

PROLINE-CE

WORKPACKAGE T2

PILOTS: IMPLEMENTATION AND FEEDBACKS

O.T2.3 PA CLUSTER ‘RIPARIAN STRIPS’ - IMPLEMENTATION, SHOWCASING BEST MANAGEMENT PRACTICES

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1. Introduction

Drinking water sources along rivers are vulnerable to several processes, which include direct and indirect impacts of floods, drought events, and chemical and biological contamination. Such impacts on river systems and drinking water resources are expected to be exacerbated by climate change. In the frame of work-package T2, best practices for water protection (in qualitative and quantitative terms) and flood management, primarily as indirect impacts on water resources were identified and tested. Specifically, their effectiveness in improving drinking water safety is accounted for, considering significant added values recurring to services provided by ecosystem as well as economic efficiency.

Review of main land use conflicts and Best Management Practices (BMPs) for drinking water protection and defence against floods at Pilot Action level is presented in *D.T2.1.2 “Transnational case review of best management practices in pilot actions”*, which is based on Pilot Actions report. Implementation and testing of BMPs in Pilot Action are described in *D.T2.2.2 “Partner-specific Pilot Action documentation report”*. Evaluation of implementation and thematic interpretation of tested management practices, as well as their acceptance among stakeholders, are described in *D.T2.3.1 “Evaluation reports for each pilot action”*.

Pilot actions and pilot sites respectively were classified into three clusters (Table 1) concerning the geographic specification and natural site characteristics (aquifer type) and main land use:

Pilot Action Cluster 1: Mountain forest and grassland sites,

Pilot Action Cluster 2: Plain agriculture/ grassland/ wetland sites and

Pilot Action Cluster 3: Special sites (riparian strips).

Table 1: Pilot Actions and Pilot Sites respectively, classified into three clusters according to land uses and geographic scope.

PILOT ACTION CLUSTER 1 (PAC1) Mountain forest and grassland sites	PILOT ACTION CLUSTER 2 (PAC2) Plain agriculture/ grassland/ wetland sites	PILOT ACTION CLUSTER 3 (PAC3) Special sites (riparian strips)
PA1.1 Catchment area of the Vienna Water Supply, AT1 Drinking water source: Karst aquifer	PA2.1 Well field Dravlje valley in Ljubljana, SI Drinking water source: Porous aquifer	PA3.1 Po river basin, IT Drinking water source: Bank filtration
PA1.2 Catchment area of Waidhofen/Ybbs, AT2 Drinking water source: Fractured aquifer	PA2.2 Water reservoir Kozłowa Góra, PL Drinking water source: Surface water	PA3.2 Along Danube Bend, HU2 Drinking water source: Bank filtration
	PA2.3 Tisza catchment area, HU1 Drinking water source: Surface water	
	P2.4 Groundwater protection in karst area, HR	
	PA2.5 Neufahrn bei Freising, DE Drinking water source: Porous aquifer	

1.1. Pilot Action Cluster 3: Special sites (riparian strips)

In the Pilot Action Cluster 3 (PAC3) two Pilot Actions were assigned, one located in Italy and the other one in Hungary. They are:

- PA3.1: Po river basin;
- PA3.2: along Danube bend.

In *D.T2.1.4 “Descriptive documentation of pilot actions and related issues”* a detailed description of geographic and social characteristics of Pilot Actions is reported. Specifically, PAs included in Cluster 3 represent a key territory for the respective countries not only for what concerns the water resources.

More specifically, Po River Basin (PA3.1) has an area of 74.000 km² extending in the Italian, French and Swiss territory. The area represents the most developed part of the country, with an important role at environmental, economical, agricultural and industrial level. In addition, around 20% of the Italian population lives in this area.

The Hungarian case study (PA3.2) is located in the Northern part of Central Hungary, in the section of Danube between Szob and Tass. It includes the municipality of Budapest, the Szentendre Island, and the Csepel Island. On these islands are located the two most important bank-filtered drinking water resources of Hungary, which provide drinking water to the capital and about 150 other settlements.

