PROLINE-CE

WORKPACKAGE T2, ACTIVITY T2.1

SET-UP OF PILOT-SPECIFIC MANAGEMENT PRACTICES

D.T2.1.5 SET-UP REPORT ABOUT ADAPTATION OF THE TRANSNATIONAL CONCEPT TO PILOT ACTION LEVEL

PILOT ACTION: PA3.1 PO RIVER BASIN

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1. Introduction

The Deliverable DT2.1.5 "Set-up report about adaptation of the transnational concept to pilot action level" presents scheme for implementation of transnational concept, developed in T1, on the level of Pilot Action ***PA3.1 Po River Basin***.

GAPs and best management practices (hereinafter BMPs) on national level are presented in *D.T1.1.1 - Country report about the implementation of sustainable land use in drinking water recharge areas* and *D.T1.2.1 – Country-specific best management practice report*. Transnational concept is presented in two main T1 deliverables:

- *D.T1.1.2 Transnational Synthesis status quo report*, where strengths and deficiencies regarding land use and water management in drinking water recharge areas are presented on regional and national level and enhanced with EU level;

and

- *D.T1.2.2 Transnational best management practice report*, a synthesis of BMPs is presented on regional and national level and enhanced with EU level. This report provides also a structure for sustainable land use regarding drinking water supply issues.

National and transnational reports regarding sustainable land use in drinking water recharge areas and BMPs were the basis for interactive workshop discussion at national stakeholder meetings (D.T1.3.2 and O.T1.1), performed in each country (Pilot Action area). Outcomes of the national stakeholder meeting set guidelines for further work in Pilot Action. On the other hand, outcomes from national workshops were gathered in transnational report *D.T1.3.3 Lessons learnt at the national stakeholder workshops*, which includes also derivation of measure groups in relation to land use types management and proposal of mitigation of the water-related natural risks.

BMPs and measures for drinking water protection and management, which are derived from T1, will be reviewed and tested in Pilot Actions.

Review of main land use conflicts and BMPs on Pilot Action level has already been done in Pilot Action BMPs reports, which were a basis for *D.T2.1.2 Transnational case review of best management practices in pilot actions*.

Description of natural characteristics of Pilot Site is presented in *D.T.1.4 Descriptive documentation of pilot actions and related issues*.

The goal of this deliverable is to set-up activities in particular Pilot Action. In this report a scheme for activities in Pilot Action is presented.

2. Climate changes

Due to the relevance of the area, in recent years several research works and institutional reports have been focused on the analysis of potential variations in weather patterns and associated impacts to which the territory may be exposed under the effects of climate changes (CC).

In this perspective, it is worth noting how the area was the topic of one among the "Special Cases" discussed in National Strategy for Adaptation to Climate Changes (SNACC, Castellari et al., 2014). Moreover, the potential impacts of CC on the area were investigated in Annex 1 of Po River Management Plan (MPPRB, 2016) and within several European research projects [Drought R&SPI (http://www.eu-drought.org/) and Enhance (http://enhanceproject.eu/)].

Climate and climate change issues in Pilot Actions will be described in detail and discussed in the deliverable D.T2.3.3 - PA reports about climate change issues in pilots.

3. Implementation of best management practices

The main conflicts between management and operation of water supply (drinking water protection and management) and land use (LU) management

As outcomes of T2.1.2 "Best management practices report in pilot action" the main conflicts are mostly between land use and water uses with water quality and quantity; the main conflicts between management and operation of water supply (drinking water protection and management) and land use management are:

- pollution and nutrients loads from urban areas, industry and agriculture and water quality/water treatment;
- withdrawals for irrigation, livestock, drinking water, hydropower and water quantity;
- conflicts within different management rules for irrigation, industrial and water demand and among all management rules and water bodies quality.

Considering land uses, in Po River Basin the Agriculture areas cover the majority of the territory, around 46%, consequently irrigation has the higher water abstraction percentage per year. Agriculture affects water quality and irrigation affects water availability, which is arising conflicts between users especially during drought events. In agriculture the main problems concern: the use of mineral fertilisers and pesticides, the inappropriate livestock waste and manure management, the increase of livestock density. All those activities lead to contamination of water bodies with chemicals, pesticide and in general build-ups of excess nutrients and heavy metal. Irrigation, instead, increases water consumption/water demand, as well as actively contributes to diffuse chemicals and pesticide contaminating water due to runoff and percolation. Water abstraction for irrigation comes mostly from surface water bodies and during drought events the conflicts between upstream and downstream users increase.

