Interreg
Danube Transnational Programme
JOINTISZA

www.interreg-danube.eu/jointisza

Flood issues and climate changes
Romania Report for Tisza River Basin

Deliverable 5.1.1

Final version, July, 2017

Project co-funded by the European Union (ERDF, IPA funds)

DANUBE REGION strategy

Acknowledgements

Lead author

Daniela Rădulescu, National Institute of Hydrology and Water Management, Romania
Sorin Rindașu, National Administration Romanian Waters, Romania

Contributing authors

Andreea Cristina Gălie, National Institute of Hydrology and Water Management, Romania
Ramona Dumitrache, National Institute of Hydrology and Water Management, Romania
Bogdan Mirel Ion, National Institute of Hydrology and Water Management, Romania
Ionela Florescu, National Institute of Hydrology and Water Management, Romania
Elena Godeanu, National Institute of Hydrology and Water Management, Romania
Elena Daniela Ghiță, National Institute of Hydrology and Water Management, Romania
Daniela Sârbu, National Institute of Hydrology and Water Management, Romania
Silvia Năstase, National Institute of Hydrology and Water Management, Romania
Diana Achim, National Institute of Hydrology and Water Management, Romania
Răzvan Bogzianu, National Administration Romanian Waters, Romania
Anca Gorduza, National Administration Romanian Waters, Romania

Contents

Tables

Figures

Abbreviations

APSFR	Areas with Potentially Significant Flood Risk
CLC	Corine Land Cover
DTM	Digital Teren Model
EU	European Union
ICOLD	International Commission on Large Dam
IED	Industrial Emissions Directive
LIDAR	Light Intensity Detection and Ranging
NAVTEQ	Navigation Technologies
RBA	River Basin Authority
SCI	Sites of Community Importance
SPA	Special Protected Area

Chapter 1 Introduction

Floods are one of the main hazards from Romania, which thorough intensity and amplitude threaten population, economic activity, environment and cultural heritage. In Romania, floods are possible throughout the year, having as a source natural overflows of river stretches, heavy rainfalls, snow melting, blockages due to ice bridges or floats, etc.

Over time, there have been several forms of addressing the phenomenon, from the notion of flood „fighting", to the notion of flood „defence" and then to flood management. The new flood risk management approach, is coordinated by all responsible actors and involves awareness and involvement of human communities in avoiding loss of life and reducing damage.

World practice has shown that floods can not be avoided, but they can be managed, and their effects can be reduced through a systematic process, represented by measures and actions designed to help reduce the flood risk associated with these phenomena.

Flood risk management means applying policies, procedures and practices to identify risks, analyze and evaluate them, treat, monitor and re-evaluate risks in order to reduce them, so that human communities, all citizens can live, work and satisfy their needs and aspirations in a sustainable physical and social environment.

Flood risk management in Romania is mainly provided by:

- Ministry of Waters and Forests, at central level;
- National Administration "Romanian Waters" through 11 River Basin Authorities (Someş-Tisa RBA, Crişuri RBA, Mureş RBA, Banat RBA, Jiu RBA, Olt RBA, Argeş-Vedea RBA, Buzău-Ialomiţa RBA, Siret RBA, Prut-Bârlad RBA, Dobrogea-Litoral RBA) at the catchment level and National Institute of Hydrology and Water Management which offers the scientific support and methodological guidance needed for implementation of European Directives at national level.
- Ministry of Internal Affairs, General Inspectorate for Emergency Situations at central level (at the level of the 41 counties), which intervene in case of emergency situations;
- Local and County Comittees for emergency situations.

The Management of Emergency Situations is ensured by the components of the National Emergency Situations Management System, according to the provisions of Emergency Ordinance of the Romanian Government no. 1/2014 regarding certain measures in the field of emergency situations management, as well as for amending and supplementing the Government Emergency Ordinance no. 21/2004 regarding the National Emergency Situations Management System, of the law 15/2005 for the approval of Government Emergency Ordinance no. 21/2004 with subsequent amendments and completions, as well as of the Joint Order of the Ministry of Administration and Interior and of the Ministry of Environment and Forests no. 1422/192/2012 for the approval of the "Regulation on management of emergency situations caused by floods, dangerous meteorological phenomena, hydrotechnical accidents, accidental water pollutions and marine pollutions in the coastal area".

The priniciples of emergency situations management are:

- forecasting and prevention;
- the priority protecting and saving of human life;

- respect for human rights and fundamental freedoms;
- assuming the responsibility of emergency management by public administration authorities;
- cooperation at national, regional and international level with similar bodies and organizations;
- the transparency of activities carried out for emergencies so that they do not lead to worsening of the effects produced;
- the continuity and graduality of the emergency management activities, from the level of the local public administration authorities to the level of the central public administration authorities, depending on their magnitude and intensity;
- operability, active co-operation and hierarchical subordination of the components of the National System.

During emergency situations or potentially emergency situations, measures and actions shall warning the population, institutions and economic agents in dangerous areas;

- declaration of alert status in the event of imminent threat or emergencies;
- implementation of prevention and protection measures specific to the types of risk and, where appropriate, evacuation from the affected or partially affected area;
- Operative intervention with forces and means specially designed, depending on the situation, for limiting and eliminating negative effects;
- granting emergency aid;
- establishment of the state of emergency, under the conditions provided by art. 93 of the republished Romanian Constitution;
- request or providing international assistance;
- granting compensation to natural and legal persons;
- other measures provided by law.

A simplified water management scheme in Romania is presented in figure 1.1.

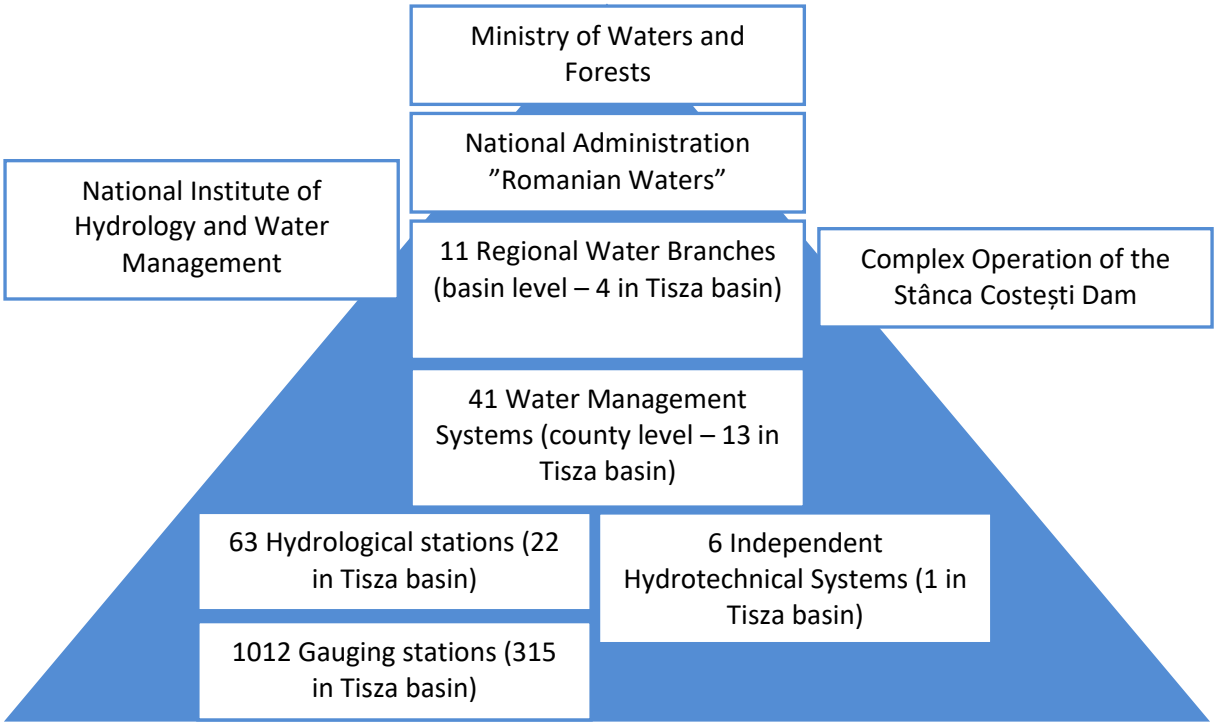


Figure 1.1 Water management scheme in Romania

Chapter 2 General description of the Tisza River Basin

Geographic characterisation

Tisa river basin includes all relief forms. Relief shows a great variety from the plain to the mountains (the minimum altitude is 75 m in the Western Plain, and the maximum of 2,509 m in the Retezat Mountains).

The physical-geographic ensemble is characterized by the existence of several relief units, and principle, shown in figure 2.1 are:

- The Carpathian Mountains Unit composed of:
  - Oriental Carpathians: Carpathians Maramureș and Bucovina (Rodnei Mountains - Pietrosul Rodnei Peak 2,303 m, Călimani Mountains - Pietrosul Călimanilor Peak 2,100 m, Maramureș Mountains - Farcău Peak 1,957 m, Suhard Mountains – Omu Peak 1,932 m, Țibleș Mountains – Țibleș Peak 1,839 m), Moldo-Transilvani Carpathians (Harghita Mountains - Harghita Mădăraș Peak 1,800 m, Hășmașu Mountains - Hășmașu Mare Peak 1,792 m, Giurgeu Mountains – Prișca Peak 1,545 m);
  - The Meridional Carpathians: Parâng Mountains (Cibin Mountains - Cândrel Peak 2,244 m, Lotrului Mountains – Ștefleşti Peak 2,242 m, Sebeșului Mountains – Pătru Peak 2,130 m), Retezat – Godeanu Mountains (Retezat Mountains – Peleaga Peak 2,509 m, Godeanu Mountains - Gugu Peak 2,291 m , Țarcu Mountains – Căleanu Peak 2,192 m);
  - Occidental Carpathians: Apuseni Mountains (Bihor Mountains - Bihor Peak 1,849 m, Vlădeasa Mountains – Vlădeasa Peak 1.836 m, Gilău - Chicera Comării Mountains 1,475 m, Metaliferi Mountains – Poienița Peak 1,437 m, Trascăului Mountains – Dâmbăul Peak 1,369 m, Zarandului Mountains - Drocea Peak 836 m), Poiana Ruscă Mountains – Padeș Peak 1,378 m;
- The Plateau of Transylvania Unit – the Someș Plauteau (Hm 650-700m), High piedmont hills in eastern Transylvania (Hm 600-700 m), high plateau of Târnavelor (Hm 600-700 m), Transylvanian Bistriţa Plateau (Hm 850-900 m), Plain of Transylvania, Secaşelor Plateau, Lower Plateau Târnava (Hm 500-600 m), Transylvanian hills and depressions;
- Western Hills and Depressions (Hm 300 m) - Baia Mare Deep and Depression, Silvania Hills, Oradea Zarand Hills, Banat Hills;
- Western Plain (high plains Hm 120-180 m, low plains 85-100 m) - Someș Plain, Crişuri Plain, Banat Plain.

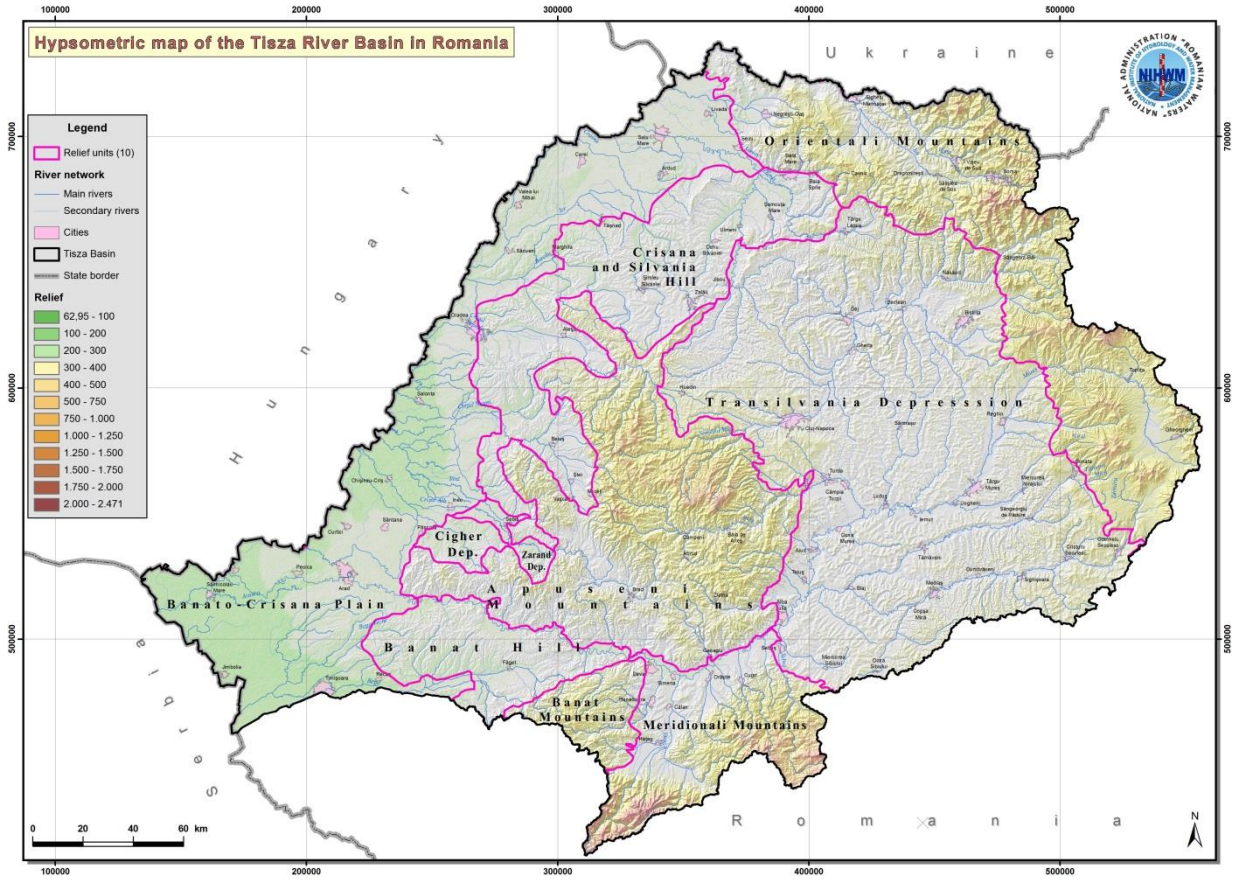


Figure 2.1 Hypsometric map of the Tisza River Basin in Romania

Geology

In the Eastern Carpathians from the west to the east, the neogene volcanoes, the crystalline-mesozoic strip, the stripe of the cretaceous and paleogenic strip are delimited.

The Geology of the Meridional Carpathians is represented for the most part by crystalline and magmatic rocks over which is also sporadically found a mesozoic (limestone) sediment and a neozoic sediment (pebbles, sands, clays).

The foundation of the Northern Apuseni Mountains is a crystalline-mesozoic area consisting of prealpine crystalline shale (micasists, micacees, quartz-feldspar gnaise, quartz shale etc.), prehercinate magmatite (granite rocks) and larmae magmatite (andesites, dacites, riolites, granites, granodiorites etc).

The southern Apuseni Mountains belong to the area consisting of crystalline prehercinal shale, hercinic crystalline shale, ololytic magmatite, prelaramic sedimentary deposits, larma magmati, neogene volcanic (riolite, dacite, andesite).

The Transylvanian Depression is an area of active sedimentation and subsidence that emerged at the end of the Lower Miocene.

The Western Hills have a crystalline foundatio, which is affected by different elevations and dives, represented by blocks at different depths, over which are sediment (sandstone, sands, etc.)

The Western Plain, overlaid over the Pannonian Depression, presents the crystalline base, over which there is a mesozoic sedimentation, then a neozoic sedimentary covering, and over the newer pleistocene and

holocene deposits (clay, loess, wind sands, lacustral sands). Pannonian Depression consists of a base made up of crystalline shale traversed of penetration and solidification of the magma and sedimentary shell.

Climate

The Tisa river basin has moderate temperate continental climate with ocean, western, Mediterranean and submediterranean nuances (influences).

For this area, the following features of the climatic factors are remarked:

- The annual average temperature varies between: 11-9 ° C In the West Hills area, 10-8 ° C in the Western Hills, 9-6 ° C in intra-mountainous depressions, 8-6 ° C in the Transylvanian Plateau, 6-0 ° C In the Western Carpathians, 6 and -2 ° C in the Eastern Carpathians, 0 and -2 ° C in the Meridional Carpathians;
- Annual average quantities rainfall ranges between 1200-800 mm in the Oriental Carpathians and the Southern Carpathians, 1200-700 mm in the Western Carpathians, 800-650 mm in the Hills West, 800-600 mm in the Transylvanian Plateau and in the intramontane depressions, and 650-550 mm in the Western Plain.

Water Resources

From the surface of Romania, the Tisza river basin collects the waters of 1,833 cadastral water courses, which equals 27,757 km of hydrographic network. The river basin of the Tisa River has an area of 72,620 km^2, which represents approximative 30.5% of Romania's surface area and 46.2% of entire Tisza River Basin.

Among the watercourses of the Tisza river basin with larger areas 1,000 km^2, the most important ones are: Vișeu, Iza, Tur, Someș, Șieu, Someșul Mic, Lăpuș, Crasna, Ier, Barcău, Crișul Repede, Crișul Negru, Crișul Alb, Mureș, Arieș, Târnava, Târnava Mică, Sebeș, Strei, Aranca, Bega and Bega Veche.

The tributary basins of the Danube-Tisza-Danube Canal on the territory of Romania are: Bârzava, Moravița and Caraș.

The Tisa River on the territory of Romania has a length of 61 km. It has an area of 4,540 km^2 and collects the water of 123 cadastral water courses with a total length of 1,592 km.

The main left tributaries of Tisa in Romania are: the Vişeu river with a length of 82 km and the basin surface of 1,581 km^2, the Iza River with a length of 80 km and with the area of the basin of 1,293 km^2 and the Tur River with a length of 68 km and the surface of the basin of 1,144 km^2.

