REPORTS FROM PILOT ACTION - TESTING THE PROTOTYPE OF THE FROGIS TOOL IN THE RIVER BASINS

Nagykunsági sub-catchment, Middle-Tisza District, Hungary

D.T1.3.1 **12.2018**

Table of contents

1. Purpose and scope of the test

"The aim of the valorisation is identifying areas with varying degree of predisposition for development (implementation of small retention facilities/ with different development needs for small retention in non-urban areas (rural areas, including rural housing, open spaces and forests)." (DT 1.1.1)

The Nagykunsági sub-catchment area will be a testing ground for the GIS valorisation tool for mapping potential locations of N(S)WRM.

2. Characteristics 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

3. Issues identified in the catchment

3.1 *Review of existing assessment of floods/drought/water* quality/sediment transport

3.1.1 Drought hazard:

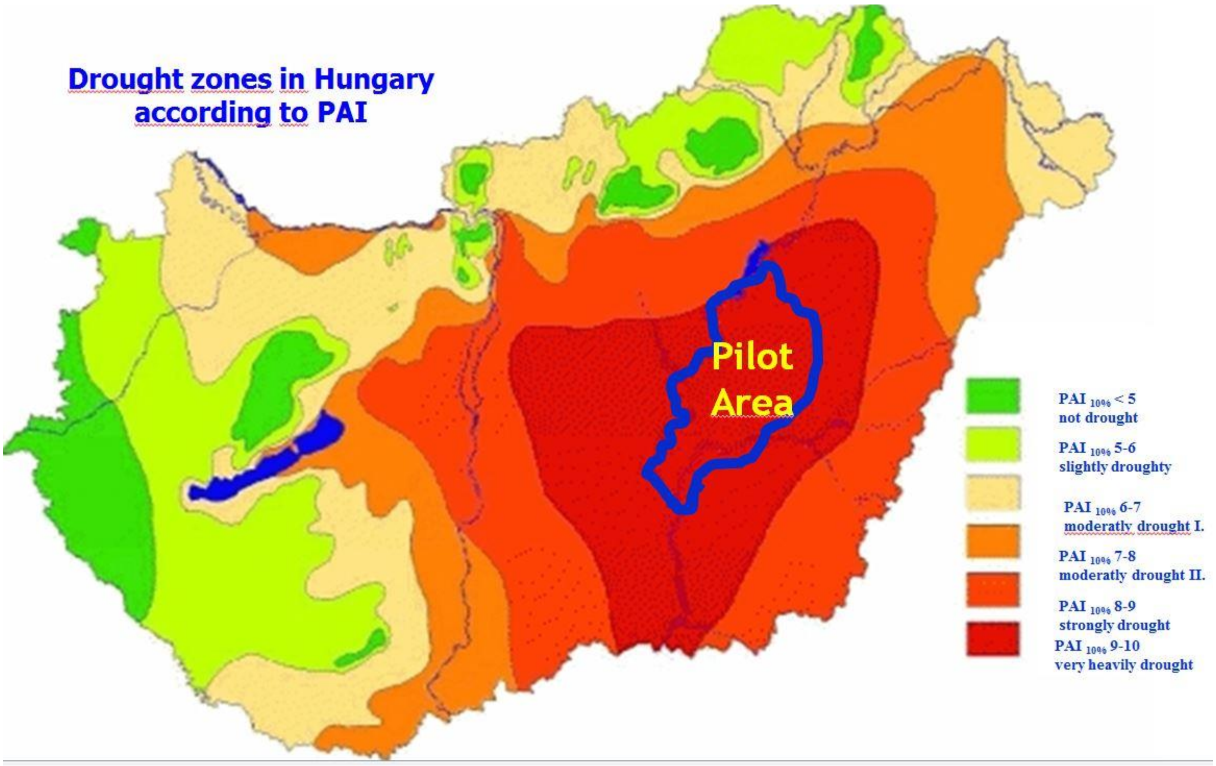


Figure 1. Drought hazard map

The pilot area is situated in the driest part of the Hungarian Great Plain. The entire area endangered by drought very heavily.

3.1.2 Flood risk in the Middle-Tisza District:

Figure 2. Flood hazard map

More than half of the area is endangered by flood, it is surrounded by well-built flood dikes, and now two emergency reservoirs help the flood protection work.

3.1.3 Excess water hazard (Pluvial flood):

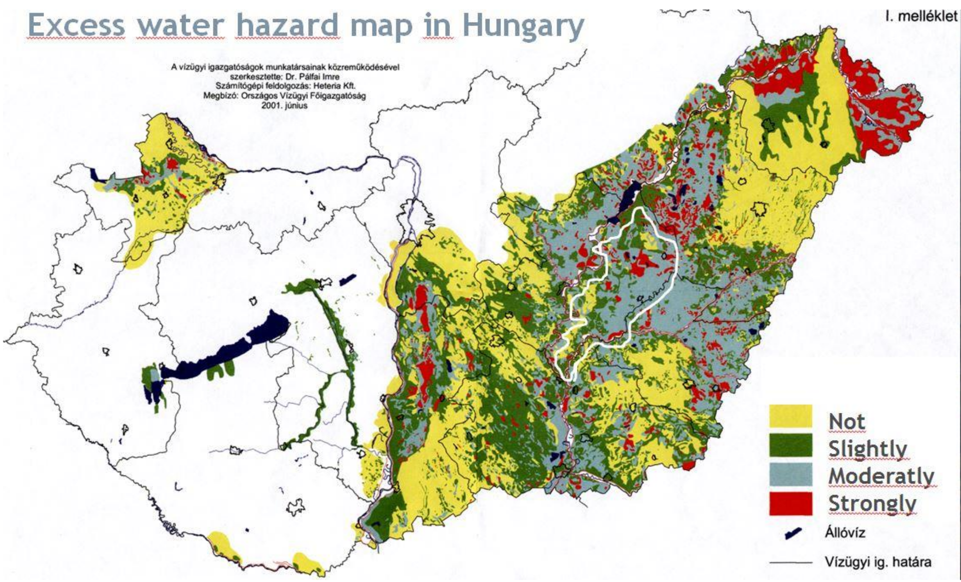


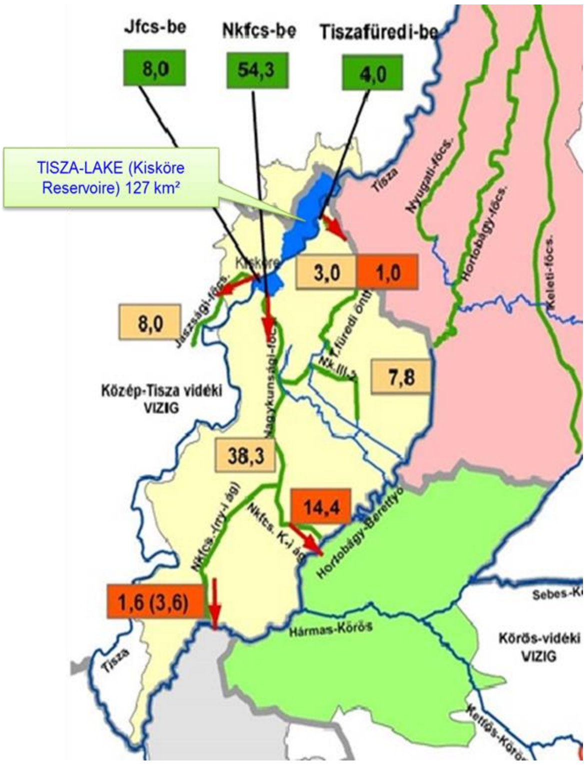
Figure 3. Pluvial flood hazard map

The pluvial flood is a yearly phenomenon in the closed lowland catchment area. 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.

3.2 Review of existing and planned measures

3.2.1 Existing measures:

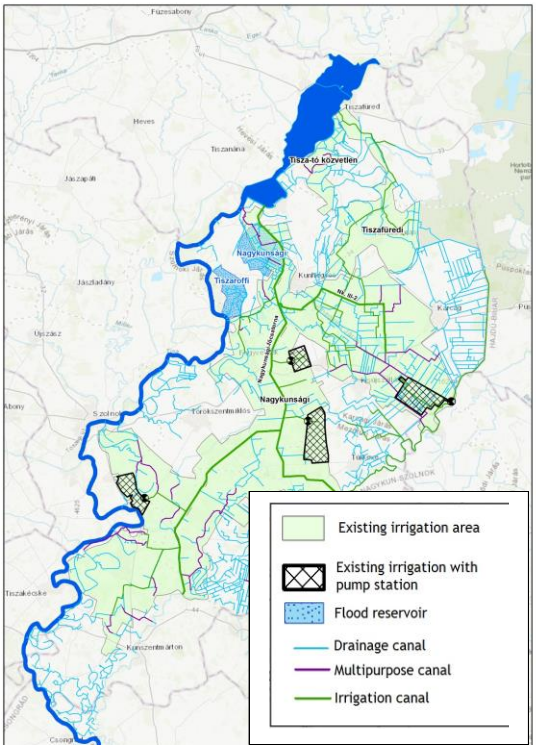
Tisza-Körös-Valley common water management system: (TIKEVIR)



The main infrastructure of water resource management in the sub basin is the Lake Tisza (Kisköre Reservoir), the largest artificial lake in Hungary.
This reservoir is the most important element in terms of water scarcity in the region. It ensures average flow of water to the Middle-Tisza Valley and the Kőrös Valley, and provides irrigation water into the Nagykunsági sub-basin.

Capacity of the reservoir: 148 – 165 million m3
Water supply:
Residential water supply,
Irrigation water supply,
Water supply for fishponds,
Ecological water supply.

Figure 3. System sketch of TIKEVIR



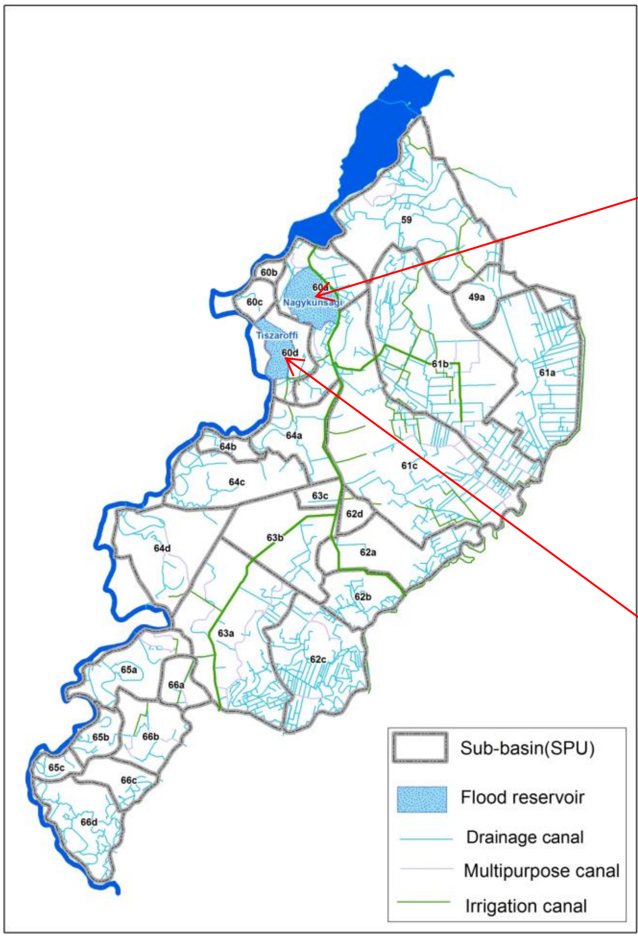
Within the catchment the irrigation canal network length is 430 km.

