PROLINE-CE

WORKPACKAGE T2, ACTIVITY T2.1

SET UP OF PILOT SCECIFIC MANAGEMENT PRACTICES

D.T2.1.4 DESCRIPTIVE DOCUMENTATION OF PILOT ACTIONS AND RELATED ISSUES

PILOT ACTION 2.3: *TISZA CATCHMENT AREA*

September, 2017

Lead Institution	General Directorate of Water Management
Contributor/s	
Lead Author/s	Agnes Tahy
Date last release	06/2017

Contributors, name and surname	Institution
Magdolna Ambrus	General Directorate of Water Management OVF
Orsolya Both	General Directorate of Water Management OVF
Ágnes Tahy	General Directorate of Water Management OVF
Róbert Hegyi	General Directorate of Water Management OVF
Tamas Belovai	General Directorate of Water Management OVF

TABLE OF CONTENTS

1. Introduction

In Hungary 95% of drinking water abstraction is from groundwater, so drinking water abstraction from surface waters is unique case in Hungary. On the Pilot Area there are two waterworks (one is located at Szolnok from Tisza and another is at Balmazújváros from Keleti Main Channel) where drinking water abstraction is from surface water. The amount of supplied drinking water by these waterworks is significant, they also serve two big settlements (~200.000 residents).

2. Basic data about pilot action

2.1. Geographical description

The pilot area is located in East Hungary, on the Middle Tisza area of the Hungarian Plain (Alföld). The pilot area follows the line of the Tisza in NE-SW direction (Figure 1). The eastern part of the pilot area extends long in the direction of South by the Keleti Main Channel.

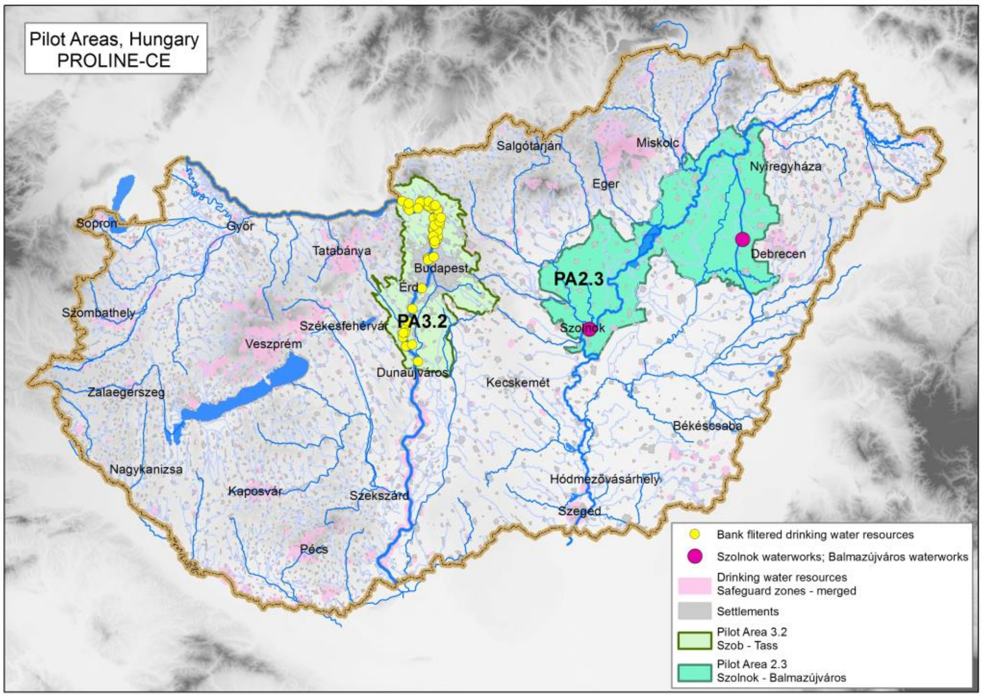

Figure 1: Location of the Tisza pilot area.

Borders of the pilot area are the borders of direct catchment areas. Northern border of the pilot area is the meeting point of the Tisza and the Lónyai Main Channel.

Towards the South-West the Sajó-Hernád meeting point is the border. Eastern boarder of the pilot area is the Zagyva-Tarna meeting point. Southern border is the edge of the catchment area of the Hortobágy Main Channel and the Kösely Main Channel.

The pilot area is a plain, with a very low altitude above sea level (avg. 85 – 150m) and a small average relative relief, i.e. 2 m/km2 on most parts. There is a more significant vertical relief in the area of Abádszalók which is covered by sand dunes, and the northern part of Hevesi Plains.

The lowest point of the pilot area is situated surroundings Szolnok (84,5 m a.s.l). The highest parts are located in the northern part of the area: Hevesi Plain, and east on the Hajdúhát (150 m a.s.l).

The morphologically monotonous surface is mostly low flood plain and higher flood-free plain. Abandoned riverbeds and oxbow lakes are located on the surface.

2.2. Geological description

The Northern part of the area is Taktaköz covered by fluvial sand and mud in a thickness of 100 -150 m from Pleistocene and fluvial mud, clay and sand from Holocene in a thickness of 6-10 m. Surrondings Szerencs is located Upper Miocene (Sarmatian stage) volcanic (Figure 2).

The North-West part of the pilot area is the Sajó-Hernád wash (alluvial-cone). This was established during Pleistocene. During Holocene it was engraved in its own wash (alluvial cone). The most widespread formation of the surface is the river pebble (often accompanied by sand and gravel).

The Sajó-Hernád wash is the deepest part of the Eastern North Hungarian Plain (Alföld). Its Southern edge is the flow of the River Tisza.

This area started to depress very dynamically after Pannonian stage (Upper Miocene). It has been accreted by rivers from Északi-középhegység with fine grained muddy sediment. The Pleistocene layers have a thickness of 400 m. The majority of sediments close to the surface are Holocene mud related to Tisza and Zagyva rivers. These rivers have significantly moved the sediment close to the surface.

On Hortobágy at the surface Holocene muds are found with a layer with a few meters of thickness; these sediments have been established during the flooding of Tisza. Under them a few meters thick Upper Pleistocene loess, infusion loess is installed.

The surface of Hajdúhát is covered by loess and loessy sand with a thickness of 2-10 m in the Southern area.

In the Southern part of Hajdúság, there are Pliocene layers covering significant reserves of natural gas (Hajdúszoboszló, Ebes). These are covered by 200 m Pleistocene river sediment. This has been built up by multiple rivers, including Sajó and Körös. From Würm, the various layers of river sediments were covered by fine grained muddy sediments.

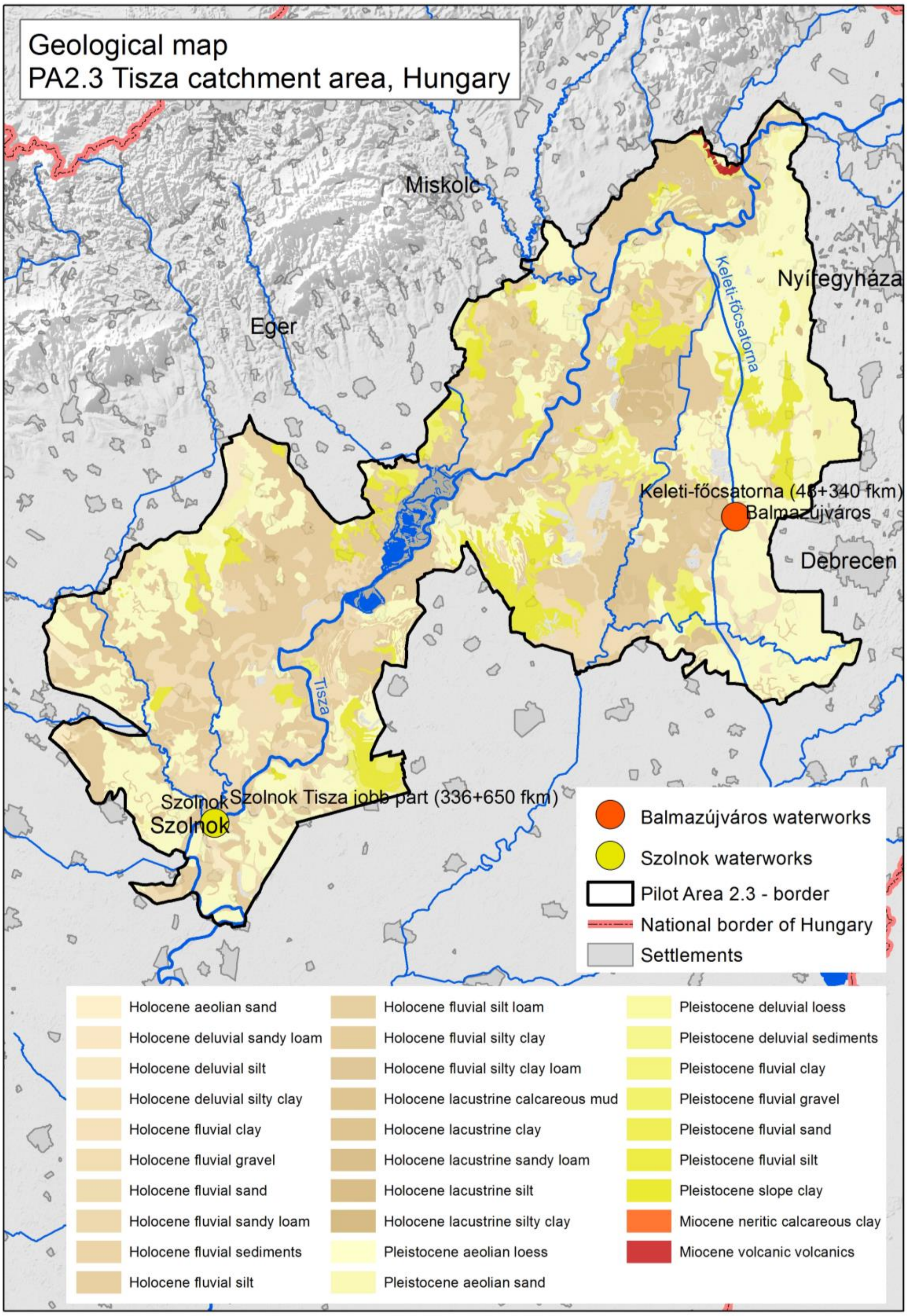

Figure 2: Geological map of the Tisza catchment area.

2.3. Pedology

Along the River Tisza the river related flood-mud and clayey soils (Figure 3) are dominant (they are inclined to salinization and hardly permeable). Soil-forming substrate is the alluvium of the floodplain or the former floodplain. The dynamics of the development of soils has a meadow character. On flood-protected sites often we can find meadow soils or alluvial soils.

In the area of Hortobágy different varieties of meadows solonetz soils occur (steppic meadow solonetz, solonetz meadow soil). In the case of meadow solonetz soils, the water permeability of the upper levels with low solubility salts allows rainwater infiltration.

Also in the Hortobágy area, the appearance of different meadow soils is characteristic.

In Hajdúság area, the occurrence of chalky chernozem soil is typical.

In the Zagyva River area at the edge of the Great Plain, chernozem and meadow soils are found.

