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PRACTICAL GUIDELINES ON PLANNING NATURAL AND SMALL WATER RETENTION MEASURES

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Practical Guidelines on planning Natural and Small Water Retention Measures in River Basins

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Content

Foreword

Despite the significant progress across Europe towards achieving good ecological and chemical status of freshwaters as required by the EU Water Framework Directive, water resources are still not managed sustainably, resulting in natural heritage loss, habitat fragmentation, hydromorphological alterations, water quality problems and water quantity deficiencies. The adverse environmental impacts of multi-stressors, the triggered abrupt ecosystem responses and the increasing vulnerability of environmental resources to climate change impacts and man-made pressures call for actions to preserve ecological values and natural heritage of the river basins and to maintain their basic functions such as water retention, self-purification and biodiversity.

The FramWat project aimed at narrowing knowledge gaps and implementation deficiencies regarding the natural (small) water retention measures (N(S)WRM) that are great examples for multi-beneficial measures in agricultural and rural areas contributing to flood, drought and pollution mitigation at the catchment scale. In the frame of the project, beneficial tools and methods were developed (i) to identify locations in a river basin where N(S)WRM are needed, (ii) to support the evaluation of cumulative effectiveness of N(S)WRM at river basin scale, (iii) and to facilitate the implementation of N(S)WRM through guidelines including policy options and cost analysis. The FramWat project also elaborated example Action Plans for several pilot river basins potentially serving as detailed instructions on how to apply N(S)WRM at the catchment scale. The cooperation with regional authorities on developing these plans is highly welcomed.

No doubt that the project delivered tangible outcomes towards better understanding of N(S)WRM and their integration into water management practice. However, the key to successful implementation is in the hands of policy-making and is therefore beyond the project mandate and capacity. The proposed measures, tools and guidelines should be included in River Basin and Flood Risk Management Plans in good synergy with the Strategic Plans of the Common Agricultural Policy post-2020 so that their potential benefits are recognized and promoted by these plans and they are transformed into appropriate policy interventions. Implementation of N(S)WRM should be supported by attractive voluntary financial schemes funded by rural development programmes and accompanied by integrated advisory services including information exchange, bottom-up approaches and demonstration events. National policies should make use of the political momentum at the EU level with the Green Deal and the Farm to Fork and Biodiversity Strategies that offer a great opportunity to achieve sustainable agriculture and rural land management. They need to remain ambitious at national level, tailored according to regional and local needs and conditions and aligned across sectorial policies.

I sincerely believe that implementation of N(S)WRM can have positive effects on water and sediment balance as well as on pollutant retention in river basins and that the tools and guidelines developed by the FramWat project could facilitate more effective flood and river basin management planning at different spatial scales. Therefore, I encourage decision makers, authorities and water managers dealing with elaboration of river basin and flood risk management plans but also interested stakeholders to consider using and further promoting the valuable outcomes of the FramWat project.

Adam Kovacs
Technical Expert for Pollution Control, International Commission for the Protection of the Danube River

Summary

The Guidelines provide a step-by-step guide to the application of natural small water retention measures (N(S)WRM) in river basins. The publication addresses the knowledge gap and issues related to the integration of N(S)WRMs into the third cycle of river basin management plans in line with the Water Framework Directive (WFD). The Guidelines describe the role of green infrastructure in the landscape in solving water management issues such as floods, water quality/quantity, and erosion. Nature-based small water retention measures improve water balance, decrease sediment transport, and improve nutrients cycle.

The target group of the guidelines are decision-makers, experts, and stakeholders involved in the design and implementation of N(S)WRMs as part of plans and programmes addressing crosscutting water management, climate change, biodiversity, forestry, agriculture, and land use issues.

The added value of the Guidelines is the fact it is based on the analytical work of the FramWat project and coordinated testing in real pilot catchments in several countries in Central Europe. The Guidelines connect all-important project outputs, highlight best practices, and summarise results from the pilot catchments in a simple 5-step process of N(S)WRM planning.

The steps comprise the preparation phase (Step 1), catchment valorisation (Step 2), potential measures and scenarios for improvement (Step 3), developing the Concept Plan (Step 4), and finally Concept Plan into Action Plan (Step 5). Each step makes a reference to the Decision Support System (DSS) and the pilot catchments.

The DSS is a web-based one-stop shop for all tools, developed in the scope of the project. FramWat tools were tested in Aist (Austria), Bednja (Croatia), Nagykunsági (Hungary), Kamienna (Poland), Slaná (Slovakia), and Kamniška Bistrica (Slovenia). The results of the testing are summarised in the Action Plans.

Next to technical tools, public participation is also important for river basin management planning. It is required by Article 14 of the WFD. More information, consultation, and active involvement increase the acceptance of the measures and their successful implementation. Multiple functions of N(S)WRM call for local level cross-sectoral cooperation with stakeholders outside water management. The Guidelines also summarise this experience based on a number of workshops and meetings held during the life of the project.

1. Introduction

1.1. Background

On the one hand, the region of Central Europe is rich in natural resources. On the other hand, its land and water is frequently used by society in unsustainable ways. This results in significant reduction of the buffering capacity of landscape, and increased risk of natural and man-made disasters. Despite significant efforts in reducing point pollution to achieve good ecological status of freshwaters, other pressing problems in the region remain unresolved. Erosion and sediment re-allocation, as well as nutrient pollution load discharges from diffuse sources (and the conflicting land use) are still the main drivers of the impoverishment of the water resources. Other common challenges arise from traditional water management practices, negatively affecting the connectivity of water bodies, but well established in this part of Europe (e.g. channelization). They result in major hydro-morphological transformations in river basins. Countries of the region are currently implementing green infrastructure measures to restore and preserve the three basic functions of every river basin, namely water retention, self-purification, and biodiversity. In order to restore these ecosystem functions back to balance, it is crucial to optimise the sustainable use of ecosystems, and therefore allow both humans and ecosystems to thrive.

Limited integration of N(S)WRM in river basins and flood risk management is primarily a consequence of lack of a knowledge base and tools for planning, assessment, and implementation of the multiple benefits of such measures at the river basin scale. The projects have so far mainly focused on one specific measure, with insignificant effects for the entire river basin. The primary focus of the FramWat project was therefore to strengthen the capacities and develop an innovative systematic approach to supporting the implementation of N(S)WRM.

1.2. FramWat Project

The FramWat Project was developed in order to support and boost knowledge on more systematic approaches towards the application of N(S)WRM in river basins. The key issues of the project are defined as follows:

The majority of water management and flood protection measures lack innovation and follow more traditional approaches, including large scale grey infrastructure investment programs or capital projects. They have not been balanced by green infrastructure that would take into account valuable ecosystem services provided by nature in landscape settings. The FramWat project supports the idea of using landscape features to help solve environmental problems in river catchments in a sustainable way.

Limited implementation of (N(S)WRM) throughout the region (Central Europe) increases the vulnerability of the environmental resources (water, biodiversity, and soil) to climate impacts (frequent severe floods and droughts) and man-made pressures.

Goal of the Project

The goal is to strengthen the regional common framework for floods, droughts, and pollution mitigation by increasing the buffer capacity of the landscape using the N(S)WRM approach in a systematic way. It can be done in an innovative way through the development of methods translating the existing knowledge regarding N(S)WRM features into river basin management practice. This results in the improvement of water balance, improvement of sediment balance, and enhancement of nutrients re-circulation. FramWat provides decision-makers with appropriate tools to incorporate N(S)WRM into the next cycle of River Basin Management Plans 2022-2027. Moreover, the project provides guidance and raises awareness regarding the importance of horizontal integration of different planning frameworks.

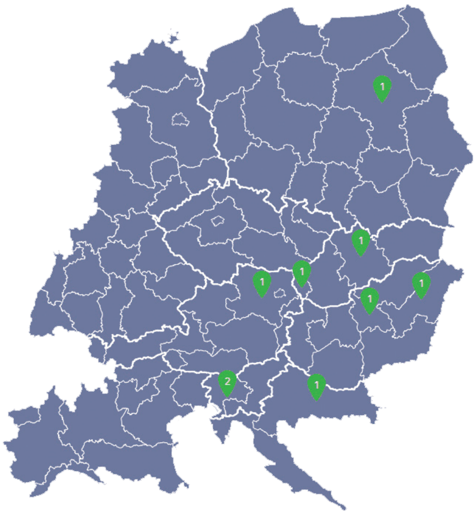


Figure 1: Map of FramWat Pilot catchments (Aist, Austria; Kamniška Bistrica, Slovenia; Nagykunsági, Hungary; Kamienna, Poland; Slana, Slovakia; Bednja, Coratia)

Approach of the Project

FramWat offers a new approach to the implementation of N(S)WRM in River Basin Management Plans. FramWat aims at changing the attitude to floods, droughts, and pollution mitigation by implementing integrated environmental management in the river basin planning process. FramWat increases the skills and capacities of water authorities and the related stakeholders for sustainable use of landscape, and for better and climate-proof water resources management. It is possible when N(S)WRMs are used in a systematic way, addressing complex challenges in river basins at the landscape scale.

