PROLINE-CE

WORKPACKAGE T2

PILOTS: IMPLEMENTATION AND FEEDBACK

OBJECTIVES OF THE PILOT ACTIONS: GEOGRAPHIC AND THEMATIC FOCUS OF EACH PILOT ACTION.

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Geographic focus	*Thematic focus*
PA1.1: Catchment area of the Vienna Water Supply	
The catchment area of Vienna Water Supply (pilot action 1.1 = PA1.1) is characterized by steep karstic mountain ranges with forest ecosystems, alpine pastures and rock areas. Focus of the broad study is the "Zeller Staritzen and Central Hochschwab area". Alpine pastures and hydrological modelling are analysed there. → karstic mountains → alpine pastures → drinking water sources	The main objective is improved protection of drinking water resources through an integrated land use management approach, focusing on alpine pasture practices in mountainous areas (mountain grasslands) within the drinking water protection area of (DWPA) Vienna Water. Source water protection will be facilitated through the implementation of Best Management Practices (BMPs) for alpine pastures, specifically designed for the DWPA of Vienna Water. Hydrological Modelling will clarify the role of surface runoff and infiltration within the DWPA. → alpine pastures (mountain grasslands) → modelling of infiltration and surface runoff → drinking water protection
PA1.2: Catchment area of Waidhofen/Ybbs	
Pilot action 1.2 (PA1.2) is situated in the Drinking Water Protection Area (DWPA) of Waidhofen/Ybbs, which is characterized by karstic mountains with steep slopes, where still semi-natural forest stands grow in a mosaic-mix with artificial conifer plantations. Forestry and hydrological modelling are analysed there.	Thematic focus is on forest management in a steep karstic alpine terrain with the overall purpose of drinking water protection. The karstic spring water with actual high quality should be protected so that the supply can be sustainably guaranteed on the present qualitative level. Source water protection will be facilitated through the implementation of Best Management Practices (BMPs) for forestry, specifically designed for the DWPA of Waidhofen/Ybbs.

→ karstic mountains → forest ecosystems → drinking water sources	Hydrological Modelling will enlarge the protection focus in the thematic field of dolomite stone quarries. → forestry – silviculture → modelling of the hydrological impacts of dolomite quarries → drinking water protection
PA2.1: Well field Dravlje valley in Ljubljana, Slovenia	
Pilot action is a recharge area of a new (potential) well field in Dravlje valley (Glinščica river sub-basin) that is part of Ljubljana field porous aquifer. Glinščica river has recharge area in sandstones and claystones. → alluvial plain with surrounding hilly area → urban environment	The potential well field is in Glinščica river sub-basin and within urbanized area crossed by highway and with large open spaces (mainly agricultural areas), urban area and industry causing high pressure on land use. Dravlje valley is also a flood area with not properly regulated surface waters coming from hilly hinterland. Most of these waters are led to the urban sewage system, which in high waters cannot receive so much water and are flooded. The project focus is to harmonize land use and drinking water source protection and management, which is prerequisite for quality of life and drinking water in this area. → land use management → urban surface water runoff → drinking water protection (spatial planning)

PA2.2: Water reservoir Kozłowa Góra, Poland

Kozłowa Góra is a dam reservoir located at km 28+000 of Brynica River watercourse in the area of Silesian voivodship (Southern Poland). Kozłowa Góra reservoir is fed mainly by Brynica waters. According to the hydrological data from 2007-2016, the inflow rates, determined by the water balance method, range from 0.011 m3/s to 32.446 m3/s. Kozłowa Góra reservoir is classified as a shallow reservoir.

In the pilot area, there are Lower and Upper Carboniferous formations. In its northern part, the Lower Carboniferous formations occur as alternate clayey-sandy shales and sandstones. A series of carbonate rocks, i.e. dolomites and limestones, was found over the clay-sandstone series (Wyczółkowski J., 1960 b). The higher-lying formations of the Upper Carboniferous have assumed the form of clayey shales, clayey-sandy shales and fine-crystalline sandstones.

