DEVELOPING THE CONCEPT PLAN FOR N(S)WRM IN RIVER BASIN

TISZA RIVER BASIN (NAGYKUNSÁGI) - MTDWD

D.T2.3.1

Version 1
30.06.2019.

Tartalom

1. Introduction

Concept plans goals to **give information on best locations and type of measures with their cumulative effect - prepared for river basins** using GIS Tool (O.T1.1), and improved with the inputs from the national trainings (O.T2.2)'.

Vision for the pilot area (few sentences for the pilot area and/or a general project vision)

The Nagykunsági river basin recently a closed, flat lowland polder, covering by flood dikes, crossed by well-built drainage and irrigation system. The water management system is artificially controlled. The flood situations in the rivers depend on the upper river catchment, this section we have well-built flood defence system, dikes and two reservoirs. In the pilot area we examine mainly drought, pluvial flood and water quality problems.

Purposes of the concept plan are:

- to explain transparently the way how the analysis of information, data and context as well as the evaluation of experts knowledge and stakeholders preferences led to the chosen design principles;
- to show how the design and location of the selected N(S)WRMs respond to the opportunities & constraints identified during the analyses;
- to explain and justify the way the N(S)WRMs are set out;
- to demonstrate a genuine response to context and not simply justify predetermined design solutions

2. Elaboration method of the concept plan

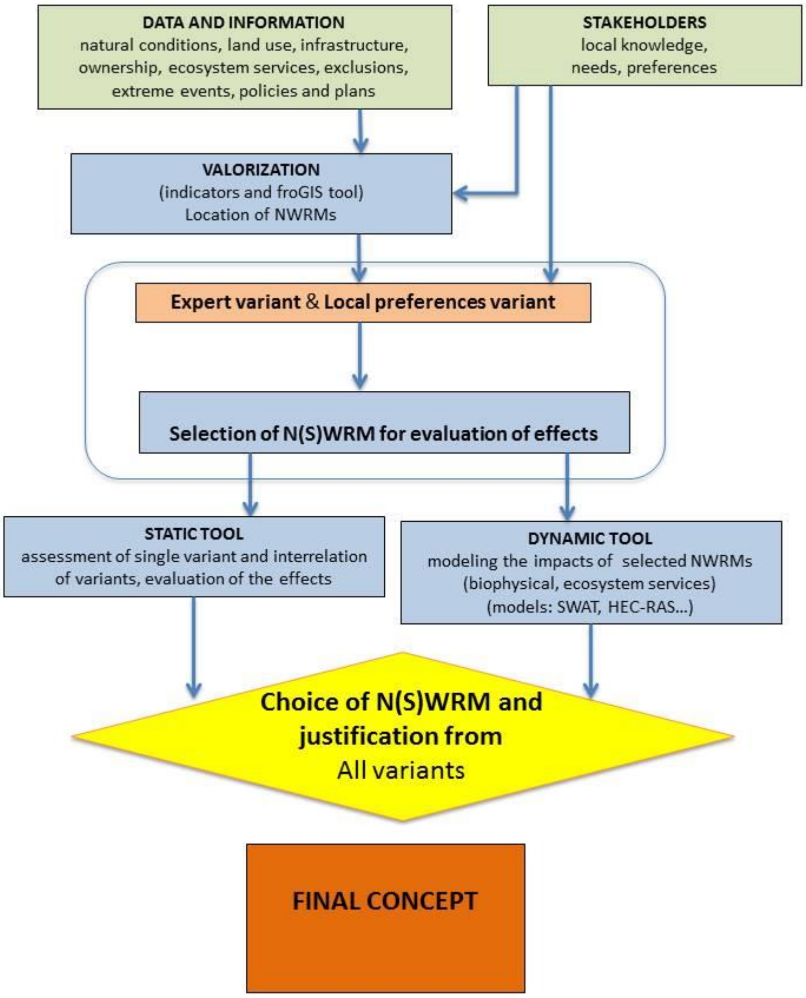


Figure 1. Main steps of the concept plan elaboration

3. Characteristics of the pilot area

3.1) Natural conditions of the catchment

The Nagykunsági Basin is one of the sub-basins of the Tisza River. Most of the sub-basin's water bodies has bad ecological status, and effected regularly by floods, droughts, and water quality problems occur almost every year.
These issues are partially included in the strategic planning documents such as: River Basin Management Plan; Flood Risk Management Plan, Drought Impact Mitigation Plan.

Characteristic	**Unit**	**Value**
Character of the catchment		Lowland
Catchment size:	km^2	2 965
Average flow low/avg/high	m^3/s	0/20/30
Extreme flow low/high	m^3/s	0/44
Annual precipitation low/avg/high	mm	382,9/513,4/929,5
Annual air temperature min/avg/max	˚C	-24,8/10,7/40,8
Agriculture area	%	73
Urban area	%	5
Forest area	%	5
Open water area	%	1
Flooded area (1/100 years)	km^2	430,5 (excess water)
Artificial drainage area	km^2	2300
Ecological status No.: good/bad	water body	5/21
Major problems to achieve good ecological status		Biology, hydromorphology,

Table 1. Characteristics of the catchment

The pilot area is located in the middle of the Hungarian Great Plain. The area is almost a perfect plain the area's topography was shaped by rivers.
The pilot area is part of the Tisza-Körös Valley Water Management System (TKVWMS) and part of the Middle Tisza District Water Directorate (MTDWD) operational area. The eastern border is the Hortobágy-Berettyó River and the Tiszafüred main irrigation canal, and the southern border of the area is the Hármas-Körös River (Figure 2). The area is characterized by low elevation (79-100 mBf).

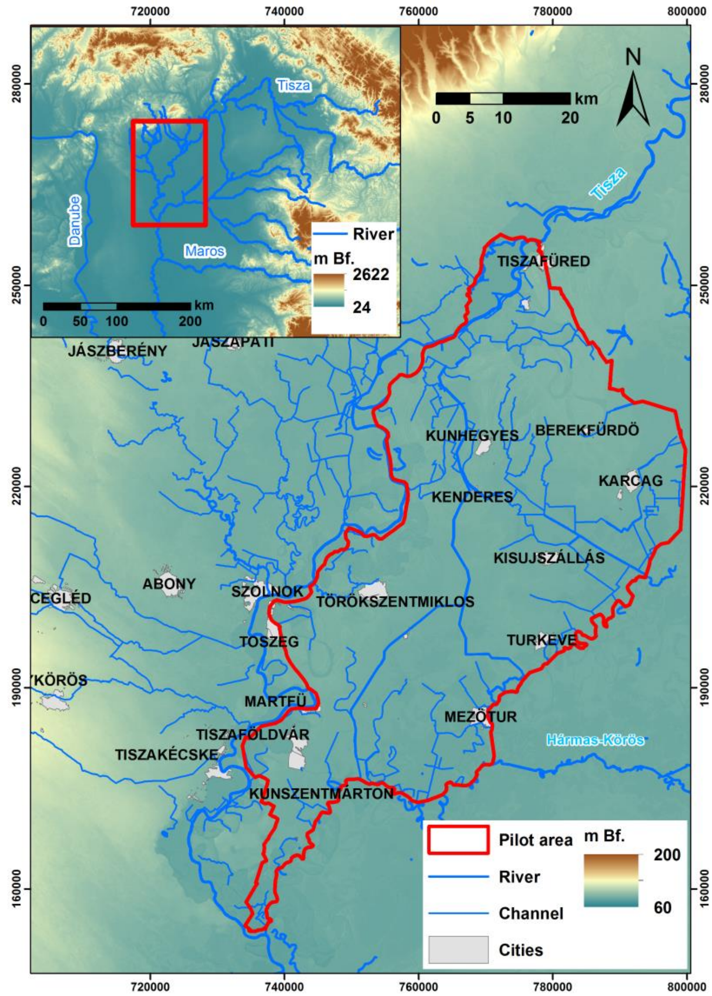


Figure 2. Characteristic of the pilot catchment

3.2) Land use and infrastructure

The proportion of the agricultural land is the largest in Hungary in the Tisza sub-basin, but from agro-ecological point of view this land use is considered to be the most unfavourable structure. Large area is arable land and they have low proportion of intensive cultures (vegetables, fruits) (Figure 3)

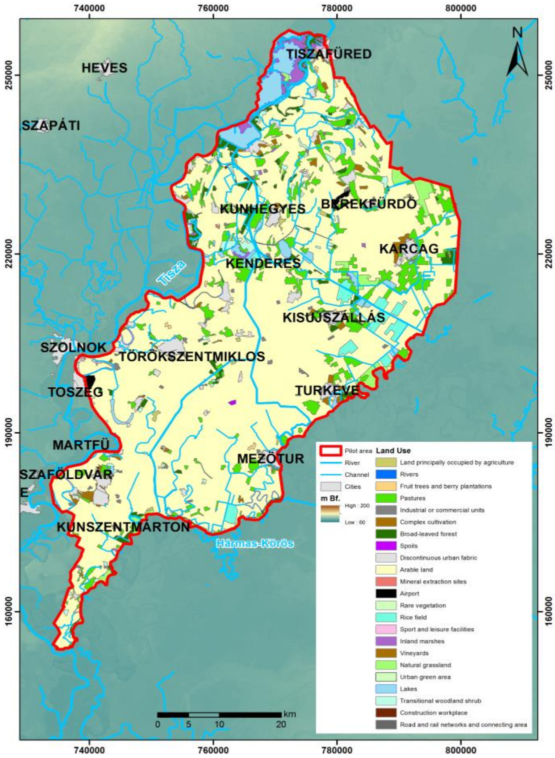


Figure 3. Distribution of soils and land use in the pilot area

A significant part of the agricultural area consists of arable land (74 %), while the share of the garden, fruit and grapes represent less than 0.1 % (Table II.1). The peculiarities of this river basin are the relative importance of fish ponds. The proportion of forest areas does not reach 5 %.

