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

D.T2.2.2

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Pilot Catchment Kamniska Bistrica
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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 implementation effects 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.

On Kamniška Bistrica we have developed one variant, which is based on local inputs together with expert opinion. Therefore, we tested static tool with one variant, but in two ways:

- Expert variant (each measure separately);
- Aggregated expert measures (natural and technical measures).

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,
- 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 possibilities, 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 Kamniška Bistrica.

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 (Tab. 1) shows the types of measures implemented in the program.

Tab. 1 The measures in the expert variant for the Kamniška Bistrica catchment.

No NSWRM	Variant	Type NSWRM	Parameters	Count of NSWRM	Unit
F09	Exp.	Sediment capture ponds	Erosion control measures.	2	-
N12	Exp.	Lake restoration	Renaturation of existing or abandoned ponds, wetlands, etc…	7	0,4 mio m^3
T1	Exp.	Polders, dry flood protection reservoirs, sediment trapping dams	Protection of natural retention areas	4	1,2 mio m^3
T3	Exp.	Construction of small reservoirs on rivers (dammed reservoirs)	Dam retentios.	13	4,6 mio m^3
RR	Exp.	River regulation	Measures are to be rather conservative – river bed slope regulation, bridge openings optimizations, stream stabilizations, etc.	5	12,4 km
FDC	Exp.	Flood diversion channels	Primarily meant for carrying excess flood water.	15	0,28 mio m^3
EFR	Exp.	Earth fill removal	Removing excessive amount of earth fill.	1	-
CM	Exp.	Complex measures	Measures include levees and road heightening - these two measures could lead to increased water retention, and culverts which do not have significant impact on water retention. All of these measures are primarily meant to increase infrastructure flood safety.	14	-
OM	Exp.	Other measures	Periodically bed load removal. None of these measures has got any measurable/significant impact on water retention.	2	-

At the initial stage, individual N(S)WRMs were meant to be merged under one measure type according to impact they have on retention properties of the catchment. Measures on Kamniška Bistrica could not be grouped due to their characteristical influence on water retention.

For each measure type 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 (Tab. 2).

Tab. 2 The estimation of the intensity - expert variant.

No	Code	Definition of the intensity criteria	TO	Tlow	Thigh	Tmax	Units
1	F09	9999	0	0	0	0	-
2	N12	Retention volume (mio m3) / Effective Percipitation (mio m3)	0	0,0075	0,0080	0,0086	mio m^3/mio m^3
3	T1	Retention volume (mio m3) / Effective Percipitation (mio m3)	0	0,0215	0,0237	0,0258	mio m^3/mio m^3
4	T3	Retention volume (mio m3) / Effective Percipitation (mio m3)	0	0,0344	0,0753	0,0989	mio m^3/mio m^3
5	RR	9999	0	0	0	0	-
6	FDC	Retention volume (mio m3) / Effective Percipitation (mio m3)	0	0,0002	0,0045	0,0060	mio m^3/mio m^3
7	EFR	9999	0	0	0	0	-
8	CM	9999	0	0	0	0	-
9	OM	9999	0	0	0	0	-

9999 – Measure not applicable.

Followed expert assessments of the impact of measures type on three elements of the catchment retention properties with maximum intensity of measures' application:

- increasing low flows,
- reducing high flows and
- improving water quality or reducing erosion.

The tables below show the parameters used for calculations for expert variant (Tab. 3-Tab.4).

Tab. 3 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) – expert variant.

No	Code	Name of the measure type	Low flows	High flows	Qual Erosion	AVG
1	F09	Sediment capture ponds				
2	N12	Lake restoration	0	1	1	0,67
3	T1	Polders, dry flood protection reservoirs, sediment trapping dams	0	3	2	1,67
4	T3	Construction of small reservoirs on rivers (dammed reservoirs)	0	5	2	2,33
5	RR	River regulation				
6	FDC	Flood diversion channels	0	2	1	1,00
7	EFR	Earth fill removal				
8	CM	Complex measures				
9	OM	Other measures				

9999 – Measure not applicable.

