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

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Pilot Catchment Bednja

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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 models, hydrological or / and hydraulic, of the analysed catchment. This estimate is a grading, based on expert knowledge and is used to compare variants of the NSWRM program.

The potential effects of individual N(S)WRM 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,
- estimation of 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) the 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 of 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 make 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 Bednja.

2. DESCRIPTION OF INPUT DATA PREPARATION

In the first step, during working with the StaticTool program, it was necessary to specify/select the N(S)WRM type, for which calculations will be carried out. The table below (Table 1.) shows the types of measures implemented in the program.

Table 1. The measures in the expert variant for the Bednja catchment.

No NSWRM	Variant	Type of NSWRM	Parameters	Count of NSWRM	Area [km2]
F02	Exp	Maintenance of forest cover in headwater areas	Maintaining the forest cover	24	43
N07	Exp.	Reconnection of oxbow lakes and similar features	Reconnection and restoration of former oxbow	3	2
T1	Exp.	Polders, dry flood protection reservoirs, sediment trapping dams	Protection of natural retention areas	8	14
T2	Exp.	Widening or removing of flood protection dikes	Increasing the spaces between dikes	4	8

At the initial stage, individual N(S)WRMs were merged under one (of the same) type and then aggregation was performed. Aggregated measures include a group of measures whose implementation in a similar way improves the retention properties of the catchment area, and assessment of the effects of individual activities, without detailed field or model studies at the current level of knowledge, is not possible.

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 (Table 2.).

Table 2. The estimation of the intensity level – expert variant.

No	Code	T0	Tlow	Thigh	Tmax
1	F02	0	0,1	0,4	1
2	N07	0	0,1	0,4	1
3	T1	0	0,05	0,2	1
4	T2	0	0,05	0,2	1

After initial stage there followed an assessment of the impact of measures type on three elements of the catchment retention with maximum intensity of measure's application.

The tables below show the parameters used for the calculations (Table 3. and Table 4.)

Table 3. The assessment of the impact of measures.

(*Note: 0 means no positive impact and 5 very high positive impact)*

No	Code	Aggregated measure name	Low flows	High flows	Qual Erosion	AVG
1	KF	Keeping forests	1	2	4	2,33
2	ER	Ecosystems Restoration / renaturisation of water dependent ecosystems	0	5	4	3,00
3	T1	Polders, dry flood protection reservoirs, sediment trapping dams	0	5	3	2,67
4	T2	Widening or removing of flood protection dikes	0	3	3	2,00

Table 4. List of parameters for measures in expert variant.

			Intensity thresholds					Grade thresholds [%]				Grade values			
No	Measure ID	Aggregated English	T0	Tlow	Thigh	Tmax	Grade_max	E%0	E%low	E%high	E%max	E0	Elow	Ehigh	Emax
1	KF	KF - Keeping forests	0,00	0,10	0,40	1,00	4	0	60	95	100	0,00	2,40	3,80	4,00
2	ER	ER - Ecosystems Restoration / renaturisation of water dependent ecosystems	0,00	0,10	0,40	1,00	5	0	60	95	100	0,00	3,00	4,75	5,00
3	T1	Polders, dry flood protection reservoirs, sediment trapping dams	0,00	0,05	0,20	1,00	5	0	60	95	100	0,00	3,00	4,75	5,00
4	T2	Widening or removing of flood protection dikes	0,00	0,05	0,20	1,00	4	0	60	95	100	0,00	2,40	3,80	4,00

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, there was provided their intensity, with the value 0 meaning no measure in the given SPU, and 1 – planning the measure with the maximum possible intensity.

The tables below show the parameters used for calculations for aggregated expert variant (Tab. 5-Tab.6).

Table 5. The assessment of the impact of 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) – aggregated

No	Code	Name of the measure type	Low flows	High flows	Qual Erosion	AVG
1	T	Technical measures	0	4	1	1,67
2	N	Natural measures	0	3	1	1,33

Table 6. List of parameters for measures in aggregated expert variant.

