Interreg CENTRAL EUROPE
European Union European Regional Development Fund

FramWat

DEVELOPING THE CONCEPT PLAN FOR N(S)WRM IN RIVER BASIN

D.T2.3.1

Pilot catchment Blh

SWME

Version 1

06 2019

Table of content

1. INTRODUCTION

The objectives/scope of the concept plan.

The goals of the Concept plans are to serve with information on variants of best location and type of natural small water retention measures proposed with the aim to reach maximal cumulative effect of measures. The Concept plans should be prepared for river basins using the Valorization tool FroGIS (O.T1.1) developed within WPT1 and should be further improved based on inputs gained during the National trainings (O.T2.2) and consultations with experts and with local stakeholders involved in measures realization or proposal.

Key features of the concept plan:

- set-up a general methodology;
- propose N(S)WRMs matched to landscape conditions, existing rural, agricultural, water management (etc…) plans, development patterns and relevant EU legislations as well as stakeholder preferences
- propose combinations of measures in SPUs relevant for static and dynamic tools on effectiveness assessment application

Purposes of the concept plan are:

- to explain transparently the way how the analysis of information, data and context as well as the evaluation of experts knowledge and stakeholders preferences led to the chosen design principles;
- to show how the design and location of the selected N(S)WRMs respond to the opportunities and constraints identified during the analyses;
- to explain and justify the way the N(S)WRMs are set out;
- to demonstrate a genuine response to context and not simply justify predetermined design solutions.

2. ELABORATION METHOD OF THE CONCEPT PLAN

The main steps of the concept plan elaboration are demonstrated in Fig. 1 below, while details of the needed actions are discussed in the chapters below.

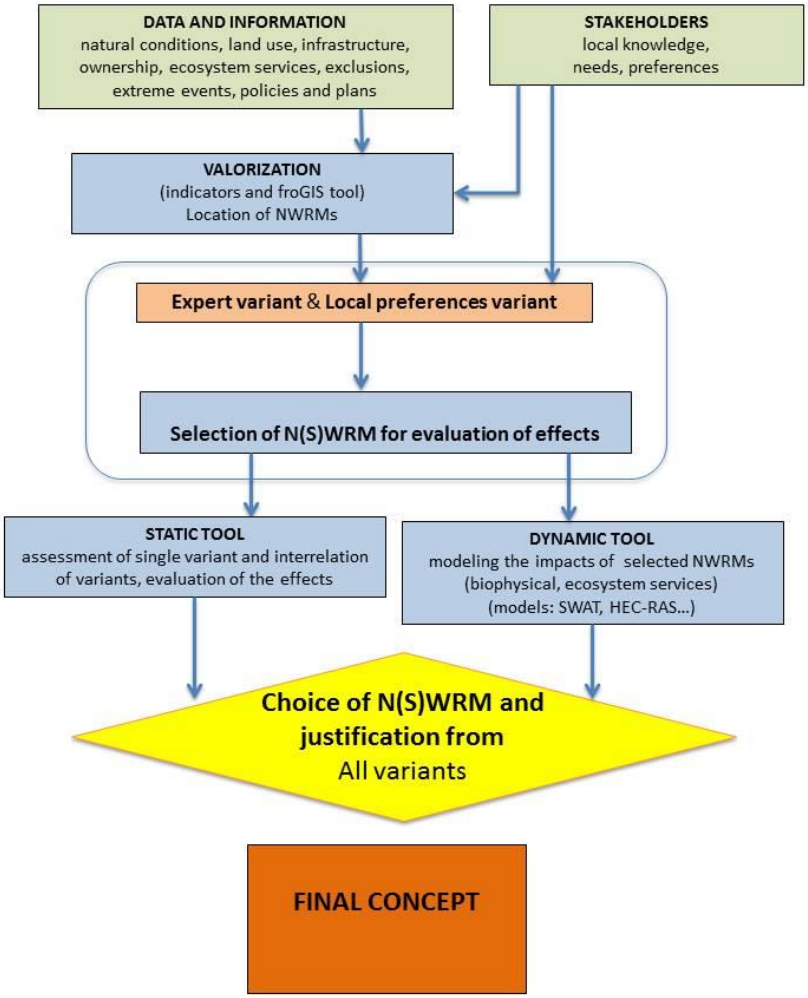


Fig. 1 Main steps of the concept plan elaboration

3. CHARACTERISTICS OF THE CATCHMENT

Maximum 2 pages. An overview table can be prepared for each pilot area and/or a comprehensive table can be elaborated including information on all pilot areas that helps to sum up the information and also to compare the characteristics of the different pilot areas.

3.1. Natural conditions of the catchment

(landscape context, geography, geomorphology, topography, geology, land cover, climatic conditions)

The Slaná River Basin (RB) is one of the ten River Basins into which is the area of the Slovak republic divided according so called Hydrological conditions of the Slovak Republic (SR). Nine of them belong to Danube River Basin District (96% of the territory of the SR) and one of them belongs to Vistula River basin District (4% of the territory of the SR). The River Basin Management Plans and Flood Risk Management Plans are compiled and reported to the European Commission for these basic management units. Slaná RB is cover by mountains but by lowlands too. It is fan-shaped RB consisting of many quite narrow sub-catchments with the orientation from south to west. These were the reasons for selection of the Slaná RB as suitable for the project purposes.

After starting the project and first discussions between project partners on the ways how to develop quite consistent and compatible methods and particular tools applicable in all river basins and suitable to test in the pilot catchments and to serve with comparable results, the consortia proposed to focused with huge Slaná River Basin (3 217 km2) on some smaller sub-catchment. Because of these reason the Slovak team was looking for some catchment serving with the most of pressures and their potential impacts to be a “representative sample” from Slaná River Basin. These was consulted with local water management authorities and with regional water management authority, it was agreed that Slovakia will focus on sub-catchment of Blh River within Slaná River Basin. Some characteristics of the Blh River sub-catchment are shown on Fig. 2 and in the Tab. 1 too.

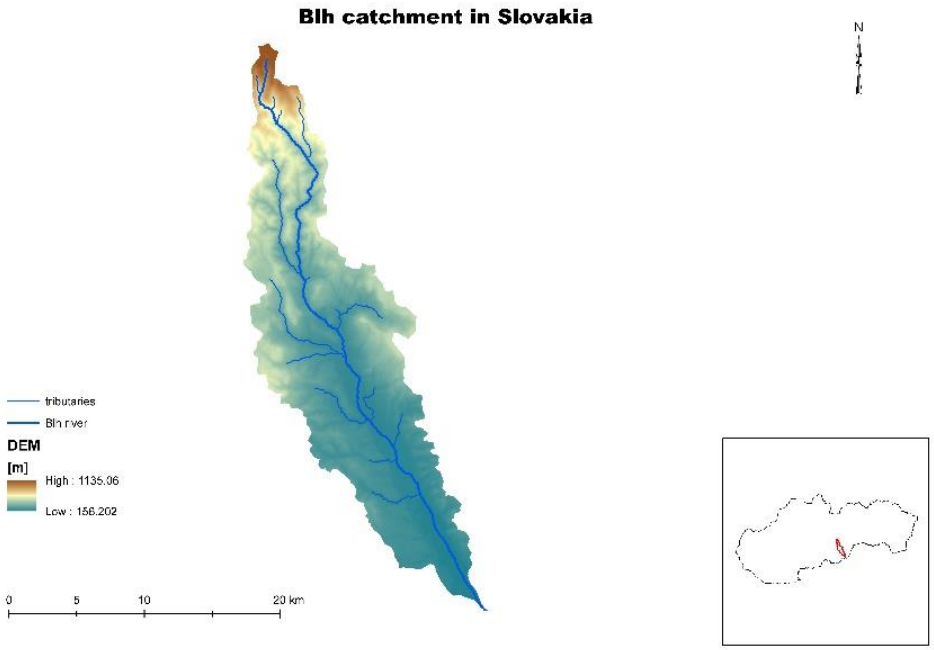


Fig. 2 Map of morphology in the Blh sub-catchment

Tab. 1 Characteristic of Blh sub-catchment

Characteristic	Unit	Value
Character of catchment		fan-shaped river network with surface of plains to higher highlands dissection
Catchment size:	km^2	270.656
Average flow low/avg/high*	m^3/s	1.064 (avg)
Extreme flow low/high**	m^3/s	Qmin = 0.001/Qmax = 69
Annual precipitation low/avg/high*	mm	568/714/1019
Annual air temperature min/avg/max*	°C	4/8/10
Agriculture area	%	43.00
Urban area	%	2.80
Forest area	%	53.76
Open Water area	%	0.43
Flooded area (1/100 years)	km^2	12.28
Artificial drainage area	km^2	
Ecological status no good/bad	water body	generally medium/bad
Major problems to achieve good ecological status		Phytobenthos, Macrophytes, NH4, PO4, Norganic

** From multiannual statistic 1961 - 2000*
*** From multiannual statistic 1931 - 2010*

3.2. Land use, infrastructure and protected areas

(including natural resources, protected areas, etc)

Pre-dominating land use types (Fig. 3) within the Blh sub-catchment are forestry (53,76%) and agriculture (43,00%), urban areas are very limited (2,80%).

