ACTION PLAN FOR TISZA NAGYKUNSÁGI RIVER BASIN (D.T3.5.6.)

Hungary

March 2020

Prepared by: Sólyom Péter, Gallé-Gázsity Nikolett

TABLE OF CONTENTS

1. Introduction, challenges and problems

The main objective of the FramWat project is to create a planning framework that helps to increase the buffer capacity of the landscape through natural small water retention measures, improving the water management status of river basins in both quantitative and water quality terms.

This action plan summarizes the work carried out in the pilot area during the project development, the results obtained and formulates a proposal for the range of possible developments in the area that are considerable in terms of drought, flood and water quality and contribute to the objectives of the Water Framework Directive.

To achieve a better ecological status of surface water bodies, the use of project results and experiences is a priority during the updating of the River Basin Management Plans.

In addition to reducing ecological pressures, more appropriate water management conditions in river basins will help to improve flood safety in the pilot area and mitigate drought damage.

The Hungarian pilot river basin (Nagykunsági sub-basin of the Tisza River) is located in the Hungarian Great Plain. Currently, this catchment exposed to the greatest hydrological extremes of climate change.

The pilot area is well protected by flood protection systems. However, drought, as well as drainage excess water damages are recurring phenomena every year (Figure 1).

Due to the natural conditions of the catchment, it cannot be characterized as a typical catchment morphology: it is almost completely flat, which makes it difficult to describe surface water runoff processes with mathematical models. Thus the test methods differ from the methods we use in the mountain-hill area, the planned N(S)WRM’s are also adapted to the local conditions.

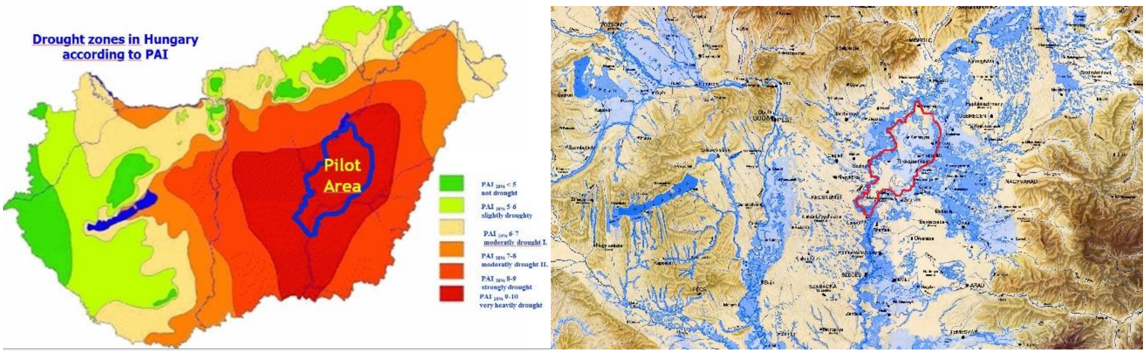

Figure 1. The formerly flooded Great Plain is today one of the driest areas in Hungary

The proportion of agricultural land is among the highest in the country, 74% of the Pilot catchment area is agricultural, but from an agroecological point of view, the land use is the most unfavourable structure: Large area is arable land and intensive crops (eg vegetables, orchards, etc.) rate is low, less than 0.1%.

In addition to drought, inland excess water is a recurring problem, causing a significant problem mainly in agricultural areas and less frequently in populated areas.

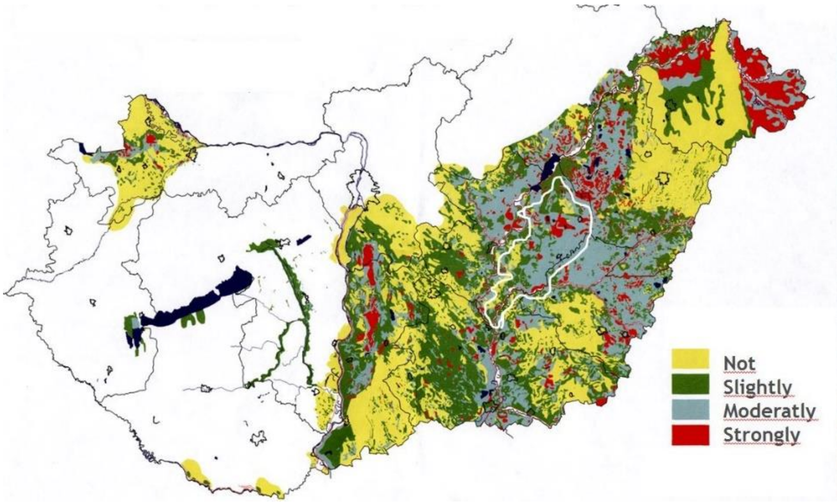

Figure 2. Pluvial flood hazard map of Hungary (by Dr. Imre Pálfai)

In the framework of the FramWat project, an internet application (user program, web application) (FroGIS) was developed for the valorisation method developed for the analysis of water retention needs within a river basin. Using the available hydrometeorological, soil, hydrographic, surface coverage, and other natural data as an indicator, the program can perform the analysis of the water retention demand within a larger river basin.