Forest and grassland areas are the second main land uses for extension, but potential conflicts are negligible. On the contrary, urban and industrial areas cover a far smaller percentage, around 7%, but they strongly affect the water cycle.

Urban area growth is strongly related on water management and supply issue. Lately the economic growth has led to lifestyles characterized by high water consumptions which means an increasing in water demand, around 307 l per person per day. Moreover the increasing in population density leads in an increasing of waste water and sewage to be treated. In Po river basin, drinking water supply for urban areas is the second main water abstraction after irrigation; while irrigation water supply mostly comes from surface water bodies, drinking water supply mainly comes from groundwater bodies, whose main quality problems are due to percolation and quantity problems are due to over-abstraction.

In industrial areas the issues concern air, soil and water pollution, for instance with partial treatment of industrial waste water discharges into surface bodies, excessive water consumption and contamination of soils and water bodies. As for drinking water also industrial water abstraction is mainly from groundwater.

Noteworthy is the outcome of ISTAT (the National Institute for Statistics) poll on water losses in the drinking water distribution systems of the Po river basin. It has been estimated around 22%, usually lost through ground infiltration. Also the irrigation network suffers the same losses but far most important is the difficulty to quantify water consumption in agriculture. For this reason the Po District Authority following European Regulation1305/2013 has implemented the Water Balance Plan for the P-RD, with a focus on irrigation water consumption. This Plan aims to connect two different water systems: the natural network and the irrigated network, which normally has been studied in a disjoint way, to have a framework for agriculture water balance within the basin water balance, to understand the water amount needed to complete the vegetative cycle of crops and improving agricultural yields. The plan wants to establish a rule to compute, measure and verify the presence of sufficient resources also implementing the evaluation of sustainable needs and the efficiency of irrigation that is potentially achievable. So that Po basin water balance is meant to define a comparative assessment of natural water availability in the hydrological basin and the volume of resources extracted from natural water bodies (rivers, lakes, underground) for different uses, including irrigation. The purpose is to verify that the resource that remains in the natural water bodies are sufficient to obtain the goals of the Water Framework Directive 2000/60/EC.

Furthermore the above described Po basin Water Balance Plan (dec2016) represents an innovative approach to reach shared solutions through participatory decision processes. Consequently the Permanent Observatory Network on water uses has been establish, aiming to strengthen cooperation and dialogue among relevant parties and promote sustainable use of the water resources within each Italian river District. The activities and meetings of the P-RD Observatory consider different levels of activation and are regulated according to water availability and water demand conditions; the higher level of activation is when an alert situation is to come and hydrological and water crisis management is needed: this is when the Drought Emergency plan is put in practice. The basic tools for low flow monitoring and forecast which support water resources management is DEWS. D.T1.3.3. pointed out how the WBP is one of the main BMPs.

The main conflicts between management and operation of water supply (drinking water protection and management) and flood protection

1. Conflicts between the need to keep the reservoir empty for flood mitigation and to keep it full for irrigation an drinking water supply.
2. Conflicts between pollutants conveyed by floods and drinking water recharge areas safety.

In P-RB flood management is well defined and finally regulated by the Italian Laws D.lgs. 49/2010, according to the European Flood Directive 2007/60/EC and D.lgs 152/2006 so that “Food Risk Management Plan” and the “District Hydrogeological Regulation Plan (PAI)” have been established with the main aim to identify flood areas, arranging and managing activities in flood areas and defining security targets and priorities actions in agree with Regional Administrations. All those consideration aid to plan and create targets rule to improve the planning of the territory. Moreover concerning non-structural actions the National Civil Protection Department, together with Administrations belonging to P-RB, drown up the flood alerting system FEWS Po (Flood Early Warning System for the Po river basin).

The second main BMP pointed out in D.T1.3.3. is the FEWS system , similar to DEWS and related to the flood early warning. Both FEWS and DEWS were briefly listed in T2.1.2. “Best management practices report in pilot action” but will be further described in this report (chapter 4).

