REPORTS FROM TESTING THE STATIC METHOD TO ASSESS CUMULATIVE EFFECT OF N(S)WRM (PILOT ACTION)

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Pilot Catchment Kamienna

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Content

1. INTRODUCTION

The purpose of developing the StaticTool method and the computer application StaticTool.xlsm is to enable the estimation of the effects of the implementation of a program of natural, small water retention measures (PoNSWRM) in a simplified way, which does not require the time-consuming and costly development of detailed hydrological or / and hydraulic models, of the analysed catchment. This method relies on grading and expert knowledge and is used to compare variants of the NSWRM program.

The potential effects of individual NSWR measures may be different, depending on the climatic and physiographic conditions (e.g. slopes, ground permeability) of the analysed area, so the method parameters should be adapted to local conditions (climate type, landscape type). The StaticTool method thus consists of two parts:

- developing method parameters for local conditions,
- estimating the effects of activities planned under the Natural Small Water Retention Program.

The StaticTool method assumes that the expected effect of the PoNSWRM is to improve catchment retention properties, which is understood as increasing low flows (LowQ), reducing high flows (HighQ) and / or limiting the load of pollutants yielded from the catchment area (Qual). This effect depends on the planned measures, in particular: i) their type and ii) their level of intensity. The measures included in the StaticTool method are summarized in the local catalogue of measures. For each measure, an intensity criterion is formulated, and threshold values are defined that correspond to the characteristic intensity levels (low, medium, high). Each measure is also assigned the expected improvement of retention properties in the SPU, expressed on a point scale (0-5 points). The greatest improvement that can be achieved (maximum points for a given measure) corresponds to the implementation of the measure with maximum intensity. For lower intensity levels, the assigned grades are proportional to the level of intensity of planned measure. Hence, developing parameters of the StaticTool method means defining a set of functions that makes the grade assessment dependent on the type of planned measures and their intensity for each measure from the local catalogue.

The StaticTool method and the StaticTool.xlsm application were developed as part of the project FramWat, Work Package T2 (Effectiveness of the Natural Small Water Retention Measure), activity A.T2.2 (Developing the GIS based method to assess cumulative effect of N(S)WRM at the river basin scale), deliverable D.T2.2.1 (Static method to assess cumulative effect of N(S)WRM in the river basins). A detailed description of the methodology is in a separate file created by the author of the program. This report presents the results of testing the static method (StaticTool.xlsm) to assess cumulative effect of N(S)WRM for the Pilot Catchment Kamienna.

2. DESCRIPTION OF INPUT DATA PREPARATION

In the first step, of working with the StaticTool program, it was necessary to specify/select the N(S)WRM type, for which calculations will be carried out in the expert variant and variant of local preferences. The table below (Tab. 1) shows the types of measures implemented in the program in individual variants (all reported measures in the expert and local variants).

Tab. 1 The measures in the expert and local preferences variant for the Kamienna catchment.

No NSWRM	Variant	Type of NSWRM	Name	Parameters	Count of NSWRM	Area [ha]
D04	Exp.	Construction of micro reservoirs on ditches	Construction of micro reservoirs on ditches	Permanent river step or ford (concrete/stone or wooden depending on the magnitude of streamflow occuring in this river section) about 1 m high, about 2 m wide; step height 0.5 m; length 20 m	29	20.61
T03	Exp.	Construction of small reservoirs on rivers (dammed reservoirs)	Dam Biernatka	Changing the shape of the concrete river step which is 3 m wide and dividing it into a double one; making dikes 0.3 m high; 200 m long	1	7.98
T03	Exp.	Construction of small reservoirs on rivers (dammed reservoirs)	Reservoir Stary Gostów	F = 2.9 ha, mean depth 1 m, construction of a permanent wooden overflow 1.5 m high, 3 m long	1	2.86
T03	Exp.	Construction of small reservoirs on rivers (dammed reservoirs)	Dry reservoir Brody Lublianka		1	0.83
A08	Exp.	Green cover/After-crops	After-crops		22	142.18
A02	Exp.	Buffer strips and hedges		Planting a tree every 6m	1709	
A03	Exp.	Crop rotation	Crop rotation		1	15752
D01	Exp.	Regulated outflow from drainage systems	Regulated outflow Kochanówka	5 culverts, height 0.9 m width 3 m	1	430.92
D01	Exp.	Regulated outflow from drainage systems		5 culverts, height 0.9 m width 3 m	1	416.29
D01	Exp.	Regulated outflow from drainage systems	Reg.Odpływ Swierczek	5 culverts with damming height 0.9m width 3m	1	1796.21
N02	Exp.	Wetland restoration and management	Artificial wetland	1x barrage 1m high, dyke height 0.5m and length 30m	2	5.48
N06	Exp.	Restoration and reconnection of seasonal streams	Oxbow Stoki Stare	1x wooden dam height 1m, width 10m; 2 x ford height 0.8 width 10m or 2x culvert with damming height 1m, width 3m	1	3.76
N06	Exp.	Restoration and reconnection of seasonal streams	Reconstruction of the water supply mill Nietulisko	Permanent river step (max. height 2 m) with a width of 35 m with a bipartite shape increasing the flooding in order to enable fish migration during medium and low water levels.	1	22.26
D01	Exp.	Regulated outflow from drainage systems	Floodplain restoration and management	Land purchase - 63.76 ha	14	342.57
N03	Exp.	Floodplain restoration and management	Oxbow Bodzechów	3 x culverts with damming 1 m wide 3 m, 1 wooden dam 1 m wide 5 m, clearing 8 km of ditches	1	172.65
F14	Exp.	Overland flow areas in peatland forests		Wooden dam height 1 m or ford height 0.8 m and width 3 m	19	1042.47
F14	Exp.	Overland flow areas in peatland forests	Odrowążek		1	13.94
F08	Exp.	Appropriate design of roads and stream crossings	The ferry Mostki	Length approx 30 m, width 4 m	1	
D02	Exp.	Water damming in ditches, weirs with constant crest (valleys)	Retention trough Kunów	One river step height: 0.5-1.5 m, width 30 m	1	5.09
F01	Exp.	Forest riparian buffers		Planting a tree every 6m	168	
T03	Exp.+Loc.	Construction of small reservoirs on rivers (dammed reservoirs)	Reservoir Mroczków	Area of approximately 5 hectares, damming height of about 3 m	1	7.76
T03	Exp.+Loc.	Construction of small reservoirs on rivers (dammed reservoirs)	Reservoir Bzin	F = estimated surface 100 ha damming height of about 6 m	1	100
T03	Exp.+Loc.	Construction of small reservoirs on rivers (dammed reservoirs)	Reservoir Górki-Gilów	F = approximately 3 hectares, damming height of about 1.5 m	1	3.26
T03	Exp.+Loc.	Construction of small reservoirs on rivers (dammed reservoirs)	Reservoir Wołów	F=33,7 ha; VNPP=674000 m3; V=253000 m3	1	33.7
A03	Exp.+Loc.	Buffer strips and hedges		Planting a tree every 6m	104	
T01	Exp.+Loc.	Polders, dry flood protection reservoirs, sediment trapping dams	Dry reservoir Jędrzejowice	Reservoir area: 5.6 ha, Total capacity: 162,700 m3, damming dam length - approx. 115 m, height in relation to the bottom of the valley 13 m	1	1

No NSWRM	Variant	Type of NSWRM	Name	Parameters	Count of NSWRM	Area [ha]
T01	Exp.+Loc.	Polders, dry flood protection reservoirs, sediment trapping dams	Dry reservoir Mychałów Kol.1	Reservoir area: 0.82 ha, total capacity: 18 400 m3, damming dam length - about 75 m, height in relation to the bottom of the valley - 8 m	1	0.82
T01	Exp.+Loc.	Polders, dry flood protection reservoirs, sediment trapping dams	Dry reservoir Mychałów Kol.2	Reservoir area: 4.9 ha, total capacity: 163,900 m3, damming dam length - about 170 m, height in relation to the valley bottom - 14 m	1	4.9
T01	Exp.+Loc.	Polders, dry flood protection reservoirs, sediment trapping dams	Dry reservoir Mychałów Kol.3	Reservoir area: 4.9 ha, total capacity: 276 300 m3, damming dam length - approx. 135 m, height in relation to the valley bottom - 15 m	1	4.9
T02	Exp.+Loc.	Widenning or removing of flood protection dikes	Increasing the spaces between dikes	9 sections of new dikes with a total length of 4,905 linear meters	1	
D03	Loc.	Active water management on a drainage system (river valleys)	Reconstruction of the Styków pumping station		1	
D04	Loc.	Construction of micro reservoirs on ditches	Construction of micro reservoirs on ditches	Permanent damming or ford (concrete / stone or wood depends on the strength of the water) about 1m high, about 2m wide; dyke height 0.5m; length 20 m	1	5.23
T03	Loc.	Construction of small reservoirs on rivers (dammed reservoirs)	Weir Brody Iłzycikie renovation		1	0.32
T03	Loc.	Construction of small reservoirs on rivers (dammed reservoirs)	Reservoir Boria	An area of 99 hectares	1	99
T03	Loc.	Construction of small reservoirs on rivers (dammed reservoirs)	Reservoir Lemierze (2 - Baltow)	The length of about 1.9 km; average width - 460 m.	1	89.34
T03	Loc.	Construction of small reservoirs on rivers (dammed reservoirs)	Reservoir Michałów	Length - 2000 m, an average width of 180 m, the average height - 2.5 m.	1	125.34
T03	Loc.	Construction of small reservoirs on rivers (dammed reservoirs)	Reservoir Rudka Bałtowska (nr 1 - Bałtów)	Length 2.9 km; average width 400 m	1	240.53
T03	Loc.	Construction of small reservoirs on rivers (dammed reservoirs)	Reservoir Ćmielów	Area of 24 ha	1	24
T03	Loc.	Construction of small reservoirs on rivers (dammed reservoirs)	Reservoir Ruda Kościelna	Area 78 ha	1	78
D01	Loc.	Regulated outflow from drainage systems	Regulated outflow Lipowe Pole	Renovation / modernization of closures - 2 weirs and a minimum of 5 valves or culverts with damming	1	351.87
N02	Loc.	Wetland restoration and management		3 x culverts with damming height 1 m width 3 m;	1	114.42
F06	Loc.	Continuous cover forestry		Area: 685.94 ha	3	685.94 (148)
F08	Loc.	Appropriate design of roads and stream crossings	Raising the elevation of the road	Renovation of a 2-lane asphalt road over a distance of 400 m, possibly replacement of a concrete rectangular culvert about 4 m wide	1	

At the initial stage, individual N(S)WRMs were merged into one (of the same) type and then aggregation was performed. Aggregated measures include a group of measures whose implementation improves in a similar way the retention properties of the catchment area. Assessment of the effects of individual activities, without detailed field or model studies at the current level of knowledge, is not possible. Finally, 11 records were received as part of the expert variant and 8 for local variant (Tab.2 - Tab. 3).