In the southern part of the area, within the reach of the Upper Silesian Coal Basin, the Lower Carboniferous formations are classified as Culm facies, while the Upper Carboniferous formations are represented by shales (classified as Paralic series), sandstones and coal of the Poręba, Grodziec and Flora beds. Their outcrops become exposed over small surfaces in the area of Kozłowa Góra.

→ shallow reservoir
→ lowland
→ mainly agricultural and woodland areas

Within a year in Kozłowa Góra reservoir water quality parameters changing is observed. Preliminary results of field and laboratory investigations indicate that pollution loads, supplied mainly through inlets, cause yearly phytoplankton bloom.

In summer season, especially in June, sometimes July, algal bloom, causing decrease in quality parameters, is reported. This condition entails difficulties in water treatment and clogging of filters by diatoms and radiators, and, consequently, significant increase in treatment costs. For years the result has been closing the Water Treatment Plant until stabilization of parameters and algal bloom disappearance. The closure of water treatment technological line is associated with additional expenditure spends on for example filters perfusion, to keep their cleansing capacity.

Main objectives of pilot action are:
1. Establishing multi-aspect water monitoring network
2. Setting up coupled models to predict water quality in the future to provide flexible fitting of water treatment technology due to current raw water quality
3. Community meeting and workshop organization to raise awareness and increase their knowledge
4. Preparation of proposal of DWPZ on the Kozłowa Góra reservoir

→ land use management
→ drinking water quality monitoring
→ drinking water protection (determination of DWPZ, spatial planning)

PA2.3: Tisza catchment area, Hungary

The pilot area is located on the Middle Tisza area of the Hungarian Great Plain. The pilot area follows the line of the Tisza River in NE-SW direction. The eastern part of the pilot area extends long in the direction of South by the Keleti Main Channel. Borders of the pilot area are the borders of direct catchment areas.

The pilot area is a plain, with a very low altitude above sea level (avg. 85 – 150m) and a small average relative relief, i.e. 2 m/km2 on most parts. There is a more significant vertical relief in the area of Abádszalók which is covered by sand dunes, and the northern part of Hevesi Plains.

→ plain covered mainly with Quaternary sediments
→ pastures
→ agriculture

On the Tisza pilot area, we are focusing on the surface drinking water abstractions located at Szolnok (River Tisza) and at Balmazújváros (Keleti Main Channel). The surface drinking water abstractions are more vulnerable because of the lack of natural protection layers. The travel time of the contamination is much shorter therefore prompt actions must be taken.

Objectives of pilot action are (1) stakeholder involvement, (2) testing of BMPs in livestock farming and plant production through comparison of current state of the pilot area and an area in Hungary which has already been monitored for possible surface water contamination coming from agriculture, and (3) data gathering and evaluation (water stage levels, precipitation, water chemistry).

→ land use management (agriculture)
→ surface water quality

PA2.4: Groundwater protection in karst area, Croatia

In the PROLINE-CE project, there are two pilot areas in South Dalmatia, which belong to the Adriatic Sea catchment area. These are typical karst fields with complex geological, lithological, hydrogeological and climatological processes.

Karst fields are very specific, because karstic rock is covered by fine deposits (mostly plain area), whereas karstic rock in surroundings (mostly hilly areas) are bare karstic rocks with lack of vegetation. Climate is a mixture of Mediterranean and sub Mediterranean climate with very dry and warm summers.

→ Adriatic river basin
→ coastal karst polje

The karst fields, due to their natural characteristics, represent a rare karst phenomenon with specific surface water flow and great suitability for agricultural activity. Given the fact that agricultural activity has a negative impact on both quality and quantity of water, karst fields represent a major challenge for drinking water protection and management. In addition, climate scenarios for this area for the period 2021 – 2050 show higher temperatures and lower recharge and therefore possible water shortages.

