COST ANALYSIS REPORT FROM THE PILOT ACTIONS (MTDWD)

D.T3.3.1

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Activity leader	GWP CEE
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Participating partners	all
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1 Introduction

One of the activities in WP 3 is the Cost analysis (A.T3.3). The goal of this activity is to develop a uniform methodology on how to calculate and analyze N(S)WRM costs on river basin scale.

The testing of the developed cost analysis approach has been made using examples from 3 countries-partners (Poland - WULS; Hungary - MTDWD, Croatia - CW). The method of testing provides information on how to estimate investment costs of N(S)WRM on basin scale based on a concept plan (AT2.3) and supports the justification of SWRM in RBMP in decision-making process.

This document presents content for a summary report of pilot actions on testing cost analysis methodology.

This document presents reports from pilot actions on testing cost analysis methodology.

2 Method testing

A simplified approach of the methodology was developed to assess N(S)WRM costs on river basin scale. The purpose of method testing is to analyse developed methodology and to evaluate its usefulness.

2.1. Data gathering

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

- Type and location of the measure;
- Preliminary size;
- Investment cost per unit for every measure;
- Pricing basis, costs for the typical group of works;
- River typology (altitude, catchment area, river width).

Type and location of the measure

Type and location of the measure was defined in the Concept plan (DT.2.3.1), while cumulative effect of the measures on the river basin was assessed with the dynamic model (DT2.4.2).

Preliminary size

For each measure preliminary size was defined for the purpose of modelling.

2.2. Cost estimation

For some of the measures there is no capital investment required, like turning meadows and pastures into arable land. For these measures only detailed approach is useful for cost analysis, with taking into account other costs (land change costs and maintenance costs). The valuation of other agricultural and forest measures in following a simplified approach that is not be too different from the detailed one. On the other hand the hydro-technical measures are more complicated. Therefore two calculations are presented below.

2.2.1. Average cost per unit of measure

For some measures from the NWRM catalogue[1] we gathered data of average cost per unit of measure (total investment cost of measure per unit), which are based on the past projects or literature review.

The costs per unit were based on previous similar projects (investment project, NWRM project) and experiences (professionals).

The average cost varies according to the region of the measure, and is therefore only an indicative estimation and provides a rough cost projection we can use for budget planning purposes in the early stages of concept development. It is not a substitute for feasibility study.

For each measure investment costs are calculated, using equation below:

$$Invesment\ cost = Units\ of\ a\ mesure * Average\ price\ per\ unit$$

To put it another way

$$IC\ [€] = U\ [m] * PU[\frac{€}{m}]$$

Where,

IC=investment costs [€]

U=units / dimensions (length, height, width. volume, area) of a measure

PU=average price per unit [€]

Table 1: Required data for cost assessment with simplified approach

Group of measures	Measure	Unit	Price [EUR/unit]	Difficulty factor [1; 1.5; 5]	Other works [25 %]	Total cost [EUR]

2.2.2. Pricing basis, costs for the typical group of works

For other measures the method described above (simplified estimation of costs) can't be realistic, due to their complexity, different version of execution, etc. Therefore the typical group of works were defined for each measure. Their costs per unit were estimated (pricing basis). These costs should be multiplied by the difficulty factor (difficulty of accessing and performing works). The examples are shown below.

Table 2: Pricing basis, costs for the typical group of works used in cost assessment

Item	Unit	Price [EUR/unit]
Excavation, off-site disposal	m3	50
Structure development < 5	pcs	2 000
Structure development > 5 m^3/s	pcs	60 000

[1] *http://nwrm.eu/measures-catalogue*

Item	Unit	Price [EUR/unit]
Dike development	m	600
Channel bed development	m	20-40
Subsurface ditches	m	600
Weir (concrete)/ Overflow structure 2-5 m3/S	pcs	100 000
Weir (concrete)/ Overflow structure 50 m3/s	pcs	300 000
Dam from 3-5m	m	1 820
Outlet structure (the depth up to 2 m)	pcs	20 000
Broken shrubs	m^2	3

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The price includes transportation up to 10 km, implementation of the material. The price per unit includes the total cost of a measure (access routes, diversion dikes, pumping, earthworks, construction / rehabilitation of the facility).The price does not include the cost of purchasing land, project documentation and preparatory and finishing works.