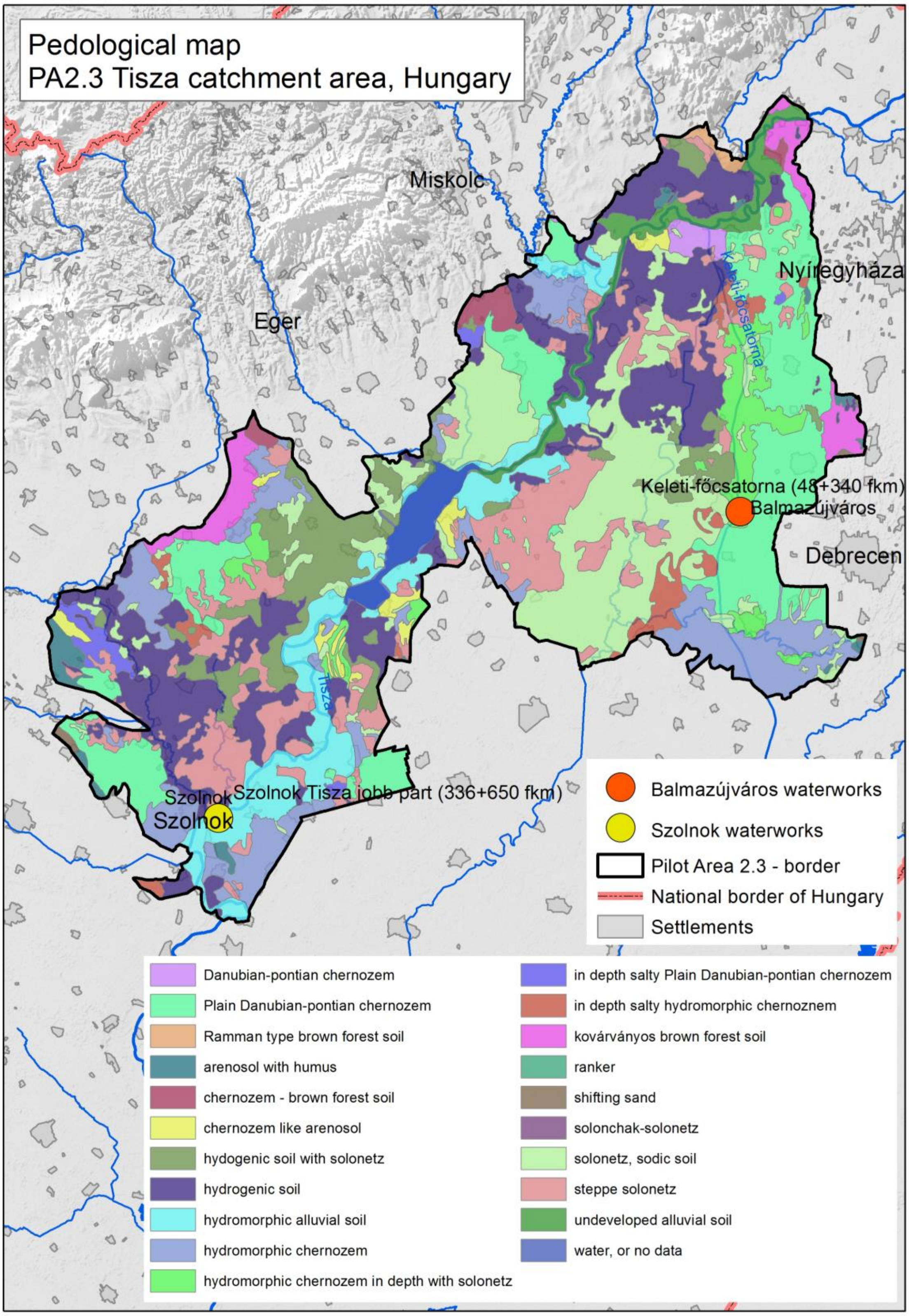

Figure 3: Pedological map of the Tisza catchment area.

2.4. Climate characteristics

The pilot area has a moderately warm and dry climate. The southern areas (near Szolnok) are bordered by the warm-dry zone. The long-term average of mean annual temperature is around 10ºC. In the northern part of the area, in the Taktaköz is 9.7 ºC, in the south of Szolnok is 10.4 ºC.

The annual rainfall in the north, around Szerencs, is 580-600 mm, which goes down to the south by about 480-510 mm (Szolnok flood plain, Southern Hortobágy). The latter is among the driest areas in the country. There is frequent water shortage and drought; other times, extensive flood and inland waters occur. The dominant wind direction in the pilot area is the NE, NW and SW.

It can be said that the Tisza-Lake region is the divide in the Northern Great Plain in terms of wind directions. To West from it NW winds, to the East the NE winds are the ruler. The evaporation value in the Great Plain may exceed 700 mm. The annual runoff can remain below 28 mm.

2.5. Hydrology

2.5.1. Surface waters

The main watercourse of the pilot area is Tisza (Figure 4), the second most significant river in Hungary. Its total Hungarian section is 595 km. The average incline of the riverbed is 0.02 m/km, average water velocity 1.2 m/s. Its average depth is 4-6 m, with depths exceeding 10 m in depth. The width of the riverbed is 150-200 m.

Waterway data of a few measuring stations along the Tisza:

Tiszadob: LNV: 783 cm, KÖQ: 464 m^3/s, NQ: 3920 m^3/s4

Tiszakeszi: LNV: 796 cm, KÖQ: 530 m^3/s, NQ: 4135 m^3/s

Szolnok: LNV: 1041 cm, KÖQ: 564 m^3/s, NQ: 3314 m^3/s

LNV: the highest water level; KÖQ: medium flow, NQ: greatest flow in certain period

Before the 19th century dredging work began, the Tisza swerved freely in most parts of the area, flooding most of the area with floods. After the flood clearance, the water management of the area has started, the natural estuaries of the inland drainage channels were eliminated and stable pumping stations were built.

Riverbed forms that determine the state of the small watercourses today were developed during the riverbed regulation works 1960-1980.

The pilot area includes 8 subunits of different size: Zagyva, Nagykőrös - sand ridge, Heves-plain, Nagykunság, Hortobágy-Berettyó, Hernád-Takta, Sajó with Bódva, Bükk and Borsodi Mezőség subunits.

A 220 km long drainage network drains the inland water area between Takta and Tisza.

Taktaköz inland water system consists of Takta-belt channel, Tiszadobi main channel, Ively-streamlet, Peres-streamlet, Northern belt channel (of dual operation) serving collection and drainage of inland waters.

The lower section of the Sajó River belongs to the pilot area, which is the right tributary of the Tisza. Characteristics of the Characteristic data of Sajó water regime around Ónod village, which lies directly on the boundary of the site: LNV: 520 cm, KÖQ: 63.1 m^3 /s, NQ: 710 m^3/s.

Hortobágy River and the Hortobágy-Berettyó main channel are the main recipients of the Eastern section of the pilot area catchment. Its natural course is 4 m^3/s. The water level fluctuation of the main channel at the estuary exceeds 8 meters.

Due to presence of the loess soil in the area, the surface water network is very scarce. Previously, while the Hortobágy was under natural conditions marshy areas were characteristic, but the after the drainage they were replaced by large-scale fishponds in many areas; later in some parts the swaps were artificially restored. Here the watercourse system is rarer, and the standing waters are more significant.

The hydrography and water regime of the area was significantly altered by the construction of the Tiszalök Irrigation System (TÖR) (Eastern and Western main channels and branches) due to the frequent water scarcity in the Great Plain. The Eastern and Western main channels are high-run type.

To the TÖR, the water supply takes place via the Eastern main channel, which branches-out above the Tiszalök Barrage. At Tiszavasvári, the water demand in the irrigation system is divided with two sluices. The Eastern main channel has an estuary capacity of 60.0 m^3/s. Its main water intake capacity is 45.0 m^3/s.

From the Eastern main channel at Ágota water distribution is carried out at 13,0 m^3/s to Hortobágy-Berettyó. Since 1994, the Western main channel has not been involved in the water supply of the Körös valley, but it can be involved in water discharge in an extreme drought situation.

The K-V (five) reservoir is directly connected to the Eastern main channel, which mainly serves as a water storage facility.

As the Hortobágy area is almost without outlet, a considerable amount of inland water can develop. Therefore, it was necessary to build inland drainage channels.

The Tisza Lake (Kiskörei reservoir), which became as a result of the damming on Tisza at Kisköre, became an important wetland habitat (originally due to the need for irrigation). Lake Tisza is a highly modified, still water body with a surface of 127 km^2. To prevent turning into a marshy area, a rinsing channel system has been built.

The Nagykunsági main channel branches-out from the Tisza Lake. It is somewhat meandering flowing within a deep hollow. It is an artificial water body with a length of 74.33 km, the recipient of which is the Hármas-Körös River.

The Nagykunság irrigation system is supplied with irrigation water through the gravity main water intake sluice at the 144 + 642 tkm section of the left bank of the Tisza lake. KÖQ: 26 m^3/s.

Zagyva is the right-hand tributary of the Tisza and adheres to it at the town of Szolnok. The Zagyva River Basin is almost entirely located in Hungary. Its water regime is impetuous, within its upper section the flood waves are passing through quickly. In the lower section of the Zagyva (this belongs to the pilot area) the highest discharge is 198 m3/s, the lowest Q is 0.4 m^3/s. Apart from the flood period, the water discharge is low.

During the flood, the damming of the Tisza has a major role in the formation of a high water level in the estuary. High water levels in the last few years have been coupled with high permanence at the mouth.

Within the pilot area, there is a significant amount of oxbow lakes, mainly along the Tisza River. Another characteristic surface water type of the pilot area (specifically the Hortobágy), a group of alkaline lakes. It is characteristic for alkaline lakes that their extension varies greatly, shrinking, even possibly drying out in summer.