The main Nagykunsági Canal and its branches ensure the necessary agricultural water supply and irrigation water for the Kőrös Valley.

The drainage canal network length is 2 030 km in the Pilot area, and there are 68 pumping stations, with a total capacity of 95 m³/s.

Figure 4. Irrigation and drainage network

More than half of the area is endangered by flood, thus a well-built flood dike system was constructed to protect the area. The dike protection system is supported with two emergency reservoirs.



Nagykunsági flood reservoir: 99 million m^3.

Tiszaroff flood reservoir: 97 million m^3.

Figure 5. Flood reservoirs in the pilot catchment

3.2.2 Planned 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.

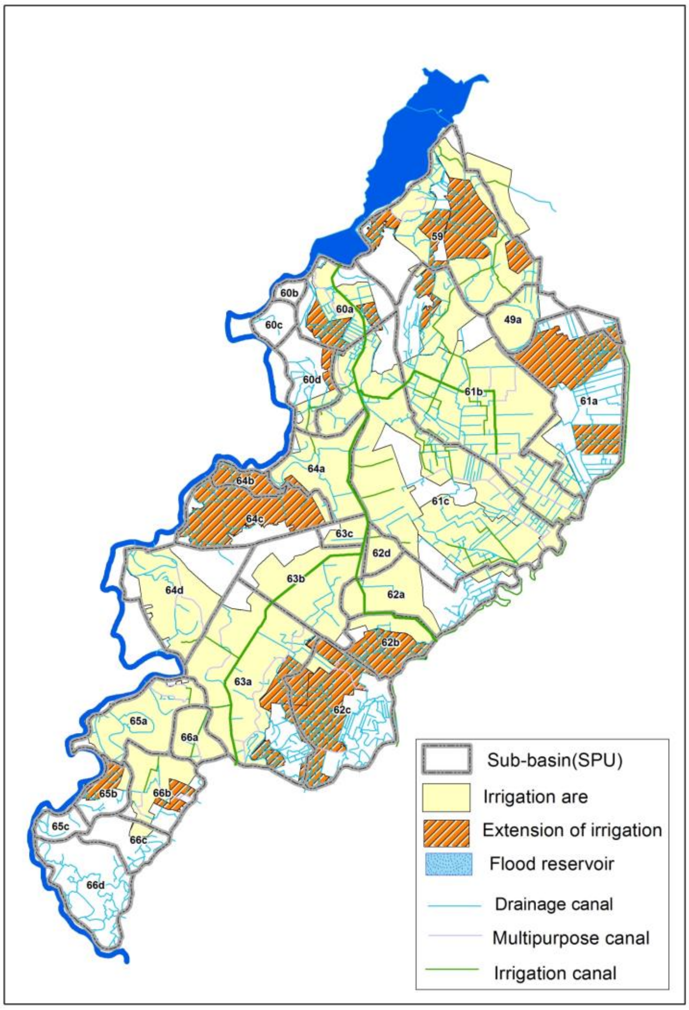


Figure 6. Impact area of the planned measures

46 projects in the pilot:

- Developing irrigation system, extending impact area, increasing retention capacity, (~130 km canal length, ~27 000 ha new irrigated area)

- Developing drainage and multipurpose canal system to enhance water retention condition (~550 km)

- Oxbow lakes: water storage capacity increase, revitalization

Planned measures
1. Development of existing irrigation water reservoirs
Kecskeri reservoir
2. Development and rehabilitation of oxbows
10 Oxbowes: Fegyvernek, Cserőköz, Alcsi, Cibakházi, Szajoli, Harangzugi, Gyova-Mámai, Halásztelki, Tiszazugi, Tehenesi. (10 project)
3. Development of new reservoirs
Water supply increase of Hortobágy-Berettyó region
4. Excess water storage
Holt-Berettyó oxbow
5. Landscape management in the area of flood reservoirs
Landscape management in the area of Tiszaroff, Nagykunsági flood reservoirs, (2 project)
Reconstruction of Tiszafüred irrigation system I.
Reconstruction of water intake structure of Gástyás irrigation system I. connecting with Nagykunság system (2 project)
Imporving 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)
6. 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 (11 project)
7. 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
8. Recommission of inoperable irrigation systems
Renew of Tiszafüred irrigation system II-III, Tiszagyenda, Kútrét V., Nk III-2-12 irrigation canals. (5 project)

3.3 Results of first consultation with stakeholders

The 1st National Consultation was held on 11 May 2018 in Szolnok, Hungary.

MTDWD presented the FramWat project in general: main goals, outcomes, structure and content, and tasks of the project focusing on N(S)WRMs.
The representative of the Hungarian Chamber of Agriculture as Associated Partner of MTDWD presented the implementation of the Irrigation Strategy of Hungary and the needs of local agriculture sector, as the main water user in the pilot area. She emphasized the important connection between water management and agriculture. Cooperation was suggested among the small holder farmers to create water supply and irrigation systems, to investigate water quality of inland excess water retention pounds for irrigation, the issue of water retention feasibility in the flood peak mitigation reservoirs and to have a wider information base of the scientific outputs investigated by the water directorates.

3.4 Summary

Considering the characteristics of the river basin, we created only one map to show the possibilities and needs in the SPU, using planned investments and existing facilities *(Figure 7.)*

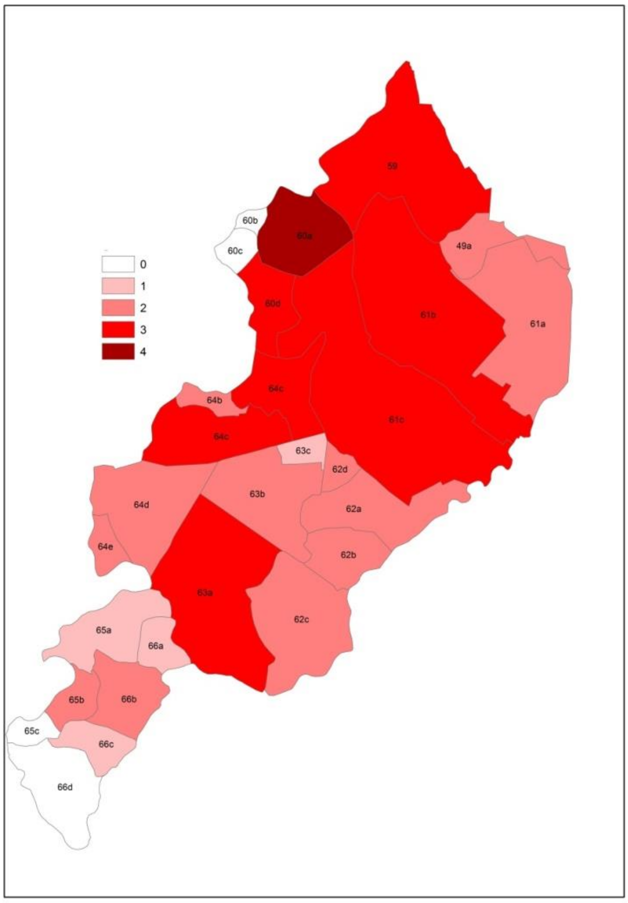
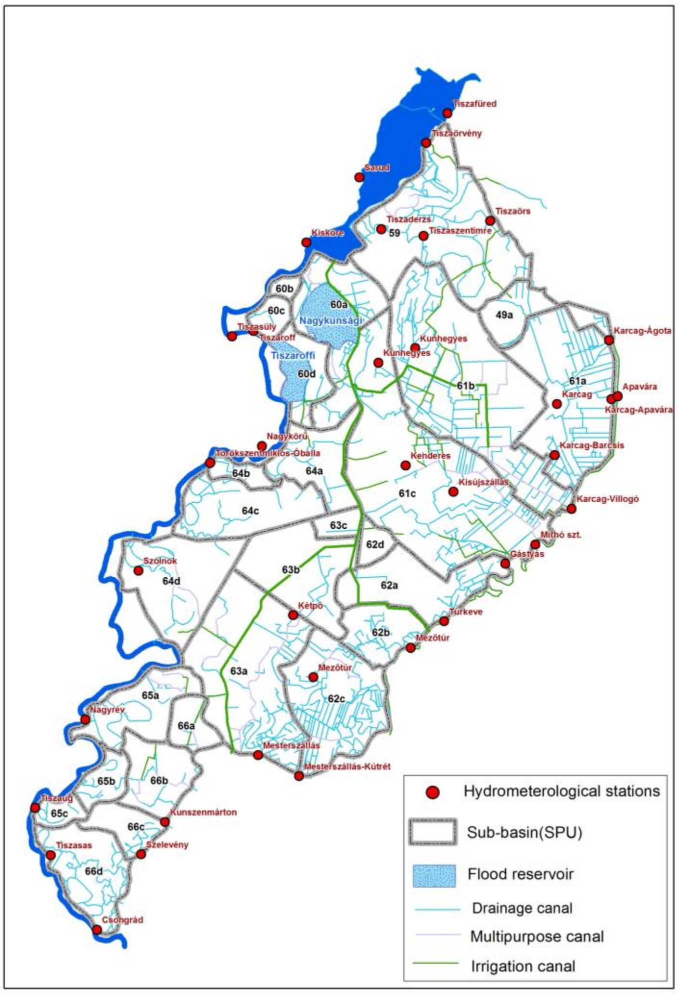


Figure 7. Number of planned and existing measures within the SPU.

4. Description of workflow

4.1 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 8. SPU's and Hydrometeorological stations

4.2 Selected indicators

Applicable indicators:

Nr	IndicatorName	Indicator ShortName	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. Selected indicators in MTDWD

Rejected indicators and reason for rejection:

Nr	IndicatorName	IndicatorShortName	Goals	Unit	Reason for rejection
1	Base Flow Index	bfi	Flood/Drought/ General	-	not relevant
2	Flood hazard zone area ratio	FloodRiskAreaRatio	Flood/General	%	not relevant
3	Ratio of high low flow to mean flow in the multiannual period	FlowMaxAvgRatio	Flood/General	-	not relevant (lowland: surface water flow is very low)*
4	Mean low flow to mean flow ratio	FlowMinAvgRatio	Drought/ General	-	not relevant (lowland: surface water flow is very low)*
5	Mean low flow to mean high flow ratio	FlowMinMaxRatio	Flood/Drought/ Quality	-	not relevant (lowland: surface water flow is very low)*
6	Low mean flow to high mean flow ratio	FlowVarRatio_m	Drought	-	not relevant (lowland: surface water flow is very low)*
7	Lake catchment area to SPU area ratio	LakeCatchRatio	Flood/General	%	not relevant (lowland: surface slope is very low)*
8	Non-forested areas with a slope above 5% to SPU area ratio	NonForestedRatio	Flood/Drought/ Quality/General/ Sediment	%	not relevant (lowland: surface slope is very low)*
9	Surface Runoff Index	sri	Flood/Drought/ General	-	not relevant (lowland: surface slope is very low)*
10	Topographic Wetness Index	twi	Flood/Drought/ Quality/General	-	not relevant (lowland: surface slope is very low)*
11	Water yield (specific runoff) for mean flow in the multiannual period	WaterYieldAvgFlow	Drought/ General	mm	not relevant
12	Water yield (specific runoff) for low flow in the multiannual period	WaterYieldMinFlow	Drought/ General	mm	not relevant
13	Wetland area to SPU area ratio	WetlandRatio	Flood/Drought/ Quality/General	%	not relevant
14	Slope of river	SlopeRiver	Flood/General/ Sediment	%	not relevant (lowland: surface water flow is very low)*
15	Slope of land area	SlopeLand	Flood/General/ Sediment	deg	not relevant (lowland: surface slope is very low)*

16	Ratio of simplify main stream length to natural length of main stream	MeanderRatio	Flood/General/ Sediment	%	not relevant (lowland: surface water flow is very low)*

Table 3. Rejected indicators

*Many indicators have been deleted due to the characteristic of the river basin. In lowland the indicator analyzing the characteristics of surface flow (Nr. 3-6, 9) is not applicable. DEM value is so low, that Topographic Wetness Index, NonForestedRatio indexes are not relevant.