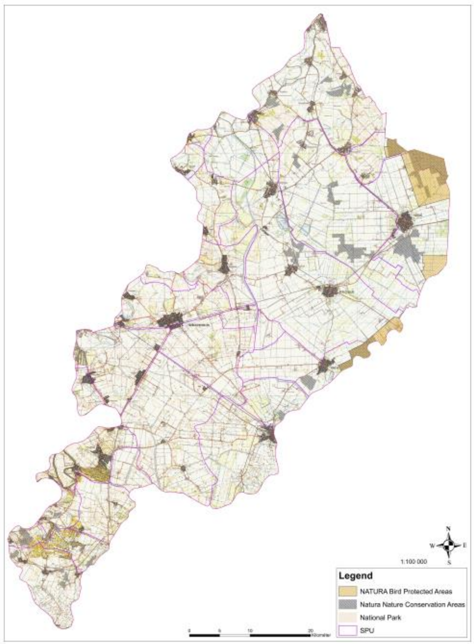


Figure 4. Protected areas

3.3) **Ecosystem services**

3.4) Extreme events

Flood:

Before the river regulation works and building flood protection system in the 18th century in Middle-Tisza the pilot area were regularly flooded by the main river branches, Tisza-Körös-Berettyó. These flood inundations occurred often at the same time from different rivers.

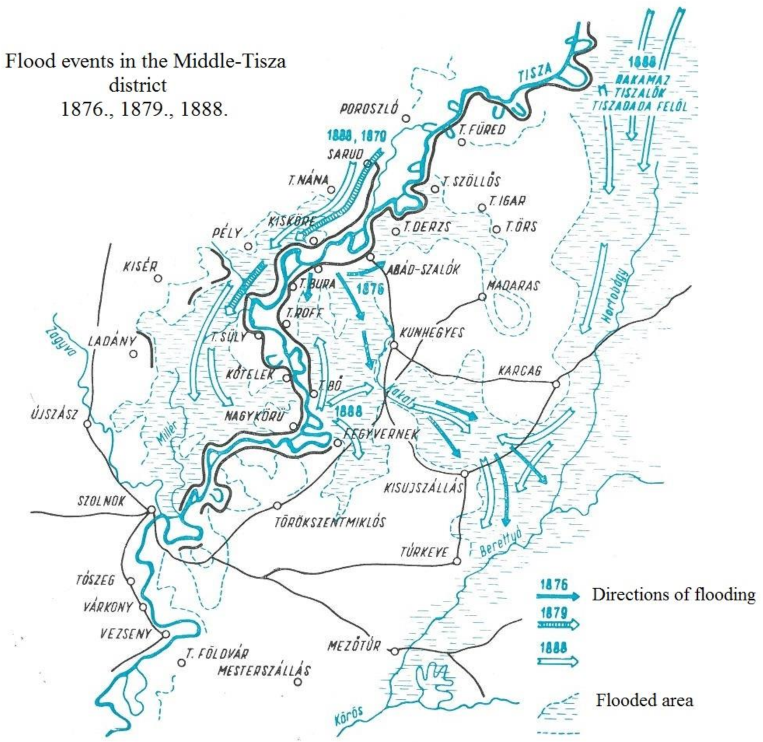


Figure 5. Flood events in the Middle-Tisza

Flood protection system development is continuous work in the middle Tisza because of rising flood levels.

Highest water level in Szolnok section:

1830: 683 cm
1888: 818 cm
1919: 884 cm
1932: 894 cm
1970: 909 cm
1999: 974 cm
2000: 1041cm.

As a response to increasing frequency and damages of flood, the Government of Hungary has been introduced a new flood defence strategy for the river Tisza based on reservoir (dry polders) to reduce the flood peaks.

Two emergency flood reservoirs were built with a total capacity of 196 million m^3.

Projects for improving water runoff conditions of River Tisza are currently in progress in several river sections.

Drought:

The Middle Tisza District has always been characterized by extreme weather conditions. The rainy weather is often followed by long lasting dry, warm periods. In recent years, increasing emphasis has been put on creating a method for drought prediction, and prevention (Somlyódy 2011, Tamás 2016).

A lot of different indexes have been developed to determine the severity of drought (WMO 2016). The indexes corresponding to the type of drought (meteorological, hydrological, and agricultural) are usually derived from time series analyses and remote sensing data. Indexes quantify an event that has already happened. They only allow the assessment of the drought status of longer periods.
In Hungary, the most widely used Pálfai drought index (PAI) is capable to characterize the meteorological drought.

The following equation describes the calculation of the Pálfai drought index:

PAI = kt * kp * kgw * PAI0,

Where: kt - temperature correction factor
kp - precipitation correction factor
kgw - groundwater correction factor

$$\text{PAI0} = \frac{100 * mean\ air\ temperature\ (from\ April\ to\ August)}{weighted\ sum\ of\ precipitation\ (from\ October\ to\ August)}$$

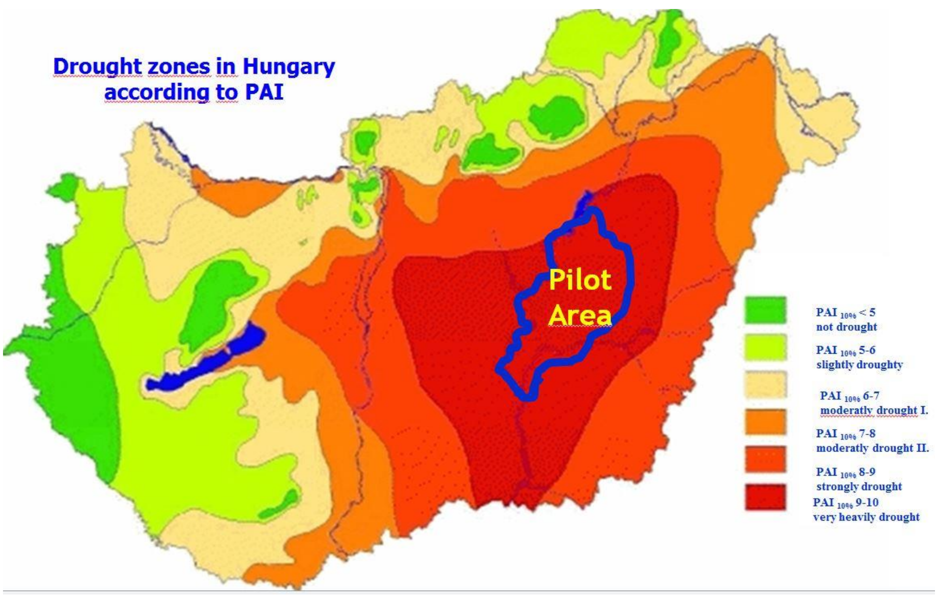


Figure 6. Droght Zones

The most serious drought events of the last decades were in 2003 and 2012, in 2003, the PAI was 14.68 °C/100 mm at Szolnok, which has never reached this high value here before. In 2012, the drought index was 14.02 °C/100 mm, which was the second highest value.

In the pilot area the biggest water shortage period was recorded from 1863 when pastures dried out, 78 % of the livestock died, people were starving.

Years of water scarcity in recent decades: 1997, 2002, 2003, 2011, 2012.

Among them 2003 needs special attention. In this year low precipitation was associated with high temperatures: the number of heat-days, when the maximum temperature exceeds 30°C was 45 in national average and this was breaking earlier records. Damage done to the agriculture in this year by drought was estimated to amount to 50–55 billion HUF.

Figure 7. Soil tillage and irrigation in drought period

Pluvial flood (excess water) :

Pluvial flood is a typical form of water damages on a flat country and a yearly phenomenon in the closed lowland catchment area of Nagykunsági. More than half of the pilot area is endangered by excess water inundation. In periods of extensive rainfall and snow melting large areas used to be flooded, that cause major economic and environmental problems annually.