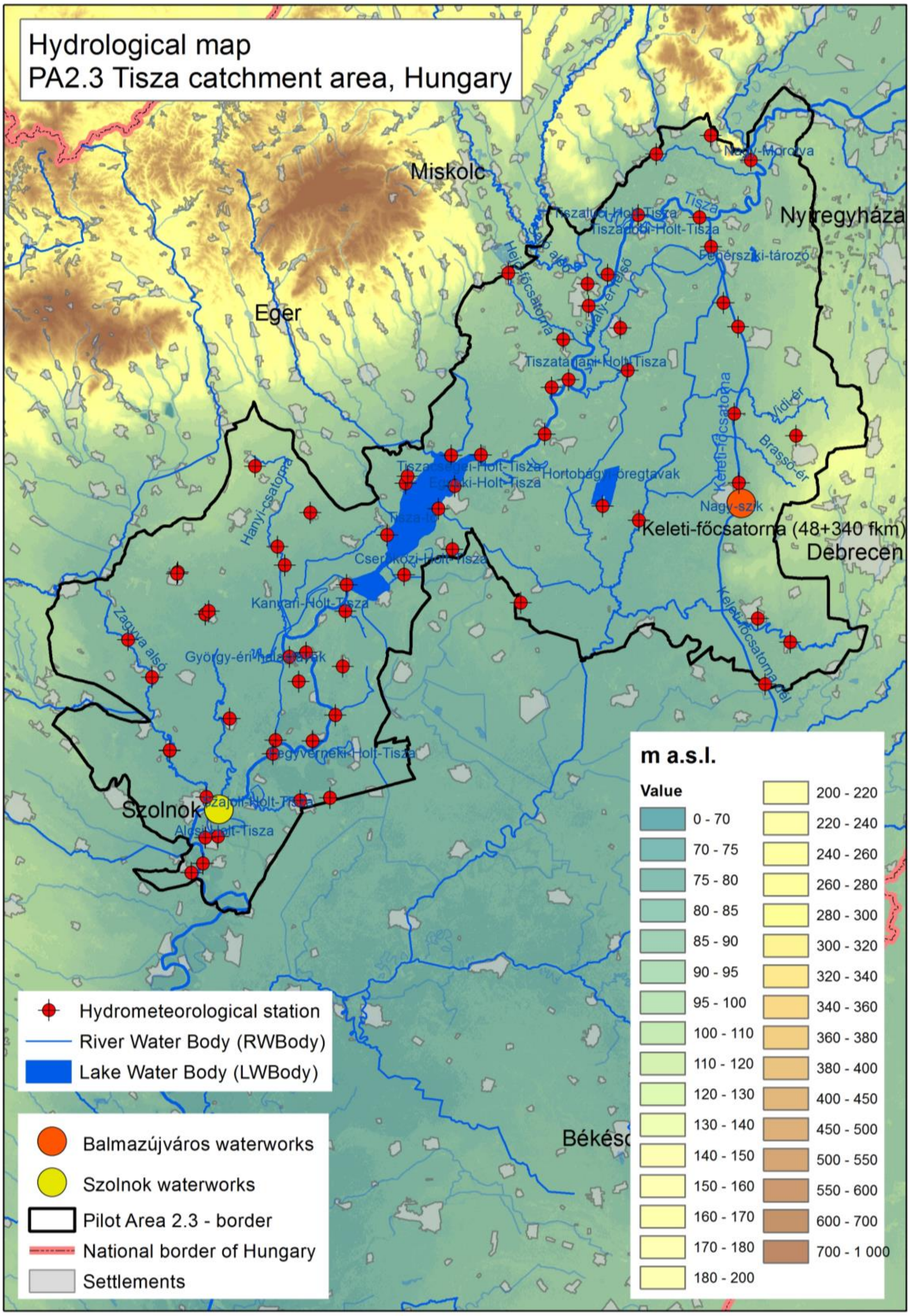

Figure 4: Hydrological map of the Tisza catchment area.

2.5.2. Flood issues

Floods in the Tisza River Basin (Figure 5.) can form at any season as a result of rainstorm, snowmelt or the combination of the two. Snowmelt without rainfall rarely occurs in the Tisza Basin and floods resulting from this account for no more than 10-12% of the total amount. The large flood waves are generated more frequently in late winter and early spring. The warm period from May to October accounts for nearly 65% of total floods. However maximum discharges and the volume of restricted flow of floods in the cold period generally exceed those observed in warm period. The floods generated in Ukraine, Romania and the Slovak Republic are mainly rapid floods and last from 2-20 days. Large floods on the Tisza in Hungary, in contrast, can last for as long as 100 days or more (the 1970 flood lasted for 180 days). This is due to the very flat characteristic of the river in this region and multi-peak waves which may catch up on the Middle Tisza causing long flood situations. Also characteristic of the Middle Tisza region is that the Tisza floods often coincide with floods on the tributaries, which is especially dangerous in the case of the Somes/Szamos, Crasna/Kraszna Bodrog, Cris/Körös and Mures/Maros Rivers. Recent severe floods have highlighted the problem of the inundation of landfills, dump sites and storage facilities where harmful substances are deposited and toxic substances can be transferred into the water posing a clear threat to the environment. Such potential threats were recognised by the ICPDR and an inventory of old contaminated sites in potentially flooded areas in the Danube River Basin was compiled in 2002- 2003, updated in 2017 ((Potential Accident Risk Sites in the Danube River Basin,ICPDR/DANUBIS). Long-observations of level regime and maximum flow provide evidence of the distribution of extremely high severe floods in the Tisza River Basin along the Upper, Middle and Lower Tisza and its tributaries. However, not all high upstream floods cause severe floods along the Middle or Lower Tisza due to attenuation. Following a relatively dry decade, a succession of abnormal floods has annually set new record water levels on several gauges over the last four years. Over 28 months between November 1998 and March 2001, four extreme floods travelled down the Tisza River. Large areas were simultaneously inundated by runoff and rapid floods of abnormal height on several minor streams. The extreme Tisza flood in April 2006 was preceded by several floods in February and March generated by melting snow and precipitation. In the 19th century, river floodplains traditionally supported flood-tolerant land uses, such as forests, meadows and fishponds. Since then, land development interests have changed to modern agricultural production demanding low and tightly-regulated water levels and protection from seasonal inundation. This trend has been facilitated by the availability of arable land, crop intervention payments and grant aid for drainage, including pumped drainage within floodplains. This has led to the development of arable agriculture that demands low water levels in associated rivers. Industrial and urban building has also increased within drained floodplains lasting recent decades. In Hungary, work to drain the Tisza wetlands began in the 19th century and today some 500,000 people – 5% of Hungary's population – live on land reclaimed from the Tisza. Efforts to reduce flood impacts by building higher dikes and continued river bed regulation have resulted in a deposit of silt within the main bed which has inadvertently increased flood risks. In addition to the altered nature of floodplains, the reduction in upper and mid-catchment water retention leads to more flood events downstream where river channels and small floodplains no longer contain peak water levels, even for minor flood events. The lack of coordinated mechanisms to mitigate floods in the upper catchment may lead to compounded impacts downstream. When flooding occurs, industrial sites, mining areas, agricultural fields and municipal waste facilities can become inundated and pollute the waters of the Tisza Basin.

In continuation remarkable floods in the Tisza River Basin ere listed:

- March 1879: devastation of Szeged claiming 151 victims, 94% of houses destroyed;
- March 1888: extreme floods with new peaks, resulting in more than 210 dike breaches across the basin, claiming 2 victims and inundating more than 100 communities including 9 towns;
- December 31, 1947: flash flood on the Upper-Tisza resulting in dike breaches at Tivadar, inundating 300 km^2 including 9 communities;
- February-March 1966: record floods and dike breaches in the Körösök/Berettyó system;
- May 1970: extreme floods in the entire Tisza River Basin, dike breaches, victims and substantial damages in the Somes and Mures Basins, record flood stages along the Middle and Lower Tisza;
- October 1974: record floods along the Bodrog, Hernád, Sajó and Zagyva-Tarna Rivers, several dike breaches along the Tarna River; o July 1975: record floods along the Mures River;
- March-April 1979: new flood peaks along the Bodrog and Middle-Tisza between Tokaj and Tiszafüred;
- Between November 1998 and March 2001, four extreme flood waves travelled down the Tisza River; ▫ November 1998: The Upper Tisza Basin in Transcarpathia, Ukraine experienced catastrophic losses due to floods, landslides and mudflows with 17 victims claimed; successful emergency operation in Hungary against new peaks exceeding those on record by 20-93 cm;
- March 1999: extreme flood along the Bodrog and Middle Tisza, exceeding previous maximum on the Bodrog River at Sárospatak by 52 cm, on the Tisza River at Szolnok by 65 cm;
- April 2000: extreme floods along the Middle Tisza, previous maximum water stages were exceeded along river section of 471 km (at Szolnok +67 cm above the record of 1999); extraordinary alert along 1342 km flood embankments of the River Tisza and tributaries; total length of flood embankments in emergency: 2980 km; days in emergency/extraordinary emergency: 114/32
- March 2001: extreme floods along the Upper Tisza, several dike breaches and 9 victims in Ukraine, in Hungary previous peaks were exceeded between Tiszabecs and Záhony in a magnitude of 1-56 cm; dike breach on the right bank of Tisza River near Tarpa, 26,000 ha flooded in Hungary and another 6,000 ha in Ukraine, 8 1/2 communities were flooded and evacuated, another 9 communities were successfully defended by confinement activities).

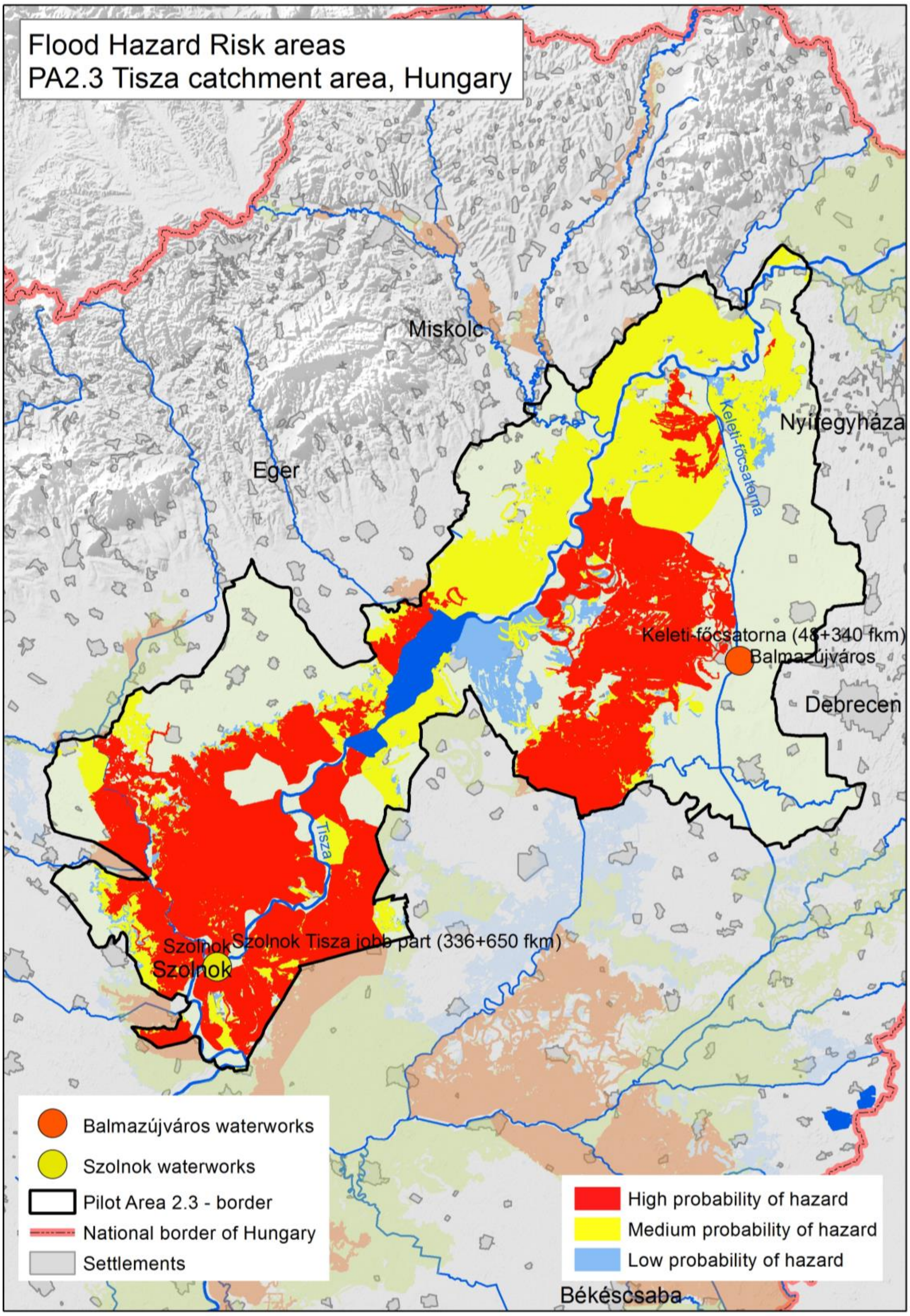

Figure 5: Flood hazard risk areas within the Tisza catchment area.