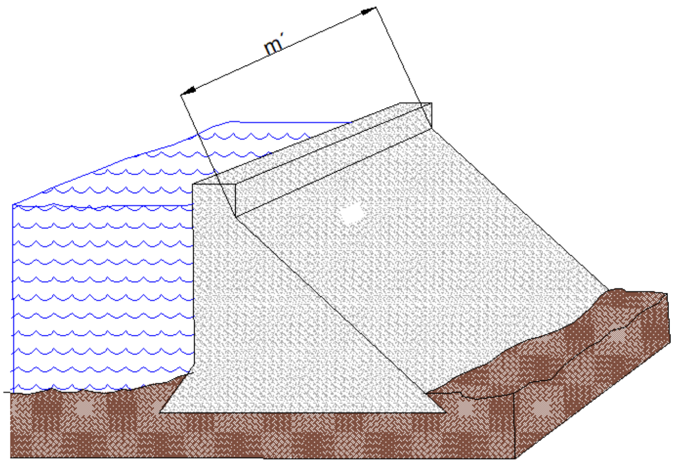

Figure 1: Scheme of dam and its’ unit for the estimation of cost

For each measure investment costs are calculated, using equation below:

$$IC\ [€] = U_{excavation}\ [m^3] * PU \left[\frac{€}{m^3}\right] + U_{sam}\ [m^3] * PU \left[\frac{€}{m^3}\right] + U_{riprap}\ [m^3] * PU \left[\frac{€}{m^3}\right]$$

Where,

IC=investment costs [€]

U=units / dimensions (length, height, width. volume, area) of a measure

PU=average price per unit [€]

River typology

The resulting costs have to be multiple by factor of the difficulty of accessing and performance of works. This factor depends of the location, altitude, river topology (catchment area or width of river stream), etc. Which factor is used has to be evaluated on the designer experiences.

- Normal availability 1.00;
- More difficult accessibility (special machinery) 1.50;
- Extremely difficult work (manual work only, helicopter) 5.00.

One has to emphasize that the pricing basis and therefore the costs are only rough estimations of actual investment costs. A large number of factors (location, method of implementation, difference prices from site to site, river typology, geomorphological conditions, catchment area, etc.) effects the costs. There is no general methodology to be used. The rough cost estimation is used for measures' screening or deciding which to proceed with.

3 Measures in the pilot area

3.1 Meadows and pastures (A01)

3.1.1 General description

Goal: Land use change into less excess-water sensitive cultivation mode.

General description: 73% of the catchment area is arable, changing the use of the area to achieve water retention goals is clear. In addition, the proportion of arable land endangered by pluvial flood can be reduced.

Criteria for selection of area to land use change:

- Poor quality arable land,
- High risk to pluvial flood.

3.1.2 Basic dimensioning

Area for measure selection with Geodatabase:

- Arable rating map,
- Pluvial flood risk area.

3.1.3 Cost assesment

Table 3: Total cost estimate for meadows and pastures measure

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	Meadows and pastures	18 517 ha	160 EUR/ha	1	1,25	3 703 496 EUR

3.1.4 Comment

Cost calculation was made using Hungarian price environment; price unit was estimated by Hungarian Chamber of Agriculture.

3.2 Buffer strips and hedges (A02)

3.2.1 General description

Goal: Buffer zones provide good conditions for effective water infiltration. They can reduce the amount of suspended solids, nitrates and phosphates from agricultural runoff.

General description: Previously used but still typical shelter belts aim to reduce wind erosion in the pilot area. Therefore, this type of measures is not unusual in the fields.

In FramWat project we decided to place buffer strips to one side of the state owned canal system, and forest buffer to the opposite side, which enables maintenance activities along the canals. (See 2.6.)