4.3 Input data

Data	Unit	Description	Data source
SPU	km2	poligon	MTDWD own data
Arable area	**km2**		Corine Land cover 2012
cwb value	mm	Average Climatic Water Balance during the growing season [mm] CWB(climatic water balance) = 1/NYears * sum(Pi-ETpi), i=1,NYears [mm]	10 years precipitation daily time series of 9 hydrometeorological stations
cwb_Var_a value	-	Monthly Climatic Water Balance Variability- average intra annual variability for growing season (cwbMaxMth-cwbMinMth)/cwbAvgMth	10 years precipitation daily time series of 9 hydrometeorological stations
cwb_Var_m value	-	Minimum (first mean for each year then min) Climatic Water Balance during the growing season cwbMinAnn	10 years precipitation daily time series of 9 hydrometeorological stations
River length	km	polyline	River network: Polyline (MTDWD own data base)
Diches length	km	polyline	Polyline (MTDWD own data base)
Semi Natural area	km2	polygon	Corine Land cover 2012
Bad River Hydromorphology Status length	km	River Hydromorphology Status (assessed and not assessed river sections (e.g. by River Habitat Survey))	River Basin Management Plan
Forest area	km2	Forested area	Corine Land cover 2012
GRR value	mm	Groundwater Renewable Resources Module	MTDWD own data and calculation
Lake area	km2	Lakes and reservoirs area to SPU area ratio	MTDWD own data
Orch-Veg area	km2	polygon	Corine Land cover 2012
Pre_Var_a value	-	Precipitation variability in annual period - amplitude of monthly sum of (pMax_i - pMin_i)/pAvg_i	20 years precipitation daily time series of 51 rain gauge stations

Data	Unit	Description	Data source
Pre_Var_m value	-	Precipitation variability in the multiannual period [pMin]/[P]	20 years precipitation daily time series of 51 rain gauge stations
PrecFreqLow75 value	-	Frequency of precipitation lower than 50% of the multiannual average (in the growing season)	20 years precipitation daily time series of 51 rain gauge stations
Mead-Pasture area	km2	polygon	Corine Land cover 2012
Swr value	mm	Maximum soil water retention	Soil map: MTDWD own data. Calculation: according to data preparation guideline
Urban area	km2	polygon	Corine Land cover 2012

Table 4. Input data

4.4 Correlation matrix

General purpose:

	ArableRatio	CWB_Var_m	DrainageD	~~EcoAraBuf20mRatio~~	LakeRatio	~~EcoAreaRatio~~	EcoCombined	EcoNumRatio	ForestRatio	CWB	OrchVegRatio	CWB_Var_a	GRR	ReclaimedRatio	SWR	UrbanRatio
ArableRatio	-	-0,3	0,26	0,37	-0,4	-0,9	0,46	-0,4	-0,3	-0,1	-0,4	0,34	-0	-0,7	0,36	-0,4
CWB_Var_m	-0,3	-	-0,1	-0,3	0,37	0,14	0,05	-0,1	0,12	0,57	0,26	0,18	0,19	0,06	0,01	0,36
DrainageD	0,26	-0,1	-	0,9	-0,1	-0	-0,2	0,27	0,14	-0,4	0,06	0,36	-0,3	0,18	0,39	-0,5
~~EcoAraBuf20mRatio~~	0,37	-0,3	0,9	-	-0,1	-0,2	-0,1	0,24	0,06	-0,4	0,01	0,23	-0,2	0,02	0,26	-0,5
LakeRatio	-0,4	0,37	-0,1	-0,1	-	0,06	0,1	-0,1	-0,2	0,23	0,44	-0,2	0,33	0,1	0,01	0,44
~~EcoAreaRatio~~	-0,9	0,14	-0	-0,2	0,06	-	-0,7	0,64	0,34	-0	0,26	-0,2	-0,1	0,9	-0,3	0,08
EcoCombined	0,46	0,05	-0,2	-0,1	0,1	-0,7	-	-0,8	-0,1	0,15	-0	0,02	0,2	-0,7	-0	0,07
EcoNumRatio	-0,4	-0,1	0,27	0,24	-0,1	0,64	-0,8	-	0,48	-0,1	-0	-0,2	-0,1	0,66	-0,2	-0,1
ForestRatio	-0,3	0,12	0,14	0,06	-0,2	0,34	-0,1	0,48	-	0,17	-0,2	-0,3	0,04	0,18	-0,2	-0,2
CWB	-0,1	0,57	-0,4	-0,4	0,23	-0	0,15	-0,1	0,17	-	-0,2	-0,3	0,63	-0,2	0	0,57
OrchVegRatio	-0,4	0,26	0,06	0,01	0,44	0,26	-0	-0	-0,2	-0,2	-	-0,2	0,02	0,23	-0,1	0,05
CWB_Var_a	0,34	0,18	0,36	0,23	-0,2	-0,2	0,02	-0,2	-0,3	-0,3	-0,2	-	-0,6	-0,1	0,4	-0,2
GRR	-0	0,19	-0,3	-0,2	0,33	-0,1	0,2	-0,1	0,04	0,63	0,02	-0,6	-	-0,2	0,07	0,32
Reclaimed Ratio	-0,7	0,06	0,18	0,02	0,1	0,9	-0,7	0,66	0,18	-0,2	0,23	-0,1	-0,2	-	-0,1	-0,1
SWR	0,36	0,01	0,39	0,26	0,01	-0,3	-0	-0,2	-0,2	0	-0,1	0,4	0,07	-0,1	-	-0,2
UrbanRatio	-0,4	0,36	-0,5	-0,5	0,44	0,08	0,07	-0,1	-0,2	0,57	0,05	-0,2	0,32	-0,1	-0,2	-

Table 5. Correlation matrix (general purpose)

Correlation threshold: 0,80.

During the calculation, highly correlated indicators were removed (EcoAra buf20m ratio, EcoAreaRatio)

Drought purpose:

	ArableRatio	CWB	CWB_Var_a	CWB_Var_m	ForestRatio	GRR	LakeRatio	OrchVegRatio	ReclaimdRatio	SWR	UrbanRatio	Pre_Var_a	Pre_Var_m	PrecFreqLow75
ArableRatio	1													
CWB	-0,1	1												
CWB_Var_a	0,34	-0,3	1											
CWB_Var_m	-0,3	0,58	0,18	1										
ForestRatio	-0,2	0,17	-0,3	0,11	1									
GRR	-0	0,63	-0,6	0,19	0,04	1								
LakeRatio	-0,4	0,23	-0,2	0,37	-0,2	0,33	1							
OrchVegRatio	-0,4	-0,2	-0,1	0,25	-0,2	0,02	0,44	1						
ReclaimdRatio	-0,7	-0,2	-0,1	0,04	0,18	-0,2	0,1	0,23	1					
SWR	0,36	0	0,4	0,03	-0,2	0,07	0,01	-0,1	-0,1	1				
UrbanRatio	-0,4	0,57	-0,2	0,35	-0,2	0,32	0,44	0,05	-0,1	-0,1	1			
Pre_Var_a	0,13	-0,1	-0,2	-0,1	0,24	0,1	0,01	0,06	-0,4	0,09	-0,2	1		
Pre_Var_m	-0,3	0,38	0,18	0,47	0,13	-0,2	0	0,07	0,41	-0,1	0,25	-0,4	1	
PrecFreqLow75	0,07	0,05	-0,2	-0,2	-0,2	0,38	0,06	0,22	-0,5	-0	0,19	0,15	-0,5	1

Table 6. Correlation matrix (drought purpose)

There were no highly correlated indicators therefore all of them was used for the calculations.

Water quality purpose:

	ArableRatio	~~EcoAreaRatio~~	EcoBadRHS	EcoCombined	EcoAraBuf20mRatio	EcoNumRatio	LakeRatio	OrchVegRatio	ReclaimedRatio	UrbanRatio	DrainageD	ForestRatio
ArableRatio	1,00											
~~EcoAreaRatio~~	-0,86	1,00										
EcoBadRHS	-0,44	0,42	1,00									
EcoCombined	0,46	-0,68	-0,24	1,00								
EcoAraBuf20mRatio	0,37	-0,21	0,12	-0,06	1,00							
EcoNumRatio	-0,42	0,64	0,54	-0,78	0,24	1,00						
LakeRatio	-0,39	0,06	0,16	0,10	-0,08	-0,09	1,00					
OrchVegRatio	-0,40	0,26	0,14	-0,02	0,01	-0,03	0,44	1,00				
ReclaimedRatio	-0,67	0,90	0,34	-0,71	0,02	0,66	0,10	0,23	1,00			
UrbanRatio	-0,41	0,08	0,27	0,07	-0,47	-0,06	0,44	0,05	-0,10	1,00		
~~DrainageD~~	0,26	-0,04	-0,02	-0,19	0,90	0,26	-0,11	0,06	0,18	-0,53	1,00	
ForestRatio	-0,25	0,34	0,31	-0,12	0,06	0,48	-0,23	-0,15	0,18	-0,16	0,14	1,00

Table 7. Correlation matrix (water quality purpose)

There were no highly correlated indicators therefore all of them was used for the calculations.

4.5 Class designation

4.5.1 Descriptive statistics of indicators values

The indicator values were calculated for all the SPU's using the input data with Frogis application, and other calculations according to preparation guideline. The table below contain the statistics of these values.

Indicator Short Name	Min	Max	Mean	Std
ArableRatio	49,19	97,95	77,19	13,67
cwb	-540,45	-439,44	-497,72	22,08
cwb_Var_a	-4,40	1,10	-2,08	1,20
cwb_Var_m	1,34	1,64	1,51	0,06
DrainageD	0,05	1,54	0,83	0,37
EcoAraBuf20mRatio	0,02	5,10	2,20	1,13
EcoAreaRatio	0,00	41,31	12,36	9,97
EcoBadRHS	0,00	1,00	0,77	0,39
EcoCombined	2,00	5,00	4,04	0,58
EcoNumRatio	0,00	77,27	47,00	19,03
ForestRatio	0,00	9,45	1,74	2,03
grr	45,00	106,26	54,65	15,04
LakeRatio	0,00	3,73	0,85	1,07
OrchVegRatio	0,00	4,75	0,26	0,90
Pre_Var_a	2,43	2,67	2,56	0,06
Pre_Var_m	0,31	0,47	0,38	0,05
PrecFreqLow75	6,50	9,00	8,07	0,73
ReclaimedRatio	0,00	5,04	1,29	1,25
swr	412,60	502,63	475,45	28,73
UrbanRatio	0,00	12,02	4,21	3,56

Table 8. Statistics of indicators values

4.5.2 Variant C3.: Three classes of indicators

The table contains the distribution of indicator values into three classes using three division method (equal width, natural breaks (Jenks), quantile).

