DELIVERABLE 3.2

Report on cost structures for nutrient mitigating, flood preventing and biodiversity promoting measures

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1 INTRODUCTION

In general, work package 3 (WP3) of the BONUS MIRACLE project aims to assess the cost and benefits of selected governance features and policy instruments, which aim to improve nutrient mitigation, flood prevention and biodiversity promotion in the different case study areas. The purpose of the following report, which serves as deliverable 3.2, is to give a first insight into the cost structures of different measures, as suggested and defined by the local stakeholders and project partners. Furthermore, the frame for subsequent economic analyses is outlined, and possible approaches to solve the issue of unavailable data are discussed.

Before proceeding, some terms need to be clarified to avoid confusion. First, the bundles of nutrient mitigating, flood preventing and biodiversity promoting measures, which are specified further in section 3, are henceforth referred to as *pathways* for catchment change. These pathways are strongly influenced by stakeholder suggestions, and they are related to a previously defined *systemic issue*[1] in the respective river catchments which - while still connected - might go beyond the three main targets. Second, the *scenarios* are from now on defined as the climate and socio-economic projections resulting in possible changes of costs, effects or benefits, and will be applied on each pathway. However, the development of these scenarios is ongoing, the impact on cost structures will therefore be elaborated in a subsequent deliverable, if possible.

In the context of the overall objective of WP3, this deliverable partly covers the third analysis stage "Valuing Impacts" of a Cost-Benefit Analysis, as defined in deliverable 3.1 (Carolus, et al., 2015). It thus outlines the measures and available cost structures, which will also be used in the Cost-Effectiveness Analyses. Due to a delay in the provision of cost data as well as the agreed adjustments in the overall project timetable, the overview of cost structures does not yet cover the whole extent of the measures as defined within the pathways, and it has only been verified by project partners but not thoroughly the respective stakeholders as originally intended.

It is important to notice that the cost structures are not final but rather considered work in progress in the sense that output from subsequent workshops should qualify and validate the data and possibly refine the pathways further. Hence, updating and modification of the cost structures and pathways might therefore still occur after the publication of this report (March 2017) as a result of the ongoing social learning process.

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[1] A systemic issue is defined as *"(i) a system property that has a demonstrable quantifiable or qualitative relationship with a subset of key stakeholder defined problems within the same context (ii) changes in the properties of the systemic issue will lead to a change in stakeholder interpretations of their own and other problems (iii) an issue that has the capacity to bring different sets of clients and actors into the same social space (iv) an issue that enables clients and actors to redefine their interests and agency through the development of shared plans and actions."* (based on *MIRACLE Working Document: Development pathways for change in the River Helge Basin, 2nd Draft of 29.11.2016*).

2 The MIRACLE Project

2.1 Project Charter

Mediating integrated actions for sustainable ecosystems services in a changing climate

More than 85 million people live in the Baltic Sea catchment area, and around 60-70 % of the land is farmland. Thus, the agriculture sector and wastewater treatment sector are key actors that have an impact on eutrophication. The problem is, however, that there are insufficient incentives within these sectors to further reduce their contributions to nutrient enrichment of aquatic ecosystems. The hypothesis underpinning the MIRACLE project is that more effective approaches to ’nutrient governance’ cannot focus solely on the nutrient issue itself. Real changes will require bringing on board new constellations of stakeholders with issues that are interconnected with nutrient enrichment. We will seek win-win models for governance by emphasising synergies between aligned policy communities, such as the flood control sector, downstream urban communities vulnerable to flooding, biodiversity conservation interests, and the human health and biosecurity sector.

In this interdisciplinary project, social scientists work with economists and hydrologists in a social learning process with stakeholders. The aim is to identify new configurations for governance (conceptual, institutional and practice based) to reduce nutrient enrichment and flood risks in the Baltic Sea region. An example could be how to reform farming practices in a way that measures such as flood control and biodiversity conservation become new ’agricultural products’ which also impact emissions of nutrients.

A set of workshops will be organised in four case areas, the Berze (Latvia), Reda (Poland), Helgeån (Sweden), and Selke (Germany). Cross-case and regional workshops will facilitate scaling up the results to the Baltic Sea region level. The workshops will identify innovative actions and plans that offer multiple ecosystem service benefits to diverse stakeholders. The social learning process will be supported by interactive hydrological modelling of what impacts the suggested measures will have on nutrient transport and flooding risks. Here, uncertainty assessments and the need for adaptation to climate change scenarios are key features. Economists will assess the cost and benefits of selected governance features and policy instruments in the environmental mitigation and flood prevention scenarios. The goal is to identify the most socioeconomically efficient measures and governance features to deliver multiple ecosystem service benefits.

In the project, an interactive visualisation platform will be used where stakeholders will guide the use of input data sets and the development of visualised scenarios. The aim is to facilitate their understanding of suggested governance actions’ consequences and assist identification of novel actions. Policy analyses will be done to identify how institutional settings have shaped governance structures in the Baltic Sea region. In the next step, opportunities for greater integration of agricultural and environmental policy actions at different scales will be identified.