Tab. 2 Aggregated measure – expert variant

No	Aggregated measure ID	Aggregated measure
1	A02	Buffer strips and hedges
2	WRAL	WRAL - best practices for Water Retention in Agricultural Lands
3	F01	Forest riparian buffers
4	F08	Appropriate design of roads and stream crossings
5	F14	Overland flow areas in peatland forests
6	ER	ER - Ecosystems Restoration / renaturisation of water dependent ecosystems
7	N06	Restoration and reconnection of seasonal streams
8	BPDA	BPDA - Best practices on drained areas
9	T1	Polders, dry flood protection reservoirs, sediment trapping dams
10	T2	Widening or removing of flood protection dikes
11	T3	Construction of small reservoirs on rivers (dammed reservoirs)

Tab. 3 Aggregated measure – variant of local preferences.

No	Aggregated measure ID	Aggregated measure
1	A02	Buffer strips and hedges
2	F06	Continuous cover forestry
3	F08	Appropriate design of roads and stream crossings
4	BPDA	BPDA - Best practices on drained areas
5	T1	Polders, dry flood protection reservoirs, sediment trapping dams
6	T2	Widening or removing of flood protection dikes
7	T3	Construction of small reservoirs on rivers (dammed reservoirs)

For each measure the intensity criteria and the threshold values for characteristic intensity levels were defined. According to the assumptions of the StaticTool method, the expected improvement in the catchment retention properties depends on the type and level of intensity of planned measures. Three levels of measures' intensity were distinguished: low, medium and high. They correspond to three levels of the expected improvement in the catchment retention properties (e.g. small, average and large). Four threshold values were used: T0 – no action, Tlow – the boundary between low and medium intensity, Thigh – the limit between medium and high intensity and Tmax, which corresponds to the maximum (hypothetically) possible intensity of measure. There were determined by expert assessments of the impact of aggregated measures on three elements of the catchment retention properties (low flows, high flows and erosion), with maximum intensity of measures' application. There was a need to formulate a general assessment of measures (3 above-mentioned elements together) and define the effect for lower than maximum intensity of measures. The tables below show the parameters used for calculations in the local and expert variants (Tab. 4- Tab. 7).

Tab. 4 The assessment of the impact of aggregated measures on three elements of the catchment retention properties (6-grade scale was adopted, 0 - 5, where 0 means no positive impact on the retention of the catchment area, and 5 - very high positive impact) - expert variant.

No	Code	Aggregated measure name	Low flows	High flows	Qual Erosion	AVG
1	A02	Buffer strips and hedges	1	1	3	1.67
2	WRAL	WRAL - best practices for Water Retention in Agricultural Lands	0	2	4	2.00
3	F01	Forest riparian buffers	0	1	3	1.33
4	F08	Appropriate design of roads and stream crossings	0	2	1	1.00
5	F14	Overland flow areas in peatland forests	1	3	2	2.00
6	ER	ER - Ecosystems Restoration / renaturisation of water dependent ecosystems	0	5	4	3.00
7	N06	Restoration and reconnection of seasonal streams	0	2	2	1.33
8	BPDA	BPDA - Best practices on drained areas	2	3	2	2.33
9	T1	Polders, dry flood protection reservoirs, sediment trapping dams	0	5	3	2.67
10	T2	Widening or removing of flood protection dikes	0	3	3	2.00
11	T3	Construction of small reservoirs on rivers (dammed reservoirs)	4	4	2	3.33

Tab. 5 The assessment of the impact of aggregated measures on three elements of the catchment retention properties (6-grade scale was adopted, 0 - 5, where 0 means no positive impact on the retention of the catchment area, and 5 - very high positive impact) - local variant.

No	Code	Aggregated measure name	Low flows	High flows	Qual Erosion	AVG
1	A02	Buffer strips and hedges	1	1	3	1.67
2	F06	Continuous cover forestry	0	0	0	0.00
3	F08	Appropriate design of roads and stream crossings	0	2	1	1.00
4	BPDA	BPDA - Best practices on drained areas	2	3	2	2.33
5	T1	Polders, dry flood protection reservoirs, sediment trapping dams	0	5	3	2.67
6	T2	Widening or removing of flood protection dikes	0	3	3	2.00
7	T3	Construction of small reservoirs on rivers (dammed reservoirs)	4	4	2	3.33

Tab. 6 List of parameters for measures in expert variant.

No	Measure ID	Aggregated	Definition of the intensity criteria in English	Intensity thresholds				Grade_max	Grade thresholds [%]				Grade values			
				T0	Tlow	Thigh	Tmax		E%0	E%low	E%high	E%max	E0	Elow	Ehigh	Emax
1	A02	Buffer strips and hedges	Buffer strips density - total lenght of strips and SPU area ratio [km/km2]	0.00	0.50	2.00	6.00	3	0	60	95	100	0.00	1.80	2.85	3.00
2	WRAL	WRAL - best practices for Water Retention in Agricultural Lands	Arable land area on which best practices of water retention are applied and SPU area ratio [km2/km2]	0.00	0.30	0.80	1.00	3	0	30	80	100	0.00	0.90	2.40	3.00
3	F01	Forest riparian buffers	Total lenght of forest riparian buffers and doubled lenght of water courses in SPU ratio [km/km]	0.00	0.30	0.70	1.00	2	0	30	70	100	0.00	0.60	1.40	2.00
4	F08	Appropriate design of roads and stream crossings	Forest area under Best Forestry Practices and SPU area ratio [km2/km2]	0.00	0.70	0.95	1.00	2	0	10	40	100	0.00	0.20	0.80	2.00
5	F14	Overland flow areas in peatland forests	Length of forest water courses under best practices and total length of water courses in the SPU ratio [km/km]	0.00	0.20	0.60	1.00	3	0	20	60	100	0.00	0.60	1.80	3.00
6	ER	ER - Ecosystems Restoration / renaturisation of water dependent ecosystems	Total area of restored (and managed) wetlands, floodplains and reconnected ox-bows and SPU area ratio [km2/km2]	0.00	0.10	0.40	1.00	5	0	60	95	100	0.00	3.00	4.75	5.00
7	N06	Restoration and reconnection of seasonal streams	Total length of restored water bodies (natural stream bed, bank protection removal, etc) and water bodies length in SPU ratio [km/km]	0.00	0.20	0.60	1.00	2	0	20	60	100	0.00	0.40	1.20	2.00
8	BPDA	BPDA - Best practices on drained areas	Drained area under Best DA Practices and SPU area ratio [km2/km2]	0.00	0.05	0.15	1.00	4	0	60	95	100	0.00	2.40	3.80	4.00
9	T1	Polders, dry flood protection reservoirs, sediment trapping dams	Catchment area upstream of measure (polder, dry reservoir) and SPU area ratio [km2/km2]	0.00	0.05	0.20	1.00	4	0	60	95	100	0.00	2.40	3.80	4.00
10	T2	Widening or removing of flood protection dikes	Active floodplain area and max (during HHQ) floodplain area in SPU ratio [km2/km2]	0.00	0.05	0.20	1.00	3	0	60	95	100	0.00	1.80	2.85	3.00
11	T3	Construction of small reservoirs on rivers (dammed reservoirs)	Total volume of storage reservoirs and yearly water yield ratio [m3/m3]	0.00	0.05	0.20	1.00	5	0	60	95	100	0.00	3.00	4.75	5.00

Tab. 7 List of parameters for measures in local variant.

AggregN	7						Intensity thresholds					Grade thresholds [%]					Grade values			
No sort_AVG	No	Measure ID	Aggregated English	Aggregated measure in Polish	Definition of the intensity criteria in English	ą się własności zlewni; niekorzystne przekształce	T0	Tlow	Thigh	Tmax	Grade_max	E%0	E%low	E%high	E%max	E0	Elow	Ehigh	Emax
3	1	A02	Buffer strips and hedges	Pasy buforowe i żywopłoty	Buffer strips density - total lenght of strips and SPU area ratio [km/km2]	Długość pasów buforowych na jednostkę powierzchni SPU [km/km2]	0.00	0.50	2.00	6.00	3	0	60	95	100	0.00	1.80	2.85	3.00
1	2	F06	Continuous cover forestry	Utrzymanie lasów (ograniczenie ilości i	(-) There is no change in hydrological conditions; undesirabled impacts are prevented	(-) Nie zmieniają się własności zlewni; niekorzystne przekształcenia nie zachodzą	0.00	0.00	0.00	0.00	0	0	0	0	0	0.00	0.00	0.00	0.00
2	3	F08	Appropriate design of roads and strea	Właściwe projektowanie dróg i przeprav	Forest area under Best Forestry Practices and SPU area ratio [km2/km2]	Stosunek powierzchni lasów, na których stosowane są dobre praktyki gospodarki leśnej, do powierzchni SPU [km2/km2]	0.00	0.70	0.95	1.00	2	0	10	40	100	0.00	0.20	0.80	2.00
5	4	BPDA	BPDA - Best practices on drained area	BPDA - Dobre praktyki na terenach zdren	Drained area under Best DA Practices and SPU area ratio [km2/km2]	Stosunek powierzchni obszarów zdrenowanych, na których stosowane są dobre praktyki ochrony wód, do powierzchni SPU	0.00	0.05	0.15	1.00	4	0	60	95	100	0.00	2.40	3.80	4.00
6	5	T1	Polders, dry flood protection reservoir	Suche zbiorniki / poldery (na terenach r	Catchment area upstream of measure (polder, dry reservoir) and SPU area ratio [km2/km2]	Stosunek powierzchni zlewni zamkniętej obiektem (polder, suchy zbiornik) i powierzchni SPU [km2/km2]	0.00	0.05	0.20	1.00	4	0	60	95	100	0.00	2.40	3.80	4.00
4	6	T2	Widening or removing of flood protect	Zwiększanie rozstawy, usuwanie obwało	Active floodplain area and max (during HHQ) floodplain area in SPU ratio [km2/km2]	Stosunek powierzchni czynnych terenów zalewowych i całkowitej powierzchni terenów zalewowych (przy WWQ) w SPU [km2/km2]	0.00	0.05	0.20	1.00	3	0	60	95	100	0.00	1.80	2.85	3.00
7	7	T3	Construction of small reservoirs on ri	Małe zbiorniki / podpiętrzenia na rzece	Total volume of storage reservoirs and yearly water yield ratio [m3/m3]	Stosunek pojemności całkowitej zbiornika i SSQ w przekroju zamykającym SPU [m3/m3]	0.00	0.05	0.20	1.00	5	0	60	95	100	0.00	3.00	4.75	5.00

For each planned measure (in SPUs), its intensity was given, expressed in accordance with the adopted intensity criterion definitions. For each SPU in the columns corresponding to individual measures, their intensity was provided, with the value 0 meaning no measure in the given SPU, and 1 – planning the measure with the maximum possible intensity. Intensity levels for 187 SPUs were determined for the Kamienna catchment.