Short name indicator	Classes	Equal width		Natural breaks		Quantile	
		Min	max	min	max	min	max
ArableRatio	1	49,19	65,44	49,19	59,25	49,19	72,40
	2	65,44	81,70	59,25	81,09	72,40	81,09
	3	81,70	97,95	81,09	97,95	81,09	97,95
cwb	1	-540,45	-506,78	-540,45	-512,00	-540,45	-506,88
	2	-506,78	-473,11	-512,00	-485,00	-506,88	-495,75
	3	-473,11	-439,44	-485,00	-439,44	-495,75	-439,44
cwb_Var_a	1	-4,40	-2,57	-4,40	-2,22	-4,40	-2,73
	2	-2,57	-0,73	-2,22	-0,65	-2,73	-1,69
	3	-0,73	1,10	-0,65	1,10	-1,69	1,10
cwb_Var_m	1	1,34	1,44	1,34	1,43	1,34	1,49
	2	1,44	1,54	1,43	1,51	1,49	1,54
	3	1,54	1,64	1,51	1,64	1,54	1,64
DrainageD	1	0,05	0,55	0,05	0,66	0,05	0,62
	2	0,55	1,05	0,66	1,11	0,62	1,01
	3	1,05	1,54	1,11	1,54	1,01	1,54
EcoAraBuf20mRatio	1	0,02	1,71	0,02	1,88	0,02	1,50
	2	1,71	3,41	1,88	3,56	1,50	2,58
	3	3,41	5,10	3,56	5,10	2,58	5,10
EcoAreaRatio	1	0,00	13,77	0,00	7,75	0,00	7,52
	2	13,77	27,54	7,75	19,77	7,52	14,74
	3	27,54	41,31	19,77	41,31	14,74	41,31
EcoBadRHS	1	0,00	0,33	0,00	0,00	0,00	1,00
	2	0,33	0,67	0,00	0,74	1,00	1,00
	3	0,67	1,00	0,74	1,00	1,00	1,00
EcoCombined	1	2	3	2	3	2	4
	2	3	4	3	4	4	4
	3	4	5	4	5	4	5
EcoNumRatio	1	0,00	25,76	0,00	14,29	0,00	42,86
	2	25,76	51,51	14,29	52,08	42,86	54,55
	3	51,51	77,27	52,08	77,27	54,55	77,27
ForestRatio	1	0,00	3,15	0,00	1,57	0,00	0,54
	2	3,15	6,30	1,57	5,20	0,54	1,57
	3	6,30	9,45	5,20	9,45	1,57	9,45
grr	1	45,00	65,42	45,00	52,47	45,00	48,69
	2	65,42	85,84	52,47	59,64	48,69	52,17
	3	85,84	106,26	59,64	106,26	52,17	106,26
LakeRatio	1	0,00	1,24	0,00	0,24	0,00	0,02
	2	1,24	2,49	0,24	1,78	0,02	0,88
	3	2,49	3,73	1,78	3,73	0,88	3,73
OrchVegRatio	1	0,00	1,58	0,00	0,00	0,00	0,00
	2	1,58	3,17	0,00	0,75	0,00	0,00

	3	3,17	4,75	0,75	4,75	0,00	4,75
Pre_Var_a	1	2,43	2,51	2,43	2,49	2,43	2,53
	2	2,51	2,59	2,49	2,57	2,53	2,57
	3	2,59	2,67	2,57	2,67	2,57	2,67
Pre_Var_m	1	0,31	0,36	0,31	0,36	0,31	0,35
	2	0,36	0,42	0,36	0,42	0,35	0,40
	3	0,42	0,47	0,42	0,47	0,40	0,47
PrecFreqLow75	1	6,50	7,33	6,50	7,33	6,50	7,67
	2	7,33	8,17	7,33	8,17	7,67	8,50
	3	8,17	9,00	8,17	9,00	8,50	9,00
ReclaimedRatio	1	0,00	1,68	0,00	0,98	0,00	0,46
	2	1,68	3,36	0,98	2,87	0,46	1,63
	3	3,36	5,04	2,87	5,04	1,63	5,04
swr	1	412,60	442,61	412,60	429,50	412,60	464,49
	2	442,61	472,62	429,50	482,40	464,49	497,68
	3	472,62	502,63	482,40	502,63	497,68	502,63
UrbanRatio	1	0,00	4,01	0,00	1,94	0,00	1,94
	2	4,01	8,01	1,94	6,20	1,94	4,36
	3	8,01	12,02	6,20	12,02	4,36	12,02

Table 9. Results of division of indicators values to three classes

Equal with Natural breaks Quantile

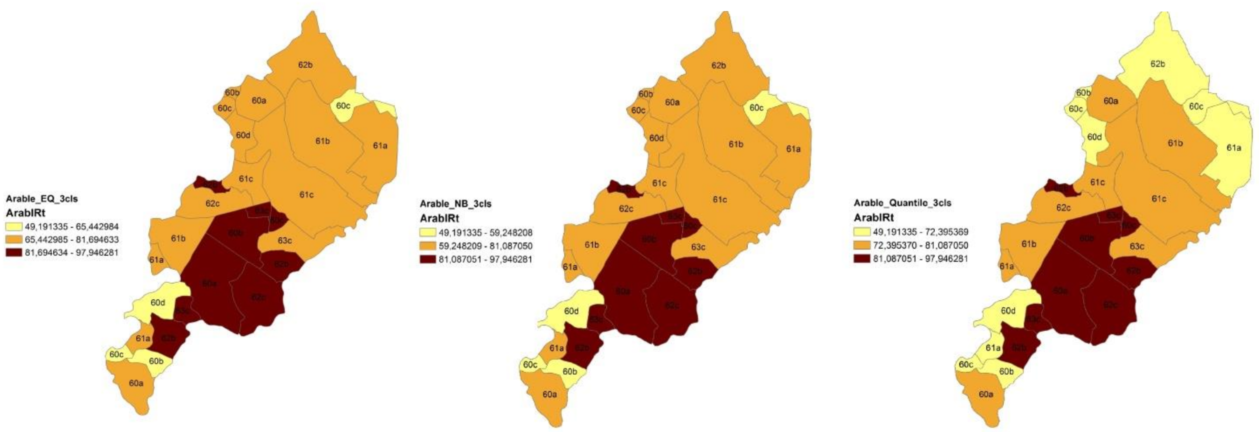


Figure 9. Example, arable land ratio values divided into 3 classes:

Analyzing the input indicator date necessary to find mistakes. The results in Table 9. has been accepted.

4.5.3 Variant C5.: Five classes of indicators

Short name indicator	Classes	Equal width		Natural breaks		Quantile	
		min	max	min	max	min	max
ArableRatio	1	49,19	58,94	49,19	59,25	49,19	68,29
	2	58,94	68,69	59,25	72,40	68,29	75,95
	3	68,69	78,44	72,40	81,09	75,95	79,07
	4	78,44	88,20	81,09	90,79	79,07	90,54
	5	88,20	97,95	90,79	97,95	90,54	97,95
cwb	1	-540,45	-520,25	-540,45	-540,00	-540,45	-513,22
	2	-520,25	-500,05	-540,00	-512,00	-513,22	-503,49
	3	-500,05	-479,84	-512,00	-490,00	-503,49	-496,93
	4	-479,84	-459,64	-490,00	-467,00	-496,93	-487,40
	5	-459,64	-439,44	-467,00	-439,44	-487,40	-439,44
cwb_Var_a	1	-4,40	-3,30	-4,40	-4,07	-4,40	-2,86
	2	-3,30	-2,20	-4,07	-2,22	-2,86	-2,51
	3	-2,20	-1,10	-2,22	-1,20	-2,51	-2,12
	4	-1,10	0,00	-1,20	-0,65	-2,12	-1,25
	5	0,00	1,10	-0,65	1,10	-1,25	1,10
cwb_Var_m	1	1,34	1,40	1,34	1,34	1,34	1,47
	2	1,40	1,46	1,34	1,46	1,47	1,49
	3	1,46	1,52	1,46	1,51	1,49	1,53
	4	1,52	1,58	1,51	1,58	1,53	1,56
	5	1,58	1,64	1,58	1,64	1,56	1,64
DrainageD	1	0,05	0,35	0,05	0,05	0,05	0,48
	2	0,35	0,65	0,05	0,66	0,48	0,72
	3	0,65	0,95	0,66	0,97	0,72	0,95
	4	0,95	1,24	0,97	1,23	0,95	1,10
	5	1,24	1,54	1,23	1,54	1,10	1,54
EcoAraBuf20m Ratio	1	0,02	1,04	0,02	0,02	0,02	1,31
	2	1,04	2,05	0,02	1,50	1,31	1,76
	3	2,05	3,07	1,50	2,38	1,76	2,41
	4	3,07	4,08	2,38	3,56	2,41	3,10
	5	4,08	5,10	3,56	5,10	3,10	5,10
EcoAreaRatio	1	0,00	8,26	0,00	4,10	0,00	3,48
	2	8,26	16,52	4,10	7,75	3,48	9,07
	3	16,52	24,79	7,75	14,74	9,07	13,69
	4	24,79	33,05	14,74	27,73	13,69	19,40
	5	33,05	41,31	27,73	41,31	19,40	41,31
EcoBadRHS	1	0,00	0,20	0,00	0,00	0,00	0,50
	2	0,20	0,40	0,00	0,48	0,50	1,00
	3	0,40	0,60	0,48	0,53	1,00	1,00
	4	0,60	0,80	0,53	0,74	1,00	1,00
	5	0,80	1,00	0,74	1,00	1,00	1,00
EcoCombined	1	2	3	2	2	2	4
	2	3	3	2	2	4	4
	3	3	4	2	3	4	4
	4	4	4	3	4	4	4
	5	4	5	4	5	4	5
EcoNumRatio	1	0,00	15,45	0,00	14,29	0,00	36,82
	2	15,45	30,91	14,29	42,86	36,82	50,00
	3	30,91	46,36	42,86	54,55	50,00	52,53
	4	46,36	61,82	54,55	65,91	52,53	60,67
	5	61,82	77,27	65,91	77,27	60,67	77,27

Short name indicator	Classes	Equal width		Natural breaks		Quantile	
		min	max	min	max	min	max
ForestRatio	1	0,00	1,89	0,00	0,54	0,00	0,45
	2	1,89	3,78	0,54	1,57	0,45	0,84
	3	3,78	5,67	1,57	3,70	0,84	1,31
	4	5,67	7,56	3,70	5,20	1,31	3,00
	5	7,56	9,45	5,20	9,45	3,00	9,45
grr	1	45,00	57,25	45,00	46,04	45,00	45,99
	2	57,25	69,50	46,04	50,61	45,99	49,79
	3	69,50	81,76	50,61	55,01	49,79	51,83
	4	81,76	94,01	55,01	59,64	51,83	56,02
	5	94,01	106,26	59,64	106,26	56,02	106,26
LakeRatio	1	0,00	0,75	0,00	0,24	0,00	0,00
	2	0,75	1,49	0,24	0,98	0,00	0,14
	3	1,49	2,24	0,98	1,78	0,14	0,84
	4	2,24	2,98	1,78	3,10	0,84	1,60
	5	2,98	3,73	3,10	3,73	1,60	3,73
OrchVegRatio	1	0,00	0,95	0,00	0,00	0,00	0,00
	2	0,95	1,90	0,00	0,40	0,00	0,00
	3	1,90	2,85	0,40	0,52	0,00	0,00
	4	2,85	3,80	0,52	0,75	0,00	0,24
	5	3,80	4,75	0,75	4,75	0,24	4,75
ReclaimedRatio	1	0,00	1,01	0,00	0,54	0,00	0,20
	2	1,01	2,02	0,54	1,36	0,20	0,54
	3	2,02	3,02	1,36	2,23	0,54	1,33
	4	3,02	4,03	2,23	2,87	1,33	1,99
	5	4,03	5,04	2,87	5,04	1,99	5,04
swr	1	412,60	430,61	412,60	418,20	412,60	460,09
	2	430,61	448,61	418,20	429,50	460,09	474,18
	3	448,61	466,62	429,50	468,40	474,18	497,24
	4	466,62	484,62	468,40	489,50	497,24	500,78
	5	484,62	502,63	489,50	502,63	500,78	502,63
UrbanRatio	1	0,00	2,40	0,00	1,94	0,00	1,12
	2	2,40	4,81	1,94	4,37	1,12	3,12
	3	4,81	7,21	4,37	7,22	3,12	3,90
	4	7,21	9,61	7,22	9,24	3,90	7,71
	5	9,61	12,02	9,24	12,02	7,71	12,02