Criteria for selection of buffer zones:

- State owned canal system,
- No existing buffer strips or forest.

3.2.2 Basic dimensioning

Area for buffer strips was selected one side of the state owned canal system without current buffer zone.

Selection with Geodatabase:

- Hydrographic map (MTDWD)
- Corin Land Cover 2012.

Buffer strip with: 3,00 m./ length: 300 km.

3.2.3 Cost assesment

Table 4: Total cost estimate for buffer strips and hedges measure

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

3.2.4 Comment

Proposal: 10 m buffer strip width instead of 3 m.

3.3 No till agriculture (A06) and Low till agriculture (A07)

3.3.1 General description

Goal: This kind of agriculture method can be used to increase organic matter and soil water retention for soil types which are susceptible to these measures. The spread of this method is hindered due to the need of special agricultural machinery.

3.3.2 Basic dimensioning

Area for measure selection with Geodatabase:
A06, A07 measures planned to good quality arable land where the soil type is easily cultivated; sandy or silty.

3.3.3 Cost assesment

Table 5: Total cost estimate for no till agriculture and low till agriculture measure

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	No till agriculture	1 100 ha	108 EUR/ha	1	1,25	148 913 EUR
Agriculture measure	Low till agriculture	1 100 ha	109* EUR/ha	1	1,25	149 875 EUR
Costs: Contractor charges for discing, contractor charges for rotor-spike/ power horrow, contractor charges for multi harrowing						

3.3.4 Comment

No till estimation cost is based on the proposal of the project, while the low till cost was estimated by Hungarian Chamber of Agriculture experts.

3.4 Green cover (A08)

3.4.1 General description

Goal: In some cases, green cover can reduce evapotranspiration, thus increasing soil water retention capacity.

3.4.2 Basic dimensioning

Planned for good arable land regardless of soil type, where other measures cannot be planned (ha).

3.4.3 Cost assesment

Table 6: Total cost estimate for green cover measure

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	Green cover	15 000 ha	61 EUR/ha	1	1,25	1 143 750 EUR

3.4.4 Comment

The cost is based on the estimation of Hungarian Chamber of Agriculture experts.

3.5 Deep plowing (A15)

3.5.1 General description

Goal: Increasing the water retention capacity of the soil in lowland areas is one of the most effective ways of improving water balance, and the largest storage volume is provided by soil poles.

Criteria for selection of the area for deep plowing (ripping):

Good quality arable land,

High risk to pluvial flood.

3.5.2 Basic dimensioning

Area for measure selection with Geodatabase:
Good quality arable land,
High risk to pluvial flood.

3.5.3 Cost assesment

Table 7: Total cost estimate for deep plowing measure

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	Deep plowing	14 000 ha	100 EUR/ha	1	1,25	1 750 000 EUR

3.5.4 Comment

In the Hungarian pilot river basin cultivation should be carried out without rotation of the soil, to preserve the soil structure and organic matter. The method should be rather ripping than plowing.

The cost was estimated by Hungarian Chamber of Agriculture experts.

3.6 Forest riparian buffers (F01)

3.6.1 General description

Goal: Buffer zones provide good conditions for effective water infiltration. They can also reduce the amount of suspended solids, nitrates and phosphates from agricultural runoff. (See: 2.2)

3.6.2 Basic dimensioning

Area for measure selection with Geodatabase:

- State owned canal system.
- No existing buffer strips or forest.
- Length 300 km× width 10 m.

3.6.3 Cost assesment

¸ Table 8: Total cost estimate for forest riparian buffers measure

Group of measures	Measure	Unit (area)	Price [EUR/unit]	Difficulty factor [1,;1,5;5]	Preparatory and finishing works [25%]	Total cost [EUR]
Forestry measure	Forest riparian buffers	300 ha	2 500 EUR/ha	1	1,25	937 500 EUR

3.6.4 Comment

Recommended price unit was used during the calculation:

Seedling for short rotation (2-5 years) coppice (for woody biomass energy) with Salix and Populus species (10.000 seedlings/ha).