A particular focus will be on identifying prospects for introduction of payments for ecosystem services as a key governance approach. Finally, emerging from the social learning process, to the project aims to support the development of road maps that integrate agricultural, environmental and risk management governance in the Baltic Sea region.

Project partners
Linköping University, Sweden, (coordinating partner)
POMinnO Sp. z o.o., Gdynia, Poland
Institute of Meteorology and Water Management, Warsaw, Poland
Johann Heinrich von Thünen-Institut, Braunschweig, Germany
Helmholtz Centre for Environmental Research, Magdeburg, Germany
University of Latvia, Riga, Latvia
Latvia University of Agriculture, Jelgava, Latvia
University of Copenhagen, Denmark
Swedish Meteorological and Hydrological Institute, Norrkoping, Sweden
Stockholm Environment Institute, Sweden
Swedish International Centre of Education for Sustainable Development, Uppsala University, Sweden.

3 Pathways - Suggested measures promoting nutrient mitigation, flood prevention and biodiversity

The following chapter shortly outlines the different pathways, as defined in the introduction, and lists their respective measures. The pathways will be described in more detail in the MIRACLE deliverable 5.3. In addition to the system boundaries, as described in the deliverable 3.1 (Carolus, et al., 2015), the pathways are central to the economic analysis as they serve as a frame for the socio-economic assessments of costs and benefits. In all case areas, the first pathway describes a business-as-usual pathway including, as far as possible, all measures that are currently being implemented or are planned to be implemented until 2020, and assuming they will remain in place up to 2030. Alternative pathways represent possible new or modified measures that may be added to pathway 1. Hence, the pathways should not be considered mutually exclusive alternatives, as pathway 1 will always be present, though certain measures in the alternative pathways may be mutually exclusive.

The development of the other pathways is strongly influenced by the relevant stakeholder groups in the four catchments, which consist of representatives from hydropower, forestry and agricultural sectors, key municipalities, water board associations, county administrative boards and different NGOs. While the interaction with those groups resulted in many different perceptions regarding the promotion of nutrient mitigation and flood prevention, common ground was found in perceiving the systemic issue. These issues are determined as brownification in the Helge, ecosystem functions in the Berze, biodiversity in the Selke, and flooding in the Reda river catchment

3.1 Helge River[2]

The first pathway of the Helge river catchment includes MIRACLE relevant measures that are being or will be implemented until 2020, which was shared as a realistic setting by the stakeholder groups.

Measures Pathway 1 – "Business as usual"
Measures by the County Administration: ▪ Liming Measures of the Rural Development Programme (RDP): ▪ Buffer Strips ▪ Wetlands ▪ Non-productive field margins in agricultural landscape Measures by the Municipalities: ▪ Upgrading of sewage treatment systems in rural areas ▪ Upgrade or removal of traditional water regulating dams

[2] based on *MIRACLE Working Document: Development pathways for change in the River Helge Basin (Draft from 28.02.2017)*.

The second pathway is based on the suggestion to recreate ecosystems, especially by identifying measures generating multiple benefits.

Measures Pathway 2 – "Ecosystem Service Approach in River Helge"
▪ Storm Water Ponds in urban areas ▪ Flood plain targeting agricultural production areas ▪ Wetlands ▪ Buffer Strips ▪ Removal of existing hydropower stations

Forestry within the river catchment is both the major land use practice and a major source of nutrients and organic maters. However, research on impact on water resources from forests is limited. Therefore, the third pathway will target the forest sector to provide improved understanding of potential measures and their effects and benefits associated with the water management in forestry.

Measures Pathway 3 – "Efforts to improve water management in forestry"
▪ Alder Swamp Forest ▪ Riparian Zones in Forest Landscape ▪ Fish Migration

3.2 Selke[3]

Again, the first pathway reflects „business as usual", i.e. the continuation of currently implemented and planned measures in the Selke river catchment.

Measures Pathway 1 – "Business as usual"
Greening measures: ▪ Flower and water protection strips (EFA, Ecological Focus Areas) Agri-environmental measures: ▪ Ploughing and cropping techniques on areas with high risk of erosion ▪ Extensive permanent grassland ▪ Organic farming RBMP measures: ▪ Ventilation and treatment of mine water and mine water retention ▪ Dismantling of transverse structures (weir) ▪ Creation of ecological bypassing options Flood Risk measures ▪ Flood Control Basins

[3] description is based on the *WP5 Working Document: Description of Development Pathways for Change in the Selke Case Study Area* (draft 08.12.2016).

The second pathway targets multiple ecosystem services from agricultural land uses and the management of streams in agricultural areas.

Measures Pathway 2 – "Ecosystem service approach"

▪ Development and management of riparian strips
  ○ Different designs (e.g. in relation to width, vegetation structure and the shape / slope of the strip) and uptakes of riparian strips
  ○ Advantages for biodiversity in and around the streams and through higher nutrient retention
▪ Stream restoration, i.e. adjustments to the morphology and characteristics of the streams (e.g. gravel and stony ground, meander measures)
▪ Optimisation of fertilizer use
▪ Contour ploughing

The third pathway aims to increase the share of household being connected to waste water treatment plants.