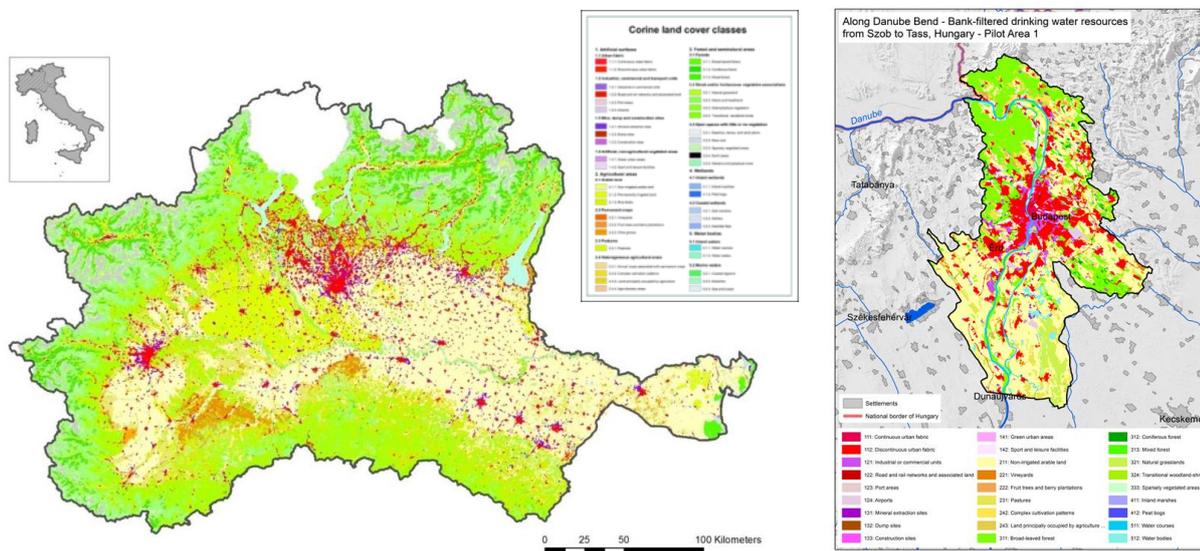


Figure 1: PAC3 land use maps. A) Po River Basin (PA3.1); B) Danube bend (PA3.2).

Based on the analysis of the local characteristics of the PAs, it emerged that the main issues for drinking water resources could be related to the water quality and water quantity protection and management. Indeed, both PAs are characterized by a prevalence of agriculture areas and, for this reason, the most relevant threats are associated to agricultural activities, which affect both the quality and the quantity of the drinking water resources. More specifically, in the Po



river basin area, the main issue is the relevant pressure on water resources demand and the associated crisis management, while in the Danube area drinking water sources (represented mostly by bank-filtration) are particularly vulnerable to contamination and, for this reason, the main issue is represented by the protection of the drinking water quality. Furthermore, both Pilot Actions face with drought and flood problems, potentially enhanced by climate change.

2. Best management practices for drinking water protection and mitigating floods

Gaps identified in PAC3 affect drinking water in terms of both quality and quantity. The assessment and the management of water scarcity events and the assessment of the main sources of contamination represent therefore priority actions for the protection of the water resource system. Furthermore, due to the relevance of Po and Danube Rivers, impacts potentially induced by flood events also represent a key challenge and need to be taken into account for an effective management of the water resources. Drinking water sources are also directly and indirectly affected by ongoing climate change and land use change, which can affect both water quantity and water quality but also can have cascading impacts on freshwater ecosystem services (FWES) and human well-being. This issue is particularly relevant in the PA3.1, where several prototypal studies have been carried out to assess future climate scenarios. The identified gaps and the selected BMPs for the PAC3 are synthetized in Table 2. Their identification is the result of desk reviews, expert judgments and a deep stakeholder involvement.

Table 2 - Gaps and related BMPs identified for PAC3.

Gaps and related BMPs identified for PA3.1 - Po River Basin	
Pressures on water resources management	The Drought Observatory/ Steering Committee and Drought Early Warning System (DEWS)
Flood impacts not fully implemented and considered	The Flood Forecast Centre and Flood Early Warning System (FEWS)
Climate change impacts on drinking water resources	Analysis of the impacts of climate changes on drinking water resources
Gaps and related BMPs identified for PA3.2 - Danube bend	
Agricultural groundwater pollution	Participation in Agro Environment Program
Lack of sanitary coverage	Municipal sewage disinfection
Flood protection protocol on bank-filtered wells operations during high water and flood events	Ensure the drinking water supply during high water or flood



2.1. Implementation possibilities of selected best management practice

There are many best management practices for drinking water protection and flood protection, which already exists, but often actual implementation of these BMPs is slowed down or limited by economic, administrative, social acceptance or governance issues. Implementation possibilities for selected BMPs were assessed in particular Pilot Action of Pilot Action Cluster 3.

In the work-package T1, BMPs for drinking water protection and flood mitigation were identified at national level for each PP. The main goal of work package T2 was testing BMPs, which are considered relevant for each PA (Figure 2). First, relevant BMPs were selected among all the management practices reviewed for each PA (Step 1). Various activities were performed for the implementation of the selected BMPs (Step 2) and to find out stakeholder’s opinion about the tested BMPs (Step 3).