AggregN	2			Intensity thresholds					Grade thresholds [%]				Grade values			
7	No	Measure ID	Aggregated English	T0	Tlow	Thigh	Tmax	Grade_max	E%0	E%low	E%high	E%max	E0	Elow	Ehigh	Emax
2	1	T	Technical	0,00	0,03	0,08	0,12	5	0	25	67	100	0,00	1,25	3,33	5,00
1	2	N	Natural	0,00	0,02	0,05	0,06	4	0	33	83	100	0,00	1,33	3,33	4,00

3. DESCRIPTION OF RESULTS

3.1 For the expert variant

The results of the assessment were obtained from the StaticAssessment tab. 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 keeping forest (KF = 90,63) and Polders, dry flood protection reservoirs, sediment trapping dams (T1 = 39,03). 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 Table 7. and Figure 1. The greatest impact on the final assessment had SPU 03 and 05 which are characterized by a proposed T1 measures.

Spatial measures distribution is shown on Figure 1.

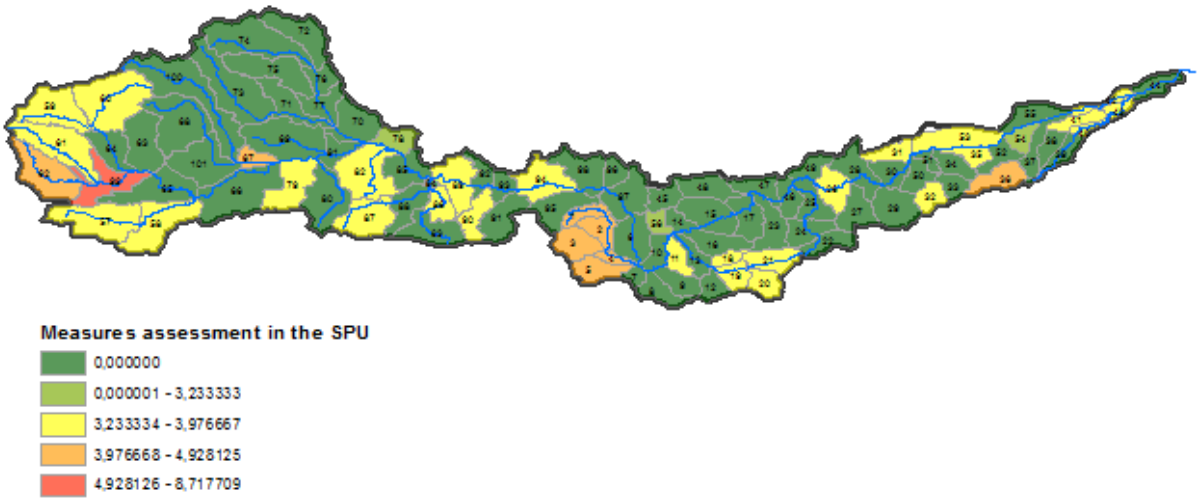

Figure 1. Map of measures assessment at the SPU level.

Table 7. Assessment of the effectiveness of expert variant.