Measures Pathway 3 – "Waste Water Treatment"
▪ Increased number of households connected to sewage plants

3.3 Berze[4]

The "business as usual" pathway in the Berze catchment consists of the planned and implemented Common Agricultural Policy (CAP) Pillar 1 "greening measures" and Pillar 2 "Agri-Environmental and Climate measures".

Measures Pathway 1 – "Business as usual"

▪ Greening
  ○ Ecological Focus Areas (EFA)
  ○ Ecological Ponds, Tree Clusters
  ○ Field Margins
  ○ Crop Diversification
  ○ Perennial grassland
▪ Agri-Environmental Measures
  ○ BDUZ – Biodiversity Preservation in Grasslands
  ○ VSMD – Ecological Horticulture
  ○ RLZP – Stubble Cover during Winter Period
  ○ BLA – Organic Farming
  ○ NIM – NATURA2000

[4] based on *WP5 Working Document: Description of Development Pathways for Change in the Berze River Basin (Draft 02.12.2016)*.

The second pathway is a result of centralised waste water treatment plants (WWTP) being the largest point source of nitrogen and phosphorus discharge into the river basin.
Upgrading existing WWTP could significantly improve the nutrient mitigation, as well as the ecological status of the river.

Measures Pathway 2 – "Waste water treatment"
▪ WWTP improvement with the following target: Achieve total nitrogen discharge concentrations of 10 mg/l and total phosphorus of 2 mg/ l in all waste water treatment plants (PE > 10000 and PE < 10000); ▪ WWTP improvement with the following target: To achieve total nitrogen discharge concentrations of 5 mg/l and total phosphorus of 1 mg/l in all waste water treatment plants (PE > 10000 and PE < 10000);

The intensive agriculture in the Berze catchment area is the major non-point source of nutrient (N, P) loading. The third pathway therefore aims to reduce nutrient loading through the creation of buffer strips.

Measures Pathway 3 – "Buffer Strips"
▪ Buffer strip of 10 m width along rivers ▪ Buffer strips of 2.5 m width along drainage ditches next to arable land fields

The fourth pathway aims to improve the nutrient reduction in drainage ditches by implementing environmentally sound on-line drainage measures.

Measures Pathway 4 – "Environmentally sound drainage measures"
▪ Sedimentation Ponds ▪ Two-Stage Ditches/Terracing ▪ Controlled Drainage ▪ Meandering ▪ Constructed Wetlands

The fifths pathway targets the equipment of five hydro-power plants with water level control mechanisms to reduce fluctuations in water levels, as well as fish-ways to allow fish migration past dam structures of the plants.

Measures Pathway 5 – „Upgrade of Hydro-electric Plants"

▪ Upgrade 5 hydro-electric plants
  ○ to reduce fluctuations in water levels
  ○ to allow fish migration

3.4 Reda

The pathways of the Reda catchment area have been delayed, but are currently under development. Besides of the business as usual setting, different pathways will target urban and rural areas (Tonderski, 2017). Due to the stakeholders' definition of flooding as the systemic issue, the pathways are dominated by measures targeting flood prevention.

Measures Pathway 1 – "Business as usual"

▪ Wastewater Infrastructure
  ○ Small WWTP
  ○ Septic tanks
  ○ Sewerage
▪ Hydrotechnical Infrastructure
  ○ Weir/Dam
  ○ Storm Sewerage
▪ Standard Agri-Environmental Measures

Measures Pathway 2 – "Focus on Urban Areas"
▪ Small urban retention (closed/open) ▪ Flood protection infrastructure ▪ Development of tourism/recreational infrastructure ▪ Urban Planning

Measures Pathway 3 – "Focus on Rural Areas"
▪ Floodplains ▪ Small rural retention infrastructure ▪ Large reservoirs ▪ Diffused wastewater ▪ Wetlands

Measures Pathway 4 – "Agro-Environmental Measures"
▪ Buffer zones ▪ Catch crop ▪ Greening ▪ Soil liming

A fifth pathway with a combination of measures of the pathways 2 - 4, based on the efficiency from both a stakeholder and an economical point of view, is under development.

4 Cost Structures for nutrient mitigating, flood preventing and biodiversity promoting measures

4.1 Definitions

In principal, three categories of costs need to be considered in the implementation and use of each selected measure: (1) establishment costs, (2) annual and periodic operational and maintenance costs and (3) any relevant opportunity costs.