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

Measure ID	Aggregated English	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
F09	Sediment capture ponds	9999	0,00	0,00	0,00	0,00	0	0	0	0	0	0,00	0,00	0,00	0,00
N12	Lake restoration	Retention volume (mio m3) / Effective Percipitation (mio m3)	0,00	0,01	0,01	0,01	2	0	10	40	100	0,00	0,20	0,80	2,00
T1	Polders, dry flood protection reservoi	Retention volume (mio m3) / Effective Percipitation (mio m3)	0,00	0,02	0,02	0,03	4	0	10	40	100	0,00	0,40	1,60	4,00
T3	Construction of small reservoirs on riv	Retention volume (mio m3) / Effective Percipitation (mio m3)	0,00	0,03	0,08	0,10	5	0	35	76	100	0,00	1,74	3,80	5,00
RR	River regulation	9999	0,00	0,00	0,00	0,00	0	0	0	0	0	0,00	0,00	0,00	0,00
FDC	Flood diversion channels	Retention volume (mio m3) / Effective Percipitation (mio m3)	0,00	0,00	0,00	0,01	3	0	60	95	100	0,00	1,80	2,85	3,00
EFR	Earth fill removal	9999	0,00	0,00	0,00	0,00	0	0	0	0	0	0,00	0,00	0,00	0,00
CM	Complex measures	9999	0,00	0,00	0,00	0,00	0	0	0	0	0	0,00	0,00	0,00	0,00
OM	Other measures	9999	0,00	0,00	0,00	0,00	0	0	0	0	0	0,00	0,00	0,00	0,00

9999 – Measure not applicable.

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

Tab. 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 expert variant.

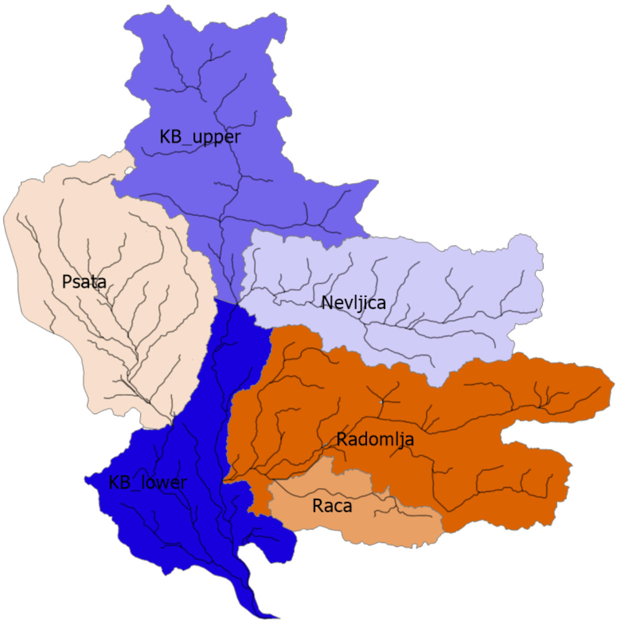
No	Code	Name of the measure type	Low flows	High flows	Qual Erosion	AVG
1	T	Technical measures (F09, T3, RR, FDC, EFR, CM, OM)	0	4	2	2,0
2	N	Natural measures (N12, T1)	0	3	2	1,67

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

AggregN	2	Measure ID	Aggregated English	Definition of the intensity criteria in English	Intensity thresholds				Grade_max	Grade thresholds [%]				Grade values			
No sort_AVG	No				T0	Tlow	Thigh	Tmax		E%0	E%low	E%high	E%max	E0	Elow	Ehigh	Emax
2	1	T	Technical measures	Retention volume (mio m3) / Effective Percipitation (mio m3)	0,00	0,03	0,08	0,10	5	0	33	76	100	0,00	1,65	3,80	5,00
1	2	N	Natural measures	Retention volume (mio m3) / Effective Percipitation (mio m3)	0,00	0,03	0,03	0,03	4	0	10	40	100	0,00	0,40	1,60	4,00

At the end of the process, for each planned measure experts defined measure intensity in accordance with the adopted intensity criteria. Those intensities were primarily meant to be defined according to SPU (spatial planning units) where measures are located. Instead of SPU's we have dicided to divide Kamniška Bistrica catchment to main rivers subcatchments as seen on the next Figure, and use those instead. This is a simplified approach, which should give equally satisfactory results. There are six (6) defined subcatchments, and intensity levels for measures within those 6 sub-basins were determined. Results of these steps are presented in the chapter 3.