Table 10. Results of division of indicators values to five classes

<u>*Example, Arable ratio 5 classes:*</u>

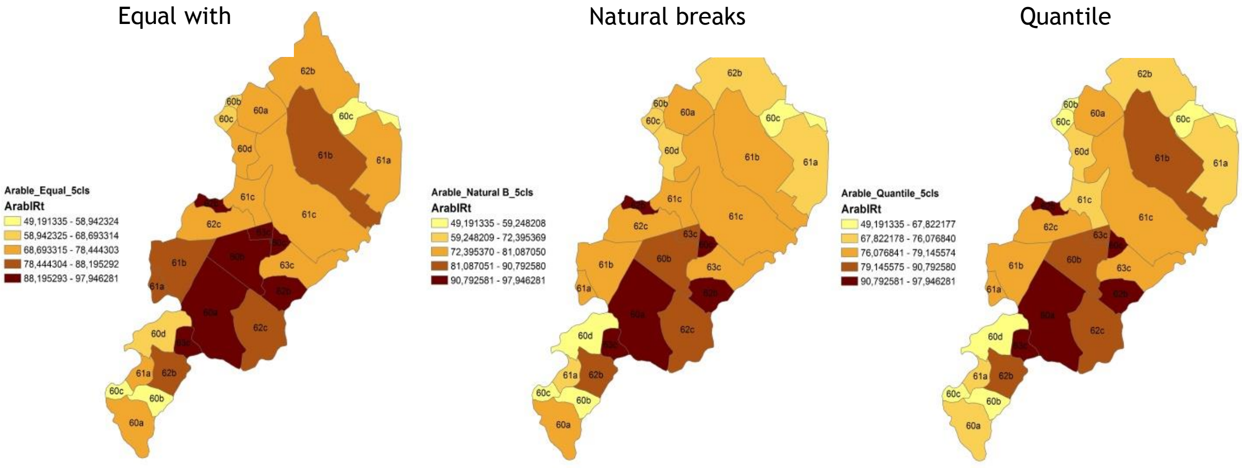


Figure 10. Example, arable land ratio values divided into 5 classes:

5. Analysis of variants

In the next stage, tests were carried out to check the operation of the FroGIS application and to develop advice/tips (default values) for future users, which will allow them to find answers to the following questions:

- What method of class division should I adopt?
- What number of classes should I implement?
- How to determine weights?

Therefore, the analyses were divided into three variants (G, D,WQ) depending on the valorisation objective and six sub-options. They were a combination of 3 classification methods and 3 weighting choices broken down into 3 and 5 classes:

5 cls:

1. EW.Wht1: division into classes by equal width for constant weight,
2. EW.Wht01: division into classes by equal width for variable weight,
3. NB.Wht1: division into classes by natural breaks for constant weight,
4. NB.Wht01: division into classes by natural breaks for variable weight,
5. Q.Wht1: division into classes by quantiles for constant weight,
6. Q.Wht01: division into classes by quantiles for variable weight.

3 cls:

7. EW.Wht1: division into classes by equal width for constant weight,
8. EW.Wht01: division into classes by equal width for variable weight,
9. NB.Wht1: division into classes by natural breaks for constant weight,
10. NB.Wht01: division into classes by natural breaks for variable weight,
11. Q.Wht1: division into classes by quantiles for constant weight,
12. Q.Wht01: division into classes by quantiles for variable weight.

Proposed selection of weight coefficients for indicators

The weight coefficients must be done manually in the FroGIS application and requires changing the values of weights multiple times and comparing with the maps developed in Chapter 3 (**Błąd! Nie można odnaleźć źródła odwołania.**7) for verification. Therefore, during the tests, a different methodology was developed that runs in MS Excel. To use it the following data is required:

- Classification results for each indicator obtained from the .csv report of the FroGIS application
- Maps with identified several SPUs with high or low water retention needs and capabilities

Afterwards input data has to be copied to spreadsheet (one table related by SPU number) which allows to calculate the class sum multiplied by weights. Next, they were divided into two groups: with high water retention needs (G1) and others (G2). Solver tool creates weights for indicators using NonLinear GRG function for all indicators. Target for the solver function will be established on the basis of the difference between group G1 and G2. These values for solver target can be obtained by using mean or median function.

According to the proposal of the Lead Partner (WULS) median function was chosen because it does not depend on the number of SPUs and it resulted in giving a better distribution of weight coefficients.

In Chapter 5, the examinations were done only with weight 1.

In Chapter 6. we show the results using variant weight coefficients with using the method above. And we created our own expert version of weights, depending on the relevance of indicator in the pilot catchment.

5.1 Valorisation for *general* purpose

Each indicator weight in this assessment: 1.

5.1.1 Variant: Three classes of indicators and weight = 1

Table above contain the results of final classifications values calculated with Frogis application, and other calculations.

SPU		Variant A division into classes by **Equal Width**	Variant B division into classes by **Natural Breaks**	Variant C division into classes by **Quantiles**
0	60dTiszabői	3	2	1
1	60aMirhó-Gyólcsi	1	1	1
2	60bLedencei	2	2	1
3	60cTólaposi	3	3	3
4	63cÖrményes II.	3	3	3
5	61aKarcagi	3	2	1
6	61bVillogói	3	2	1
7	61cKakati	2	2	1
8	62cMezőtúr-Halásztelki	3	3	3
9	62bMezőtúr-Álomzugi	3	3	3
10	59Örvényabádi	3	2	3
11	63aMesterszállás- Bartapuszta	3	2	3
12	63bSzenttamási	3	2	1
13	62dÖrményes I.	3	3	2
14	62aTúrkevei-Kiserdei	3	2	2
15	64eRákóczifalva-Szandai	1	1	1
16	64dAlcsi-Tenyő-Kengyeli	1	1	1
17	64aFegyvernek-Büdöséri	3	3	3
18	64cSzajoli	2	2	2
19	64bÓballai	3	3	2
20	49aNémetéri	2	2	1
21	66bKungyalu I.	3	3	2
22	65aCibakházi	2	2	1
23	66dTőkefoki	2	3	2
24	66cTóközei	2	2	2
25	65cTiszaugi	3	2	2
26	66aKungyalu II.	3	2	3
27	65bTiszakürti	2	2	1

Table 11. Classification of SPU's

Equal with **Natural breaks** **Quantile**

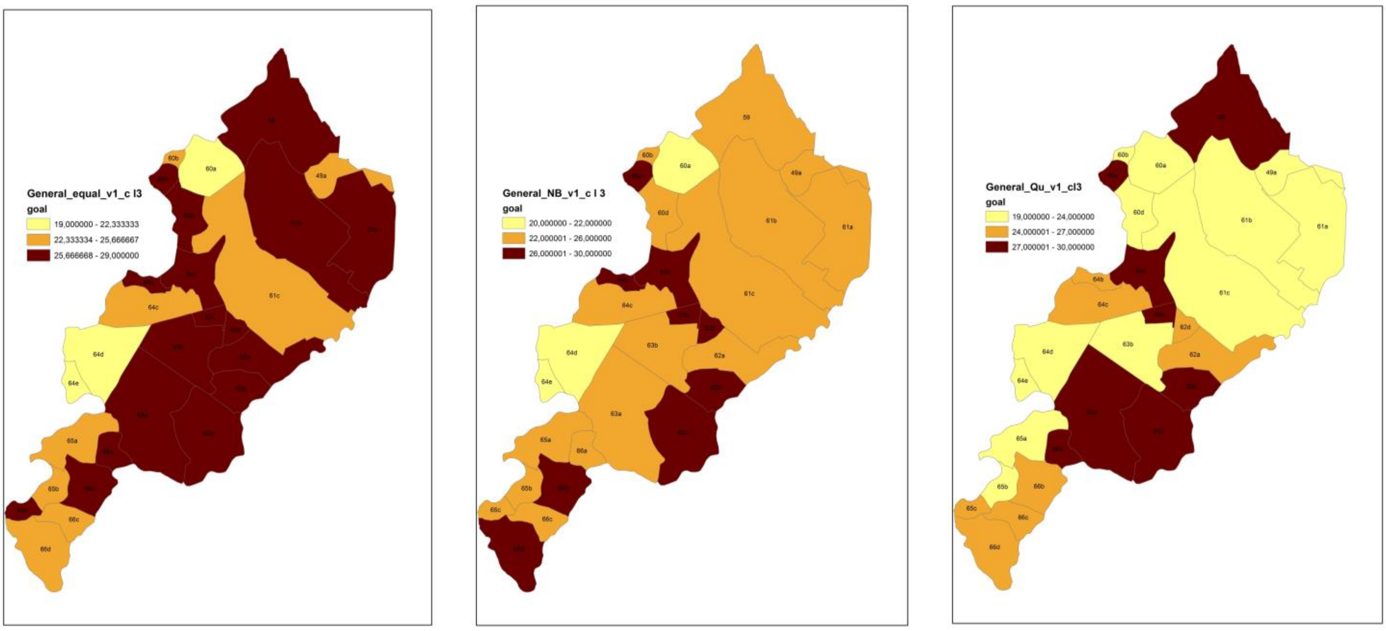


Figure 11. Map of valorisation for general purpose (3cls). Darker colors indicate higher retention need.

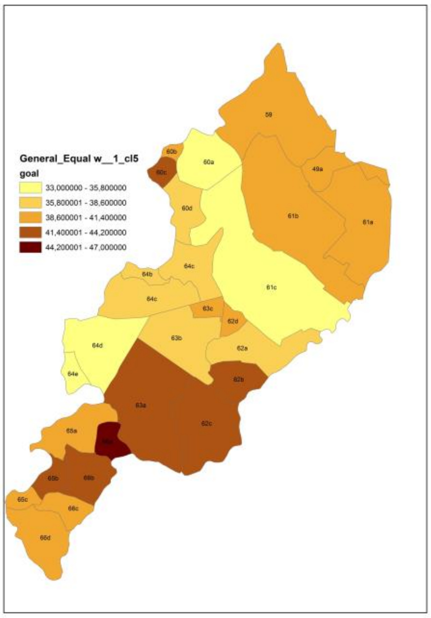
As we can see, classification is very different depending on the method.