3. MODIFICATIONS TO THE STATICTOOLS.XLSX TOOL PARAMETERS

Defining the measures of the intensity and determining the thresholds for the characteristic levels of intensity (low, medium, high) was done with methodology developed by the company Pro-Woda (Tyszewski S. 2019). This company proposed that the assessment should be carried out in the following manner:

- a team of 3 specialists prepared a preliminary version of the table for assessing the impact of measures on the three adopted retention rates of the catchment (**Błąd! Nie można odnaleźć źródła odwołania.**).

- This table was forwarded to other experts and the FramWat Team. Each of the experts made such assessments for all 23 catalog measures and in dubious situations posted comments,

- On 10/12/2019, a seminar was organized at the SGGW headquarters devoted to these issues in order to determine the final form of the matrix of assessments of the impact of individual activities from the local catalog on the three above-mentioned retention rates of the drainage basin:

$ODi,j = \{ LowQi, HighQi, Quali \}$ where: $i = 1, 2, \ldots, LD$; $j = 1, 2, 3$

The meeting was attended by experts of Pro-Woda (Piotr Herbich, Andrzej Brandyk, Sylwester Tyszewski, Wiesław Fiałkiewicz; Ryszard Majewicz), invited experts (Jan Szatyłowicz, Laura Brandyk) and the Fram-Wat Team (Ignacy Kardel, Dorota Mirosław-Świątek, Paweł Marcinkowski, Dorota Pusłowska-Tyszewska).

At the meeting, each of the experts / expert groups presented their own proposal of the assessment table together with a justification, then joint (final) assessments of the impact on low flows (LowQi), high flows (HighQi) and limiting the load of outgoing pollutants (Quali) were established in the form of discussions for each of the local catalog activities. A joint (global) impact assessment (OGDi) of individual measures on the catchment area retention (SPU) was also established. It was proposed that the global rating will be calculated as the average of partial grades:

$OGDi = (LowQi + HighQi + Quali) / 3$ for $i = 1, 2, \ldots, LD$

The results of this step were given in the last columns of **Błąd! Nie można odnaleźć źródła odwołania.**.

Tab. 8 Expert assessment of NWRM impact on catchment retention properties – for maximum intensity level

Increasing low flows (***LowQ***), reducing high flows (***HighQ***) and limiting the load of generated pollution (***Qual***)

		Initial valuea Impact on (0-5):			Accepted values Impact on (0-5):			
Code	Measures (NWRM/NSWRM)	Low flows	High flows	Qual Erosion	Low flows	High flows	Qual Erosion	AVG
A02	Buffer strips and hedges	1	1	3	1	1	3	1.7
WRAL	WRAL - best practices for Water Retention in Agricultural Lands	1	2	5	0	2	4	2.0
F01	Forest riparian buffers	0	0	3	0	1	3	1.3
KF	KF - Keeping forests	0	0	0	0	0	0	0.0
F04	Targeted planting for 'catching' precipitation; Mediterrenian region	0	0	0	0	0	0	0.0
BFP	BFP - Best forestry practices	0	2	1	0	2	1	1.0
BPFWC	BPFWC - Best Practices for Forest Water Courses	1	3	2	1	3	2	2.0
ER	ER - Ecosystems Restoration / renaturisation of water dependent ecosystems	2	5	4	0	5	4	3.0
BPDA	BPDA - Best practices on drained areas	1	3	2	2	3	2	2.3
T1	Polders, dry flood protection reservoirs, sediment trapping dams	0	4	3	0	5	3	2.7
T2	Widening or removal of flood protection dikes	0	3	3	0	3	3	2.0
T3	Construction of small reservoirs on rivers (dammed reservoirs)	4	4	2	4	4	2	3.3

4. DESCRIPTION OF THE RESULTS

4.1 For the expert variant

The results of the assessment were obtained from the StaticAssessment tab (Tab. 9). This tab contains a table with the cumulative assessment for the entire catchment and partial assessments for each group of measures and for each SPU. The obtained results show that the highest impact on the final grade had buffer strips and hedges (A2 = 30.43), best practices on drained areas (BPDA = 24.63) and construction of small reservoirs on rivers (T3 = 23.52). In order to assess a single SPU while taking into account the size of the catchment area, additional calculations were made according to the following equation SPUgrades * F_SPU / Σ F_SPU. The results are shown in Tab. 9 and Fig. *1*. The greatest impact on the final assessment had SPU 82 and 92, which are characterized by a large catchment area and proposed A2 measures. Next is SPU 33 with proposed reservoirs (T3). The SPU rating which does not take into account the area shows different results: the highest rating was obtained by SPU 105 in which reservoirs T3 are planned. In a situation where the SPUs have different sizes, comparing their ratings is questionable. The final rating for the catchment also depends largely on the size of the SPUs. This variant contained a large number of

measures with low efficiency, therefore the SPU assessment results are spatially dispersed and their discrepancies are small. The overall rating for this option is 0.71.