Figure 8. Pluvial flood inundated road in the Middle-Tisza

Due to the extreme weather conditions in the last decade (1999-2000, 2006, 2010-2011), serious problems occurred causing heavy loss to the national wealth as well as the river management works, residential areas and the whole agriculture.

Inland excess water started to cause serious problems following river regulations and levee construction works in the 19th century. The constructed levees exempted the floodplains from the floods but prevented the flow from the protected flood plain to the rivers (Bíró 2016). This problem was initially helped by the use of locks built into the levees and later by the establishment of pumping stations. The changes that have occurred over the past decades in land use, the spatial structure of agriculture and forestry, due to changes in ownership, have significantly altered the runoff and confluence processes of the affected areas.

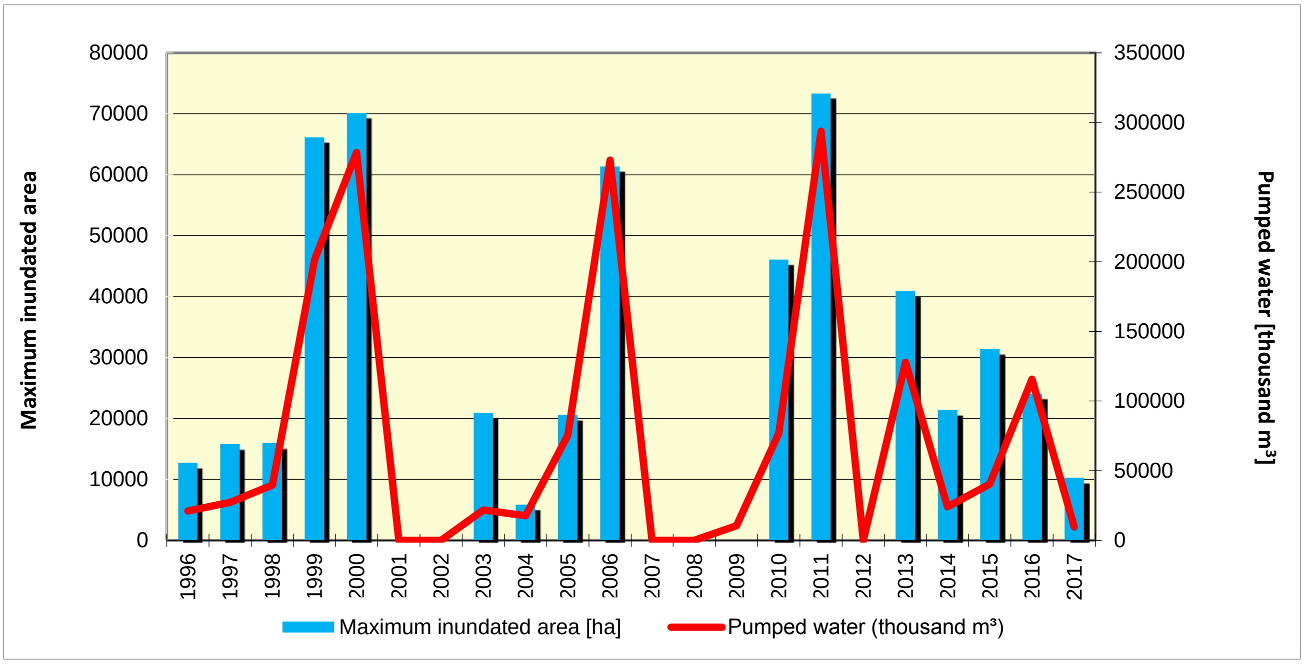


Figure 9. Development of water cover and the amount of water pumped (MTDWD 2019)

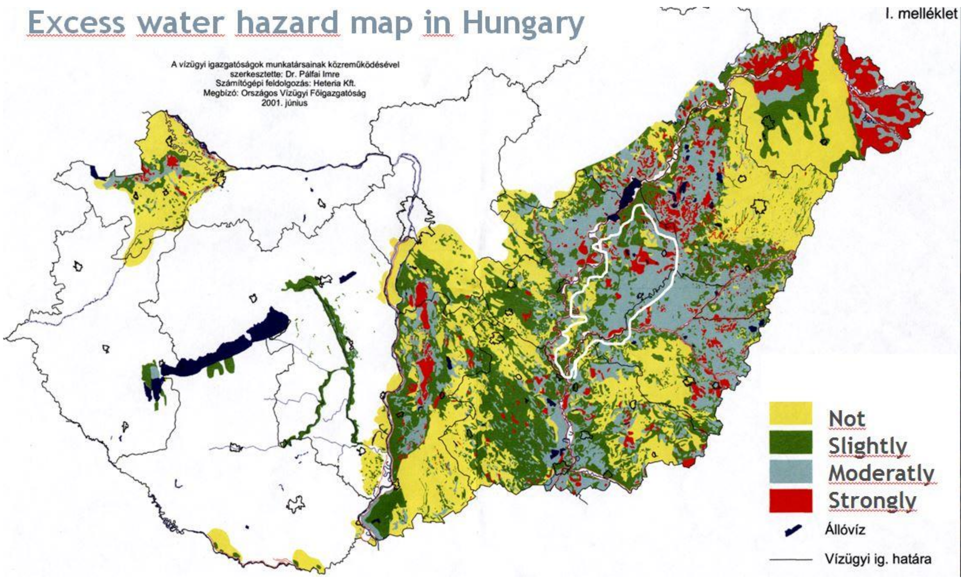


Figure 10. Excess water (pluvial flood) hazard map in lowlands of Hungary

4. Valorisation: a multi-criteria analysis

4.1) The valorisation method and tool

In the frame of the valorisation method the FroGIS tool was developed, where users are able to fill in the tool with their data and after the calculations are performed, to review the resulting maps and statistics.

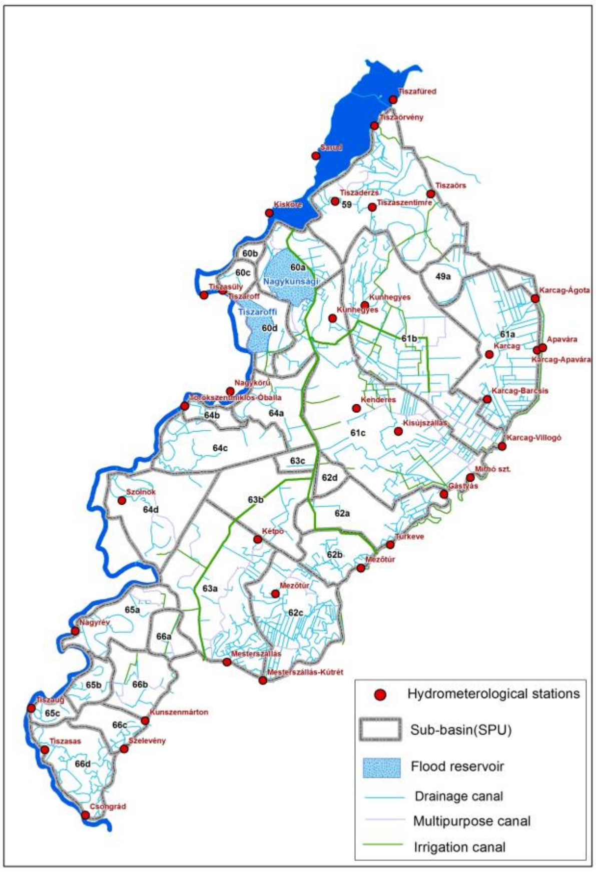
The valorisation method is developed for:

- To apply FroGIS Web application in the Hungarian pilot catchment Nagykunsági.
- To develop valorisation maps for existing flood, drought and water quality issues in the pilot catchment to analyse water retention needs for each SPU's.
- To analysis of the results of FroGIS and provide suggestion for the developments of the tool. (choosing SPU, indicators used, weights, final aggregation).

4.2) Present the results of the valorisation method:

4.2.1) Selected SPU

The selected SPU's to analyse the Pilot catchment was the 28 sub-basins: Main drainage canal catchments.



Sub-basins in the Pilot area

059. Örvény-Abádi
060/a. Mirhó-Gyócsi
060/b. Ledencei
060/c. Tólaposi
60/d Gyenda-Tiszabői
61/c Kakati
62/d Örményes I.
63/c Örményes II.
64/a Fegyverneki
049. Hortobágyi
61/a Karcagi
61/b Villogó
64/b Óballai
64/c Szajoli
64/d Alcsi-Tenyő-Kengyeli
64/e-f Rákóczifalva-Szandai
65/a Cibaki
65/b Tiszakürti
65/c Tiszaugi
66/b Kungyalu I.
66/c Tóközei
66/d Tőkefoki
62/a Túrkeve - Kiserdei
62/b Mezőtúr - Álomzugi
62/c Mezőtúr – Halásztelki
63/a Mesterszállás-Bartap.
63/b Szenttamási
66/a Kungyalu II.