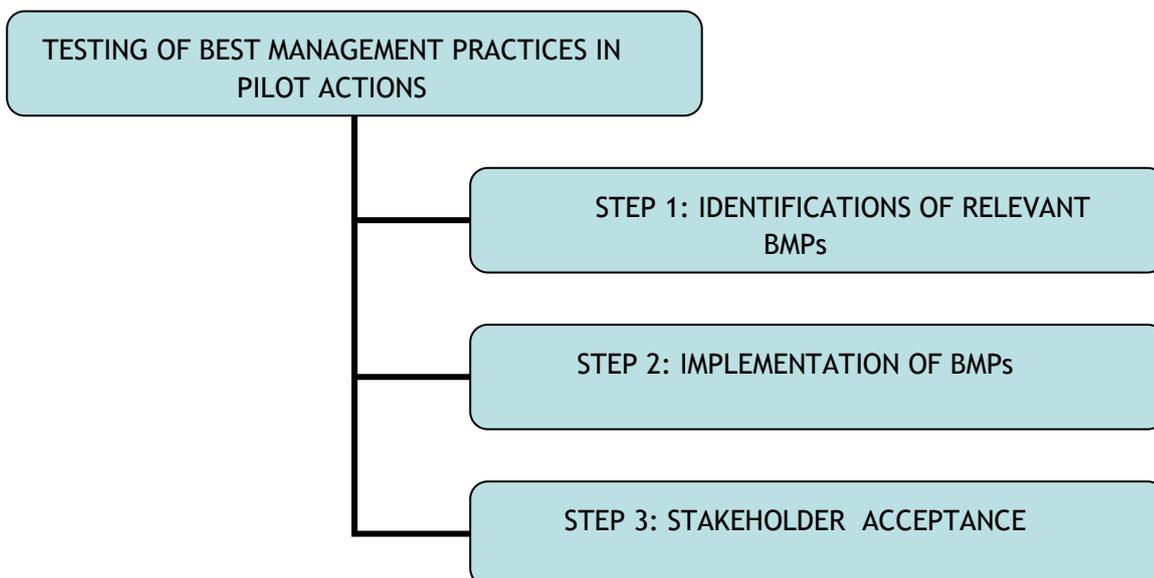


Figure 2: Testing of Best Management Practices (BMPs) in Pilot Actions.

On the Pilot Action level, some BMPs were already implemented in the frame of T2 activities. On the other hand, some BMPs are very complex and require system change or even policy change, which are long-lasting procedures. Implementation of BMPs may require:

- adaptation of existing land use management practices with the purpose of drinking water protection,
- adaptation of existing flood/drought management practices with relation to drinking water protection,
- adaptation of policy guidelines.

How such issues have been/could be addressed in two PAs is displayed in the following. Specifically:



- Table 3 reports solutions and recommendations for adaptation of best management practices
- Table 4 reports an assessment about possibilities of implementation for the selected BMPs and the identification of more suitable implementation strategies (procedures).
- Table 5 deals with acceptance of best management practices for drinking water protection and flood mitigation among stakeholders and experts

As indicated in Table 2, in PA3.1 pressures on water resources are mainly associated to the heavy exploitation of the water system and therefore the management of drought events is crucial for the protection of drinking water availability. In 2007, in order to respond to the drought emergency management, a Civil Protection Act established the Drought Steering Committee for the Po river basin, led by the Po River Basin Authority, with the Operational Support of the Emilia Romagna Environmental Agency. Since 2010, the activities related to drought prediction and simulations are supported by the DEWS System, designed and implemented on the basis of the above-mentioned agreement among Institutions and stakeholders.

Considering the flood management issue, in accordance with the National Civil Protection Department, the flood alerting system FEWS Po (Flood Early Warning System for the Po river basin) was drawn up in the 2000s. In 2013, the Po River Flood Forecast Centre was also established to provide flood forecasts, monitoring, and evaluation at local scale. The BMPs selected for the first two gaps identified in PA3.1 (Table 2) are primarily devoted to empower the operational tools already working in the area. The enhancements are primarily related to management aspects in the first case and to modelling processes in the second case. Aspects related to increasing awareness and enlarging the purposes of the tool, including proper assessments of exposure and vulnerability, are also taken into account in the second BMP.

In PA3.1, the potential impacts of climate change and their evaluation have been selected as the third gap, being this area particularly sensitive to the expected climate variations. According to BMP identified for this gap (Table 2), the objective of Pilot Action is to propose strategies for increasing of the awareness among all stakeholders (actors or users: administrators, decision-makers but also communities) about the potential impacts of climate changes and partly associated land use changes on drinking water resources.