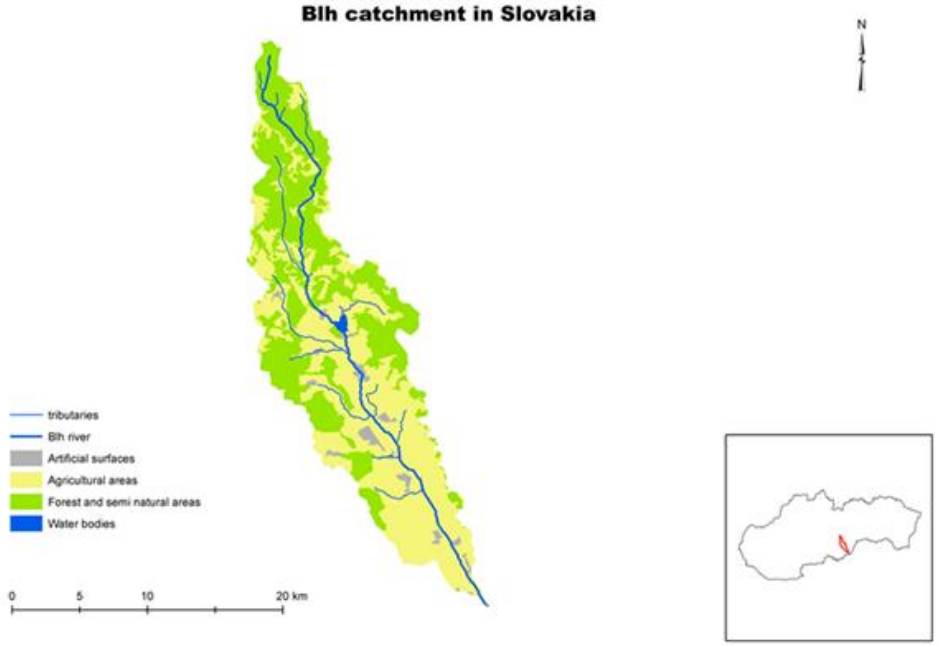


Fig. 3 Map of landuse in the Blh sub-catchment

In the Blh sub-catchment there are quite lot of existing flood protection measures and water reservoir to manage water flows during dry periods, but also a lot of flood protection measures as e. g. dry polders planned with the aim to mitigate flood impacts. The existing water management infrastructure consist of water reservoir Teplý Vrch (Tab. 2), existing regulations of water courses in the Blh sub-catchment are mentioned in the Tab. 3 and existing pumping of inland waters (Tab. 4).

Tab. 2 Existing water reservoir in the Blh sub-catchment

Name	Water course	Usage
WR Teplý Vrch	Blh	flood protection, water retention, irrigation, fishery

Tab. 2 Existing regulations of water courses in the Blh sub-catchment

Waer course	Identification No. of water course	Regulation of water course			Flood protection dyke / flood protection line			
					left bank		right bank	
		start	end	Design flow	start	end	start	end
		[rkm]	[rkm]		[rkm]	[rkm]	[rkm]	[rkm]
Blh	4-31-03-24	0,00	9,15	Q_{100}	0,00	20,485	0,00	20,318
		9,15	17,41	Q_{100}				
		17,41	24,20	Q_{100}				

Tab. 4 Existing pumping of inland waters

Water course	Identification No. of water course	Type of canal system	Pumping station	
			Name	[rkm]
Blh	4-31-03-24	inland waters canal	PS Budikovany	25,50

In the Blh sub-catchment there are declared also nature protection areas. There of depending on water were identified based on data in River Basin Management Plan II (RBMP II), management of these areas officially reported to RBMP II is also substantial part of Action Plans on wetlands management. In the catchment there are also very small wetlands of local importance not officially reported by national nature protection authority to the RBMP II, these are identified based on communication with local nature protection authorities. The protected areas are shown in Fig. .

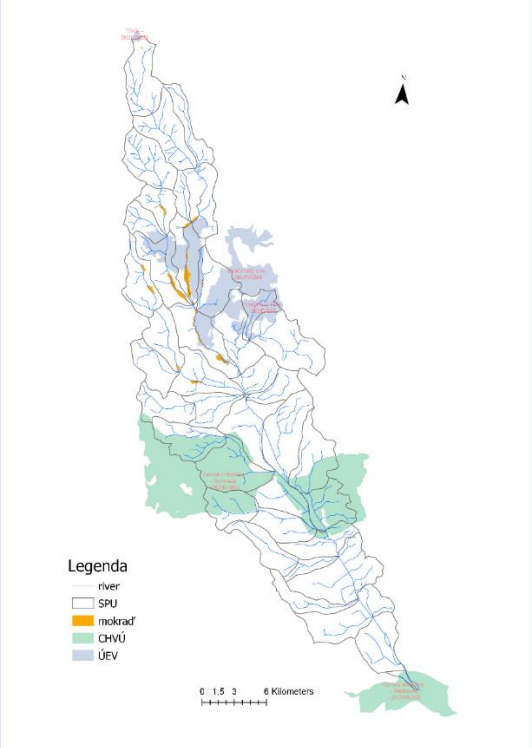


Fig. 4 Protected areas dependent on water

3.3. Ecosystem services

(listing - and short description - of recent ES available in the area based on MAES / CICES: https://biodiversity.europa.eu/maes/common-international-classification-of-ecosystem-services-cices-classification-version-4.3)

The basic for the concept of ecosystem services is a mutual interaction between nature and human being. Humans by its activities directly or indirectly influences the environment and the quality of its components – in the time and space too. The influence can be divided into short, medium and

long term on local, regional and global scale. The concept of ecosystem services is based on complex research of ecosystems, their functions and evaluation of benefits for the society.

Within the Blh sub-catchment there have been identified ecosystems which can potentially serve with ecosystem services, these are shown in the Tab. 5.

Tab. 5 Ecosystems identified within Blh sub-catchment

C - Inland surface waters	C1 - Surface standing waters
E - Grasslands and land dominated by forbs, mosses or lichens	E2 - Mesic grasslands
F - Heathland, scrub and tundra	F2 - Arctic, alpine and subalpine scrub
G - Woodland, forest and other wooded land	G1 - Broadleaved deciduous woodland
	G3 - Coniferous woodland
	G4 - Mixed deciduous and coniferous woodland
	G5 - Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice
I - Regularly or recently cultivated agricultural horticultural and domestic habitats	I1 - Arable land and market gardens
J - Constructed, industrial and other artificial habitats	J1 - Buildings of cities, towns and villages
	J2 - Low density buildings

In the Slovak republic there have been identified as relevant 18 ecosystem services divided into 3 groups of ecosystem services.

Based on the national web service of ecosystems types it was compiled map for the Blh sub-catchment shown in the Fig. 5.