Application of BMPs in PA to solve these conflicts for the purpose of assuring safe drinking water supply

We can consider two different types of BMP:

- Quantitative or direct BMPs are related to actions, procedures and operations with a straight and measurable effect on water management; they are based on statistical and numerical hydrologic modelling that supply objective values of climate change, land use, extreme events impacts. Objective BMPs can be used in real time early warning systems or for planning or project purposes; among the last we can consider nitrates management, good cultivation techniques, hydraulic invariance, and green management of land reclamation and irrigation open channel network.
- Qualitative or indirect BMPs are related to processes developing in a wider and more complex context, including social and cultural features and new communication tools. Even thought this kind of measures and practices at a first glance can sound less important with respect to the previous ones, their main strengthens rely on the opportunity they give for dissemination, community building, education and social awareness.

While protection measures are already completely well defined to guarantee the water quality targets, water availability management aspects are still developing. The increase of water consumption and climate change are the main pressure to take into account for the next plans and actions to avoid spreading of conflicts for water use; the effects of this drivers, especially during water crisis could be even more severe in the absence of an exhaustive analysis of reservoir management needs and of agreements between water users, possibly based on water monitoring and forecasting tools, a proper monitoring and predictive activities to clearly retrieve actual conditions and deal with future challenges on short and long term horizons. In the P-RD low flow monitoring and forecast, including both direct and indirect BMPs in supporting water resources management, plays a key role for drought events management when conflicts spread out.

Implementation strategies (stakeholder involvement – local round tables etc.)

Cooperating with Po District Authority and National Civil Protection Department.

Organizing stakeholder meetings, media/social media releases (to alert, to spread information, and so on).

Testing of BMPs

With stakeholders involvement /opinions and modelling

4. Modelling

All models available could be distinguished between flood forecast and drought/water balance evaluation, respectively used by the FEWS and the DEWS systems.

For flood forecast there are several hydrological and hydraulic models coupled for a good representation of the flood with adequate time resolution. Basically the FEWS system is configured to use three different hydrological and hydraulic couples that are:

- DHI NAM / DHI M11
- HEC-HMS / HEC-RAS
- Topkapi / Sobek

Below is a brief description of each hydrological and hydraulic model, which will be used:

- DHI NAM is a hydrological continuous, lumped, conceptual model developed by the Department of Hydrodynamics and Water Resources at the Technical University of Denmark. The NAM model use mathematical statements to represent hydrological cycle between four different linked storage representing different physical elements of the hydrological basin (snow, surface zone, lower zone and groundwater) and dynamically evaluate water content and water exchange between all components. The NAM model is a continuous model; this means that every simulation is directly affected by the initial condition that is basically the content in storages. The model requires a small amount of parameters and is widely applied all over the world.

- DHI M11HD is a hydraulic model that uses an implicit finite difference scheme to solve the continuity and momentum equations in a 1D environment. The solution scheme was developed by Abbot and Jonescu (1967) and uses a different grid to solve alternatively continuity and momentum equation in Q (discharge) and h (water level) points along the computational grid. The entire network is described using cross sections and the software is capable to model both simply and complex hydraulic structures like weirs, dams, bridges, lateral structures, gates, etc. The HD model in capable to correctly represent both sub-critical and super critical flow conditions also for steep channels.
- HEC-HMS is software developed by the Hydrological Engineer Centre of the U.S. Army Corps and contains several models for simulating the hydrological cycle, in fact HMS stands for Hydrological Model System and could not be classified as a model, but a set of models that can be combined to properly simulate the hydrological cycle. In the FEWS system the HMS is applied using basically the SMA model for losses evaluation and Clark UH model for rainfall-runoff transformation, also a base flow model is used to correctly evaluate the recession part. With this configuration the model can be classified as empirical, continuous and lumped. Also in this case continuous means that the model is affected by initial conditions.
- HEC-RAS is also developed by the Hydrological Engineer Centre of the U.S. Army Corps and is one of the most widely used hydraulic models for river and estuaries simulations, it can perform steady and unsteady flow simulation in 1D and 2D mode (since version 5.0). The RAS model for unsteady problems solves the momentum and continuity equation using the box scheme with the Preissman algorithm (Liggett and Cunge, 1975) and is capable to simulate critical, sub-critical or mixed regime flows taking into account structures like weirs, dams, lateral structures, controlled structures, etc.
- TOPKAPI (TOPographic Kinematic APproximation and Integration) is a hydrological continuous, distributed and physically based model (Todini and Ciarapica, 2001; Liu and Todini, 2001; Liu et al., 2005) and couples the kinematic approach with the topography of the catchment and transfers the rainfall-runoff processes into three 'structurally-similar' zero-dimensional non-linear reservoir equations. Everything derives from the integration in space of the non-linear kinematic wave model: the first represents the drainage in the soil, the second represents the overland flow on saturated or imperious soils and the third represents the channel flow. The parameter values of the model are shown to be scale independent and obtainable from digital elevation maps, soil maps and vegetation or land use maps in terms of slopes, soil permeabilities, topology and surface roughness.
- SOBEK is a suite developed by Deltares for flood forecasting, optimization of drainage systems, control of irrigation systems, sewer overflow design, river morphology, salt intrusion and surface water quality. The modules within the SOBEK modelling suite simulate the complex flows and the water related processes in almost any system. The