Considering the PA3.2, the impacts on water quality induced by agricultural production, sewage infiltration, and flood events are recognized as the most relevant gaps and the protection of the extraction wells results fundamental to ensure the drinking water resources. In order to protect the drinking water resource, the Government Regulation 123/1997 “*on the protection of the actual and potential sources and water supply structures*” defined criteria of water protection zones based on the implementation of safeguarding measures. In this context, changes in water chemistry have been deeply examined and monitoring wells have been located mostly in Szentendre Island, which represent the most complex area being characterized by agricultural production, recreational areas with no sewerage system connection, and high flood risk vulnerability.



Table 3: Solutions and recommendations for adaptation of best management practices (STEP 1: Identification of BMPs).

PA3.1 Po river basin (IT)					
Actual management practice (GAP)	Proposed BMP	Proposed solutions and recommendations			Remaining issues to be solved
		Adaptation of existing land use management practices towards the purpose of drinking water protection	Adaptation of existing flood/drought management practices with regard to drinking water protection	Adaptation of policy guidelines	
Pressures on water resources management	The Drought Observatory/ Steering Committee and DEWS (Drought Early Warning System)	<p>Improvement of knowledge on links between land use and water resources through:</p> <ul style="list-style-type: none"> - Periodical updating of the assessment of land use (e.g. agricultural practices) impact on drinking water; - Increasing of number, spatial/temporal detail and type of data about land use and environment representation. 	<p>Increase the use and sharing of drought early warning system among stakeholders.</p> <p>Creation within the DEWS system of drought /water scarcity indicators and indices easier to understand for stakeholders.</p> <p>Investment in monitoring, simulation, and analysis.</p> <p>Increase weather, ice/snow cover and ground water information.</p> <p>Operational platforms maintenance,</p>	<p>Improvement of potential synergies among stakeholders on water demand and land use.</p> <p>Give more decisional power to the Permanent Observatory on water uses.</p>	<ul style="list-style-type: none"> - Guarantee resources allocation for maintenance and improvement of existing platforms, procedures expertise and activities. - Increase awareness on drinking water as a not renewable resource. - Drought and water scarcity characterization. - Environmental and Economic Water accounting. <p>Further developments in:</p> <ul style="list-style-type: none"> - integration of climate, snow/ice water,



			<p>education, and training.</p> <p>Consider site-specific drought impacts on drinking water.</p> <p>Fix water shortage/drought thresholds.</p>		<p>reservoirs, surface water, and ground water observation, simulation, and management;</p> <ul style="list-style-type: none"> - integration of in situ and remote sensing; - coupling of water quality and water quantity observation and simulation; - scalable simulation tools considering different temporal and spatial scales (point, river, network, basin, district); - unification of flood, water shortage and drought observation and simulation platforms; - interactive, spatially based, web based, standardized and open architecture retrieving/ access services (data, metadata, and information); - harmonization among real-time and delayed
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					<p>time applications;</p> <ul style="list-style-type: none"> - consideration of joint effects/impacts of strategies, guidelines, planning, design management, constraints, and practices; - standardization of tools methodologies, terminology, criteria, and procedures for water shortage damage assessment.
<p>Flood impact not fully implemented and considered</p>	<p>The Flood Forecast Centre and FEWS (Flood Early Warning System)</p>	<p>Strengthening role and requirements of flood management system in relation to the operational needs in all phases of disaster management (forecast, preparation, and response).</p> <p>Increase synergies among land use planning/management and emergency planning/management.</p> <p>Periodical updating of</p>	<p>Improvement of the monitoring and modelling system, also considering interactions with exposed elements and operational procedures.</p> <p>Investment in flood analysis, operational platform maintenance, education, and training.</p> <p>Consider flood, drought and water management as a unique operational process.</p>	<p>Integration in policy guidelines of the fundamental role of predictability, uncertainty, and communication of extreme events in losses of lives and damages linked to heavy rain and floods, including losses in drinking water supply systems</p>	<ul style="list-style-type: none"> - Guarantee resources allocation for maintenance and improvement of existing platforms, procedures expertise and activities. - Increase awareness on heavy rain and flood as potential cause of not reversible damages. <p>Further developments in:</p> <ul style="list-style-type: none"> - integration of meteorological, snow water, reservoirs, water devices, surface water