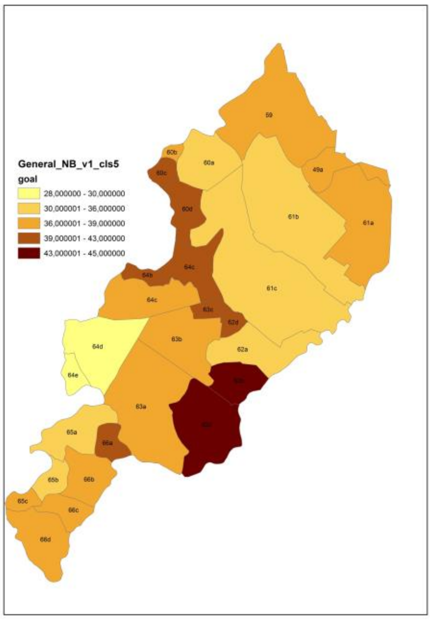
5.1.2 Variant: Five classes of indicators and weight =1

SPU		Variant A division into classes by **Equal Width**	Variant B division into classes by **Natural Breaks**	Variant C division into classes by **Quantiles**	Goals from field recognition
0	60dTiszabői	2	4	2	1
1	60aMirhó-Gyólcsi	1	2	1	4
2	60bLedencei	3	3	3	0
3	60cTólaposi	4	4	4	0
4	63cÖrményes II.	3	4	5	1
5	61aKarcagi	3	3	1	4
6	61bVillogói	3	2	2	2
7	61cKakati	1	2	2	4
8	62cMezőtúr-Halásztelki	4	5	5	4
9	62bMezőtúr-Álomzugi	4	5	5	3
10	59Örvényabádi	3	3	3	2
11	63aMesterszállás-Bartapuszta	4	3	4	3
12	63bSzenttamási	2	3	3	1
13	62dÖrményes I.	3	4	4	1
14	62aTúrkevei-Kiserdei	2	2	3	3
15	64eRákóczifalva-Szandai	1	1	1	0
16	64dAlcsi-Tenyő-Kengyeli	1	1	1	2
17	64aFegyvernek-Büdöséri	2	4	5	3
18	64cSzajoli	2	3	4	2
19	64bÓballai	2	4	5	1
20	49aNémetéri	3	3	2	0
21	66bKungyalu I.	4	3	2	0
22	65aCibakházi	3	2	1	3
23	66dTőkefoki	3	3	4	1
24	66cTóközei	3	3	2	1
25	65cTiszaugi	3	3	3	1
26	66aKungyalu II.	5	4	5	1
27	65bTiszakürti	4	2	1	1

Table 12. Classification of SPU's

Equal with **Natural breaks** **Quantile**





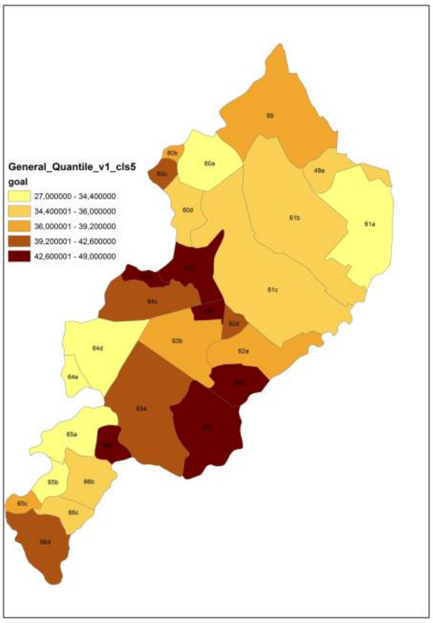


Figure 12. Map of valorisation for general purpose (5cls)

Classification is different depending on the method. Proposed: Natural breaks. Indicators should be weighted.

5.2 Valorisation for *drought* mitigation purpose

5.2.1 Variant - Three classes of indicators and weight =1

	SPU	Variant A division into classes by **Equal Width**	Variant B division into classes by **Natural Breaks**	Variant C division into classes by **Quantiles**
0	60dTiszabői	**2**	**1**	**1**
1	60aMirhó-Gyólcsi	**1**	**1**	**1**
2	60bLedencei	**2**	**1**	**1**
3	60cTólaposi	**3**	**2**	**2**
4	63cÖrményes II.	**2**	**2**	**2**
5	61aKarcagi	**2**	**1**	**1**
6	61bVillogói	**2**	**1**	**1**
7	61cKakati	**1**	**1**	**1**
8	62cMezőtúr-Halásztelki	**3**	**3**	**3**
9	62bMezőtúr-Álomzugi	**3**	**3**	**3**
10	59Örvényabádi	**1**	**1**	**2**
11	63aMesterszállás-Bartapuszta	**3**	**3**	**3**
12	63bSzenttamási	**2**	**2**	**2**
13	62dÖrményes I.	**2**	**2**	**2**
14	62aTúrkevei-Kiserdei	**3**	**2**	**3**
15	64eRákóczifalva-Szandai	**1**	**1**	**1**
16	64dAlcsi-Tenyő-Kengyeli	**1**	**1**	**1**
17	64aFegyvernek-Büdöséri	**1**	**2**	**1**
18	64cSzajoli	**3**	**2**	**2**
19	64bÓballai	**3**	**2**	**2**
20	49aNémetéri	**1**	**1**	**1**
21	66bKungyalu I.	**3**	**3**	**3**
22	65aCibakházi	**2**	**1**	**2**
23	66dTőkefoki	**2**	**2**	**2**
24	66cTóközei	**3**	**3**	**3**
25	65cTiszaugi	**2**	**2**	**2**
26	66aKungyalu II.	**3**	**2**	**3**
27	65bTiszakürti	**3**	**2**	**2**

Table 13. Classification of SPU's

Table above contain the results of final classifications values calculated with Frogis application, and other calculations.

Equal with **Natural breaks** **Quantile**

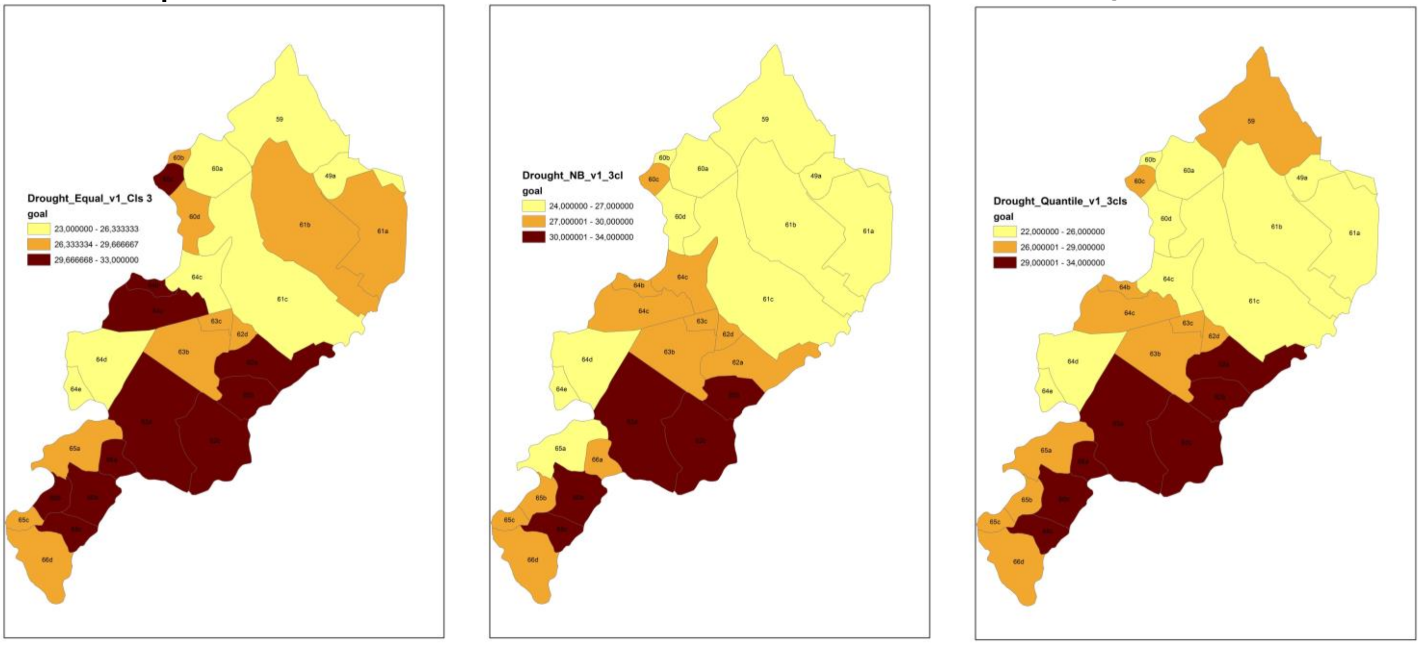


Figure 13. Map of valorisation for drought mitigation purpose (3cls)

5.2.2 Variant – Drought mitigation -Five classes of indicators and weight =1

	SPU	Variant A division into classes by **Equal Width**	Variant B division into classes by **Natural Breaks**	Variant C division into classes by **Quantiles**
0	60dTiszabői	**4**	**4**	**2**
1	60aMirhó-Gyólcsi	**1**	**2**	**1**
2	60bLedencei	**5**	**4**	**2**
3	60cTólaposi	**5**	**5**	**5**
4	63cÖrményes II.	**4**	**4**	**4**
5	61aKarcagi	**4**	**3**	**2**
6	61bVillogói	**4**	**3**	**1**
7	61cKakati	**2**	**2**	**1**
8	62cMezőtúr-Halásztelki	**5**	**5**	**5**
9	62bMezőtúr-Álomzugi	**5**	**5**	**5**
10	59Örvényabádi	**4**	**4**	**3**
11	63aMesterszállás-Bartapuszta	**4**	**4**	**3**
12	63bSzenttamási	**4**	**3**	**3**
13	62dÖrményes I.	**4**	**4**	**3**
14	62aTúrkevei-Kiserdei	**4**	**2**	**2**
15	64eRákóczifalva-Szandai	**1**	**1**	**1**
16	64dAlcsi-Tenyő-Kengyeli	**1**	**1**	**1**
17	64aFegyvernek-Büdöséri	**4**	**4**	**4**
18	64cSzajoli	**5**	**4**	**3**
19	64bÓballai	**5**	**4**	**5**
20	49aNémetéri	**4**	**3**	**2**
21	66bKungyalu I.	**5**	**4**	**3**
22	65aCibakházi	**3**	**2**	**1**
23	66dTőkefoki	**4**	**4**	**5**
24	66cTóközei	**4**	**3**	**3**
25	65cTiszaugi	**4**	**4**	**2**
26	66aKungyalu II.	**5**	**4**	**4**
27	65bTiszakürti	**5**	**3**	**1**