The Someș River with a length of 376 km drains a river basin with a 15,740 km^2 area, collecting the waters of 403 cadastral water courses. It is formed by the union of the Someşul Mare river (L = 130 km; S = 5,033 km^2) with the Someşul Mic river (L = 178 km; S = 3,773 km^2). The most important tributaries of the Somes river are the Lăpuş River (S = 1,820 km^2, L = 114.6 km) and the Crasna River (L = 134 km, S = 1,931 km^2).

The Crişul Alb river has a length of 234 km in Romania and a total area of 4,240 km^2.

the Crişul Negru river has a length of 164 km in Romania and a total area of 4,237 km^2.

the Crişul Repede river has a length of 171 km in Romania, the slope and a surface area of 2,986 km^2.

The Barcău river (cadastral code III.1.44.33), a tributary of the Crişul Repede river, has a length of 134 km in Romania and a surface area of 2,005 km^2. One of its main tributaries is the the Ierul/Eriul river. It has a length of 100 km in Romania and a surface area of 1,392 km^2.

The Mureș River has a length of 761 km. The coded hydrographic network totals 797 water courses with a length of 10,800 km and a surface area of 27.890 km^2.

The main tributaries of the Mureş river are: the Arieș river (cadastral code IV.1.81, L = 166 km, S = 3,005 km^2), the Târnava river (cadastral code IV.1.96, L = 246 km, S = 6.253 km^2, called from the spring of the Târnava Mare river L=223 km, S= 3,666 km^2 up to the confluence with the Târnava Mică river), the Târnava Mică river (cadastral code IV.1.96.52, L = 196 km, S = 2.071 km^2), the Sebeș river (cadastral code IV.1.44, L = 96 km, S = 1,304 km^2) and the Strei river (cadastral code IV.1.117, L = 93 km, S = 1,983 km^2).

The Bega River (cadastral code V.1) is the left tributary of the Tisa river, is located in the western part of the country, has a general East-West orientation and has a length (up to the border) of 170 km. The total length of the hydrographic network is 1,418 km. The total area of the basin is 4,470 km^2 and the main course of 2,362 km^2. The Bega's main tributary is the Bega Veche river (cadastral code V.1.21, L = 107 km, S = 2,108 km^2), the confluence point is located on the territory of Serbia.

The Aranca River (cadastral code IV.2.) has a length of 114 km within Romania and collects 19 water courses with a total length of 328 km. The river basin has an area of 1,080 km^2.

The Bârzava river, the Moravița river and the Caraș river are rivers that bring their contribution to the Danube - Tisa - Danube canal.

The Tisza River Network in Romania is presented in figure below (figure 2.2).

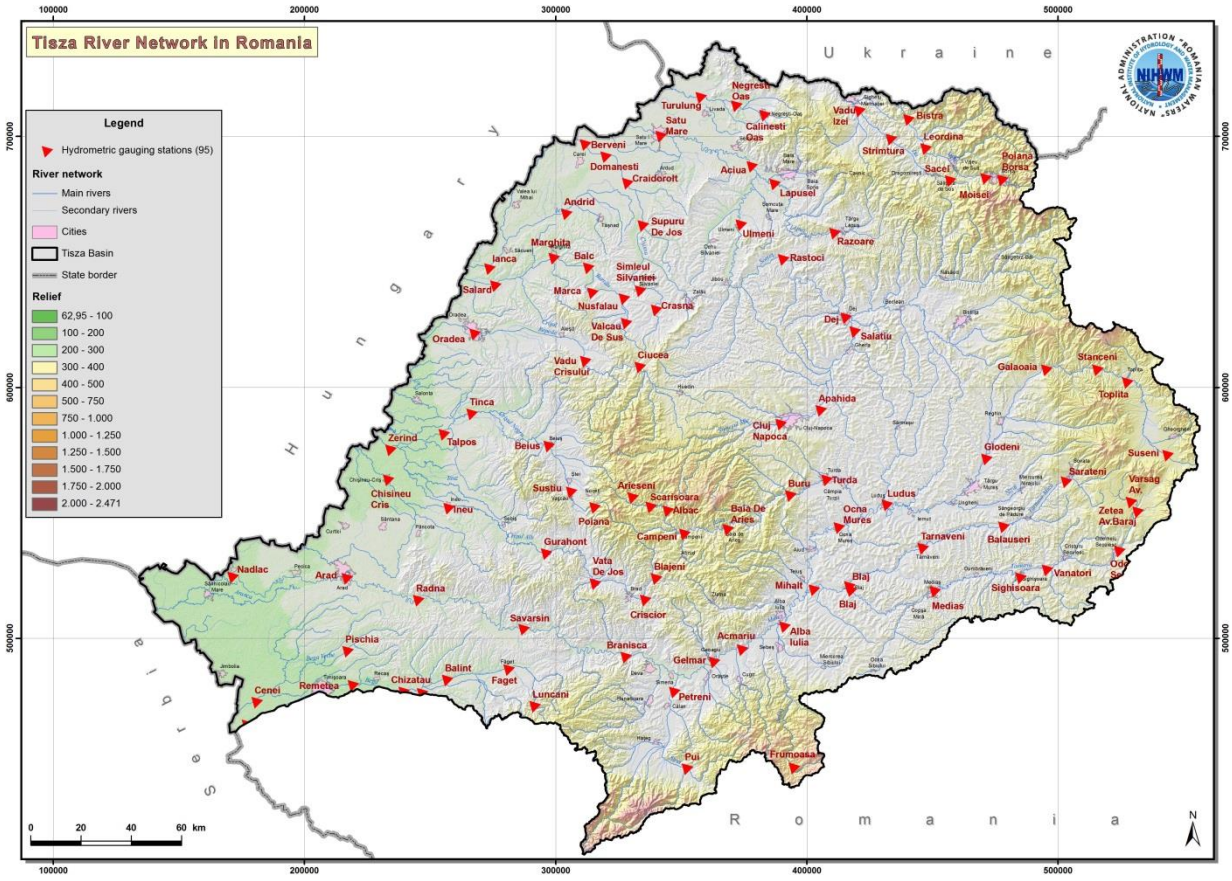


Figure 2.3 Tisza River Network in Romania

Soil

Oriental Carpathians - class of spodosols is represented by brown soils, feriiluvial and podzols, class of umbrisols, class of cambisols with the types of brown and acidic brown soils, and the class of andosols.

Southern Carpathians - class spodosols is specific to conifer and juniper forests, with prepodzol types and humic-fertile podsols; the cambisols class with the eu-mesobazic and brownish brown types; class luvisols with the types of preluvisols, luvosols and planosols; class cernisols with cambic types, rendzina, chernozem and faeziom.

Western Carpathians - class of umbriosols with nigrosol and humosiosol. In the north-western mountainous region the soil cover is heterogeneous. Besides brown acidic and brown soils there are clay and brown soils (on sedimentary rocks), in patches terra rossa (on limestone) and sometimes ando-soils (on volcanic rocks).

Transylvanian Plateau - soils cover consists of cernisols class with cernizom cambic types, argillaceous chernozems and cernoziomoides, pseudorendzines; the class of luvisols with brown argillic type, brown luvic and white luvisols; class cambisols represented by eu-mezobase brown.

Western Hills - predominant soils are part of the class of luvisols with the types of planosols, brown argillaceous, brownish luvic and white luviosols; Class cernisols with chernozem types and rarer rendzines. Hydromorphic soils appear in humid areas, and alluvial protosols appear in low meadows.

The Western Plain – predominant soils are those of cernisols class with cambic chernozems, argillaceous chernozems and black soils; Class luvisols with brown argillaceous, brownish lucius and white luvisols. Halomorphic (salisodisols), hydromorphic (hydrousols), sandy and alluvial soils appear on salty areas.

Population and human settlements

From the administrative point of view, the Tisza river basin comprises fully and almost entirely the counties of Mureş, Alba, Cluj, Satu Mare, Salaj, Bihor, Arad, Maramureş and Bistriţa Năsăud, part of the counties of Harghita, Sibiu, Hunedoara, Timiş and Caraș-Severin and small areas of Brasov county.

Also from administrative point of view, the Tisza river basin in Romania is located on the territory of 3 development regions: North-West Development Region, West Development Region and Center Development Region.

Total population in the Tisa river basin at the level of 2011 was 4,972,912 inhabitants with an approximately equal distribution in the urban and rural areas (2,415,092 inhabitants and 2,134,820 inhabitants in the rural areas).

At the level of the Tisa river basin in Romania, there are about 80 urban centers (municipalities and towns) and about 875 rural centers (communes).

Among the major urban agglomerations we mention: Cluj-Napoca, Timisoara, Oradea, Arad, Tg. Mureş, Baia Mare, Satu Mare, Bistrita, Alba-Iulia, Deva, Hunedoara, Turda, Mediaș, Sighișoara, Recaş, etc.

Land use

Land usage is influenced both by physical and geographic conditions and by the anthropic factors, thus distinguishing an uneven distribution of forests, pastures, arable land, urban and industrial land.

According to Corine Land Cover, at the level of the year 2012, the land use had the following distribution: non-irrigated arable land – 19,728 km^2; deciduous forests – 19,060 km^2; secondary pastures – 9,218 km^2; predominant agricultural land mixed with natural vegetation – 4,588 km^2; coniferous forests – 4,004 km^2;

discontinuous urban space and rural area 3,095 km^2; Complex crop areas - 2,957 km^2; natural meadows - 2,642 km^2; mixed forests - 2,195 km^2; transition areas with shrubs – 1,261 km^2; orchards - 958 km^2; vineyards - 525 km^2; water courses 280 km^2; industrial or commercial units - 230 km^2; subalpine vegetation - 192 km^2; water accumulations - 137 km^2; marshes - 118 km^2; ore extraction areas - 54 km^2; areas with rare vegetation - 35 km^2; rocks - 31 km^2; land cultivated with rice - 14 km^2; network of communication routes and associated land - 14 km^2; garbage pits - 13 km^2; recreational areas - 10 km^2; urban green areas - 7 km^2; airports - 7 km^2; areas under construction - 7 km^2; permanently irrigated land - 2 km^2; beaches, dunes, reeds - 1 km^2; peatland – 0.004 km^2. Figure 2.3 shows the usege of land belonging to the Tisza river basin from Romania.

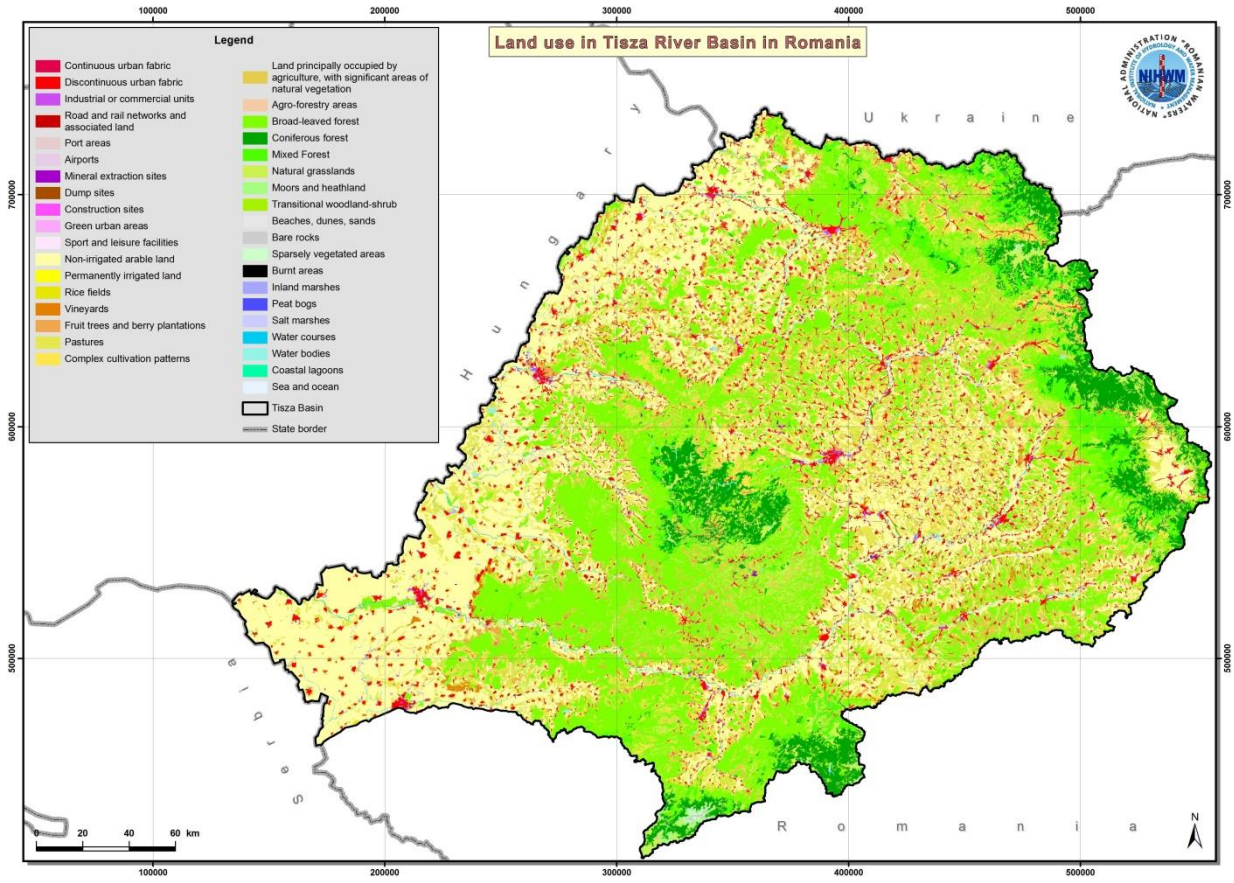


Figure 2.4 Land use in Tisza River Basin in Romania

Economic activity

The main economic activities are: zootechnics, irrigation, fish farming, food industry, extractive industry, light industry, wood processing industry, chemical processing industry, metallurgy industry, building materials industry, machine building industry, electronics, extractive industries and crude oil processing, transport industry, furniture production, electricity and heat production, construction, trade and servicing of population, transport, education, health, other service activities. There has been an unprecedented increase in the IT&C industry, with a number of companies focusing on the production of electronics and home electronics components or equipment.

The degree of industrialization is relatively high, the industrial production in the area being destined both to meet the consumption requirements of the domestic market and for export.

The distribution of the main economic activities in the Tisza river basin in Romania, represented by the range of industrial and agricultural products, is as follows:

- Industrial products: garments, timber, PVC products, polyethylene products, glassware, prefabricated reinforced concrete, knitwear, textiles, footwear, metal fabrications, furniture, thermal energy, etc.
- Agricultural products: bakery products, meat and meat products, edible oils, dairy products, etc.

As for agriculture, the main agricultural products in the Tisza basin are: cereals (wheat, barley, rye, maize), oily plants (sunflower, soybean), vegetables and legumes, industrial plants (sugar beet), vines, orchards (plums, apples, pears, cherries and sour cherries).

Biodiversity and Protected areas

The current distribution of plant and animal species in the Tisza basin is the result of climate, relief, human activity interference.

In the mountainous regions the vegetation is represented by: conifer forests, alpine and secondary meadows, mixed forests (conifer-beech), beech floors (oak, hornbeam, ash), sessile, hornbeam, birch ash, juniper, shrubs, etc. The vegetation is complemented by species of great phytogeographical interest, such as: lotus flower, edelweiss, mountain avens, bearberry, slipper flower, red vanilla orchid, gentiana, bellflower, carnations, yellow gentiana.

The fauna is diverse and rich, represented by species of great hunting interest we draw your attention about: black goat, deer, lynx, bear, deer, boar, wolf, wild cat, alpine marmot, fox, wolf, squirrel, jder, mountain rooster, birch cock, finch, squeaky hammer, etc.

In the hills area and the plains areas the vegetation is represented by beech forests, mixed forests (beech, oak, hornbeam, garneau, linden), oak forests (oak, pedunculate oak, garneau), shrubs (hazelnut, horn, bloom) to which the meadow vegetation (tremulous poplar, white walnut, alder, and salty plants) are added. The fauna is represented by wolf, wild boar, fox, wild cat, rabbit, roe deer, rodent, hamster and many birds, including: the woodpecker, the blackbird, the pheasant, the partridge, the jay and the hoopoe.

Ichthyological researches of recent years have revealed the existence of many species of fish in the rivers and lakes of the interior: common trout, grayling, chub, bream, barbell, breeding, pike, etc.

In this area, there are 40 sites of SPA type, 170 SCI type sites, about 355 natural parks.

Here are some examples of SCI and SPA:

- SPA type sites: Dealurile Târnavelor and Valea Nirajului, Piemontul Munţilor Metaliferi and Vinţului, Lunca inferioară a Turului, Câmpia Nirului - Valea Ierului, Câmpia Crişului Alb and Crişului Negru, Câmpia Nirului - Valea Ierului, Teremia Mare - Tomnatic, Mlaștinile Murani, Uivar-Diniaș, etc.;
- SCI type sites: Defileul Mureșului; Munții Călimani – Gurghiu, Valea Izei and Dealul Solovan, Câmpia Careiului, Câmpia Ierului, Pajiștea Cenad, Pădurea Paniova, etc.

Cultural heritage

Cultural heritage is represented by, churches, monasteries, treasures, etc. Among the most important cultural objectives are the Sighisoara Historical Center, including the area listed on the World Heritage List, the Roman Necropolis at Sighisoara, the Roman Castles in Sighișoara, the Roman settlement in Sovata, the remains of Porolissum, the ruins of the Cice Fortress, the Alba Iulia archaeological site from the 11th-12th centuries from Oradea, the Potaissa archaeological site, the Apulum ancient city, the Dacian Fortress of Capalna, the Morisena Fortress, the Apollo Palace, the Toldalagi Palace, the Nakó Castle, the Bella Fay Castle; Castle of the Premonstratens Order in Sânmartin, Obelisk dedicated to Horea, Cloşca and Crişan, Custozza

Monument (Alba County); Traian Vuia Museum, Crisan Country Museum, Iancu de Hunedoara House, George Coşbuc and Liviu Rebreanu Memorial Houses, Recea Monastery, St. John the Evangelist Church of the Prislop Monastery, Stâna de Vale Monastery, Huta, Inand, Flower Poiana, The old church of Ineu (XIII - XIV centuries), the Cathedral of Coronation.