2.6. Hydrologeology

In the Great Hungarian Plain the average depth of the groundwater under the terrain is 1-5 meters, the groundwater level fluctuates primarily due to the precipitation. The groundwater has a significant role in the functioning of the highly valuable and unique ecosystem of the Great Plain -the steppe - thus significance is further increased by the fact that the westernmost occurrence of such ecosystems are within our country. In terms of phreatic water, the Pleistocene formations are the most important aquifer layers of the Great Plain (Figure 6). On the edge of the Great Plain, the coarse grain layers situated close to the surface, while in other areas generally the lower Pleistocene layers are the best aquifers. The main aquifer layer on the northern edge of the Great Plain can be found within the 650 m deep upper Pannonian subfloor, while in the Körös sinking at 700 m depth, both supplied by sand groups. Accordingly, there are significant water resources at the foothills of the Northern Mountain Range, along the Upper Tisza and in Hajdúság and in Viharsarok. The majority of water supplied by the artesian wells is mainly used as drinking water, but in certain places may contain mineral substances of natural origin, which can make their use difficult (e.g. iron, arsenic).

Due to the geothermal gradient higher than average, this area is rich in thermal waters (Hajdúszoboszló, Mezőkövesd).

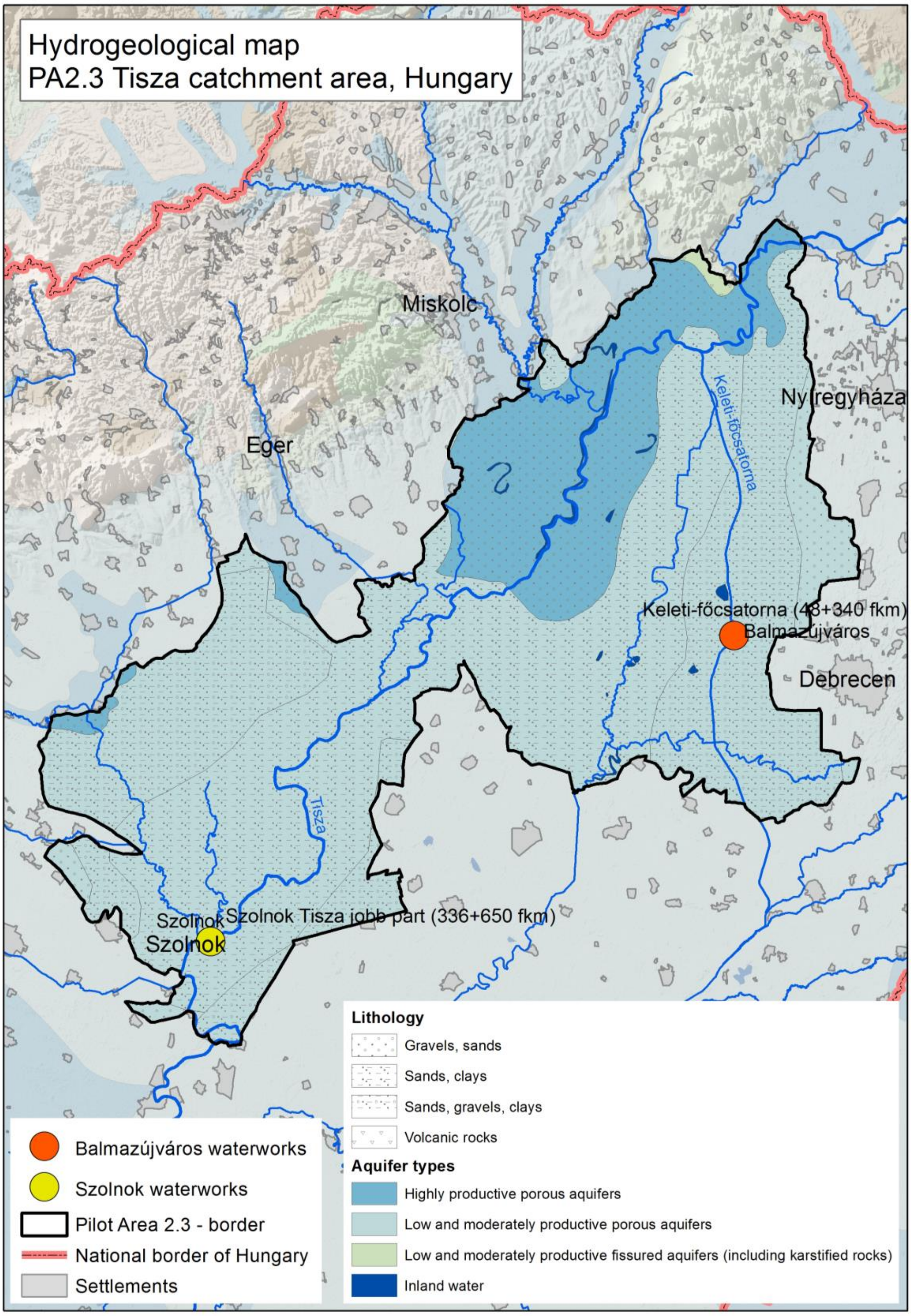

Figure 6: Hydrogeological map of the Tisza catchment area.

2.7. Land use

Land use map according to CORINE land cover map is presented in Figure 7. Percentages of particular land use category according to CORINE classification is presented in Table 1.

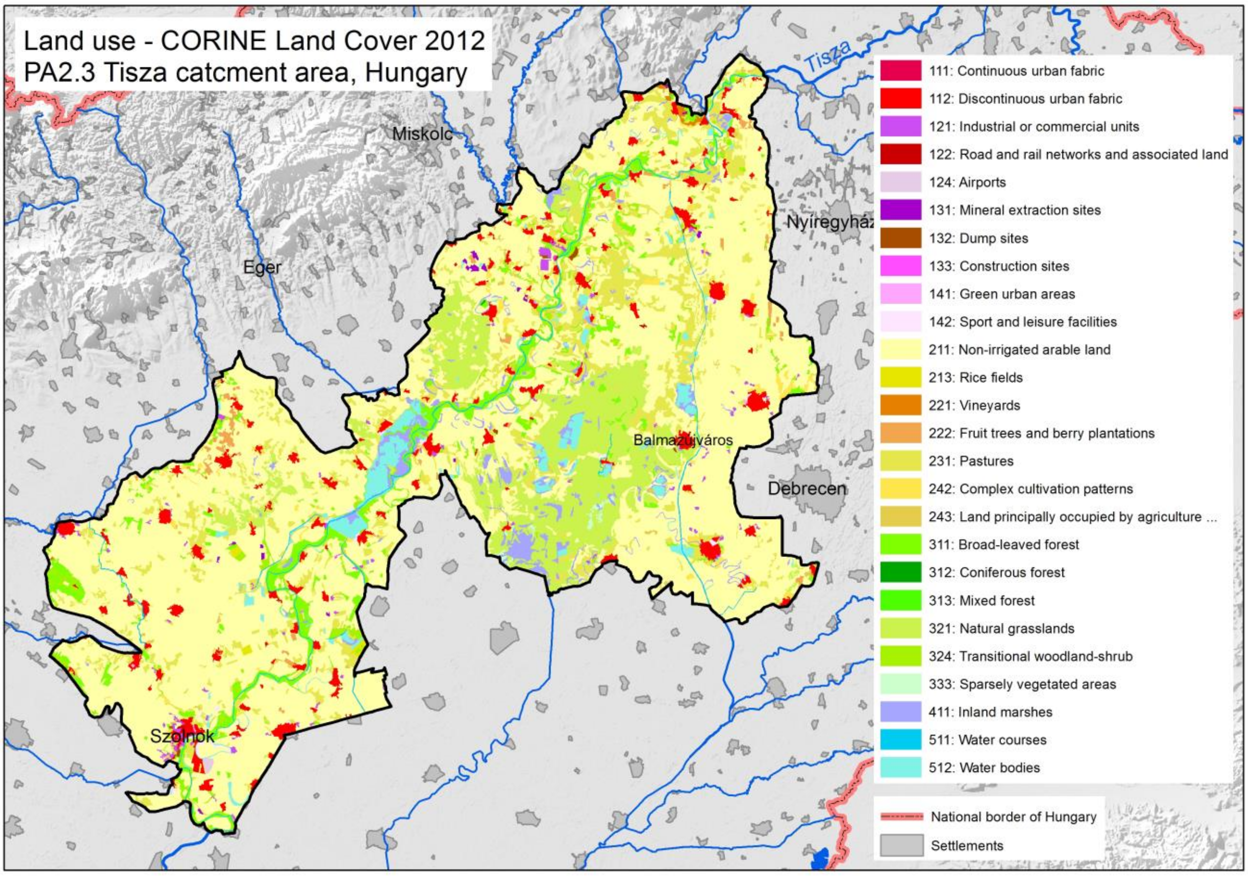

Figure 7: CORINE land cover map of the Tisza catchment area.

The highest rate is represented by the non-irrigated arable land (35,42%), the broad-leaved forest (17,36%) discontinuous urban fabric (14,06%,), and the pasture (6,44%).

Table 1: Shares of particular CORINE land cover categories in the Tisza catchment area.