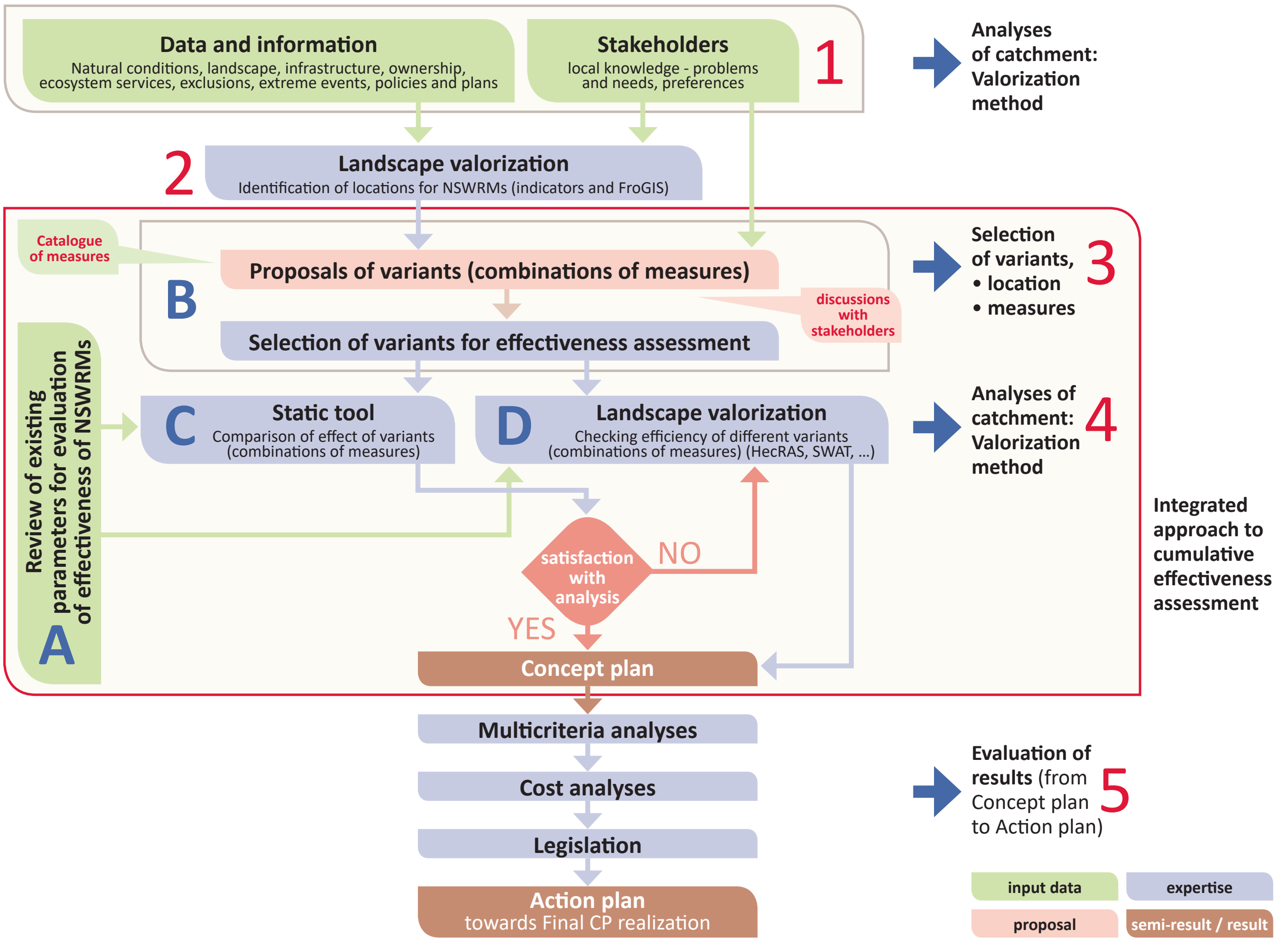


Figure 2: Diagram of the proposed procedure for N(S)WRM planning in river basins, and role of the Guidelines and Manual in this process (1, 2, 3, 4, 5 – steps in the Guidelines; A, B, C, D – phases in the Manual on cumulative effectiveness of the system of N(S)WRMs)

1.3. Guidelines to improve water balance and nutrient mitigation by applying a system of Natural (Small) Water Retention Measures

The primary objective of the Guidelines is to provide a step-by-step guide to the application of N(S)WRM in river basins. They address the current gaps and problems of integration of N(S)WRMs in water management plans in order to meet the obligations resulting from the Water Framework Directive (WFD), particularly during the preparation of the 3rd Cycle River Basin Management Plans.

The present Guidelines also provide methods of using landscape features to help solve environmental problems in river basins in a sustainable (long-term) way. This will improve the water and sediment balance, prevent erosion, and enhance nutrients re-circulation.

1.3.1. Users

The Guidelines have been developed for decision-makers, experts, and stakeholders involved in the selection, design, and implementation of N(S)WRM as part of plans and programmes addressing water, floods, droughts, biodiversity, climate change adaptation, agriculture, etc.

N(S)WRM also require a cross-sectoral and bottom-up approach. Sectors important for NSWRM planning and implementation include: water management; nature conservation; agriculture, forestry, fisheries; recreation and tourism; and civil protection.

Spatial planning, as one of the main and most important activities in water management, is considered a cross-cutting planning activity, and not a sector.

1.3.2. Methodology and Structure

The Guidelines describe N(S)WRM planning based on analytical work and pilot actions from the FramWat Project.

The Guidelines offer a connection with all important outputs developed within the FramWat project, best practices from participating countries, and practical recommendations from pilot catchments through the 5-step process of N(S)WRM Planning:

STEP 1: Preparation Phase

STEP 2: Catchment valorisation

STEP 3: Potential measures and scenarios for situation improvement

STEP 4: Developing the Concept Plan

STEP 5: Concept Plan into Action Plan

Each step provides a reference to:

a) The decision support system

Decision Support System for Planning of Natural (Small) Water Retention Measures

The web application *planning.waterretention.sggw.pl* introduces and integrates access to the aforementioned tools. It was created for people involved in planning water retention measures to mitigate the effects of drought, floods, and surface contamination by biogenes. The goal of the application is to familiarise the user with the catalogue of N(S)WRM and the planning process, as well as to survey their preferences for their area of interest. Part of the DSS is the N(S)WRM planner which facilitates inclusion of local stakeholders' preferences for planning measures in the field of water retention. It is helpful in data preparation, necessary for developing a concept plan and estimating the investment risk.

Practical workflow in DSS is followed by:

1) Creating a valorisation map in FroGIS.
2) Installing DSS on own server and public web map area of interest (Frogis maps, hydrography, orthophoto, TWI, shadow DEM, parcels).
3) Sending an invitation to submit N(S)WRM actions to a local stakeholder with an instruction and a link to DSS & Planner of N(S)WRM.
4) Wait-time until placing the measure on the map by means of the NSWRM planner by the stakeholder.
5) Download of all applied measures by server administrator.
6) Supplementing missing action parameters by experts.
7) Estimating effectiveness with the StaticTools tool or using dynamic model.
8) Estimating investment risk and final prioritisation of actions.

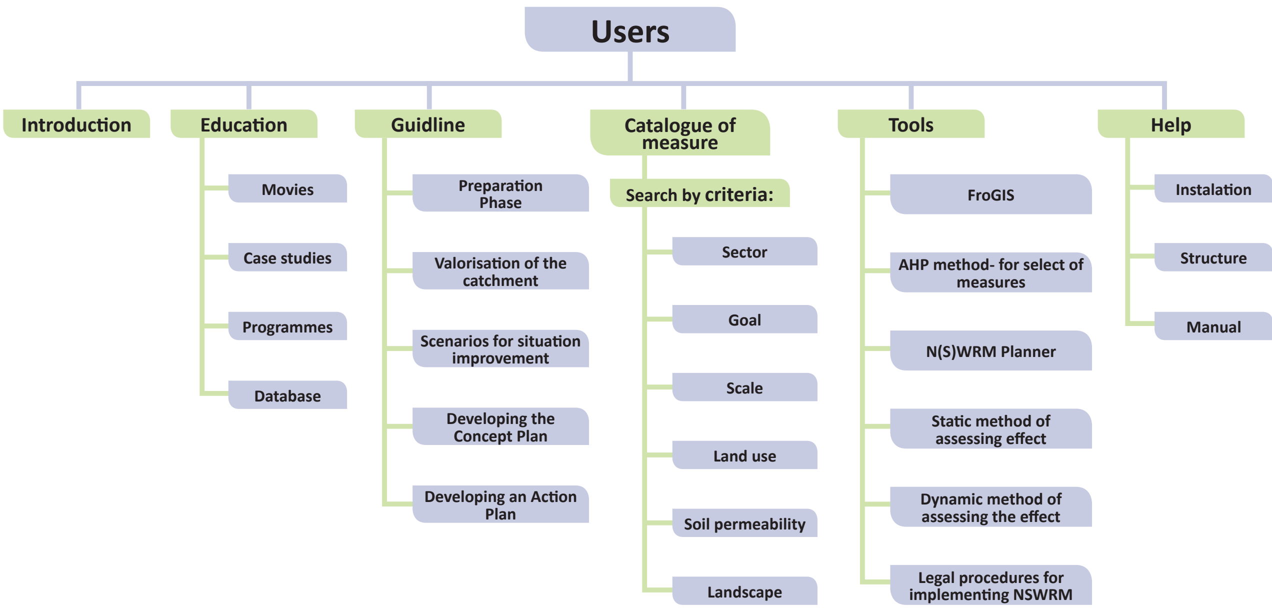


Figure 3: Map of the Decision-Support System

b) Examples from pilot catchments

The N(S)WRM approach was tested in 6 pilot catchments by means of Innovative FramWat tools. The pilot catchments were selected to represent the prevailing landscapes of Central Europe: Highlands (Aist, Austria and Kamniška Bistrica, Slovenia) and Lowlands (Nagykunsági, Hungary; Kamienna, Poland; Slana, Slovakia; Bednja, Coratia).

Results of testing in the pilot catchments were summarised in *FramWat reports*, and in particular in *Action Plans*.

Steps towards the application of N(S)WRM in river basins

STEP 1: Preparation Phase

Goal

To define catchment characteristics, collect input data, map stakeholders and plan their engagement from the beginning, and start the planning process.

Results

- Catchment analysis: Problem identification, description of catchment characteristics, physical data of the catchment
- Stakeholder involvement plan

Decision-Support System contain links to global and national databases to help characterise and identify problems in the catchment.

2.1. Catchment identification

2.1.1. Catchment Characteristics

Before commencing the process, the main characteristics of the selected catchment need to be identified:

- Natural conditions of the catchment (character, catchment size, average flow, annual precipitation, urban area, forest area, etc.)
- Land use and infrastructure: information on the share of agricultural land, highland, urban, forest, etc.
- Ecosystem services in the catchment; the Common International Classification of Ecosystem Services (CICES) has been designed to help measure, account for, and assess ecosystem services. CICES seeks to classify final ecosystem services, defined as the contributions that ecosystems (i.e. living systems) make to human well-being. A fundamental characteristic of final services is that they retain a connection to the underlying ecosystem functions, processes, and structures that generate them.

Table 1: Example of main characteristics of the Kamniška Bistrica (Slovenia) River catchment

Characteristic	Unit	Value
Character of catchment		Upper part: highland: wooded, sparsely populated
Middle and lower part: lowland: highly urbanized		
Catchment size:	km^2	539
Average flow low/avg/high*	m^3/s	2.2/7.9/67.2
Extreme flow low/high*	m^3/s	0.9/282
Annual precipitation low/avg/high**	mm	998/1383/1851
Annual air temperature min/avg/max **	9C	9/11/13
Agriculture area	%	34.5
Urban area	%	8.2
Forest area	%	54.1
Open Water area	%	2.8
Flooded area (1/100 years)	km^2	39.2
Artificial drainage area	km^2	12.7

2.1.2. Problem identification

Based on the geographical, climatic, geomorphological, and anthropogenic characteristics of the catchment, the main problems of the catchment need to be identified: floods, erosion, droughts, pollution, etc.

This information permits identification of areas with different needs for water retention in the catchment for different purposes: drought mitigation, flood control, water quality improvement, enhancing nutrient re-circulation, and improvement of sediment balance.

2.2. Planning stakeholder involvement

Next to its technical part, river basin management planning also has a strong social dimension. A programme of measures including N(S)WRMs cannot be implemented in the long term without a broader consensus of all local stakeholders and economic and social partners. A vital aspect of N(S)WRMs planning and implementation is therefore “mobilising stakeholders and citizens”. Engaging stakeholders in a way that they actively contribute to the process will encourage them to take part in planning and implementing the measures. This will increase the likelihood of successful implementation of N(S)WRMs.

Because the majority of N(S)WRMs have local impacts, a bottom-up approach is even more desirable. Multiple benefits offered by N(S)WRMs facilitate the challenge of widening the circle of stakeholders. In addition to the traditional “water stakeholders”, it means involvement of land use and spatial planning stakeholders, farmers, foresters, and landowners. It is therefore critical to take on board views and stakes from different policy areas, and to identify, discuss, and consider the expected multiple benefits when deciding on the measures to be financed and implemented.

This approach is not new. It follows international conventions and EU legislation already promoting the consultation and participation of stakeholders and the wider public in the process (management plans, agriculture strategies, flood protection plans, climate change adaptation plans, etc.). The Aarhus Convention also establishes several provisions with regard to the environment.