Table 14. Classification of SPU's

Equal with **Natural breaks** **Quantile**

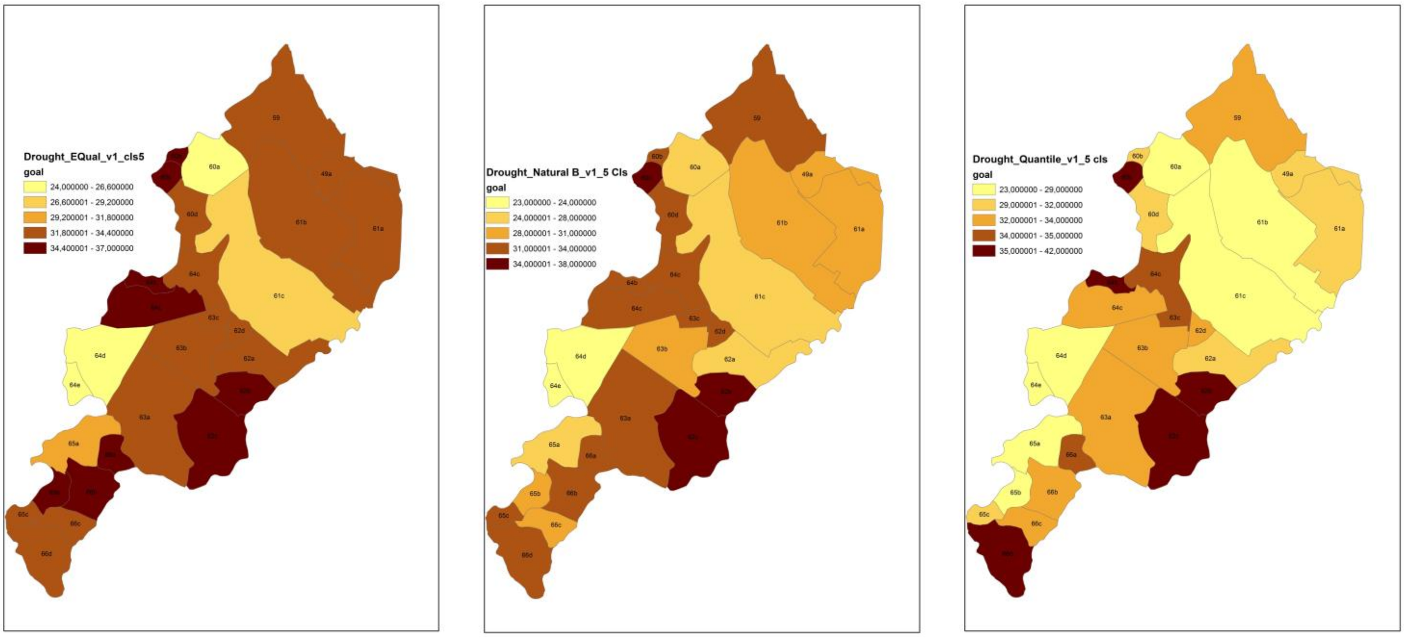


Figure 14. Map of valorisation for drought mitigation purpose (5cls)

5.3 Valorisation for *water quality improvement* purpose

5.3.1 Variant - *water quality improvement-* Three classes of indicators and weight =1

SPU		Variant A division into classes by **Equal Width**	Variant B division into classes by **Natural Breaks**	Variant C division into classes by **Quantiles**
0	60dTiszabői	2	2	1
1	60aMirhó-Gyólcsi	1	1	1
2	60bLedencei	2	3	1
3	60cTólaposi	3	3	2
4	63cÖrményes II.	2	2	2
5	61aKarcagi	3	2	1
6	61bVillogói	3	2	1
7	61cKakati	1	1	1
8	62cMezőtúr-Halásztelki	3	3	3
9	62bMezőtúr-Álomzugi	2	2	3
10	59Örvényabádi	2	2	3
11	63aMesterszállás-Bartapuszta	2	2	3
12	63bSzenttamási	2	1	1
13	62dÖrményes I.	1	1	1
14	62aTúrkevei-Kiserdei	1	1	1
15	64eRákóczifalva-Szandai	2	2	1
16	64dAlcsi-Tenyő-Kengyeli	1	1	1
17	64aFegyvernek-Büdöséri	1	3	3
18	64cSzajoli	3	3	3
19	64bÓballai	3	3	2
20	49aNémetéri	2	2	1
21	66bKungyalu I.	2	2	1
22	65aCibakházi	2	1	2
23	66dTőkefoki	2	3	3
24	66cTóközei	1	1	1
25	65cTiszaugi	3	3	3
26	66aKungyalu II.	3	3	2
27	65bTiszakürti	1	2	1

Table 15. Classification of SPU's

Equal with **Natural breaks** **Quantile**

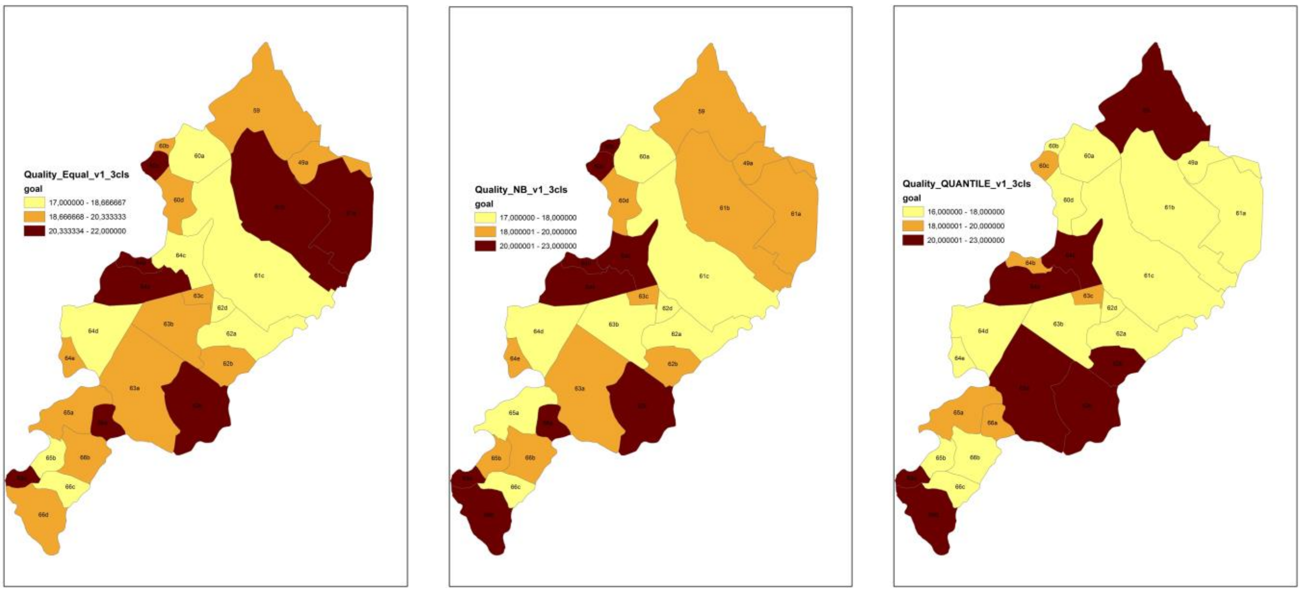


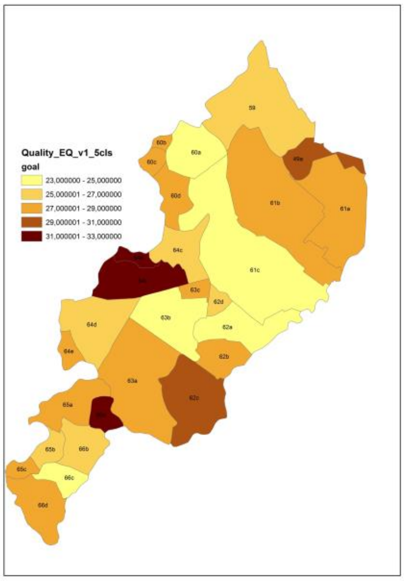
Figure 15. Map of valorisation for water quality improvement purpose (3cls)

5.3.2 Variant - *water quality improvement* -Five classes of indicators and weight=1

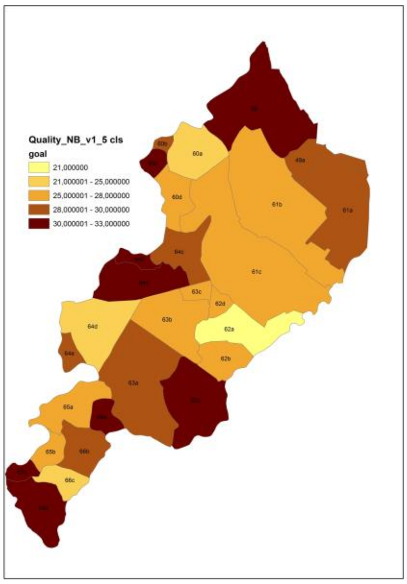
SPU		Variant A division into classes by **Equal Width**	Variant B division into classes by **Natural Breaks**	Variant C division into classes by **Quantiles**
0	60dTiszabői	**3**	**3**	**2**
1	60aMirhó-Gyólcsi	**1**	**2**	**2**
2	60bLedencei	**3**	**4**	**2**
3	60cTólaposi	**3**	**5**	**3**
4	63cÖrményes II.	**3**	**3**	**2**
5	61aKarcagi	**3**	**4**	**2**
6	61bVillogói	**3**	**3**	**3**
7	61cKakati	**1**	**3**	**3**
8	62cMezőtúr-Halásztelki	**4**	**5**	**5**
9	62bMezőtúr-Álomzugi	**3**	**3**	**5**
10	59Örvényabádi	**2**	**5**	**4**
11	63aMesterszállás-Bartapuszta	**3**	**4**	**2**
12	63bSzenttamási	**1**	**3**	**2**
13	62dÖrményes I.	**2**	**3**	**2**
14	62aTúrkevei-Kiserdei	**1**	**1**	**1**
15	64eRákóczifalva-Szandai	**3**	**4**	**3**
16	64dAlcsi-Tenyő-Kengyeli	**2**	**2**	**1**
17	64aFegyvernek-Büdöséri	**2**	**4**	**4**
18	64cSzajoli	**5**	**5**	**5**
19	64bÓballai	**5**	**5**	**5**
20	49aNémetéri	**4**	**4**	**1**
21	66bKungyalu I.	**2**	**4**	**1**
22	65aCibakházi	**3**	**3**	**3**
23	66dTőkefoki	**3**	**5**	**5**
24	66cTóközei	**1**	**2**	**1**
25	65cTiszaugi	**3**	**5**	**5**
26	66aKungyalu II.	**5**	**5**	**4**
27	65bTiszakürti	**2**	**3**	**1**

Table 16. Classification of SPU's

Equal with



Natural breaks



Quantile

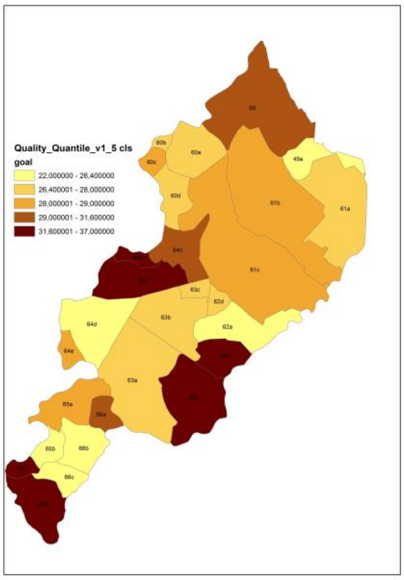


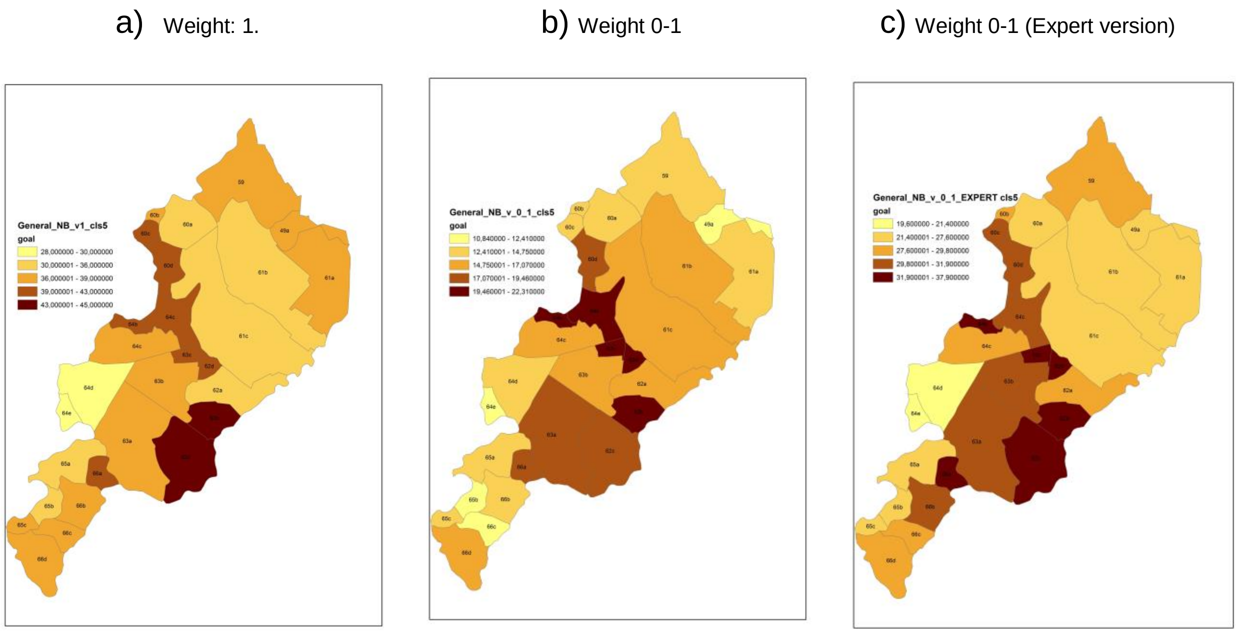
Figure 16. Map of valorisation for water quality improvement purpose (5cls)

6. Comparison and description of results

6.1 General purpose

Examining the results of the Frogis program the highest needs of water retention comes from the three classes, equal with classifications. The deviation between classes is extremely high if the weighting for each indicator is constant, thus the variant was not chosen for further examination.
(Figure 11.)