Chapter 3 Flood risk at Tisza River Basin level

Flood protection infrastructure

In the Romanian part of the Tisza river basin as flood protection infrastructures are the following: embankments works (with a total length of 3,634.778 km), 133 permanent reservoirs with a total attenuation volume of 378.841 mil m^3, 87 temporary reservoirs with a total volume of 199.623 mil.m^3, 19 polders with a total volume of 153.888 mil.m^3, 621.71 km of diversion canals with a derived discharge of 843.83 mil.m^3 and 9 hydraulic complex facilities with a total maximum discharges of 714.8 mil.m^3.

The repartition of flood protection works on Tisza's subbasins is presented in table 3.1.

Table 3.1 Flood protection infrastructure at Tisza's subbasins in Romania

No.	Subbasin	Dikes (km)	Permanent reservoirs (nr)	Permanent reservoirs attenuation volume (mil.m^3)	Temporary reservoirs (nr)	Temporary reservoirs volume (mil.m^3)	Polders (nr)	Polders (mil.m^3)	Diversion canals (nr)	Diversion canals Discharge (km)	Diversion canals discharge (mil.m^3)	Hydraulic complex facilities (no)	Hydraulic complex facilities (m^3/s)
1	Someș-Tisa	1132.708	72	133.66	9	4.963	3	6.013	11	69.695	59.62	0	0
2	Crișuri	1334.065	37	97.404	58	84.064	13	124.475	27	376.17	335.05	0	0
3	Mureș	879.469	14	101.761	8	72.66	2	19.4	12	160.626	9.16	5	64.3
4	Banat	288.536	10	46.016	12	37.936	1	4	2	15.270	440	4	650.5
Total		**3634.778**	**133**	**378.841**	**87**	**199.623**	**19**	**153.888**	**52**	**621.71**	**843.83**	**9**	**714.8**

The flood protection infrastructures with principals elements are presented in the next tables, respectively tables from 3.2 to 3.7, with some specifications:

- dikes related to the rivers with catchment over 1,000 km^2,
- the permanent reservoirs found in the ICOLD database with the following criteria: height over 15 m and volume over 1 mil. m^3 or height between 10 and 15 m and volume over 3 mil. m^3,
- all temporary reservoirs in Tisza River Basin in Romania,
- polders with a volume over 1 mil. m^3 ,
- the diversion canals with a derived flow over 1 m^3/s,
- all hydraulic complex facility in Tisza River Basin in Romania.

Table 3. 2 Dikes

Crt. nr.	Dike name	Water course	Dike position	Locality name	Length (m)	Medium height (m)	YCO	Normal operating conditions		Status
								Probability of exceeding (%)	Q (m^3/s)	
Someș-Tisa subbasins										
1	Someș in Dej	Someș	LB	Dej	1700	3	1981	5	1570	satisfying
2	Someș in Cuzdrioara	Someș	RB	Cuzdrioara	2100	3	1964	5	1500	Satisfying
3	Someș in Mica	Someș	LB	Mica	1600	2	1964	5	1500	Satisfying
4	Someș in Cetan	Someș	LB	Cetan	3800	0.7	2001	5	1660	Satisfying
5	Someș in Vad	Someș	LB	Vad	700	1.5	2001	5	1660	Satisfying
6	Someș in Vad	Someș	LB	Vad	1500	1.5	2001	5	1660	Satisfying
7	Someșul Mic in Gherla	Someșul Mic	RB	Gherla	5800	3	1981	1	700	Satisfying
8	Someșul Mic in Mintiu Gherlii	Someșul Mic	RB	Mintiu Gherlii	1000	1.3	1982	-	-	Satisfying
9	Someșul Mic in airport Cluj Napoca	Someșul Mic	RB	Cluj-Napoca	2400	2	1961	5	350	Satisfying
10	Someșul Mic in Hășdate	Someșul Mic	RB	Hășdate	500	1.5	1961	5	460	Satisfying
11	Someșul Mic in Dej	Someșul Mic	LB	Dej	300	2	1983	5	450	Satisfying
12	Someșul Mic in Răscruci	Someșul Mic	LB	Răscruci	1800	1.4	1960	5	365	Satisfying
13	Someșul Mic in Bontida	Someșul Mic	LB	Bontida	1640	2	2007	5	400	satisfying
14	Someșul Mic in Nima	Someșul Mic	LB	Nima, Salatiu	5900	2.2	1965	5	445	satisfying
15	Someșul Mic in Mintiu Gherlii	Someșul Mic	RB	Mintiu Gherlii	2400	1.5	1962	5	445	Satisfying
16	Someșul Mic in Livada	Someșul Mic	LB	Livada	1340	2	2007	5	425	Satisfying
17	Tur superior	Tur	RB	Negrești Oaș / Tur	4600	2.2	1974	5	-	Satisfying
18	Embankment	Tur	RB	Călinești Oaș - Turulung	15950	2.6	1973	5	-	Satisfying
19	Embankment	Tur	RB	Turulung – Ukraine border	16000	3	1956 1973	2	275	Satisfying
20	Tur superior	Tur	LB	Negrești Oaș / Tur	3980	1.7	1974	5	-	Satisfying
21	Embankment	Tur	LB	Călinești Oaș - Livada / Adrian	11500	3.3	1973	5		Satisfying
22	Embankment	Tur	LB	Livada / Adrian – Hungary border	25090	3.3	1973	2	275	satisfying
23	Embankment	Someș	RB	Apa / Someșeni - Medieș / Băbășești	18705	3.5	1973	5	2400	Satisfying
24	Embankment	Someș	RB	Odoreu/Berindan - Satu Mare	13900	3.5-4	1972-1975	1	3400	Satisfying
25	Embankment	Someș	RB	Satu Mare – Hungary border	15000	4	1918-1973	1	3400	Satisfying
26	Embankment	Someș	LB	Pomi / Aciua	2300	2	1986	5	2400	Satisfying
27	Embankment	Someș	LB	Culciu / Cărășeu - Satu Mare	18343	4	1975	1	3400	Satisfying

Crt. nr.	Dike name	Water course	Dike position	Locality name	Length (m)	Medium height (m)	YCO	Normal operating conditions		Status
								Probability of exceeding (%)	Q (m^3/s)	
28	Embankment	Someș	LB	Satu Mare - Hungary border	19000	4	1973-1975	1	3400	Satisfying
29	Embankment	Crasna	RB	Supur / Giorocuta - confl. cu Cerna	6286	2	1980-1988	5	175	Satisfying
30	Embankment	Crasna	RB	Confl. cu Cerna - Confl.cu Maria	14520	2.5	1980-1988	5	210	Satisfying
31	Embankment	Crasna	RB	Confl. cu Maria - Moftin / Ghilvaci	15580	2.5	1980-1988	5	280	Satisfying
32	Dike inelar	Crasna	RB	Moftin / Ghilvaci	1260	2	1980-1988	5	280	Satisfying
33	Embankment	Crasna	RB	Moftin /Ghilvaci - Hungary border	23200	3.5	1901	5	280	Satisfying
34	Embankment	Crasna	LB	Supur / Supuru de Sus - Cerna confl.	7000	2	1980-1988	5	175	Satisfying
35	Embankment	Crasna	LB	Confl. cu Cerna – Maria confl.	14600	2.5	1980-1988	5	210	Satisfying
36	Embankment	Crasna	LB	Confl.cu Maria - Moftin / Ghilvaci	15400	2.5	1980-1988	5	280	satisfying
37	Dike road	Crasna	LB	Moftin / Moftinu Mare	4310	2	1980-1988	5	280	Satisfying
38	Embankment	Crasna	LB	Moftin / Ghilvaci - Căpleni	15100	3	1980-1988	5	280	Satisfying
39	Embankment	Crasna	LB	Căpleni / Căpleni	1300	3	1996	5	280	Satisfying
40	Circular Dike Căpleni	Crasna	LB	Căpleni / Căpleni	3450	3	1901	5	-	Satisfying
41	Embankment	Crasna	LB	Căpleni / Hungary border	9400	3	1980-1988	5	280	Satisfying
42	Dike Agerdo	Crasna	LB	Berveni / Lucăceni	600	2.5	1942	5	280	Satisfying
43	Circular Dike Lucăceni	Crasna	LB	Berveni / Lucăceni	1300	1.5	1942	5	280	Satisfying
44	Complex Improvement Craidorolț - Vârșolț	r. Crasna and afl. L=34900 ml	RB	Sărmășag Măieriște Bobota	16400	1.5-2.0	1982	10	5%	Satisfying
			LB	Sărmășag Măieriște Bobota	15800	1.5-2.0	1982	-	-	Satisfying
45	Improvement r. Someș and affluents in Jibou	Someș	LB	Jibou	5200	2.0-2.5	1982	10	D1=2% D2=1%	Satisfying
46	Dikes Crasna	Crasna	LB,RB	Crasna	4200	1.5 -2.0	1980	10	-	Satisfying
47	Vârșolț reservoir Dike interriver, Dike backwater	Crasna	RB	Crasna	2100	2.0-2.5	1979	10	1%	Satisfying
			RB	Crasna	800	2.0-2.5	1979	10	1%	Satisfying
48	Lăpuș in Remetea Chioarului	Lăpuș	LB	Remetea Chioarului, Sacalaseni, Coltau, Recea	16600	2	1973	5	660	Satisfying
49	Lăpuș in Târgu Lăpuș	Lăpuș	RB	Târgu Lapuș	590	3	1976	5	-	Satisfying
50	Lăpuș in Târgu Lăpuș	Lăpuș	LB	Târgu Lapuș	500	1	1976	5	-	Satisfying

Crt. nr.	Dike name	Water course	Dike position	Locality name	Length (m)	Medium height (m)	YCO	Normal operating conditions		Status
								Probability of exceeding (%)	Q (m^3/s)	
51	Vișeu in Vișeu de Sus (Vișeu de Mijloc)	Vișeu	LB	Vișeu de Sus	1750	2	1984	5	480	Satisfying
52	Vișeu la Vișeu de Jos	Vișeu	LB,RB	Vișeu de Jos	1700	2	1984	5	480	Satisfying
53	Vișeu in Leordina	Vișeu	LB	Leordina	1550	1.2	1984	5	690	Satisfying
54	Vișeu in Petrova	Vișeu	LB	Petrova	2850	2	1984	5	-	Satisfying
55	Vișeu in Vișeu de Sus (Vișeu de Est)	Vișeu	RB	Vișeu de Sus	600	2.5	1981	5	480	Satisfying
56	Vișeu in Petrova	Vișeu	LB	Petrova	285	2.4	1981	5	690	Satisfying
57	Improvement Viseu in Petrova - Leordina - V. Vișeului area – Petrova area	Vișeu	LB	Petrova	1005	2	2004	5	690	Satisfying
58	Vișeu in Petrova	Vișeu	LB	Petrova	1290	3	2012	5	690	Satisfying
59	Vișeu in Valea Vișeului	Vișeu	LB	Leordina	550	3.5	2009	5	690	Satisfying
60	Improvement Vișeu in Petrova - Leordina - V. Vișeului - OB area - V. Vișeului area	Vișeu	LB	Petrova	550	2	2009	5	690	Satisfying
61	Iza in Bogdan Voda	Iza	RB	Bogdan Voda	1400	2	1983	5	330	Satisfying
62	Iza in Bârsana	Iza	RB	Bârsana	750	2	1989	5	540	Satisfying
63	Iza in Rozavlea	Iza	RB	Rozavlea	2100	2	1990	5	330	Satisfying
64	Iza in Sighetu Marmației	Iza	LB	Sighetu Marmației	2000	1.5	1990	5	-	Satisfying
65	Iza in Oncești Nănești	Iza	RB	Oncești	3050	1.7	1989	5	540	Satisfying
66	Iza in Bârsana (between bridges)	Iza	RB	Bârsana	1100	2	1970	5	540	Satisfying
67	Iza in Sighetu Marmației	Iza	RB	Sighetu Marmației	3050	1.8	1943	5	-	Satisfying
68	Iza in Bârsana	Iza	RB	Bârsana	1300	2	1989	5	540	Satisfying
69	Iza in Rozavlea	Iza	RB	Rozavlea	925	2	2004	5	330	Satisfying
70	Tisa in Sighetu Marmației	Tisa	LB	Sighetu Marmației	4900	3	1964	1	1645	Satisfying
Crișuri subbasin										
1	Sâniob – Sălard	Barcău	RB	Sâniob	4100	2.50	1991	5		Satisfying
2	Marghita – Abrămuț	Barcău	LB	Marghita	8000	2.50	1991	5	215	Satisfying
3	Abrămuț – Sâniob	Barcău	LB	Sâniob	1300	2.50	1991	5		Satisfying
4	Marghita – Abram	Barcău	LB	Marghita	4000	2.00	1991	5	215	Satisfying
5	Abramuț – Sâniob	Barcău	RB	Sâniob	9800	2.50	1991	5		Satisfying
6	Sântimbreu	Barcău	RB	Sântimreu	16000	3.00		5	255	Satisfying
7	Marghita – Chiribiș	Barcău	LB	Marghita	2300	2.00	1983	5	215	Satisfying
8	Marghita – Abrămuț	Barcău	RB	Marghita	7500	2.00	1991	5	215	Satisfying
9	Ciuhoi – Sălard	Barcău	LB	Sâniob	7100	2.50	1987	5		Satisfying
10	Ciuhoi – Sâniob	Barcău	RB	Sâniob	2600	2.50	1991	5		Satisfying

Crt. nr.	Dike name	Water course	Dike position	Locality name	Length (m)	Medium height (m)	YCO	Normal operating conditions		Status
								Probability of exceeding (%)	Q (m^3/s)	
11	Marghita – S.I.R.D.E.S.C.	Barcău	LB	Marghita	100	2.50	1975	5	215	Satisfying
12	left bank Barcău Ip	Barcău	LB	Ip	1830	2.00	2001			Satisfying
13	Barcău right bank – Zăuan	Barcău	RB	Zăuan	3000	1.00	1959			Satisfying
14	Cohani – Suiug	Barcău	RB	Cohani	1400	2.00	1991	5		Satisfying
15	Marghita – Chiribiș	Barcău	LB	Marghita	300	2.00	1983	5	215	Satisfying
16	Sălard – Frontieră	Barcău	LB	Sălard	1750	3.00	1967	5	255	Satisfying
17	Marghita – I.T.A.	Barcău	LB	Marghita	400	2.50	1975	5	215	Satisfying
18	Ghida – Balc	Barcău	RB	Ghida	7000	2.00	1991	5		Satisfying
19	right bank Barcău Ip	Barcău	RB	Ip	1320	1.50	2001			Satisfying
20	Brad	Crișul Alb	RB	Brad	4190	0.00	2011			Satisfying
21	Brad	Crișul Alb	LB	Brad	220	0.00	2011			Satisfying
22	Mesteacăn	Crișul Alb	LB	Mesteacăn	1000	1.50	1976			Satisfying
23	Bocsig – Ineu	Crișul Alb	LB	Bocsig	5700	1.50	1924	1	880	Satisfying
24	Sicula – Vărșand	Crișul Alb	LB	Șicula	47620	3.50	1924	1		Satisfying
25	Vața de Jos	Crișul Alb	LB	Vața de Jos	300	2.50	1970			Satisfying
26	Crișcior	Crișul Alb	RB	Crișcior	200	2.50	1920			Satisfying
27	Brad	Crișul Alb	LB	Brad	2200	2.00	1976	2		Satisfying
28	Brad	Crișul Alb	RB	Brad	510	0.00	2011			Satisfying
29	Ineu – Șicula left bank 0+000-5+900	Crișul Alb	LB	Șicula	5900	2.00	1924	1		Satisfying
30	Crișcior left bank	Crișul Alb	LB	Crișcior	100	1.00	1920			Satisfying
31	Gurahonț left bank	Crișul Alb	LB	Gurahonţ	800	2.00	1980	1	680	Satisfying
32	Brad	Crișul Alb	RB	Brad	3400	2.00	1976	2		Satisfying
33	Brad	Crișul Alb	LB	Brad	430	0.00	2011			Satisfying
34	Brad	Crișul Alb	RB	Brad	900	0.00	2011			Satisfying
35	Bocsig Vărșand	Crișul Alb	RB	Bocsig	66900	4.00	2011			Satisfying
36	left bank right affl. Crișul Alb – Revetiș	Crișul Alb	RB	Revetiș	160	2.00	2002			Satisfying
37	Zdrapți	Crișul Alb	LB	Zdrapți	1200	1.20	1920			Satisfying
38	Grădinari	Crișul Negru	RB	Grădinari	2500	2.50	1982	5		Satisfying
39	Uileacu de Beiuș	Crișul Negru	RB	Uileacu de Beiuș	3200	2.50	1943	1		Satisfying
40	Tărcaia	Crișul Negru	LB	Tărcaia	2300	2.50	1982	5		Satisfying
41	Finiș	Crișul Negru	LB	Finiș	2700	2.50	1982	5	510	Satisfying
42	Tărcaia	Crișul Negru	LB	Tărcaia	620	2.00	1968	1		Satisfying
43	Iermata – Talpoș	Crișul Negru	LB	Iermata	36600	4.00	1900	5		Satisfying
44	Tărian – Tămașda right bank (CC)	Crișul Negru	RB	Tărian	56600	4.00	2010	5		Satisfying
45	Dike right bank Tinca	Crișul Negru	RB	Tinca	1030	2.00	2000			Satisfying