CLC code	LABEL 3	Surface area (%)	Surface area (km^2)
111	Continuous urban fabric	0,34	13,71
112	Discontinuous urban fabric	14,06	559,85
121	Industrial or commercial units	3,27	130,39
122	Road and rail networks and associated land	0,75	29,84
123	Port areas	0,07	2,86
124	Airports	0,55	21,92
131	Mineral extraction sites	0,32	12,64
132	Dump sites	0,08	3,33
133	Construction sites	0,14	5,47
141	Green urban areas	0,38	15,19
142	Sport and leisure facilities	2,51	99,99
211	Non-irrigated arable land	35,42	1 410,24
213	Rice fields	0	0
221	Vineyards	0,58	23,06
222	Fruit trees and berry plantations	1,04	41,55
231	Pastures	6,44	256,57
242	Complex cultivation	3,03	120,48
243	Land principally occupied by agriculture, with significant areas of natural vegetation	1,71	68,04
311	Broad-leaved forest	17,36	691,31
312	Coniferous forest	0,71	28,25
313	Mixed forest	1,08	42,99
321	Natural grassland	2,81	111,98
324	Transitional woodland shrub	3,39	135,16
331	Beaches, dunes, and sand plains	0	0
333	Sparsely vegetated areas	0,1	3,81
411	Inland marshes	0,25	10,02
412	Peat bogs	0	0,18
511	Water courses	2,43	96,57
512	Water bodies	1,17	46,54

2.8. Protected areas

According to the Water Framework Directive (2000/60/EC), ANNEX IV: The register of protected areas required under Article 6 shall include the following types of protected areas:

- areas designated for the abstraction of water intended for human consumption under Article 7;
- areas designated for the protection of economically significant aquatic species;
- bodies of water designated as recreational waters, including areas designated as bathing waters under Bathing Water Directive (76/160/EEC);
- nutrient-sensitive areas, including areas designated as vulnerable zones under Nitrates Directive (91/676/EEC) and areas designated as sensitive areas under Urban waste water treatment Directive (91/271/EEC); and
- areas designated for the protection of habitats or species where the maintenance or improvement of the status of water is an important factor in their protection, including relevant Natura 2000 sites designated under Habitats Directive (92/43/EEC(1)) and Birds Directive (79/409/EEC(2)).

There are large areas of Natura 2000 on the central and northern parts of the Pilot Area (Table 2 and Figure 8). The SAC types cover 1720 km2, the SPA types cover 2276 km2, and between them there are overlaps.

The national protected areas (National Parks, Landscape Protection Areas and Nature Conservation Areas) cover altogether 1244 km2, and there are 584 km2 Ramsar areas on the Pilot Area (Table 3 and Figure 9). Natural bathing waters are also protected, of which 12 are located on the Pilot Area (Figure 10). A significant part (65%) of the Pilot Area is nitrate-sensitive, an area of 4939 km2, of which 1636 km^2 (21%) is nutrient-sensitive area also (Figure 10).

Table 2: Natura 2000 SPA and SAC sites on Surface drinking water resources Szolnok and Balmazújváros

OBJECTID	Name	Code	Type
1	Girincsi Nagy-erdő	HUBN20029	SAC
2	Hejő mente	HUBN20030	SAC
3	Mezőcsáti Rigós	HUBN20031	SAC
4	Tiszakeszi-morotva	HUBN20032	SAC
5	Borsodi-Mezőség	HUBN20034	SAC
6	Poroszlói szikesek	HUBN20035	SAC
7	Kétútközi-legelő	HUBN20036	SAC
8	Nagy-Hanyi	HUBN20037	SAC
9	Nagy-fertő-Gulya-gyep-Hamvajárás szikes pusztái	HUBN20040	SAC
10	Pélyi szikesek	HUBN20041	SAC
11	Kesznyéteni Sajó-öböl	HUBN20069	SAC
12	Hajdúszoboszlói szikes gyepek	HUHN20069	SAC

13	Alattyáni Berki-erdő	HUHN20074	SAC
14	Pusztamizsei-erdő	HUHN20079	SAC
15	Újszász-jászboldogházi gyepek	HUHN20081	SAC
16	Jászapáti-jászkiséri szikesek	HUHN20085	SAC
17	Alsó-Zagyva hullámtere	HUHN20089	SAC
18	Hajdúszováti gyepek	HUHN20092	SAC
19	Tiszalöki szikesek	HUHN20114	SAC
20	Tiszavasvári szikesek	HUHN20116	SAC
21	Czakó-tó	HUHN20121	SAC
22	Szalóki Nagy-fertő	HUHN20139	SAC
23	Úrbéri-legelő	HUHN20140	SAC
24	Tápiógyörgye-Újszilvási szikesek	HUDI20024	SAC
25	Rekettyés	HUDI20043	SAC
26	Hortobágy	HUHN20002	SCI, SAC
27	Tisza-tó	HUHN20003	SAC
28	Derecske-konyári gyepek	HUHN20009	SCI,SAC
29	Közép-Tisza	HUHN20015	SAC
30	Debrecen-hajdúböszörményi tölgyesek	HUHN20033	SAC
31	Hernád-völgy és Sajóládi-erdő	HUAN20004	SAC
32	Bodrogzug és Bodrog hullámtere	HUBN20071	SAC
33	Tokaji Kopasz-hegy	HUBN20072	SAC
34	Jászalsószentgyörgyi erdő	HUHN21162	SCI
35	Jászkarajenői puszták	HUDI21056	SCI
36	Felső-Tisza	HUHN20001	SAC
37	Tiszaújvárosi ártéri erdők	HUBN22096	pSCI
1	Borsodi-sík	HUBN10002	SPA
2	Hevesi-sík	HUBN10004	SPA
3	Kesznyéten	HUBN10005	SPA
4	Hortobágy	HUHN10002	SPA
5	Jászság	HUHN10005	SPA
6	Közép-Tisza	HUHN10004	SPA
7	Felső-Tisza	HUHN10008	SPA
8	Jászkarajenői puszták	HUDI10004	SPA
9	Zempléni-hegység a Szerencsi-dombsággal és a Hernád-völggyel	HUBN10007	SPA
10	Bodrogzug-Kopasz-hegy-Taktaköz	HUBN10001	SPA

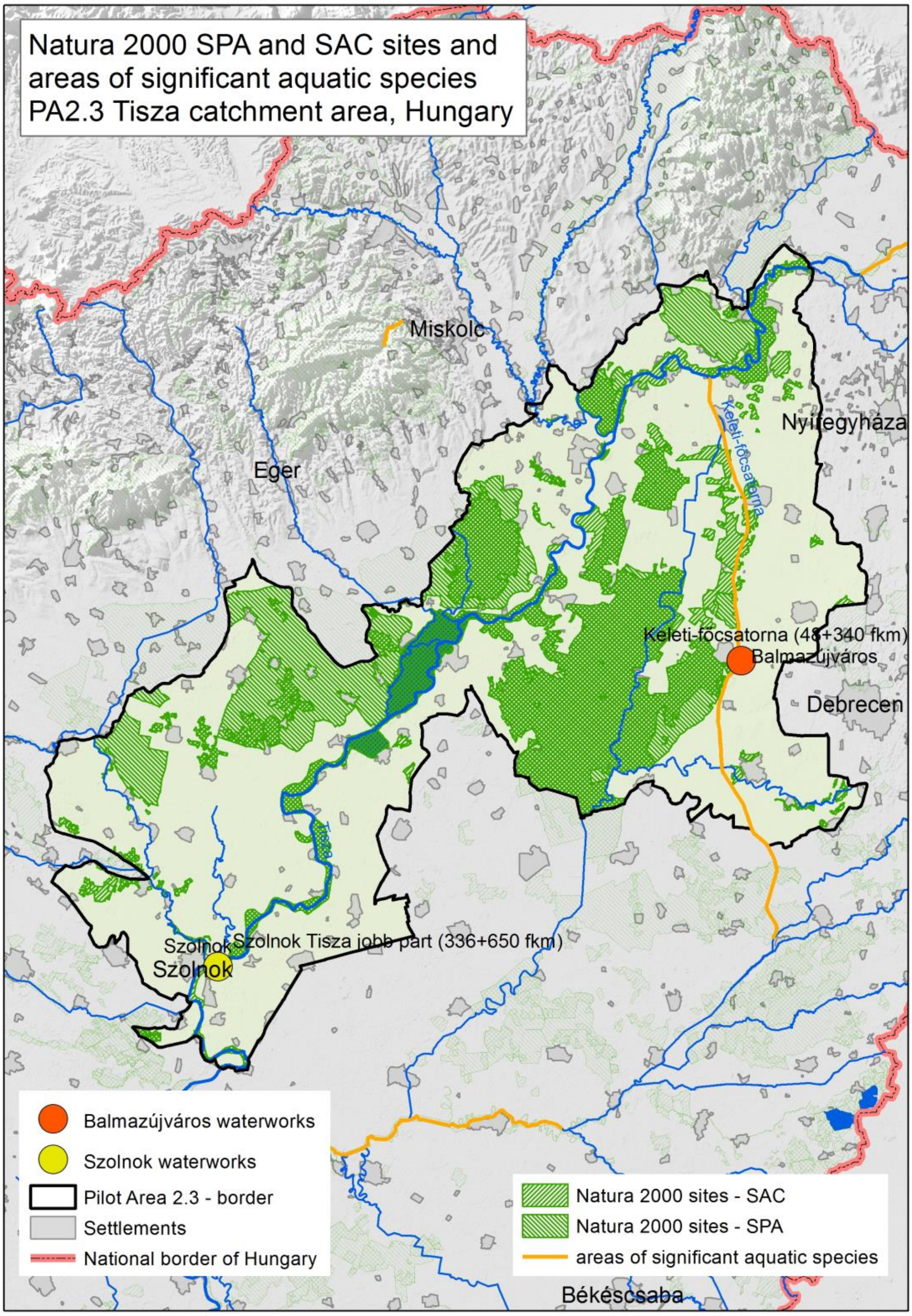

Figure 8: NATURA 2000 SPA and SAC sites and areas of significant aquatic species within the Tisza catchment area.

Table3: Nature Reserve and Ramsar Sites on Surface drinking water resources Szolnok and Balmazújváros

OBJECTID	Name	MOSAIC	Nature_Park	Code	Type
1	Bihari-sík Tájvédelmi Körzet		Hortobágyi NPI	284/TK/98	LPA
2	Hortobágyi Nemzeti Park	Ároktő	Hortobágyi NPI	97/NP/73	NP
3	Tiszadobi-ártér természetvédelmi terület	Tiszadobi-ártér TT	Hortobágyi NPI	148/TT/77	NR
4	Hortobágyi Nemzeti Park		Hortobágyi NPI	97/NP/73	NP
5	Hortobágyi Nemzeti Park		Hortobágyi NPI	97/NP/73	NP
6	Hortobágyi Nemzeti Park		Hortobágyi NPI	97/NP/73	NP
7	Hortobágyi Nemzeti Park		Hortobágyi NPI	97/NP/73	NP
8	Hortobágyi Nemzeti Park		Hortobágyi NPI	97/NP/73	NP
9	Hortobágyi Nemzeti Park		Hortobágyi NPI	97/NP/73	NP
10	Hortobágyi Nemzeti Park		Hortobágyi NPI	97/NP/73	NP
11	Hortobágyi Nemzeti Park		Hortobágyi NPI	97/NP/73	NP
12	Hortobágyi Nemzeti Park		Hortobágyi NPI	97/NP/73	NP
13	Hortobágyi Nemzeti Park		Hortobágyi NPI	97/NP/73	NP
14	Borsodi-Mezőség Tájvédelmi Körzet		Bükki NPI	212/TK/89	LPA
15	Borsodi-Mezőség Tájvédelmi Körzet		Bükki NPI	212/TK/89	LPA
16	Tiszadorogmai Göbe-Erdő természetvédelmi terület	Tiszadorogmai Göbe-Erdő TT	Hortobágyi NPI	175/TT/84	NR
17	Tápió-Hajta Vidéke Tájvédelmi Körzet		Duna-Ipoly NPI	287/TK/98	LPA
18	Közép-tiszai Tájvédelmi Körzet	Közép-tiszai TK	Hortobágyi NPI	158/TK/78	LPA
19	Hortobágyi Nemzeti Park	HNP-Tiszató	Hortobágyi NPI	97/NP/73	NP
20	Erdőtelki-égerláp természetvédelmi terület	Erdőtelki-égerláp TT	Bükki NPI	206/TT/89	NR
21	Erdőteleki arborétum természetvédelmi terület	Erdőteleki arborétum TT	Bükki NPI	19/TT/50	NR
22	Tarcali Turzó-dűlő	Tarcali Turzó-dűlő	ANPI	320/TT/09	NR
23	Tokaj-Bodrogzug Tájvédelmi Körzet		Aggteleki NPI	183/TK/86	LPA
24	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
25	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
26	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
27	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
28	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
29	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
30	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
31	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
32	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
33	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
34	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
35	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
36	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
37	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
38	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
39	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
40	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
41	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
42	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
43	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
44	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA