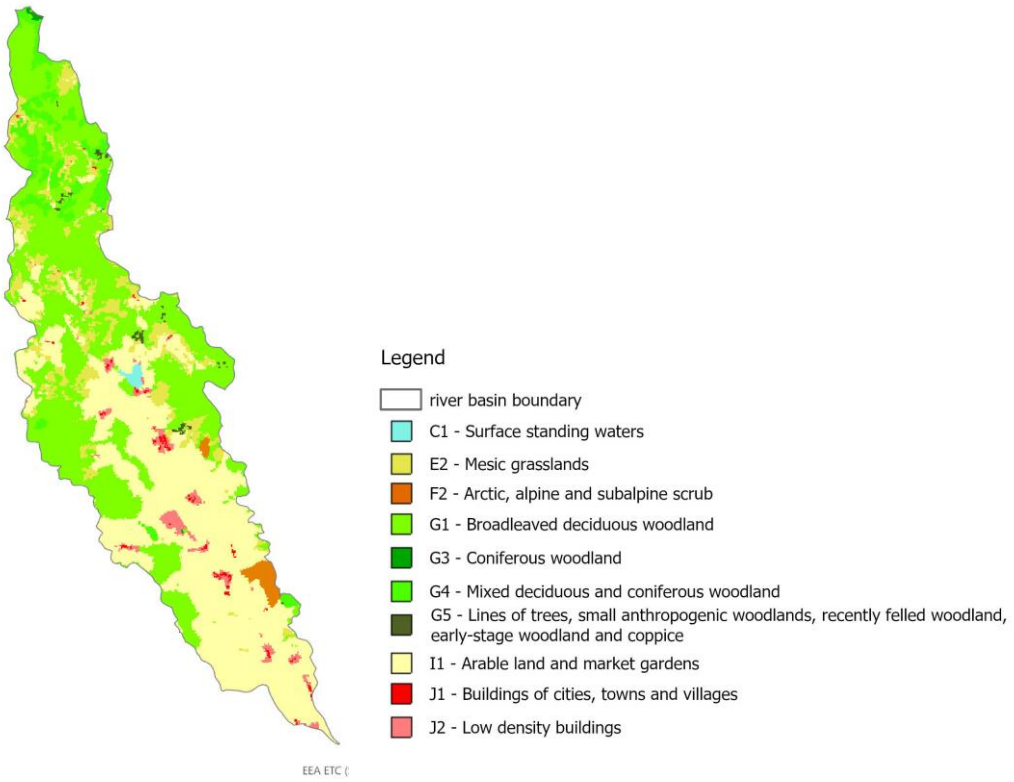


Fig. 5 Map of ecosystems in the Blh sub-catchment

For Slovakia there is defined (3) a common approach to express relative landscape capacity to serve with each of ecosystem services based mainly on biophysical (environmental) data expressed in the space. Result of landscape capacity evaluation is the relative scale 0 – 100, where is minimal and 100 is maximal suitability of landscape to serve with ecosystem services within whole territory of Slovakia. This relative values can be classified into simple suitability scale as minimal/low – below average – average – above average – high/very high.

Based on the evaluation of landscape capacity to serve with ecosystem services in Slovakia there have been created landscape capacity maps according 3 main groups of ecosystem services. It means that the map of landscape capacity to serve with provisioning ecosystem services (Fig. 6), the map of landscape capacity to server with regulation and maintenance ecosystem services (Fig. 7) and the map of landscape capacity to server with cultural ecosystem services (Fig. 8).

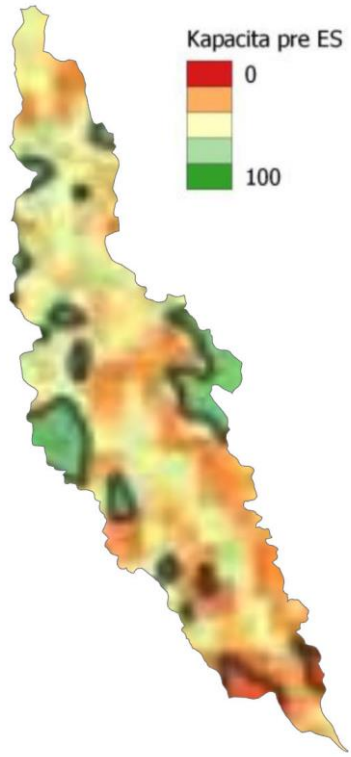


Fig. 6 Map of landscape capacity to serve with provisioning ecosystem services

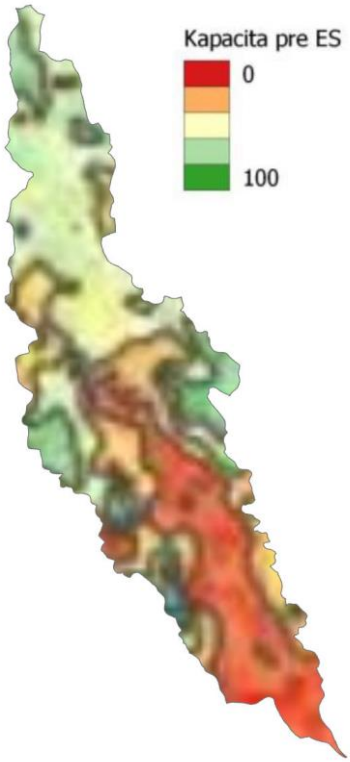


Fig. 7 Map of landscape capacity to server with regulation and maintenance ecosystem services

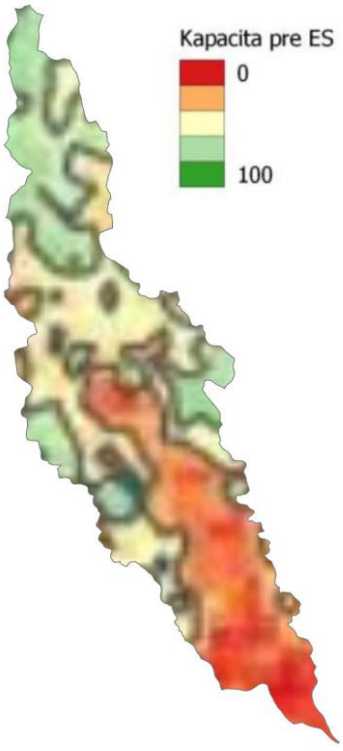


Fig. 8 Map of landscape capacity to server with cultural ecosystem services

There was produced also map of total landscape capacity to server with ecosystem services (Fig. 9).

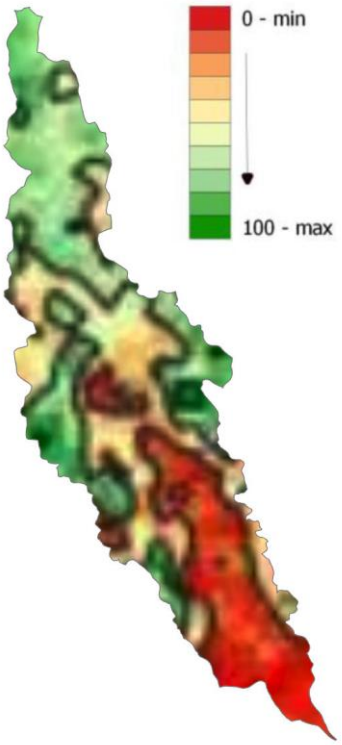


Fig. 9 Map of total landscape capacity to server with ecosystem services

Within 3 main groups of ecosystem services there have been identified 18 ecosystem services to be provided by ecosystems within the Blh sub-catchment listed in the Tab. 6.