Crt. nr.	Dike name	Water course	Dike position	Locality name	Length (m)	Medium height (m)	YCO	Normal operating conditions		Status
								Probability of exceeding (%)	Q (m^3/s)	
46	Dike right bank Râpa	Crișul Negru	RB	Râpa	610	1.00	2000			Satisfying
47	CN right bank upstream – downstream bridge Tinca	Crișul Negru	RB	Tinca	1420	2.00				Satisfying
48	Dike right bank Căpâlna	Crișul Negru	RB	Căpâlna	1200	2.00	1980	5		Satisfying
49	left bank Crișul Negru in Șoimi – Borz	Crișul Negru	LB	Borz	1300	2.50	2010	5		Satisfying
50	Cucuceni - Valea Mare left bank	Crișul Negru	LB	Cucuceni	2600	1.80	1982	5		Satisfying
51	Beliu – Berechiu left bank	Crișul Negru	LB	Beliu	31100	3.00	1900	1		Satisfying
52	Dike left bank Tăut - Batar	Crișul Negru	LB	Tăut	3160	4.00	2000			Satisfying
53	Beliu – Berechiu	Crișul Negru	RB	Beliu	30000	3.00	1970	2		Satisfying
54	Tinca left bank upstream bridge	Crișul Negru	LB	Tinca	600	1.20	1984			Satisfying
55	Dike right bank Tinca	Crișul Negru	RB	Tinca	380	1.00	2000			Satisfying
56	Uzina de Apă Beiuș	Crișul Negru	RB	Beiuș	1000	1.20	1968	1	750	Satisfying
57	Tăut – Ant right bank	Crișul Negru	RB	Ant	46200	4.00	1900	2		Satisfying
58	Tprian – Tămașda left bank	Crișul Negru	LB	Tărian	56250	4.00	2010	5		Satisfying
59	Beiuș	Crișul Negru	RB	Beiuș	1100	2.20	1982	5	510	Satisfying
60	Tileagd	Crișul Repede	LB	Tileagd	5000	1.80	1966	5		Satisfying
61	Oradea	Crișul Repede	LB	Oradea	4100	2.30	1971	5	690	Satisfying
62	Bucea	Crișul Repede	LB	Bucea	300	1.00	1971	10		Satisfying
63	Aleșd	Crișul Repede	RB	Aleșd	400	3.50	1935	1		Satisfying
64	Fughiu	Crișul Repede	LB	Fughiu	2400	3.00	1969	5		Satisfying
65	City Strand	Crișul Repede	RB	Oradea	200	1.30	1977	5	690	Satisfying
66	Bulz	Crișul Repede	RB	Bulz	400	1.00	1955	10		Satisfying
67	Fughiu	Crișul Repede	RB	Fughiu	1345	3.00	1974	1		Satisfying
68	upstream railway bridge right bank Vadu Crișului	Crișul Repede	RB	Vadu Crișului	300	3.20	1949	5	565	Satisfying
69	Aleșd right bank	Crișul Repede	RB	Aleșd	1200	1.00	1969	1		Satisfying
70	Oradea	Crișul Repede	RB	Oradea	3200	3.70	1963	5	690	Satisfying
71	Șuncuiuș left bank upstream LP	Crișul Repede	LB	Șuncuiuș	300	1.00	2011	5		Satisfying
72	Gheghie – Ausșeu	Crișul Repede	RB	Gheghie	300	3.00	1980	5		Satisfying
73	right bank Oradea upstream BROOK CET I	Crișul Repede	RB	Oradea	1600	3.50	1963	1	1000	Satisfying
74	Cacuciu Vechi	Crișul Repede	LB	Cacuciu Vechi	800	1.20	1968	10		Satisfying
75	Oradea – Border	Crișul Repede	RB	Oradea	23500	4.00	2010	5	690	Satisfying
76	Tărian – Border	Crișul Repede	LB	Tarian	11600	4.00	2010	5		Satisfying
77	Bucea left bank	Crișul Repede	LB	Bucea	200	1.00	1970	10		Satisfying
78	Șuncuiuș right bank downstream LP	Crișul Repede	RB	Șuncuiuș	700	2.50	1959	5		Satisfying

Crt. nr.	Dike name	Water course	Dike position	Locality name	Length (m)	Medium height (m)	YCO	Normal operating conditions		Status
								Probability of exceeding (%)	Q (m^3/s)	
79	left bank Crișul Repede upstream BROOK CET 1	Crișul Repede	LB	Oradea	1600	35.00	1993	1	1000	Satisfying
80	Gheghie – Ausșeu	Crișul Repede	RB	Gheghie	600	3.00	1979	5		Satisfying
81	Gheghie – Ausșeu	Crișul Repede	RB	Gheghie	400	2.00	1979	5		Satisfying
82	Șuncuiuș right bank upstream LP.	Crișul Repede	RB	Șuncuiuș	300	1.00	1952	5		Satisfying
83	Diosig – Sălacea	Ier (Eriu)	LB	Sălacea	48000	3.00	1970	5		Satisfying
84	Andrid left bank	Ier (Eriu)	LB	Andrid	16550	2.00	1970	5	65	Satisfying
85	Căuaș – Ady Endre	Ier (Eriu)	RB	Ady Endre	16550	2.60	1970	5		Satisfying
86	Adoni – Cherechiu right bank (Canal Anticar)	Ier (Eriu)	RB	Cherechiu	3450	2.00	1970	5		Satisfying
87	Adoni - Cherechiu left bank (Canal Anticar)	Ier (Eriu)	LB	Cherechiu	3900	2.00	1970	5		Satisfying
88	Diosig	Ier (Eriu)	RB	Sălacea	48000	2.50	1970	5		Satisfying
89	Diosig – Sălacea left bank	Ier (Eriu)	LB	Sălacea	48000	3.00	1970	5		Satisfying
Mureș subbasin										
1	Improvement of Mureș river and affluents in Lalașinț	Mureș	LB	Bârzava	2720	2.2	1979	5	1750	Satisfying
2	Mureș river in Chelmac	Mureș	LB	Conop	6000	2.7	1976	20	1120	Satisfying
3	Improvement of Mureș river and affluents in Chelmac	Mureș	LB	Conop	3000	2.0	1979	5	1750	Satisfying
4	Improvement of Mureș river and affluents in Ususău	Mureș	LB	Ususău	2900	2.8	1980	5	1750	Satisfying
5	Mureș river in Lipova	Mureș	LB	Lipova	4740	4.0	1981	2	2300	Satisfying
6	Mureș river in Baraţca	Mureș	RB	Păuliș	850	2.1	1980	5	1650	Satisfying
7	Improvement Mureș river in Păuliș -Sâmbăteni	Mureș	RB	Păuliș	9850	2.6	1978	5	1650	Satisfying
8	Partition Dike right bank Mureș river in CICH Arad	Mureș	RB	Vladimirescu	2500	3.0	1976	1	2600	Satisfying
9	Mureș river in Pecica - Vladimirescu	Mureș	RB	Vladimirescu, Arad, Pecica	36993	6.0	1975 1981	1	2600	Satisfying
10	Dike left bank Mureș river in Arad	Mureș	LB	Arad	9930	5.0	1976	1	2600	Satisfying
11	Partition Dike left bank Mureș river in Arad	Mureș	LB	Arad	2100	1.5	1969	5	1720	Satisfying
12	Mureș river in Bodrogul Nou	Mureș	LB	Zădăreni	2131	3.0	2009	5	1720	satisfying
13	Canal Arad - Pecica	Mureș	LB	Pecica	1350	1.5	1969	1	2600	Satisfying
14	Canal Arad - Pecica	Mureș	RB	Pecica	1350	1.5	1969	1	2600	Satisfying
15	Mureș river in Pecica	Mureș	RB	Pecica	6691	3.5	1975	1	2600	Satisfying

Crt. nr.	Dike name	Water course	Dike position	Locality name	Length (m)	Medium height (m)	YCO	Normal operating conditions		Status
								Probability of exceeding (%)	Q (m^3/s)	
16	Mureș river Felnac - Periam harbour	Mureș	LB	Felnac, Secusigiu	22365	4.5	1975	2	2050	Satisfying
17	Mureș river in Semlac	Mureș	RB	Semlac	1350	4.5	1968	5	1720	Satisfying
18	Mureș river in Seitin	Mureș	RB	Seitin	2150	3.0	1968	1	2600	Satisfying
19	Mureș river in Nadlac - Seitin	Mureș	RB	Nadlac, Șeitin	17400	3.0	1989	2	2050	Satisfying
20	Mureș river Nadlac	Mureș	RB	Nadlac	4375	4.0	1968	1	2600	Satisfying
21	Partition Dike left bank Mureș river in Periam	Mureș	LB	Periam	2500	2.5	1932	10	1310	Satisfying
22	Mureș river in Cenad	Mureș	LB	Periam Sânpetru Mare Cenad	43374	4.5	1932	2	2050	Satisfying
23	Târnava Mică in Ghindari	Târnava Mică	RB	Ghindari	2400	2	1977-1981	5	240	Satisfying
24	Târnava Mica in Sângeorgiu de Pădure	Târnava Mică	RB	Fântanele	1046	1.2	1987	5	185	Satisfying
25	Târnava Mică in Coroi	Târnava Mică	RB	Coroi	1630	1.3	2010	5	127	Satisfying
26	Embankment and regulation of Târnava Mică river and affluents in Târnăveni	Târnava Mică	RB	Cuştelnic	596	3	1972 1982	1	444	Satisfying
		Târnava Mică	RB	Târnăveni	3850	3	1972-1982	1	444	Satisfying
		Târnava Mică	RB	Dâmbău	2517	3	1972-1982	1	444	Satisfying
		Târnava Mică	LB	Seuca	4968	3	1972-1982	1	444	Satisfying
		Târnava Mică	LB	Adămuş	2244	3	1972-1982	1	444	Satisfying
27	Improvement of Târnava Mică river in Suplac, Adămuş, Cornești, Crăiești	Târnava Mică	RB	Suplac	2489	1.2	2001	5 & 1	240	Satisfying
		Târnava Mică	LB	Adămuş	1130	2	2002	5	240	Satisfying
		Târnava Mică	RB	Crăieşti	1984	2	2004	5	240	Satisfying
		Târnava Mică	LB	Cornești	4510	2	2009	5	240	Satisfying
28	Embankment and regulation of Mureș in Gheorgheni depression	Mureș	RB	Suseni	300	2	1984	5	112	Satisfying
		Mureș	LB	Suseni	300	2	1984	5	112	Satisfying
		Mureș	RB	Ciumani	1220	2	1984	5	112	Satisfying
		Mureș	LB	Ciumani	1800	2	1984	5	112	Satisfying
		Mureș	LB	Borzonț	500	2	1984	5	105	Satisfying
29	Mureș river in Topliţa	Mureș	RB	Topliţa	1100	2	2007	5	353	Satisfying
		Mureș	LB	Topliţa	1200	2	2007	5	353	Satisfying
30	Improvement Mureș in Răstoliţa	Mureș	LB	Răstoliţa/Iod	2610	2	2004	5	559	Satisfying
		Mureș	LB	Răstoliţa/Iod	1130		2014			Satisfying
31	Mureș in Lunca Mureșului	Mureș	LB	Aluniș/Lunca Mureșului	2430	2	2000	5	523	Satisfying
32	Embankment and regulation Mureș in Reghin	Mureș	LB	Reghin/Reghin	4730	2.25	1979	1	895	Satisfying
			RB	Reghin/Reghin	10620	2.25				Satisfying
33	Regulation and Embankment right bank Mureș in Suseni	Mureș	RB	Suseni / Suseni	315		2008			Satisfying

Crt. nr.	Dike name	Water course	Dike position	Locality name	Length (m)	Medium height (m)	YCO	Normal operating conditions		Status
								Probability of exceeding (%)	Q (m^3/s)	
34	Improvement Mureș in Iernut DJ 152 A Iernut-Lechinţa	Mureș	LB	Iernut	2040		2011	2	1135	Satisfying
35	Mureș in Sânpaul	Mureș	LB	Sânpaul	857	1	1968	1	1548	Satisfying
36	Mureș in Iernut D2	Mureș	LB	Iernut	3070	3	2004-2008	2	1135	Satisfying
37	Embankment and regulation Mureș and affluents in Târgu Mureș	Mureș	LB	Tg. Mureș	11000	3	1977	1	1110	Satisfying
		Mureș	RB	Sântana	15230	3	1982	1	1110	Satisfying
		Mureș	LB	Tg. Mureș	480		1982	1	1110	Satisfying
38	Embankment and regulation Mureș in Luduș	Mureș	LB	Luduș	7650	5	1982	1	1560	Satisfying
39	Mureș in Șibot	Mureș	LB	Șibot	290	0	1974	5	1700	Satisfying
		Mureș	LB	Șibot	5840	2.7	1974	5	1700	Satisfying
40	Blandiana-up. confl.Mureș	Mureș	RB	Blandiana	1600	2.5	1975	10	1310	Satisfying
41	Mureș in Blandiana - Acmariu	Mureș	RB	Blandiana	4960	2.5	1975	10	1310	Satisfying
42	Târnava in Mihalţ	Târnava	LB	Mihaţ	2550	2.5	1977	5	645	Satisfying
43	Mureș in Cistei	Mureș	LB	Cisteiu de Mureș	2400	2	1977	5	1215	Satisfying
44	Mureș in Drâmbar	Mureș	LB	Drâmbar	1260	3.5	1980	1	2600	Satisfying
45	Mureș in Rădeşti	Mureș	LB	Rădești	2380	1.8	1981	10	948	Satisfying
46	Dike right bank and regulation Târnava Mare in Blaj	Târnava	RB	Blaj	4170	2.5	1981	2	745	Satisfying
47	Improvement Târnava Mare and Tiur in Blaj	Târnava	LB	Tiur	6990	2.5	1981	2	745	Satisfying
48	Dike right bank Mureș in Vurpăr	Mureș	RB	Vurpăr	4900	2.8	1982	5	1420	Satisfying
		Mureș	RB	Vurpăr	470	2.8	1982	5	1420	Satisfying
49	Improvement Mureș and Affl. Alba Iulia area	Mureș	LB	Ciugud	2610	4.4	1984	5	1404	Satisfying
		Mureș	RB	Alba Iulia	4940	6.5	1984	1	2600	Satisfying
		Mureș	LB	Oarda	2020	6.5	1984	5	1404	satisfying
		Mureș	LB	Oarda	720	3	1984	5	1404	Satisfying
		Sebeș	LB	Oarda	1550	4.5	1984	5	1404	Satisfying
		Sebeș	RB	Oarda	1290	4.5	1984	5	1404	Satisfying
50	Improvement Mureș and V. Blandiana	Mureș	LB	Mereteu	3750	1.5	1986	10	1310	Satisfying
51	Improvement Târnava Mică in Cetatea de Baltă - Jidvei	Târnava Mică	RB/LB	Cetatea de Baltă	340	3.5	2009	5	345	Satisfying
		Târnava Mică	LB	Cetatea de Baltă	2500	3	1989	5	345	Satisfying
		Târnava Mică	LB	Jidvei	1900	2	1998	5	345	Satisfying
		Târnava Mică	RB	Jidvei	3290	2.3	1998	5	345	Satisfying
		Târnava Mică	RB	Şona	4780	2	1989	10	205	Satisfying
		Târnava Mică	RB/LB	Cetatea de Baltă	70	0	2009	5	345	Satisfying

Crt. nr.	Dike name	Water course	Dike position	Locality name	Length (m)	Medium height (m)	YCO	Normal operating conditions		Status
								Probability of exceeding (%)	Q (m^3/s)	
		Corund (Târnava Mică)	RB/LB	Jidvei	160	0	2009	5	345	Satisfying
52	Dike right bank and regulation Arieş la Mihoieşti	Arieş	RB	Mihoeşti	800	2.5	1987	5	350	Satisfying
53	Improvement Arieş right bank Tronson 8 - Viişoara	Arieş	RB	Viişoara	2100	2.5	1985	1	1100	Satisfying
54	Improvement r. Arieş Tronson 6 and 7 - Poiana - C.Turzii	Arieş	RB	Turda	5660	2	1987	1	1100	Satisfying
55	Improvement Arieş Tr. 4 - Turda	Arieş	RB	Turda	480	2	1987	1	1100	Satisfying
56	Improvement Arieş Tr. 5 - Oprisan	Arieş	RB	Turda	1200	2	1987	1	1100	Satisfying
57	Improvement Arieş.Tr. 2 – Cement Manufacture	Arieş	RB	Turda	720	2	1987	1	1100	satisfying
58	Improvement Arieş.Tronson 1 - Mihai Viteazu	Arieş	RB	Mihai Viteazu	5380	2.5	1988	1	1100	Satisfying
59	Improvement Arieş.Tr. 3 left bank - Electroceramica	Arieş	LB	Turda	590	2.5	1988	5	670	Satisfying
60	Improvement Arieş.Tr. 3 right bank - Electroceramica	Arieş	RB	Turda	1000	2.5	1988	1	1100	Satisfying
61	Improvement Arieş. Left bank Tr. 8 - Viişoara	Arieş	LB	Viişoara	310	1.5	1988	5	670	Satisfying
		Arieş	LB	Viişoara	500	2	1988	5	670	Satisfying
62	Dike Remuu Câmpia Turzii	Arieş	RB	Câmpia Turzii	1250	2	1988	1	1100	Satisfying
63	Closing Dike Cheia	Arieş	RB	Mihai Viteazu	1550	2	1988	1	1100	Satisfying
64	Dike LB.and consolidation Mureş in Ocna Mureş	Mureş	LB	Ocna Mureş	1760	1.8	1971	5	1215	Satisfying
65	Dike and consolidation Arieş zone Baia de Arieş	Arieş	RB	Baia de Arieş	170	1.2	2002	2	536	Satisfying
66	Mureş in Vinţu de Jos	Mureş	LB	Vinţu de Jos	3930	2.5	1973	5	1420	Satisfying
		Mureş	LB	Vinţu de Jos	900	2.5	1973	5	1420	Satisfying
67	Improvement Mureş and affl. Coşlariu-Sântimbru	Mureş	RB/LB	Sântimbru	6260	3.5	2012	5	1475	Satisfying
68	Improvement Arieş in Câmpeni	Arieş	RB	Câmpeni	450	2.2	2004	2	450	Satisfying
		Arieş	LB	Câmpeni	240	2.2	2004	2	450	Satisfying
69	Dike right bank Mureş in Sărăcsău	Mureş	RB	Sărăcsău	430	0	2011	5	1550	Satisfying
		Mureş	LB	Sărăcsău	430	0	2011	10		Satisfying
		Mureş	RB	Sărăcsău	1130	0	2011	5		Satisfying
70	Embankment right bank in Lunca Arieş	Arieş	RB	Lunca	2200	2	1997	5	638	Satisfying