Figure 1: Used subcatchments instead of SPU, for the purpose of defining measures intensities



3. DESCRIPTION OF RESULTS

3.1 For the expert variant

The results of the assessment were obtained from the StaticAssessment tab (Tab. 7). This tab contains a table with the cumulative assessment for the entire catchment and partial assessments for each group of measures and for each sub-basin.

Tab. 7 Assessment of the effectiveness of the expert variant

Number of measures	9			Grading of the Program of Small Water Retention Measures								
Number of SPUs	6		Measure No.	1	2	3	4	5	6	7	8	9
			Grade for a measure (total by SPUs):	0,00	0,19	0,50	5,98	0,00	0,00	0,00	0,00	0,00
No.	SPU Id	SPU name	Measure Id by User	F09	N12	T1	T3	RR	FDC	EFR	CM	OM
			F_SPU [km²]	-	mio m3/mio m3	mio m3/mio m3	mio m3/mio m3	-	mio m3/mio m3	-	-	-
1	179	Psata	106,60		0,02	0,30	3,37					
2	192	Raca	25,50									
3	194	Radomlja	134,30		0,03		0,87					
4	199	Nevljica	90,60			0,20	0,65					
5	203	KB_lower	75,00		0,14		1,09					
6	204	KB_upper	105,90									

The obtained results show that the highest impact on the final grade have construction of retention reservoirs (T3=5,98), followed by protection of natural retention areas (T3=0,50) and renaturation of existing or abandoned ponds, wetlands and similar (N12=0,19). Flood diversion channels (FDC) have a minor impact compared to other proposed measures. Results of assessment are presented on the figures below.

Figure 2: Map of measures used in the expert variant of estimation of effects

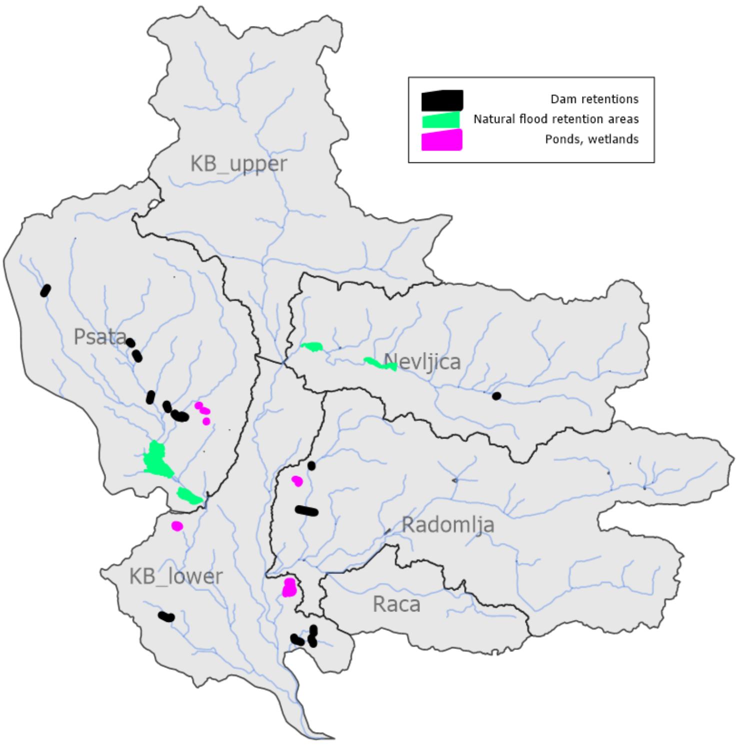
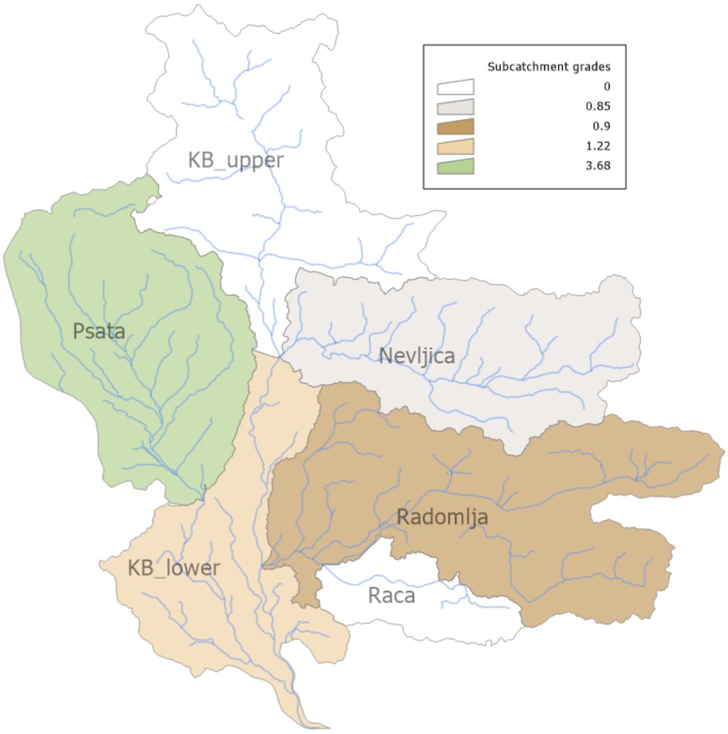