Table 2: EU Policies and linkages with Stakeholder involvement

Water Framework Directive	Article 14: “Member States shall encourage the active involvement of all interested parties in the implementation of this Directive.... in the production, review and updating of the river basin management plans....“
Flood Directive	Article 10: “Member States shall encourage active involvement of interested parties in the production, review and updating of the flood risk management plans.“
Biodiversity Strategy	Section 4.1: …“active involvement of civil society will be encouraged at all levels of implementation.“
European Regional Development	Regulation (EU) No. 1305/2013 on support for Rural Development by the EAFRD; Article 4: … “Objectives” It can play a very important role in improving the quality of rural development programmes by increasing the involvement of stakeholders in the governance of rural development as well as in informing the broader public of its benefits.

When planning stakeholder involvement, key questions need to be asked:

- Why to involve?
- Who to involve with?
- What to involve about?
- How to involve?

FramWat Example

FramWat partners first mapped/identified stakeholders in their pilot catchments, and then consulted/ discussed with them through 2 series of consultation workshops. At the first consultation workshop, stakeholders provided information and pointed out areas of interest/problems according to their knowledge. The 2nd round focused on discussing some solutions/measures for the pilot catchment presented by the partners in the Concept Plan. Stakeholders also contributed their comments and views on the structure of these Guidelines and made them more practical to be useful for better implementation and integration of N(S)WRMs into RBMPs and other “water-related national plans”. Therefore, the consultations played a crucial role in bringing those who have a genuine interest in the pilot catchment to discuss practical development of N(S)WRMs. For stakeholders at the local level, communication and consensus in decision making are among the major challenges of successful implementation of N(S) WRMs.

Link to national consultation dialogues conclusions: ***Austria, Croatia, Hungary, Slovakia, Slovenia, Poland.***

STEP 2: Catchment valorisation

Goal

To assess where N(S)WRM are possible and needed in the catchment, and to prioritise areas with different needs of water retention.

Results

Scenarios and prioritisation of areas for implementation of N(S)WRM (valorisation maps for one or more goals).

3.1. Valorisation method and FroGIS

The objective of landscape valorisation was to identify areas with the greatest need for N(S)WRM in the catchment for one of the overarching goals: (1) drought mitigation, (2) flood control, (3) water quality improvement, or (4) sediment balance improvement. The valorisation spatial scale (resolution) is based on the concept of spatial planning units (SPUs) which are homogeneous patches of the catchment assumed to have uniform hydrological response to meteorological drivers (rain, temperature). Input data are processed and synthesised as indicators at the SPU scale. The valorisation methodology allows for incorporating different indicator classes such as land use, geological conditions, catchment morphology, climate, and hydrology into a multi-criteria analysis. The valorisation methodology is static, i.e. the indicators are spatially explicit but time independent. Statistics can be used to summarise multiannual time series of flow and climatic indicators into single values.

The GIS based tool **FroGIS (Framework for Retention Optimisation)** was developed for valorisation purposes, i.e. to identify the most relevant areas for N(S)WRMs in particular catchments. Users can fill the online tool with their catchment data, and obtain catchment maps and statistics as results showing areas with the greatest need for implementation of small water retention measures.

FroGIS Tool

A publicly available web application to analyse the needs and possibilities of water retention, the result of which is the valorisation map supporting the N(S)WRM planning process. Available at *https://WaterRetention.sggw.pl*

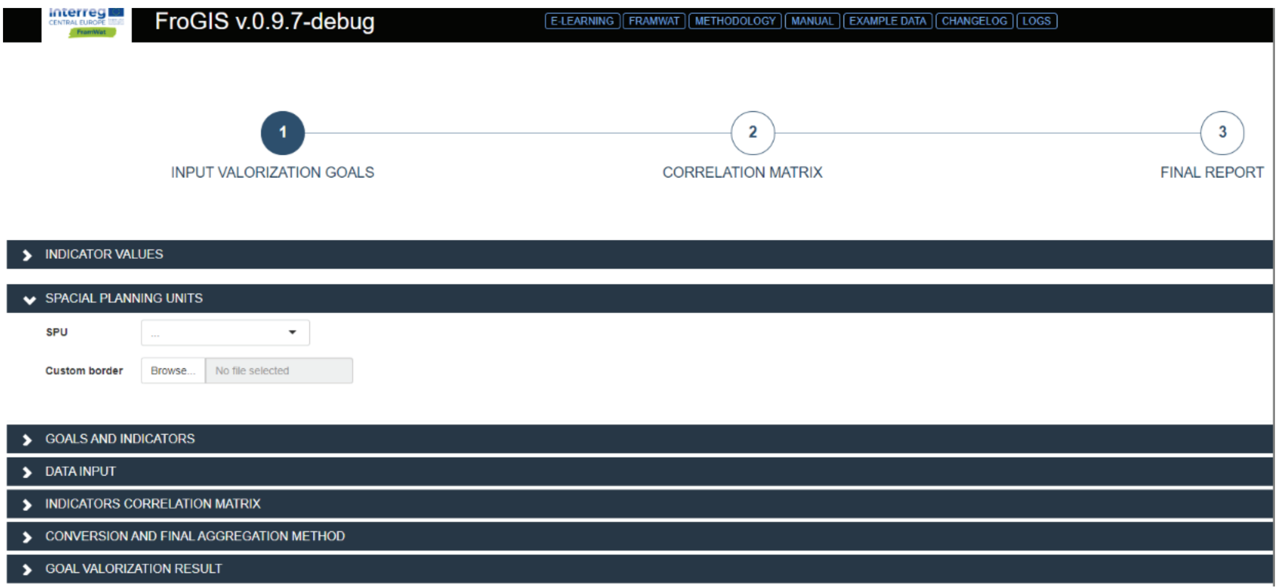


Figure 4: FroGIS user interface (https://WaterRetention.sggw.pl)

Choosing the most suitable location for N(S)WRM is one of the most crucial parts of the planning process. The FroGIS tool was developed in the scope of the FramWat project to assess where small water retention measures are possible and needed in the catchment. Based on FroGIS results, stakeholders are able to locate and define N(S)WRM.

Why and when to use FroGIS?

Valorisation enables consideration of environmental conditions already at the initial stage of the planning process. The input data for this analysis are already created and easily accessible in accordance with the INSPIRE Directive. The methodology is universal and can be used in various locations, but requires individual selection of indicators and valorisation scales. The analysis area may be e.g. a municipality or a catchment area, although the tool is dedicated to measures for non-urban areas.

How does FroGIS work?

FroGIS workflow is presented in the example, and requires prior preparation of data described in the ***help***. The following steps can be particularly highlighted:

- uploading Spatial Planning Unit (SPU)
- choosing a valorisation goal
- choosing indicators
- uploading input data necessary to calculate the indicators
- computing indicators and their statistics for SPU
- review of the correlation matrix and choice of final set of indicators
- choosing the conversion method of indicator values to index
- defining an aggregation method for indices and number of classes
- computing and printing of map
- downloading the report and map

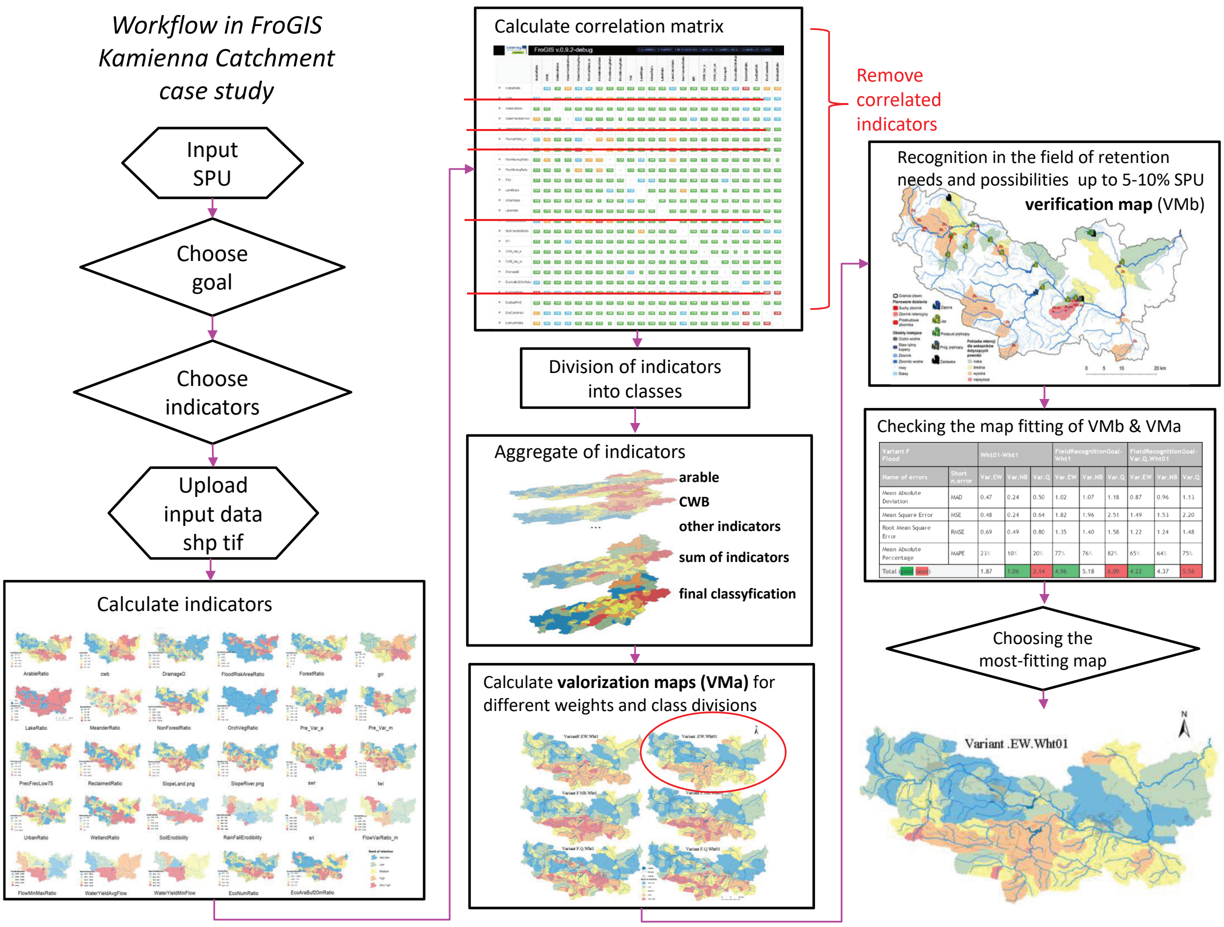
The ***FroGIS app*** is publicly available on Demo server ***http://WaterRetention.sggw.pl***. If any users are interested, further development of the FroGIS app is still possible due to providing its ***source code on the website***.

The ***online course*** for the tool has also been developed.

Stakeholders involvement in this step relies on recognising the hotspots of a specific problem in the catchment, identification of the existing and planned small water retention measures, and verification of the final FroGIS map.

FramWat Example

Diagram describing the analysis process carried out for the Kamienna River catchment in the FroGIS tool



Detailed reports from the six case study catchments are available on the ***FramWat project website***.