3.7 Reconnection of oxbow lakes and similar features (N07)

3.7.1 General description

Goal: Excavation of organic sediment and provision of water supply from existing irrigation system.

General description: Oxbow-lakes in the pilot basin evolved as the result of river regulation activities during the 18th century. In the period of construction of river regulation works, no one planned the later operation of these lakes, thus most of them may not be supplied with freshwater. The river beds were filled with sediment, the water quality is periodically moderate or bad.

3.7.2 Basic dimensioning

Excavation: m^3.
Structures to develop: pcs.

3.7.3 Cost assesment

Table 9: Total cost estimate for reconnection of oxbow lakes measure

Group of measures	Name of specific measure	Sizing (pcs, m, m3...)	Price (EUR/unit)	Difficulty factor	Preparatory and finishing works (25 %)	TOTAL (EUR)
NO7 Reconnection of oxbow lakes and similar features	Excavation of former stream, off-site disposal	500 000 m3	50	1	1,25	31 250 000
NO7 Reconnection of oxbow lakes and similar features	Structure development < 5 m3/s	15 pcs	2 000	1	1,25	37 500
					TOTAL:	**3 1287500**

3.7.4 Comment

The biggest problem of the oxbows is the sedimentation: the result of a long process caused by the content of sediment from water supply, and organic matter enrichment caused by vegetation growth.

The excavation aim is to reconstruct the original river bed condition that provides the necessary water depth for aquatic communities.

In order to provide fresh water to the oxbows outflow structure and their sluice gates have to be developed. The water supply canal development details are in the ‘Active water management on a drainage system’ chapter.

3.8 Drainage measures

Drainage measures:

- Active water management on a drainage system (river valleys) (D03),
- Construction of micro reservoirs on ditches (DO4),
- Construction of reservoirs on outflows from drainage systems (DO7).

3.8.1 General description

The planned measures were selected on the basis of the Irrigation Strategy of MTDWD (in accordance with National Climate Change Strategy 2008-2025) and the river basin management plan:

- Reconstruction and improvement of existing irrigation systems,
- Extending impact area of existing irrigation system by using drainage canal system,
- Water supply for water shortage area,
- Recommission of inoperable irrigation systems.

3.8.2 Basic dimensioning

It depends on type of planned work (m, m^2, pcs).

3.8.3 Cost assesment

Table 10: Total cost estimate for drainage measures measure

	Name of specific measure	Sizing (pcs, m, m3...)	Price (EUR/unit)	Difficulty factor	Preparatory and finishing works (25 %)	TOTAL (EUR)
Do3 Active water management on a drainage system (river valleys)	**Improving water retention in Nagykunsági main canal (1,2,3,4,section), Nk III-2, Nk East branch. (4 project)**					
Do3	Dike development	59 500 m	600	1	1,25	44 625 000
Do3	Broken shrubs (workspace preparation)	120 000 m2	3	1	1,25	450 000
Do3	Chanel bed development	119 000 m	40	1	1,25	5 950 000
Do3	Structure development > 5 m3/s	11 pcs	60000	1	1,25	825 000
Do3	Structure development < 5 m3/s	25 pcs	2000	1	1,25	62 500
Do3	Developing of Nagykunság, Nk X-2, Nk XII-1 irrigation system (3 project)					
Do3	Broken shrubs (workspace preparation)	23 000 m2	3	1	1,25	86 250
Do3	Chanel bed development	56 000 m	20	1	1,25	1 400 000
Do3	Structure development < 5 m3/s	5 pcs	2000	1	1,25	12 500
Do3	Extending impact area of existing irrigation system by using drainage canal system					
Do3	Broken shrubs (workspace preparation)	250 000 m2	3	1	1,25	937 500
Do3	Chanel bed development	135 000 m	40	1	1,25	6 750 000
Do3	Structure development < 5 m3/s	20 pcs	2000	1	1,25	50 000
Do3	Water supply for water shortage area (Tilalmas, NK VI, Álomzug)				1,25	0
Do3	Broken shrubs (workspace preparation)	150 000 m2	3	1	1,25	562 500
Do3	Chanel bed development	17 000 m	20	1	1,25	425 000
Do3	Subsurface ditches	56 000 m	600	1	1,25	42 000 000
Do3	Weir (concrete)/ Overflow structure 2-5 m3/S	91 pcs	100000	1	2,25	20 475 000
DO4 Construction of micro reservoirs on ditches	**Harangzugi I. new reservoir**					
DO4	Structure development < 5 m3/s	1 pcs	2000	1	1,25	2 500
Do7 Construction of reservoirs on outflows from drainage systems	**Water supply increase of Hortobágy-Berettyó region**					