Ecosystem services				
Section	**Division**	**Group**	**Class**	**Related ecosystems**
Provisioning services	Nutrition	Biomass	Cultivated crops (SK code: P1)	cropland
			Wild plants, algae and their outputs (SK code: P5)	forests and other wooded land, grassland
			Wild animals and their outputs (SK code: P5)	forests and other wooded land, grassland, rivers and lakes
		Water	Ground water for drinking (SK code: P3)	all
	Materials	Biomass	Fibres and other materials from plants, algae and animals for direct use or processing (SK code: P2)	forests and other wooded land
		Water	Surface water for non-drinking purposes (SK code: P4)	all
Regulation & Maintenance services	Maintenance of physical, chemical, biological conditions	Atmospheric composition and climate regulation	Air quality regulation (SK code: R1)	forests and other wooded land, grassland, rivers and lakes
			Micro and regional climate regulation (SK code: R5)	forests and other wooded land, grassland, rivers and lakes
			Global climate regulation by reduction of greenhouse gas concentrations (SK code: R6)	forests and other wooded land, grassland, rivers and lakes
		Water conditions	Chemical condition of freshwaters (SK code: R2)	forests and other wooded land, grassland, rivers and lakes
		Lifecycle maintenance, habitat and gene pool protection	Maintaining nursery populations and habitats (SK code: R7)	forests and other wooded land, grassland
			Pollination and seed dispersal (SK code: R8)	forests and other wooded land, grassland
		Pest and disease control	Pest control (SK code: R9)	forests and other wooded land, grassland
			Disease control (SK code: R9)	forests and other wooded land, grassland
		Soil formation and composition	Weathering processes (SK code: R10)	forests and other wooded land, grassland, rivers and lakes
	Mediation of flows	Mass flows	Mass stabilisation and control of erosion rates (SK code: R3)	forests and other wooded land, grassland
		Liquid flows	Flood protection (SK code: R4)	forests and other wooded land, grassland
Cultural services	Physical and intellectual interactions with biota, ecosystems, and landscape	Physical and experiential interactions	Recreation and tourism - physical use of nature and landscape (SK code: C1)	all
		Intellectual and representational interactions	Natural and cultural heritage - intellectual and scientific values (SK code: C3)	all
	Spiritual, symbolic and other interactions with biota, ecosystems, and landscape	Spiritual and / or symbolic	Landscape character and aesthetics - aesthetic values (SK code: C2)	all

Tab. 6 Ecosystem services relevant for the Blh sub-catchment

3.4. Extreme events/Catchment problems

(flood/drought/excess water/heavy rain, etc…)

The land in the Blh sub-catchment is used for agricultural purposes too. Not well managed agricultural practises in the river basin are causing slight deviations from reaching the good ecological status of river water bodies due to the nitrates and phosphorus (urban waste water is a pressure too), nutrient pollution is causing eutrophication in water bodies. Except organic and nutrient pollution, further impacts on water body status are change of biotopes (phytobentos and macrophytes) due to hydromorphological pressures. The southern part of the Slaná river basin is assessed as vulnerable to fluctuation of discharges potentially caused by climate change.

The Slaná river basin and the Blh sub-catchment itself is quite often attached by flash floods with a necessity to find solutions to protect municipalities and farms in the lowlands against floods and during dry periods to help improve water amount in rivers with the aim to mitigate the impacts of drought.

3.4.1. Floods

Extreme floods events which have occurred in the Blh sub-catchment and are registered in the official national evidence (6, 7) are listed in table 7. There is mentioned source of flood and consequences too if available in the national evidence.

Tab. 7 Extreme flood events and their consequences within Blh sub-catchment

Municipality	Water course/stretch	Year	Short description of flood source	Short description of cionsequences
Bátka	Blh	1974	dlhotrvajúce výdatné zrážky	
		1995	extrémne výdatne zrážky	
		1996	výdatné zrážky, topenie snehu	
	inland waters	2010	intenzívne zrážky	zaplavenie intravilánu obce
	Bátka	2010	intenzívne zrážky	zaplavenie intravilánu obce svahovými vodami
Budikovany	Blh	1983	intenzívne zrážky	
		1995	extrémne intenzívne zrážky	
	inland waters	2010	intenzívne zrážky	
Cakov	Blh	1974	dlhotrvajúce výdatné zrážky	
		1995	extrémne intenzívne zrážky	
		2010	intenzívne zrážky	ľavostranné vybreženie vôd z koryta toku, zaplavená poľnohospodárska pôda a záhrady
	Cerov	2010	intenzívne zrážky	vybreženie vôd z koryta toku, zaplavená orná pôda a záhrady
Dražice	Dražický	1995	extrémne výdatné zrážky	
		2010	intenzívne zrážky	
Drienčany	Blh	1974	dlhotrvajúce výdatné zrážky	
		1999	intenzívne zrážky a topenie snehu	
		2009	intenzívne zrážky	
Dulovo	Blh	1974	dlhotrvajúce výdatné zrážky	
		1979	ľadová povodeň	

Municipality	Water course/stretch	Year	Short description of flood source	Short description of cionsequences
		2010	intenzívne zrážky	
Hrušovo	Turiec	1974	dlhotrvajúce výdatné zrážky	
	Blh	1999	extrémne zrážky	
		2002	inteznívne zrážky	
		2009	inteznívne zrážky	
	Striežovský	2002	inteznívne zrážky	
Ivanice	Blh	1974	dlhotrvajúce výdatné zrážky	
		1983	intenzívne zrážky	
		1995	extrémne výdatné zrážky	
Lukovištia	Pápča	1999	extrémne zrážky	zdevastovanie koryta toku, vytvorenie nánosov
Potok	Blh	1974	dlhotrvajúce výdatné zrážky	
		2010	intenzívne zrážky	
Padarovce	Pápčanský	1995	extrémne výdatné zrážky	
	Padarovský	1999	extrémne zrážky	poškodenie korytovej úpravy toku po celej dĺžke intravilánu obce
	inland waters	2010	inteznzívne zrážky	zaplavenie poľnohospodárskej pôdy
Radnovce	Blh	1974	dlhotrvajúce výdatné zrážky	
		1995	extrémne dlhotrvajúce zrážky	
		2010	intenzívne zrážky	
	Radnovský	2010	intenzívne zrážky	vybreženie vôd z koryta toku v intraviláne obce
Rakytník	Blh	1974	dlhotrvajúce výdatné zrážky	
		1983	intenzívne zrážky	
		2010	extrémne výdatné zrážky	
Rimavská Seč	Blh	1974	intenzívne zrážky, prietok 69 $m^3.s^{-1}$	
		1979	intenzívne zrážky, prietok 66,4 $m^3.s^{-1}$	
		1977	intenzívne zrážky, prietok 62,7 $m^3.s^{-1}$	
	Rimava	1974	dlhotrvajúce výdatné zrážky	
		1976	intenzívne zrážky	
		1977	ľadová povodeň	
Rovné	Blh	1974	dlhotrvajúce výdatné zrážky	
Teplý Vrch	Blh	1974	dlhotrvajúce výdatné zrážky	
	Pápčanský	2009	intenzívne zrážky	
		2010	intenzívne zrážky	
Tomášovce	Blh	1974	dlhotrvajúce výdatné zrážky	
		1995	extrémne výdatné zrážky	
		2002	intenzívne zrážky	
	Tomášovský	1995	extrémne výdatné zrážky	
	inland waters	2010	intenzívne zrážky	zaplavenie poľnohospodárskej pôdy
Uzovská Panica	Blh	1969	ľadová povodeň	
		1974	dlhotrvajúce výdatné zrážky	
		1995	extrémne výdatné zrážky	
	Panický	1999	extrémne zrážky	zaplavenie 10 rodinných domov a poľnohospodárskej pôdy
	Dražický	1999	extrémne zrážky	
		2010	intenzívne zrážky	vybreženie vôd z koryta toku, zaplavenie poľnohospodárskej pôdy a komunikácií
Veľký Blh	Blh	1974	dlhotrvajúce výdatné zrážky, prietok 53 $m^3.s^{-1}$	

Municipality	Water course/stretch	Year	Short description of flood source	Short description of cionsequences
		1976	intenzívne zrážky, prietok 48 $m^3.s^{-1}$	
		1979	ľadová povodeň, prietok 420,8 $m^3.s^{-1}$	prelievanie ochrannej hrádze, aj neohrádzovaného úseku toku
	Brádňanský	1999	extrémne zrážky	zaplavenie poľnohospodárskej pôdy, komunikácií, ohrozenie rodinných domov
Vieska nad Blhom	Blh	1974	dlhotrvajúce výdatné zrážky	
		1995	extrémne dlhotrvajúce zrážky	
		2005	intenzívne zrážky	
		2010	intenzívne zrážky	
Zádor	Blh	1974	dlhotrvajúce výdatné zrážky	
		1999	extrémne zrážky	zhromaždenie vnútorných vôd, ohrozenie rodinných domov
		2005	intenzívne zrážky	vytvorenie nátrže brehov koryta toku
		2010	intenzívne zrážky	zaplavenie intravilánu obce
Žíp	Blh	1974	dlhotrvajúce výdatné zrážky	
		1995	extrémne výdatné zrážky	
		2010	intenzívne zrážky	vybreženie vôd z koryta toku, zaplavenie poľnohospodárskej pôdy
	inland waters	2010	intenzívne zrážky	vybreženie vôd cez cestný priepust na poľnohospodársku pôdu