Main focus in these pilot areas is to develop and implement measures for drinking water quality and quantity protection in relation

→ agriculture	to land use activities (above all agricultural activities) and climate change scenarios. → flood protection → land use → drinking water protection (determination of DWPZ, spatial planning)
PA2.5: Neufahrn bei Freising, Germany	
Neufahrn bei Freising is a community situated in the district of Freising (Landkreis Freising), which belongs to the administration district of Upper Bavaria (Regierungsbezirk Oberbayern). The community covers an area of 45.51 km2 and has a population of 21.486 inhabitants. The pilot area relates to the Alpine foreland of Bavaria and thus accounts for the sedimentary basin of the Alpine orogeny. For the purposes of the activities related to PROLINE-CE, the important and thus considered lithostratigraphical units are related to the Quaternary and the Tertiary ages. Both units are characterized by loose sediments, i.e. mostly gravels, sands and clay (lenses), which originates from the Alps. Both units are separated by an extensive marl layer from the Miocene age with an average thickness of 15m. → Alpine foreland of Bavaria → mainly non-irrigated arable land, pastures, broad leaved forests	The pilot area Neufahrn bei Freising represents the groundwater recharge zone that is related to the groundwater pumping wells of the local water supplier. Groundwater is used both for agricultural activities and as water supply for industrial usage (upper aquifer) and as drinking water supply (lower aquifer) in the area. Operational changes in agricultural practices are commonly related to economical driving forces, leading to the fact that agricultural land management is regulated by economic welfare. However, the supply of high-quality freshwater counts as one of the most important fundamental needs, although it is not always respected when adapting agricultural and industrial practices. The main objectives are 1) setting up a comprehensive data base including existing data and filling data gaps by installing new measuring points 2) set up of an integrated hydrological modelling framework, 3) integration of past land use changes and evaluation of the models' functionality and 4) testing, possible future land management scenarios and their impacts on the water resources. → land use management (agriculture, urban areas) → hydrological modelling for the recharge area of the Neufahrn wellfield → drinking water protection (spatial planning)

PA3.1: Po River Basin	
Po River Basin is mostly occupied by agricultural and forest/grasslands areas, which cover respectively 46% and 45% of the basin, while urban and industrial areas concern about 7%. The area includes 2155 surface water bodies, and 167 groundwater bodies. Hydrological and hydraulic modelling are considered for flood risk mitigation, hydrological and water balance modelling for water resources assessment including CC and LULC change. → riparian strips → complex landscape (agricultural areas prevailing) → drinking water availability	The main objective is improved protection of drinking water resource through an integrated land-use management approach, focusing on drought/flood planning, forecasting, early warning and management, also taking into account future climate change impacts. Water protection is carried out through the implementation of BMPs primarily designed for water availability, particularly during extreme events (drought and water scarcity/flood). Activities are focused on the improvement of hydrological modelling and related web tools, also considering CC and LULC and enhancement of planning processes, civil protection mechanisms and regulatory systems. → complex landscape (agricultural areas prevailing) → drought, flood, climate change modelling → drinking water availability
PA3.2: Along Danube bend	
Danube bend area is mostly occupied by non-irrigated arable land (38.5%), discontinuous urban fabric (11.4%), broad-leaved forest (11%) and pasture (6.5%). The pilot area hosts the two most important bank-filtered drinking water resources of the Country. Water-quality monitoring systems and the implementation of proper land use practices are deeply investigated. → riparian strips → agricultural and urban → drinking water sources	The main objective is improved protection of drinking water resource through an integrated land-use management approach, focusing on the water quality protection and on the proper management of bank-filtered wells during flood events. Water protection is carried out through the implementation of BMPs primarily designed for reducing potential damages to water quality through sustainable agricultural practices and improved of municipal sewage treatments. Activities are focused on water quality monitoring systems in order to evaluate the effectiveness of BMPs implementation, also accounting for flood

	risk reduction. → agricultural and urban areas → groundwater quality damage mitigation → bank-filtered water/extraction wells protection (DWPZ and technical protection)

Table 4: Summary of activities performed in the Pilot Actions.