	Name of specific measure	Sizing (pcs, m, m3...)	Price (EUR/unit)	Difficulty factor	Preparatory and finishing works (25 %)	TOTAL (EUR)
Do7	Weir (concrete)/ Overflow structure 2-5 m3/S	2 pcs	100000	1	1,25	250 000
Do7	Weir (concrete)/ Overflow structure 50 m3/s	1 pcs	300000	1	1,25	375 000
Do7	Dam from 3-5m	13 700 m	1820	1	1,25	31 167 500
Do7	Subsurface ditches	3 300 m	600	1	1,25	2 475 000
					TOTAL:	**158 881 250**

3.8.4 Comment

The planned measures basically come from the *National Irrigation strategy of MTDWD (2015)*.

During the cost calculation either recommended price units or Irrigation Strategy Plan prices were used. If there was no recommended specific measure price unit (e.g. dam development) the Hungarian price estimation was used.

3.9 Wetland restoration (N02)

3.9.1 General description

The Concept plan local preferences version was to revitalize the former streams that connected river beds before river regulation in the Hungarian Great Plain.

3.9.2 Basic dimensioning

Depends on type of planned work (m, pcs).

3.9.3 Cost assesment

Table 11: Total cost estimate for wetland restoration measure

NWRM	Name of specific measure	Sizing (pcs, m, m3...)	Price (EUR/unit)	Difficulty factor	Preparatory and finishing works (25 %)	TOTAL (EUR)
N02 Wetland restoration	Outlet structure (the depth up to 2 m)	17 pcs	20 000	1	1,25	425 000
N02 Wetland restoration	Renaturalization of meander	16 000 m	326	1	1,25	6 520 000
					TOTAL:	**6 945 000**

3.9.4 Comment

The estimated prices comes from the MTDWD own calculations because of the special conditions.

4 Cost assesment on a river basin scale

Table 12 summarizes the estimated costs by sector of the planned measures in Nagykunsági river basin.

Table 12: Estimated cost per sector

Sector	Measure code	Total estimated cost (€)
Agriculture measures	A01, A02, A06, A07, A08, A15	6 272 120
Forestry measures	F01	937 500
River regulations / Lateral structures measures	N07	31 287 500
Drainage measures	D03, D04, D07	158 881 250
Other (Wetland restauration)	N02	6 945 000
	TOTAL:	**204 323 370**

The relatively low cost of agricultural measures occurs due to the smaller size of the area where the type of measure is located. The location of the measure is defined in the concept plan and takes into account the natural factors that make it suitable for lowland agricultural production.

Drainage measures cause the highest percentage of costs because the pilot area water management system is well built. The lowland area water retention is not possible to build/implement/consider (?) without using and developing the existing drainage and irrigation canal network.

5 Conclusions

The cost estimation quantitative data and type of measures are based on the Concept Plan of the FramWat project.

The price units were collected by the Activity Leader, but in many cases other prices were used in the calculation taking into account local conditions. The estimation are mainly based on realized investments in MTDWD operational area.

There were big price differences between outlet structures. In Nagykunsági pilot area the preferred reinforced concrete structures with adjustable steel sluice gate is more expensive than suggested ones in the project.

Cost calculation was made on the bases of 2019 Hungarian prices in €, including VAT.