STEP 3: Potential measures and scenarios for situation improvement

Goal

To prepare a possible set of measures (scenarios) to solve the identified problems (and to improve water retention in the catchment).

Results

Set of measures aimed at improving water retention in the catchment with stakeholders as initiators of the process.

Step 3 involves continuation of interaction with stakeholders, and discussing with them the results from FroGIS and potential N(S)WRM types that could be used for a certain location.

This is an important step permitting matching the needs (linked to the problem identified in the beginning of the process) with actions/measures possible to implement in a given area.

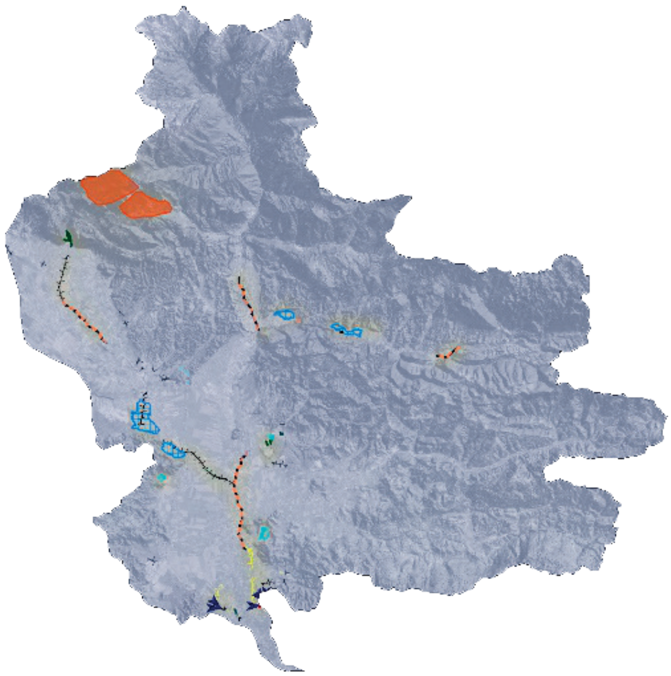
The usual course of action involves experts proposing measures for implementation, and stakeholders simply responding and commenting on them. In our process, we ask stakeholders to be the party proposing measures. Experts share all the possibilities with them, and expand their understanding of all possible measures and their effects.

As shown during testing of FroGIS in the pilot catchments, active involvement of stakeholders from the early stage is perquisite for successful implementation of small water retention projects.

FramWat Example: **Kamniška Bistrica River basin**

In the case of the Kamniška Bistrica River basin, potential scenarios of measures were identified already during the cooperation of experts (flood modellers) and local communitiy. This interactive work empowers the local community in the decision making process, with the representatives of local community understanding better the governing processes related to NSWRM. On the other hand, the experts were provided with direct feedback regarding the key priorty of measures (experience from past floods, validation of the models), and the feasibility of measures (land availability and spatial planning procedures in a given municipality).

Proposed Measures (combined)	No.
dam reconstruction	1x
new levee with river widening	4x
new retention reservoir	4x
bridge reconstruction	2x
stream regulation	3x
erosion control measures	2x
flood diversion	2x
bed-load trap cleaning	2x
new bed-load trap	3x



Expert knowledge list of N(S)WRMs was based on expert knowledge of the catchment and how N(s) WRMs would affect it. The proposed measures take into account the planning process and participation of catchment stakeholders, including local authorities. The selected measures, shown in the figure above, were later evaluated by means of the static and/or dynamic tool.

Decision-Support System can help:

Match the type of measure by using the *Catalogue of Measures* or *AHP Method*.

Review valorisation map and get report of meteorological and hydrological condition.

STEP 4: Developing the Concept Plan

Goal

To select the best scenario by comparing different scenarios from Step 3 – checking the efficiency and combinations of different N(S)WRMs.

Result

Concept plan with information on the type of measures, best locations, and cumulative effectiveness of N(S)WRMs in the selected river basin.

In step 4, the best scenario for situation improvement is selected by means of the Static (Chapter 5.1) and Dynamic methods (Chapter 5.2). The static tool allows for a quick and easy comparison of different variants/scenarios, and dynamic (hydrological and/or hydraulic) models are used for the analysis of the efficiency of different scenarios in more detail.

The primary purpose of this step is to assess the effectiveness of the system of measures in the river basin for which a special manual on cumulative effectiveness of the system of N(S)WRMs (Chapter 4.3) was developed.

The result of STEP 4 is the Concept Plan providing information on the type of measures, best locations, and cumulative effectiveness of N(S)WRM in the basin. The Concept Plan should explain how the analysis of information, data, and context, as well as the evaluation of expert knowledge and stakeholders' preferences led to choosing the selected scenario/combination of measures. The Concept Plan shows how the design and location of the selected N(S)WRMs respond to the opportunities and constraints identified in the analysis (Step 1 and 2).

Such a process demonstrates that response to context (situation, problem, existing measures, local knowledge, etc.) is more important than a simple justification of planned measures designed by experts or authorities.

STATIC tool

Tool that allows the assessment and comparison of different variants of N(S)WRM. It uses a simplified approach to assess the effect of implemented measures. The core element is a set of relationships between measures intensity and expected change in water retention properties of a catchment.

The Decision-Support System can help:

Invite stakeholders to add their own ideas to the map using the ***N(S)WRM Planner***.

Include a transparent link distribution to individual ***tools/methods*** and ***case studies*** in this area

FramWat examples of concept plans for six pilot catchments: ***Aist (AT), Bednja (HR), Kamienna (PL), Kamniska Bistrica (SL), Middle-Tisza (HU), Slaná (SK)***, and in the ***summary report***.

4.1. Static Tool for comparison of scenarios

Static tool is an expert-knowledge-based system for support of planning of natural small water retention measures in the landscape. Its main goal is to enable the estimation of the effects of the planned N(S)WRMs in a simplified way without the requirement of a time-consuming and costly setup of a detailed hydrological model.

The ***StaticTool method*** is universal in terms of the size of the analysed area and climatic and geographical conditions, although relatively similar conditions should occur throughout a given area. The choice of N(S)WRM and determination of parameter values requires the participation of experts who know local conditions and have experience in the planning and implementation of small retention measures, representing the fields of hydrology, hydrogeology, agriculture, drainage, hydrological engineering, forestry, and ecology.

The computer application ***StaticTool.xlsm*** is dedicated for estimating the effects of the planned N(S)WRM. The grade obtained from it is useful for comparing variants of the measures.

Static tool was developed based on an assumption that potential effects of individual N(S)WRM depend on the number and range of impact measures (intensity) in a separate Spatial Planning Unit. This relationship may be determined through expert knowledge, and varies depending on the climatic and physiographic conditions (e.g. slopes, ground permeability) of the analysed area.

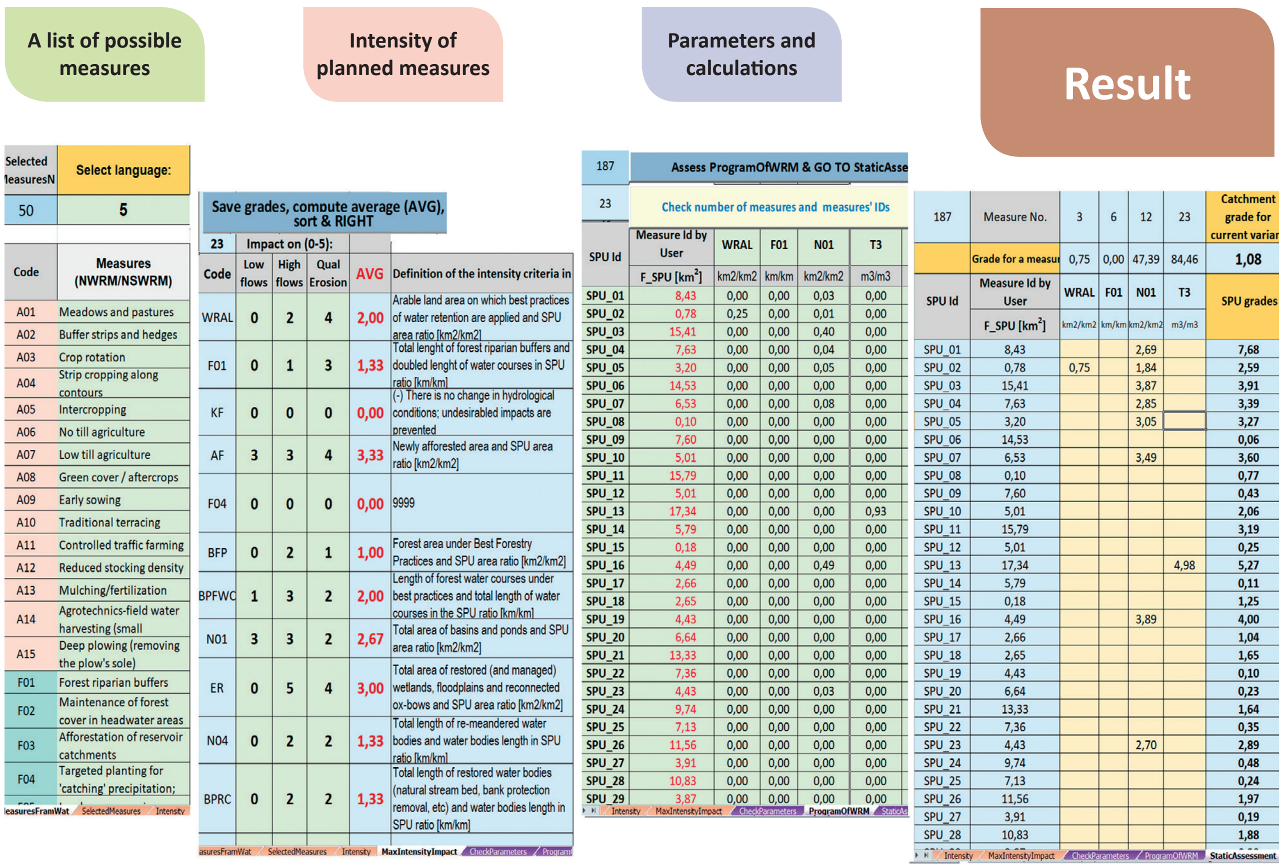


Figure 5: Process included in Static Tool

Static Tool allows comparison of different scenarios/set of N(S)WMRs regardless of how they were developed (local preferences, expert knowledge). Static tool, however, cannot replace modelling.

FramWat Example: **Results for the Kamienna River catchment**

Programme of measures:

a) 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)

Final score: 0.71

b) Local preferences variant:

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)

Final score: 0.49

4.2. Dynamic Modelling

Different mathematical models can be used to assess the effectiveness of different N(S)WRMs for solving typical water management issues such as flood risk, drought, and water scarcity and water quality.

Dynamic modelling within the FramWat project was carried out in six pilot catchments (Table 3). Hydrological models were applied in three countries, and hydraulic models in six countries.