45	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
46	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
47	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
48	Hevesi Füves Puszták Tájvédelmi Körzet		Bükki NPI	258/TK/93	LPA
49	Tiszavasvári Fehér-szik természetvédelmi terület		Hortobágyi NPI	142/TT/77	NR
50	Tiszavasvári Fehér-szik természetvédelmi terület		Hortobágyi NPI	142/TT/77	NR
51	Kesznyéteni Tájvédelmi Körzet		Bükki NPI	232/TK/90	LPA

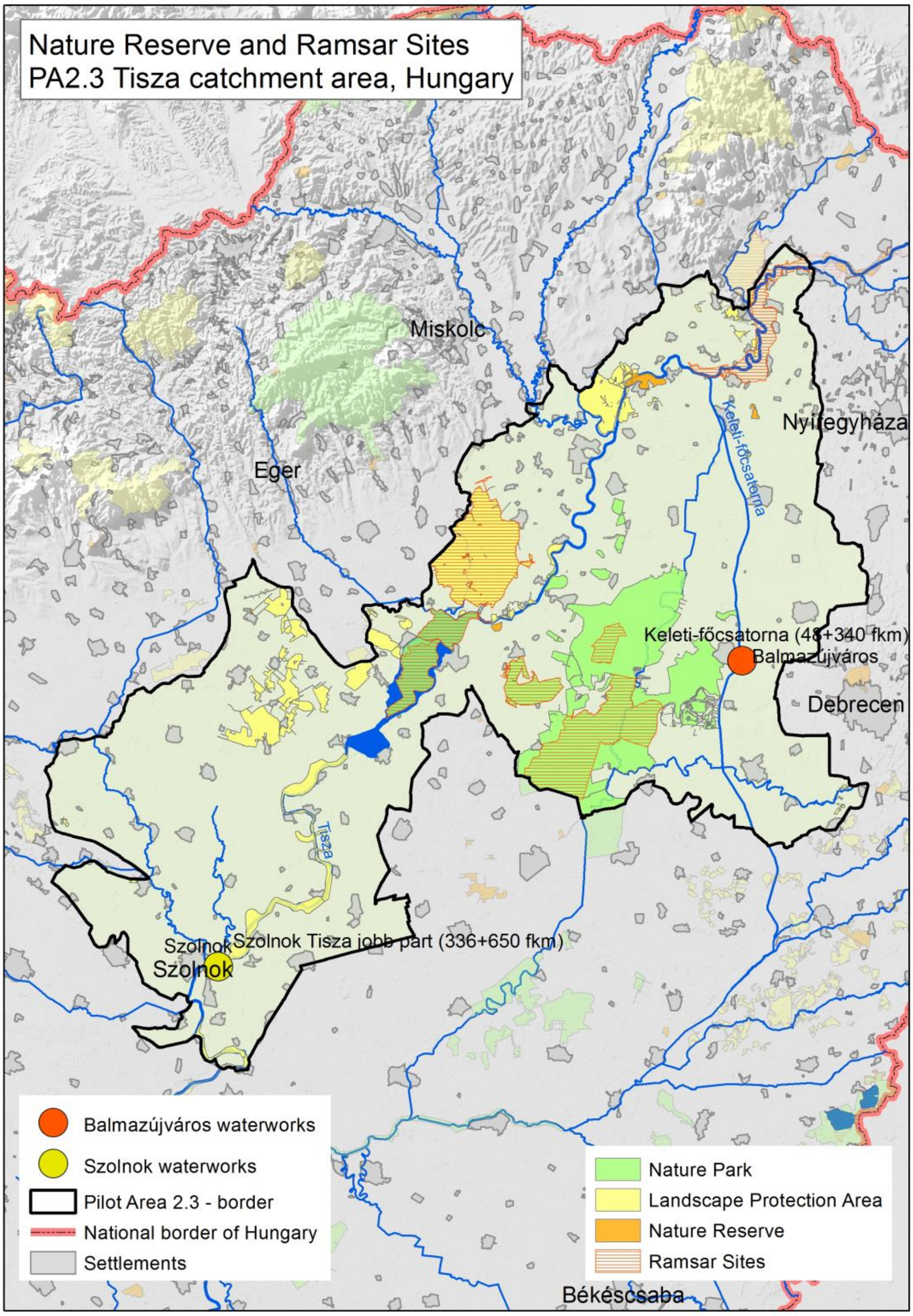

Figure 9: Nature reserves and RAMSAR sites within the Tisza catchment area.

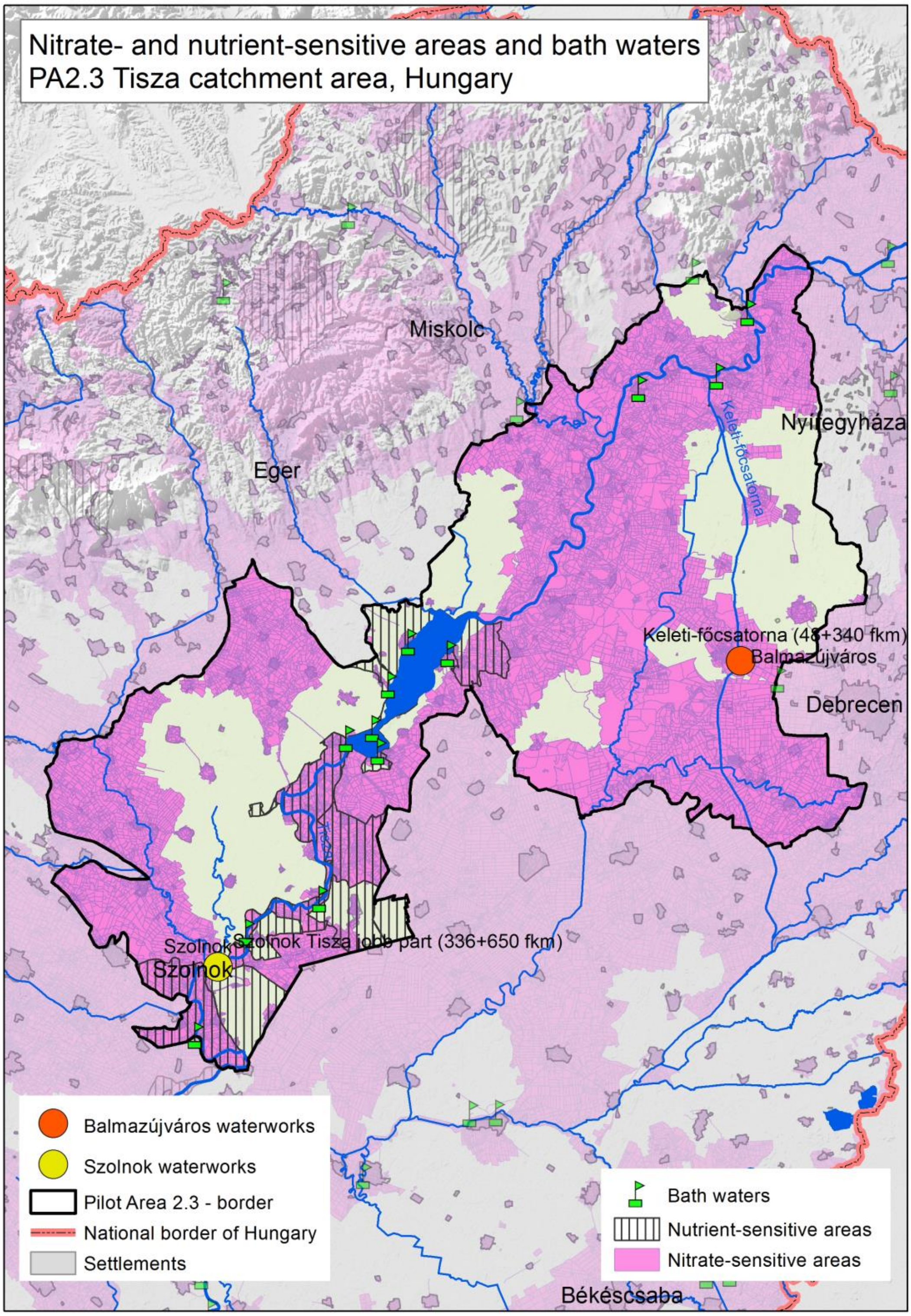

Figure 10: Nitrates and nutrient sensitive areas and bathing waters within the Tisza catchment area.

3. Water supply in the pilot action

3.1. Drinking water sources

The main source of drinking water in the pilot site is groundwater from porous aquifers. Most of these groundwater resources are not vulnerable for contamination arriving from surface. There are also 6 perspective drinking water resources (of which 4 bank-filtered resources), with 222 million m^3/day capacity.

On the Tisza Pilot Area we are focusing to the surface drinking water abstractions (Figure 11) located at Szolnok (River Tisza) and at Balmazújváros (Keleti Main Channel). The surface water drinking water abstractions are more vulnerable because of the lack of natural protected layers. The traveltime of the contamination is much shorter, so actions must be taken prompt.

The **Szolnok Surface Waterwork** is situated in the north-eastern border of Szolnok (Figure 11), on the right riverside of the Tisza. The capacity of the waterworks is 50 000 m^3/d, the settlements supplied are: Szolnok and 7 surrounding settlements (Rákóczifalva, Rákócziújfalu, Szajol, Szászberek, Újszász, Zagyvarékas és Tószeg; Figure 12).

Considering it the River Tisza is very variable in quantitative and qualitatively aspects, for secure drinking water supply was built a reserve surface water abstraction. The Alcsi Holt – Tisza reserve surface drinking water resource in qualitative aspect is total independent from the River Tisza. It will be activating in case of havaria-like pollution that comes on the River Tisza. The oxbow (the intake works) is situated to 2-3 km from the water treatment plant in south direction. The capacity is 30 000 m^3/d.

Balmazújváros – Keleti Main Channel Surface Waterwork is situated on south-eastern part of Balmazújváros outer area (Figure 11), on the right riverside of the Keleti Main Channel. The water treatment plant is situated to 1 km from the water abstraction, in east of the Keleti Main Channel. The capacity of the waterworks is 30 000 m3/d, the treated water is 13 000 m3/d. The settlements supplied with exclusively treated surface drinking water are: Nagyhegyes, Nagyhegyes-Elep, Balmazújváros-Nagyhát, Debrecen-Nagymacs, Debrecen-Ondód (Figure 12). Debrecen and Debrecen –Józsa district are supplied with mixed water (treated surface water and groundwater).