Activities in PA
PA1.1: Catchment area of the Vienna Water
In PROLINE-CE, Vienna Water aims to enlarge an already developed model (KAMPUS) for surface run-off, erosion and infiltration dynamics. We suppose that all addressed dynamics exert considerable pressures on the karstic groundwater resources. Vienna Water also combines this model with other outputs and results (snow model, climate model and measuring stations) from former – also partly EU-funded – projects. The validation of this model will be tested by model outputs compared to hydrological measurements at springs during strong precipitation events. The main pilot activities are situated in the area of "Zeller Staritzen and Central Hochschwab". In the field of alpine pastures (mountain grasslands) Vienna Water aims to communicate and implement Best Management Practices which support drinking water supply security. The most crucial BMPs in the field of alpine pastures were elaborated and defined as guidelines for the farmer's staff working in the mountainous areas. In the course of information transfer meetings and workshops with farmers, alpine pasture related authorities and water works staff, the thematic field of BMP on alpine pastures was opened and discussed. The information transfer activities can be regarded as crucial for the thematic field and persuasive efforts are integrated in order to ensure application of the BMPs.
PA1.2: Catchment area of Waidhofen/Ybbs
Within the drinking water protection area (DWPA) it is necessary to convince the private and federal forest owners about the requirements of drinking water protection in relation to forestry. This is necessary as the overall purpose of drinking water protection in the field of forestry is new for the private and federal forest owners. Hence also the Best Practice Catalogue is new or unknown for them and as a result of this situation the activities focus on knowledge transfer to forest owners in the course of individual round table discussions about the requirements of drinking water protection within forested DWPA.

Incentive payments (payments for ecosystem services) from the water supplier should motivate the stakeholders to apply Best Practices. The Best Practice catalogue of the project was written in short comprehensible style and translated into German language in order to be a potential tool for the stakeholders. The implementation of BMPs in PA1.2 Waidhofen/Ybbs was strategically planned through the elaboration of the "Guideline for securing the Water Protection functionality of the forest ecosystems within the DWPZ" (GWP) which defines all relevant BMPs for the watershed. As the implementation process in forest management needs time, GWP sets the foundation for a sustainable BMP application. GWP was resolved through the city council of Waidhofen/Ybbs and has now normative character.

As part of the testing/demonstrating character of the PA, stakeholders will be invited to visit specific sites of the DWPA where results of already fulfilled or outstanding management activities will be showcased and discussed.

PA2.1: Well field Dravlje valley in Ljubljana, Slovenia

Inventory of possible polluters in the urban recharge area of potential well field Dravlje was made with assessment of their impact on drinking water source and elaboration of measures and best management practices for protection of drinking water source. Strong involvement of stakeholders for implementation of best management practices with several national meetings with particular stakeholder (one-to-one) and regular interactive workshops with local stakeholders.

Distributed hydrological surface runoff model was established with full hydraulic propagation functions for surface waters, with evaluation of new flood measures (retention reservoir built in 2017) and climate change scenarios. Also, simulations of the groundwater pumping effects in the recharge area of planned well field Koseze were made, taking into account the impact of climate change. Several different pumping scenarios were modelled according to climate change and recharge conditions.

PA2.2: Water reservoir Kozłowa Góra, Poland

In June 2017 multiscale monitoring of the water resources was set up to investigate and assess water resources, sources of pollution and possible hazards. Based on the results mathematical models of hydrology and ecology of the Kozłowa Góra reservoir was established. Simulations run allowed to assess a.o. an impact of land use and water management to water quality and quantity and its ecology. A proposal for DWPZ was prepared and is being implemented. The proposal includes a.o. limitation in land use, wastewater management and fishery.

The most important BMP is reaching the society and raise the awareness. In a situation where the guidelines, policies exist and are not enforced raising awareness among society, especially small, local ones is crucial to implement.

PA2.3: Tisza catchment area, Hungary

Data evaluation and comparisons highlighted that current practices in livestock farming, plant production and flood mitigation are good enough to keep the raw surface water in an overall good quality. Data on chemical parameters (NO_3^-, NH_4-N, COD_{Mn}, NO_2^- and pH) measured at Szolnok *(Szolnok Waterworks)* were evaluated and showed very few momentary contamination events from the last six years. Although on most of the livestock farms open manure storages are still in use, the runoff coefficient is so small on the pilot area that the water originating from in situ precipitation is negligible. Overall low annual precipitation, high temperature and radiation contribute to the fact that contaminated rainwater rather evaporates back to the atmosphere or infiltrates into the soil. Water quality did not deteriorate considerably during the serious flooding in 2013 either.