The test target can be flood, drought, water quality, and general.

The general results obtained in the Nagykunsági catchment area are shown in Figure 3.

Detailed report: D.T1.3.1 Reports from pilot action - testing the prototype of the FroGis tool in the river basins. *(The activity number and title within the FramWat project)*

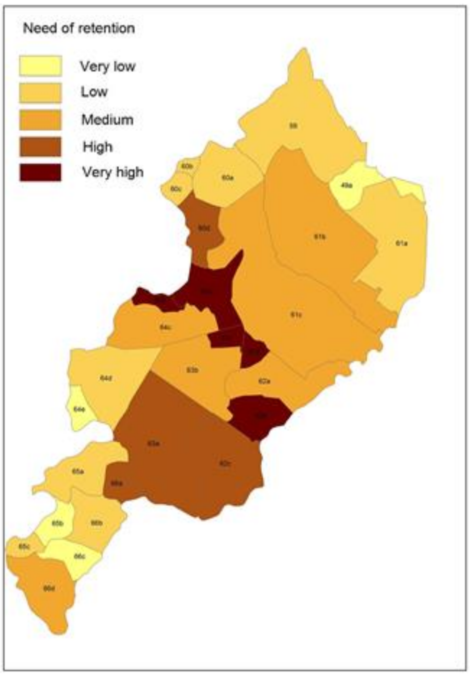

Figure 3. Valorisation analysis using the FroGIS application for general purpose

2. Selected measures

Within the framework of the project, the range of measures to be examined was selected in the Concept Plan (D.T2.3.1), which was completed for each pilot river basin.

The concept plan presents the spatial natural features of the river basin, the local challenges of water resource management, and the shortcomings identified during river basin management planning.

The most important task of the concept plan is to provide a proposal for the small water retention measures (N(S)WRM) that can be applied in the river basins, as well as present a method how to identify the location of each measure in the river basin.

Together with the project partners, the Project Lead Partner decided to prepare two versions of the plan:

- Expert version,
- Local preference version.

The expert version has been compiled by experts of water management, forestry, and agriculture. The local preference version contains the local needs and ideas, discussed with local governments, NGOs, and other local experts.

A large part of the measures is included in the Natural Small Water Retention Measure Guidelines 2015 prepared by the Global Water Partnership (GWP), which document provides a detailed description of each measure (http://nwrm.eu).

The selectable measures can be divided into four main groups:

- Agriculture,
- Hydromorphology,
- Forestry,
- Drainage areas,
- Hydraulic structures.

Measures proposed for further implementation from the KÖTIVIZIG Concept plan are in the following table:

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
D03	Drainage	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

The agricultural sector has gotten special attention in the project, as almost three quarter (74%) of the river basin is agricultural land, and the selected measures can contribute to the creation of more optimal water management conditions in areas with different soil conditions.

2.1 Agricultural measures

The appropriate sites for agricultural measures were selected based on GIS.

Changing arable land into meadow-pasture cultivation was planned for poor quality arable land that endangered by excess water (Figure 4.)

In good quality arable land with higher excess water hazard we planned agrotechnical measures that favourably affect soil water management (See Figure 5, deep plowing).

Areas in the pilot river basin are:

A01 Meadows and pastures: 18,517 ha.

A06, A07 No-till and low till agriculture: 1 100 ha.

A08 Green cover: 15,000 ha.

A15 Deep plowing: 14,000 ha.

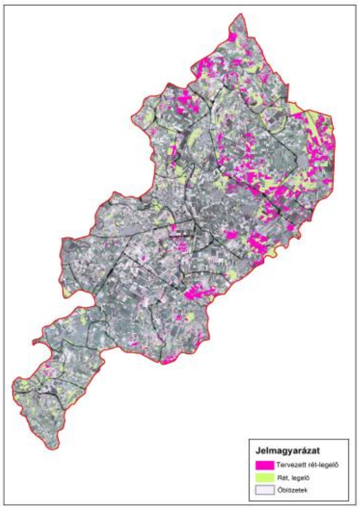

Figure 4.
Planned land-use change to meadow and pasture

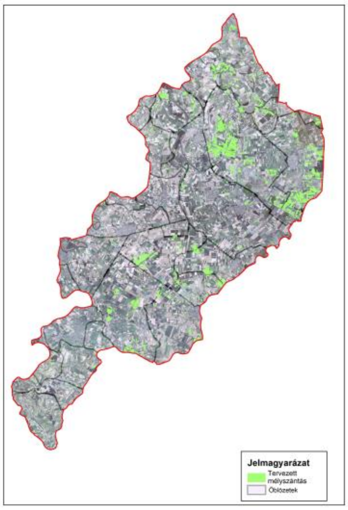

Figure 5.
Planned deep plowing

Based on the simplified cost analysis, the total one-time or regular costs, depending on the intervention are:

A01 Meadows and pastures: 3 703 e€

A06, A07 No-till and low till agriculture: 299 e€

A08 Green cover: 1 144 e €.