Tab. 9 Assessment of the effectiveness of the expert variant

Number of measures	11			Grading of the Program of Small Water Retention Measures												
Number of SPUs	227		Measure No.	1	2	3	4	5	6	7	8	9	10	11	Catchment grade for current variant	SPU grades *F_SPU/ Sum_F_ SPU
Grade for a measure (total by SPUs):				30.43	18.66	2.91	0.00	5.99	6.85	0.12	24.63	7.80	2.94	23.52	0.71	
No.	SPU Id	SPU name	Measure Id by User	A02	WRAL	F01	F08	F14	ER	N06	BPDA	T1	T2	T3	SPU grades	
			F_SPU [km^2]	km/km2	km2/km2	km/km	km2/km2	km/km	km2/km2	km/km	km2/km2	km2/km2	km2/km2	m3/m3		
6	Sub_06	Oleśnica od dopł. spod Łazów do dopł. z Lipowego Pola (l	2.16					2.62			0.28				2.91	0.003
7	Sub_07	Oleśnica od dopł. spod Łazów do dopł. z Lipowego Pola (l	0.82								0.13				0.13	0.000
8	Sub_08	Dopływ z Lipowego Pola do dopł. spod Świerczka (l)	2.70								3.92				3.92	0.005
9	Sub_09	Dopływ spod Świerczka	8.55								3.85				3.85	0.017
12	Sub_12	Oleśnica od dopł. spod Łazów do dopł. z Lipowego Pola (l	20.55					0.25			2.65				2.90	0.030
13	Sub_13	Oleśnica od dopł. spod Łazów do dopł. z Lipowego Pola (l	2.30								0.98				0.98	0.001
14	Sub_14	Dopływ z Lipowego Pola od dopł. spod Świerczka do ujści	2.66								3.95				3.95	0.005
17	Sub_17	Dopływ spod Leszczyn od dopł. z Zapowiedzi do ujścia	1.16											4.86	4.86	0.003
20	Sub_20	Oleśnica od dopł. z Lipowego Pola do ujścia	2.56						0.03						0.03	0.000
21	Sub_21	Kamienna od Oleśnicy do Wężyka (l)	9.99					0.03	1.16						1.20	0.006
23	Sub_23	Kamienna od Bernatki do Oleśnicy (l)	13.76						0.60				2.94		3.55	0.025
24	Sub_24	Bernatka	21.27											1.80	1.80	0.019
25	Sub_25	Kamienna od dopł. spod Leszczyn do Kuźniczki (p)	7.63											0.60	0.60	0.002
29	Sub_29	Kuźniczka do dopł. z Piechotnej (l)	18.00					0.33							0.33	0.003
33	Sub_33	Kamienna od dopł. w Cyganowie do Kamionki (p)	15.80											4.93	4.93	0.039
34	Sub_34	Kamienna od Wężyka do Żarnówki (p)	1.94						0.64						0.64	0.001
37	Sub_37	Żarnówka od Kaczki do ujścia	8.41						0.27						0.27	0.001
38	Sub_38	Dopływ spod Grechowa	6.64	0.01							3.82				3.83	0.013
40	Sub_40	Wolanka do dopł. spod Grechowa (l)	19.28	0.01		0.07					2.85				2.93	0.029
41	Sub_41	Kamienna od Żarnówki do dopł. z Podławek (p)	4.75						1.11						1.11	0.003
43	Sub_43	Kamienna od dopł. spod Czerwonej Góry do dopł. w Cygar	5.13											4.78	4.78	0.012
44	Sub_44	Kamienna od Ścięgna do ujścia	23.26	0.19											0.19	0.002
46	Sub_46	Kamienna od dopł. z Podławek do dopł. z Sinej Wody (l)	13.95			0.03		0.01	0.42						0.46	0.003
49	Sub_49	Dopływ z Podławek	6.90						0.75						0.75	0.003
56	Sub_56	Kamienna od Wolanki do Ścięgna (p)	30.53	1.17											1.17	0.018
60	Sub_60	Dopływ spod Czerwonej Góry	6.38											1.80	1.80	0.006
64	Sub_64	Ścięgno od dopł. spod Dąbrowy do ujścia	13.82	1.67											1.67	0.012
65	Sub_65	Kamienna od Wolanki do Ścięgna (p)	49.60	0.66											0.66	0.017
70	Sub_70	Lubianka do dopł. spod Lubieni-Podlesia (l)	15.39					0.17							0.17	0.001
72	Sub_72	Dopływ spod Lubieni-Podlesia	5.98			0.02									0.02	0.000
82	Sub_82	Wolanka do dopł. spod Grechowa do ujścia	54.78	2.03					0.01						2.04	0.056
88	Sub_88	Dopływ spod Dąbrowy	26.08	1.62											1.62	0.021
91	Sub_91	Bezpośrednia zlewnia zb. Brody Iłżeckie	5.27			0.07									0.07	0.000
92	Sub_92	Ścięgno do dopł. spod Dąbrowy (l)	45.67	2.48											2.48	0.057
97	Sub_97	Kamienna od dopł. spod Podgórza do Wolanki (l)	51.96	0.05											0.05	0.001
100	Sub_100	Kamionka od Jaślanej do dopł. z Michniowa (p)	10.72	0.11											0.11	0.001
104	Sub_104	Kamienna od dopł. z Lubieni do dopł. spod Boru Kunowsk	2.97	0.12											0.12	0.000
105	Sub_105	Dopływ spod Boru Kunowskiego	10.55					0.57						4.75	5.32	0.028
108	Sub_108	Lubianka od dopł. spod Ostrej Górki do Szczebrzy (p)	10.55			0.02									0.02	0.000
109	Sub_109	Dopływ z Kuczowa (p)	15.97	0.16				0.33							0.49	0.004
114	Sub_114	Bezpośrednia zlewnia zb. Brody Iłżeckie	1.45	0.18											0.18	0.000
115	Sub_115	Dopływ spod Podgórza	13.61	0.69											0.69	0.005
116	Sub_116	Bezpośrednia zlewnia zb. Brody Iłżeckie	4.09	0.38											0.38	0.001
117	Sub_117	Jaślana	21.45			0.04									0.04	0.000
122	Sub_122	Kamienna od dopł. spod Boru Kunowskiego do dopł. spoc	12.00						0.48						0.48	0.003
123	Sub_123	Dopływ spod Smug	17.42						0.00						0.00	0.000
124	Sub_124	Świślina od Węgierki do ujścia	5.20	0.27											0.27	0.001
125	Sub_125	Świślina od Psarki do Jaworek (p)	12.71	0.02	0.01	0.03									0.06	0.000
128	Sub_128	Świślina do Psarki (p)	14.16		0.00	0.01									0.01	0.000
129	Sub_129	Jaworki	13.90	0.23	0.00	0.02					0.03				0.28	0.002
130	Sub_130	Dopływ z Godowa	6.46	0.32											0.32	0.001
131	Sub_131	Świślina od Węgierki do ujścia	3.00			0.11				0.05					0.16	0.000
135	Sub_135	Kamienna od dopł. w Borowni do starego koryta w Stokac	40.80	0.01											0.01	0.000
136	Sub_136	Stare koryto w Stokach Starych	113.01							0.07					0.07	0.004
137	Sub_137	Psarka od Sieradowianki do ujścia	6.85	0.01		0.04									0.05	0.000
138	Sub_138	Świślina od Jaworek do zb. Wióry	8.44	0.18		0.02					0.01				0.21	0.001
139	Sub_139	Świślina od zapory zb. Wióry do dopł. z Godowa (l)	1.37		0.06			1.41							1.47	0.001
140	Sub_140	Psarka do dopł. spod Wzdołu Rządowego (l)	11.89	0.00											0.00	0.000
141	Sub_141	Dopływ spod Wzdołu Rządowego	5.49	0.12											0.12	0.000
142	Sub_142	Węgierka	26.53	0.23		0.05									0.27	0.004
145	Sub_145	Bezpośrednia zlewnia zb. Wióry	24.22	1.00	0.01	0.56					0.00				1.57	0.019
146	Sub_146	Dopływ spod Chocimowa	3.75	0.66											0.66	0.001
147	Sub_147	Psarka od Gozdkówki do Sieradowianki (l)	3.75	0.10											0.10	0.000
148	Sub_148	Sieradowianka	8.52	0.10	0.01										0.11	0.000
149	Sub_149	Kamienna od Świśliny do Dunaju (l)	0.88			0.03					1.11				1.14	0.001

Tab.9 Assessment of the effectiveness of the expert variant - continued

Grade for a measure (total by SPUs):			30.43	18.66	2.91	0.00	5.99	6.85	0.12	24.63	7.80	2.94	23.52	0.71	SPU grades *F_SPU/ Sum_F_ SPU
No.	SPU Id	SPU name	Measure Id by User	A02	WRAL	F01	F08	F14	ER	N06	BPDA	T1	T2	T3	SPU grades	
			F_SPU [km^2]	km/km2	km2/km2	km/km	km2/km2	km/km	km2/km2	km/km	km2/km2	km2/km2	km2/km2	m3/m3		
150	Sub_150	Dunaj	20.83			0.04		0.07							**0.11**	0.001
152	Sub_152	Olszówka	9.85	0.23											**0.23**	0.001
153	Sub_153	Modła od dopł. spod Swarszowic do ujścia	2.07	0.48											**0.48**	0.001
154	Sub_154	Kamienna od dopł. spod Bukowia do Modły (p)	6.00	0.02		0.05									**0.06**	0.000
155	Sub_155	Kamienna od Dunaju do dopł. spod Bukowia (p)	0.88	0.58		0.07									**0.65**	0.000
156	Sub_156	Kamienna od Świśliny do Dunaju (l)	2.13		0.03	0.22									**0.25**	0.000
157	Sub_157	Kamienna od dopł. spod Bukowia do Modły (p)	7.52	0.23	0.01	0.09									**0.33**	0.001
158	Sub_158	Dopływ spod Bukowia do dopł. spod Chocimowa (l)	5.92	0.61		0.24									**0.85**	0.003
159	Sub_159	Psarka od Olszówki do Gozdkówki (p)	25.61	0.15	0.00										**0.15**	0.002
162	Sub_162	Dopływ spod Kowalkowa	5.17	0.54						0.02					**0.56**	0.001
163	Sub_163	Gozdkówka do dopł. spod Kowalkowa (p)	5.99	0.20											**0.20**	0.001
164	Sub_164	Szewnianka od Pokrzywianki do ujścia	26.06	0.01	0.01										**0.02**	0.000
167	Sub_167	Modła od dopł. spod Swarszowic do ujścia	4.92	0.78											**0.78**	0.002
170	Sub_170	Kamienna od Przepaści do dopł. w Borowni (p)	8.00		0.01										**0.01**	0.000
171	Sub_171	Modła do dopł. spod Swarszowic (p)	11.98	0.38	0.01						3.86				**4.24**	0.026
172	Sub_172	Dopływ spod Rzuchowa do dopł. spod Moczydła (p)	11.21	0.03		0.05									**0.08**	0.000
174	Sub_174	Kamienna od dopł. z Ostrowca-Rzeczek do dopł. spod Rzu	15.88						1.29						**1.29**	0.010
175	Sub_175	Dopływ spod Moczydła	6.43	0.07	0.02	0.03									**0.12**	0.000
176	Sub_176	Kamienna od dopł. z Ostrowca-Rzeczek do dopł. spod Rzu	0.69						0.08						**0.08**	0.000
177	Sub_177	Dopływ z Boleszyna Dolnego (p)	6.64	0.23											**0.23**	0.001
178	Sub_178	Dopływ spod Swarszowic	4.91	0.22	0.01						3.94				**4.17**	0.010
179	Sub_179	Dopływ spod Chybic	7.66	0.23	0.00										**0.24**	0.001
180	Sub_180	Pokrzywianka od dopł. spod Chybic do ujścia	1.18	0.16	0.09										**0.26**	0.000
182	Sub_182	Pokrzywianka od Dobruchny do dopł. spod Chybic (l)	1.71		0.13										**0.13**	0.000
184	Sub_184	Dopływ z Bodzechowa	19.48	0.28	0.89										**1.16**	0.011
185	Sub_185	Pokrzywianka od Słupianki do Dobruchny (p)	16.80	0.20	0.01		0.02			0.01					**0.24**	0.002
186	Sub_186	Pokrzywianka do Czarnej Wody (l)	18.65	0.09						0.06					**0.15**	0.001
187	Sub_187	Czarna Woda	36.79	0.12						0.00					**0.12**	0.002
188	Sub_188	Dobruchna od dopł. spod Czajęcic do ujścia	1.93	0.28											**0.28**	0.000
189	Sub_189	Przepaść od Krzczonowianki do dopł. z Bodzechowa (l)	2.47	0.10	0.04										**0.14**	0.000
190	Sub_190	Dopływ spod Czajęcic	6.15	0.25											**0.25**	0.001
191	Sub_191	Pokrzywianka od Czarnej Wody do dopł. z Bielowa (p)	3.03	0.08			0.05								**0.13**	0.000
192	Sub_192	Dopływ z Bielowa	5.27							0.02					**0.02**	0.000
193	Sub_193	Krzczonowianka od Lipowej do ujścia	16.45	0.59	2.33	0.01									**2.93**	0.024
194	Sub_194	Przepaść od dopł. spod Bidzin do Krzczonowianki (l)	5.53	0.64	0.69										**1.33**	0.004
195	Sub_195	Dobruchna od dopł. ze Skoszyna do dopł. spod Czajęcic (p	3.99	0.12											**0.12**	0.000
196	Sub_196	Pokrzywianka do dopł. spod Garbacza (p)	10.30	0.66		0.04									**0.69**	0.004
197	Sub_197	Pokrzywianka od dopł. z Bielowa do Słupianki (p)	11.20	0.14			0.04			0.08					**0.25**	0.001
198	Sub_198	Słupianka od dopł. z Łaz do ujścia	8.47	0.17			0.02			0.01					**0.20**	0.001
199	Sub_199	Dopływ ze Skoszyna	10.91	0.14											**0.14**	0.001
200	Sub_200	Dobruchna od dopł. z Wronowa do dopł. ze Skoszyna (l)	3.97	0.38											**0.38**	0.001
201	Sub_201	Dopływ spod Garbacza	3.89			0.11									**0.11**	0.000
202	Sub_202	Dopływ spod Bidzin	11.63	0.03	0.02	0.06									**0.10**	0.001
203	Sub_203	Pokrzywianka od dopł. spod Garbacza do Garbutki (p)	6.53	0.31	0.01										**0.32**	0.001
205	Sub_205	Krzczonowianka do dopł. z Małoszyc (p)	15.99	0.88	1.15	0.06									**2.09**	0.017
207	Sub_207	Przepaść od dopł. spod Grochocic do dopł. spod Bidzin (p	13.45	1.17	2.51										**3.68**	0.025
208	Sub_208	Dobruchna do dopł. z Wronowa (l)	9.55	0.14		0.02									**0.15**	0.001
209	Sub_209	Słupianka od Łagowianki do dopł. z Łaz (l)	6.47	0.26						0.06					**0.32**	0.001
210	Sub_210	Dopływ z Łaz	4.53							0.03					**0.03**	0.000
211	Sub_211	Garbutka do dopł. z Wierzbontowic (l)	16.55	0.12		0.11									**0.22**	0.002
212	Sub_212	Dopływ spod Sadowia Poduchownego	8.38												**0.00**	0.000
213	Sub_213	Dopływ z Małoszyc	4.40	0.75	2.50										**3.25**	0.007
214	Sub_214	Lipowa od dopł. z Rosoch do ujścia	5.88	0.29	0.90	0.00									**1.19**	0.004
215	Sub_215	Krzczonowianka od dopł. z Małoszyc do Lipowej (p)	1.97	0.11	0.89										**0.99**	0.001
218	Sub_218	Łagowianka od dopł. w Jeleniowie do ujścia	0.11							0.74					**0.74**	0.000
219	Sub_219	Łagowianka do dopł. w Jeleniowie (p)	14.57				0.05			0.01					**0.06**	0.000
220	Sub_220	Słupianka do Łagowianki (p)	7.33							0.00					**0.00**	0.000
221	Sub_221	Lipowa do dopł. z Rosoch (p)	17.46	1.21	1.64	0.04									**2.89**	0.025
223	Sub_223	Dopływ z Rosoch	2.92		0.59	0.36									**0.95**	0.001
224	Sub_224	Przepaść od dopł. z Kaliszan do dopł. spod Grochocic (p)	0.81	0.16	1.88										**2.04**	0.001
225	Sub_225	Dopływ spod Grochocic	15.48	0.57	1.06	0.18									**1.82**	0.014
226	Sub_226	Dopływ z Kaliszan	7.23	0.07	0.05										**0.12**	0.000
227	Sub_227	Przepaść do dopł. z Kaliszan (l)	8.18	0.22	1.10										**1.31**	0.005