Figure 3: Map of subcatshment grades for expert variant



3.2 For the variant of aggregated expert measures

The results of the local variant assessment are also presented in the form of a table and map (Tab. 8 and Fig. 4). 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 the spreadsheet. We found out, that in this case technical measures have the biggest impact on the final score had technical measures (T=5.64) and natural measures had much lower averall impact (N=0.47). Results of assessment are presented on the figures below.

Tab. 8: Assessment of the effectiveness of the variant of aggregated expert measures

1										
2	Number of measures	2			Grading of the Program of Small Water Retention Measures					
3	Number of SPUs	6		Measure No.	1	2				
4				Grade for a measure (total by SPUs):	5.64	0.47				
5	No.	SPU Id	SPU name	Measure Id by User	T	N				
6				F_SPU [km^2]	km2/km2	km/km2				
7	1	179	Psata	106.60	3.18	0.23				
8	2	192	Raca	25.50						
9	3	194	Radomlja	134.30	0.82	0.02				
10	4	199	Nevljica	90.60	0.61	0.15				
11	5	203	KB_lower	75.00	1.02	0.07				
12	6	204	KB_upper	105.90						
13										
14										

Figure 4: Map of measures used in the aggregated expert measures variant of estimation of effects

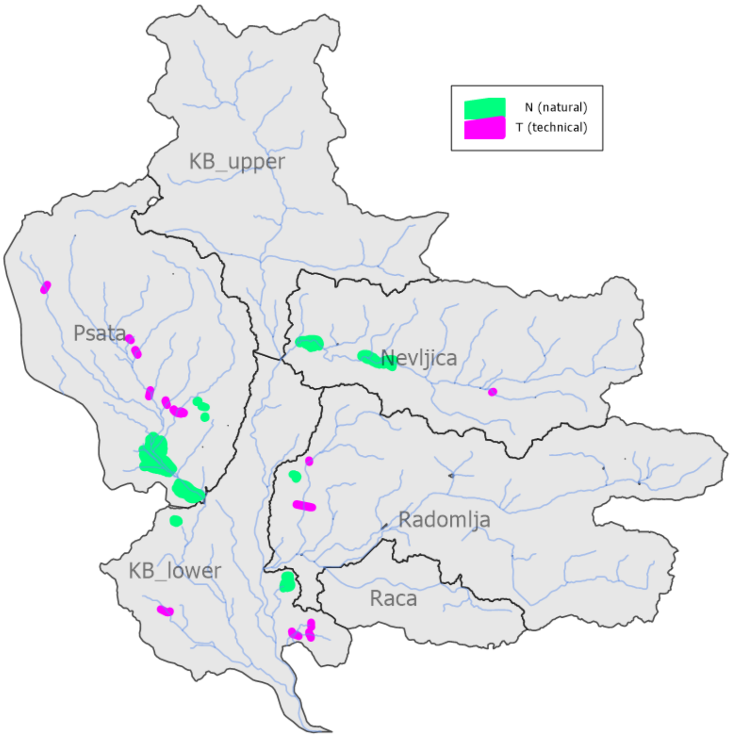
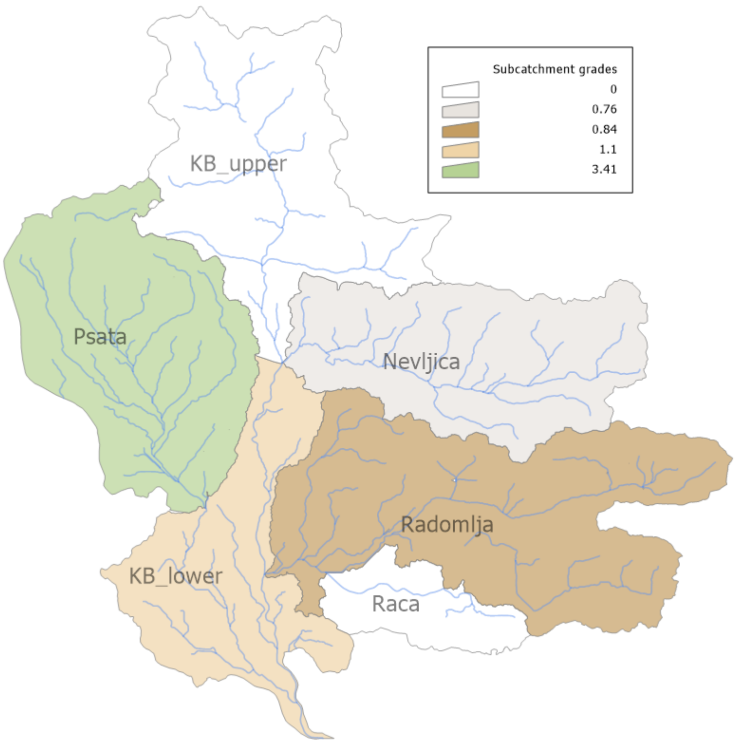


Figure 5: Map of subcatshment grades for variant of aggregated expert measures



3.3 Comparison of variants

From the comparison we can see (Tab. 9), that both variants do not differ by a big margin. The result is somehow expected as both variants describe the same measures, the only diffrence is whether they are aggregated in classes (natural, technical) or not. That is true for both spatial represenation of subcatchment grades and numerical values of the same grades.

From the results we can assume, that the most important part of the catchment regarding water retention is Psata subcatchment (grade=3.41, followed by KB_lower (grade=1.1), Radomlja (grade=0.84) and Nevljica (grade=0.76). KB_upper and Raca have no impact on water retention, which is correct as there are no measures to be made.

These results show that the program itself is robustly made, and that it accounts all of the most important parameters in a way that results are consistent regarding the inputs.

Tab. 9: Comparison of variants

Variant	Expert variant	Aggregated expert measures
Technical measures	5,98	5,64
Natural measures	0,69	0,47

4. CONCLUSIONS

- The tool results are highly influenced by the expert opinion and thus variable;
- Estimations are mostly experience based, which requires the involvement of experts;
- The tool cannot replace modelling or designing;
- It is not a common practice to model whole river basins, so this tool can be the basis for the guidance on how to solve catchment problems;
- Consistent inputs result in consistent outputs, hence calculation engine is robustly made.

5. REFERENCES

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