A15 Deep plowing: 1 082 e €.

(Details: DT 3.3.2 Cost calculation)

2.2 Hydro-morphology measures

Before the river regulation works started in the 19th century the two main rivers Tisza and Körös were connected with numerous seasonal streams applying uncontrollable operation and the streams meandered across the area causing temporary inundations in deep terrain lines.

In the group of hydromorphological measures, we proposed for the water supply of the former watercourses and oxbows to use the existing irrigation network. (Figure 6.)

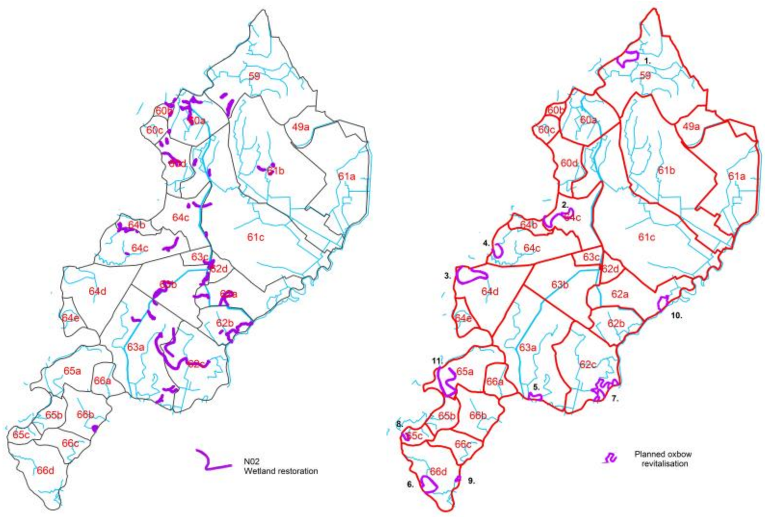

Figure 6.
Wetland restoration

Estimated implementation costs of the planned hydromorphological measures are:

N02 Wetland restoration 17 pcs: 6 945 e €.

N07 Oxbow revitalization 11 pcs: 32 287 e €.

Name of Oxbows: Cserőközi-, Fegyverneki-, Cibakházi-, Alcsi-, Gyova-Mámai-, Tiszaugi-, Szajoli Holt-Tisza, Tehenesi-, Harangzugi-, Halásztelek-Túrtő-Harcsás Holt Körös, Holt-Berettyó (Túrkeve).

2.3 Buffer zones

In order to reduce nutrient leaching into surface water bodies, buffer strips have been planned along the banks of state-owned watercourses. There are two similar types of measures in the small water retention measure catalogue: A02 Buffer strip area and the F01 Forest riparian buffers. These measures are planned along state-owned canals, in places where there are currently no such green bands. The CORIN Land Cover 2012 layer was used for GIS analysis.

Estimated implementation costs of the planned buffer zone type measures are:

A02 Buffer strip area: 45 e €.

F01 Forest riparian buffers: 938 e €.

2.4 Drainage measures

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

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.

D03 Active water management on a drainage system

Developing the Nagykunsági main canal and its branches, increasing the storage capacity, extending the impact area of the irrigation system. (Figure 8.)

Estimated cost: 124 611 e €.

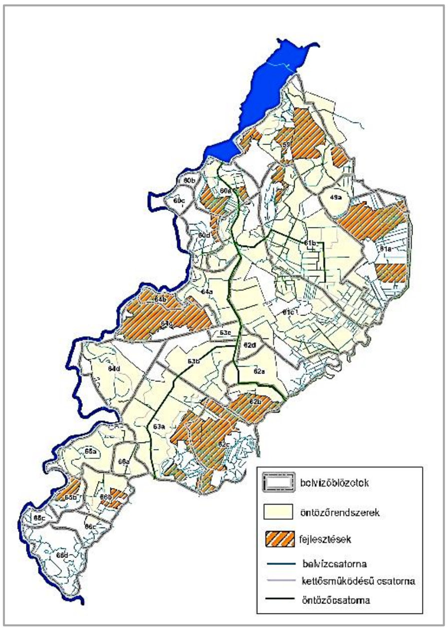

Figure 8. Irrigation developments

D04 Construction of micro reservoirs on ditches

Due to topography conditions, this type of measure includes only one project, the Harangzugi Reservoir I.

Estimated implementation cost: € 2,500, which includes the reconstruction of the outlet structure.