Number of measures	4			Grading of the Program of Small Water Retention Measures					
Number of SPUs	101		Measure No.	1	2	3	4	Catchment grade for current variant	SPU grades *F_SPU/ Sum_F_ SPU
Grade for a measure (total by SPUs):				90,63	11,10	39,03	15,68	1,52	
No.	SPU Id	SPU name	Measure Id by User	KF	ER	T1	T2	SPU grades	
			F_SPU [km^2]	km2/km2	km2/km2	km2/km2	km2/km2		
1	SPU_01	SPU_01	2,97			4,83		4,83	14,3
2	SPU_02	SPU_02	3,86			4,85		4,85	18,8
3	SPU_03	SPU_03	5,60			4,86		4,86	27,2
4	SPU_04	SPU_04	1,63			4,93		4,93	8,0
5	SPU_05	SPU_05	5,10			4,92		4,92	25,1
6	SPU_06	SPU_06	8,33					0,00	0,000
7	SPU_07	SPU_07	1,52					0,00	0,000
8	SPU_08	SPU_08	4,31					0,00	0,000
9	SPU_09	SPU_09	4,04					0,00	0,000
10	SPU_10	SPU_10	3,05					0,00	0,000
11	SPU_11	SPU_11	3,22	3,52				3,52	0,019
12	SPU_12	SPU_12	3,13					0,00	0,000
13	SPU_13	SPU_13	3,68					0,00	0,000
14	SPU_14	SPU_14	2,27					0,00	0,000
15	SPU_15	SPU_15	7,80					0,00	0,000
16	SPU_16	SPU_16	5,36					0,00	0,000
17	SPU_17	SPU_17	5,53					0,00	0,000
18	SPU_18	SPU_18	1,78	3,91				3,91	0,012
19	SPU_19	SPU_19	3,62	3,94				3,94	0,024
20	SPU_20	SPU_20	3,90	3,89				3,89	0,026
21	SPU_21	SPU_21	5,30	3,90				3,90	0,035
22	SPU_22	SPU_22	4,21					0,00	0,000
23	SPU_23	SPU_23	5,84					0,00	0,000
24	SPU_24	SPU_24	4,63					0,00	0,000
25	SPU_25	SPU_25	5,03					0,00	0,000
26	SPU_26	SPU_26	5,23	3,82				3,82	0,034
27	SPU_27	SPU_27	5,53					0,00	0,000
28	SPU_28	SPU_28	6,49					0,00	0,000
29	SPU_29	SPU_29	7,29					0,00	0,000
30	SPU_30	SPU_30	3,89					0,00	0,000
31	SPU_31	SPU_31	3,69	3,66				3,66	0,023
32	SPU_32	SPU_32	3,47	3,98				3,98	0,024
33	SPU_33	SPU_33	2,91					0,00	0,000
34	SPU_34	SPU_34	3,62					0,00	0,000
35	SPU_35	SPU_35	2,89	3,81				3,81	0,019
36	SPU_36	SPU_36	5,48		4,40			4,40	0,041
37	SPU_37	SPU_37	4,07					0,00	0,000
38	SPU_38	SPU_38	2,85					0,00	0,000
39	SPU_39	SPU_39	3,56					0,00	0,000
40	SPU_40	SPU_40	1,55				3,96	3,96	0,011
41	SPU_41	SPU_41	2,83				3,88	3,88	0,019
42	SPU_42	SPU_42	2,21				3,96	3,96	0,015

Table 7. Assessment of the effectiveness of expert variant – continued.

Number of measures	4			Grading of the Program of Small Water Retention Measures					
Number of SPUs	101		Measure No.	1	2	3	4	Catchment grade for current variant	SPU grades *F_SPU/ Sum_F_ SPU
		Grade for a measure (total by SPUs):		90,63	11,10	39,03	15,68	1,52	
No.	SPU Id	SPU name	Measure Id by User	KF	ER	T1	T2	SPU grades	
			F_SPU [km^2]	km2/km2	km2/km2	km2/km2	km2/km2		
43	SPU_43	SPU_43	1,91				3,88	3,88	0,013
44	SPU_44	SPU_44	3,72					0,00	0,000
45	SPU_45	SPU_45	3,62					0,00	0,000
46	SPU_46	SPU_46	3,81					0,00	0,000
47	SPU_47	SPU_47	4,06					0,00	0,000
48	SPU_48	SPU_48	5,71					0,00	0,000
49	SPU_49	SPU_49	3,37					0,00	0,000
50	SPU_50	SPU_50	3,76					0,00	0,000
51	SPU_51	SPU_51	1,42					0,00	0,000
52	SPU_52	SPU_52	3,46					0,00	0,000
53	SPU_53	SPU_53	7,87		3,47			3,47	0,047
54	SPU_54	SPU_54	2,80		3,23			3,23	0,015
55	SPU_55	SPU_55	4,94					0,00	0,000
56	SPU_56	SPU_56	2,17	3,19				3,19	0,012
57	SPU_57	SPU_57	12,50	3,94				3,94	0,084
58	SPU_58	SPU_58	11,41	3,91				3,91	0,076
59	SPU_59	SPU_59	10,45	3,96				3,96	0,071
60	SPU_60	SPU_60	15,70	3,90				3,90	0,105
61	SPU_61	SPU_61	12,13	3,91				3,91	0,081
62	SPU_62	SPU_62	11,22			4,91		4,91	0,094
63	SPU_63	SPU_63	8,94					0,00	0,000
64	SPU_64	SPU_64	5,87					0,00	0,000
65	SPU_65	SPU_65	9,80					0,00	0,000
66	SPU_66	SPU_66	14,78					0,00	0,000
67	SPU_67	SPU_67	2,70			4,84		4,84	0,022
68	SPU_68	SPU_68	13,08					0,00	0,000
69	SPU_69	SPU_69	13,04					0,00	0,000
70	SPU_70	SPU_70	7,74					0,00	0,000
71	SPU_71	SPU_71	6,56					0,00	0,000
72	SPU_72	SPU_72	8,33					0,00	0,000
73	SPU_73	SPU_73	15,37					0,00	0,000
74	SPU_74	SPU_74	14,29					0,00	0,000
75	SPU_75	SPU_75	9,64					0,00	0,000
76	SPU_76	SPU_76	3,57					0,00	0,000
77	SPU_77	SPU_77	4,80					0,00	0,000
78	SPU_78	SPU_78	4,02	2,54				2,54	0,017
79	SPU_79	SPU_79	8,47	3,81				3,81	0,055
80	SPU_80	SPU_80	10,28					0,00	0,000
81	SPU_81	SPU_81	3,50					0,00	0,000
82	SPU_82	SPU_82	11,56	3,71				3,71	0,073
83	SPU_83	SPU_83	7,18					0,00	0,000
84	SPU_84	SPU_84	0,51					0,00	0,000