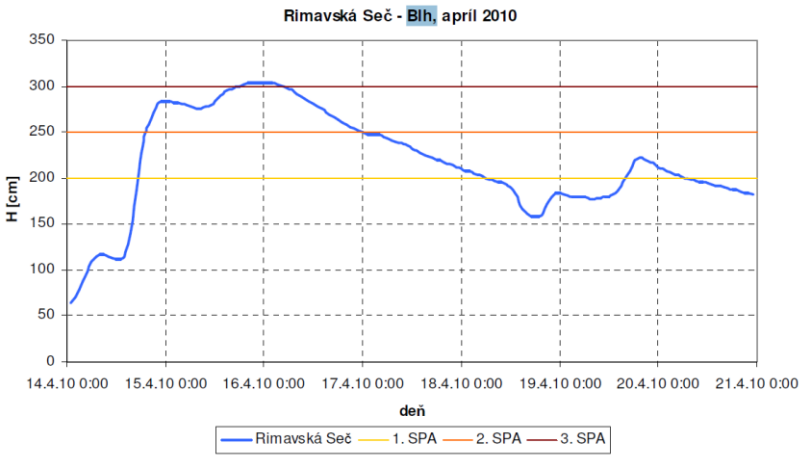
In the table 8 there are marked stretches of water courses in the Blh sub-catchment where the flood situation occurred assessed according national definition of flood activity degrees within the period 1997 - 2010.

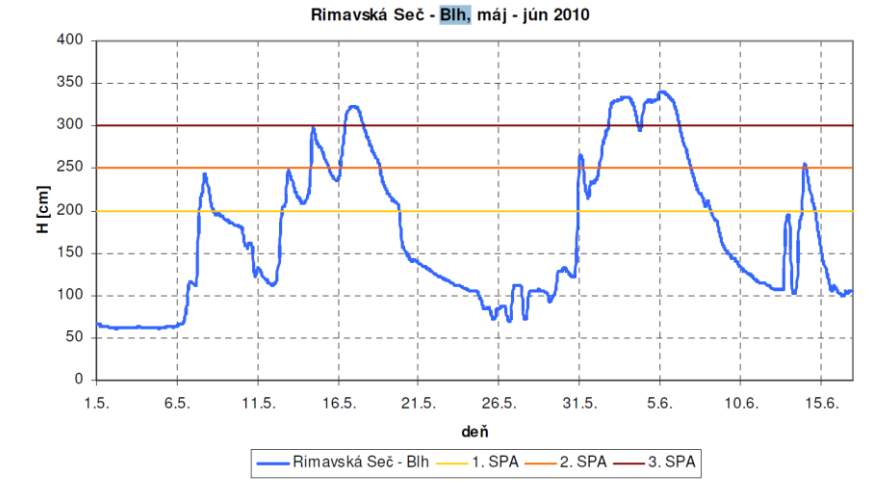
Tab. 8 Extreme flood events and their consequences within Blh sub-catchment

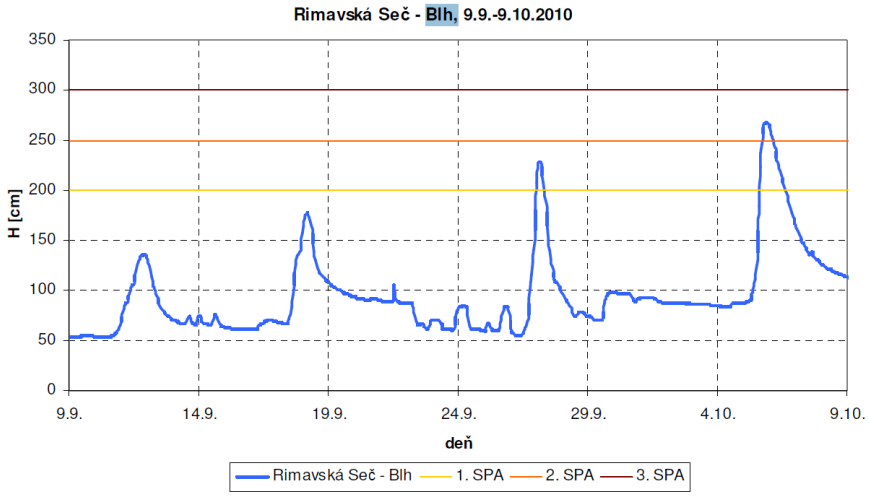
Water course	District	Municipality		Year, when III. degree of flood acivity occured at least once													total
		Name	No. of inhabitants	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Blh	Rimavská Sobota	Rimavská Seč	1 968						x							x	x	3
Blh	Rimavská Sobota	Bátka	1 000													x	x	2
Blh	Rimavská Sobota	Cakov	301													x	x	2
Blh	Rimavská Sobota	Číž	691														x	1
Blh	Rimavská Sobota	Drienčany	244													x	x	2
Blh	Rimavská Sobota	Hrušovo	197														x	1
Blh	Rimavská Sobota	Radnovce	761														x	1
Blh	Rimavská Sobota	Rovné	140													x	x	2

Water course	District	Municipality		Year, when III. degree of flood acivity occured at least once														total
		Name	No. of inhabitants	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Blh	Rimavská Sobota	Teplý Vrch	272			x										x	x	3
Blh	Rimavská Sobota	Tomášovce	203			x											x	2
Blh	Rimavská Sobota	Uzovská Panica	715			x										x	x	3
Blh	Rimavská Sobota	Veľký Blh	1 193			x										x	x	3
Blh	Rimavská Sobota	Vieska nad Blhom	154			x											x	2
Blh	Rimavská Sobota	Zádor	139			x											x	2
Blh	Rimavská Sobota	Žíp	233			x										x	x	3
Tomášovský potok	Rimavská Sobota	Bátka	1 000					x										1
Tomášovský potok	Rimavská Sobota	Rimavská Sobota	24 040														x	1
Hnojník	Rimavská Sobota	Rimavská Sobota	24 040														x	1

The year 2010 was extremely dry across whole Slovakia. It is obvious also from record, where the highest degree of flood activity (III. degree) was achieved more times a year in Blh sub-catchment in April 2010, May 2010, in September 2010 the II. degree of flood activity was reached again, see figures below.







3.4.2. Droughts

Regarding the drought impacts and assessment, southern part of the Blh sub-catchment is evaluated in more literature/conceptual documents (5) as vulnerable to drought impacts. According RBMP II the southern part of the Slaná river basin is assessed as vulnerable to fluctuation of discharges potentially caused by climate change in the frame of discharges decrease. The drought occurrence in the 2013 and its evaluation showed very significant drought in the Blh sub-catchment.

4. VALORISATION: A MULTI-CRITERIA ANALYSIS

OUTLINE OF THE DELIVERABLE ON VALORISATION: Presentation of the process and results of the valorisation method (FroGIS tool) in the pilot catchment. Describe and present maps of selected indicators. Describe the verification process and valorisation maps for individual goals.

4.1. The valorisation method and tool

The main aim of the valorisation method is to:

- identifying the areas where the need of water retention exists, and
- identification of potential locations for N(S)WRMs design.

For the easier application of developed valorisation method, the online tool FroGIS was developed. The users are able to fill-in their own data or use global publicly available data, define their spatial/management units, run calculations and to reach the result, which is calculated valorization for each spatial/management unit. The valorization results are available in the table or map format.

4.2. Results of the valorisation method

Present the results of the valorisation method

In the following chapter the basic principles and main results proceeded within application of the developed Valorization method for the Blh sub-catchment are described.

4.2.1. Selected SPU

Firstly was the Blh sub-catchment divided into 26 SPUs, which correspond to natural hydrological units and are the smallest hydrological management units defined within so called National hydrological division. The testing of the developed GIS tool FroGIS showed that such division is insufficient for proper functioning of FroGIS and it was necessary to subdivide the SPUs into more detailed units. Based on DEM the natural hydrological units were subdivided into 40 more precise units.

So after division into 40 SPUs, the smallest one (No. 16) is of area of 0,042 km^2 and the biggest one is of area of 17.201 km^2. The division of the Blh sub-catchment into SPUs is shown in the Fig. 10.