		<p>vulnerability and exposure evaluation.</p>	<p>Make flood information more understandable to citizens.</p> <p>Consider event related flood impact on drinking water.</p>		<p>and ground water observation, simulation, and management;</p> <ul style="list-style-type: none"> - coupling of water quality and water quantity observation and simulation; - coupling water and sediment cycles; - unification of flood, water shortage and drought observation and simulation processes and platforms; - interactive, spatially based, web-based, standardized and open architecture retrieving/ access services (data, metadata, and information); - harmonization among real-time and delayed time applications; - consideration of joint effects/impacts of strategies, guidelines, planning, design management,
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					<p>constraints, and practices, (land use, water use, civil/environmental protection);</p> <ul style="list-style-type: none"> - Standardization of tools methodologies, terminology, criteria, procedures for flood and heavy rain damage assessment.
Climate change impacts on drinking water resources	Analysis of the impacts of climate changes on drinking water resources	<p>The proposed solution is to carry out detailed studies about the potential impacts of climate changes and partly related land use change.</p> <p>The main goal is to provide probabilistic evaluations of impacts on drinking water resources accounting for multiple constraints.</p> <p>Furthermore, it could increase the awareness of all the stakeholders about the topic.</p>	<p>Investment in data collection, monitoring, model simulation and analysis, operational platform maintenance education and training.</p> <p>Promote synergic approaches between Disaster Risk Reduction and Climate Change Adaptation communities by considering the cross-dependence between droughts and floods periods.</p> <p>The assessments could support systemic evaluations about the</p>	<p>Test the implementation of proposed solution by relevant stakeholder's communication in the decision-making process.</p> <p>Improving the decision-making process increasing the awareness of all the stakeholders about the future challenges for effectively preserving drinking water resources.</p>	<ul style="list-style-type: none"> - Enhance in understanding of physical behaviour and increasing in computational power to reduce remarkable uncertainties that characterized, at the moment, several elements of proposed modelling chain. - Adoption of probabilistic approaches or findings provided by ensemble initiatives to manage complex atmospheric processes and gaps about future paths in socio-



			<p>management of extreme events (flood and droughts) achieving solutions effective also for preserving drinking water resources.</p> <p>Moreover, the approaches are straightly exploitable also for other test cases.</p>		<p>economic and demographic trends.</p> <ul style="list-style-type: none"> - Enhance the dissemination of the findings accounting for pros and cons in the modelling chain and permitting to have a clearer view about future state of drinking water resources that could be exploited by stakeholders. - Improve management and use of natural resources and ecosystem services to use and modify less the natural capital. - Encourage natural capital valorisation, circular economy and ecosystem optimal management through climate change simulation. - Implement complex, physically based, socially based and evidence
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					<p>related design, planning and governance tools linking environmental, economic and social resources, services and processes.</p> <ul style="list-style-type: none"> - Promote the availability and practicality of climate projection ensembles to enable robust decision making thanks to a likelihood-based analysis.
PA3.2 Along Danube Bend (HU)					
Actual management practice (GAP)	Proposed BMP	Proposed solutions and recommendations			Remaining issues to be solved
		Adaptation of existing land use management practices towards the purpose of drinking water protection	Adaptation of existing flood/drought management practices with regard to drinking water protection	Adaptation of policy guidelines	
Agricultural groundwater pollution	Participation in Agro Environment Program	Such practices are already part of the program.	Such practices are already part of the program.	The Agro-Environmental Program is already based on existing policy guidelines.	<ul style="list-style-type: none"> - Data gathering on how many participants joined the National Agro-Environmental Program since it was first launched.
Lack of sanitary	Municipal sewage	Not applicable	Not applicable	There are already	<ul style="list-style-type: none"> - Development of sanitary



coverage	disinfection			relevant existing policy guidelines.	coverage in Pócsmegyer and Szigetmonostor. - Identification of contamination source at Dunakeszi
Flood protection protocol on bank-filtered wells operations during high water and flood events	Ensure the drinking water supply during high water or flood.	Not applicable	Management practices could be applied for better protection of the wells during floods.	There are no clear recommendations at present.	- Further investigation of water chemistry measured in observation wells located on Szentendre Island. - Revising flood management in context of future climate conditions.



Table 4: Implementation possibilities of best management practices for drinking water protection and flood mitigation with implementation strategies (procedures) (STEP 2: Implementation of BMPs).

