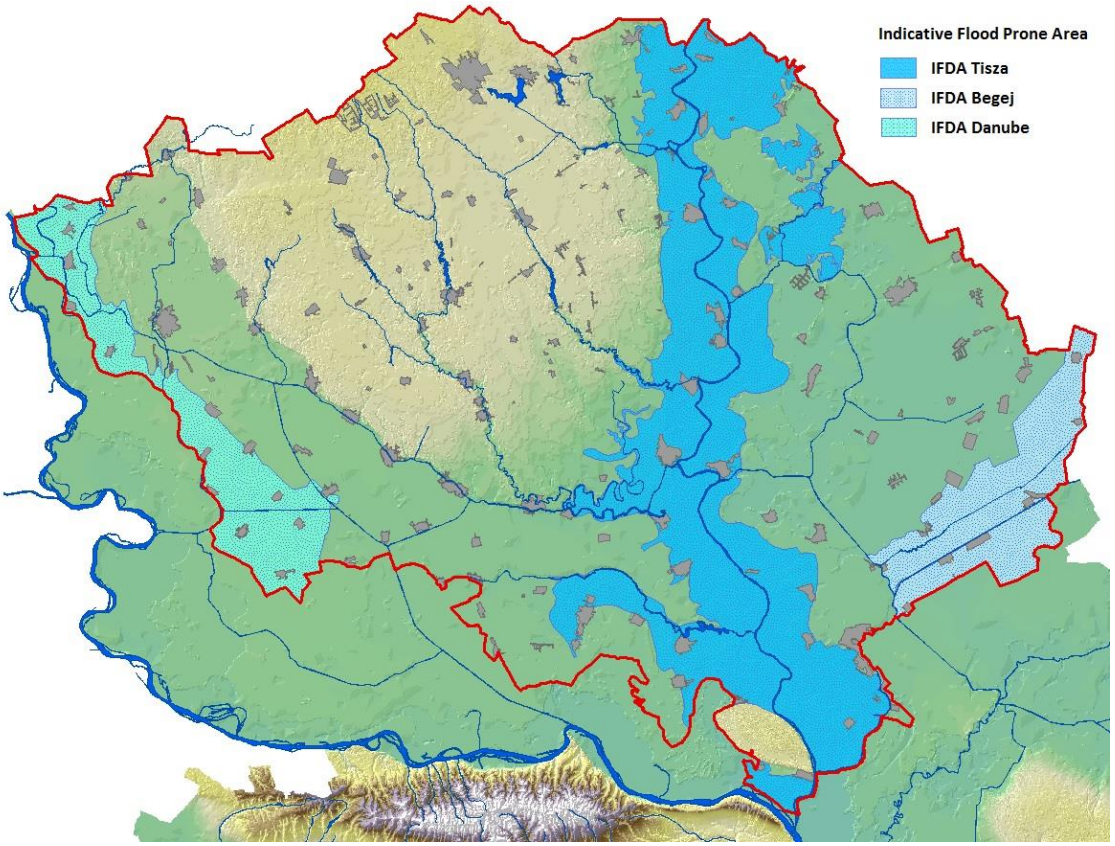

Figure 3.5 Flood hazard map in the TRB in Serbia

Potential adverse consequences

Indicative flood prone areas map in Figure 3.5 shows that over 2,000 km^2 are potentially endangered by flooding. This area is predominantly under agricultural land while there are numerous settlements with accompanying infrastructure, economic activities, cultural heritage, as well as nature protected areas. Precise data will be obtained after completion of flood risk maps.

Estimation of the impact of Climate Change on flood risk

Estimation of the Climate Change impacts on floods in the Republic of Serbia within the Tisza River Basin has not been studied in details. However, based on available data and information the high flow frequencies will likely increase in the future, but statistically significant trends are not detected in evaluated time series. ICPDR Strategy on Adaptation to Climate Change clearly underlined high level of uncertainty with respect to floods and projected Climate Changes that should be considered by decision makers within the Danube River basin. Given the natural features and hydrology (precipitation bellow country average, low specific runoff – 0.5 – 1 l/s/km^2, etc) within the Tisza River Basin in Serbia, the floods in the most downstream Tisza country are greatly influenced by upstream countries hydrology, measures and land use practices in country and beyond. Given the high level of uncertainty associated with flood events CC projections the recently finalized Second National Communication to the United Nation Framework Convention on Climate Change for Serbia (funded by UNDP) in report on the Vulnerability Assessment and Adaptation Action Plan for Water Sector (Deliverable 7) specific measures for adaptation with respect to flood events are proposed and classified

with low regret, no regret etc. attributes given the identified problems/issues. The activities and documents that address Climate Change at the state level (all relevant institutors and sectors) are:

- Second National Communication (SNC) to the United Nation Framework Convention on Climate Change (UNFCCC) for Serbia , funded by United Nations Development Programme);
- Climate Adaptation Strategy for the Danube River Basin (ICPDR);
- The ,Climate Strategy and Action Plan project (ongoing) will provide support to the Ministry of Environmental Protection to prepare a Climate Change Strategy and Action Plan in order to develop the strategy and policy framework required.
- In addition to above mentioned activities, due to geographic location of Serbia mainly transnational .