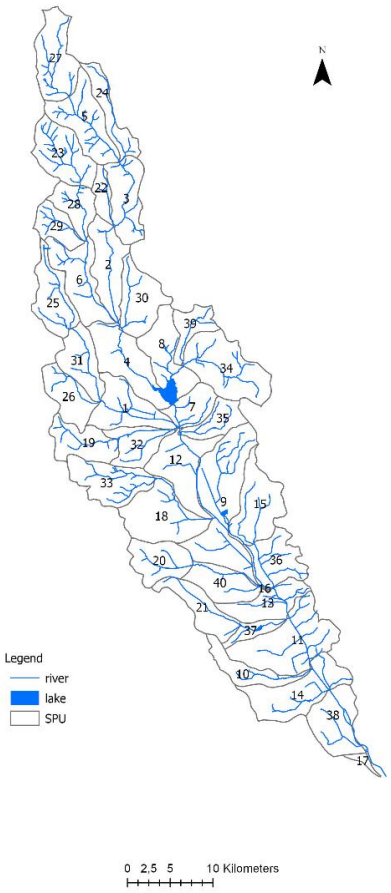


Fig. 10 SPU of Blh sub-catchment

As the biggest problems in the Blh sub-catchment are caused by floods, the valorization calculations were run for the floods goal.

4.2.2. Selected indicators

For the analyses of floods goal there have been used 10 indicators. The list of indicators used is shown in the Tab. 9 where also the relevance of indicators for particular goals is marked.

Tab. 9 List of selected indicators

Indicator name	Description	Jednotky	Topics	Goal drought	Goal flood	Goal waters quality	Goal sediment transport	stimulant / non-stimulant	Importance
DrainageD	Drainage Density	km/km2	Hydrography						1
FloodRiskAreaRatio	Flood hazard zone area ratio	%	Hydrology						1
ForestRatio	Forested area to SPU area ratio	%	Landuse						1
LakeRatio	Lakes and reservoirs area to SPU area ratio	%	Hydrography						1
LakeCatchRatio	Lake catchment area to SPU area ratio	%	Hydrography						2
MeanderRatio	MeanderRatio	%	Hydrography						1
NonForestedRatio	Non forested area with a slope above 5% to SPU area ratio	%	Ecology						1
OrchVegRatio	Orchards & vegetable farming area to SPU area ratio	%	Landuse						1
RiverSlope	Slope of river	°	Topography						1
UrbanRatio	Urban area to SPU area ratio	%	Landuse						1

4.3. Results of the valorization

Final valorisation maps with identification of varying degree of development needs for small retention in river basin.

Show the variants of valorisation result for different purposes, the aggregation methods and results.

The resulting valorization maps for Blh sub-catchment were produced through FroGIS tool. In the figure 11 are shown final valorization maps produced for the user defined goal Floods. The most acceptable valorization results were calculated for Egual Width method and 5 classes by using constant weight equal to 1 for each indicator (this means that all indicators have the same relative importance).

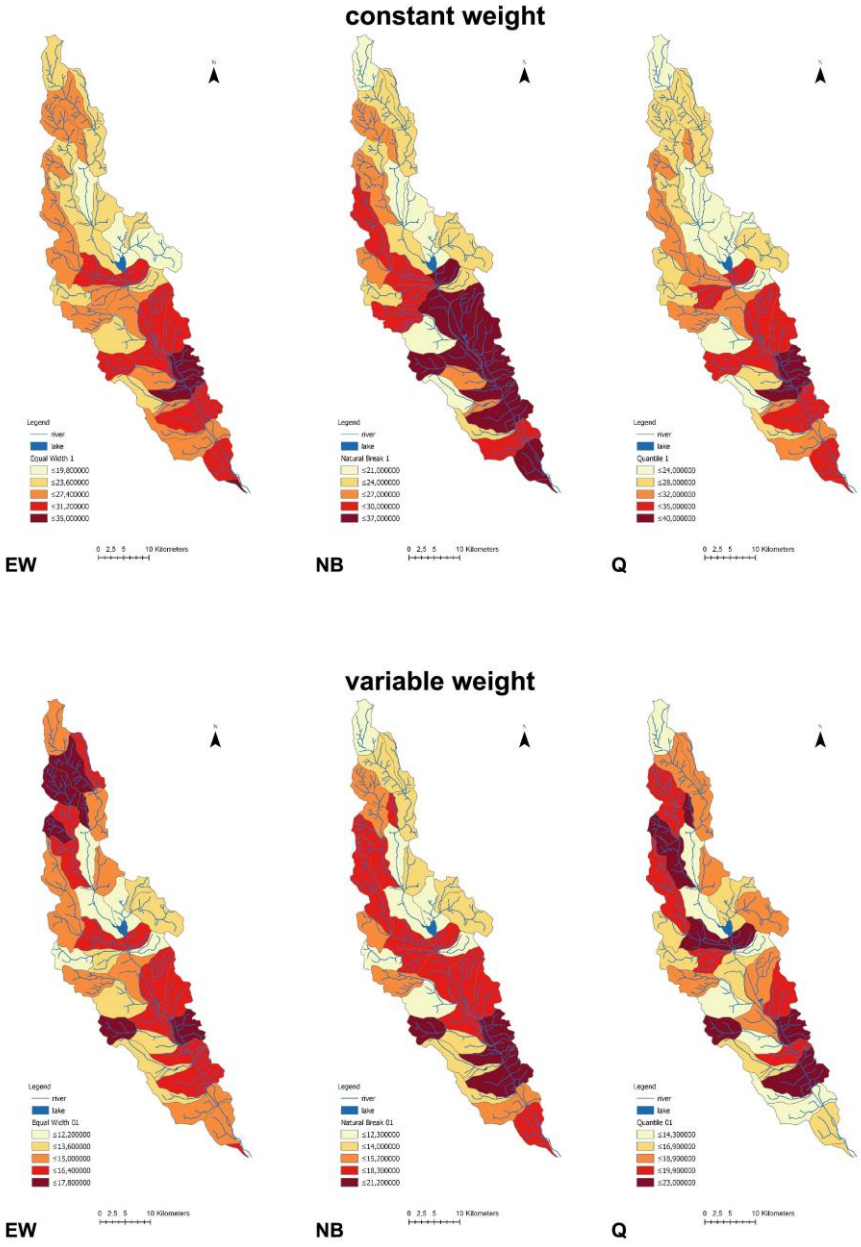


Fig. 11 Final valorization maps for the goal Floods

Only SPUs with classification into class 4 or 5 are further taken into account, as the need of water retention is highest there. The SPUs with classes 4 or 5 are listed in the table 10, so in total there is necessity to propose relevant measures somewhere in the Blh sub-catchment and to solve the problem of water retention need in 11 SPUs.

Tab. 10 SPUs with valorization classes 4 and 5 within Blh sub-catchment

SPU	valorization class
1	4
7	4
9	4
11	4
13	5
15	4
16	5
17	5
20	4
36	5
38	4

More details on valorization calculations for Blh sub-catchment and its results are available in the report “D.T1.3.1Report from pilot action – testing the prototype of the FroGIS tool in the river basin, Testing in the Blh pilot catchment” (1).

5. DEFINING VARIANTS

Within the project it is necessary to propose few variants of combinations of natural small water retention measures which can contribute to the reaching of goals and needs analysed for pilot catchment within the valorization process.

There are two types of variants that will be elaborated in the frame of the concept plan:

- Expert variant,
- Local preferences variant.