To avoid confusion about usage of words, we briefly define different types of costs that are mentioned in the following description of cost structures. However, depending on the data source, the following types of costs (a – e) are not necessarily linked to just one, or even the same cost categories (1-3):

a) Investment costs address the costs associated with an initial establishment or construction that is necessary to put some measure into operation. These costs may also be referred to as establishment costs (Gachango, et al., 2015). The costs occur in year 0 and, if based on the VISS databank[5], are excluding VAT. Examples are the planting of buffer zones, installation or upgrading of wastewater treatment systems, or the construction work to improve fish migration routes such as fish ladders (VISS database, 2016).
b) Administration and investigation costs include things like project planning and analyses that can be directly linked to the establishment and maintenance of the measure. In the VISS database where the majority of information for the Helge River case is found, administration and investigation costs are assumed to occur in year 0 only (VISS database, 2016). Other sources combine the cost indications for investment and administration, or handle investigation costs separately.
c) Ongoing costs are the annual costs associated with ensuring that a measure is functioning over its entire expected lifetime. These may also be referred to as running costs or maintenance costs. It involves e.g. the daily or annual routine checks of the sites by local personnel.
d) Opportunity cost or economic loss refers to any additional cost and production loss experienced by e.g. a farmer or other stakeholder due to implementing measures with the consequence of reducing supply on the market concerned (European Union, 2013). The opportunity costs associated with a measure are in the form of foregone net revenues as a result of, for instance, putting agricultural land or hydropower plants out of production or. These costs may vary depending on crop rotations, soil type, land use and output prices as well as other production factors. Since most of these factors are not easily predicted with accuracy, the opportunity cost of land is sometimes

[5] VISS (Water Information System Sweden, https://viss.lansstyrelsen.se) is a database and managed by the County Administrative Board of Kalmar. It is developed by authorities of the Swedish water districts, the County Administrative Boards and the Swedish Agency for Marine and Water Management (VISS database, 2016).

determined based on existing land prices in the region or rental rates. A farm's net profit (gross margins) may also be used to measure the opportunity cost of land change (Refsgaard, et al., 2007). Some sources define the opportunity costs or economic losses as being part of the ongoing costs.

4.2 Payments and tariffs to estimate total costs

Due to limited availability of data, the suitability of using payments for the CAP agri-environmental and greening measures, as well as tariffs for wastewater treatment, as proxies for total costs is discussed in the following. A more detailed description of the measures from a policy perspective can be found in the MIRACLE deliverable 6.1 (Zilans, et al., 2016).

4.2.1 Agri-Environment Measures

"*Agri-environment measures provide payments to farmers who subscribe, on a voluntary basis, to environmental commitments related to the preservation of the environment and maintaining the countryside*" (European Comission, 2016). The European Union's (2013, p. 516) determination that these payments "*shall compensate beneficiaries for all or part of the additional costs and income foregone resulting from the commitments made*" entails that payments could potentially only reflect the costs of the respective measures to some extent rather than representing the full costs to the farmer. However, since implementation of these measures is voluntary*, "payment levels have to be set so that they are sufficiently attractive to farmers when compared to the actions required to comply with the scheme and their associated costs, any income forgone, and related administrative costs"* (Lastra-Bravo, et al., 2015, p. 2). It is thus generally unlikely that the farmer generates a significantly lower income or payment if voluntarily implementing an agri-environmental measure, compared to continuing the previous use of the area for regular agricultural production. Hence, the agri-environmental payments serve as a reasonable proxy for the actual costs to the farmers of implementing these measures. These cost indications, including the addition of administrative costs, are used for some extent in the Berze and Selke catchments.

4.2.2 Greening measures

Greening measures are mandatory for the majority of the farmers and should therefore be a measure of the business-as-usual pathways. However, unlike the agri-environmental measures, greening measures are mandatory components of the CAP direct payment scheme, and as such they are not necessarily reflect actual costs of the measures for the farmer. It therefore cannot be assumed that the payments reflect the real costs of greening measures. However, the European Commission's latest review on greening measures states that "*sufficient hard data on the costs and burdens associated with the new greening measures is still not available*" and "*credible cost information related to current practices under the greening measures is currently missing*" (European Comission, 2016, p. 18). This implies that Greening measures can only be assessed in the economic analyses if alternative comparable cost structures exist (e.g. using the gross margin as cost proxy for the non-productive field margins in agricultural landscapes in the Swedish case).

4.2.3 Wastewater Treatment

The following description covers the case of wastewater treatment in the Berze river catchment. For the assessment of costs for measures regarding wastewater treatment in the case study areas in Germany, further input by the partners is needed.

The Berze catchment is dominated by small wastewater treatment plants (WWTP) with a population equivalent (PE) of less than 2000 PE, resulting in an insufficient amount of available cost data. The use of tariffs (or service charges) paid by the clients of WWTP may serve as a simplified approach to estimate the total costs.

In Latvia, tariffs are reported to, and approved by, a Service Regulator (the Public Utilities Commission). The tariffs must reflect the total costs of operating the WWTP, including capital, operating, management and maintenance costs, as well as the profit (Public Utilities Commission, 2010). However, the profit "*percentage may not exceed profitability in the amount of 7%, which [is] calculated in per cent from the costs of the provision of the water management service*" (Public Utilities Commission, 2011, p. 4). For an assessment more closely to reality, the establishment costs of similar WWTPs are additionally incorporated. To avoid double counting, the establishment costs are deducted from the tariffs, as they are (labelled as "capital costs"), already included in the tariffs.