D07 Construction of reservoirs on outflows from drainage systems

Construction of 3 reservoirs along the Hortobágy-Berettyó main canal (Figure 9).

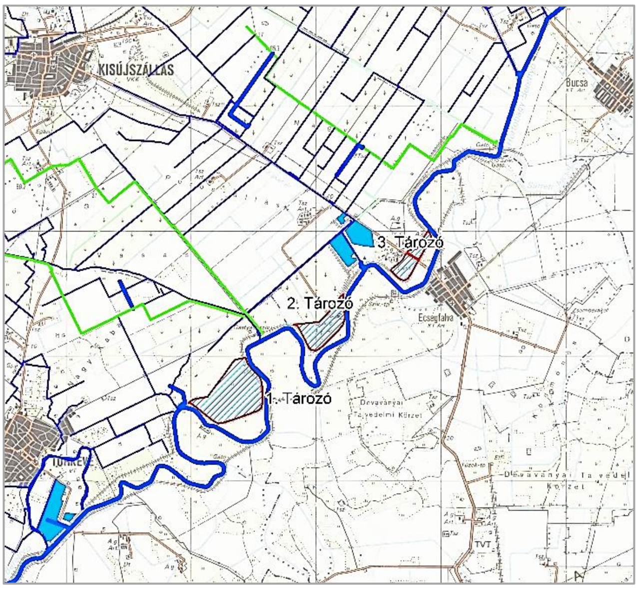

Figure 9. Reservoirs alongside Hortobágy-Berettyó

Estimated costs of planned reservoirs: 34 268 e €.

2.5 Summary of impact assessment (Static Tool, Dynamic tool)

2.5.1 Results of Static tool

The project developed a simplified impact analysis method for the planned measures, and this method is suitable for analyzing the individual effects of each measure as well as its cumulative impact on the river basin, based on a kind of improvement gradient value. (Details: D.T 2.2.2 Reports from testing the static method to assess the cumulative effect of N(S)WRM)

The analysis examined two types of expert options that differ in the intensity of agricultural-type measures. In the first version, these measures were analysed with the intensity planned in the concept plan, while in the second version their proportion was reduced based on expert recommendation, which can be considered more rational under the current agricultural conditions.

In comparison, the valorisation results with the Static tool results see Figures 10-12.

It can be seen that these variants result in improvements in areas that are more critical for water retention needs. Some exceptions are the 64c, 64b, 63c, 62d SPUs, but these are smaller catchments where the intensity of the planned agricultural measure was lower.

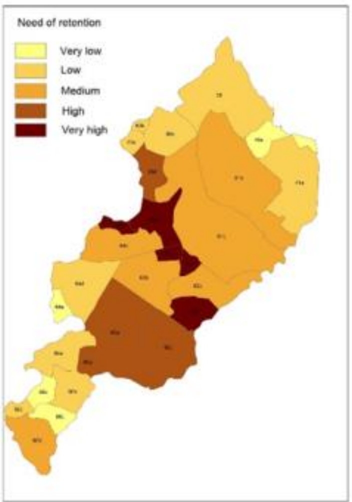

Figure 10. Valorisation result

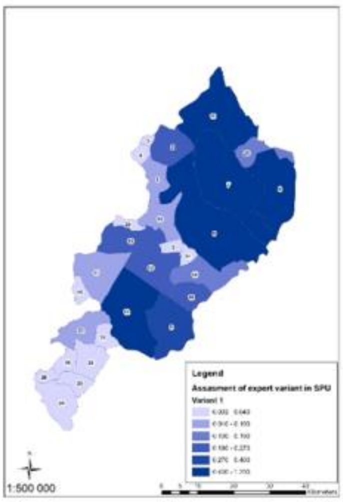

Figure 11. 1st version of static tool

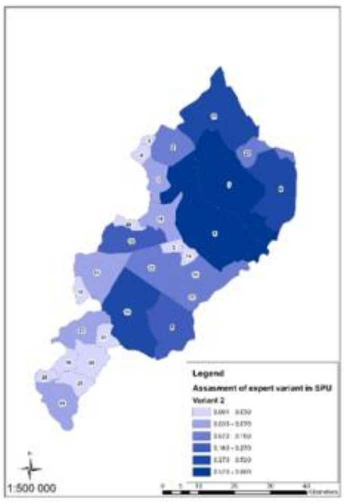

Figure12. 2nd version of the static tool

2.5.2Results of Dynamic tool

The analysis of the possible effects of the planned measures in the pilot area of the Nagykunsági river basin was performed with a 1D HEC-RAS model, selecting those for which the model can be applied.

(See DT 2.4.1 Report from testing dynamic tool for details)

Among the measures described in Table 4, the following were directly or indirectly assessed:

Water management type-, hydro morphological and agricultural measures: change of arable into meadow and pasture and deep ploughing.