Figure 11. SPU and hydrometerological stations in the Pilot area

4.2.2) Selected indicators to analyse the pilot catchment

Nr	Indicator Name	Indicator Short Name	Goals	Unit	Stimulant/ Destimulant
1	Arable area in SPU area ratio	ArableRatio	Flood/Drought/ Quality/General	%	Stimulant
2	Climatic Water Balance	cwb	Drought/ General	mm	Destimulant
3	Climatic Water Balance - average intra year variability (cwbMax-cwbMin)/cwb	cwb_Var_a	Drought/ General	-	Stimulant
4	Climatic Water Balance - variability in the multiannual period cwbMin/cwb	cwb_Var_m	Drought/ General	-	Destimulant
5	Drainage Density	DrainageD	Flood/Drought/ Quality/General	km/km2	Stimulant
6	Arable lands in 20-meters buffer around surface waters area to SPU area ratio	EcoAraBuf20mRatio	Quality/General	-	Stimulant
7	Semi-natural land cover types area to SPU area ratio	EcoAreaRatio	Quality/General	%	Destimulant
8	Bad morphological elements length to total length of river in SPU	EcoBadRHS	Quality/General	%	Stimulant
9	Combination of number of semi-natural land cover patches and their area	EcoCombined	Quality/General	-	Destimulant
10	Number of semi-natural land cover patches to total number of land cover patches in SPU	EcoNumRatio	Quality/General	%	Destimulant
11	Forested area to SPU area ratio	ForestRatio	Flood/Drought/ Quality/General/ Sediment	%	Destimulant
12	Groundwater Renewable Resources Module	grr	Drought/ General	mm	Destimulant
13	Lakes and reservoirs area to SPU area ratio	LakeRatio	Flood/Drought/ Quality/General	%	Destimulant
14	Orchards & vegetable farming area to SPU area ratio	OrchVegRatio	Flood/Drought/ Quality/General/ Sediment	%	Stimulant
15	Precipitation variability in annual period - amplitude of monthly sum of (pMax_i - pMin_i)/pAvg_i	Pre_Var_a	Drought/ General	-	Stimulant
16	Precipitation variability in the multiannual period [pMin]/[P]	Pre_Var_m	Drought/ General	-	Destimulant
17	Frequency of precipitation lower than 50% of the multiannual average (in the growing season)	PrecFreqLow75	Drought/ General	-	Stimulant
18	Reclaimed meadows and pastures area to SPU area ratio	ReclaimedRatio	Flood/Drought/ Quality/General	%	Stimulant
19	Maximum soil water retention	swr	Drought/ General	mm	Destimulant
20	Urban area to SPU area ratio	UrbanRatio	Flood/Drought/ Quality/General	%	Stimulant

Table 2. Indicators used in assessment

Many indicators of the method have been deleted due to the characteristic of the river basin. In lowland the indicators analyzing the characteristics of surface flow are not applicable. DEM value is so low, that eg. Topographic Wetness Index, or NonForestedRatio indexes are not relevant.

Further details on the calculations, analysis of variations, final version selection can be found in D.T1.3.1 Reports from pilot action - testing the prototype of the Frogis tool in the river basins

4.2.3) Final results of Valorisation method (using Frogis tool):

4.2.3.1) General purpose

The most acceptable Frogis result: Five classes, natural breaks classification, where the indicators were weighted:

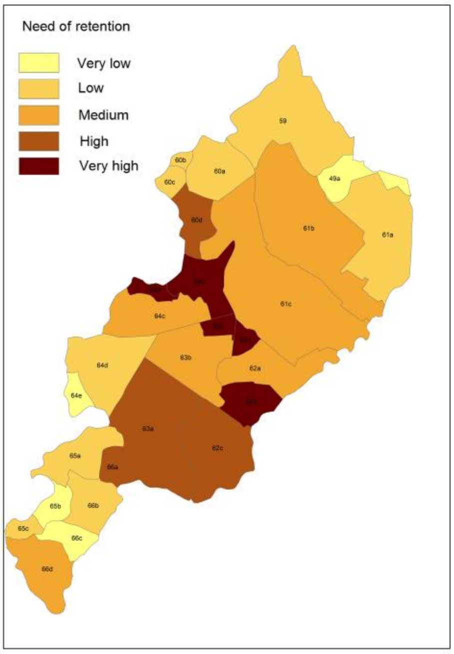


Figure 12. Final valorisation map for General purpose

4.2.3.2) Drought mitigation purpose

Examining the Frogis result, the most acceptable: Five classes, Equal with classification.

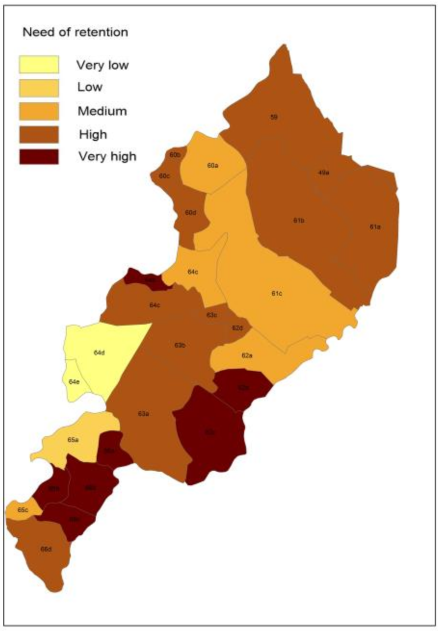


Figure 13. Final valorisation map for Drought mitigation purpos

4.2.3.3) Water quality improvement purpose:

Water quality is a periodically recurring problem of the catchment, however the beneficial effect of water retention on water quality in the flatland is often uncertain. (Shallow water bodies can quickly eutrophicate in summertime).

Therefore, with the planning we should focus on that area where water supply is available, or possible to design the necessary infrastructure for that.

Using Frogis application, the most acceptable variant: Natural breaks, five classes division.

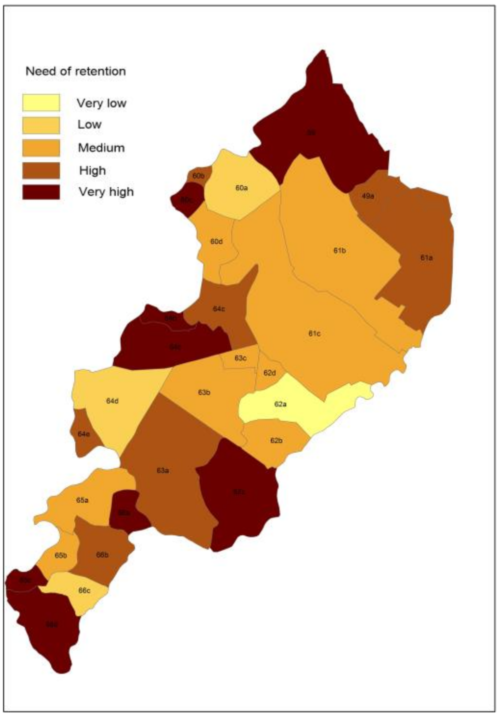


Figure 14. Final valorisation map for water quality improvement purpose

5. Defining variants

There are two types of variants that will be elaborated in the frame of the concept plan:

- **Expert variant,**
- **Local preferences variant.**

In this part of the planning process of the project, we have to select and place the appropriate measures and measures combinations for further examinations.

The expert variant developed by experts in the field of water management, protection of water resources, aquatic ecosystems and ecosystems dependent on water.

5.1) Natural small water retention measures in the project:

The basis for the measures in FramWat project is from Natural Water Retention Measures (NWRM), which was developed by a EU project, and the results can be found on the official website (http://nwrm.eu/measures-catalogue).

This platform gathers information on NWRM at EU level, cover a wide range of actions and land use types.

Main sectors of NWRM:

- Agriculture,
- Forestry,
- Hydro-morphology,
- *Urban. (Not relevant in FramWat project)*

In FramWat project the NWR measures were completed with other relevant technical measures regarding:

- Drainage area and,
- Hydro technical structures.

Figure 15. Water retention measures (www.nwrm.eu)

5.2) The expert variant

Sectors representing the expert version of measure combinations in the Middle-Tisza:

- Water management sector: MTDWD.
- Forestry: MTDWD.
- Agriculture: Hungarian Chamber of Agriculture

MTDWD experts preselected the appropriate measure combinations for Nagykunsági pilot catchment, taking into account the local conditions:

Code	Sector	Measures (NWRM/NSWRM)
A01	Agriculture	Meadows and pastures
A02		Buffer strips and hedges
A06		No till agriculture
A07		Low till agriculture
A08		Green cover
A15		Deep plowing (removing the plow's sole)
N02	Hydro-morphology	Wetland restoration and management
N07		Reconnection of oxbow lakes and similar features
F01	Forestry	Forest riparian buffers
D01	Drainage area	Regulated outflow from drainage systems
D02		Water damming in ditches, wires with constant crest (valleys)
D03		Active water management on a drainage system (river valleys)
D04		Construction of micro reservoirs on ditches
D07		Construction of reservoirs on outflows from drainage systems
D08		Construction of small reservoirs on rivers (dammed reservoirs)

Table 3. Preselected measures

The choice of measures is very limited due to the characteristics of the river basin. About 72 % of the pilot area is arable land; therefore agriculture type of measure group is of great importance.