In case of the surface drinking water abstractions the waterworks have smaller DWPZs like in the case of groundwater drinking waterworks. Therefore the appropriate land uses are also important outside the DWPZs particularly in upstream region. Upstream of the Szolnok waterworks there are the reservoir Kisköre and the Lake Tisza, which moderate the impact of floods and secure the minimum level in dry period. The Keleti Main Channel is more protected, because the water level is driven and the discharges into it are not allowed.

The system is integrated in TIKEVIR (River Tisza - River Körös Water Management System) which is one of the most connected water management system in Europe. The goal is complementing the water resource from the Tisza by water transfer to regions of water scarcity. With this action it is possible to decrease the influence of climate change. The two most important river-training works in the TIKEVIR system are the Tiszalök Barrage and the Kisköre Barrage.

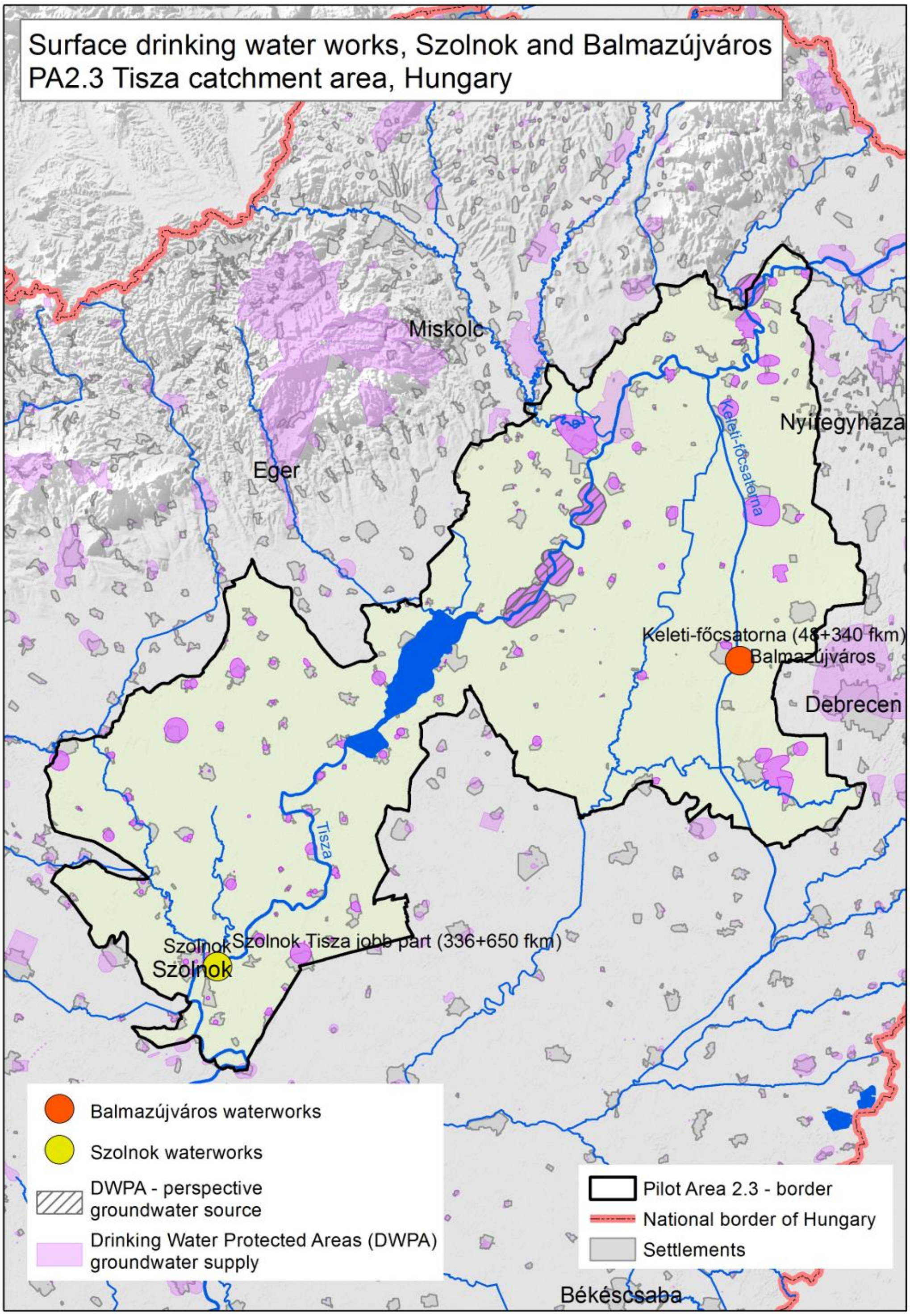

Figure 11: Surface drinking water works within the Tisza catchment area.

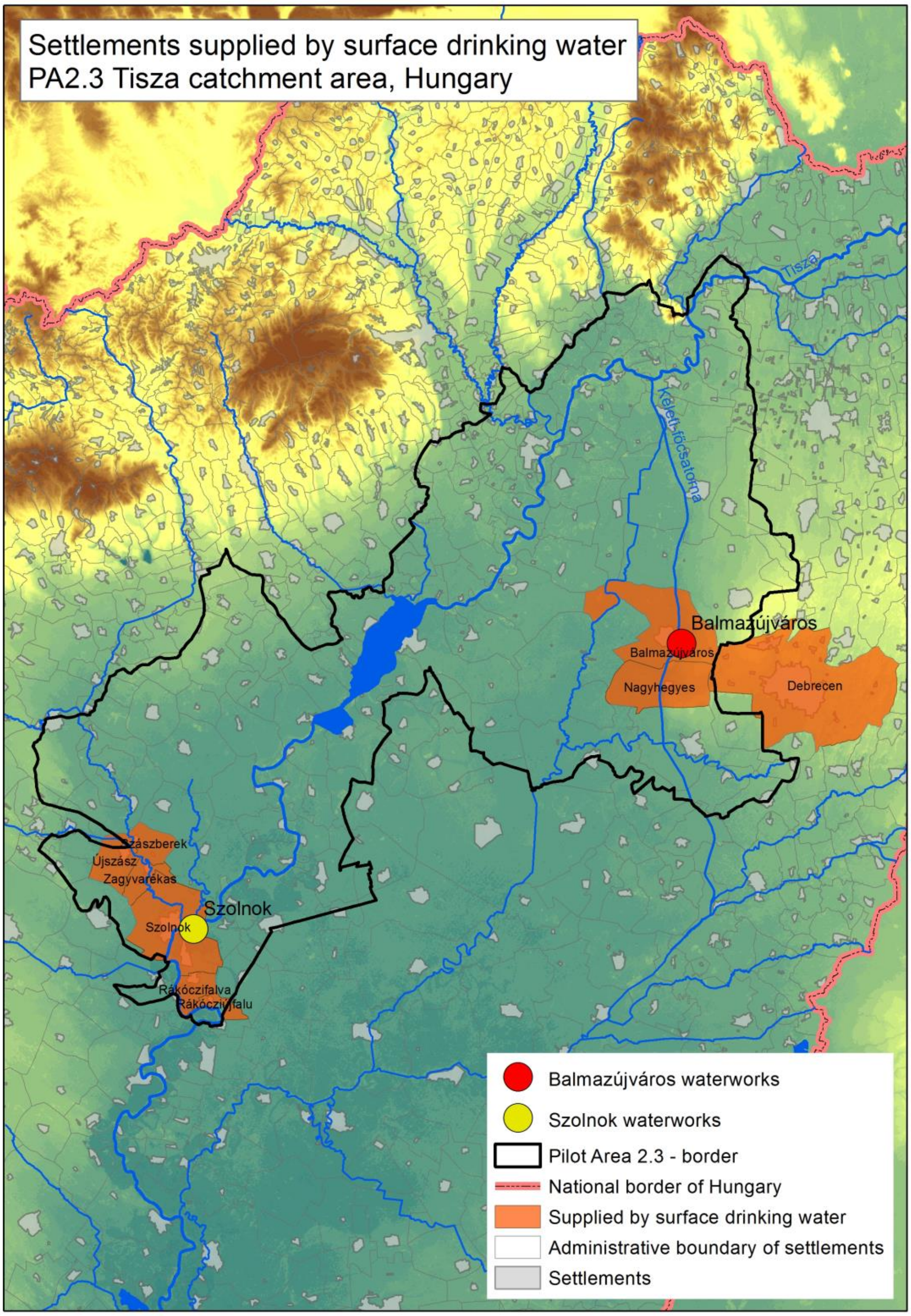

Figure 12: Settlements, supplied by surface drinking water within the Tisza catchment area.

3.2. Drinking water protection

The Balmazújváros water intake waterworks has not DWPZs delimitated and assigned by authorities, but because of the Keleti Main Channel conditions (it is a channel raised, there are not waste water discharges) can be considered relatively protected. The main danger presents the possible pollution from the River Tisza, in particular reference to the heavy metals.

The DWPZs of Szolnok drinking water resource has been determined (Figure 13); the designation by authority is currently in progress. The waterworks is situated in the eastern border of the city, on the built-in area, but the DWPZs are not affected by the dense built-in zones. Half of the outer DWPZ is covered by forests; other main land use is agriculture, particularly kitchen-garden. Despite of determined DWPZs, also in this case the most danger presents the possible pollution from the River Tisza, in particular reference to the heavy metals.

In January of 2000 cyanide pollution arrived from Romania in River Szamos (river mouth to Tisza at Vásárosnamény-HU) which caused ecological damage and the necessity of prohibition of surface water abstractions. Therefore both of the surface drinking water works was stopped suppling the drinking water. In this case the Kisköre Barrage helped decreasing the concentration of cyanide and the Lake Tisza was isolated by sluices from the Tisza River, so its ecosystem survived the disaster.