In the case of water management and hydromorphological measures, the retention of surface water and the increase of storage capacities were taken into account, and in the case of meadow and pasture areas, where the cultivation way provides periodic excess water storage capacity. The soil water retention capacity was also taken into account in the calculation reached by appropriate agricultural techniques.

The effect of water retention was carried out by analysing the change of water level and discharges in one of the main recipient Hortobágy-Berettyó in a real flood situation.

Tisza and Hármas-Körös Rivers flow depend on the upper catchment areas, local influence is minimal, meanwhile Hortobágy-Berettyó flow highly depend on the pumping activity in the pilot river basin, that can be reduced with retention measures.

The modelling task for 2010-2011. It was carried out by examining flood wave happened in 2006, analysing the situation if the water flow to be pumped into the Hortobágy-Berettyó main canal decreases due to the territorial storage.

Figure 13 shows the effect of the cumulative effect of the planned reservoirs on the water surface of the Hortobágy-Berettyó main canal (light blue line).

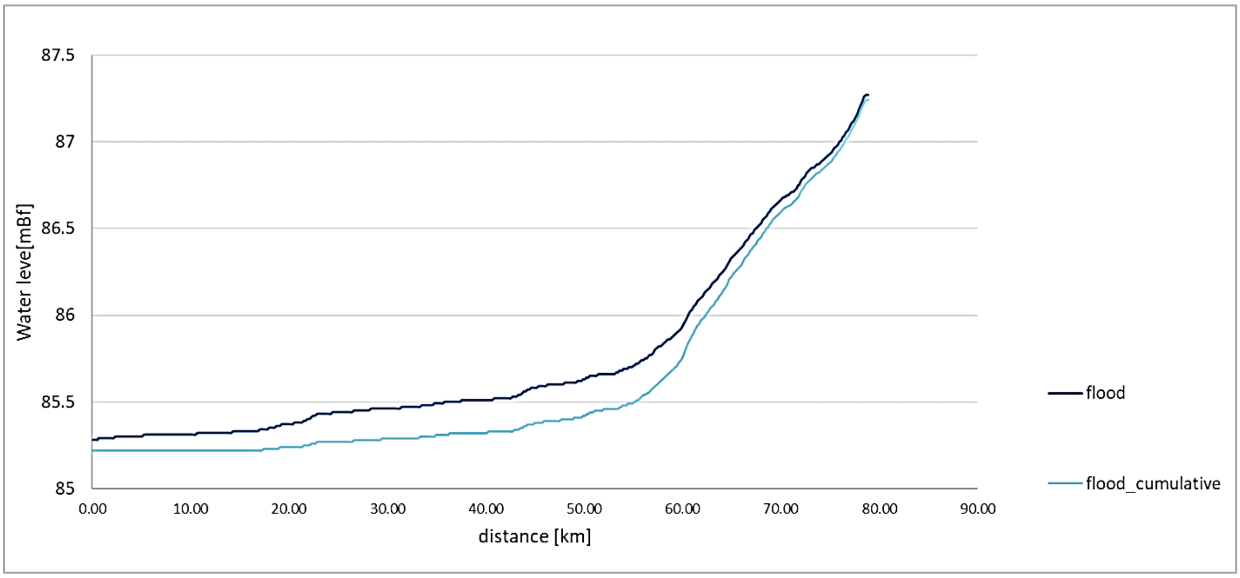

Figure 13. Decrease of Hortobágy-Berettyó water level

Similarly, the planned storage measures for the runoff conditions of a regional irrigation main canal, Harangzugi Main Canal I was examined. Here, the simulation period is the 2015 spring pluvial flood. The positive effect of the test is the reduction of the channel load in the final section. This means about 0,30 m3/s, which is about 10% of the designed water flow of the channel.

During the modelling work, we examined the effect of surface storage on the agricultural conditions of the region in addition to the expected increase in water demand due to the extreme weather conditions. The positive impact is obvious, but it was difficult to model with the tools available in the project.

The HEC-RAS modelling work focused on the Main Nagykunsági Canal. The task was carried out to check whether the planned canal bed storage can guarantee the long-term water needs of the irrigation system that exists in the basin. Determination of the long-term water needs was based on the 2018 survey of the National Chamber of Agriculture. The modelling was performed for the drought period of 2012 assuming that the obligatory water discharges are secured for Hortobágy-Berettyó and Hármas-Körös Rivers (TIKEVIR regulation).

Modelling scenarios:

- Ensure long-term water needs with current operating conditions,

- The effect of raising the static water level of the Nagykunság Main Canal and the Eastern branch by 0.5 and 1.0 m,

- The effect of the increase of the water flow in the Nagykunság Main Canal with raising the water level by 0.5 and 1.0 m,

- Reduced water requirements due to spatial storage,

- The provision of water supply to the Mezőtúr-Álomzugi areas. (Based on the FroGis results the area has high water retention needs in terms of drought),

- Water quality improvement effect: Analysis of salt concentration reduction in Harangzugi channel I.