Crt. nr.	Dike name	Water course	Dike position	Locality name	Length (m)	Medium height (m)	YCO	Normal operating conditions		Status
								Probability of exceeding (%)	Q (m^3/s)	
71	Embankment and regulation albie râu Mureș la Ilia-Dike Ilia	Mureș	RB	Ilia/Ilia	5260	5	1981	2	2530	Satisfying
	Embankment and regulation of Mureș in Ilia- Dike Brâznic	Mureș	LB	Ilia/Brâznic	1600	3	1981	5	1875	Satisfying
72	Mureș in Lăpușnic	Mureș	LB	Dobra/Lăpușnic	6520	3	1971	5	1850	Satisfying
73	Mureș in Stretea	Mureș	LB	Dobra/Stretea	4600	2	1972	5	1850	Satisfying
74	Embankment and bank protection Strei in Covragiu	Strei	RB	Bretea Română/ Covragiu	1100	2.5	1976	5	430	Satisfying
75	Embankment and regulation Strei in Simeria-Batiz	Strei	LB	Băcia/Batiz	7500	2	1981	5	386	Satisfying
76	Embankment and regulation Mureș in Homorod - Dike Gelmar	Mureș	LB	Geoagiu/Gelmar	3080	4	1981	5	1410	Satisfying
77	Embankment and regulation Mureș in Homorod-Dike Aurel Vlaicu	Mureș	LB	Geoagiu/ Aurel Vlaicu	2650	3	1981	5	1410	Satisfying
78	Embankment and regulation Mureș in Homorod-Dike Suinprod Orăştie	Mureș	LB	Orăştie/ Orăştie	2060	3.3	1981	5	1410	Satisfying
79	Embankment and regulation Mureș in Deva	Mureș	LB	Deva/Deva	8830	5	1981	1	2640	Satisfying
80	Mureș in Brănişca	Mureș	RB	Brănişca/ Brănişca	4690	2	1985	5	1850	Satisfying
81	Improvement Mureș in Folt	Mureș	RB	Rapoltu Mare/Folt	1840	3	2002	5	1710	Satisfying
82	Improvement Mureș in zone Turdaş,Pricaz,Folt- Dike Pricaz	Mureș	LB	Orăştie/Pricaz	5160	2.5	2007	5	1710	Satisfying
83	Improvement Mureș in zone Turdaş,Pricaz,Folt- Dike Turdaş	Mureș	LB	Turdaş/Turdaş	1270	1	2007	5	1710	Satisfying
84	Improvement Mureș in Zone Turdaş, Pricaz, Folt - Dike Bobâlna	Mureș	RB	Rapoltu Mare/Bobâlna	3170	1.4	2007	5	1710	Satisfying
85	Dileul Nou/Sânpaul	Mureș	RB	Sânpaul/Dileu	1820	2	12/31/1968			Satisfying
86	SC AGRIM, ferma Sânpaul	Mureș	LB	Sânpaul	1800	2	12/31/1968	5		Satisfying
87	Dike Ocna Mureș	Mureș	RB	Ocna Mureș	900	1.3	12/23/1987	10		Satisfying
88	Dike Mureș in Aiud	Mureș	RB	Aiud	2250	2.7	12/30/1979	5	1021	Satisfying
89	Dike Mureș in Leorinţ	Mureș	LB	Leorinţ	1130	1.5	12/30/1972	10		Satisfying
90	Dike Mureș in Beldiu	Mureș	RB	Beldiu	3940	1.4	12/30/1976	10		Satisfying
91	Dike Mureș in Totoi Sat	Mureș	LB	Totoi	2200	1.8	12/30/1982	10		Satisfying
92	Dike Mureș in Totoi	Mureș	LB	Totoi	800	2	12/30/1976	10		Satisfying

Crt. nr.	Dike name	Water course	Dike position	Locality name	Length (m)	Medium height (m)	YCO	Normal operating conditions		Status
								Probability of exceeding (%)	Q (m^3/s)	
93	Dike Mures La Vinţu De Jos Downstream	Mureș	LB	Vinţu de Jos	1840	1.8	12/30/1982	10		Satisfying
94	Dike Mures in Vinţu De Jos Câmpu Goblii	Mureș	RB	Vinţu de Jos	1500	2	12/30/1981	10		Satisfying
95	Dike Blandiana	Mureș	RB	Blandiana	2080	2.5	12/30/1984	10		Satisfying
96	Dike Blandiana	Mureș	RB	Blandiana	830	1.8	12/30/1983	5	638	Satisfying
97	Dike Blandiana	Mureș	RB	Blandiana	3600	2.7	12/30/1984	1		Satisfying
98	Dike right bank Câmpia Turzii – downstream purge station	Arieş	RB	Câmpia Turzii	1970	0	06/17/2008	10		Satisfying
99	Embankment Sântămărie	Târnava Mică	LB	Sântămărie	2100	2.5		10		Satisfying
100	Embankment downstream Bridge B.A. Biia	Târnava Mică	LB	Biia	940	1.5				Satisfying
101	Embankment Biia- Sântămărie	Târnava Mică	RB	Biia	2500	2.7		10		Satisfying
102	Embankment Şona - upstream	Târnava Mică	RB	Şona	980	2.2		0		Satisfying
103	Embankment Biia - Sânmiclauş	Târnava Mică	RB	Biia	1750	2.5		10		Satisfying
104	Embankment Electrocentrale Branch Deva in Mintia	Mureș	LB	Veţel/Mintia	2900	3.5	1969	1	2640	Satisfying
105	Embankment Electrocentrale Branch Deva in Mintia	Mureș	RB	Veţel/Mintia	2400	3.5	1969	1	2640	Satisfying
106	Embankment Mureș in Sălciva	Mureș	LB	Dobra/ Sălciva	2200	1	1958	10	999	Satisfying
Banat subbasin										
1	Navigable Bega	Bega	LB	Timişoara, Peciu, Uivar	37340	3	1915	5	47,00	Satisfying
2	Bavigable Bega	Bega	RB	Timişoara, Sinmihaiul Roman, Uivar	39595	3	1915	5	47,00	Satisfying
3	Dike nonnavigabile Bega	Bega	RB	Topolovat, Remetea	12865	3	1915	2	72	Satisfying
4	Nonnavigable Bega	Bega	LB	Topolovat, Remetea	20375	3	1915	2	72	Satisfying
5	Bega	Bega	RB	Balint, Belint, Chizatau	10051	3	1860	2	365	Satisfying
6	Bega	Bega	LB	Bethausen, Balint, Chizatau	26285	3	1860			Satisfying
7	Bega Veche	Bega Veche	LB	Sacalaz, Becicherec, Cenei	33360	4	1898	5	47	Satisfying
8	Bega Veche	Bega Veche	RB	Sacalaz, Becicherec, Cenei	32080	4	1898	5	47	Satisfying
9	Dike discharge cannal Bega right bank	Bega	RB	Topolovat	5758	4	1910	2	350	Satisfying
10	Dike discharge cannal Bega left bank	Bega	LB	Topolovat	5777	4	1915	2	350	satisfying

Table 3.3 Permanent reservoirs

Crt. Nr.	Reservoir name	Water course	Nearest locality name	Height of the dam (m)	Type of dam	Volume at NRL (mn.m³)	Volume at MEL (mn.m³)	Attenuation volume (mn.m³)	Use
Someş-Tisa subbasin									
1	Fântânele	Someşul Cald	Beliş	92	AM	213	250.42	37.42	HVR
2	Tarniţa	Someşul Cald	Someşu Cald	97	A	70,3	77.4	7.1	A,H,V,R
3	Someşul Cald	Someşul Cald	Someşu Cald	34	G	7,47	9.53	2.07	A,H,V,R
4	Gilău	Someş Mic	Gilău	23	G+AM	2.44	3525	1.085	A,H,
5	Vârşolţ	Crasna	Vârşolţ	14	PM	16.070	39.388	23.318	A,V,P
6	Strâmtori - Firiza	Firiza	Firiza	51,5	C	15.77	17.52	1.75	AH
Crişuri subbasin									
1	Leşu	Iad	Remeţi	60,5	AM	28,3	33,8	4,2	AHVR
2	Tauţ	Cigher	Tauţ	22	PM	15.21	33.7	18.49	VR
3	Suplacu de Barcău	Barcău	Suplacu de Barcău	11	PM	6,2	15.849	13.649	AV
4	Mihăileni	Crişul Alb		34	A		10.33		AHV
5	Cărăsău	Valea de Izvor	Cociuba Mare/Cărăsău	15	PM	1,148	1.920	0.772	IV
6	Lugaşu	Crişul Repede	Lugaşu de Jos	37	PM	63.500	74.500	11	H
7	Tileagd	Crişul Repede	Tileagd	37	PM	52.900	63.300	10,4	H
8	Drăgan	Drăgan	Lunca Vişagului	120	A	112.000	127.050	15,1	H
Mureş subbasin									
1	Zetea	Târnava Mare	Zetea	48	PA	16.50	44.10	18.40	VH
2	Bezid	Cuşmed	Sangeorgiu de Pădure	29	PA	15	31	16	VH
3	Ighiş	Ighiş	Mediaş	36	PA	5		6,27	VA
4	Mihoeşti	Arieş (Arieşul Mare)	Câmpeni/Mihoieşti	25,35	PM	6.25	9.45	3,25	V,A,H
5	Cinciş	Cerna	Teliucu Inferior/Cinciş Cerna	48,00	A	24.910	32.086	7.176	A,H,V
6	Gura Apelor	Râu Mare	Râu de Mori/Brazi	168,00	AA	200.000	226.180	26.180	H
7	Ostrovu Mic	Râu Mare	Râu de Mori/Ostrovu Mic	32,50	G	9.200	10.020	0,820	H
8	Păclişa	Râu Mare	Toteşti/Păclişa	32,50	G	9.100	10.420	1.320	H
9	Haţeg	Râu Mare	Haţeg/Haţeg	32,50	G	11.580	13.480	1.900	H
10	Subcetate	Strei	Sântămărie Orlea/Subcetate	23,50	G	6.070	6.600	0.530	H
Banat subbasin									
1	Surduc	Gladna	Surducu Mic	34,0	AM	24.225	50.000	25.775	V,H,R,A

*	Type of the dam	** Uses
A	Arch dam (or gravity arch)	V – flood protection
G	Concrete Gravity Dam	I - irigation
C	Concrete Buttress Dams	H - hydroenergie
AA	Rockfill dam sealed with clays	P – pisciculture
AM	Roclfill dam sealed with upstream mask	A – water supply
PO	Earthfill homogenous dam	R – recreation
PA	Earthfill dam sealed with clays	X – other uses
PM	Earthfill dam sealed with upstream mask	
SS	Weir with surface weirs	
SBB	Weir with closing concrete dam	
SBML	Weir with closing dam or earth perimeter dam	

Table 3.4 Temporary reservoirs

Crt. nr.	Reservoir name	Water course	Type of dam	Hight dam (m)	Total volume (attenuation volume) (mil.m³)
Someș-Tisa subbasin					
1	V. Vinului	Rodina	PO	7.9	1.7
2	Crucisor III	V. Vinului	PO	7.0	1.13
Crișuri subbasin					
1	1 Mai	Peţa	PO	10.2	1.212
2	Felix	Hidişel	PO	13.5	2.48
3	Adona	Adona	PO	8.5	2.024
4	Ciutelec	Bistra	PO	7.7	3.4
5	Egher	Cheţ	PO	7	1.561
6	Sânnicolau de Munte	Sânnicolau	PO	8	2.30
7	Uileacul de Munte	Cosmo	PO	6	2.75
8	Hodişel	Hodişel	PO	12.55	1.879
9	Cărand – Răpsig	Teuz	PO	6	20.20
10	Cârpeştii Mici	Cârpeştii Mici	PO	7.2	2.60
11	Galoşpetreu I	Rât	PO	5	3.84
12	Gepiu II	Gepiu	PO	8.15	1.59
13	Bicaciu	Corhana	PO	7.6	3.59
14	Şipot	Afl. Valea Nouă	PO	7	1.04
15	Andrid	Ier	PO	6	17.5
Mureș subbasin					
1	Cladova	Cladova	PO	10.0	1.01
2	Şiştarovăţ	Şiştarovăţ	PO	9.0	2.1
3	Drauţ	Drauţ	PO	10.0	1.16
4	Vânători	Tânava Mare	G/PO	24	25.5
5	Bălăuşeri	Târnava Mică	G/PO	19	24.5
6	Nemșa	brook Moșna	PO	21.3	7.94
7	Valea	Niraj	PO/G	14	6
8	Tăul Ceanului	Valea Caldă Mare	PO	8.5	4.45
Banat subbasin					
1	Cosarii II	Chizdia	PO	7.6	2
2	Repas	Repas	PO	7.6	1.6
3	Pischia	Bega Veche	PO	10.4	13.3
4	Manastur	Apa Mare (Rat)	PO	8	10.15
5	Izvorin	Slatina (Izvorin)	PO	8.05	6.64

Type of the dam
PO *Earthfill omogenous dam*
PA *Earthfill dam sealed with clays mask*
PM *Earthfill dam sealed with upstream mask*
SS *Weir dam with surface weirs*

Table 3.5 Polders

Crt. nr.	Polder name	Water course	Locality name	Dike type	Length (km)	Height of the dike (m)	Total surface (ha)	Total volume (attenuation volume) (mn.m³)
Someș-Tisa subbasin								
1	Moftin	Crasna	Moftin/Ghilvaci	lateral	7.596	3.50	294.00	Total 5.686(2.052 comp,I+3.634 comp,II)
2	Supur	Crasna	Supur/Supuru de Jos	Contour	5.943	5.00	134.23	5.88
Crișuri subbasin								
1	Tămaşda	Crişul Negru	Tămaşda	Perimeter Enclosure Partition	9.779	2.3 - 7	507	22.12
2	Coşdeni	Holod	Coşdeni	Lateral Contour	4.635	9	148	2.9
3	Ginta	Holod	Ginta	Contour	7.800	4		17.3
4	Sâmbăta	Topa	Sâmbăta	contour, enclosure	6.822	3	104	4.5
5	Sălard	Barcău	Sălard	contour	10.960	4		15
6	Chier	Valea Mare	Chier	contour	6.940	4	404	9.95
7	Zerindu Mic	Crişul Negru	Avram Iancu/Tămaşda	Lateral Partition	12.680	2.40 - 7	475	23.38
8	Beliu	Beliu	Beliu	Parimeter Enclosure Partition	4.440	2.15 - 3.9	143	2.7

9	Sartiş	Sartiş	Cermei	Parimeter Enclosure Partition backwater	7.360	1.5 - 3.2	210	3.6
10	Frunziş	Frunziş	Apateu/ Berechiu	Perimeter Enclosure backwater	9.250	2 – 3.3	405	6.2
11	Şes Inand	Corhana	Cefa	Perimeter	2.117	3		2.325
12	Şicula	Crişul Alb	Şicula	Perimeter backwater Enclosure	10.052	4 – 4.5	680 (2%)	6.5
13	Cigher	Crişul Alb	Zărand	Perimeter backwater Ring	13.771	4.5	1,000 (2%)	8
Mureş subbasin								
1	Vânători	Tânava Mare	Albeşti	Contour and partition	6.500 2.090	10	350	8
2	Balăuşeri	Târnava Mică	Bălăuşeri	Contour and partition	7.300 3.670 2.330	0.5-12 2.4-6.6 2	325	11.4
Banat subbasin								
1	Cenei	Bega Veche	Cenei	lateral	3.200	3	193	4

Table 3.6 Diversion canals

Crt. nr.	Name	Locality name	Derived stream	Receiver water course	Length (km)	Derived discharges (m^3/s)
Someş-Tisa subbasin						
1	Someşul Rece I	Măguri Răcătău	Someşul Rece	Someşul Cald (Fântânele reservoir)	7.206	17.8
2	Negruţa	Măguri Răcătău	Pârâul Negru	Someşul Rece (Someşul Rece I reservoir)	4.018	1
3	Dumitreasa	Măguri Răcătău	Dumitreasa	Someşul Rece (Someşul Rece I Reservoir)	1.060	1.6
4	Răcătău	Măguri Răcătău	Răcătău	Someşul Cald (Fântânele Reservoir)	3.637	5
5	Someşul Rece II	Măguri Răcătău	Someşul Rece	Someşul Cald (Tarniţa Reservoir)	3.339	10
6	Colibiţa dam – Colibiţa HPP	Bistriţa Bârgăului/Colibiţa	Bistriţa (Colibiţa reservoir)	Bistriţa	6.385	15.5
7	Repedea	Bistriţa Bârgăului/Mita	Repedea	Bistriţa	0.880	3.92
8	Straja	Tiha Bârgăului/Straja	Bârgau	Bistriţa	5.380	4.8
Crişuri subbasin						
1	Beliu – Tăut Pipeline	Beliu	Beliu	Crişul Negru	31.8	66
2	Pipeline Canalul Morilor (Buteni – Pilu – Vărşand)	Crişul Alb	Canalul Morilor	Crişul Alb	92	2.5
3	Diversion CPE2	Ant	Crişul Negru	Crişul Negru	8.8	3.5
4	Vad – Aştileu Pipeline	Vadu Crişului	Crişul Repede	Crişul Repede	14.5	10
5	Pipeline Tileagd – Săcădat – Fughiu	Tileagd	Crişul Repede	Iad	11	90
6	Canal Colector (Tărian – Tămaşda)	Tamaşda	Crişul Repede	Crişul Negru	61.8	3.5
7	Remeţi – Munteni Pipeline	Remeţi	Dasor	Iad	2.1	49
8	Drăgan – Remeţi	Lunca Vişagului	Drăgan	Iad	4.3	40
9	Leşu – Remeţi Pipeline	Remeţi	Iad	Iad	8.1	8.5
10	Iad – Cârligate – Drăgan Pipeline	Remeţi	Iad	Iad	4.67	1.16
11	Iad – Drăgan Pipeline	Remeţi	Iad	Iad	4.7	2.8
12	Munteni – Bulz Pipeline	Munteni	Iad	Iad	4.3	49
13	Matca Pipeline	Andrei Şaguna	Mureş	Cigher	41.2	3
14	Săcuieu – Drăgan Pipeline	Săcuieu	Săcuieu (Henţ)	Iad	16.6	4.76
Mureş subbasin						
1	Cannal Batiz - Simeria	Băcia/Batiz	Strei	Mureş	15.500	7.93
2	Şoimu	Valea Ierii/Măguri - Racătău	Şoimu	Someşul Cald	5.079	1.75
3	Lindru	Valea Ierii/Caps	Lindru	Someşul Cald	0.884	1.03
Banat subbasin						
1	Discharge Cannal Bega - Timiş	Topolovăţ	Bega	Timiş	5.570	400
2	Supply Cannal Timiş - Bega	Costei	Timiş	Bega	9.700	40