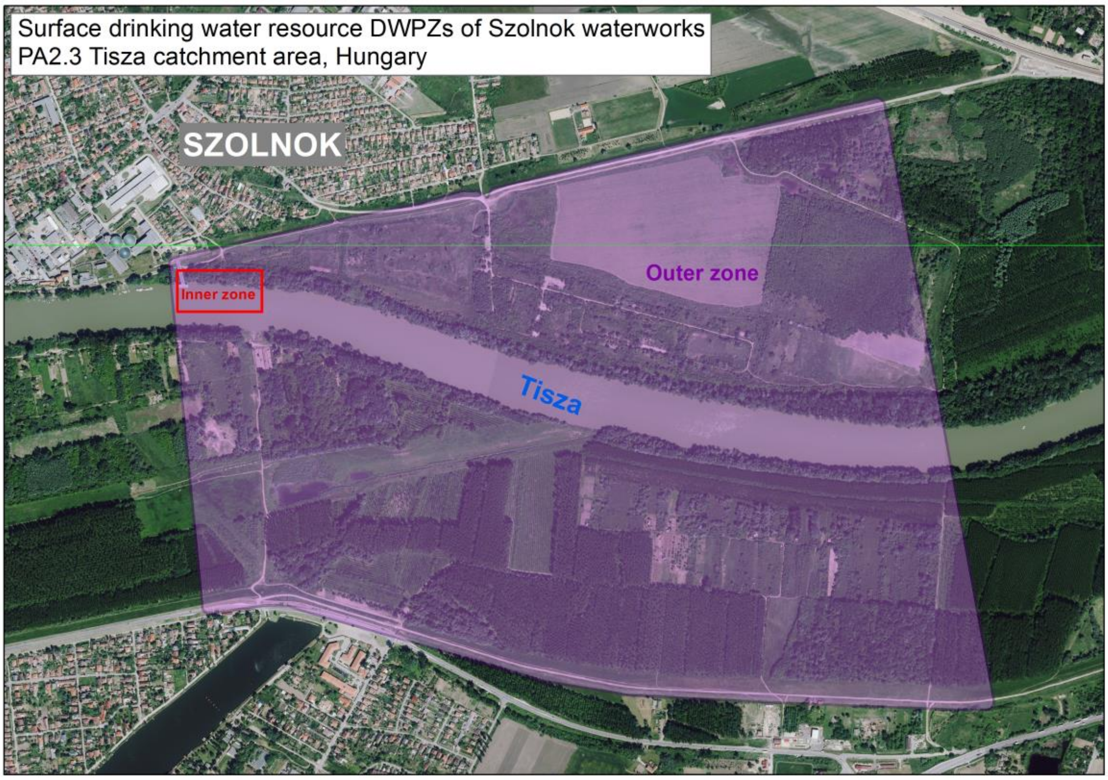

Figure 13: Surface drinking water resource DWPZs of Szolnok waterworks.

The most stringent restrictions are in the inner zone, for example: The inner zone shall be fenced or guarded in another effective manner. The owner of the inner zone shall be the same as that of the water facilities. Regular access shall be permitted to the personnel of the operator of the water facility, who perform work there and who possess a "health book" demonstrating the regular medical checks provided for in another act of legislation. Entry shall be authorised further to superiors of the personnel and representatives of the supervisory authority, further to persons authorised specifically (e.g. for the period of performing work) by the owner of the protective area. The person authorising entry shall be responsible for preventing those staying temporarily in the protective area from causing pollution.

In the protection zones depending on in which zone, several activities are prohibited, or prohibited for new facilities and activities, or may be allowed pending on the outcome of an environmental audit or environmental impact assessment. Other activities are allowed if they operates without pollution or new facilities and activities can let pending on the outcome of an EIA, or environmental audit, or an equivalent investigation.

Table4: Allowed and prohibited activities in the drinking water protection zones

	Surface and subsurface supplies		Subsurface supplies, hydrogeological	
	inner	outer	A	B
	protective zones			
Residential, recreation development				
Housing colony, real-estate development for recreation	-	-	-	o
Residential- or office building with sewerage	-	x	+	+
Residential buildings without sewerage	-	-	x	o
Sewer crossing the area	-	x	o	o
Sewage treatment plant	-	-	o	+
Domestic sewage seepage pit	-	-	o	o
Construction and operation of communal liquid wastes disposal facility	-	-	-	o
Communal solid (non-hazardous) wastes landfill	-	-	-	o
Building rubble deposit	-	-	o	x
Cemetery	-	-	x	+
Hobby gardens	-	-	o	o
Camping, bathing	-	x	+	+
Sports ground	-	x	+	+
Industry				
Production, processing of highly toxic or radioactive materials, storage, disposal thereof	-	-	-	-
Production, processing, storage of toxic materials	-	-	-	o
Plants using no toxic materials, with appropriate sewerage	-	x	o	+
Production, transport in pipelines, processing and storage of petroleum and such products	-	-	x	o
Hazardous wastes disposal facility	-	-	-	x
Hazardous wastes landfill	-	-	-	-
On-site collection of hazardous wastes	-	-	x	o
Seepage disposal and storage of food industry effluents	-	-	-	o
Seepage disposal of other industrial waste waters	-	-	-	-
Landfilling with slag and ash	-	-	o	o
Agriculture				

	Surface and subsurface supplies		Subsurface supplies, hydrogeological	
	inner	outer	A	B
	protective zones			
Forest planting and management without chemicals	-	+	+	+
Crop farming[1]	-	o	o	o
Composting facility	-	-	x	o
Animal farming beyond the home demand level	-	-	x	o
Grazing, keeping domestic animals	-	o	o	+
Manure application[1]	-	o	o	+
Fertiliser application[1]	-	o	o	o
Application of dissolved fertiliser and liquid manure	-	-	-	o
Release of liquid manure	-	-	-	-
Sewage irrigation[1]	-	-	-	o
Irrigation with sewage treatment plant effluent[1]	-	-	o	+
Pesticide application[1]	-	o	o	o
Pesticide application from aircraft[1]	-	-	-	o
Pesticide storage and residues disposal	-	-	-	x
Washing pesticide equipment, effluent disposal	-	-	-	o
Manure- and fertiliser storage	-	-	x	o
Sewage sludge storage	-	-	x	o
Farmland disposal of sewage sludge[1]	-	-	x	o
Burying carcasses, construction and operation of carcass wells	-	-	-	o
Fish farming, feeding	-	-	o	o
Transportation				
Motorway, highway, sealed storm drain	-	x	o	+
Other road with sealed storm drain	-	x	+	+
other road	-	-	x	+
Railway	-	-	o	+
Vehicle parking area	-	-	o	+
Fuel filling station	-	-	x	o
Washing, repair shop, de-icing salt storage	-	-	o	+
Other activities				
Mining	-	-	x	o
Drilling, sinking new well	-	o	o	o
Other activities affecting the cover, or the aquifer	-	-	o	o

[1] In particular investigations the provisions of the directive 91/676 EEC on pollution control against nitrate from agriculture should be applied

[1] In particular investigations the provisions of the directive 91/676 EEC on pollution control against nitrate from agriculture should be applied

4. Main identified problems / conflicts

Approximately 95 % of drinking water in Hungary is from groundwater sources (including bank filtration). However, almost 2/3 of the sources are vulnerable. Unique solution on the PA is the two surface drinking water abstractions from river or channel.

The PA is a plain area, the River Tisza runs through the area. Therefore, the main land use is agriculture; and the flood plains are mainly covered by broad-leaved forest. Also, significant land uses are discontinuous urban fabric, pastures, grasslands and shrubs.

Due to the geographical location of the PA, the drought and water scarcity is a real problem in the dry periods.

Our goal is to apply good practices and with this prevent the quality and quantity deterioration of drinking water sources. In case of surface drinking water abstraction the particular challenge is the necessity of protection the river upstream and the background. The systems are vulnerable for the contaminations arriving on the River Tisza and the Keleti Main Channel. There are some conflict of interest with flood protection, so for solving this conflict it is necessary to secure strong expert background and multipoint consultations.

In Hungary there are a lot of best practices, aiming to minimise the negative impact of agriculture, industry, flood and drought included in national plans (River Basin Management Plan, Flood Risk Management Plan in regards of drinking water protection) and legislation (Government Regulation on the protection of the actual and potential sources, defines the criteria of water protection zones). Despite of the legislation, the implementation and authority inspection is insufficient. Further problem is the low willingness for cooperation among farmers, other stakeholders and some water suppliers in order to ensure water protection.

In case of the surface drinking water abstractions the waterworks have smaller DWPZs like in the case of groundwater drinking waterworks. Therefore, the appropriate land uses are also important outside the DWPZs particularly in region of upstream. On the upstream of the Szolnok waterworks there are the reservoir Kisköre and the Lake Tisza, which moderate the impact of floods and secure the minimum level in dry period. The Keleti Main Channel is more protectable because the water level is driven and the discharges are not allowed.

On the PA there are some detected contaminated sites, on which remediation has been going on.

Many nature reserve areas are situated on the PA, which are protected national and international levels (Ramsar, Natura 2000, Nature Parks). In aspect of drinking water protection, the nature protection is favourable because of the lack of significant polluter activities.

5. References

Levente Czeglédi – Andrea Radácsi, 2005: Overutilization of Pastures by Livestock Gyepgazdálkodási Közlemények, 2005/3. p. 29-35.

Commission Staff Working Document Member State: Hungary - Accompanying the document Report from the Commission to the European Parliament and the Council on the Implementation of the Water Framework Directive (2000/60/EC) River Basin Management Plans (SWD(2012) 379 final 15/30)

Jurij Diaci at all, 2006: Nature-based forestry in Central Europe: Alternatives to Industrial forestry and Strict Preservation, Ljubjana, Biotechnical Faculty, Department of Forestry and Renewable Forest Resources, ISBN-13 978-961-6020-44-2 http://www.bf.uni-lj.si/gozdarstvo/oddelek/katedre/goj_gozd/objave/Nature-based_forestry_in_CE.pdf

Diagnostic studies of drinking water resources with vulnerable geological environment – funded by National Water Resources Protection Program 1997-2017

Diagnostic studies of drinking water resources – funded by Environment and Energy Operational Program (KEOP) 2004-2013

Gálhidy László at all, 2008. december: Örökerdők Magyarországon (Continuous Forests in Hungary), Budapest, WWF Magyarország, ISBBN 1216-2825

Központi Statisztikai Hivatal, 2013: Az erdőgazdálkodás jellemzői, Statisztikai Tükör VII. évfolyam 95. szám 2013. november 18., www.ksh.hu

MTA Geography Science Research Institute, 2010: Microregions in Hungary

MTA (2016) Water in Hungary (manuscript)

National legislation repertory on internet http://www.njt.hu/

New Hungary Rural Development Programme, Budapest (March 2011) Version 7

OVF (2016) 2nd River Basin Management Plan of Hungary – 2015 http://www.vizugy.hu/index.php?module=vizstrat&programelemid=149

OVF (2015) 1st Flood Risk Management Plan of Hungary http://www.vizugy.hu/index.php?module=vizstrat&programelemid=145

Pálfai, I. 2004: Inland waters and droughts in Hungary – Hydrological studies, Company of transportation documentation (Hungarian)

Saláta Dénes, Horváth Soma, Varga Anna, 2009: Az erdei legeltetésre, a fás legelők és legelőerdők használatára vonatkozó 1791 és 1961 közöttI törvények, Tájökológiai Lapok 7 (2): 387–401

Á. Tahy, T. Ács, P. Csathó, N. Fodor, Sz. Gombár, K. Gondár-Sőregi, T. Gyulai, R. Hegyi, A. Könczöl-Hegyi, G. Máthéné-Gáspár, Z. Simonffy, L. Radimszky, Gy.I. Tóth, T. Tóth, J. Zachar, 2011: WP5 Report Nyírség / Bükk Test Area, Hungary, CC-WaterS project

Varga Anna és Bölöni János, 2009: Erdei legeltetés, fás legelők, legelőerdők tájtörténete, Természetvédelmi Közlemények 15, pp. 68-79

Potential Accident Risk Sites in the Danube River Basin, 2002, updated 2017, ICPDR/DANUBIS