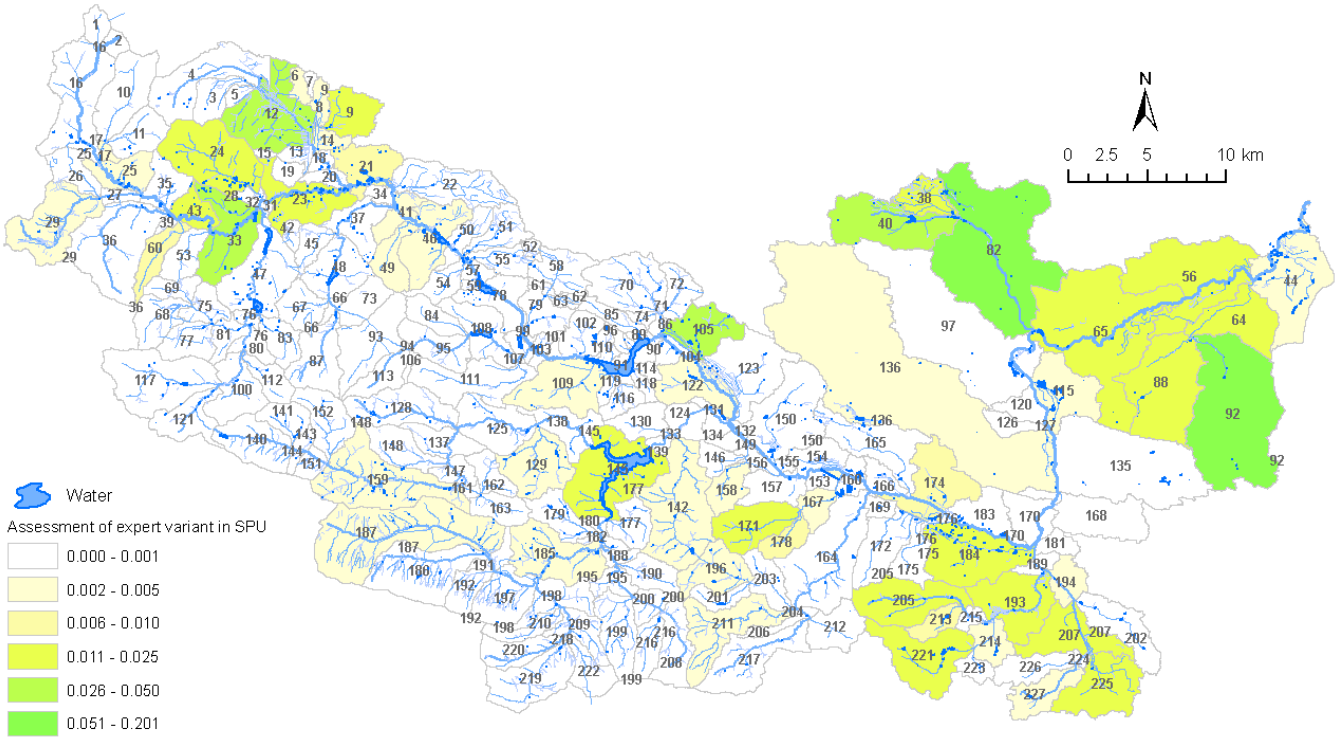

Fig. 1 Assessment map of the expert variant at the SPU level

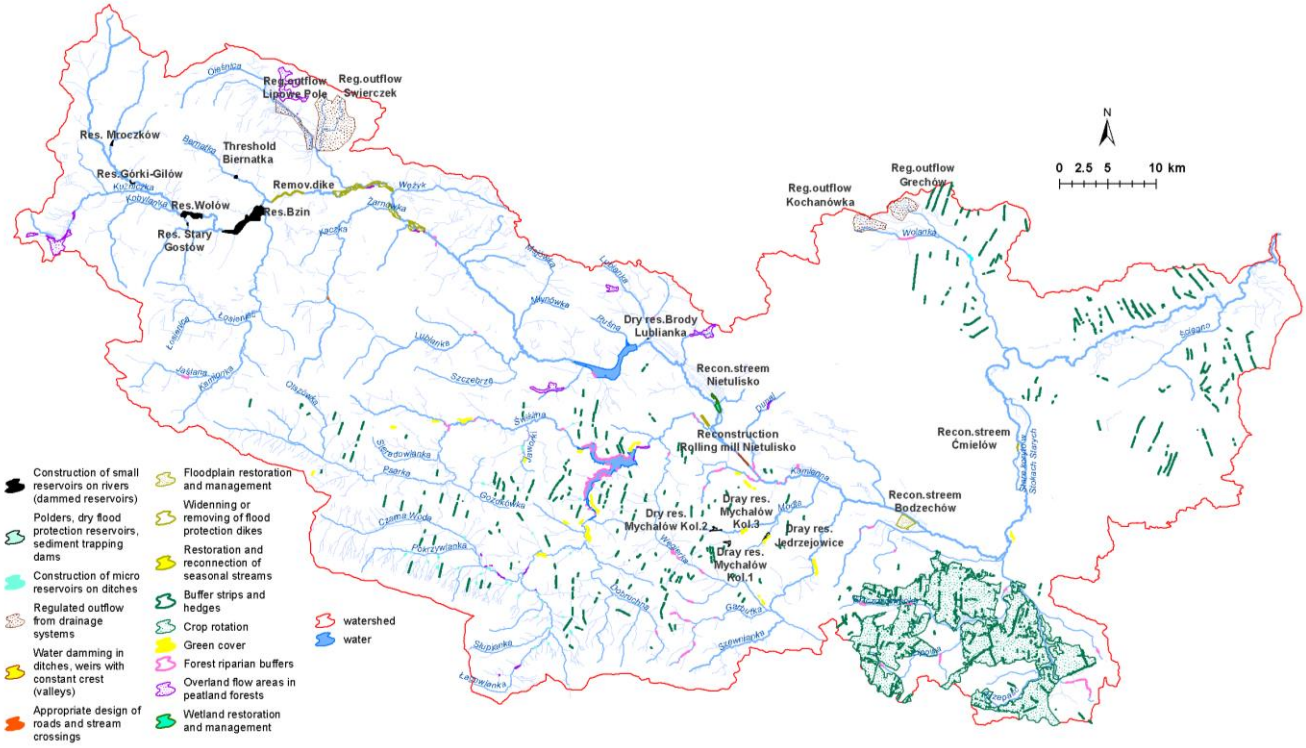

Fig. 2 Map of measures selected in the expert variant

4.2 For the variant of local preferences

The results of the local variant assessment are also presented in the form of a table and map (Tab. 10 and Fig. 4). In this variant, the small reservoirs on rivers (T3 = 52.73) have the greatest impact on the final score while the impact of other measures is negligible. Measure T3 and a large catchment area had an impact on the very high rating of SPU 136. As before, SPU assessment without taking into account its area gives different results, and in this case the SPU 13 dominates with a score of 5.9. This variant included a small number of measures with high efficiency which caused the SPU assessment results to be cumulated only in a couple of areas and divergences between them are very significant. The overall rating for this variant is 0.49.