Table 3.7 Hydraulic complex facilities

Crt. nr.	Name	Water course	Locality name	Maximum derived discharges (m^3/s)
Mureș subbasin				
1	Regulation of Ditrău and Martonka brooks in Ditrău, Harghita county (right arm of HCF 1)	Ditrău	Ditrău	6.2
2	Regulation of Ditrău and Martonka brooks in Ditrău, Harghita county (left arm of HCF 2)	Ditrău	Ditrău	1.6
3	Gurghiu	Gurghiu	Reghin	0.5
4	Water intake and turbine cannal	Mureș	Târgu Mureș	56
5	Niraj	Niraj Mic	Miercurea Nirajului	
Banat subbasin				
1	Sânmartinu Maghiar	Bega	Sânmartinu Maghiar	83.5
2	Topolovăţ	Bega	Topolovăţ	400
3	Sânmihaiu Roman	Bega	Sânmihaiu Roman	83.5
4	Bega – dam and water intake	Bega	Timișoara	83.5

Drainage systems

Drainage systems are referring to internal water leakage through drainage cannals and through valleys and depressions, by maneuvering of weirs and the operation of pumping stations serving for this purpose from internal water systems and subsystems.

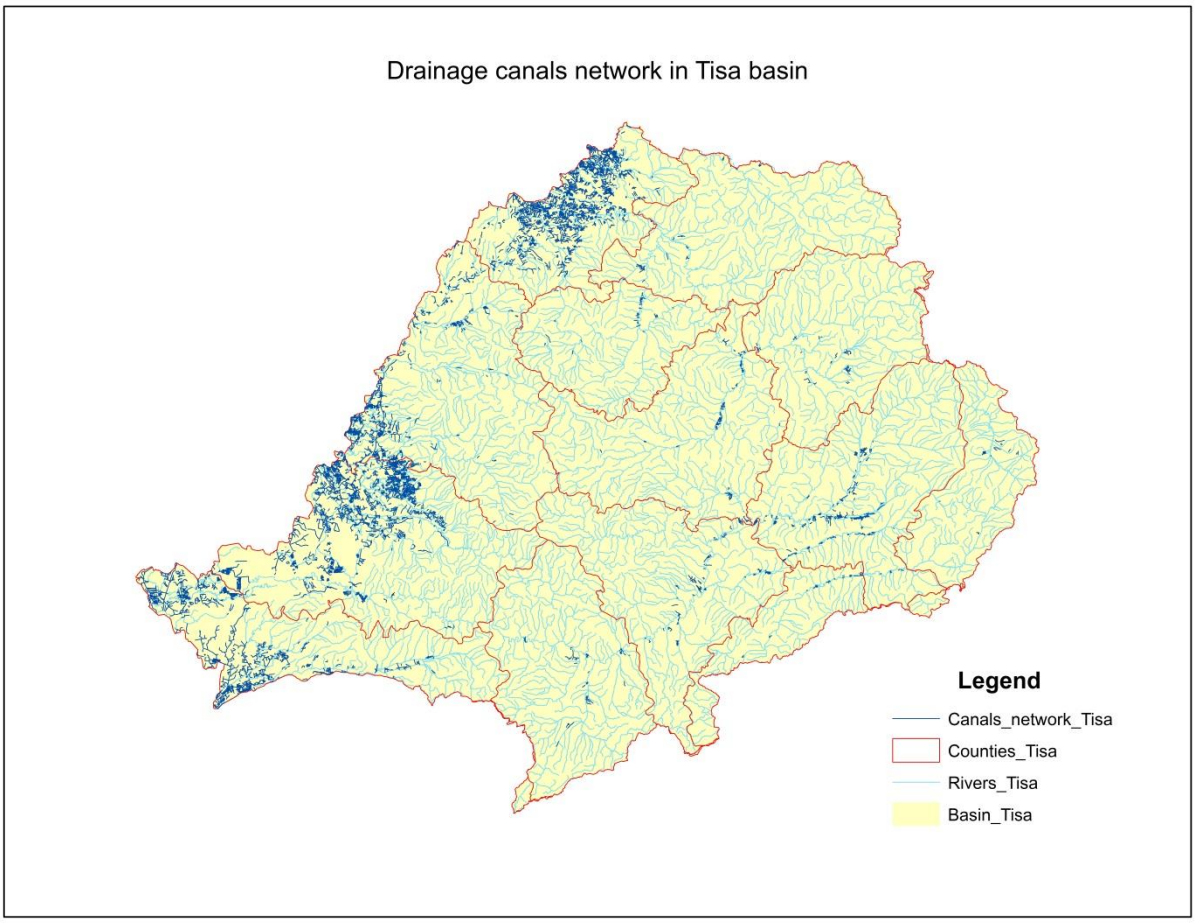
The discharge of internal waters to the maximum discharge capacity will be achieved through collection and evacuation systems in the reciver river as well as through the existing canals.

The discharge of internal waters from areas where they can not be collected by existing systems, as well as of exceptional domestic waters that exceed the maximum discharge capacity of these systems, will be done both through canals, valleys and depressions. The limitation of internal water flows will be done by weirs, riverbed restraints or other ways.

Table 3.8 Drainage systems

Crt. nr.	Name	Function	Drained area (km²)	Receiver river
Someș-Tisa subbasin				
1	Tarna Bătarci	Internal water evacuation	22.15	Tarna Mică
2	Tur-right bank	-"-	97.93	Tur
3	Turulung-Negrești	-"-	139.39	Tur
4	Tur-left bank	-"-	96.3	Tur
5	Aluniș-Potău	-"-	75.16	Someș
6	Someș-right bank	-"-	274.17	Sar, Tur, Someș
7	Homorod-right bank	-"-	91.71	Someș
8	Someș-Crasna	-"-	383.17	Crasna
9	Crasna-left bank	-"-	275.02	Crasna
10	Terebești-Gelu	-"-	63.37	Crasna
11	Craidorolț-Vârșolț	-"-	161.54	Crasna
12	Cărășeu-Valea Vinului-Pomi	-"-	97.86	Someș
13	Iojib-Seini	-"-	50.41	Someș
Crișuri subbasin				
1	Teuz-right bank	-"-	249.16	Crișul Negru
2	Teuz-left bank	-"-	203.77	Crișul Negru
3	Cermei -Tăuț	-"-	68.15	Crișul Negru
4	Sistem Hanios Vărșand	-"-	234.89	Crișul Alb
5	Cigher	-"-	99.22	Crișul Alb
6	Budier	-"-	204.96	Canalul Morilor
7	Vărșand	-"-	37.44	Crișul Alb
8	Chișer	-"-	170.08	Canalul Morilor
9	Morilor I-left bank	-"-	50.32	Crișul Alb
10	Gut	-"-	38.09	Crișul Alb
11	Canalul Morilor	-"-	118.04	Crișul Alb
12	Teuz right bank	-"-	104.87	Crișul Negru
13	Canal Colector –left bank Inand	-"-	450.77	Crișul Negru
14	Canal Colector+right bank-Cefa	-"-	446.18	Crișul Negru
15	Peța-Hidișel	-"-	20.61	Crișul Repede
16	Valea Bistra	-"-	11.05	Barcău
17	Valea Inot	-"-	12	Barcău
18	Barcău right bank upstream Marghita	-"-	10.27	Barcău
19	Barcău right bank downstream Sălard	-"-	26.12	Barcău
20	Barcău left bank downstream Sălard	-"-	76.21	Barcău
21	Cermei-Tăuț	-"-	18.91	Crișul Negru
22	Crișul Repede-right bank upstream Oradea	-"-	29.7	Crișul Repede
23	Crișul Repede right bank upstream Tileagd	-"-	13.27	Crișul Repede
24	Crișul Repede right bank donstream Oradea	-"-	98.6	Crișul Repede
25	Crișul Repede left bank downstream Tileagd	-"-	42.68	Crișul Repede
26	Valea Holod	-"-	49.3	Crișul Negru
27	Valea Ierului	-"-	274.62	Ier
28	Valea Nouă-Guberdiu	-"-	22.75	Crișul Negru

29	Valea Rătăşel	-"-	48.43	Crişul Negru
30	Ier	-"-	27.37	Ier
Mureş subbasin				
1	Şard Ighiu	-"-	21.57	Ampoi
2	Secaş Mic	-"-	15.5	Secaş
3	Orăştie - Romos - Aurel Vlaicu	-"-	30	Vaidei-Romos-Mureş
4	Sibişel - Beriu	-"-	19.19	Sibişel
5	Boţărod - Bretea	-"-	18.5	Luncanilor
6	Bretea - Vâlcele - Băţălar	-"-	14.38	Strei
7	Haţeg - General Berthelot - Tuştea	-"-	34.15	Galbena
8	Ier Arad frontieră, subbazin Cutaş, Ţiganca, Dorobanţi, Hathaz-Putri	-"-	239.38	Mureş river right bank upstream Pecica
9	Ier Arad frontieră subbazin Pe sub vii	-"-	11.5	Mureş river right bank downstream Pecica
10	Crac, subbasin Crac	-"-	121.04	Mureş river right bank upstream Nădlac
11	Crac, subbasin Crac	-"-	145	Mureş river right bank upstream Nădlac
12	Ier-Arad frontieră Subbasin Forgacea	-"-	32.49	Mureş river right bank upstream Pecica
13	Aranca-Secusigiu, subbasin Secusigiu	-"-	64.08	Mureş river, left bank downstream Secusigiu
14	Mureş right bank 1	-"-	48.1	Mureş river,right bank upstream Arad
15	Mureş right bank 2	-"-	88	Mureş river right bank upstream Arad
16	Sânnicolau-Saravale	-"-	26	Mureş river left bank
Banat subbasin				
1	Aranca	-"-	555.82	Aranca
2	Galaţca	-"-	82.8	Galaţca-Giucaşin
3	Beheiu Vechi-Vest Timişoara	-"-	105	Bega Nouă-Bega Veche
4	Beregsău Amonte	-"-	15.13	Beregsău Vechi
5	Răuţi-Sânmihaiu German	-"-	51.28	Bega navigabilă
6	Vinga-Biled-Beregsău	-"-	255.3	Bega Veche
7	Checea-Jimbolia	-"-	544.51	Bega Veche
8	Behala	-"-	16.62	Behala
9	Mureşan	-"-	60.4	Mureşan
10	Sânnicolau-Saravale	-"-	199.98	Aranca
11	Râu-Glavița	-"-	84.86	Bega-Glavița
12	Uivar-Pustiniș	-"-	54.03	Bega Veche-Bega



Significant historical floods and Areas with Potentially Significant Flood Risk

On the surface of the Tisza River Basin, floods were recorded in all seasons of the year, but the most significant are formed in the winter, spring and summer season, the phenomenon being influenced by the moisture intake brought by the air masses.

Among the most known floods is mentioned those from: 1912, 1932. 1941, 1966, 1970, 1974, 1975, 1978, 1979, 1980, 1981, 1989, 1993, 1995, 1996, 1997, 2001, 2005, 2006, 2008 and 2010.

In 1970 important floods have occurred that had as a triggering factor a heavy rain regime, recording significant water flows in almost all the big watercourses in Romania. The maximum recorded flows had values of: 576 m^3/s at the Oradea gauging station on the Crisul Repede River, 626 m^3/s at the Tinca gauging station and 517 m^3/s at the Zerind gauging station both on the Crişul Negru river, 466 m^3/s at the Bocsig gauging station on the Crişul Alb River, 1,580 m^3/s in Ocna Mureş, 2,450 m^3/s in Alba Iulia, 2,320 m^3/s in Arad and 700 m^3/s in Topa (on the Târnava Mare river).

The main cause of flood formation in 1975 was the extremely heavy rainfall from July 1 to July 3 on a high percentage of saturation soil. At short intervals, precipitation was sometimes extremely torrential, with 2.5 mm/min in Odorheiul Secuiesc town. The maximum recorded flows had values of: 900 m^3/s in Medias, 851 m^3/s in Blaj, 630 m^3/s in Târnăveni and 950 m^3/s in Turda.

The floods formed between December 1995 and January 1996 resulted in the rapid warming and melting of the snow layer, an event overlaid with significant liquid precipitations falling under a frozen soil, unable to allow infiltration, and runoff on the slopes into the riverbeds. The probability of exceeding the maximum flows was between 5 and 30% on the rivers in Maramures county and the Somes river basin. The maximum recorded flows had values of: 605 m^3/s at the Chişineu Criş gauging station on the Crisul Alb river, 548 m^3/s at Zerind on the Crişul Negru river, 1,125 m^3/s at Glodeni gauging station on the Mures river, Alba-Iulia – 1,247 m^3/s and Arad – 1,046 m^3/s. On the Arieş river the maximum flow was recorded at Baia de Arieş gauging station - 805 m^3/s.

In 2006, there were floods that had the effect of exceeding the defense level, at the gauging station Cristeştii Ciceului on the Ilişua river having a maximum flow of 212 m^3/s, resulting in 13 losses of human lives and large material damage.

The identification/selection of significant historical floods was made considering the hydrological criteria (to identify significant floods in terms of hazard) but also the extent of their effects (criteria for identifying significant historical floods in terms of damage). The criteria for the number of victims and the economic ones (number of homes, km of affected roads) were considered as priority.

Thus, 39 significant historical events were selected at the Tisza basin (Tisza and its tributaries with catchment over 1000 km^2) for the period from 1970 to 2010 presented in table 3.9. and figure 3.4.

Table 3.9 Significant historical floods

Nr. crt.	Event name	Source, characteristics, mecanism of flood[1]	Date of flood
1	r. Tisa - downstream loc. Bocicoiu Mare, upstream loc. Teceu Mic	A11, A21, A36, A38	May 1970
2	r. Vişeu - downstream confl. r. Ţâsla	A11, A12, A21, A31, A36, A38	May 1970
3	r. Iza - downstream loc. Săcel	A11, A12, A21, A31, A36, A38	May 1970
4	r. Tur	A11, A12, A21, A31, A36, A38	May 1970
5	r. Someş - downstream confl. Şieu	A11, A21, A38	May 1970
6	r. Lăpuş - downstream confl. Suciu	A11, A15, A21, A31, A38	May 1970
7	r. Crasna – r. Ier	A11, A13, A15, A21, A24, A38	May 1970
8	r. Mureș - downstream loc. Neagra	A11, A21, A32, A38	May 1970
9	r. Târnava - downstream loc. Sub Cetate	A11, A12, A21, A31, A32	May 1970
10	r. Târnava Mică - downstream loc. Praid	A11, A12, A21, A31, A32	May 1970
11	r. Strei - downstream confl. Crivadia am. Loc. Călan	A11, A21, A32, A38	May 1970
12	r. Mureș - downstream loc. Glodeni	A11, A21, A38	July 1975
13	r. Arieş - downstream loc. Albac	A11, A21, A38	July 1975
14	r. Târnava - downstream loc. Cristuru Secuiesc	A11, A21, A38	July 1975
15	r. Târnava Mică - downstream loc. Praid	A11, A21, A38	July 1975
16	r. Strei - loc. Ohaba de Sub Piatră and r. Sălaş	A11, A21, A38	July 1975
17	r. Crişul Negru – downstream confl. Criştior	A11, A21, A22, A23, A32, A38	July 1980
18	r. Crişul Repede – downstream loc. Izvoru Crişului	A11, A21, A32, A38	July 1980
19	r. Barcău – downstream confl. Valea Mare	A11, A21, A22, A32, A38	July 1980
20	r. Crişul Alb – downstream loc. Criş, upstream Ţipar temporay reservoir	A11, A21, A32, A38	December 1995
21	r. Barcău – downstream loc. Marca	A11, A21, A38	June 1997
22	r. Ier – loc. Săcueni	A11, A12, A21, A22, A31	June 1997
23	r. Mureș - downstream confl. Arieş	A11, A12, A23, A38	June 1998
24	r. Târnava - downstream confl. Vişa	A11, A21, A38	June 1998