In the next section of this chapter we summarize the measures were selected by experts for further analysis.

5.2.1) Agricultural measures:

The measures were chosen jointly with the Hungarian Chamber of Agriculture, which institution is associated partner of the Middle-Tisza district Water Directorate in FramWat project.

The **distributions of the chosen measures were** carried out with ArcGIS software in the river basin.

A01) Meadows and pastures:

Most of the catchment area is arable, changing the use of the area to achieve water retention goals is clear. In addition, the proportion of arable land endangered by pluvial flood can be reduced.

Criteria for selection of area to land use change:

- Poor quality arable,
- High risk of pluvial flood.

Geodatabase for selection:

- Arable rating map,
- Pluvial flood risk area (NAIK ÖVKI 2015.)

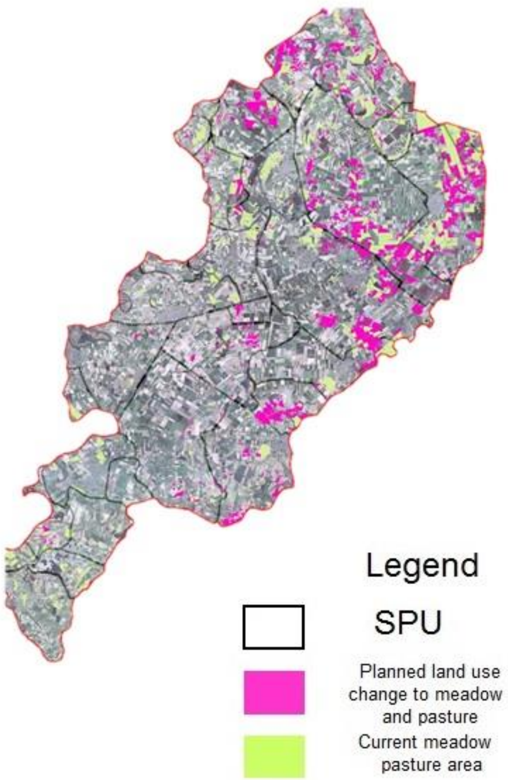


Figure 16. Planned land use change into meadow and pasture

A02) Buffer strips and hedges,

F01) Forest riparian buffers:

Buffer zones provide good conditions for effective water infiltration; it can also reduce the amount of suspended solids, nitrates and phosphates from agricultural runoff.

Previously used but still typical that shelter belts were used to reduce wind erosion in the pilot area, so this kind of measures are not unusual in the field.

In FramWat project we decided to place buffer strips for one side of the state owned canal system, and forest buffer for the opposite side, which is reasonable to carry out maintenance activities of the canals.

Criteria for selection of buffer zones:

- State owned canal system,
- No existing buffer strips or forest.

Geodatabase for selection:

- Hydrographic map (MTDWD)
- Corin Land Cover 2012.

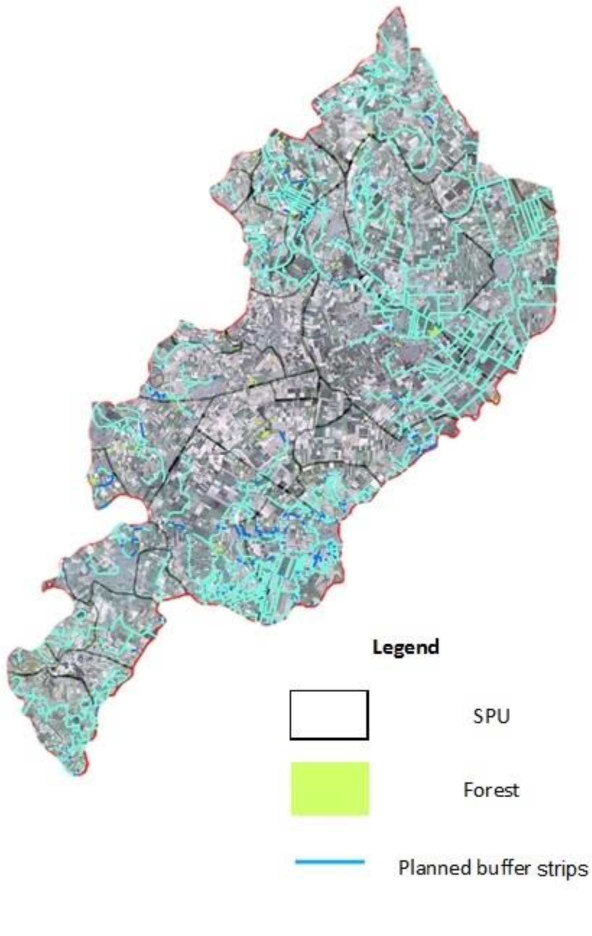


Figure 17. Planned buffer zones

A06) No till agriculture,

A07) Low till agriculture,

A06, A07 measures planned to good quality arable where the soil type is easily cultivated sandy or silty.

This kind of agriculture method can be used to increase organic matter and soil water retention for the appropriate soil type.

The spread of this method is obstruct by the need for special agricultural machines.

Figure 18. No till cultivation *www.agrarunio.hu*

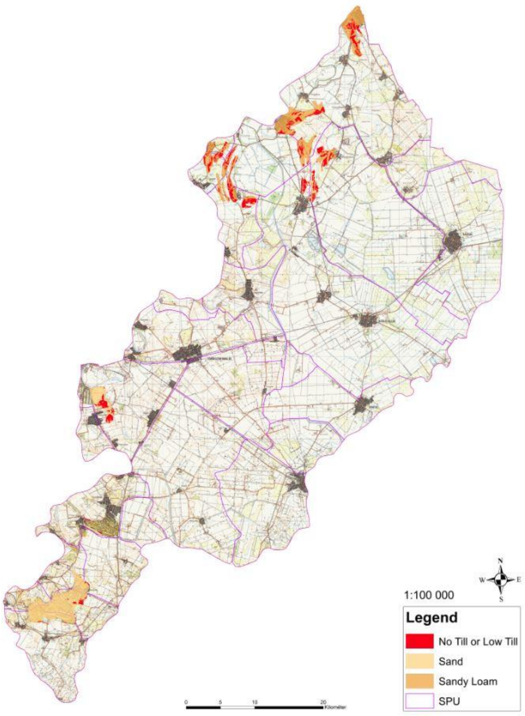


Figure 19. No till and Low till cultivation

A08) Green cover:

A08) Green cover was planned in good arable regardless of soil type, where other measures was not planned.

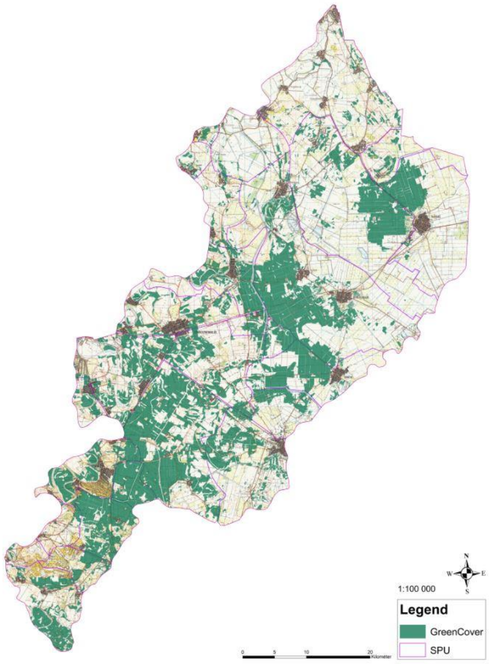


Figure 20. Planned Green cover in the Pilot area

A15) Deep plowing:

Increasing the water retention capacity of the soil in lowland areas is one of the most effective ways of improving water balance, the largest storage volume is provided by soil poles.

In the pilot river basin to preserve the soil structure and organic matter, cultivation should be carry out without rotation of the soil, thus the method is rather ripping than plowing.

Criteria for selection of the area for deep plowing (ripping):

- Good quality arable,
- High risk of pluvial flood.

Geodatabase for selection:

- Good quality arable,
- High risk of pluvial flood.