The modelling results shows that the long-term water needs cannot be ensured with the current operation method, consequently additional water flow is necessary from the Lake Tisza (See Figure 14).

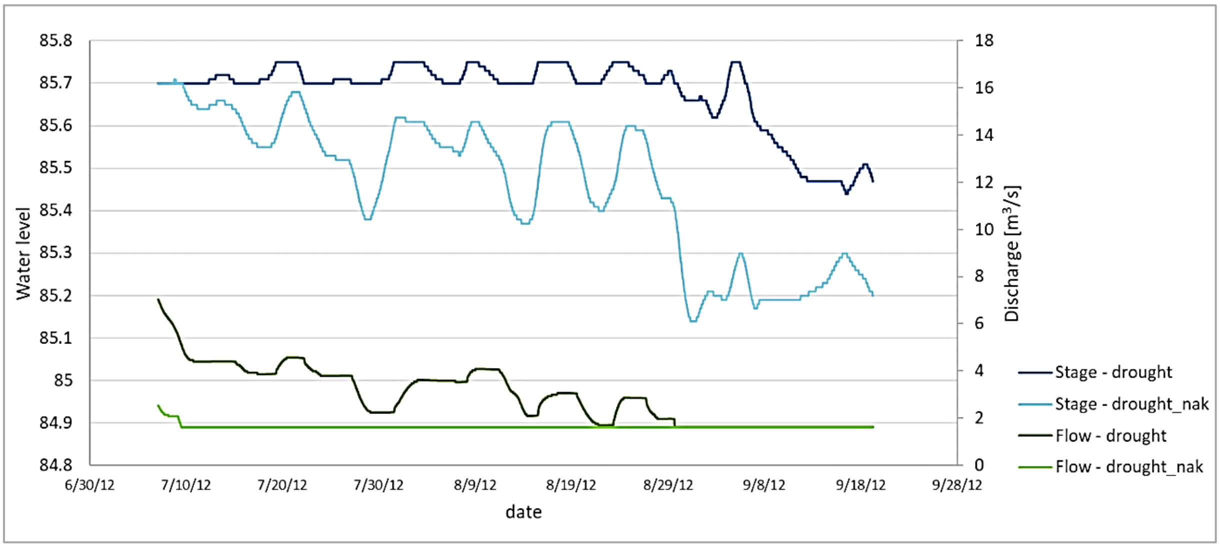

Figure 14. Water level time series in the end section of the Nagykunság main canal

3. Legislation/policy

Act LVII of 1995 on water management.

Act LIII of 1995 on general rules for the protection of the environment.

Act LIII of 1996 on the protection of nature.

Act XXI of 1996 on spatial development and spatial planning.

Act CXXII of 2013 on the concept of agricultural and forestry land.

Act LV of 1996 on wildlife conservation, game management, and hunting.

Act LXXVIII of 1997 on built environment evolving and protection (and other implementing regulations).

Act CII of 2013 on fisheries management and protection.

Act CXLI of 1997 on real estate registration.

Act LXVII of 2004 on the implementation of the program for the improvement of the flood safety of the Tisza Valley and the territorial and rural development of the affected area (further development of the Vásárhelyi plan).

Act XXXVII of 2009 about the forest, forest protection and forest management.

Act CXLIV of 2009 about water associations.

Act CXIII of 2019 about irrigation management

Government decree No. 191/2009. (IX. 15.) on construction activity

Government decree No. 312/2012 (XI.8.) on construction and building supervision authority procedures and inspections, and on building authority service

Government decree No. 120/1999.(VIII.6.) On tasks related to the maintenance of waters and public water facilities

Government decree No. 178/1998.(XI.6.) About basic data related to water management tasks

Government decree No. 194/2009.(IX.15.) On detailed rules for the integrated management of procedures for the execution of works and the designation of intermediate bodies

Government decree No. 2/2005.(I.11.) On the environmental assessment of certain plans or programs

Government decree No. 83/2014. (III. 14.) on rules of use and utilization of the flood beds, maintenance zone along the channels, vulnerable territories by under seepages, and rules of making high-water management plants

Government decree No. 219/2004.(VII.21.) On the protection of groundwater

Government decree No. 220/2004.(VII.21.) On rules for the protection of surface water quality

Government decree No. 221/2004.(VII.21.) On certain rules of river basin management

Government decree No. 240/2000.(XII.23.) On the identification of surface waters and river basins sensitive to

urban waste water treatment

Government decree No. 253/1997.(XII.20.) On national urban planning and construction requirements

Government decree No. 275/2004(X.8.) On European Community nature conservation areas

Government decree No. 314/2005.(XII.25.) On the environmental impact assessment and the uniform environmental permit procedure