The measures are proposed based on the Catalogue of measures developed within the project which comes out from the results of previous EU project www.nwrm.eu. Measures are divided into five groups of sectors or areas where their impact is obvious or which are defining the type of measures. These are as follows:

- agriculture
- forestry
- drainage areas
- hydromorphology
- hydrotechnical structures

Basic spatial data used:

- water management structures
- water courses and water reservoirs, lakes
- SPU (40 SPUs)
- municipalities
- Land Parcel Identification System (LPIS) for Blh sub-catchment
- protected areas
- digital elevation model
- watermanagement map, scale 1:50000 (VHM50)
- Drought map 1 – ratio of minimum and average discharge [%],
- Drought map 2 – map of drought occurrence 2013

Analyses provided:

- chemical status of water bodies (lakes, rivers)
- ecological status or ecological potential of water bodies (lakes, rivers)

- arable land from national evidence LPIS (slope from 7° untill 12° - arable land prone to erosion, DEM)
- arable land – hydromeliorations (arable land from national evidence LPIS, hydromeliorations identified based in national watermanagment map VHM50)
- flood hazard Q_{100},
- land ownership by state and municipalities according ownership ratio [%],
- Dem analyses - depression Z limit = 1 m (based on DEM analyses – depression of depth at least 1 m, and depresion of area at least 1 ha)
- topographic wet index – TWI (DEM analyses – water most amount flowing through area with least slope)
- slope of the water course
- slope of the hills
- maximum retention of soil up to 1m

5.1. The expert variant

The proposal of the main workflow

The expert variant was proposed based on measures already mentioned in the strategic documents as River Basin Management Plan of Slovakia 2015 – 2021 and Flood Risk Management Plan of Slaná River Basin 2015 – 2021. Further based on consultations with State Nature Conservancy as authority for management of protected areas and its 2 local branches Muránska Planina and Cerová vrchovina, and on experiences of local Water Management Authority, branch Rimavská Sobota. Spatial extent and localization of some measures was identified through GIS analyses done over the available spatial data.

There was proposed and selected 8 types of measures as relevant for the expert variant. They are listed and explained in the text below:

A04 - Strip cropping along contours (Fig. 12)

As suitable were defined areas of arable land with average slope within interval 7° do 12°. The relevant areas were delineated based on GIS analyses over the shape file of arable land from National evidence LPIS (Land Parcel Identification System) and DEM elevation model. The DEM raster was analysed according the slope and there of the Slope DEM raster was created (in degrees). Zonal statistics was used to determine average slope for each parcel of arable land. The slope values have been divided into 4 categories of land potentially endangered by water erosion (Tab. 11).

Tab. 11 Categories of water erosion danger based on slope determination

Category	Slope	Erozion intensity
1	0 - 3°	no erosion
2	3 - 7°	medium erosion
3	7 - 12°	high erosion
4	over 12°	extrem erosion

The shape file of areas with category of water erosion danger 3 (7° - 12°) was chosen as relevant for proposal of measures, measures against erosion are proposed. Areas of arable land with category of water erosion danger 4 (over 12°) do not occur in the Blh sub-catchment.

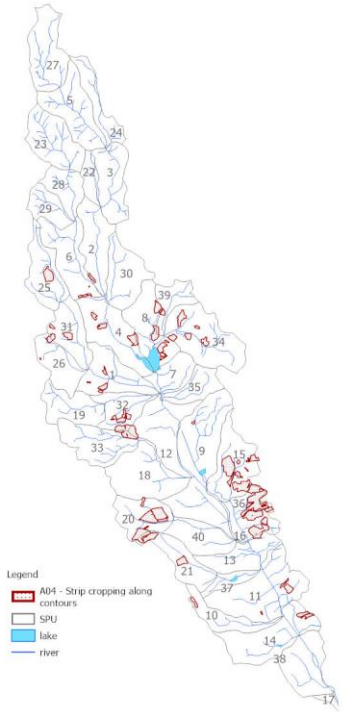


Fig. 12 Strip cropping along contours

D01 - Regulated outflow from drainage systems (Fig. 13)

As suitable have been proposed areas where existing hydromeliorations are located and are proposed for reconstructions/intensification. Data was selected based on Flood Risk Management Plan Slaná and are collected from spatial plans. At such areas the measures to regulate outflow from drainage systems are proposed.

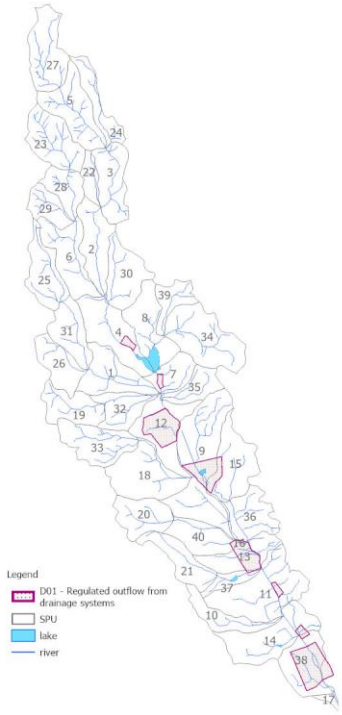


Fig. 13 Regulated outflow from drainage systems

N02 - Wetland restoration and management (Fig. 14)

As suitable have been proposed areas where existing wetlands of local importance are located. Data was selected based on consultations with State Nature Protection Authority and its local branches Cerová vrchovina a Muránska planina. At such areas the management measures to restore existing wetlands are proposed.

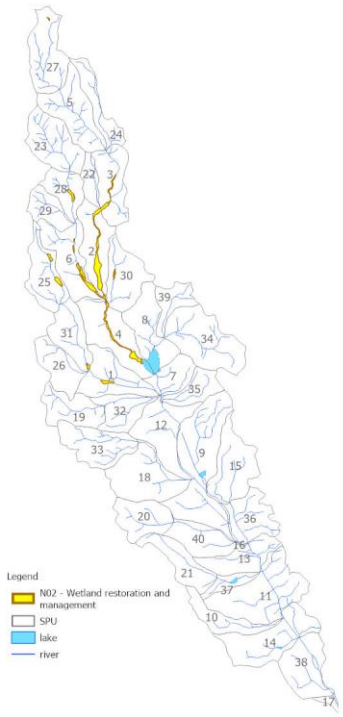


Fig. 14 Wetland restoration and management

N03 - Floodplain restoration and management (Fig. 15)

As suitable have been proposed natural areas suitable for natural or artificial transformation of flood waves. Data was selected based on Flood Risk Management Plan Slaná and are collected from spatial plans. At such areas the management measures are proposed.

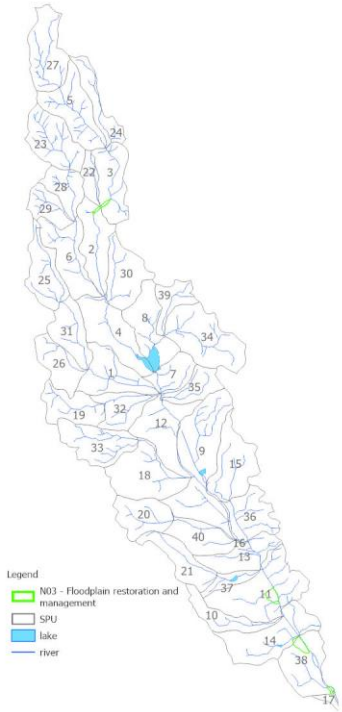


Fig. 15 Floodplain restoration and management

T1 - Polders, dry flood protection reservoirs, sediment trapping dams (Fig. 4)

As suitable have been proposed areas where dry polders are planned, these are profiles suitable from geomorphological and hydrological point of view. Data was selected based on proposals of regional Water Management Authority, branch Banská Bystrica.

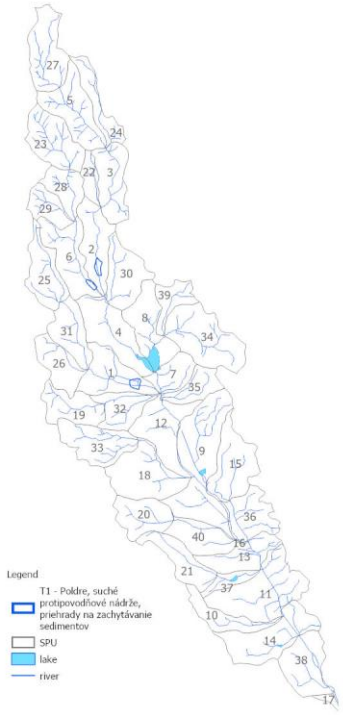


Fig. 4 Polders, dry flood protection reservoirs, sediment trapping dams

D03 - Active water management on a drainage system (river valleys)

Tx - Removal of sediments and / or bank vegetation

Ty – Adjustment of watercourse

As last there are also technical measures proposed to be kept, which does not belong to natural small water retention measures but their effect is necessary to keep. As suitable have been proposed areas where existing pumping of inland waters are located, removal of sediments and/or bank vegetation at water courses is planned and adjustment of water courses are planned (Fig. 5). Data was selected based on Flood Risk Management Plan Slaná. At such areas the management and adjustment measures are proposed, as they are evaluated by experts as necessary technical measures to be kept.