PA3.1 Po river basin (IT)				
Actual management practice (GAP)	Proposed BMP	Implementation of best management practices for drinking water protection and flood mitigation		
		Possibility of implementation	Proposal of procedure for implementation	other
Pressures on water resources management	The Drought Observatory/ Steering Committee and DEWS (Drought Early Warning System)	<p>For the complete implementation, it is necessary to:</p> <ul style="list-style-type: none"> - empower modelling system; - increase accessibility and availability of information; - further develop stakeholders awareness and engagement; - assure incentives and investments to prevent, mitigate and better manage water scarcity events; - improve dialogue and communication. 	<ul style="list-style-type: none"> - Confirm and intensify already started activities and projects; - implement economic and environmental methodologies for water resource. 	<ul style="list-style-type: none"> - Extend the number of stakeholders and stimulate attention to drinking water.
Flood impact not fully implemented and considered	The Flood Forecast Centre and FEWS (Flood Early	<p>For the complete implementation, it is necessary to:</p>	<ul style="list-style-type: none"> - Confirm and intensify already started activities and projects; 	<ul style="list-style-type: none"> - Extend the number of stakeholders and stimulate attention to drinking water supply



	Warning System)	<ul style="list-style-type: none"> - empower modelling system; - improve operational procedures and activities considering the whole disaster cycle; - further develop citizen information and operation tools for alert dissemination; - assure incentives and investments to prevent, mitigate and better manage floods. 	<ul style="list-style-type: none"> - implement impact based economic evaluations of flood management. 	systems protection in case of floods.
Climate change impacts on drinking water resources	Analysis of the impacts of climate changes on drinking water resources	<ul style="list-style-type: none"> - The topic about implementation should be differentiated considering the implementation on test case simply requiring the stages above described; - in general, to properly account for CC in drinking water protection management, Acts as National Strategy for Adaptation (published in 2014) and next National Adaptation 	<ul style="list-style-type: none"> - Regional and Urban Adaptation Plans should be performed; - following EU Directive, the updates in Plans should explicitly account for CC issue (e.g. second implementation of actions required by flood Directive). 	<ul style="list-style-type: none"> - More quantitative evaluations activities could permit better driving decisions of Administrators also if carried out only on limited domains.



		Plan represent key activities; - it should be integrated with analogues experiences at regional and urban scale.		
PA3.2 Along Danube Bend (HU)				
Actual management practice (GAP)	Proposed BMP	Implementation of best management practices for drinking water protection and flood mitigation		
		Possibility of implementation	Proposal of procedure for implementation	other
Agricultural groundwater pollution	Participation in Agro Environment Program	Implemented	-	-
Lack of sanitary coverage	Municipal sewage disinfection	Implemented	-	-
Flood protection protocol on bank-filtered wells operations during high water and flood events	Ensure the drinking water supply during high water or flood.	Implemented	-	-



Table 5: Acceptance of best management practices for drinking water protection and flood mitigation among stakeholders and experts (STEP 3: Stakeholder acceptance).

PA3.1 Po river basin (IT)				
Actual management practice (GAP)	Proposed BMP	Acceptance of BMPs among stakeholders and experts		
		Possibility of implementation	Proposal of procedure for implementation	other
Pressures on water resources management	The Drought Observatory/ Steering Committee and DEWS (Drought Early Warning System)	<p>Stakeholders are a bit doubtful about the success of this measure because their involvement is more recent with respect to flood issues. Although positive trends can be observed, the process is slow and requires persistence.</p> <p>Experts put in evidence the main implementation opportunities underlining the role of funding, multi-sectoral partnership, interdisciplinary qualitative-quantitative approaches, and innovation (ICT, humanities, applied</p>	<ul style="list-style-type: none"> - Insert easier and more accessible water information, especially drinking water, according to stakeholders needs; - increase the involvement of experts from different fields (communication, economy, environment, and social sciences) to test operational tools and share knowledge; - funding and implementation of interactive systems for hydrological simulation and application. 	<ul style="list-style-type: none"> - Increase the knowledge of existing and potential problems and vulnerabilities linked to pressure on water resources; - increase the awareness on benefits of information and scenario (evidence-based) based decisions; - share with stakeholders and citizens the main steps and results.



		research etc.), social awareness, training, and stakeholder involvement.		
Flood impact not fully implemented and considered	The Flood Forecast Centre and FEWS (Flood Early Warning System)	<p>Stakeholders gave positive feedback, putting in evidence some difficulties and proposing ideas and solutions to complete the implementation.</p> <p>Experts put in evidence the main implementation strategies whose added value rely on funding opportunities, innovation (ICT, humanities, applied research etc.), social awareness, interdisciplinary applications, and stakeholder involvement.</p>	<ul style="list-style-type: none"> - Insert easier and more accessible water information, especially drinking water, according to stakeholders needs; - increase the involvement of experts from different fields (communication, economy, environment, and social sciences) to test operational tools and share knowledge; - funding and implementation of interactive systems for hydrological simulation and application. 	<ul style="list-style-type: none"> - Increase the knowledge of existing and potential problems and vulnerabilities linked to floods; - increase the awareness on benefits deriving from decisions based on full information and specific scenarios; - share with stakeholders and citizens the main steps and results.
Climate change impacts on drinking water resources	Analysis of the impacts of climate changes on drinking water resources	Due to high complexity of investigated issue, several expertises are required to effectively address the topic; the starting point could be represented by Observatories proposed in	<ul style="list-style-type: none"> - Promote the development of participative processes and stakeholder engagement to promote bottom-up approaches; - integrate the activities about adaptation in Observatories, Technical panels and other decision-making bodies in which 	-