Number of measures	4			Grading of the Program of Small Water Retention Measures					
Number of SPUs	101		Measure No.	1	2	3	4	Catchment grade for current variant	SPU grades *F_SPU/ Sum_F_ SPU
		Grade for a measure (total by SPUs):		90,63	11,10	39,03	15,68	1,52	
No.	SPU Id	SPU name	Measure Id by User	KF	ER	T1	T2	SPU grades	
			F_SPU [km^2]	km2/km2	km2/km2	km2/km2	km2/km2		
85	SPU_85	SPU_85	6,19					0,00	0,000
86	SPU_86	SPU_86	3,79	3,92				3,92	0,025
87	SPU_87	SPU_87	8,63	3,95				3,95	0,058
88	SPU_88	SPU_88	5,75					0,00	0,000
89	SPU_89	SPU_89	7,72	3,89				3,89	0,051
90	SPU_90	SPU_90	4,74	3,84				3,84	0,031
91	SPU_91	SPU_91	7,00					0,00	0,000
92	SPU_92	SPU_92	3,38					0,00	0,000
93	SPU_93	SPU_93	2,83					0,00	0,000
94	SPU_94	SPU_94	8,39	3,91				3,91	0,056
95	SPU_95	SPU_95	6,70					0,00	0,000
96	SPU_96	SPU_96	2,90					0,00	0,000
97	SPU_97	SPU_97	7,93					0,00	0,000
98	SPU_98	SPU_98	7,53					0,00	0,000
99	SPU_99	SPU_99	8,34	3,83		4,88		8,72	0,124
100	SPU_100	SPU_100	18,52					0,00	0,000
101	SPU_101	SPU_101	10,32					0,00	0,000

3.2 For the variant of aggregated expert measures

In this variant, we aggregated all the measures defined in expert variant into two groups, that is natural (marked as N) and technical (marked as T) measures and recalculated in the spreadsheet. We found out, that in this case natural measures have a bigger impact on the final score (N=95,12) and technical measures had much lower overall impact (T=24,41).

The results are shown in Table 8. and Figure 2. The greatest impact on the final assessment had SPU 03 and 05 which are characterized by a proposed T1 measures.

Spatial measures distribution is shown on Figure 2.