Government decree No. 147/2010. (IV.29) on rules of activities and facilities for the recovery, protection and damage prevention of waters

Government decree No. 50/2001.(IV.3.) On rules for the agricultural use and treatment of waste water and sewage sludge

Government decree No. 72/1996.(V.22.) On practice of water management authority law

Government decree No. 78/2007.(IV.24.) On the basic environmental register

Government decree No. 269/2007.(X.18.) On land use rules for the maintenance of NATURA 2000 grasslands

Government decree No. 223/2014.(IX.4.) Designation of bodies responsible for water administration and water management and water protection

Government decree No. 366/2015.(XII.2.) On the designation of bodies performing water protection administrative tasks and amending certain government decrees in the field of water management

Government decree No. 12/2013.(I.22.) On the declaration of priority administrative matters related to the implementation of investments related to the construction and reconstruction of lowland and hilly reservoirs and the designation of the acting authorities

Government decree No. 146/2011.(VII.27.) On the rules for the construction of reservoirs for the prevention of water damage, the use of the properties concerned and the compensation procedure

Government decree No. 178/2010.(V.13.) On the identification of areas affected by the risk arising from flood and excess water, the preparation and content of hazard and risk maps and risk management plans
The planned implementations must comply with the legislation listed above.

The implementation of the planned interventions is not in conflict with the objectives of other sectors. In the agricultural sector, the legal and tendering environment in line with the planned measures supports the objectives of the project.

4. Implementation of planned measures

No.	Steps/Activities	Duration of the activity and Deadline	Estimated cost (thousand €)	Financial resources	Responsible
1.	Meadows and pastures	**Agricultural measures:** - Development and adoption of a support system 2021-2023., - Tendering 2023-2024. - Implementation of the measure 2024-2025.	3 703	EU or National financial source	**Proposed: Ministry of Agriculture, National Chamber of Agriculture**
2.	Buffer strips and hedges		45		
3.	No-till agriculture		289,79		
4.	Low till agriculture				
5.	Green cover		1 143,75		
6.	Deep ploughing		1 081		
7.	Wetland restoration and management	2 years in case of availability of financial resources and the right to dispose of the area.	6 945		General Directorate of Water Management, Middle-Tisza district Water Directorate
8.	Reconnection of oxbow lakes and similar features	4 years in case of availability of financial resources and the right to dispose of the area.	31 287,5		
9.	Forest riparian buffers		937,5		
10.	Active water management on a drainage system (river valleys)		124 611,25		
11.	Construction of micro reservoirs on ditches		2,5 (1 outlet structure)		
12.	Construction of reservoirs on outflows from drainage systems		34 267,5		

5. Monitoring

Besides the legal background, cost-effectiveness and possible effects of the selected measures, monitoring of the implementation of each measure are also important topics. The table below shows the type of monitoring activities that can be carried out to monitor the different sectors and measures. The observations can be divided into two groups for current and future possibilities.

Code	*Sector*	*N(S)WRM*	*Monitoring*
A01	Agriculture	Meadows and pastures	Irrigation water volume, pumping volume / soil moisture measurement, HDI*
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	Irrigation water quantity / soil moisture measurement, HDI
N07		Reconnection of oxbow lakes and similar features	Irrigation water quantity / soil moisture measurement, HDI
F01	Forestry	Forest riparian buffers	Irrigation water quantity / soil moisture measurement, HDI
D03	Drainage	Active water management on a drainage system (river valleys)	Pumping volume / soil moisture measurement HDI
D04		Construction of micro reservoirs on ditches	
D07		Construction of reservoirs on outflows from drainage systems	

*Hungarian Drought Index

5.1 Current monitoring options

We were not able to fully monitor the implementation of the selected measures in Hungary directly, and some areas were incomplete due to the lack of a sufficiently dense global and local monitoring stations.

Two types of monitoring listed in the table above that are currently applicable are:

- Irrigation water volume,
- Pumping volumes.

The amount of irrigation water can be used locally and globally as a control in the agricultural sector, and globally for hydro-morphological and forestry measures. In the case of agricultural land, as a result of the cultivation change, the water balance of the topsoil improves, thereby reducing the amount of irrigation water used.

The effects of wetland restoration, oxbows reconnection and forest buffers can be monitored similarly to those presented above. With the implementation of each hydromorphological measure, the water management of the surrounding lands will improve, so the demand for irrigation water in the agricultural area will decrease. An obstacle to the application of this type of monitoring is the fact that most agricultural areas are currently cultivated without irrigation.

The other type of control is the change of excess water pumping volumes, which we can apply in both the agricultural and water management sectors. In case of agricultural areas, as a result of the measures listed in the table, the water balance of the land will improve, the storage capacity of irrigation and drainage canals increase, and less excess water will be drained from the land.