		<p>other BMPs involving also expert in atmospheric sciences or adaptation processes.</p> <p>Moreover, awareness about the future potential issues for drinking water should be increased also in general public, making the results of research and institutional activities easier for all potential stakeholders (for example, stressing pros and cons or uncertainties in current estimations).</p>	<p>experts and communities are already involved;</p> <ul style="list-style-type: none"> - replicate the experiences carried out on different contexts favouring the dissemination of the results. 	
PA3.2 Along Danube Bend (HU)				
Actual management practice (GAP)	Proposed BMP	Acceptance of BMPs among stakeholders and experts		
		Possibility of implementation	Proposal of procedure for implementation	other
Agricultural groundwater pollution	Participation in Agro Environment Program	Financial aspects significantly limit widespread implementation.	<ul style="list-style-type: none"> - Educating farmers about the available methods; - raising awareness; - improving available subsidies and grants. 	-
Lack of sanitary	Municipal sewage	Sewage systems are	- Increasing funding in critical regions	-



coverage	disinfection	continuously being improved in the region.	in order to improve results.	
Flood protection protocol on bank-filtered wells operations during high water and flood events	Ensure the drinking water supply during high water or flood.	Location of individual wells is a critical factor, some are easier to protect than others.	- Implementation can only be done at a local level.	-

3. Conclusions

Pilot Action Cluster 3 (PAC3) encompasses Pilot Action 3.1 (PA3.1 - Po River Basin) and Pilot Action 3.2 (PA3.2 - Danube Basin). These areas represent key territories for the respective countries not only for what concern the local water resources: Po River Basin District is one of the main national economic force while the Hungarian case represent the most important water supply area in the country.

Within the PROLINE-CE Project, the whole water governance process has been investigated for the PAs: the main problems, pressures and gaps and the related heterogeneous measures and practices for land management and drinking water protection have been reviewed at national level. Furthermore, relevant BMPs have been selected and strategically implemented in each pilot action, in order to achieve a function-oriented land-use based spatial management for water protection at the operational level.

In the Italian case study (PA3.1), the increase of water consumption, the indirect impacts of floods, and climate change impacts represent important issues, affecting the drinking water availability especially in terms of water scarcity. Managers expressed a strong interest in flood and drought modelling (FEWS and DEWS) for their possible application in the operational daily management, whilst the climate change simulated scenarios could be useful to address strategic planning and investment options assessment on new supply resources. National meeting has highlighted that the proposed practices are well accepted among the stakeholders well understanding the potential benefits coming from integrated water management, appropriate modelling and simulation, projected climate change and land use change, opening the way to new methodologies and tools for transactions, cooperation and information sharing.

On the other hand, in the Hungarian case study (PA3.2), preventing the quality deterioration of drinking water sources and ensuring an adequate standard for the drinking water supply during flood events represent the main issues and the proposed BMPs are aimed to the identification of strategies and practices for the protection of the water quality. In this case, the implementation of the proposed BMPs is partially ongoing. Farmers, particularly in highly sensitive areas, are using better management practices.

In both investigated cases, direct and indirect impacts of flood events need to be better investigated and, in this case, stakeholders proposed detailed mapping and planning of areas prone to be impacted, especially of most vulnerable elements in terms of both drinking water resources and potential sources of pollution. Finally, taking into account PAC3, the comparison of the gaps and related BMPs in PA3.1 and PA3.2 allows stating that in PA3.1 more attention is required for the management of the drinking water supply while in PA3.2 the protection of the drinking water quality is the major challenge.

The evaluation of the BMPs implementation, current activities and ongoing projects concerning the current and potential effectiveness of the selected BMPs in PAC3 has been undertaken with a strong engagement of stakeholders and experts. From the thematic interpretation of tested management practices emerged that work is still needed in order to:

- empower, maintain and integrate modelling system;
- increase accessibility and availability of information;
- improve the understanding of the impacts of climate change and land uses changes;
- increase the awareness of all the stakeholders (actors or users: administrators, decision-makers but also communities) about the future challenges for effectively preserving drinking water resources.