Tab. 10 Assessment of the effectiveness of the local variant

Number of measures	7			Grading of the Program of Small Water Retention Measures								
Number of SPUs	227		Measure No.	1	2	3	4	5	6	7	Catchment grade for current variant	SPU grades *F_SPU/Sum_F_SPU
		Grade for a measure (total by SPUs):		0.90	0.00	0.00	4.07	7.80	2.94	52.78	**0.49**	
No.	SPU Id	SPU name	Measure Id by User	A02	F06	F08	BPDA	T1	T2	T3	SPU grades	
			F_SPU [km^2]	km/km2	-	km2/km2	km2/km2	km2/km2	km2/km2	m3/m3		
12	Sub_12	Oleśnica od dopł. spod łazów do dopł. z Lipowego Pola (l)	20.55				2.61				**2.61**	0.029
13	Sub_13	Oleśnica od dopł. spod łazów do dopł. z Lipowego Pola (l)	2.30				0.94			4.98	**5.91**	0.007
17	Sub_17	Dopływ spod Leszczyn od dopł. z Zapowiedzi do ujścia	1.16							4.86	**4.86**	0.003
23	Sub_23	Kamienna od Bernatki do Oleśnicy (l)	13.76						2.94		**2.94**	0.022
25	Sub_25	Kamienna od dopł. spod Leszczyn do Kuźniczki (p)	7.63							0.60	**0.60**	0.002
33	Sub_33	Kamienna od dopł. w Cyganowie do Kamionki (p)	15.80							4.93	**4.93**	0.042
37	Sub_37	Żarnówka od Kaczki do ujścia	8.41							4.77	**4.77**	0.021
43	Sub_43	Kamienna od dopł. spod Czerwonej Góry do dopł. w Cygano	5.13							4.78	**4.78**	0.013
50	Sub_50	Kamienna od dopł. z Podławek do dopł. z Sinej Wody (l)	5.43							4.81	**4.81**	0.014
57	Sub_57	Kamienna od dopł. z kopalni żelaza do Młynówki (l)	2.13							4.94	**4.94**	0.006
65	Sub_65	Kamienna od Wolanki do Ścięgna (p)	49.60		0.00						**0.00**	0.000
67	Sub_67	Dopływ z Kleszczyn	7.07			0.00					**0.00**	0.000
91	Sub_91	Bezpośrednia zlewnia zb. Brody Iłżeckie	5.27							4.78	**4.78**	0.013
97	Sub_97	Kamienna od dopł. spod Podgórza do Wolanki (l)	51.96				0.42				**0.42**	0.012
105	Sub_105	Dopływ spod Boru Kunowskiego	10.55		0.00		0.09				**0.09**	0.001
109	Sub_109	Dopływ z Kuczowa (p)	15.97				0.00				**0.00**	0.000
115	Sub_115	Dopływ spod Podgórza	13.61							4.99	**4.99**	0.036
135	Sub_135	Kamienna od dopł. w Borowni do starego koryta w Stokach	40.80		0.00						**0.00**	0.000
136	Sub_136	Stare koryto w Stokach Starych	113.01		0.00					3.58	**3.58**	0.217
168	Sub_168	Dopływ w Borowni	14.03		0.00						**0.00**	0.000
170	Sub_170	Kamienna od Przepaści do dopł. w Borowni (p)	8.00		0.00						**0.00**	0.000
171	Sub_171	Modła do dopł. spod Swarszowic (p)	11.98					3.86			**3.86**	0.025
178	Sub_178	Dopływ spod Swarszowic	4.91					3.94			**3.94**	0.010
181	Sub_181	Kamienna od Przepaści do dopł. w Borowni (p)	3.10		0.00						**0.00**	0.000
183	Sub_183	Kamienna od dopł. spod Rzuchowa do Przepaści (p)	8.86		0.00						**0.00**	0.000
184	Sub_184	Dopływ z Bodzechowa	19.48		0.00					4.75	**4.75**	0.050
185	Sub_185	Pokrzywianka od Słupianki do Dobruchny (p)	16.80	0.11							**0.11**	0.001
186	Sub_186	Pokrzywianka do Czarnej Wody (l)	18.65	0.09							**0.09**	0.001
187	Sub_187	Czarna Woda	36.79	0.03							**0.03**	0.001
195	Sub_195	Dobruchna od dopł. ze Skoszyna do dopł. spod Czajęcic (p)	3.99	0.09							**0.09**	0.000
197	Sub_197	Pokrzywianka od dopł. z Bielowa do Słupianki (p)	11.20	0.14							**0.14**	0.001
198	Sub_198	Słupianka od dopł. z łaz do ujścia	8.47	0.17							**0.17**	0.001
209	Sub_209	Słupianka od łagowianki do dopł. z łaz (l)	6.47	0.26							**0.26**	0.001