4.3 Cost Structures

The following chapters show cost structures, which are available at the time of writing (March 2017). The structures are either, as agreed upon in the project work description, provided by the project partners responsible for the social learning process in the four case study areas, or, in the case of Sweden, mainly based on the VISS database.

4.3.1 Helge river

The following tables show examples of cost structures of different nutrient mitigating, flood preventing and biodiversity promoting measures, whereas the structures are based on the definitions in Chapter 4.1.

Table 1 Cost Structures of liming measures

	Liming by air	Liming by boat	Liming by doser
Investment Cost	-[a]	- [a]	Investment: 2.000.000 per doser Doser capacity: 131 tons/year
Investigation and Administration Cost (SEK/ton)	80	80	60
Ongoing Costs (SEK/ton/year)	1580	960	Lime: 610 Operation and maintenance: 450
Expected Life Time (years)	1	1	20

[a] Helicopter and boat are assumed to be rented. Rental costs are included in the ongoing costs.
Source: (VISS database, 2016)

Table 2 Cost structures of buffer strips

	Buffer strips on farmland - unharvested with grass
Investment Cost (SEK/ha)	machine cost: 300 seed (7,5 kg * 40 SEK/kg): 300 work: 200 **Total: 800**
Standard Range	75 – 150 %
Investigation and Administration Cost[6]	not required/ not available
Ongoing Costs (SEK/ha/year)	Ongoing: 1100 Production loss: 1500
Standard Range	20 – 160 %
Expected Life Time (years)	10

Source: (VISS database, 2016)

Table 3 Cost structures of wetlands, Helge River catchment[7]

	Wetlands for nutrient retention	Phosphorus wetland
Investment Cost (SEK/ha)	Construction & Excavating: 200.000 Degraded land value and degraded land consolidation: 30.000 **Total: 230.000**	600.000
Standard Range	15 – 120 %	15-150 %
Investigation Cost (SEK)	153.341,64 – 5.750.311,64[8] (per study)	no specific information available
Ongoing Costs (SEK/ha/year)	Digging: 390 (10 hours over a 20-year period, 650 SEK/h) Tractor and Trailer: 60 (1 hour over a 5-year period, 320 SEK/h) Chainsaw and brush cutter: 110 Replacement of pipes and wells: 300 Work: 560 Reed cleansing: 230 (1 time every 20 years) **Total: 1650**	12.000
Standard Range	50 – 130 %	15-150 %
Production loss (SEK/ha/year)	1.200	1.200
Standard Range	50 – 200 %	50 – 200 %
Expected Life Time (years)	30	30

(VISS database, 2016)

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[6] based on (NWRMe, 2013), no pre-implementation studies are required for buffer strips. VISS indicates no administration costs..

[7] no indications regarding the scope of the wetlands the numbers are based on are available (but general numbers per hectare). However, for artificial wetlands it is indicted that the surface of the wetland should be at least 1 % of the size of the catchment area (VISS database, 2016).

[8] the costs are not specific for the Helge River catchment or Sweden, but based on NWRMc (2013), and explained as follows: *"All investment works require investigations and technical/design projects. The projects implemented represent a combination of measures related to river restoration (reconnection, re-meandering and removing of embankments). For example in Spain, the preparatory actions in the LIFE + project on Arga and Aragón rivers cost about 600 000 EUR, while in Lithuania for restoration of hydrological regime in the Amalvas wetland areas direct costs related to technical studies were about 16000 EUR"* (NWRMc, 2013, p. 10).

Table 4 Cost structures of non-productive field margins in an agricultural landscape

	Non-productive filed margins in agricultural landscape
Investment Cost (SEK)	no investment costs
Production loss (SEK/ha/year)	2.000
Expected Life Time (years)	1

Source: VISS database (2016) and stakeholder confirmation

Table 5 Cost structures of upgrading sewage treatment systems in rural areas

	Reduction to normal level	Reduction to high level
Investment Cost (SEK)	75.600/unit	13.400/unit
Ongoing Cost (SEK)	no additional ongoing costs	no additional ongoing costs
Investigation and Administration Cost	2.400/unit	2.400/unit
Expected Life Time (years)	20	20

Source: (VISS database, 2016)

Table 6 Cost structures of upgrading or removing traditional water regulating dams

	Upgrade or removal of traditional water regulating dams
Investment Cost (SEK)	500.000 – 3.000.000/unit
Ongoing Cost (SEK)	15.000-90.000/unit
Investigation and Administration Cost	50.000-300.000/unit

Source: Investment cost information by the Water Board and Osby municipality, the additional indications by (NWRMf, 2013)

Table 7 Cost structures of urban stormwater ponds

	Stormwater Pond
Investment Cost (SEK/ha)	2.500.000
Standard Range	50 – 200 %
Investigation Cost (SEK)	20.000 – 100.000[9]
Ongoing Costs (SEK/ha/year)	operation, maintenance, supervision of installation, mowing, clearing away debris: 20.000 + opportunity cost of not using the land for development[10]
Expected Life Time (years)	25