Nr. crt.	Event name	Source, characteristics, mecanism of flood[1]	Date of flood
25	r. Târnava Mică - downstream loc. Crăieşti	A11, A21, A38	June 1998
26	r. Sebeş - downstream confl. Dobra and r. Secaş	A11, A21, A38	June 1998
27	r. Strei - downstream confl. Crivadia	A11, A21, A38	June 1998
28	r. Crişul Alb – downstream loc. Mihăileni	A11, A13, A21, A32, A38	April 2000
29	r. Crişul Negru – downstream loc. Poiana	A11, A21, A22, A32, A38	April 2000
30	r. Bega - downstream loc. Luncanii de Jos, upstream loc. Topolovăţu Mare	A11, A21, A32	April 2000
31	r. Tisa - downstream loc. Bocicoiu Mare, upstream loc. Teceu Mic	A11, A21, A22, A36, A38	March 2001
32	r. Vişeu - downstream confl. Vaser and r. Vaser	A11, A12, A21, A22, A31, A36, A38	March 2001
33	r. Iza - downstream Confl. Boicu	A11, A12, A21, A22, A31, A36, A38	March 2001
34	r. Someş - sector loc. Şanţ Valea Luncii	A11, A21, A38	March 2001
35	r. Lăpuş – downstream confl. r. Craica and tributaries Săsar, Firiza	A11, A21, A36, A38	March 2001
36	r. Bega - downstream loc. Luncanii de Jos, upstream loc. Topolovăţu Mare	A11, A21, A38	April 2005
37	r. Tisa - downstream loc. Bocicoiu Mare	A11, A21, A36, A38	July 2008
38	r. Vişeu - downstream confl. Ţâsla	A11, A12, A21, A23, A31, A36	July 2008
39	r. Iza - downstream loc. Dragomireşti	A11, A12, A21, A23, A31, A36	July 2008

[1] –use the cods established in the Guidance for Reporting under the Floods Directive (2007/60/EC) - Guidance Document No. 29 A compilation of reporting sheets adopted by Water Directors Common Implementation Strategy for the Water Framework Directive (2000/60/EC)

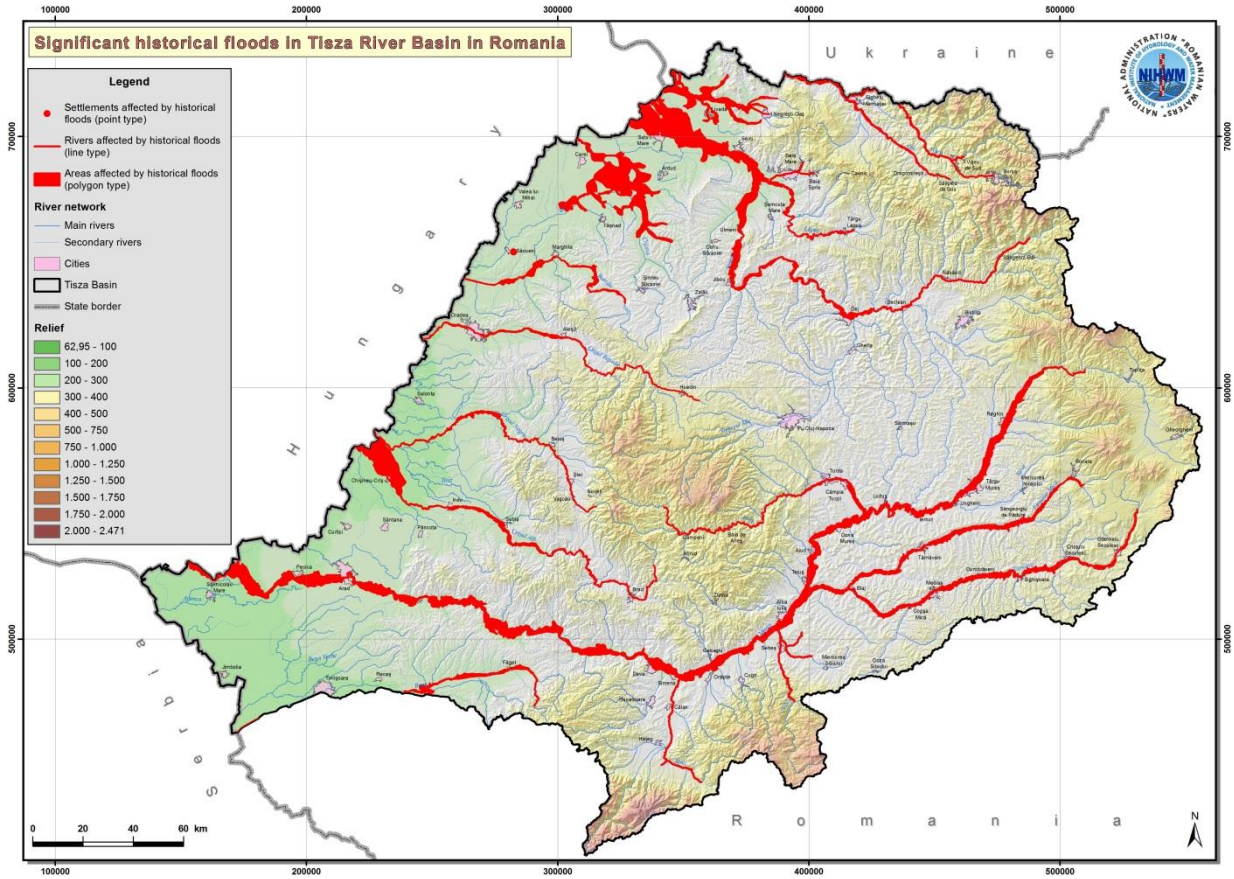


Figure 3.1 Map with significant historical floods in Tisza River Basin in Romania

Areas with Significant Potentially Flood Risk were defined after consulting the information available at the moment, within the Projects *Prevention and protection against floods, dangerous meteorological*

phenomena, hydrotechnical accidents and accidental pollutions and the results of *PHARE 2005 /017-690.01.01 Contributions to the development of the flood risk management strategy*. At the same time, has been taken into account the flood-protected areas with hydrotechnical works, considering all the floods that have occurred in the past and which had a significant negative impact, without removing from that list those floods that can occur on sectors that have been hydrotechnically arranged (impounded).

A table with Areas with Significant Potentially Flood Risk related to the Tisza River and its tributaries with a catchment size over 1.000 km^2 at Tisza River Basin level in Romania is showed in table 3.10 and in the figure 3.5.

Table 3.2 Areas with Significant Potentially Flood Risk

Nr. crt.	APSFR name	Representation type	Lenght/Surface (km)/(km^2)
1	r. Tisa - downstream loc. Bocicoiu Mare	Poligon	25,6
2	r. Vişeu - av. confl. r. Ţâsla	Poligon	10,8
3	r. Iza - downstream loc. Săcel	Poligon	17,8
4	r. Tur - downstream loc. Negreşti-Oaş	Poligon	142,1
5	r. Someş - downstream loc. Şanţ, upstream loc. Roşiori	Poligon	230,9
6	r. Someş - downstream loc. Roşiori	Poligon	334,5
7	r. Şieu	Poligon	10,8
8	r. Someşul Mic - downstream loc. Floreşti	Poligon	23,9
9	r. Lăpuş - downstream confl. r. Suciu	Poligon	28,1
10	r. Crasna - upstream loc. Vârşolţ	Poligon	2,8
11	r. Crasna - downstream loc. Vârşolţ, upstream loc. Acâş	Poligon	40,2
12	r. Crasna - downstream loc. Acâş, upstream loc. Moftinu Mare	Poligon	125,9
13	r. Crasna - downstream loc. Moftinu Mare	Poligon	36,9
14	r. Ier – downstream loc. Mihăieni	line	64,3
15	r. Crișul Alb – downstream confl. Valea Satului	poligon	242,79
16	r. Crișul Negru - downstream loc. Poiana	poligon	53,77
17	r. Crișul Repede – downstream confl. r. Șipot	poligon	50,02
18	r. Barcău – downstream loc. Subcetate	poligon	132,85
19	r. Ier - downstream loc. Unimăt, upstream confl. r. Checheţ	poligon	114,61
20	r. Mureș - downstream loc. Neagra	polygon	906,69
21	r. Aries – downstream loc. Albac	polygon	38,66
22	r. Târnava Mică - downstream loc. Praid	polygon	110,41
23	r. Târnava - downstream loc. Sub Cetate	polygon	151,96
24	r. Sebeş – downstream Confl. Dobra	polygon	26,05
25	r. Strei – downstream Loc. Petros	polygon	32,37
26	r. Bega - downstream loc. Luncanii de Jos, upstream confl. Iosifalău	polygon	54,97
27	r. Bega - downstream loc. Topolovăţul Mic	line	77,5
28	r. Bega Veche - loc. Sânandrei	line	31,6
29	r. Bega Veche - downstream loc. Săcălaz	line	7,2

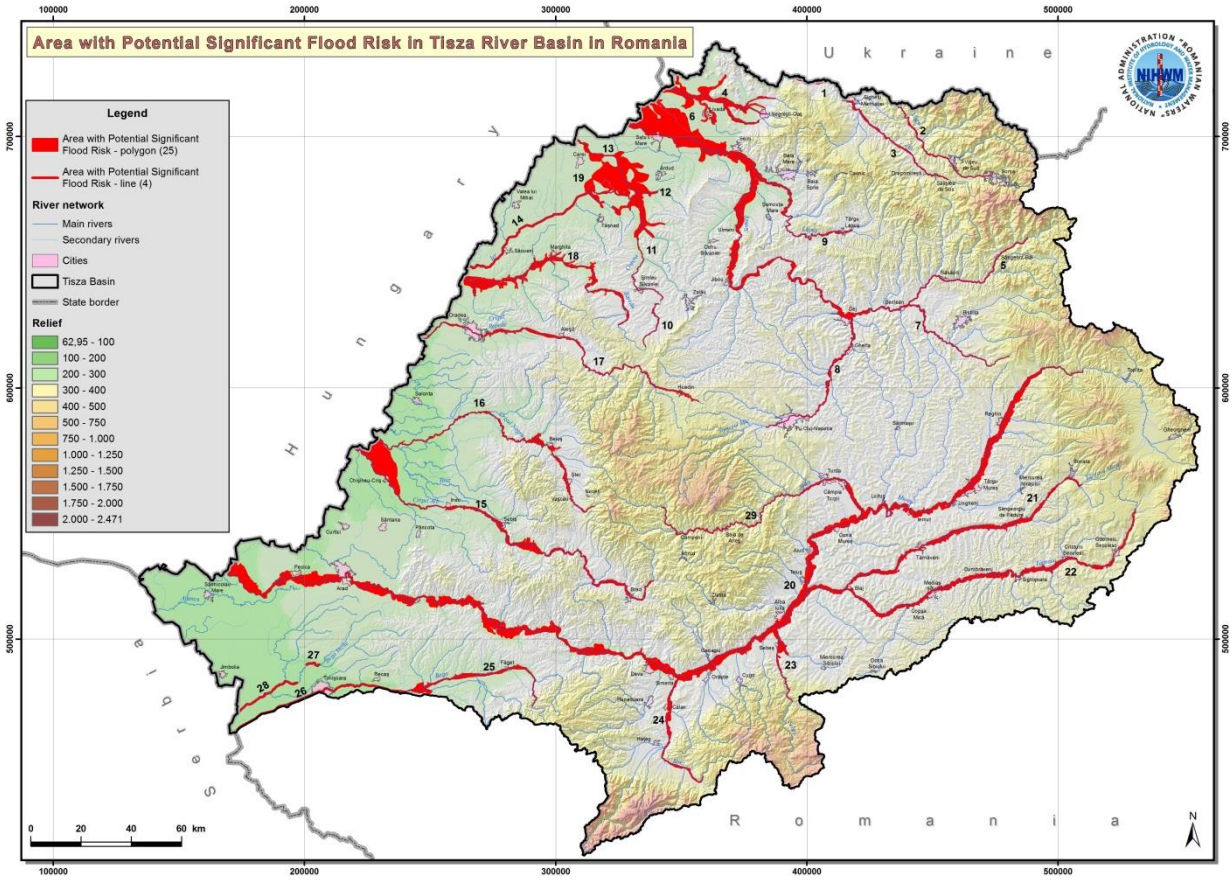


Figure 3.3 Map with A.P.S.F.R. in Tisza River Basin in Romania

National Flood Hazard Maps and Flood Risk Maps for Tisza River Basin

Hazard maps at the Tisza basin reported at European Commision have been prepared in accordance with the requirements of the Floods Directive for areas designated as having a significant flood risk. The hazard map cover the geographical areas that may be flooded in the scenarios:

- low probability scenario (Q0,1% - floods that can occur, on average, once every 1000 years);
- medium probability scenario (Q1% - floods that can occur, on average, once every 100 years);
- high probability scenario (Q10% - floods that can occur, on average, once every 10 years).

The results obtained in the *Plan for prevention, protection and mitigation of the floods effects*, were mostly, used to make hazard maps.

The method used for the elaboration of hazard maps at the Tisza river basin, within the *Plan for prevention, protection and mitigation of the floods effects National Program* (during the period 2011-2014), is based on complex studies and contains two components: I) topographic and geodetic studies, and II) hydrological and hydraulic studies.

- As a result of topographic and geodetic studies a DTM has been obtained which has a very high resolution (± 10 - 15 cm vertically - A Level detail) for the area considered as a priority and a high resolution (± 15 - 20 m vertically - B Level detail) and corresponds to the LIDAR method, complemented with classical topographical measurements for engineering structures on water courses (bridges, small bridges, defense works etc.), and for the rest of the river basin DTM has been obtained based on vectorization available topographic maps (C level detail).

- Hydrological modeling consisted in calculating the hydrographs of flows on the rivers basines, propagation and composition thereof on the main rivers and tributaries. The hydrological models CONSUL and RAZVAN heave been using which have been elaborated within National Institute of Hydrology and Water Management. The hydraulic modeling of the water courses identified as flood potential consisted in one-dimensional (1D) simulation of flow with HEC-Ras 4.1.0 software and two-dimensional (2D) with the SMS HYDRO_AS - 2D software under the current conditions of river basin management.

For the Tisza river and its tributaries with catchment over 1.000 km^2 hazard maps were made in the *Plan for prevention, protection and mitigation of the floods effects* for 24 areas with a total length of about 2.975 km, declared as potentially significant flood risk areas.

The hazard maps were verified and corrected, harmonized and structured unitary, codified according to WISE and then transmitted to the EC.

Moreover, for 5 areas reported to the European Commission and not covered by the *Plan for prevention, protection and mitigation of the floods effects*, flood curves were generated based on simplified approximate methods (modeling with fuzzy systems - GrassGIS, tools that use ArcView extensions, approximate hydraulic modeling with HEC-RAS etc.) over a length of about 369 km, these areas will be modeled in detail until the next reporting stage.

A qualitative assessment of flood risk was chosen; this assumed, first, identification of risk receptors and then assessing the vulnerability of the identified and exposed flood risks objectives, taking into account the depth of water[1] and potential damage to flooded objectives, respectively the impact on the risk receptor considered.

Flood risk maps are made based on a methodology developed within the National Institute of Hydrology and Water Management for each probability of exceeding the maximum flow rate of: 0,1%, 1% and 10%, according to law, for the following indicators:

- the approximate number of affected inhabitants (for which the statistical method was used);
- indicators, related to the other types of consequences - economic, environment, cultural heritage.

A risk matrix has been elaborated and applied which takes into account various layers of information from CLC and NAVTEQ for indicators related to economic consequences, for the elaboration of flood risk maps.

For each depth class, the magnitude of the hazard is evaluated, assigning three classes with the following meanings: class 1 - less than 0,5 m; class 2 - 0,5 – 1,5 m; class 3 - more than 1,5 m, resulting 3 areas: major risk areas - represented in red, medium risk areas - represented in orange, low risk areas - represented in yellow.

Figures 3.11 and 3.12 present hazard maps and flood risk maps (average scenario – 1%) for the Tisza river and its tributaries with catchment over 1.000 km^2 in Romania.