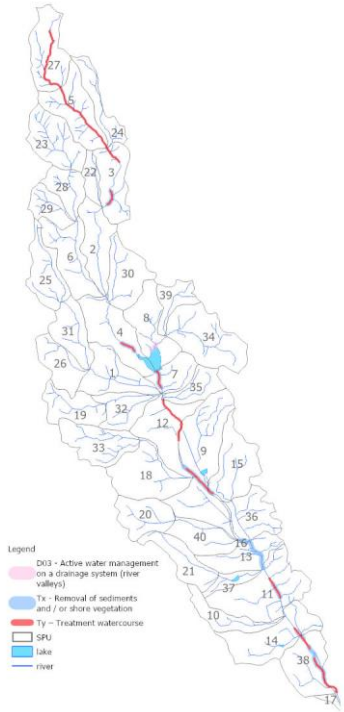


Fig. 5 Expert variant - lines

All types of proposed measures for the SPUs classified into valorization classess 4 or 5 are summarized in the table 12.

Tab. 12 SPUs with proposed types of measures within Blh sub-catchment

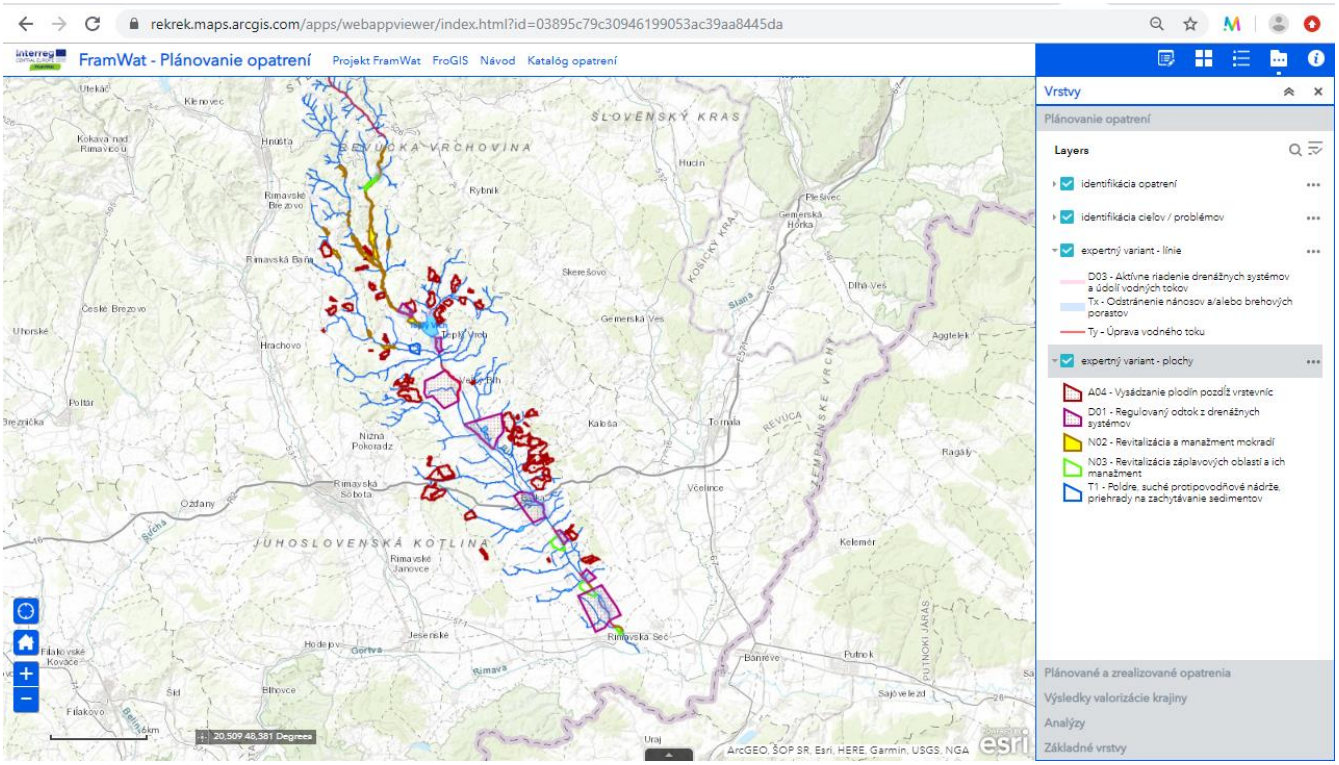
SPU	valorization class	measures
1	4	A04, N02, T1
7	4	D01, Tx, Ty
9	4	A04, D01, Tx, Ty
11	4	A04, D01, N03, Tx, Ty
13	5	D01, Tx
15	4	A04, D01
16	5	D01, Tx
17	5	-
20	4	A04
36	5	A04, Tx
38	4	D01, N03, Tx, Ty

From these types of potential measures different combinations should be designed which will be further tested through Static method on effectiveness assessment and/or through Dynamic modelling.

5.2. The local preferences variant

The local preferences variant was proposed based on communication with different types of local stakeholders. For that purpose the web-application (Fig. 18) was developed using all the input data mentioned above.

Fig. 6 Web application developed for Local preferences variant design



From types of potential measures which will be proposed by local stakeholders, different combinations should be designed which will be further tested through Static method on effectiveness assessment and/or through Dynamic modelling.

5.3. Selection of N(S)WRM for evaluation of effects

Choosing the variants for further analysis using the results of Expert and Local preferences examinations.

Choosing the best version we should estimate the expected effects of measures combinations in each SPU's for certain goal.

For the estimation we can use "LookUpTable of BiophysicImpact-NWRM-Effectiveness" table and other expert knowledge. (Review of the existing parameters for evaluation of effectiveness of N(S)WRM, Anex 1)

The rating of estimated effects of measure combination for each SPU's is done based on expert knowledge.

6. MEASURES TESTING

6.1. Measures for Static method testing

Show the list of measures, that can only be assessed using static method in river basin.

In the following text there are described final combinations of measures for each SPU selected for further testing through application of Static method to assess effectiveness of measures.

6.2. Measures for Dynamic method testing

Show the list of measures, that can only be assessed using dynamic method in river basin.

In the following text there are described final combinations of measures for each SPU selected for further testing through application of Dynamic method to assess effectiveness of measures.

6.3. Measures for Static and Dynamic method testing

Show the list of measures, that can be assessed both by static and dynamic model.

In the following text there are described final combinations of measures for each SPU selected for further testing through application of both, Static and Dynamic method to assess effectiveness of measures.

7. FINAL CONCEPT FOR THE BLH PILOT SUB-CATCHMENT

Povide a map (places) with list of measures as the final result that will be further assessed in the action plan. This will be the output of the concept plan and input to modelling process.

In the following text there is described the final concept plan resulting from the testing of the different measure combinations described in the chapter 6.

This final concept plan will be recommended for realization or at least consideration to be realized within next update of strategic documents and will be discussed further within National and Regional policy dialogues to be organized during the next period.

8. REFERENCES

(1) D.T1.3.1Report from pilot action – testing the prototype of the FroGIS tool in the river basin, Testing in the Blh pilot catchment.

(2) CICES

https://biodiversity.europa.eu/maes/common-international-classification-of-ecosystem-services-cices-classification-version-4.3

(3) Catalogue of ecosystem services in Slovakia

http://www.sopsr.sk/natura/dokumenty/Katalog-ES.pdf

(4) Catalogue of selected adaptation measures to the adverse impacts of climate change in relation to land use

https://www.sazp.sk/app/cmsSiteBoxAttachment.php?ID=597&cmsDataID=0

(5) River Basin Management Plan of Slovakia 2015 – 2021, Flood Risk Management Plan of Slaná River Basin 2015 – 2021

(6) Reports on floods situation

http://www.shmu.sk/sk/?page=128

(7) Information on progress and consequences of floods on the territory oft he Slovak republic

https://www.minzp.sk/oblasti/voda/ochrana-pred-povodnami/informacie-priebehu-nasledkoch-povodni-uzemi-sr.html