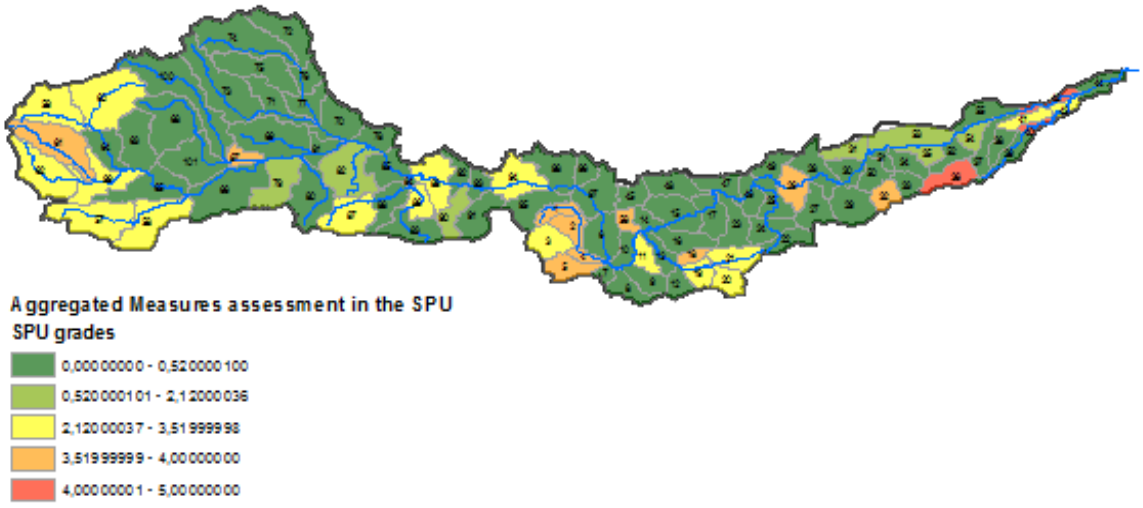

Figure 2. Map of aggregated measures assessment at the SPU level.

Table 8. Assessment of the effectiveness of aggregated variant.

Number of measures	2			Grading of the Program of Small Water Rete		
Number of SPUs	101		Measure No.	1	2	Catchment grade for current variant
		Grade for a measure (total by SPUs):		24,41	95,12	1,09
No.	SPU Id	SPU name	Measure Id by User	T	N	SPU grades
			F_SPU [km^2]	km2/km2	km/km2	
1	SPU_01	SPU_01	2,97		4,00	4,00
2	SPU_02	SPU_02	3,86		4,00	4,00
3	SPU_03	SPU_03	5,60		3,33	3,33
4	SPU_04	SPU_04	1,63		4,00	4,00
5	SPU_05	SPU_05	5,10		4,00	4,00
6	SPU_06	SPU_06	8,33			0,00
7	SPU_07	SPU_07	1,52			0,00
8	SPU_08	SPU_08	4,31			0,00
9	SPU_09	SPU_09	4,04			0,00
10	SPU_10	SPU_10	3,05			0,00
11	SPU_11	SPU_11	3,22		3,33	3,33
12	SPU_12	SPU_12	3,13			0,00
13	SPU_13	SPU_13	3,68			0,00
14	SPU_14	SPU_14	2,27			0,00
15	SPU_15	SPU_15	7,80			0,00
16	SPU_16	SPU_16	5,36			0,00
17	SPU_17	SPU_17	5,53			0,00
18	SPU_18	SPU_18	1,78		4,00	4,00
19	SPU_19	SPU_19	3,62		3,28	3,28
20	SPU_20	SPU_20	3,90		2,64	2,64
21	SPU_21	SPU_21	5,30		2,84	2,84
22	SPU_22	SPU_22	4,21			0,00
23	SPU_23	SPU_23	5,84			0,00
24	SPU_24	SPU_24	4,63			0,00
25	SPU_25	SPU_25	5,03			0,00
26	SPU_26	SPU_26	5,23		4,00	4,00
27	SPU_27	SPU_27	5,53			0,00
28	SPU_28	SPU_28	6,49			0,00
29	SPU_29	SPU_29	7,29			0,00
30	SPU_30	SPU_30	3,89			0,00
31	SPU_31	SPU_31	3,69		1,48	1,48
32	SPU_32	SPU_32	3,47		4,00	4,00
33	SPU_33	SPU_33	2,91			0,00
34	SPU_34	SPU_34	3,62			0,00
35	SPU_35	SPU_35	2,89		1,68	1,68
36	SPU_36	SPU_36	5,48	5,00		5,00
37	SPU_37	SPU_37	4,07			0,00
38	SPU_38	SPU_38	2,85			0,00
39	SPU_39	SPU_39	3,56			0,00
40	SPU_40	SPU_40	1,55	5,00		5,00
41	SPU_41	SPU_41	2,83	3,33		3,33
42	SPU_42	SPU_42	2,21	4,99		4,99
43	SPU_43	SPU_43	1,91	2,94		2,94
44	SPU_44	SPU_44	3,72			0,00
45	SPU_45	SPU_45	3,62			0,00
46	SPU_46	SPU_46	3,81			0,00
47	SPU_47	SPU_47	4,06			0,00
48	SPU_48	SPU_48	5,71			0,00
49	SPU_49	SPU_49	3,37			0,00
50	SPU_50	SPU_50	3,76			0,00
51	SPU_51	SPU_51	1,42			0,00

Table 8. Assessment of the effectiveness of aggregated variant - continued.