The results achieved during the PROLINE-CE project highlight that an integrate and effective management of the drinking water resources, carried out taking into account both the direct and indirect impacts of the analysed processes, could provide benefits to all the involved stakeholders. Administrators and decision-makers could benefit from the availability of more detailed data on events occurrence and on the area more vulnerable, as well as from the availability of high-resolution climate scenarios. On the other hand, farmers could benefit from a better land use planning and from the implementation of sustainable agricultural practices, which could also provide possible resolution to the potential use conflicts among different stakeholder's groups. At the same time, an adequate territorial planning coupled with a more effective modelling and prevision of flood and drought events, will ensure the drinking water supply to the local population even during crisis.

Environmental challenges related to sustainable land use and water management have a transnational relevance and for this reason several projects have been previously funded to improve knowledge and research to propose strategies for water protection and water resources vulnerability mitigation, even including the climate change issue. Such topics have been largely covered in LIFE+ initiatives and Horizon2020 calls. Specifically, integrated water resources and land use management as well as raising awareness and involvement of stakeholders are the common topics of PROLINE-CE and CAMARO-D, a EU-funded project within Interreg DANUBE initiative sharing with PROLINE-CE several Project Partners although if on different Pilot cases. Furthermore, PROLINE-CE outputs, which include the proposal of efficient management methods and strategies for the sustainable use of water resources, the correct land use planning, and the protection of drinking water, could contribute to the implementation of EU policies purposes on such topics (Water Framework Directive, Drinking Water Directive, Groundwater Directive, Flood Directive) providing cutting-edge tools and frameworks.

In this regard, PROLINE-CE permitted clearly identifying gaps, needs and the most effective ways to address them. The implementation process was undertaken driven by innovative and agreed technical, scientific and governance solutions. Nevertheless, as well known, such processes require long times for implementation often affected by administrative or unforeseeable delays for external causes. In this regard, further steps for capitalizing the experiences gained during the Project should pursue two main roads. First, technical solutions (as that proposed for Szentendre) or conceptual frameworks (as those provided for Taro River Basin) require to be validated in other contexts within the same PA site or, hopefully, by means of an actual "BMP exchange" within the same cluster. It could allow testing, in effective way, the reliability of solutions and approaches and their broadness. On the other side, the identified BMPs and the

improved knowledge acquired during the Project are expected driving the processes of “mainstreaming” of these BMPs in regional and national policies or governance processes. Of course, it should require further careful evaluations about the more adequate ways to achieve such ambitious targets also broadening the number and expertise of stakeholders. Furthermore, D.T.2.3.3 stressed the role that climate changes could have in exacerbating the issues currently suffered by communities and assets in the areas and the potential direct and indirect impacts on drinking water resources. Then, further investigations should include a proper assessment of the climate change issue for all the related aspects promoting, also in this case, a proper mainstreaming of adaptation actions in policies and regulations.

4. References

PROLINE-CE WORKPACKAGE T2, ACTIVITY T2.1 REPORTS:

- D.T2.1.2 Best management practices report. PILOT ACTION: PA3.1 Po River Basin
- D.T2.1.2 Best management practices report. PILOT ACTION: PA3.2 Along Danube bend
- D.T2.1.4 Descriptive documentation of pilot actions and related issues. PILOT ACTION: PA3.1 Po River Basin
- D.T2.1.4 Descriptive documentation of pilot actions and related issues. PILOT ACTION: PA3.2 Along Danube bend

PROLINE-CE WORKPACKAGE T2, ACTIVITY T2.2 REPORTS:

- D.T2.2.2 Partner-specific pilot action documentations. PILOT ACTION: PA3.1 Po River Basin
- D.T2.2.2 Partner-specific pilot action documentations. PILOT ACTION: PA3.2 Along Danube bend
- D.T2.2.3 Pilot action cluster report: PILOT ACTION CLUSTER 3 SPECIAL SITES (Riparian Strips)

PROLINE-CE WORKPACKAGE T2, ACTIVITY T2.3 REPORTS:

- D.T2.3.1 Evaluation reports for each pilot action. PILOT ACTION: PA3.1 Po River Basin
- D.T2.3.1 Evaluation reports for each pilot action. PILOT ACTION: PA3.2 Along Danube bend
- D.T2.3.3 PA reports about climate change issues in pilots. Transnational report.
- D.T2.3.4 Strategic identification of needs for action for clusters. PILOT ACTION CLUSTER 3 SPECIAL SITES (Riparian Strips)