5.2 Future monitoring possibilities

The number of drought monitoring stations increase year by year, therefore a reliable monitoring system is expected to be available in the future assuring more detailed analysis of the impact of measures.

A relatively new development is the Hungarian Drought Index (HDI), which was developed in 2015-2016, and suitable for characterizing daily water shortages / droughts.

The basic concept of HDI is that the meteorological drought factor (HDI0) which includes a multiplication factor (k35) depends on the moisture status of the topsoil (0-35 cm). This is important for arable land with crops, but it considers with less weight the moisture content of the deeper soil layers (35-80 cm).

Additional multiplication factor (k80) is added depending on the reserve. Also, a so-called stress factor (S) is entered during the extremely dry and/or extreme heat periods.

$HDI = HDI0*k35*k80*S$

Meteorological Drought Index HDI0: it uses only daily precipitation and daily average temperatures.

k35, k80: both values depend on the water capacity of the field in case of lower water content, therefore, they increase the value of the drought index.

S: in the case of long dry or hot periods, the effect of stress on the plants is expressed in this value

For continuous calculation of HDI, drought monitoring stations provide precipitation, temperature, and soil moisture data. The map below shows the density of the current monitoring network as well as an example of the spatial distribution of drought index. It can be seen that the density of drought monitoring stations is not yet appropriate to monitor the groundwater that improves as a result of the measures with the soil moisture at or near the planned measures. (Figure 15).

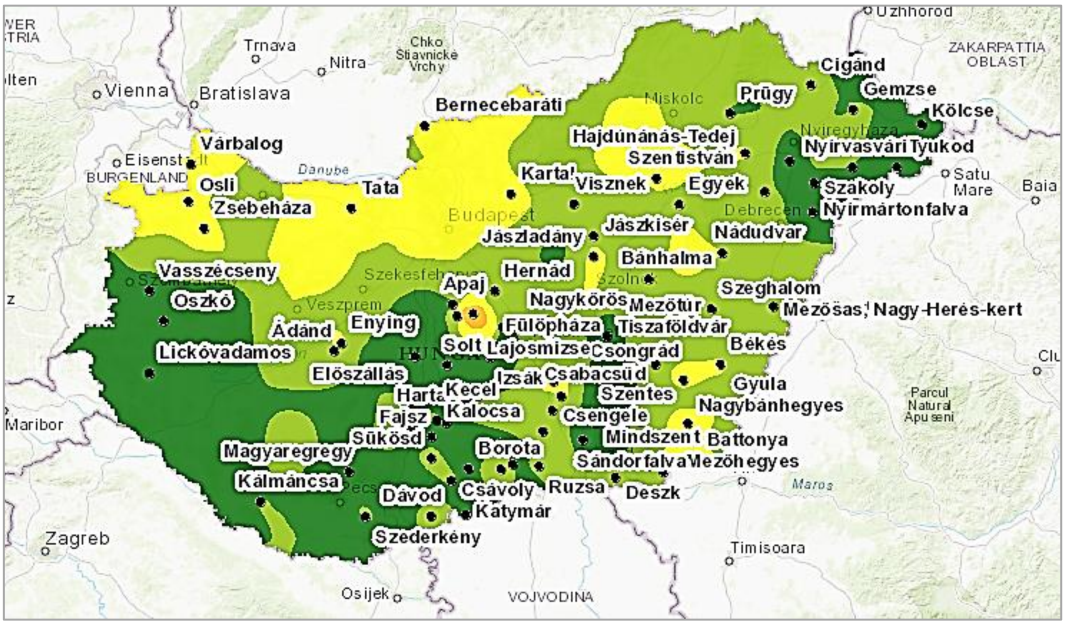

Figure 15. Drought index monitoring stations

In the future, after the improvements, the presented system will allow reliable monitoring of the implementation of the selected measures.

6. Summary

Water retention options in lowland areas are limited due to the morphology and runoff conditions of the catchment areas. Mathematical modelling of the processes has not been developed for lowlands, and their operation is limited.

Besides the existing canal network, former watercourses, oxbows, and wetlands, the greatest opportunity is using the storage capacity of the soil profile, increasing soil storage capacity is very effective in the lowland area. As most of the pilot area is agricultural, the incentive effect of agriculture is necessary, and there are good examples of this in Hungary.

FroGis application is available to support the planning process, identifying areas for water retention, for prioritization on the river basin. The Static tool is suitable for comparing variants in the pilot catchment without using detailed hydrological and hydraulic models of the analysed catchment

HEC-RAS 1D model as a dynamic tool is available to model hydrodynamic processes. We could analyse some of the processes indirectly, in a few watercourses.

Even if we cannot examine and describe every process with mathematical models and other methods, we know that the beneficial effects of small water retention are wider. Small water retentions can optimize the local microclimate and can provide habitat for aquatic communities. They help to achieve good ecological status and better landscape attraction.