modules represent phenomena and physical processes in an accurate way in one-dimensional (1D) network systems and on two-dimensional (2D) horizontal grids. The hydrodynamic simulation engine has a very efficient numerical solution algorithm. The algorithm is based upon the optimum combination of a minimum connection search direct solver and the conjugate gradient method. It also applies a variable time step selector, which suppresses the waste of computational time wherever this is feasible.

The DEWS system is a drought event and water management evaluation system that uses some different models at different time scale and lead time. In particular the hydrological part is simulated using the same Topkapi model described above, but with a different time scale, approach and calibration. Model outputs are discharges used as input in RIBASIM.

- RIBASIM (RIver BAsin SIMulation Model); this water balance model analyses the behavior of river basins under various hydrological conditions and it is designed for river basin planning and management.

  Both models use real-time data on precipitations and discharges provided in telemetry, as well as forecasted data elaborated by long term deterministic and seasonal models. The modeling chain is implemented in two operative configurations, providing forecasts on the variables of interest on two different timeframes: the first covers 2 weeks, while the second one is seasonal and covers 3 months.

- The DEWS-Po system has mainly been developed as a decision support tool for the management of water crisis, promoting the system employment when periods of water scarcity arise in order to evaluate the insurgence of droughts, monitor their development, quantify the severity and provide the necessary information for prospective coping actions as well as the formulation of possible scenarios.

All these models will be deployed using the RCP 4.5 scenario to evaluate climate and hydrological projections applied to droughts, water crisis and floods with a special focus on climate change impacts on drinking water protection.

5. Conclusions

In this report a scheme for Pilot Action activities, which will be performed in Pilot area, is presented.

Description of performance of pilot activities and first outlining of foreseeable solutions will be described more in detail *in D.T2.2.4. - Partner-specific interim pilot action progress report*. This preliminary report will be discussed and presented during TM4 and Project First Review in April 2018 (D.M.2.5).

Outcomes from the management actions examined in Pilot Actions, description of conducted activities and identified solutions for case-specific adaptations of management concepts will be described in *D.T2.2.2. - Partner-specific pilot action documentation*. In this report, also gaps between the revised best management practices and actual management practice will be outlined.

6. References

AdBPo (Autorita di Bacino del fiume Po) (2010). Piano di gestione del distretto idrografico del fiume Po. Autorita di Bacino del Fiume Po. Parma.

Delft Hydraulics (2006) RIBASIM River basin planning and management simulation program. In: Proceedings of the iEMSs Third Biennial Meeting: "Summit on Environmental Modelling and Software". Burlington, USA: International Environmental Modelling and Software Society.

Liu Z. e Todini E. (2002) Towards a comprehensive physically-based rainfall-runoff model. Hydrology and Earth Sy- stem Sciences 6 (5): 859-881.

MPPRB, Management Plan of Po River Basin (Piano di Gestione del Distretto Idrografico del Fiume Po: Stato delle Risorse Idriche) (2016)

Vezzoli, R. et al. 2015. "Hydrological Simulation of Po River (North Italy) Discharge under Climate Change Scenarios Using the RCM COSMO-CLM." Science of the Total Environment 521-522: 346–58.

Vezzoli, Renata, Paola Mercogliano, and Sergio Castellari. 2016. "2050: quale disponibilità idrica nel bacino del fiume Po ?" Ingegneria dell'Ambiente 3: 44–52.

AdPo, Piano del Bilancio Idrico per il Distretto del fiume Po, Allegato 2 alla Relazione Generale Uso dell'acqua in agricoltura nel distretto del Po http://pianobilancioidrico.adbpo.it/