In addition to above mentioned activities, due to geographic location of Serbia mainly transnational projects that address climate change and water resources have been implemented or are ongoing in Serbia and some of them addressed various aspects of climate change impact on water resources, including vulnerability assessment, mitigation issues, and adaptation measures recommendations to reduce the water and other sectors vulnerability in Serbia:

- CARPATCLIM - Climate of the Carpathian Region, the regional project financed by the Joint Research Center of the European Commission – JRC;
- CCWaterS – Climate Change and Impacts on Water Supply ,the transboundary project funded by European Regional Development Fund (ERDF) and IPA;
- WATCAP- Water and Climate Adaptation Plan for the Sava River Basin funded by World Bank;
- CC-WARE - Integrated transnational strategy for water protection and mitigating water resources vulnerability, the transboundary project funded by European Regional Development Fund (ERDF) and IPA;
- ClimWatAdapt - Climate Adaptation–modeling water scenarios and sectoral impacts, funded by the European Commission - DG Environment;
- Modelling of climate change impacts on water fluxes and states in the Kolubara and Toplica catchments in Serbia;
- Further Improvement and Development of Flood Forecasting Service in Serbia;
- SEERISK -Joint Disaster Management Risk Assessment and Preparedness in the Danube macro-region;
- OrientGate A network for the integration of climate knowledge into policy and planning;
- PROMITHEAS-4K -knowledge transfer and research needs for preparing mitigation/adaptation policy portfolios;
- South East European Forum on Climate Change Adaptation - SEE Forum on CCA (CCAFORUM);
- Assessment of climate change impacts on the water resources of Serbia (financed by the Republic of Serbia Ministry of Education, Science and Technological Development);
- Climate Change Impacts on River Hydrology in Serbia – National Study in Serbian (financially supported by Water Directorate – Ministry of agriculture, forestry and water management of Serbia);
- Weather extremes and climate change in Serbia financed by the Ministry of Education, Science and Technological Development;
- Studying climate change and its influence on the environment: impacts, adaptation and mitigation (CLENIAM - III43007), funded by the Ministry of Education and Science of the Republic of Serbia;
- etc.

International Cooperation in the TRB

Bilateral cooperation between Republic of Serbia and neighbouring countries in the TRB (Hungary and Romania) exists more than 60 years:

- Bilateral cooperation between RS and Hungary is based on the Agreement between the Government of the People's Republic of Hungary and the Government of Federal People's Republic of Yugoslavia on water management issues, signed in Belgrade in 1955. The Agreement binds the parties thereto to review and jointly resolve all issues, measures, and activities related to flood and ice control; obligates coordinated management and operation of structures and equipment; requires the Committee, set up pursuant to the Agreement, to generate joint flood and ice control rules. In 1998, the Committee adopted new Rules for external and internal flood and ice control related to border or cross-border watercourses and hydro-technical systems in sectors of joint interest to RS and HU, as well as rules on hydrologic cooperation, which also has an important function in the domain of flood control. The new bilateral agreement, based on fruitful past cooperation and EU legislation is in preparation.
- Bilateral cooperation between RS and Romania is based on the Agreement between the Government of Romania and the Government of the Federal Republic of Yugoslavia on hydro-technical issues from the hydro-technical systems and watercourses on the boundary or crossing the state boundary, signed in Bucharest in 1955. The parties agreed to review and jointly resolve all issues, measures, and activities related to flood and ice control; each party on its territory and the parties jointly along the border should adequately maintain riverbeds, hydro-technical systems, structures, and installations etc. The Joint Flood Control Rules for border or cross-border watercourses and hydro-technical systems were approved in 1971. Timely dissemination of hydro-meteorological information of significance for flood and ice control, as well as information on flood control phases and any accidents, is also an obligation under the Joint Flood Control Rules. The new bilateral agreement, based on fruitful past cooperation and EU legislation is in preparation.

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The Water Law (Official Gazette of the Republic of Serbia, nos. 30/10 and 93/12);

The Water Management Strategy of the territory of the Republic of Serbia (Official Gazette of the Republic of Serbia no. 3/2017).

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Partners: General Directorate of Water Management, Hungary | Global Water Partnership Central and Eastern Europe, Slovakia | International Comission for the Protection of the Danube River, Austria | Ministry of Environment, Water and Forest, Romania | Ministry of Foreign Affairs and Trade, Hungary | National Administration "Romanian Waters", Romania | National Institute of Hydrology and Water Management, Romania | Public Water Management Company "Vode Vojvodine", Serbia | Regional Environmental Center for Central and Eastern Europe, Hungary | The Jaroslav Černi Institute for the Development of Water Resources, Serbia | Water Research Institute, Slovakia | World Wide Fund for Nature Hungary

Associated Partners: Interior Ministry, Hungary | Republic of Serbia Ministry of Agriculture and Environmental Protection – Water Directorate | Secretariat of the Carpathian Convention (SCC), Austria | State Agency of Water Resources of Ukraine | Tisza River Basin Water Resources Directorate, Ukraine

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