Source: (VISS database, 2016)

Table 8 Cost structures of floodplain restoration and management

	Floodplain restoration and management
Investment Cost (SEK/ha)	200.000
Ongoing Costs (SEK/ha)	5.000
Expected Life Time (years)	30[11]

Source: Information provided by MIRACLE partners from the Helge case study area. Based on interview with the Osby municipality (2016/17)

[9] The indication is based on the investigation cost for *retention ponds*, and describes the potential requirement of geotechnical investigations to confirm land stability, as well as the underlying soil and geology conditions prior to the construction. (NWRMa, 2013). The indication is therefore not specific for the Helge River catchment, a further use in the subsequent Cost-Benefit Analysis needs to be verified. Exchange rate: 9.55 SEK equals 1 Euro.

[10] opportunity costs based on (NWRMa, 2013).

[11] assumption

Table 9 Cost structures of an alder swamp forest

	alder swamp forest
Investment Cost (SEK/ha)	40.000
Production Loss (SEK/ha)	400-600
Expected Life Time (years)	not available

Source: Information provided by MIRACLE partners from the Helge case study area. Information is based on stakeholder information in context of the third Swedish stakeholder workshop (March 2017).

Table 10 Cost structures of riparian zones in forest landscape

	riparian zones in forest landscape
Investment Cost (SEK/ha)	selective cutting of forest land: 2.500 redemption of land: 20.000 – 70.000 **Total: ~45.000**
Standard Range	5 – 160 %
Investigation and Administration Cost (SEK/ha)	9.000
Standard Range	50 – 200 %
Expected Life Time (years)	30

Source: Cost indications are for ecological buffer zones (VISS database, 2016)

Table 11 Cost structures of Removal of barriers to fish migration

	Removal of Hydropower Plant	Fish Ways / Obstacle removal
Investment Cost (SEK)	2.500.000/unit[12]	100.000 – 1.000.000/m
Investigation and Administration Cost (SEK)	20.000,00/unit[13]	10.000 – 50.000/m
Ongoing Costs (SEK/year)	not applicable	0 - 1.000/m
Production Loss (SEK/year)[14]	2.700.000	not applicable
Expected Life Time (years)	30	30

(VISS database, 2016)

[12] the estimated cost for the demolition of a medium-sized hydropower plant with an output of approximately 330 kW (VISS database, 2016).

[13] these costs reflect the cost directly linked to the action. Other preparational costs for technical descriptions or court expenses are not included (VISS database, 2016)

[14] yearly production x electricity price (0.311 SEK/kWh as the average 2011-2016, based on http://www.energimarknadsbyran.se)

4.3.2 Selke river

The following tables show Selke-specific examples of cost structures of different nutrient mitigating, flood preventing and biodiversity promoting measures, whereas the structures are based on the definitions in Chapter 4.1. The establishment of cost structures of different measures is still under development, such as the different adjustments to the morphology and characteristics of the natural streams or sewage plant connection in pathway 3. For the latter measure, the information if households need to be only connected to the system, or if new sewage plants need to be established, is currently under investigation.

Table 12 Cost structures of agri-environmental measures (based on payments 2015 & 2016)

	Ploughing and cropping techniques on areas with high risk of erosion	Flower and water protection strips	Extensive permanent grassland	Organic Farming
Ongoing costs (EUR/ha)	73	65	219	230
Production Loss (EUR/ha)	464	-	-	-
Administration costs (EUR/ha)	75,04	9,36	40,25	8,05

Source: (Ministry of Finances, 2015), (Tietz et al., 2016)

Table 13 Cost structures of flood control basins

	Flood Control Basin Straßberg	Flood Control Basin Meisdorf
Investment Cost (EUR)	19.700.000	10.400.000
Expected Life Time (years)[15]	50	50

Source: NHWSP - Liste prioritärer Maßnahmen zur Verbesserung des präventiven Hochwasserschutzes

Table 14 Cost structures of contour ploughing

	Contour ploughing
Total Cost (EUR/ha)	cost neutral

Source: Assumption, confirmed by the local stakeholder during the third stakeholder workshop (March 2017)

Table 15 Cost structures of riparian stripes

	Riparian stripes
Investment Cost (EUR/ha)	21
Ongoing Costs (EUR/ha/year)	83
Production Loss (EUR/ha)[16]	464
Expected Life Time (years)	1[17]

Source: based on average gross margin and on http://www.llg.sachsen-anhalt.de/service/publikationen/betriebswirtschaft/, approved by stakeholders (workshop March 2017)

[15] assumption

[16] average weighted gross margin per hectare

[17] assumption

4.3.3 Berze river

The following tables show Berze-specific examples of cost structures of different nutrient mitigating, flood preventing and biodiversity promoting measures, whereas the structures are based on the definitions in Chapter 4.1.