Partner	Pilot catchment	Model name	
		Hydrological	Hydraulic
Austria -WCL	Aist	SWAT	HEC-RAS 1D
Croatia - HV	Bednja	HEC-HMS	MIKE21
Hungary - MTDWD	Nagykunsagi	-	HEC-RAS 1D
Poland - WULS	Kamienna	SWAT	HEC-RAS 1D/2D
Slovenia - UL	Kamniška Bistrica	RiverFlow 2D	
Slovakia - SVP	Blh	-	HEC-RAS 2D

Table 3: List of models applied in FramWat case studies

Dynamic modelling is a labour-intensive process that involves several major steps as presented in Figure 2. The general purpose of dynamic modelling is to assess the impact of changes in specific driving factors (climate change, land use, and water management), or to assess the effectiveness of specific measures such as N(S)WRMs.

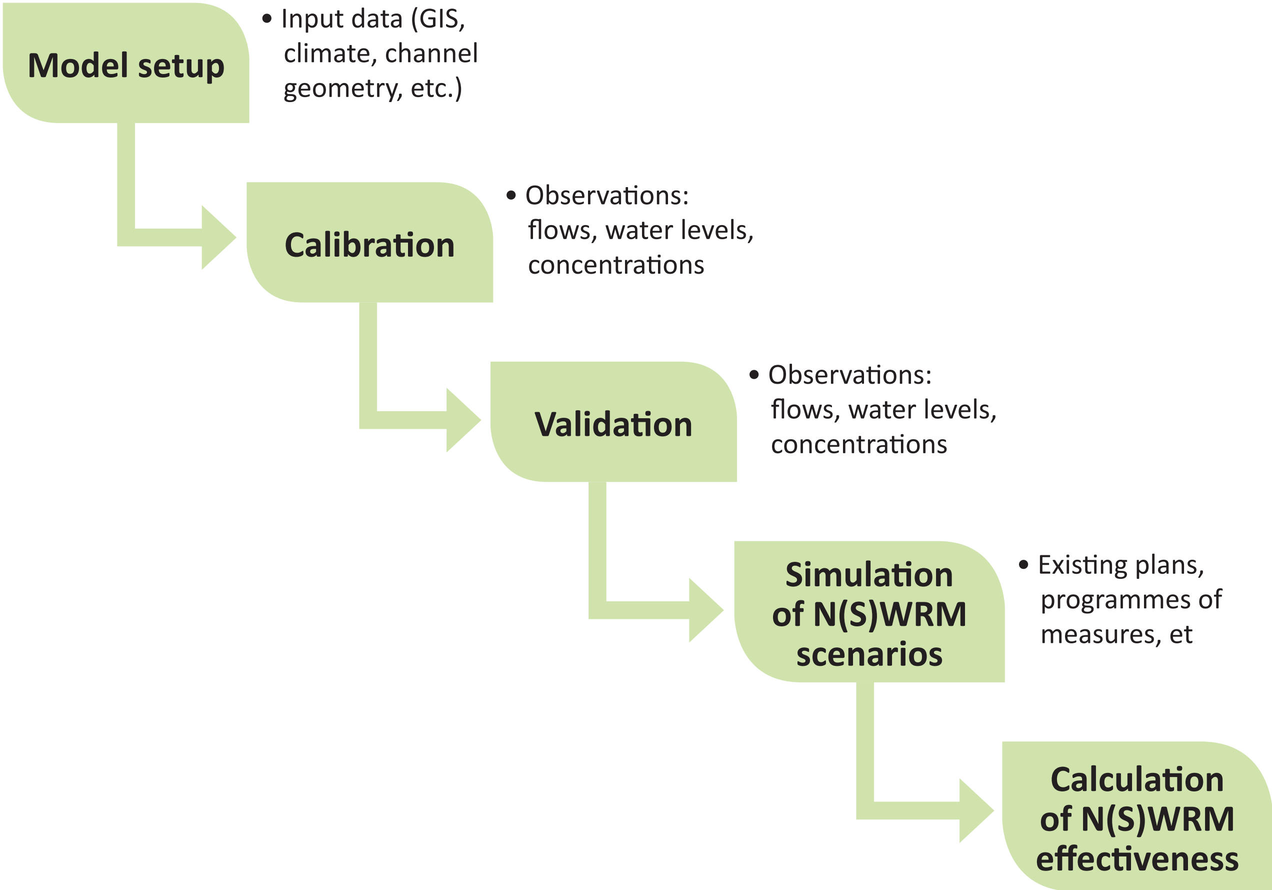


Figure 6: Typical hydrological/hydraulic modelling workflow

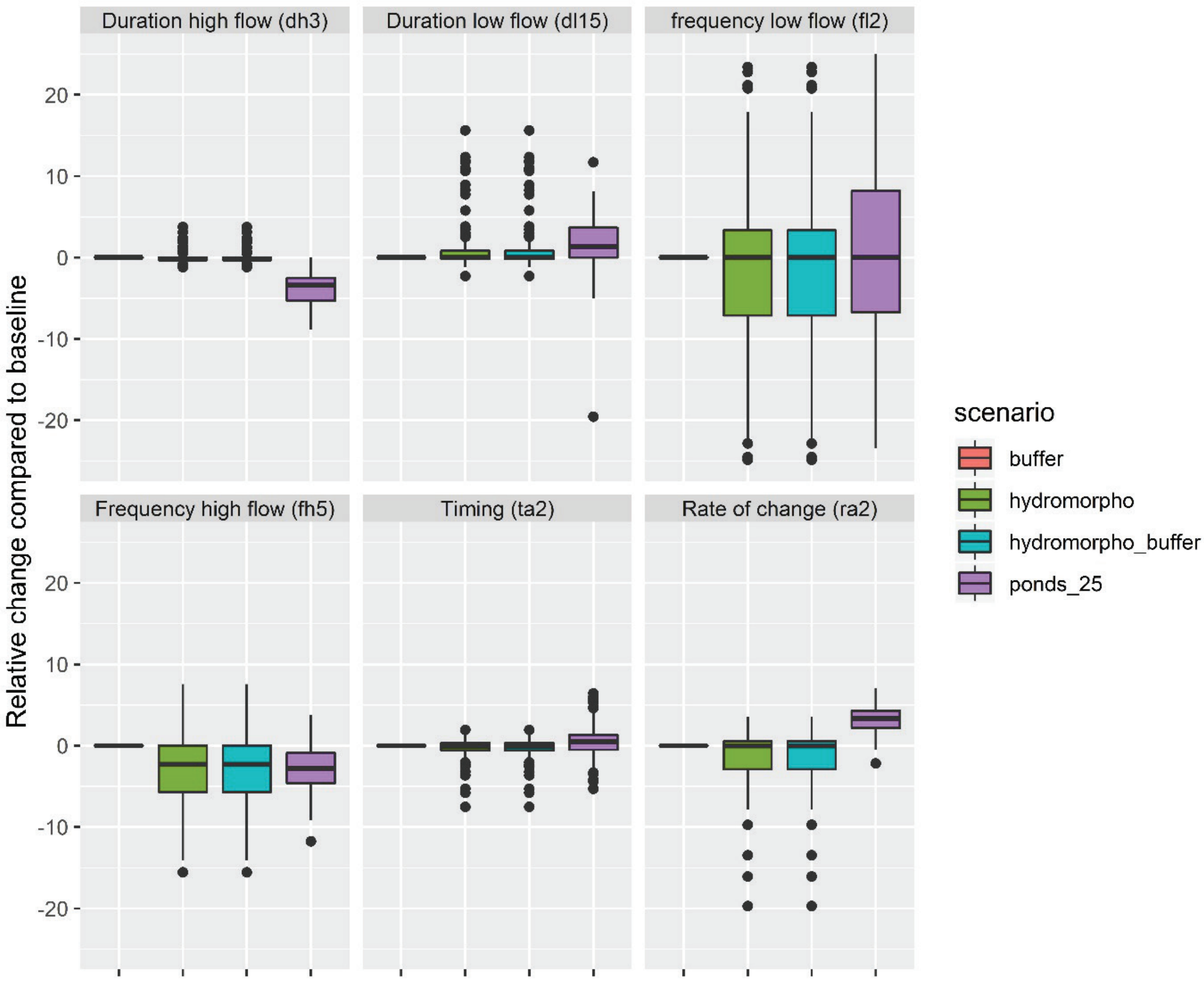
The key part of the workflow in the context of these Guidelines is the implementation of measures in the models. Hydrological models are suitable for including landscape-scale measures such as land cover changes (e.g. afforestation, conversion to meadows and pastures), changes in management practices (e.g. crop rotation, no-till agriculture), and definition of new water constructions such as constructed wetlands or sedimentation ponds. In contrast, hydraulic models are suitable for in-stream measures such as re-meandering, removal of dykes, or reconnection of oxbow lakes. Two important aspects in this context are measure location and parametrisation. While location can be determined from the Concept Plan, model users should follow best modelling practice in setting parameter values representing different N(S)WRMs.

FramWat Example: **Results from the Aist River catchment**

In the Aist River catchment (Austria), an ecohydrological modelling cascade was set up consisting of four inter-connected models: (1) the SWAT model simulating water balance and sediment generation at sub-catchment scale, (2) the 1D hydraulic model HEC-RAS simulating the reach-scale hydraulics, (3) a Random Forest (RF) model for fine sediment accumulation, and (4) species distribution models (SDMs) for the target species Freshwater Pearl Mussel (FPM). Details on the model's implementation and interlinkage are described in the Dynamic modelling report. Accordingly to the concept plan, three types of measures were implemented in SWAT, tackling both the issue of water retention and sediment cycle balance: (1) in-stream hydro-morphological improvement (HYDROMORPHO); (2) vegetated buffer strips (BUFFER), and (3) sediment retention ponds (PONDS_25). The fourth scenario included vegetated buffer strips and hydro-morphological improvement (HYDROMORPHO_BUFFER).

FramWat Example: **Results from the Aist River catchment**

The results shown on the plot below present the hydrological effectiveness of these four N(S)WRMs as simulated by SWAT for a range of different high and low flow indicators. The reader is referred to the *Action Plan* and the paper "A multi-scale, integrative modeling framework for setting conservation priorities at the catchment scale for the Freshwater Pearl Mussel Margaritifera margaritifera."[1] from testing the dynamic model to assess the cumulative effect of N(S)WRM for the Aist River catchment for more results and methodological details



Dynamic (hydrological and hydraulic) models can be useful tools in predicting the effect of various N(S)WRMs on flood and drought mitigation and improvement of water quality. Model selection should be guided by a specific set of measures designed for implementation/testing in a given catchment. As a rule of thumb, landscape-scale measures can be properly applied in hydrological models, whereas hydraulic models are usually more suitable for in-stream measures. Model complexity (in terms of spatial/temporal scale as well as description of physical processes) depends on the desired objectives.

[1] Baldan, Damiano, et al. "A multi-scale, integrative modeling framework for setting conservation priorities at the catchment scale for the Freshwater Pearl Mussel Margaritifera margaritifera." Science of The Total Environment 718 (2020): 137369

4.3. Manual on cumulative effectiveness of the system of N(S)WRMs

The Manual supports the selection of most effective N(S)WRMs and allows decision makers and authorities to:

- prepare River Basin Management Plans, Flood Risk Management Plans, etc.
- facilitate the consultation processes between different sectors (water management, agriculture, forestry, municipal authorities, etc.)
- choose the best scenario of N(S)WRMs in the basin

The ***Manual*** is an applicable tool providing a set of procedures for the evaluation of direct or cumulative effects of several N(S)WRMs. It builds upon knowledge and experience of partners gained during the FramWat project in N(S)WRMs effectiveness assessment. The Manual helps the user follow particular steps of the ***StaticTool method*** and to pass via steps of ***Dynamic modelling***. Even if the user is not familiar with individual steps of the FramWat project described in these Guidelines, the Manual navigates through each of the steps. It uses knowledge on ***N(S)WRMs effectiveness*** compiled and analysed by partners. The logic of the Manual workflow is presented in Figure 3. The Manual will guide the user to develop the Concept Plan comprising information on the type of measures, their locations, and expected cumulative effectiveness. The Concept Plan can be further adjusted via the application of the ***AHP Method***, if needed.