Overall the most acceptable Frogis result: Five classes, natural breaks classification (Figure 17.)



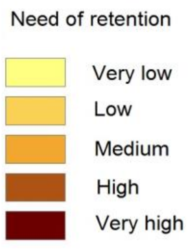


*Figure 17. **Final valorisation map for general goal** with constant and variable weight division into classes Natural breaks.*

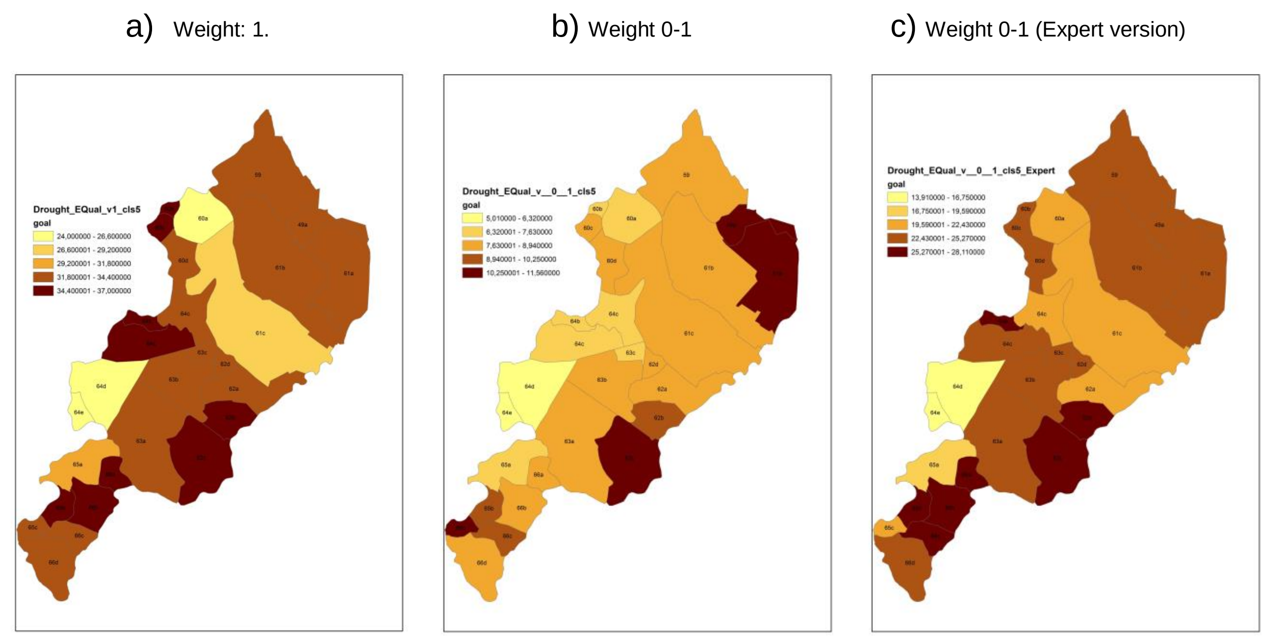
(a) Indicators weight constant: 1.
(b) The theoretical optimization (according to Chapter 5.) of indicator weight values was determined with solver, using expert recognition in SPU. (weight: 0-1)
(c) The MTDWD expert version of indicator weights. (weight: 0-1)

The three variations (a-c) for General purpose do not show great differences, each of them acceptable taking into account local knowledge. <u>Proposed variation: b).</u>

6.2 Drought mitigation purpose

One of the biggest problems in the Middle-Tisza district is drought. Therefore, we choose the version with the highest retention needs.

Examining the Frogis result, the most acceptable: Five classes, Equal with classification.
(Figure 18.)



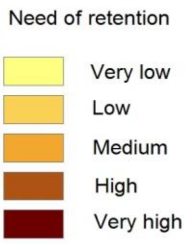


Figure 18. Final valorisation map for drought goal *with constant and variable weight division into classes Equal With.*

a) Indicators weight constant: 1.
b) The theoretical optimization (according to Chapter 5.) of indicator weight values was determined with solver, using expert recognition in SPU. (weight: 0-1)
c) The MTDWD expert version of indicator weights. (weight: 0-1)

There is a significant difference between the valorisation values of the three variations (a-c) for Drought purpose. Whereas the problem is serious at all part of the river basin (Figure 1.) <u>Proposed variant: c).</u>

6.3 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 19.)

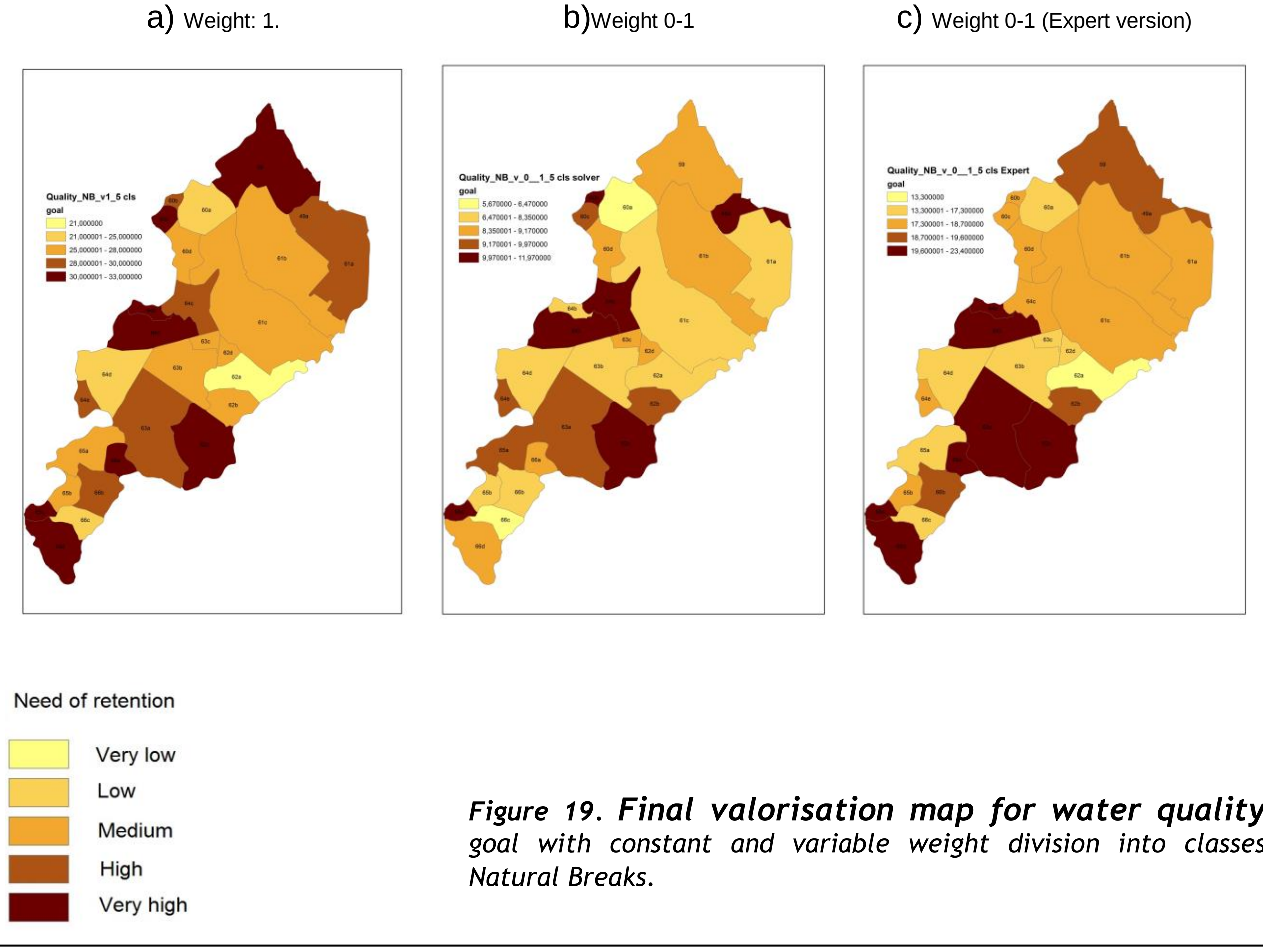


Figure 19. ***Final valorisation map for water quality*** *goal with constant and variable weight division into classes Natural Breaks.*

a) Indicators weight constant: 1.
b) The theoretical optimization (according to Chapter 5.) of indicator weight values was determined with solver, using expert recognition in SPU. (weight: 0-1)
c) The MTDWD expert version of indicator weights. (weight: 0-1)

The three variations (a-c) for water quality improvement purpose do not show great differences, each of them acceptable taking into account local knowledge. <u>Proposed: a).</u>

7. Summary

- As a result of tests, it was found that the best results were obtained from the natural breaks and equal width method of division into classes.
- The division into 5 classes seems to be most suitable for the final classification map.
- Required data for evaluation and calculations are available easily, however pre-processing calculation for valorisation method needs careful work.
- There is an opportunity to use specific indicators to the river basin, in this assessment we used only the standard ones.
- Depending on the division method, the results may be very different from each other for the same valorisation purpose.
- Comparing Frogis results with planned actions: The planned measures are strongly influenced by the impact area of the built irrigation system in this catchment. Development needs are influenced by other external reasons: e.g.: agricultural needs.
- Frogis program is available to support planning process of N(S)WRM, identifying areas for water retention, for prioritisation on river basins.
- The program provides flexible design by changing the indicators and their weight values.
- Not possible to evaluate the results without field knowledge.

List of Abbreviations:

PAI: Drought hazard index in Hungary (made by Dr. Imre Palfai)

Indicator abbreviations (eg: cwb): see on chapter 4.2, page 9.

SPU: Spatial planning unit.

NB: Natural Breaks classification (Jenks)

EQ: Equal interval classification.

Quantile: Quantile data classification (classifications were made using the percentile)