Number of measures	2			Grading of the Program of Small Water Rete		
Number of SPUs	101		Measure No.	1	2	Catchment grade for current variant
		Grade for a measure (total by SPUs):		24,41	95,12	1,09
No.	SPU Id	SPU name	Measure Id by User	T	N	SPU grades
			F_SPU [km^2]	km2/km2	km/km2	
52	SPU_52	SPU_52	3,46			0,00
53	SPU_53	SPU_53	7,87	1,06		1,06
54	SPU_54	SPU_54	2,80	2,08		2,08
55	SPU_55	SPU_55	4,94			0,00
56	SPU_56	SPU_56	2,17		4,00	4,00
57	SPU_57	SPU_57	12,50		3,24	3,24
58	SPU_58	SPU_58	11,41		2,92	2,92
59	SPU_59	SPU_59	10,45		3,52	3,52
60	SPU_60	SPU_60	15,70		2,76	2,76
61	SPU_61	SPU_61	12,13		4,00	4,00
62	SPU_62	SPU_62	11,22		2,84	2,84
63	SPU_63	SPU_63	8,94			0,00
64	SPU_64	SPU_64	5,87			0,00
65	SPU_65	SPU_65	9,80			0,00
66	SPU_66	SPU_66	14,78			0,00
67	SPU_67	SPU_67	2,70		4,00	4,00
68	SPU_68	SPU_68	13,08			0,00
69	SPU_69	SPU_69	13,04			0,00
70	SPU_70	SPU_70	7,74			0,00
71	SPU_71	SPU_71	6,56			0,00
72	SPU_72	SPU_72	8,33			0,00
73	SPU_73	SPU_73	15,37			0,00
74	SPU_74	SPU_74	14,29			0,00
75	SPU_75	SPU_75	9,64			0,00
76	SPU_76	SPU_76	3,57			0,00
77	SPU_77	SPU_77	4,80			0,00
78	SPU_78	SPU_78	4,02		0,52	0,52
79	SPU_79	SPU_79	8,47		1,72	1,72
80	SPU_80	SPU_80	10,28			0,00
81	SPU_81	SPU_81	3,50			0,00
82	SPU_82	SPU_82	11,56		1,52	1,52
83	SPU_83	SPU_83	7,18			0,00
84	SPU_84	SPU_84	0,51			0,00
85	SPU_85	SPU_85	6,19			0,00
86	SPU_86	SPU_86	3,79		3,08	3,08
87	SPU_87	SPU_87	8,63		3,36	3,36
88	SPU_88	SPU_88	5,75			0,00
89	SPU_89	SPU_89	7,72		2,64	2,64
90	SPU_90	SPU_90	4,74		2,12	2,12
91	SPU_91	SPU_91	7,00			0,00
92	SPU_92	SPU_92	3,38			0,00
93	SPU_93	SPU_93	2,83			0,00
94	SPU_94	SPU_94	8,39		2,96	2,96
95	SPU_95	SPU_95	6,70			0,00
96	SPU_96	SPU_96	2,90			0,00
97	SPU_97	SPU_97	7,93			0,00
98	SPU_98	SPU_98	7,53			0,00
99	SPU_99	SPU_99	8,34		3,33	3,33
100	SPU_100	SPU_100	18,52			0,00
101	SPU_101	SPU_101	10,32			0,00

3.3 Comparison of the variants

From the comparison (Tab 9) we can see that both variants somewhat differ, results show that the bigger impact on Bednja cathment come from Natural measures than Technical measures.

These results show that the static tool responds to different inputs in the right way and gives consistent outputs which leeds us to conclude that the tool is robust in it's application.

Tab. 9: Comparison of variants

Variant	Expert variant	Catchment grade for expert variant	Aggregated expert measures	Catchment grade for aggregated variant
Technical measures	26,78	0,16	24,41	0,12
Natural measures	129,66	1,36	95,12	0,97

4. CONCLUSIONS

- 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 than it is possible 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).
- Tool results depend on the quality of data input, but it gives consistent results for right inputs.

5. REFERENCES

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