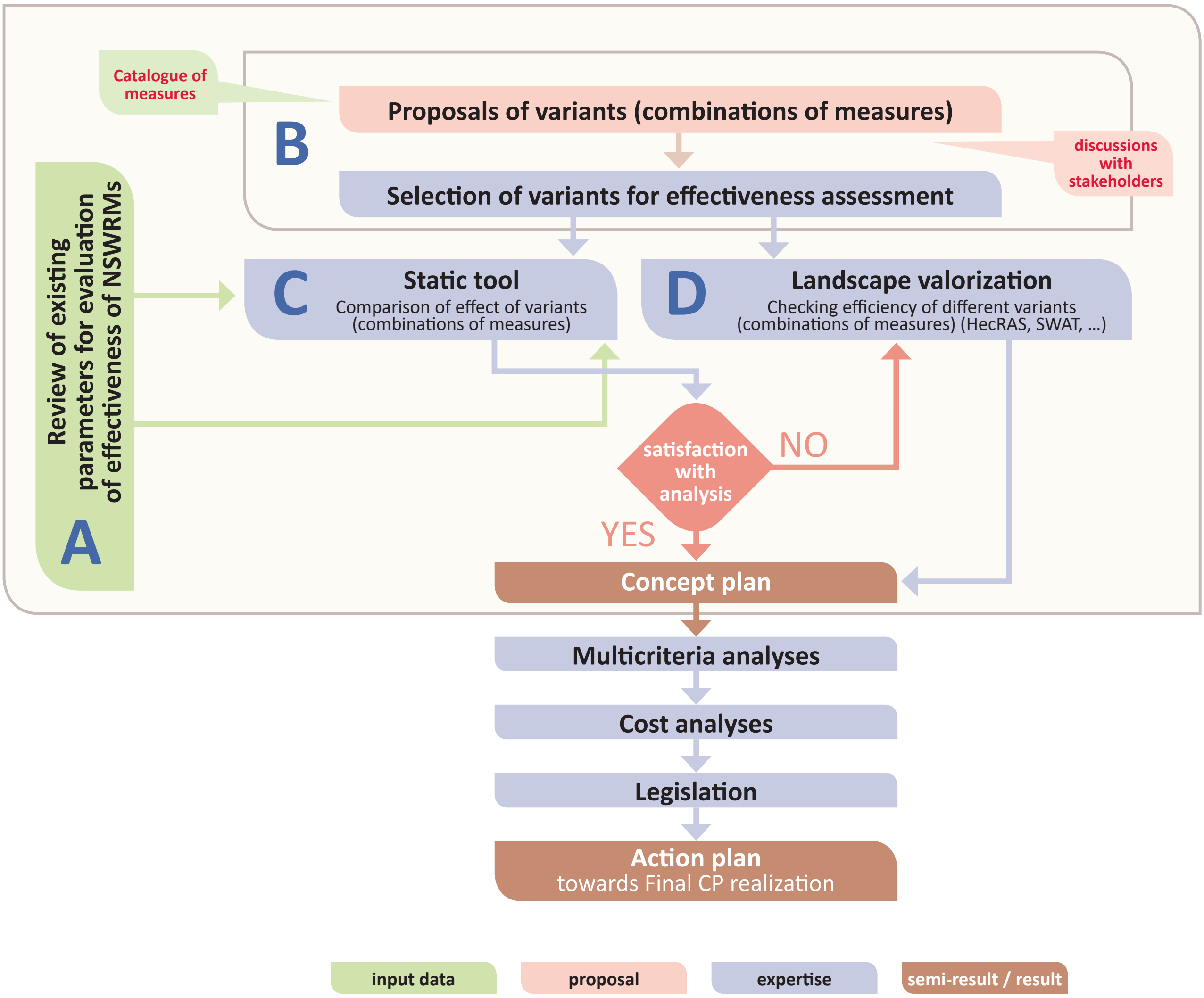


Figure 7: Logic of the Manual workflow

STEP 5: Concept plan into Action Plan

Goal

To develop an Action Plan explaining the objectives and steps to be taken, or activities that must be performed with a timeline, financial resources, and a definition of the responsible actors.

Result

Concept Plan

Set of measures that can improve water retention in the catchment

Action Plan

Clear steps, timeline, financial resources, and actors responsible for integrating N(S) WRMs into RBMPs

A Concept Plan is upgraded to an Action Plan by adding:

- Multicriteria analysis
- Cost analysis
- Legislation analysis

Decision-Support System:

Contains a query system that allows searching for legal procedures and documents necessary for the investment process for N(S)WRM after prior indication of the type of measure, description of the place of implementation (watercourse or outside, private area, protected area), and current land use – link.

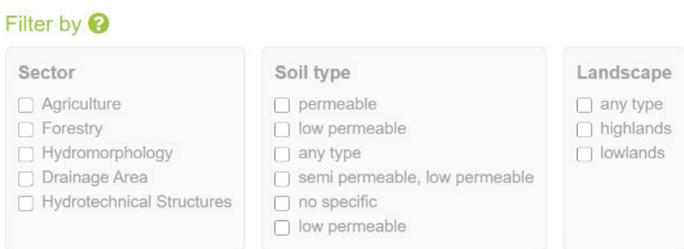
Contains quick links to individual ***tools/methods*** and ***case studies*** in this area

5.1. Multicriteria analysis

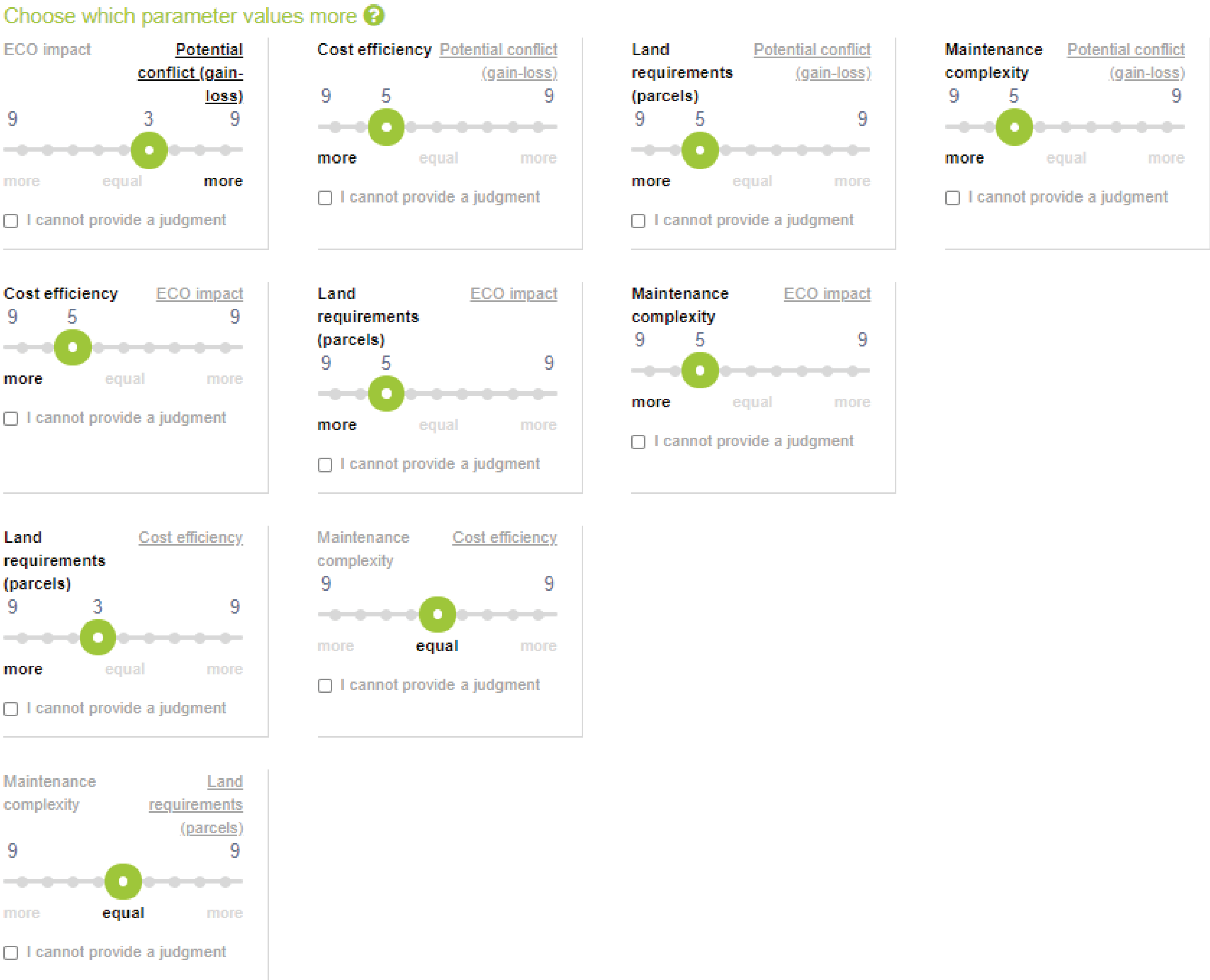
Multicriteria analysis – the Analytical Hierarchical Process (AHP) tool was developed for prioritisation of N(S) WRMs. It is available at ***http://ahp.framwat.apps.vokas.si/step1***.

The tool can be used to support the communication process and harmonisation of views of different stakeholders while enabling user-friendly identification of individual priorities of users regarding the application of different measures from the catalogue of measures. The AHP analysis enables pre-filtration of NSWRM measures from the developed catalogue based on three filtration criteria:

- Sector
- Soil type, and
- Landscape



In the next step, following the basic principles of the Analytical Hierarchical Process method, the user is invited to provide their personal perception relative to the pairwise comparison of the four governing criteria important for the priority selection of N(S)WRM: ecological impact, cost efficiency, land requirements, maintenance complexity.