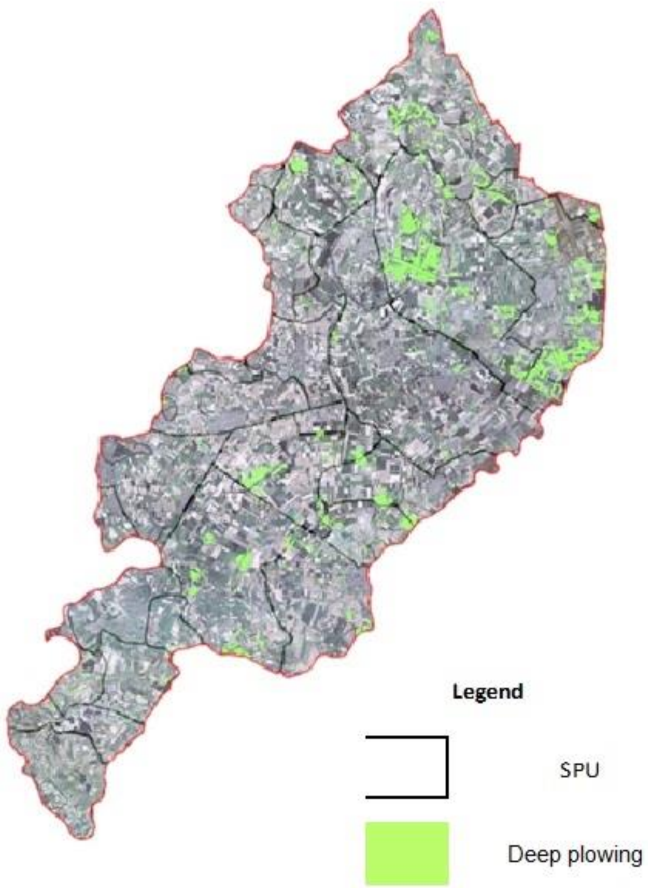
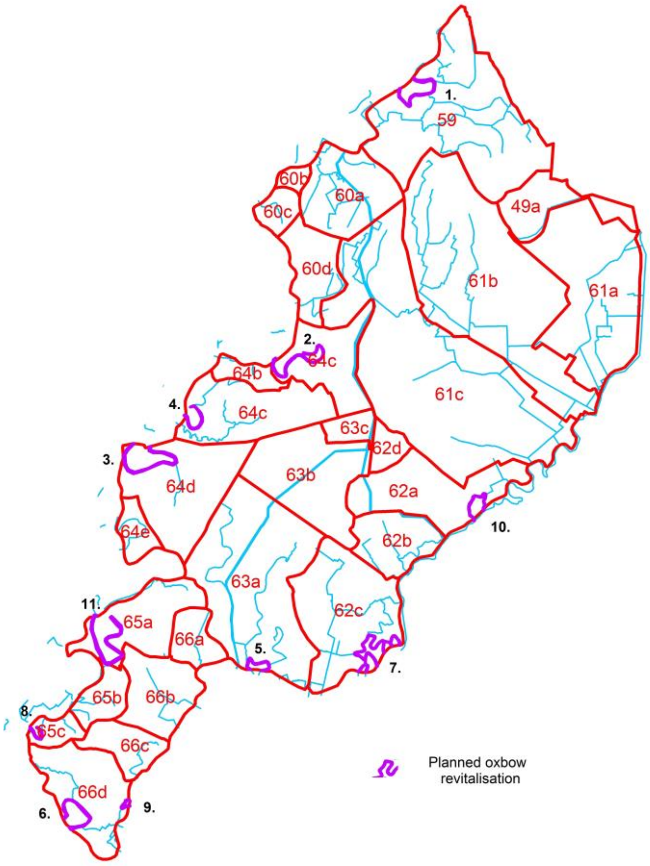


Figure 21. Planned Deep plowing

5.2.2) Hydro-morphology measure:

N07) Reconnection of oxbow lakes and similar features

Oxbow-lakes in the pilot are evolved as the result of river regulation activities during the 18th century. In the period of construction of regulation works, no one planned the later operation of these lakes, thus most of them may not be supplied with freshwater, the river bed was filled with sediment, the water quality is periodically moderate or bad.



1.	Cserőközi Dead Tisza
2.	Fegyverneki Dead Tisza
3.	Alcsi Dead Tisza
4.	Szajoli Dead Tisza
5.	Harangzugi Dead Körös
6.	Gyova-Mámai Dead Tisza
7.	Halásztelek-Túrtő-Harcsás Dead Körös
8.	Tiszaugi Dead Tisza
9.	Tehenesi Dead Körös
10.	Dead Berettyó (Túrkeve)
11.	Cibakházi Dead Tisza

Figure 22. Planned oxbow revitalisations

5.2.3) Drainage measures:

D01) Regulated outflow from drainage systems

Meadows and pastures areas tolerate periodic flooding caused by pluvial flood, moreover excess water increase grass yields.

The stored excess water helps to maintain the water balance, and create habitats.

Selection criteria:

- Regularly inundated area by pluvial flood
- Meadow and pasture areas

Geodatabase:

- Analysed Satellite Pluvial flood map (Landsat8 satellite recordings),
- Corin Land Cover 2012.

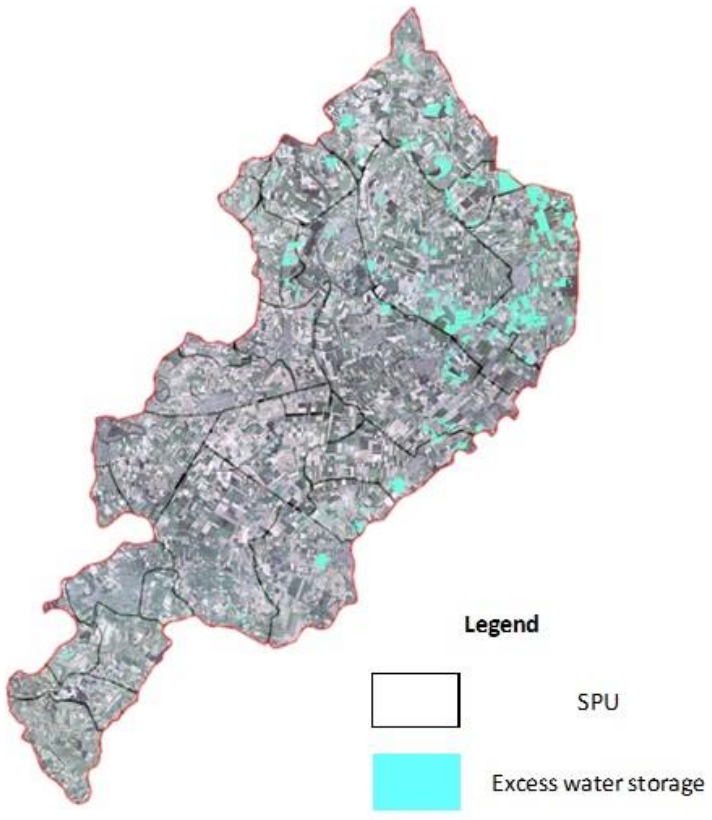


Figure 23. Planned excess water storage in meadow and pasture area

D02, D03, D04, D07 Measures

The planned measures were selected on the basis of the Irrigation Strategy of MTDWD in accordance with National Climate Change Strategy 2008-2025) and the river basin management plan.

Measure group NWRM and FramWat	Type of measure MTDWD	Planned measure in the pilot river basin
Do2 Water damming in ditches, wires with constant crest (valleys)	Water storage in existing canal system	Water storage in drainage-, multipurpose-, and irrigation canals by improving water retention capacity and conditions of the canal system.
Do3 Active water management on a drainage system (river valleys)	Landscape management in the area of flood reservoirs	Reconstruction of Tiszafüred irrigation system I.
		Reconstruction of water intake structure of Gástyás irrigation system I. connecting with Nagykunság system (2 project)
		Improving water retention in Nagykunsági main canal (1,2,3,4,section), Nk III-2, Nk East branch. (4 project)
		Developing Nk. III-2-5 irrigation canal connection with Tiszafüred main irrigation system
		Developing of Nagykunság, Nk X-2, Nk XII-1 irrigation system (3 project)
	Extending impact area of existing irrigation system by using drainage canal system	Developing Mirhó-Gyócsi drainage canal on both side of Nagykunsági main canal, on the impact area of Tiszafüred irrigation system. Kakat, Kisújszállási II., Mezőtúri VI., Harangzugi I. Cibak-Martfű, Nagyrév- Nádastói, Nagyrév- Tiszakürt, Tégláslaposi , Mezőhéki I-13. drainage canals
	Water supply for water shortage area	Building of Nk. VI main irrigation system – Multipurpose development of Fegyvernek-Szajol sub-basins
		Building of Tilalmas irrigation system (Nk. III-2-7.→ Nk III-2-7-1.→ N11.→ HB)
		Developing of Nk. III. irrigation system
		Developing of Mezőtúr-Álomzug sub-basin
	Recommission of inoperable irrigation systems	Renew of Tiszafüred irrigation system II-III, Tiszagyenda, Kútrét V., Nk III-2-12 irrigation canals. (5 project)
Do4 Construction of micro reservoirs on ditches	Development of new reservoirs	Harangzugi I. new reservoir
Do7 Construction of reservoirs on outflows from drainage systems	Development of existing irrigation water reservoirs	Developing Kecskeri and no. X. reservoir
	Development of new reservoirs	Water supply increase of Hortobágy-Berettyó region
	Landscape management in the area of flood reservoirs	Landscape management in the area of Tiszaroff, Nagykunsági flood reservoirs, (2 project)