Table 16 Cost structures of agri-environmental measures (based on payments 2015)

	Biodiversity Preservation in Grasslands	Ecological Horticulture	Stubble Cover during Winter Period
Ongoing costs (EUR/ha)	83	74 – 304	87
Administration costs (EUR/ha)	1,64	3,74	1,72

Source[18]

Table 17 Cost structures of the rural development programme (based on payments 2015)

	Organic Farming	NATURA2000
Ongoing costs (EUR/ha)	116	45
Administration costs (EUR/ha)	2,30	0,90

Source[19]

Table 18 Cost structures of establishing wastewater treatment plants (WWTP)

	WWTP Dobele	WWTP Dobele	WWTP Brocenu	WWTP Jaunpils
Size (in PE)	300 – 2000	100 – 300	100 – 300	100 – 300
Investment Cost (EUR/unit)[19]	236.025	81.865	81.865	81.865
Ongoing Costs (EUR/year)[20]	4.212,90	2.170,13	7.659,02	1.905,65
Expected Life Time (years)[21]	30	30	30	30

Source: Information provided by MIRACLE partners from the Berze case study area (see footnotes)

[18 + 19] Letter from Indulis Abolins, Assistant Director, Rural Support Service of Latvia dated 18.03.2016, in response to a letter requesting information from the University of Latvia, Faculty of Geography and Earth Sciences, MIRACLE project, dated 26.02.2016.

[19] Investment costs:

WWTP Dobele (300 – 2000 PE): based on cost of establishing a new WWTP in Gardenes settlement in 2014 with a capacity of 200 m3 day and a PE of approximately 1400. Costs are without Value Added Tax 21%. Costs are provided by the water and wastewater utility company SIA DOBELES UDENS (03.02.2017).

WWTPs (100 – 300 PE): based on cost of establishing a new WWTP in Krimuna settlement in 2014 with a capacity of 50 m3 day and a PE of approximately 400. Costs are without Value Added Tax 21%. Costs provided by the water and wastewater utility company SIA DOBELES UDENS (03.02.2017).

[20] Ongoing Costs: Based on tariffs (excluding capital costs and 7% profit) and wastewater capacity

[21] assumption

Table 19 Cost structures of buffer strips

	Ecological Buffer Zones
Ongoing Costs/Production Loss (EUR/ha/year)	300
Expected Life Time (years)[22]	10

Source: Information provided by MIRACLE partners from the Berze case study area. Information based on internal stakeholder survey in Latvia

Table 20 Cost structures of Sedimentation Ponds

	Sedimentation Ponds
Investment Cost (EUR/ha)	100.000
Investigation/Administration Cost (EUR/ha)	25.000
Expected Life Time (years)	5

Source: MK Regulations Nr. 600, Appendix 8, 2014.09.30

[22] assumption

4.3.4 Reda river

The following tables show Reda-specific examples of cost structures of different nutrient mitigating, flood preventing and biodiversity promoting measures, whereas the structures are based on the definitions in Chapter 4.1.

Table 21 Cost structures of small WWTP

	Riparian stripes
Investment Cost (EUR/unit)	2.000
Investigation/Administration Cost (EUR/unit)	250
Ongoing Costs (EUR/unit/year)	52
Expected Life Time (years)	25

Source: Tonderski 2016, Analysis 1, water Pollution; Obarska 2015, Analysis 2, Seidel Przywlocki

Table 22 Cost structures of septic tanks (8000 litre)

	Riparian stripes
Investment Cost (EUR/unit)	1.561
Investigation/Administration Cost (EUR/unit)	340
Ongoing Costs (EUR/unit/year)	723
Expected Life Time (years)	10

Source: Information provided by MIRACLE partners from the Reda case study area [23]

Table 23 Cost structures of sewerage

	Sewerage
Investment Cost (EUR/km)	8.170
Expected Life Time (years)	45

Source: Information provided by MIRACLE partners from the Reda case study area[24]

Table 24 Cost structures of weir/dam

	Weir/dam
Investment Cost (EUR/unit)	377.900
Investigation/Administration Cost (EUR/unit)	789
Expected Life Time (years)	50[25]

Source: Information provided by MIRACLE partners from the Reda case study area[26]

[23] Provided by MIRACLE partner Andrzej Tonderski (POMInnO), based on
http://www.czystyzysk.eu
http://www.biosanit.com.pl
http://przydomowe-oczyszczalnie-sciekow-lublin.com.pl
http://www.greenea.com.pl/szamba.html
http://www.geotest.pl

[24] Provided by MIRACLE partner Andrzej Tonderski (POMInnO), based on
http://www.mpwik.bedzin.pl
http://ecotechnologie.pl
http://zwiuk.pl
http://www.os.not.pl

[25] assumption

[26] Provided by MIRACLE partner Andrzej Tonderski (POMInnO), based on
http://przetargi.money.pl
http://www.przetargi.pl
http://www.eccospec.pl

Table 25 Cost structures of storm sewerage

	storm sewerage
Investment Cost (EUR/km)	452.000
Ongoing Costs (EUR/km/year)	306
Expected Life Time (years)	50[27]

Source: Information provided by MIRACLE partners from the Reda case study area[28]