PA2.4: Groundwater protection in karst area, Croatia

In situ measurements of physical-chemical parameters and sampling of spring, surface and rain waters, located in the area of explored karst fields and its catchment areas, will be carried out in monthly intervals. Physical-chemical and isotopic laboratory analyses of samples will enable assessing of land use impact on water quality.
Hydrological modelling of possible impacts of climate change on water resources will be carried out based on the established correlations between the precipitation and the air temperature during the historical period and their correlative discharges, for climate scenarios for the future (by 2050). Hydrological model will provide scenarios of average annual discharges and assessment of possible water shortages in terms of expected climatic conditions in the future.
In order to familiarize stakeholders, especially those in the pilot area, and locals with the results of this research, we will organize a workshop for stakeholders and inform local population through media and brochures.

PA2.5: Neufahrn bei Freising, Germany

In PROLINE-CE, a hydrological model was developed for the recharge area of the well field in Neufahrn bei Fresing. The model was set up using the One-Water Hydrologic Flow Model framework (OWHM), comprising several modules to simulate different hydrological processes in the area. The model integrates the current land use operations performed in Neufahrn, including different crops with different multi-annual crop rotations. This enables to simulate the impact of land use changes on the water quantity available for water extraction from the shallow wells in Neufahrn.

Using the present time series of nitrate from mandatory water quality analysis, we detected a general trend towards lower nitrate concentrations in the shallow aquifer. This points towards more sustainable application of fertilizers and more sound land use practices. This information will help future applications of transport models which can easily be coupled to the existing groundwater flow model.

Generally, we figured out that groundwater modelling and a more distributed monitoring

of hydrochemical data with a higher temporal resolution is a timely challenge to continuously observe the relation between land use practices and groundwater properties.

During our 2nd stakeholder workshop, we informed people in Neufahrn about our activities and outcomes to familiarize them with our identified BMPs and inform them about activities planned in the future.

PA3.1: Po River Basin

The activities carried out in PA3.1 mainly concern the drinking water protection in terms of water-quantity and flood risk mitigation.

The main gaps identified in PA3.1 account for the overexploitation of water resources, especially during drought events, and for the potential impacts of floods on drinking water resources, which are currently not fully considered in the integrated water management strategies. Furthermore, in PA3.1 strong attention is given to the evaluation of the potential impacts of climate change, which will directly and indirectly affect the drinking water supply.

In order to cope with these issues, suitable BMPs for the protection and management of drinking water have been selected and implemented. Specifically, in order to improve the flood forecast and water managing during droughts, respectively employed in FEWS and the DEWS systems, hydrological and hydraulic models have been configured and implemented at the basin scale.

Furthermore, current climate characterization and future variations in weather patterns have been evaluated by means of an integrated modelling chain that allows quantifying the impacts of climate change and land-use change, with a specific attention on their relation with freshwater ecosystem services.
Stakeholders have been the main actors in all phases of BMPs testing. They welcomed basic principles and methodologies for flood/drought operational management and for climate change simulation and projections. Meeting events highlighted that stakeholders involved in management of water shortage crisis should be not only professionals but also communities and non-experts.

PA3.2: Along Danube bend

In the Danube area, groundwater is particularly vulnerable to contamination induced by agricultural production, pollution by not adequate sewage systems or during floods. For this reason, activities proposed for PA3.2 concern the implementation of BMPs that are aimed at solving issues related to groundwater quality damage and its protection.

The issues associated to agriculture primarily affect bank-filtered water sources while poor quality water from urban areas arrive in water bodies after not adequate treatments. Furthermore, water quality is potentially affected by flood events because of river waters may reach the extraction structures and surface water can enter the wells.

In this context, selected BMPs account for the water quality monitoring, both in

agricultural and in urban areas, the implementation of proper land-use practices and the construction of sewage systems and devices for wastewater treatment.

Activities are also focused on the evaluation of the BMPs effectiveness by clarifying the decrease in the groundwater chemical pollution due to the changes in agricultural activities and examining the increase in groundwater quality as consequence of the improvement of sewerage services and network connection.

In order to gain a good insight into the challenges of drinking water resources protection and in further developing of best land-use practices, stakeholders from various domains (Universities, scientific institutes, water management bodies, ministries, national parks, and NGOs concerned with environment and water protection) have been invited to participate in national meeting and workshops.