Table 4. Planned drainage and irrigation type developments in the Pilot area

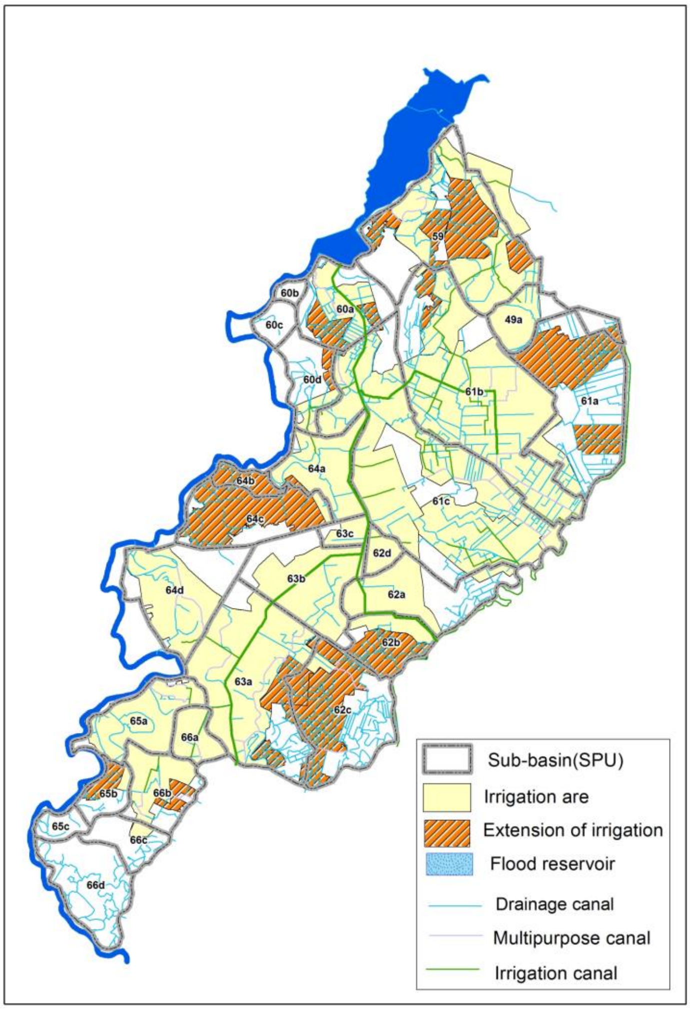


Figure 24. Impact area of the planed measures

5.3) The local preferences variant

To create the variant of local preferences we contacted with official letter the local community, local authorities, organizations and agencies, show them the targets and strategic of the project and asked proposals for measures reported by the operating in the area of interest.

There were only a few proposals that were already considered in the project. But on the National training in May a new natural type of measure was suggested by an NGO, we added to the measure list:

N02) Wetland restoration and management

Before the river regulation works in 19th century the two main rivers Tisza and Körös were connected with numerous seasonal streams with uncontrollable operation and meandering across the field caused temporary inundations in deep terrain lines.

The main irrigation canal of Nagykunsági and its tributaries are similar than the former streams, but the discharge and water levels are controlled, the water higher than the surrounding terrain, thus the former streams and wetlands in the operational area can be supplied with water gravitationally.

Selection of areas was done by MTDWD using topographic maps, orthophotos and the 2[nd] military geodetic survey (1829-1866) (See Figure 25.)

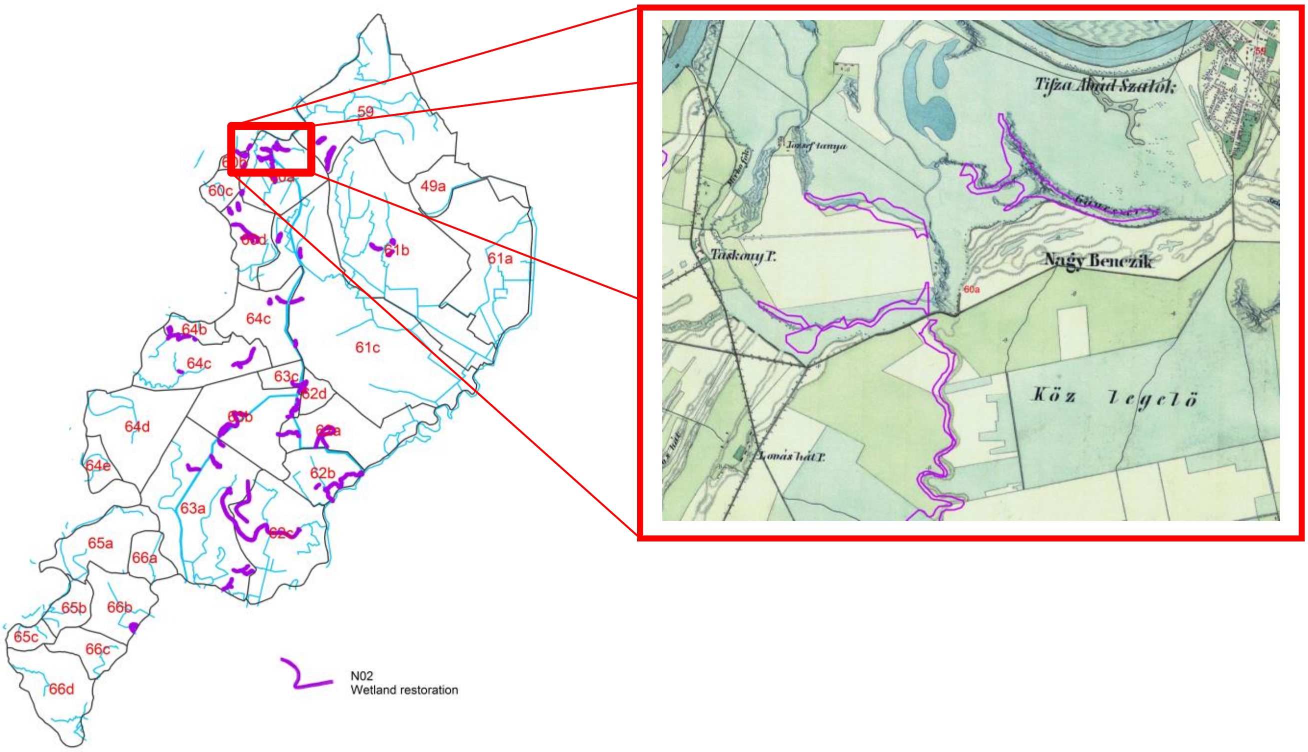


Figure 25. planned wetland restoration, and map of 2[nd] military geodetic survey

5.4) Selection of N(S)WRM for evaluation of effects

There were few substantive comments to the Local Preferences version, so no separate version was made. The only measure (N02) has been incorporated into the final version.

Planned measures in the Pilot catchment	Estimated impacts of measures (rating 1-5)						SUM
	Surface water	Reducing Pollution (N, P, sediment)	Soil conservation	Ground-water retention	Landscape	Creating Habitat	
A01 Meadow/Pasture area	0	3	3	0	4	3	13
A02 Buffer strip area	0	5	5	0	4	4	18
A06 No till agriculture	0	0	5	3	0	0	8
A07 Low till agriculture	0	0	2	2	0	0	4
A08 Green cover	0	2	3	0	1	2	8
A15 Deep plowing (ripping)	0	0	0	5	0	0	5
F01 Forest riparian buffers	0	5	5	0	4	5	19
N02 Wetland restoration and management	5	2	0	4	5	5	21
N07 Reconnection of oxbow lakes and similar features	3	2	0	2	4	4	15
D01 Regulated outflow from drainage systems	2	1	0	3	3	3	12
Do2 Water damming in ditches, wires with constant crest (valleys)	2	2	0	2	1	2	9
Do3 Active water management on a drainage system (river valleys)	2	2	0	2	1	2	9
Do4 Construction of micro reservoirs on ditches	4	2	0	3	3	4	16
Do7 Construction of reservoirs on outflows from drainage systems	4	2	0	3	3	4	16

Table 5. Estimated impact of planned measures

Separate evaluation of planned measures shows that the highest estimated impacts come from wetlands and reservoir (N02, D04, D07), and also buffer zones (A02, F01). However more than 70% of the Hungarian pilot area is agricultural, thus this types of measures (A01-A15) can be very effectives because of the scale.