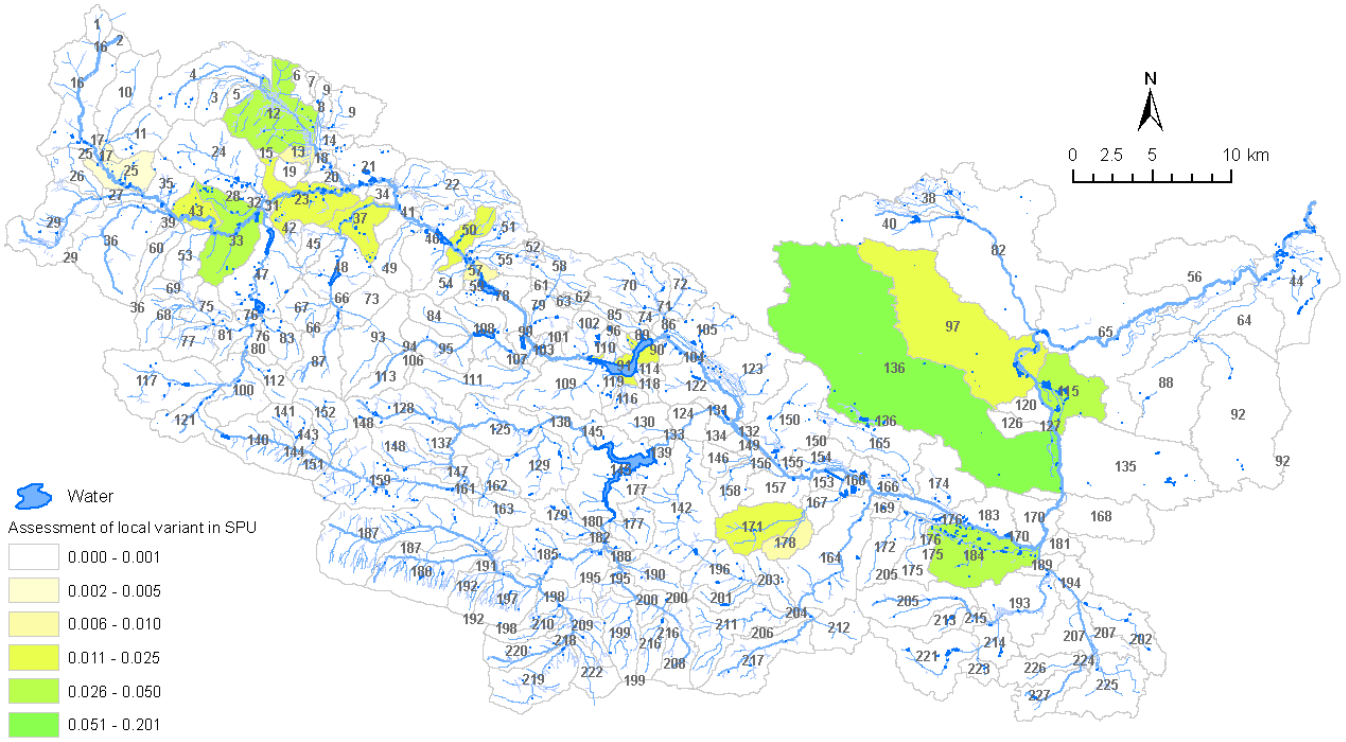

Fig. 3 Assessment map of the local variant at the SPU level

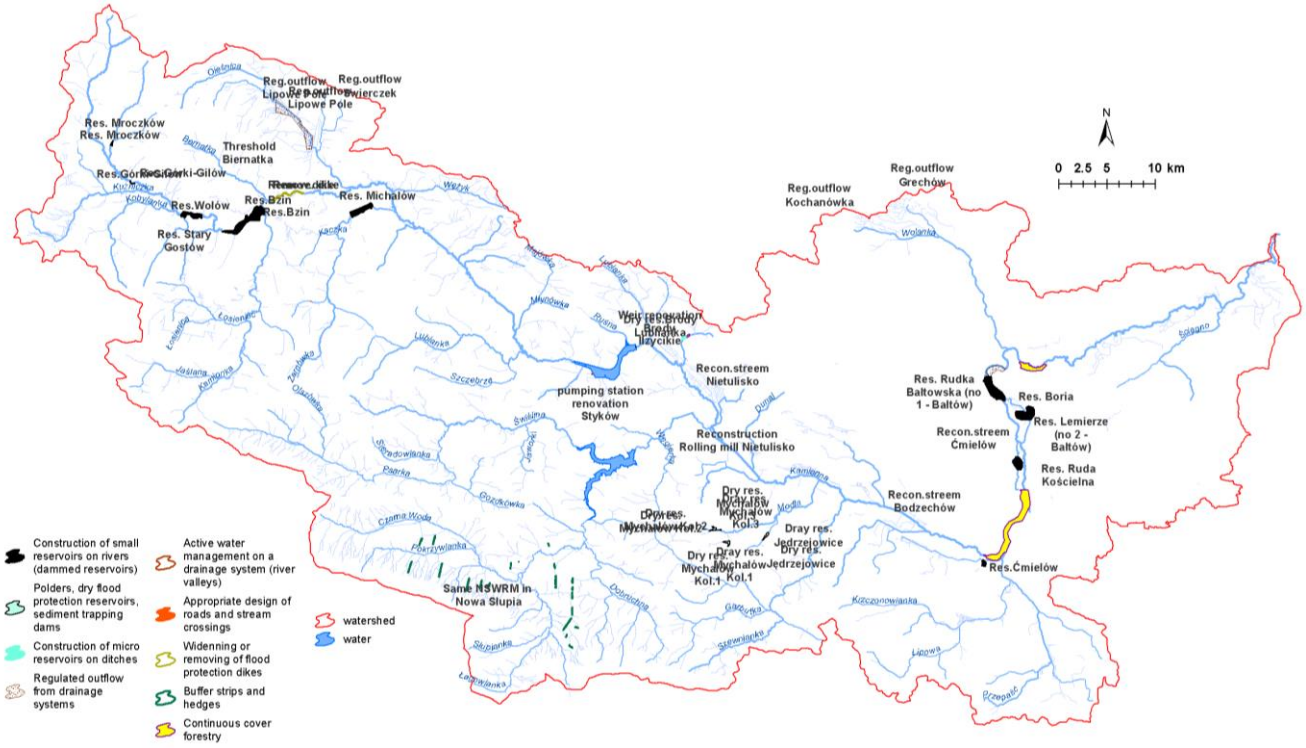

Fig. 4 Map of measures selected in the local preferences variant

4.3 Reducing the number of SPUs variant

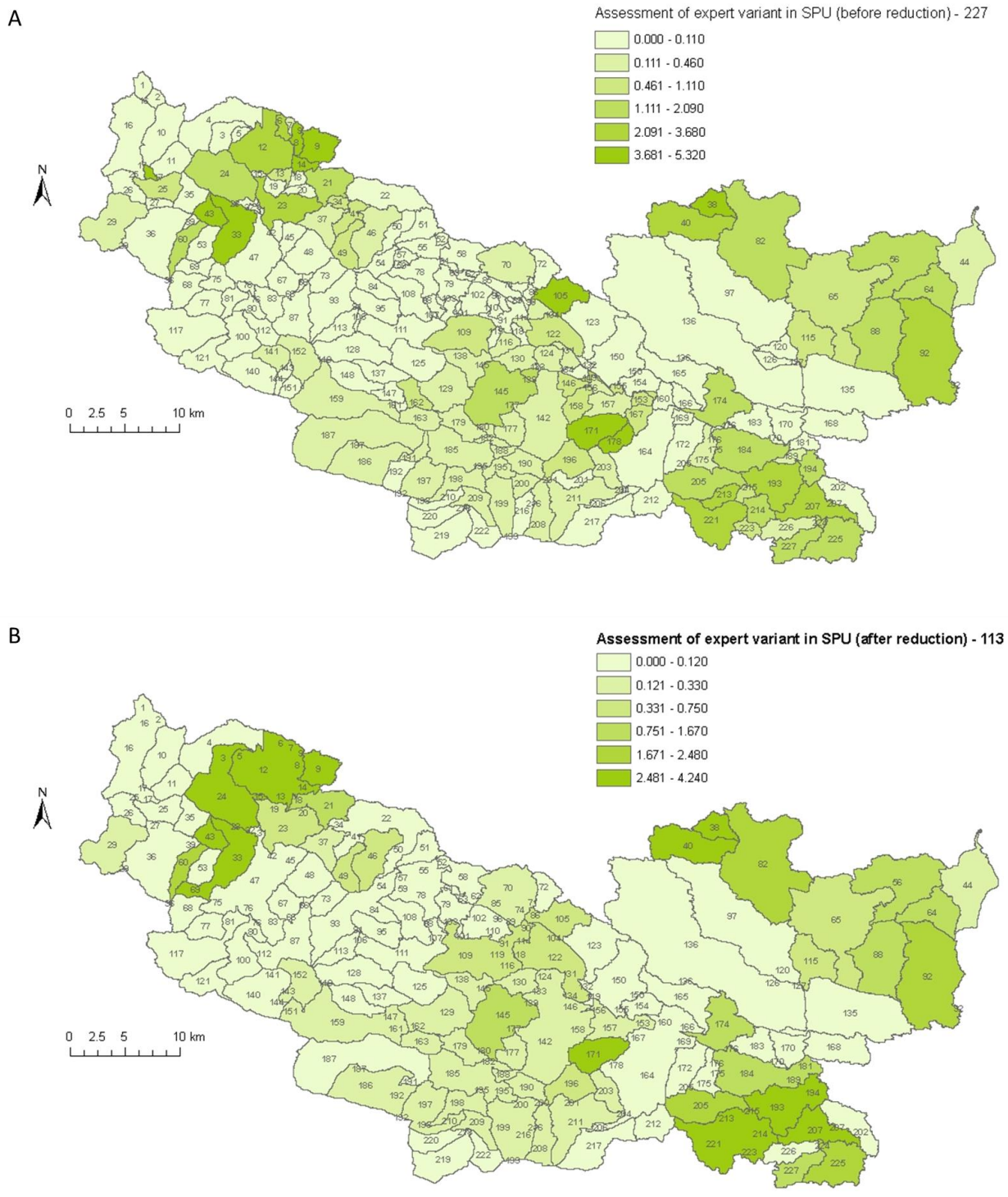

Fig. 5 Map of SPU – a) basin for 227 SPU, b) after reduction to SPU 113 – expert variant.

Tab. 11 Assessment of the effectiveness of the local variant after reducing the number of SPUs

Number of measures	7			Grading of the Program of Small Water Retention Measures							
Number of SPUs	113		Measure No.	1	2	3	4	5	6	7	Catchment grade for current variant
		Grade for a measure (total by SPUs):		0.81	0.00	0.00	3.13	3.86	0.00	20.42	0.47
No.	SPU Id	SPU name	Measure Id by User	A02	F06	F08	BPDA	T1	T2	T3	SPU grades
			F_SPU [km^2]	km/km2	-	km2/km2	km2/km2	km2/km2	km2/km2	m3/m3	
5	12	Sub12	20.55				2.61				2.61
11	25	Sub25	7.63							0.04	0.04
14	33	Sub33	15.80							3.46	3.46
17	37	Sub37	8.41							4.79	4.79
29	60	Sub60	6.38							2.07	2.07
46	97	Sub97	51.96				0.42			1.30	1.72
49	105	Sub105	10.55		0.00		0.09				0.09
54	115	Sub115	13.61							0.43	0.43
64	136	Sub136	113.01		0.00					3.56	3.56
81	171	Sub171	11.98					3.86			3.86
88	184	Sub184	19.48		0.00					4.76	4.76
89	185	Sub185	16.80	0.11							0.11
90	186	Sub186	18.65	0.09							0.09
91	187	Sub187	36.79	0.03							0.03
95	197	Sub197	11.20	0.14							0.14
96	198	Sub198	8.47	0.17							0.17
103	209	Sub209	6.47	0.26							0.26

Tab. 12 Assessment of the effectiveness of the expert variant after reducing the number of SPUs

Number of measures	11			Grading of the Program of Small Water Retention Measures											
Number of SPUs	113		Measure No.	1	2	3	4	5	6	7	8	9	10	11	Catchment grade for current variant
		Grade for a measure (total by SPUs):		22.32	10.85	1.70	0.00	1.91	4.99	0.07	13.45	3.86	0.00	8.66	0.69
No.	SPU Id	SPU name	Measure Id by User	A02	WRAL	F01	F08	F14	ER	N06	BPDA	T1	T2	T3	SPU grades
			F_SPU [km^2]	km/km2	km2/km2	km/km	km2/km2	km/km	km2/km2	km/km	km2/km2	km2/km2	km2/km2	m3/m3	
2	9	Sub9	8.55								3.85				3.85
5	12	Sub12	20.55					0.25			2.65				2.90
7	21	Sub21	9.99					0.03	1.16						1.20
9	23	Sub23	13.76						0.60						0.60
10	24	Sub24	21.27											3.12	3.12
11	25	Sub25	7.63											0.04	0.04
13	29	Sub29	18.00					0.33							0.33
14	33	Sub33	15.80											3.46	3.46
17	37	Sub37	8.41						0.27						0.27
18	38	Sub38	6.64	0.01							3.82				3.83
19	40	Sub40	19.28	0.01		0.07					2.85				2.93
20	44	Sub44	23.26	0.19											0.19
21	46	Sub46	13.95			0.03		0.01	0.42						0.46
24	49	Sub49	6.90						0.75						0.75
27	56	Sub56	30.53	1.17											1.17
29	60	Sub60	6.38											1.98	1.98
30	64	Sub64	13.82	1.67											1.67
31	65	Sub65	49.60	0.66											0.66
34	70	Sub70	15.39					0.17							0.17
35	72	Sub72	5.98			0.02									0.02
40	82	Sub82	54.78	2.03					0.01						2.04
42	88	Sub88	26.08	1.62											1.62
43	92	Sub92	45.67	2.48											2.48
46	97	Sub97	51.96	0.05											0.05
47	100	Sub100	10.72	0.11											0.11
49	105	Sub105	10.55					0.57						0.07	0.64
50	108	Sub108	10.55			0.02									0.02
51	109	Sub109	15.97	0.16				0.33							0.49
54	115	Sub115	13.61	0.69											0.69
55	117	Sub117	21.45			0.04									0.04
57	122	Sub122	12.00						0.48						0.48
59	125	Sub125	12.71	0.02	0.01	0.03									0.06
60	128	Sub128	14.16		0.00	0.01									0.01
61	129	Sub129	13.90	0.23	0.00	0.02					0.03				0.28
62	130	Sub130	6.46	0.32											0.32
63	135	Sub135	40.80	0.01											0.01
64	136	Sub136	113.01							0.07					0.07
65	137	Sub137	6.85	0.01		0.04									0.05
66	138	Sub138	8.44	0.18		0.02					0.01				0.21
68	142	Sub142	26.53	0.23		0.05									0.27
69	145	Sub145	24.22	1.00	0.01	0.56					0.00				1.57
70	148	Sub148	8.52	0.10	0.01										0.11