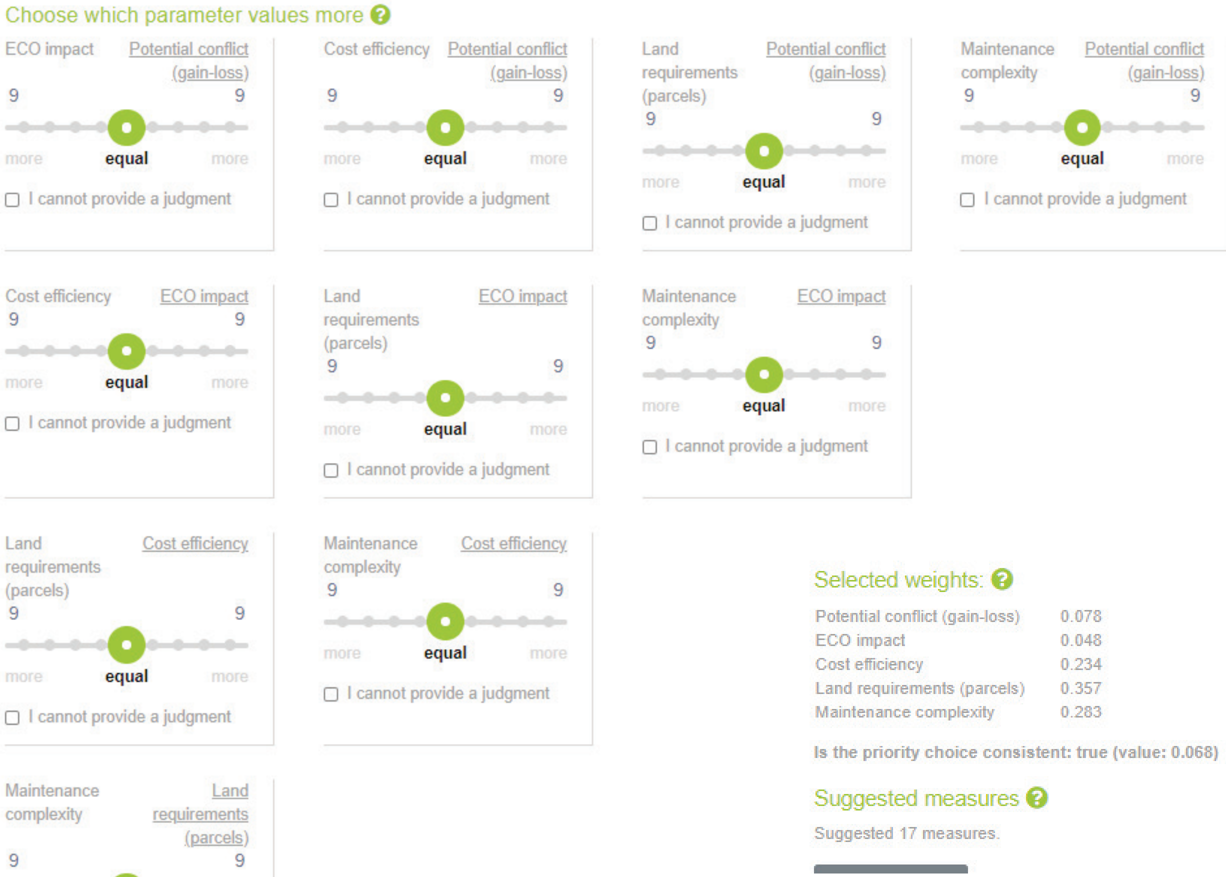


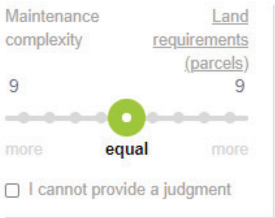
An important feature of the AHP tool is that there is no right or wrong answer. Instead, it mirrors and evaluates (using the consistency verification process) different views and priorities of different stakeholders that use the tool. In the guided evaluation process, the users would understand better the possible criteria applied by other stakeholders in the evaluation and decision-making process, and gradually converge towards a mutually agreed set of priority measures.

The result is a prioritised set of measures (from the N(S)WRM catalogue) applicable to a given area and accepted by the participating stakeholders.

FramWat Example: **Results of the AHP MCA tool use from Kamniška Bistrica River catchment (Slovenia)**

Selection of priority measures using the AHP Multicriteria Analysis in the Kamniška Bistrica River catchment was based on the following criteria:





The selected criteria reflect the understanding that the highland part of the river basin is well preserved from the ecological point of view, while its lowland part is heavily urbanised, with intensive agriculture.

This mirrors low relative criteria of ecological impact in relationship to other criteria of the AHP procedure. Land requirement is the most important criterion, with identified difficulties in land availability for different remediation measures. The consistency check turns out adequate (0.068). The suggested priority measures mirror the ongoing work and evaluated measures in the static and especially dynamic evaluation process:

Some measures are already thoroughly implemented (i.e. afforestation). Measures related to agricultural production are less relevant due to the limited agriculture production on catchments in highlands. Due to the specific topology and necessity of the effects, it was also recognised that measure "Construction of small reservoirs – retention" does not necessary stand for small reservoirs. In some parts of the catchment, only reservoirs with a dynamic retention volume of more than 500,000^0 m^3 would have a substantial effect.

Description of the NSWRM	AHP MCA Score
Active water management on a drainage system (river valleys)	1.00
Widening or removing of flood protection dikes	1.00
Afforestation of reservoir catchments	0.98
Appropriate design of roads and stream crossings	0.98
Restoration of natural infiltration to groundwater	0.98
Meadows and pastures instead arable land	0.94
Buffer strips and hedges	0.94
Intercropping	0.94
Re-naturalization of polder areas	0.94
Land use conversion	0.94
Removal of dams and other longitudinal barriers	0.93
Construction of small reservoirs on rivers (dammed reservoirs)	0.93
Floodplain restoration and management	0.93

5.2. Cost analysis - how to calculate costs of selected measures?

N(S)WRMs are dispersed on small rivers within the river basin. Their cost assessment is therefore complex and goes beyond administrative boundaries. The idea of cost analysis is consistent with broader development ambitions to foster implementation of N(S)WRM.

The goal is to reach a beneficial and cost-effective decision.

The approach has two main applications:

- to determine the investment costs, and
- to provide the basis for the comparison of investments, and determine financially acceptable options.

Cost Analysis

Methodology to calculate the costs of selected measures. Allows the choice of the most suitable financing resources and instruments for NSWRM, and preparation of a financial plan for the implementation of the measures.

The Approach is designed to provide the user with information on N(S)WRM costs and impacts of the overall investment. The document covers the most common approaches, and reflects on how prices differ across the Central European Region. The ***Approach on how to calculate N(S)WRM on a river basin scale is published online***.

5.2.1. Cost analysis of structural (engineered) NSWRM

There are several approaches to the assessment of construction costs of N(S)WRM. In principle, we distinguish between the detailed and simplified approach. The advantages and disadvantages of these different cost approaches are summarised in Table 1.

Table 4: Comparison of the cost evaluation approach

Cost method	Advantage	Disadvantage	Applicability
Simplified approach – cost by comparison	No cost assessment needed.	Can lead to major mistakes and poor judgement.	Not recommended.
Simplified approach – cost by typical group of works	Only a rough estimation.	Needs basic design. Common use in feasibility studies. Possible mistakes	Applicable for experts for screening or deciding which among several measure to proceed with.
Detailed approach	Most accurate method.	Needs detail design and time consuming.	Applicable for experts.

Simplified approach – cost by comparison

Few projects have attempted estimation of the capital and operational costs of engineered measures and expressed them in unit costs of EUR/ha, EUR/km, or EUR/m3 over the last decade. This kind of generalisation can be very misleading, because it can generate major mistakes. Cost assessment of N(S)WRM is very case specific. Therefore, costs cannot be transferred from one location to another. Costs are generally impacted by the type, complexity, location, size, and river/catchment typology.

Simplified approach – cost by typical group of works

The most accurate cost assessment without analysing the detail design is the assessment of cost groups that have the greatest impact on the construction costs. Such situations are common, and public administration officials trust expert judgement. The estimates are usually used for pre-tendering, screening of possible solutions, and even for on-site inventory of damages caused by natural disasters. Basic or conceptual design is the basis for cost estimation with a simplified approach.

Detailed approach

The most accurate cost assessment is based on detailed design, where construction costs are broken-down in bill of quantities. In the case of the N(S)WRM planning process at a river basin scale, however, it is questionable whether the detailed approach is reasonable. The choice of approach depends on:

- Project type and purpose (why the cost assessment is needed);
- Number and complexity of measures;
- River basin size;
- Available resources.

Data collection

Before implementation of the simplified cost analysis, the following must be identified for all measures for which cost analysis would be done:

- Elaboration of basic design;
- Assessment of typical group of works;
- Assessment of the difficulty factor;
- Assessment of preparatory and finishing works;

Typical groups of works were defined for each measure, and their costs per unit were estimated (pricing basis). These costs should be multiplied by the difficulty factor (difficulty of accessing and performing works) and preparatory and finishing work percentage.

5.2.2. Cost analysis of non-structural N(S)WRM

The applied approach to cost assessment of non-structural measures contains measures grouped in two main categories: soil conservation practices and tree planting.

Soil conversation practices

Total costs of the implementation of non-structural N(S)WRM derived from changes in agricultural practices can be understood from the perspective of the cost of farming. The implementation costs comprise fixed costs (building cost, infrastructure, and machinery) and variable cost (material, labour, fuel for farm machinery, machinery).

Tree planting

The establishment costs of N(S)WRM derived from planting can be broken down into site preparation, costs of plants, and planting.

Overview of non-structural measures

The overview of non-structural measure costs and factors affecting their costs is presented in Chapter 4 of the Approach (link).

Pilot action

The level of detail of cost assessment remains an issue across the approach. It was confirmed by the pilot action. A degree of pragmatism is required here. The cost assessment of N(S)WRMs investment costs in three pilot catchments demonstrated extreme vulnerability related to local (specific) conditions and expert judgment.

The pilot action was influenced by a number of specifics of N(S)WRMs, and required collaboration of various experts (agriculture, forestry and hydrotechnical engineering, economics). The approach can be used and implemented in Central Europe by policy officers, planners, water managers, etc.

FramWat Example: **Results from the Nagykunsági River basin**

Total cost estimation for buffer strips and hedges measure (A02) in the Nagykunsági River basin:

Group of measures	Measure	Unit (area)	Price [EUR/unit]	Difficulty factor [1,;1,5;5]	Preparatory and finishing works [25%]	Total cost [EUR]
Agriculture measure	Buffer strips and hedges	90 ha	400 EUR/ha	1	1,25	45 000 EUR

Cost analysis report from the Pilot action:
Describing the process of cost analysis. Experts approach – evaluation, specific.

5.2.3. Replicability of the Cost Analysis

The pilot action can also be used in other territorial settings, but needs to be managed carefully and linked to the challenges of developing a N(S)WRM (concept) plan for the river basin. The obtained knowledge on the pilot action can be considered as achieving desirable outcomes.

Table 5: Lessons learned from the pilot action

Lessons learned	Added value
• It is possible to assess costs based on limited information, but the results should be approached with caution. • Cost assessment should only be done by an experienced expert; • The results are not based on detailed design – only indicative values for planning purposes are considered, not for project development; • Increasing uncertainty over time (price change with time); • Use of unit costs per measure (e.g. cost of buffer per m2) can lead to serious mistakes; • Pilot action reflects regional prices.	• Pilot action encourages debate on how to secure political commitment and financial resources for N(S)WRM implementation; • Cost assessment emphasises the importance of adopting a long-term perspective. It allows authorities to make realistic long-term plans; • Pilot action responds to N(S)WRM cost-efficiency questions across the region; • It fosters implementation of the Water Framework Directive by the EU member states by supporting the preparation of environmental financing strategies for N(S) WRM;

5.3. Legislation - how it is on the national level

All European Union countries have been using the river basin approach to water management since the adoption of the EU Water Framework Directive and the EU Floods Directive. International river basin commissions such as the International Commission for the Protection of the Danube River (ICPDR) act as transboundary coordination platforms. Linking of flood risk management with river basin management is one of their key goals. The Flood Risk Management Plan for the Danube River Basin District included national activities towards water retention.