Table 26 Cost structures of urban retention infrastructure

	closed	open
Investment Cost (EUR)	0,48/m³	1.790.000/ha
Investigation/Administration Cost (EUR)	-	721/ha
Ongoing Costs (EUR/year)	-	30.000/ha
Expected Life Time (years)	-	150

Source: Information provided by MIRACLE partners from the Reda case study area[29]

Table 27 Cost structures of floodbanks

	floodbanks
Investment Cost (EUR/km)	2.331.000
Investigation/Administration Cost (EUR/km)	718
Ongoing Costs (EUR/km/year)	1.891
Expected Life Time (years)	20

Source: Information provided by MIRACLE partners from the Reda case study area[30]

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[27] assumption

[28] Provided by MIRACLE partner Andrzej Tonderski (POMInnO), based on
Ochrona wód Zatoki Gdańskiej
http://www.dbc.wroc.pl
http://www.pwik-rybnik.pl
http://www.pewik.gdynia.pl

[29] Provided by MIRACLE partner Andrzej Tonderski (POMInnO), based on
katalog waving
http://wavin.home.pl
http://www.bankier.pl
http://www.srodowisko.abc.com.pl
http://bip.rbip.wzp.pl
http://szmiuw.kielce.com.pl
http://www.rzgw.szczecin.pl
http://brzeg.pl
http://www.przetargi.egospodarka.pl
http://prawo.gazetaprawna.pl

[30] Provided by MIRACLE partner Andrzej Tonderski (POMInnO), based on
http://www.bankier.pl
http://szmiuw.kielce.com.pl
http://www.przetargi.egospodarka.pl
http://www.ekomeritum.pl
http://mojafirma.infor.pl
http://prawo.gazetaprawna.pl

Table 28 Cost structures of flood plains

	flood plains
Investment Cost (EUR/ha)	36.500
Investigation/Administration Cost (EUR/ha)	12.300
Expected Life Time (years)	20[31]

Source: Information provided by MIRACLE partners from the Reda case study area[32]

Table 29 Cost structures of wetlands

	Wetlands
Investment Cost (EUR/ha)	153.000
Investigation/Administration Cost (EUR/ha)	2.745
Ongoing Costs (EUR/ha/year)	30.000
Expected Life Time (years)	40

Source: Information provided by MIRACLE partners from the Reda case study area[33]

Table 30 Cost structures of buffer zones

	Buffer zones
Investment Cost (EUR/ha)	5.454
Ongoing Costs (EUR/ha/year)	179
Expected Life Time (years)	5

Source: Information provided by MIRACLE partners from the Reda case study area[34]

[31] assumption

[32] Provided by MIRACLE partner Andrzej Tonderski (POMInnO), based on
http://ekoprojekty.pl
http://parseta.org.pl

[33] Provided by MIRACLE partner Andrzej Tonderski (POMInnO), based on
EKONOMICZNE I EKOLOGICZNE ASPEKTY BUDOWY I FUNKCJONOWANIA MAŁEJ RETENCJI WODNEJ NA PODLASIU: http://www.ekonomiaisrodowisko.pl

[34] Provided by MIRACLE partner Andrzej Tonderski (POMInnO), based on
Ochrona krajobrazu i zadrzewieńna obszarach wiejskich metodąaktywizowania społeczności wiejskich metodą aktywizowania społeczności lokalnych. Jakub Józefczuk
http://files.dnr.state.mn.us
http://www.drzewa.pryzmat.org.pl
Agencja Restrukturyzacji i Modernizacji Rolnictwa: ZAZIELENIENIE - przewodnik

5 Concluding remarks

The current report is intended to provide an overview of the cost structures of the different measures implied by the different pathways in each of the four case areas. As a mid-term report it should be regarded as a working document in progress and a tool for the ongoing regional workshops in the MIRACLE project.

Given the lack of available/existing estimates for a substantial part of the measures, the focus of the report is to provide an overview of the many available pieces of information and measures. This is especially the case for the Berze, Selke and Reda catchment case areas, while the Helge River catchment has a more complete level of information available. It is beyond the scope of the MIRACLE project to generate new estimates of costs of measures, and the economic analyses is intended to rely on existing and available information. Since the lack of cost estimates will potentially be invalidating for the subsequent Cost-Benefit and Cost-Effectiveness Analyses of pathways in each case area, it will be necessary to use proxies for costs that would potentially not normally be considered valid for Cost-Benefit Analyses conducted with the purpose of providing decision support in specific project or policy evaluations. However, given that the main purpose with the economic analyses in the MIRACLE project is to provide input and inspiration to the social learning process among stakeholders in the stakeholder workshops, a relatively low degree of precision in the Cost Benefit Analyses may be deemed acceptable as long as the stakeholders are thoroughly informed about the background, limitations and uncertainties of the economic figures presented to them. Thus, where cost information is missing about what may be considered non-negligible parts of the total costs of a pathway in a case area, the Cost-Benefit Analyses will have to make use of transferred cost estimates from other countries or from similar, but not identical, measures.

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