1The water depth ranges for which the vulnerability of goods in floodplains was determined the following: (a). Water depth below 0,5 m; (b) water depth between 0,5 m and 1,5 m; (c) water depth greater than 1,5 m

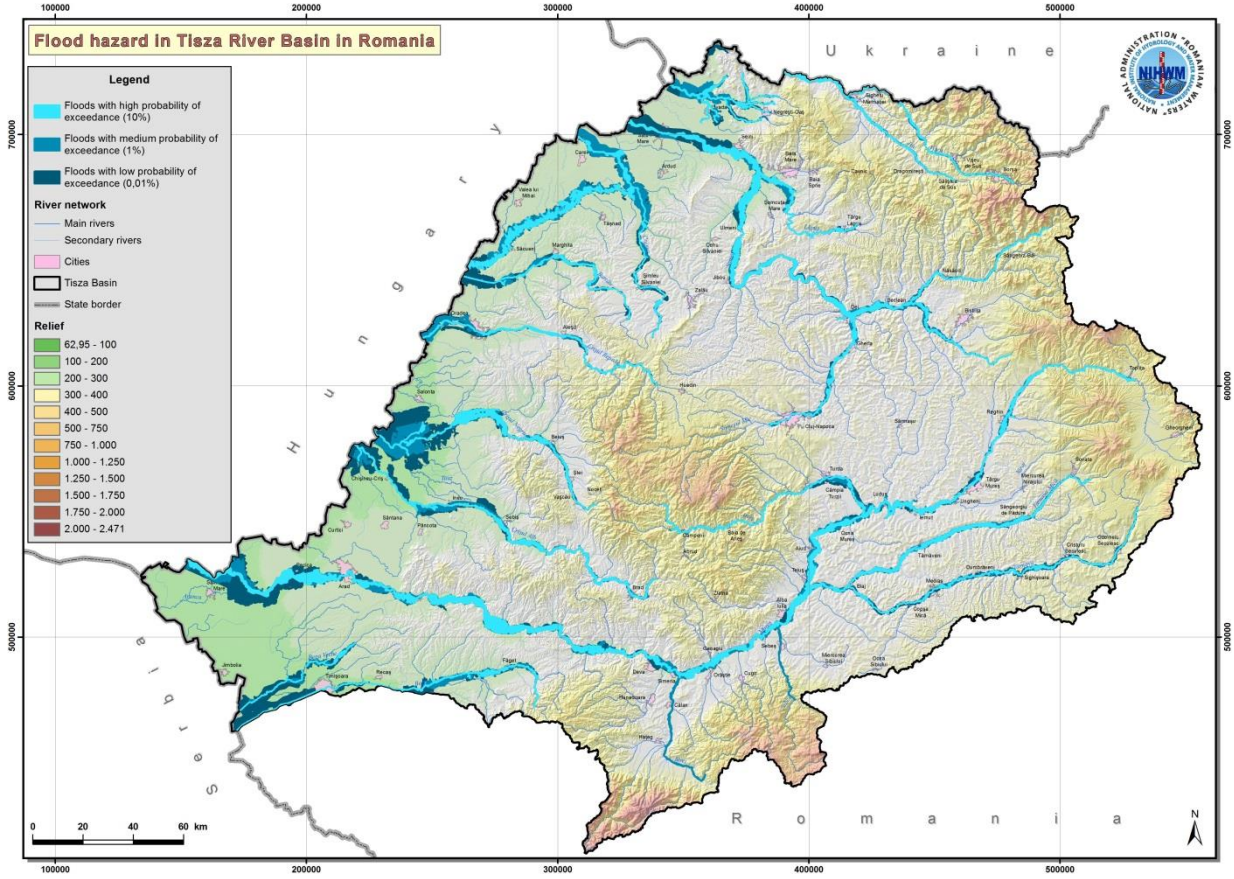


Figure 3.4 Flood hazard map of Tisza River Basin in Romania

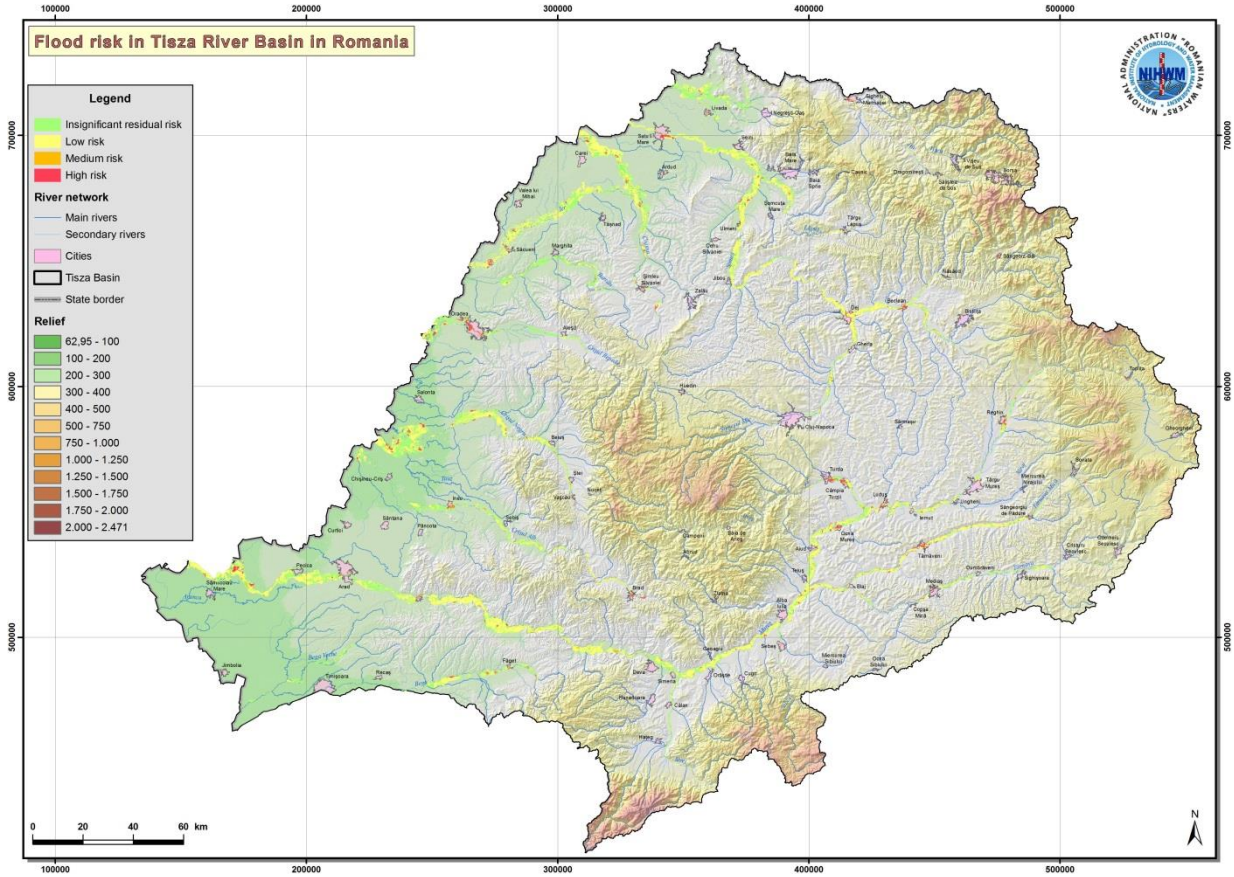


Figure 3.5 Flood risk map of Tisza River Basin in Romania

Flood hazard and flood risk maps published on the National Administration Romanian Waters and reported to EC are made for the probability of exceeding the maximum flow rate of 1% (average overrun probability) covering about 3126 km of watercourses at the Tisza river and its tributaries with catchment over 1000 km^2.

Subsequently, maps developed in the other two scenarios: 0.1% (low probability of exceedance) and 10% (high probability of exceedance), according to law were published, but these cover only the areas for which flood hazard maps were available within the *Plan for prevention, protection and mitigation of the floods effects* (2975 km - for Tisza river and its tributaries with catchment over 1000 km^2).

Potential adverse consequences

Based on hazard and flood risk maps a statistical analysis has been developed a statistical analysis based on the results from the application of the average scenario, respectively events with medium probability (every 100 years).

One of the most susceptible categories to flooding is the population. In the case of Tisza river basin on the territory of Romania (for Tisza river and its tributaries with catchment over 1000 km^2), about 376,252 inhabitants are at risk of flooding.

Also, a number of key indicators have been calculated which describing the main consequences that floods can have on the environment, such as IED installations, protected areas (national, SCI, SPA, Habitats, Protected Areas for water capture for human consumption etc.), but also other indicators that can describe the potential adverse effects on the environment. Thus, they resulted as follows: 17 IED installations, protected areas that are located in floodable areas of which: 66 protected areas for water capture for human consumption, 40 SPA, 46 SCI.

Infrastructure is an important link in the economy of a country, so this indicator has been chosen to describe the impact that floods can have on Romania's economy. Railways are considered one of the cheapest means of transport when it comes to transporting different goods/merchandise. An analysis made after finalization of hazard and flood risk maps indicates that aproximativ 500 km of railways can be affected by floods.

Public roads along with shipping and railways complete the transport infrastructure. The implementation process of Phase 2 of the Floods Directive has taken into account national and European roads, county roads, communal roads, and the street network.

For this analysis, they were used the results for 3 categories of roads mentioned before. Thus, there is a risk of flooding about 311 km of national/European road, about 612 km of county road and about 434 km of communal road.

The effects that floods have on cultural heritage are another consequence that the Floods Directive imposes to the Member States to assess. Thus, in the analyzed area, about 217 churches, 9 museums and 2 cultural monuments which can be flooded in the event of floods with a return period every 100 years, have been identified.

The centralized situation with the statistical indicators (key indicators) determined for the four categories of consequences established in accordance with the Floods Directive, in the case of the average scenario, respectively events with average probability (every 100 years), is presented in table 3 .11.

Table 3.11 Statistical risk indicators

Consequences categories	Potential adverse consequences	Cunatification (number/lenght/etc.)
Social	Population	376.252 exposed inhabitants

Economic	Infrastructure	500 km railway 311 km national/European road 612 km county road 434 km communal road
Environment	protected areas	40 areas SPA 46 areas SCI 66 protected areas for water capture for human consumption 17 IED installations
Cultural heritage	cultural objectives	217 churches 9 museums 2 cultural monuments

Estimation of the impact of Climate Change on flood risk

The results of some climate models with increasingly fine spatial resolutions to capture the complex orography of each region allowed the development of scenarios for different river basins on the territory of Romania regarding the impact assessment on water resources.

The methodology used is based on the following steps:

- Hydrological model selection

  The CONSUL hydrological model was used, which allows simulation of discharge hydrographs on sub-basins, their routing and composition on the main river and tributaries, and attenuation by reservoirs.

  Generally, the CONSUL model was used for flow simulation and forecasting (Leonte-Neagu et al., 1997; Stănescu et al., 1997; Mic et al., 2006; Stanciu et al., 2009) and represent a valid tool for assessing the impact of climate change on water resources in a river basin (Corbuș et al., 2011; Corbuș et al., 2012; Corbuș et al., 2013; Corbuş et al., 2014).

- Calibration of the hydrological model

  For the calibration of the CONSUL model parameters, corresponding to the hydrometric stations located in the closing sections of the river sub-basins, the largest rainfall-runoff events from the historical period were simulated, covering a wide range of possible situations in case of floods formation.

- Setting the Climate Change Scenario

  Climate evolution simulations obtained using meteorological models have been used.

- Flow simulation over the long period using the hydrological model

  The calibrated hydrological model allowed the long-term simulation of discharge hydrographs at 6-hours time step for both the reference period 1971-2000 and the future period 2021-2050.

- Analysis of the results

  The discharge series resulting from the two long-term simulations were analyzed comparatively in order to estimate the effects of climate change on maximum discharges.

Until now, the methodology for estimating variations at 6 hours time step of precipitation and temperatures as well as the maximum discharges from the future period compared to the reference period was applied to 6 river basins in Romania, among wich the Crişul Alb river basin and the Mureş river basin.

In a first step, the comparative analysis of the results obtained for the two periods (the reference period and the future period) was performed for the maximum monthly instantaneous discharges, multiannual averages. The following results were obtained for the analyzed river basins:

- the Crişul Alb river basin: an increase of maximum discharges in January, April, July, September and December and a decrease in the other months of the year;
- the Mureş river basin: an increase of maximum discharges in the winter months as well as in March and July and a decrease in the other months of the year.

For multiannual maximum discharges, the simulations indicated:

- the Crişul Alb river basin: decrease of about -22.7 % (between a minimum of -35.0% and a maximum of 7,6%);
- the Mureş river basin: decrease of about -11.3 % (-39,0 % and 16.6 %).

With regard to the variation of maximum discharges with different probabilities of exceedance in sections of hydrometric stations on main river courses, the results are itemed below:

- the Crişul Alb river basin: maximum discharges with probabilities of exceedance 0.1%, 1%, 2%, 5% and 10% have a decreasing trend of up-to -14% in the upper zone and maximum -10% in the lower zone;
- the Mureş river basin: maximum discharges with probabilities of exceedance 0.1%, 1%, 2%, 5% and 10% have a decreasing trend of up to -7% in the upper zone and maximum -9% in the lower one, and a tendency of increase of up to 7% in the middle zone.

International Cooperation in the Tisza River Basin

The **Romanian** International Cooperation with the countries which are parts of the Tisza basin, is developing as bilateral as in the frame of international bodies such as the International Commission for the Protection of the Danube River (ICPDR).

Within ICPDR, the Tisza Group has been established for strengthening coordination and information exchange related to international, regional and national activities and to ensure harmonisation and effectiveness of related efforts.

Also, the international cooperation in the Tisza River Basin in Romania includes the bilateral agreements, presented as it follows.

- Romania – Ukraine

Cooperation shall be conducted under the Agreement between the Government of Romania and the Government of Ukraine on cooperation in border water management (Galati, 30 September 1997), ratified by the Romanian Parliament by Law no. 16 of 11 January 1999.

- Romania – Hungary

The first agreement in water field between Romania and Hungary was signed in Bucharest on 14 April 1924 and was in force until 1945. This was followed by 4 cycles of cooperation, 1945-1961, 1962-1965, 1965-1970, 1970 to 1986, the agreement was renewed every time. On 25 June 1986 was signed in Bucharest Convention between the Government of Romania and the Republic of Hungary on the regulation of issues related to hydraulic structures on water which form or cross the border. The Convention entered into force November 20, 1986.

Currently, cooperation is performed under the Agreement between Romania and the Republic of Hungary on cooperation for the protection and sustainable use of water in the border region (Budapest, September 15, 2003), ratified by Government Decision no. 577/15.04.2004.

The agreement applies to the following rivers: Tur, Somes, Crasna, Barcau, Ier, Crisul Repede, Crisul Negru, Crisul Alb and Mures by hydrotechnical Romanian-Hungarian Commission.

- Romania – Serbia

Cooperation is achieved under the Agreement between the Romania and FPR Yugoslavia on hydraulic problems in hydraulic systems and watercourses that cross the border or are the border (Bucharest, April 7, 1955), ratified by Decree no. 242 / 06.17.1955.

The agreement applies to the following rivers: the Danube, Nera, Moravita, Aranca, Bega Veche, Bega Channel, Timis, Caras and Nera by hydrotechnical Romanian-Serbian Commission.

It is currently negotiating text of the new Agreement between Romania and Serbia on cooperation in the sustainable management of transboundary waters.

References

Mutihac, V. (1990) Structura geologica a teritoriului României, Editura Tehnică, Bucureşti;

Stănescu V. A., Neda A., Simota M., Corbuş C. (1997) Hydrological forecast - activity directly involved in water management and flood defense. Symposium "Non-structural measures in water management", November 28-29, Technical University of Civil Engineering Bucharest, p. 165-174, in Romanian;

Leonte-Neagu E., Corbuş C., Mătreaţă M., Simota M. (1997) Elaboration of discharge continuous forecasting models (floods, daily and monthly mean discharges) in the Dâmboviţa River Basin. Collection of articles presented at the ARDI seminar, January 31, National Institute of Meteorology and Hydrology, Bucharest, p. 46-58, in Romanian;

Mic R., Corbuş C., Pescaru V. I., Velea L. (2006) Coupling the hydrologic model CONSUL and the meteorological model HRM in the Crisul Alb and Crisul Negru river basins. J. Marsalek et al. (eds.), Transbourdary Floods: Reducing Risks through Flood Management, NATO Science Series, IV. Earth and Environmental Sciences, Vol. 72, pp. 67-77, ISBN 1-4020-4901-3, Springer, Printed in the Netherlands;

Posea, G. (2006) Geografia fizică a României, Partea a II-a, Editura Fundației România de Mâine, București;

Iordan, I. (2006) Geografie umană și economică, Editura Fundației România de Mâine, București;

Cruceru, N. (2008) Introducere în Geografia Regională a României, Editura Fundației;

Marin, C. (2008) Geologia României, Editura Fundației România de Mâine, București;

Stanciu P., Chendeş V., Corbuş C., Mătreaţă M. (2009) G.I.S. Procedure for Flood-Prone Areas Mapping Based on the Results of the Flood Simulation Models. Studia Universitatis Babeş-Bolyai, Geographia, LIV, 3;

Corbuș C., Mic R., Mătreaţă M. (2011) Assessment of climate change impact on peak flow regime in the Mureş river basin, XXVth Conference of Danubian Countries, 16-17 June, Budapest, Hungary;

Corbuş C., Mic R. P., Mătreaţă M., Chendeş V. (2012) Climate change impact upon maximum flow in Siret river basin, 12th International Multidisciplinary Scientific GeoConference SGEM 2012, Conference Proceedings, Volume III, Albena, Bulgaria, pp. 587-594;

Corbuş C., Mic R.-P., Mătreaţă M. (2013) Potential climate change impact upon maximum flow in Ialomita river basin. National Institute of Hydrology and Water Management - Scientific Conference, “Water Resources Management under Climate and Anthropogenic Changes”, 23-26 September, Bucharest;

Corbuş C., Mic R.-P., Mătreaţă M. (2014) Estimation of the impact of potential climate change on the maximum flow in the Olt River Basin. Hidrotehnica Review, vol. 59, no. 10-11, Bucharest, ISSN 0439-0962, p. 28-38, in Romanian;

*** Studii de hidrologie VI – Monografia hidrologica a Bazinului hidrografic Mureș, București 1963, Institutul de studii si cercetari hidrotehnice;

*** Studii de hidrologie IX – Monografia hidrologica a râurilor din Banat, București 1964, Institutul de studii și cercetari hidrotehnice;

***Atlasul Cadastrului Apelor din România, Bucureşti, 1992;

***Raport privind starea mediului în judeţul Bihor, 2013;

***Planul de Management actualizat al Bazinului Hidrografic Mureș 2016-2021, Vol. – 1 2016;

***Planul de Management actualizat al Spaţiului Hidrografic Banat 2016-2021, Vol. 1 – 2016;

***Planul de Management actualizat al Spaţiului Hidrografic Crişuri 2016-2021, Vol. 1 – 2016;

***Planul de Management actualizat al Spaţiului Hidrografic Someș - Tisa 2016-2021, Vol. 1 – 2016;

***Planul de management al riscului la inundatii Administratia Bazinala de Apa Mureș, 2016;

***Planul de management al riscului la inundatii Administratia Bazinala de Apa Banat, 2016;

***Planul de Management al Riscului la Inundaţii, Administraţia Bazinală de Apă Someș – Tisa, 2016;

***Planul de Management al Riscului la Inundaţii, Administraţia Bazinală de Apă Crişuri, 2016;

***Planul de Management al Sitului Natura 2000 ROSPA0067 Lunca Barcăului, Anexa nr. 1

http://apmbh.anpm.ro/-/natura-2000---sci_-spa-

http://www.rowater.ro

http://biodiversitate.mmediu.ro/information-and-links/romania/arii-protejate-parcuri-nationale-si-naturale - parcurile naturale și naționale

http://enciclopediaromaniei.ro

http://www.rowater.ro/dacrisuri/Documente%20Repository/Planuri%20de%20aparare%20impotriva%20inundatiilor/Planuri%20bazinale/01%20Descriere%20Bazin%20Hidrografic.pdf

Project co-funded by the European Union (ERDF, IPA funds)

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