71	150	Sub150	20.83			0.04		0.07							**0.11**
72	152	Sub152	9.85	0.23											**0.23**
73	154	Sub154	6.00	0.02		0.05									**0.06**
74	157	Sub157	7.52	0.23	0.01	0.09									**0.33**
75	159	Sub159	25.61	0.15	0.00										**0.15**
76	163	Sub163	5.99	0.20											**0.20**
77	164	Sub164	26.06	0.01	0.01										**0.02**
80	170	Sub170	8.00		0.01										**0.01**
81	171	Sub171	11.98	0.38	0.01							3.86			**4.24**
82	172	Sub172	11.21	0.03		0.05									**0.08**
83	174	Sub174	15.88						1.29						**1.29**
84	175	Sub175	6.43	0.07	0.02	0.03									**0.12**
85	177	Sub177	6.64	0.23											**0.23**
86	179	Sub179	7.66	0.23	0.00										**0.24**
88	184	Sub184	19.48	0.28	0.89										**1.16**
89	185	Sub185	16.80	0.20	0.01			0.02			0.01				**0.24**
90	186	Sub186	18.65	0.09							0.06				**0.15**
91	187	Sub187	36.79	0.12							0.00				**0.12**
92	190	Sub190	6.15	0.25											**0.25**
93	193	Sub193	16.45	0.59	2.33	0.01									**2.93**
94	196	Sub196	10.30	0.66		0.04									**0.69**
95	197	Sub197	11.20	0.14				0.04			0.08				**0.25**
96	198	Sub198	8.47	0.17				0.02			0.01				**0.20**
97	199	Sub199	10.91	0.14											**0.14**
98	202	Sub202	11.63	0.03	0.02	0.06									**0.10**
99	203	Sub203	6.53	0.31	0.01										**0.32**
100	205	Sub205	15.99	0.88	1.15	0.06									**2.09**
101	207	Sub207	13.45	1.17	2.51										**3.68**
102	208	Sub208	9.55	0.14		0.02									**0.15**
103	209	Sub209	6.47	0.26							0.06				**0.32**
104	211	Sub211	16.55	0.12		0.11									**0.22**
107	219	Sub219	14.57					0.05			0.01				**0.06**
109	221	Sub221	17.46	1.21	1.64	0.04									**2.89**
111	225	Sub225	15.48	0.57	1.06	0.18									**1.82**
112	226	Sub226	7.23	0.07	0.05										**0.12**
113	227	Sub227	8.18	0.22	1.10										**1.31**

4.4 Comparison of variants

The differences between variants result mainly from the spatial distribution, structure and number of planned measures. The expert variant is characterized by a large number of diverse measures spread over a vast area (15 types and 11 groups of measures spread over 128 SPUs). On the contrary, the local variant contains only 9 types and 7 groups of measures placed in 33 SPUs. Despite these large differences, the assessment ratio of the final score of the expert to local variant is only 1.45 (0.71 / 0.49). Larger differences are noticeable after comparing the spatial distribution, which is shown in Fig. 5 as a difference between local and expert variants. The map shows that the local variant dominates in only 10 out of 128 SPU.

Calculations were also made for the reduced number of SPUs (the number was reduced by half, eliminating smaller units by including them in larger ones). As a result, the number of SPUs decreased from 227 to 113 (chapter 4.3). It is worth emphasizing that the surface of the SPU does not have a big impact on the result (the final grade has slightly decreased).

Additionally, by carrying out a visual comparison of both variants (Fig. 6) and the valorization map from FroGIS, it can be concluded that introducing the expert variant will reduce the need for water

retention in particularly sensitive areas. On the other hand, in the local variant, in most cases, it would improve areas with low water retention needs.

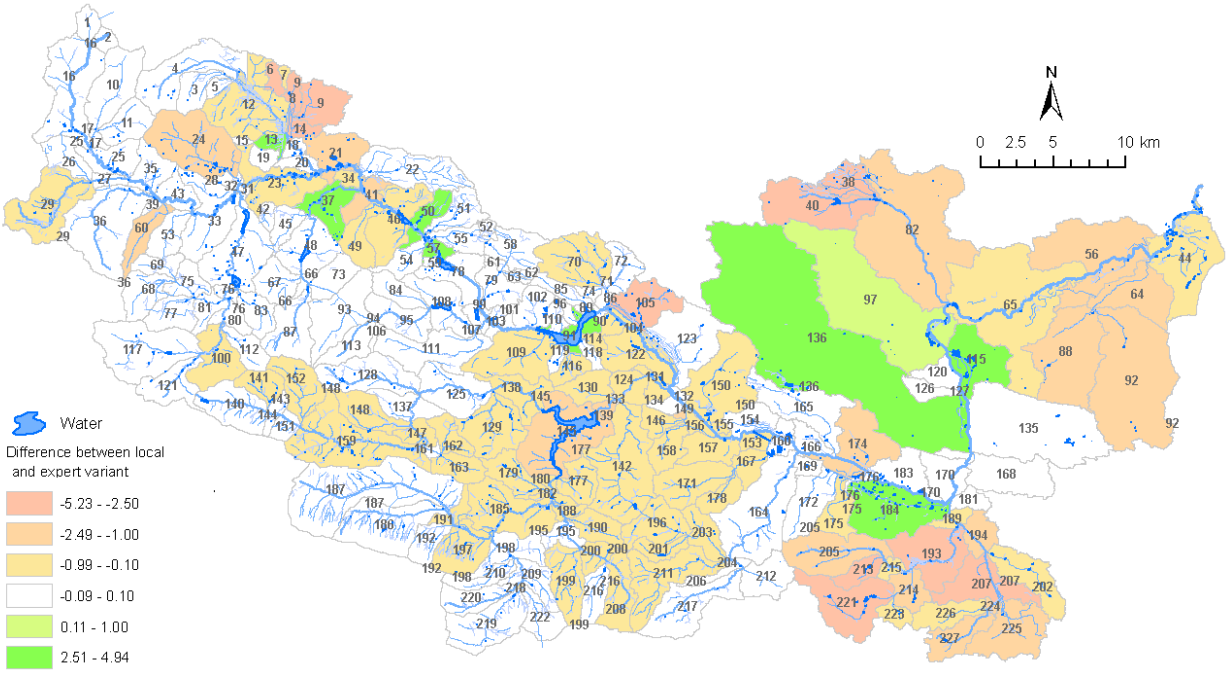

Fig. 6 Map of differences between local and expert variant (green color shows dominance of local variant and red shows the opposite)

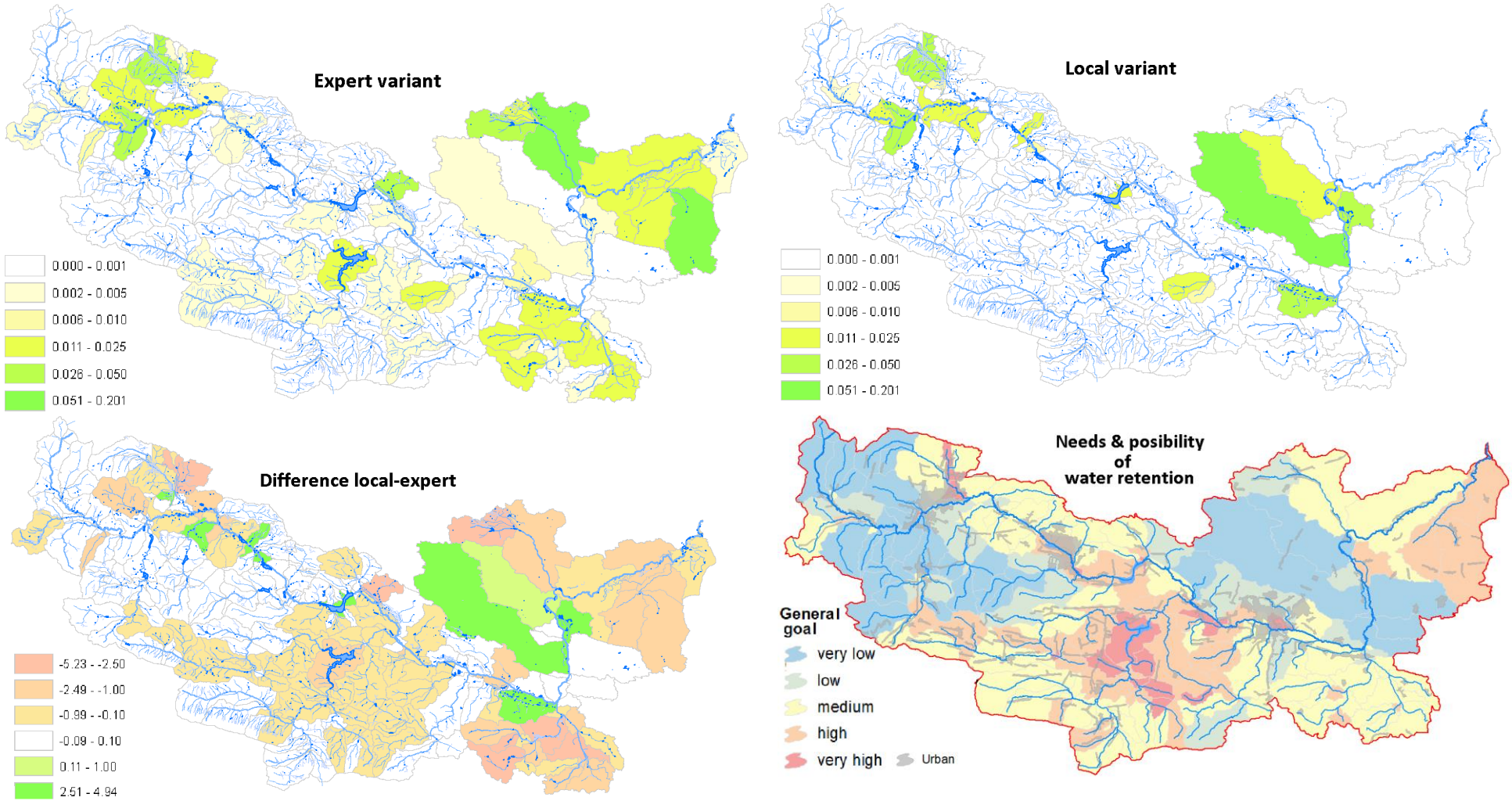

Fig. 6 Visual comparison of variants' assessments with the map of valorisation of needs and water retention possibilities

5. CONCLUSIONS

- The tool is easy to use, however, preparing intensity for T1 polders, increasing the spaces between dikes T2 and reservoirs T3 is labour intensive and requires detailed data,
- Each new catchment requires verification / adjustment of parameters so that the intensity of planned measures does not exceed Tmax, which affects the final results,
- The catchment grade value is not highly influenced by the SPU surface area, however, its number is affected by the number of SPUs that have obtained grade 0,
- When comparing variants, use the same SPU layer so that the results correspond with each other,
- The tool cannot replace modelling or designing;
- It is recommended to compare the effectiveness assessment map with the map of needs and possibilities of small water retention development, because it allows to additionally assess whether measures are planned where they are needed,
- StaticTool.xlsm is a good solution to enable the estimation of the effects of the implementation of a program of natural, small water retention measures (PoNSWRM) in a simplified way, which does not require the time-consuming and costly development of detailed hydrological or/and hydraulic models of the analysed area (catchment).

6. REFERENCES

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