5.4.1) Measures for Static method testing:

Code	Sector	Measures (NWRM/NSWRM)	Measures for testing Static method
A01	Agriculture	Meadows and pastures	A01
A02		Buffer strips and hedges	A02
A06		No till agriculture	WRAL
A07		Low till agriculture	
A08		Green cover	
A15		Deep plowing (removing the plow's sole)	A15
N02	Hydro-morphology	Wetland restoration and management	N02
N07		Reconnection of oxbow lakes and similar features	N07
F01	Forestry	Forest riparian buffers	F01
D01	Drainage	Regulated outflow from drainage systems	BPDA
D02		Water damming in ditches, wires with constant crest (valleys)	
D03		Active water management on a drainage system (river valleys)	
D04		Construction of micro reservoirs on ditches	
D07		Construction of reservoirs on outflows from drainage systems	

Table 6. Measures for Static tool

WRAL: Best practices for Water Retention in Agricultural Lands.

BPDA: Best practices on drained areas.

WRAL and BPDA are measure groups in Static tool, thus the examination carry out not separately.

5.4.2) Measures for Dynamic method testing:

In the pilot catchment of Middle-Tisza District we use HEC-RAS 1D model to evaluate the hydrodynamic and water quality effects of the planned measures. Due to the design of the HEC-RAS model, we do not have the opportunity to examine all the planned measures.

Measures, that can be assessed using 1D HEC-RAS model in river basin.

Water quality:

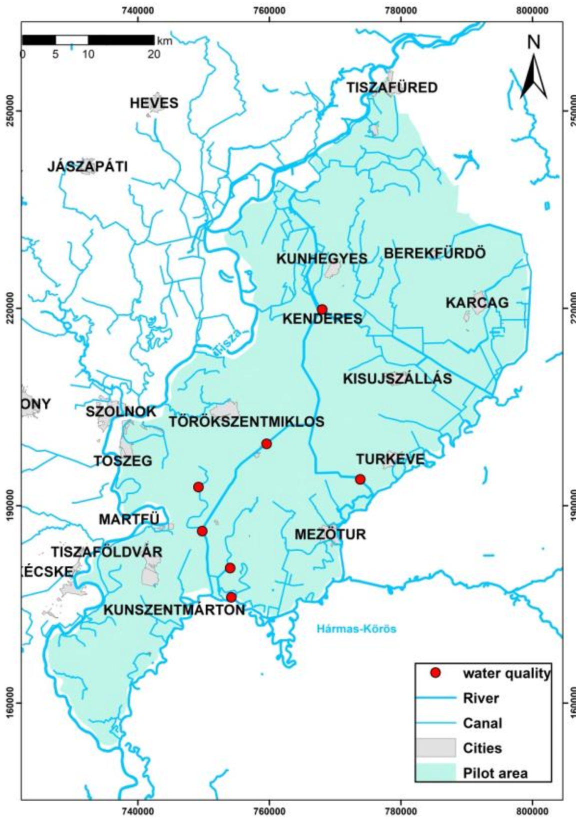


Figure 26. Water quality sampling places

There are four sampling points along the Nagykunsági main canal, and three points on the Harangzug Canal.
(Figure 26.)

Nagykunsági main canal water quality for all component group of Water Framework Directive is excellent or good. Therefore this water body can be used for dilution.

Harangzugi canal salt component group is only moderate.
So we can model, how to dilute the salted water to reach a better status of the water body.
Calibration of Water quality is in progress, with the challenge of infrequent sampling.

Excess water storage:

The measure is the same as D01) Regulated outflow from drainage systems.

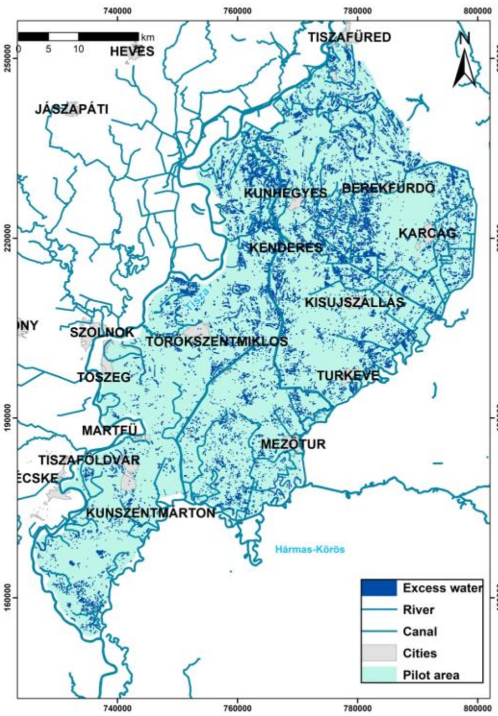


Figure 27. Excess water inundation

In this measure we consider the excess water flood (or pluvial flood) as small temporary wetlands, and do not want to drain it. We could take into account this wetlands like reservoirs in the model.

Deep plowing (Measure A15):

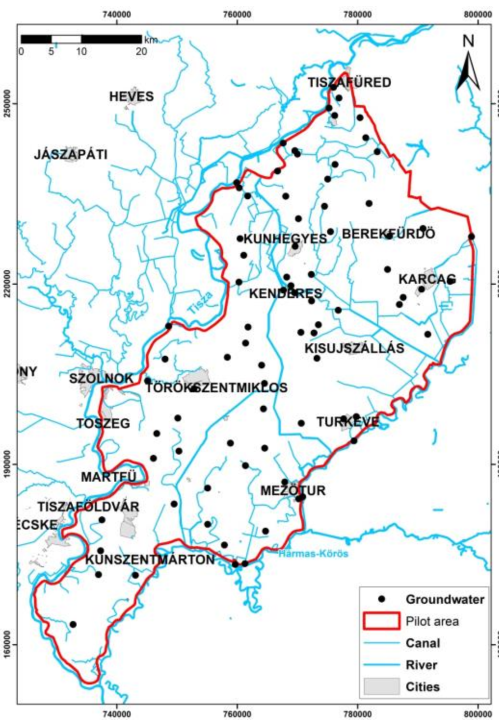
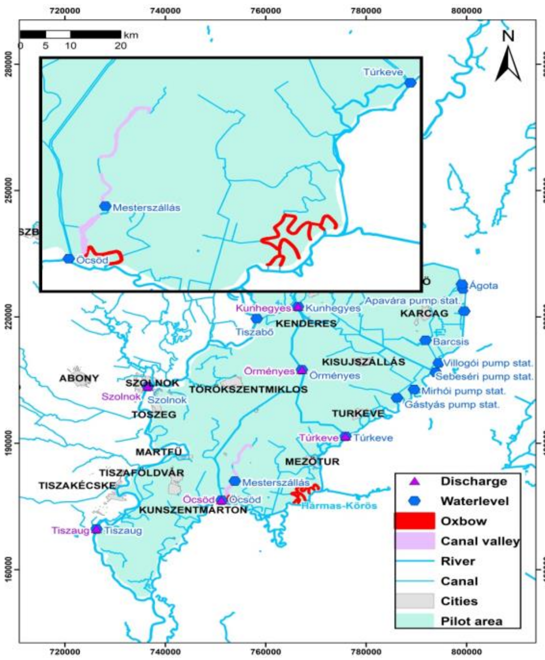
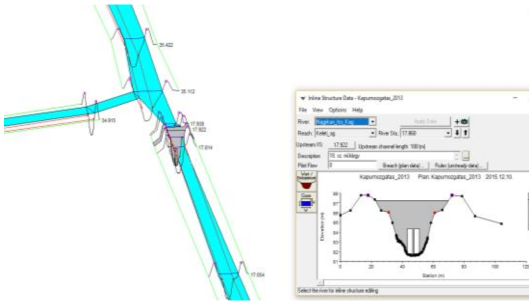


Figure 28. Groundwater wells

In HEC-RAS modelling process we assume that the groundwater is growing as a result of deep plowing and we analyze the effect of the higher groundwater level on the water courses.

Surface storage based on the water resources of Nagykunsági main canal:





Surface storage in existing canal bed, oxbows, former streams, and canal valley.

Measures: N02, N07, D02, D03, D04, D07.

Figure 29. Canal storage

5.4.3) Measures for Static and Dynamic method testing:

Measure Code	Measures (NWRM/NSWRM)	Assessment: S) Static tool D) Dynamic tool
A01	Meadows and pastures	S
A02	Buffer strips and hedges	S
A06	No till agriculture	S
A07	Low till agriculture	S
A08	Green cover	S
A15	Deep plowing (deep ripping)	S/(D)
N02	Wetland restoration and management	S/D
N07	Reconnection of oxbow lakes and similar features	S/D
F01	Forest riparian buffers	S
D01	Regulated outflow from drainage systems	S/D
D02	Water damming in ditches, wires with constant crest (valleys)	S/(D)
D03	Active water management on a drainage system (river valleys)	S/(D)
D04	Construction of micro reservoirs on ditches	S/D
D07	Construction of reservoirs on outflows from drainage systems	S/D
	Water quality improvement	D

Table 7. Measures for Static and Dynamic tools

6. Final Concept of the Nagykunsági pilot area

In FramWat project we recommend to test with static and dynamic tool all the measure listed above, and taking account of cost benefit analysis the final version should be developed in Action Plan.

Figure 30. Wetland in the Middle-Tisza District