N(S)WRMs are, however, primarily planned and implemented at the national or sub-catchment level. Legislation concerning N(S)WRM is different in different countries of Central Europe. The example from Slovakia shows the complexity of legislation and permit processes for N(S)WRMs in urban areas, landscape, or forests.

The Water Act 364/2004 defines "water construction" and the role of the state water administration. State water administration bodies include the Ministry of Environment, district authorities, Environmental Inspectorate, and municipalities. N(S)WRMs mainly fall in the category of flood protection structures or constructions by which the riverbed is modified, changed, or established, including the surrounding landscape. The state water administration resolves all doubts regarding differentiation between a water structure and its part. A permit is required for the implementation of a water construction, its change, change in use, and removal. The notification of the state water administration is sufficient for the implementation of modifications to a water construction. The state water administration can, however, determine that the notified construction modification can be carried out only based on a building permit. In any case, a permit of the state water administration is required for planting, shading, and removal of trees in riverbeds, riparian areas, and in floodplains.

In urban areas, the building authority, constituting a part of the municipality office, discusses the builder's application of N(S)WRMs in the construction proceedings according to the Building Act 50/1976 with the authorities concerned and known stakeholders. After a review, it makes a decision regarding a building permit under §66 of the Building Act. N(S)WRMs also require construction documentation.

On forest land, construction of simple flood protection N(S)WRMs in forests, such as wooden dikes or loose stone dikes, does not require a building permit. Other more complex N(S)WRMs on forest land, divided among state forests and private owners, require a building permit. Examples are construction and reconstruction of technical works in forests for flood protection, erosion prevention, and accumulation of water for fire protection according to Forest Act 326/2005.

Different countries have different regulations regarding the implementation/introduction of N(S)WRMs in the landscape. No clear procedure can be therefore determined for the required type of permits and documentation. Local authorities can include N(S)WRMs in local spatial planning documentation (e.g. municipal detailed spatial plan for industrial zone), where they can define the exact location and size of the measure. They can also suggest the use of local (woody) native vegetation, or define the species (e.g. willows).

Table 6: Procedure and documentation for buffer strips and hedges in Slovenia

Type	Description
Buffer strips and hedges at margins of transport infrastructure	In accordance with Roads Act (ZCes-1, Official Gazette of the Republic of Slovenia, No. 109/10, 48/12, 36/14 , 46/15 in 10/18), the applicant of an intended construction within a state road buffer zone shall have no right to require the implementation of protection measures against the effects of the road and the traffic on it. The state road buffer zone shall be 40 metres on motorways, 35 metres on highways, 25 metres on main roads, 15 metres on regional roads, 5 metres on state cycle routes. The municipal road buffer zone shall be a maximum of 10 metres on local roads, 5 metres on public routes, 2 metres on municipal cycle routes. Within the state and municipal roads shall not be permitted to establish any vegetation that would reduce the visibility of the road, intersection, or access road. The use of space within a municipal road buffer zone is limited but not prohibited. For reasons of transparency, the height of the hedge should not exceed 75 cm above the level of the carriageway, the trees growing along these roads must be trimmed so that the free height above the road is at least 4.5^{0}m, and the shrubs or trees must be trimmed at least to the outer edge of the bank. For state roads Agency and for municipal roads, the municipal road operator decides in favour or against buffer strips.
Buffer strips and hedges at margins of a watercourse	In accordance with Water Act (ZV-1, Official Gazette of the Republic of Slovenia, No. 67/2002), ensure area for 1st order watercourse type is 15 meters and 5 meters for 2nd order watercourse type. Main function of coastal line is the provision of interim zone between watercourse and area of intervention (construction, farming etc.) thus enabling water pollution mitigation. Buffer stripes and hedges can be implemented as measures to improve hydromorphological and biological properties of surface waters or as measures for nature conservation. Owner of the land decides in favor or against riparian corridor.
Buffer strips and hedges at margins of arable land	**Hedges in rural areas under Natura 2000 protection** Rural Development Program of the Rep.of Slovenia (2014-2020) supports environmental functions of farming. It targets increased implementation of natural/sustainable farming practices for sustaining biodiversity. The program includes preservation of hedges, particularly in 6 defined areas within Natura 2000. The following definition is agreed: a hedge is min. 10^{0}m long and 20^{0}m wide (canopy parameter) group or line of trees or shrubs that is not being interrupted on 10^{0}m distance with a permissible gap of max.3^{0}m. The subsidy received is 1.6^{0}eur/m per year (under defined conditions)[2] **Buffer stripes and hedges at margins of arable land** Rules on the register of agricultural holdings[3] (Official Gazette of the Republic of Slovenia, No. 83/16). It determines that limited areas that aren not in direct farming use are included in legal farming unit (basic for CAP subsidy receipt). Buffer strips and hedges that are wider than 2^{0}m are excluded from legal farming unit and therefore abandoned by farmers and replaced by cultivated land subjected to subsidies. In the case of buffer strips and hedges narrower than 2^{0}m, the farmer decides on their preservation/removal. There are no refunds or subsidies for land or income loss for buffer strips and hedges implementation.

[2] https://www.program-podezelja.si/sl/knjiznica/133-navodila-za-izvajanje-operacije-ohranjanje-mejic-v-okviru-kmetijsko-okoljskih-podnebnih-placil-kopop-2017/file

[3] http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV12579

5.4. Structure of the Action Plan

The Action Plan provides clear steps, timeline, financial resources, and responsible actors for integrating N(S)WRMs into river basin management plans.

- The Action Plan is an implementation document.
- The Action Plan should also include a monitoring procedure of its implementation (annex 2 – checklist verifying its implementation).
- It should be “signed” (agreed) by all responsible institutions.

Structure and content of an Action Plan:

1) **Introduction, description of the catchment, main problems**

2) **Selection of N(S)WRMs for the catchment** – describing the process (modelling results, effectiveness, stakeholder input)

3) **N(S)WRMs legislation and financing** – identifying existing national legislation supporting N(S)WRMs implementation and possible sources of financing the measures Legislation/policy

4) **Monitoring** – describing the monitoring of the implementation of the Action Plan and the measures

FramWat example: *Action Plan for the Aist River catchment*

CONTENT

6. Conclusion/Summary

The Guidelines build on FramWat project outputs, transnational cooperation, and results of other water related projects. The Guidelines summarise results of FramWat related to planning, building, and maintaining N(S)WRMs in different conditions in Central Europe. The publication is well-timed for decision-makers with appropriate tools to incorporate N(S)WRM into the river basin management plans 2022-2027. They offer guidance and raise awareness of the importance of horizontal integration of different planning frameworks.

Green infrastructure will play a vital role in economic recovery from the coronavirus pandemic. A recently approved recovery instrument, Next Generation EU, offers an opportunity to solve heritage from the past regarding environmental burdens, fix current lack of water supply and sanitation, and look ahead to the implementation of structureal reforms, facilitation of innovation, and support of climate-proof solutions. Not all the priorities are directly connected to water, although water is an important connector, particularly with respect to climate change.

The Guidelines highlight the importance of stakeholder involvement and social capital for the successful uptake of N(S)WRMs. The pilot actions benefited from the bottom-up approach and cross-sectoral cooperation of agriculture, forestry, fisheries, tourism, and civil protection sectors. This might be relatively new to water management that has so far fulfilled its traditional roles in isolated silos. The implementation of N(S)WRMs requires cooperation and leaving the sector’s comfort zone.

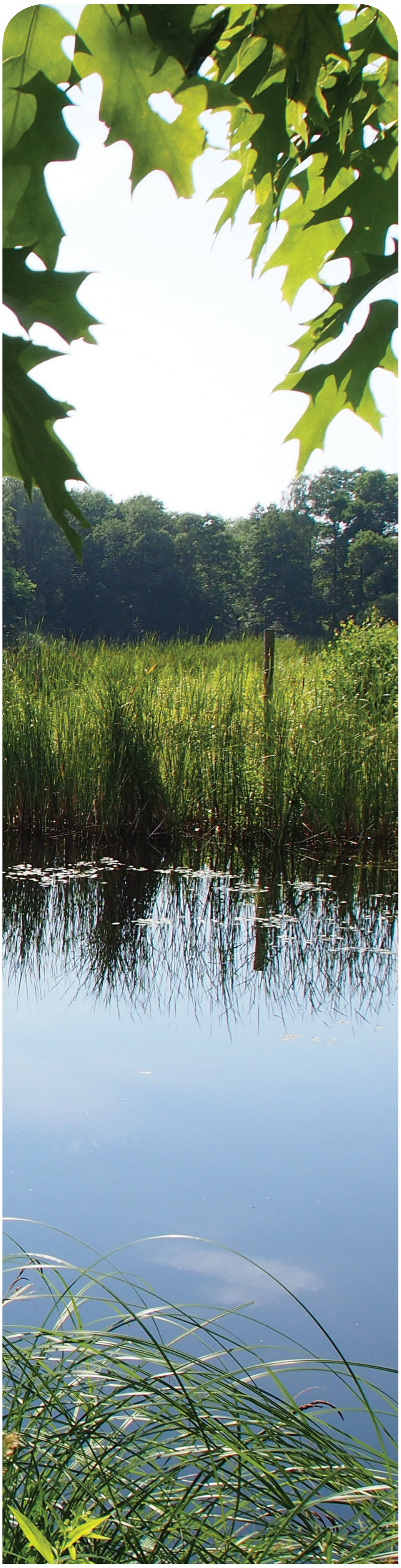
The Guidelines are among the most important outputs of the FramWat project. They connect and summarise all other outputs in a holistic way. The publication is therefore a must-read for anyone interested in river basin management or land use planning.

Acknowledgements

The work leading to the FramWat results, reflected in these Guidelines, has received funding from the Interreg CENTRAL EUROPE Programme. This document has relied heavily on the dedication and expertise of the entire FramWat partnership. Sincere gratitude goes to all other cooperative institutions with their experts and scientists who provided inspiration during the project planning and implementation, and to all who gave support for the successful completion of the project. We are grateful to the associated strategic partners and international bodies, especially the International Sava River Basin Commission, for their contribution and support throughout the project development cycle and beyond. Our gratitude also goes to the participants of FramWat events, national seminars, workshops, and conferences who have been an important source of insight and advice.

Thank you.

Small retention - Big deal!



Lead Partner:

Warsaw University of Life Sciences, Poland

Partners

Croatian Waters - legal entity for water management, Croatia

Global Water Parntership Central and Eastern Europe, Slovakia

LIMNOS Ltd, Company for applied ecology, Slovenia

Middle Tisza District Water Directorate, Hungary

Slovak Water Management Enterprise, Slovakia

University of Ljubljana, Slovenia

WasserCluster Lunz – biologische Station GmbH, Austria

Asociated Partners

International Comission for the protection of the Danube River

International Sava River Basin Comission

Hungarian Chamber of Agriculture, Hungary

Ministry of the Environment of the Slovak Republic, Slovakia

Regional Water Board Warsaw, Poland

Slovenian Water Agency, Slovenia