Technological platform for catchment water safety planning

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INTRODUCTION

Water safety plans (WSP) is a concept introduced by the World Health Organisation (WHO, 2004) for risk assessment and risk management in drinking water systems. This approach has been increasing embraced by water suppliers, governments and other stakeholders. Raw water quality is a key factor for ensuring good and safe drinking water. Water use, land use and polluting human activity in the catchment area all have significant impacts on surface and groundwater quality, and thus the level and complexity of treatment plants necessary to ensure that the water leaving the works is safe and acceptable to consumers. Protection of raw water sources should be seen as the first, and often the most important, barrier to prevent microbial, chemical and radiological contamination of drinking water sources (Vieira et al., 2011).

Due to continuously emerging threats to the drinking water quality from organic matter, pesticides, fertilizers, pharmaceuticals, trace metals, and other types of contaminants, much effort has been put in the development of knowledge that is capable to effectively identify potential risks. Information on catchment characteristics (e.g. geology, hydrology, meteorology, land use, competing water uses), surface water bodies (e.g. flow rate, water quality and seasonality) and groundwater (e.g. aquifer flow rate, flow direction and aquifer vulnerability to pollution) and application of models to quantify the spatial and temporal dynamics of transport and attenuation of hazards that arise from the pollution sources across a catchment are of paramount importance for evaluating and prioritizing risks in raw water sources (Vieira & Pinho, 2014; WHO, 2016). This paper presents the use of the Delft-FEWS platform (Werner et al., 2012) in implementing an early warning system supported by proper hydrodynamics and water quality models for supporting catchment water safety plans in two river basins of the NW region of Portugal.

METHODS

Rivers Cávado and Ave basins are located in the north-western region of Portugal (Figure 1). At these basins important water treatment plants are installed abstracting water both from river Cávado and river Ave. At the same time, these rivers are used as receiving bodies of wastewater treatment plants (WWTP) discharges.

WSPs identified different threats that needs proper early warnings for effective action to avoid the interruption of public water supply. This is achieved recurring to a technological platform that is being implemented using Delft-FEWS software.

The platform was implemented based on rivers and WWTP hydrodynamic and water quality data. It is also based on a modelling system that simulates rivers network hydrodynamics and the transport of matters that are used as water quality indicators.

A set of water quality processes were selected, considering either simple processes (such as accidental discharges simulations considering conservative pollutants) or more complex processes (such as organic matter degradation).

Bacterial contamination resulting from urban wastewater discharges or diffuse pollutant sources were simulated by taking a 1st order decay approach. Models were implemented using Sobek software and calibrated using available measured data (Figure 2).

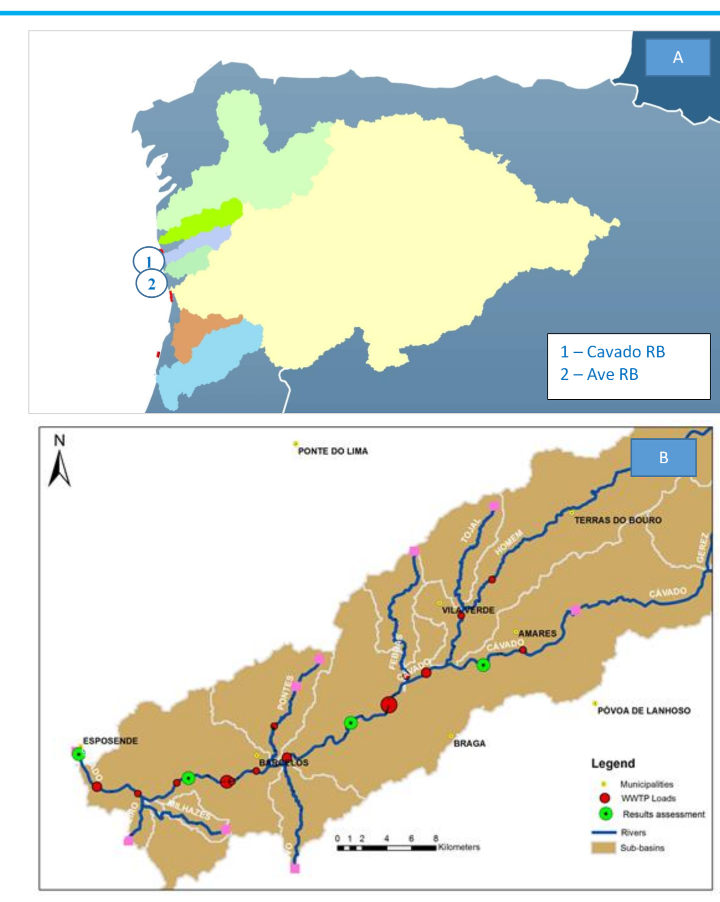

Figure 1: Catchment water safety planning: A) location of river basins, B) Main pollutant point sources and sub-basins of Cavado river basin.

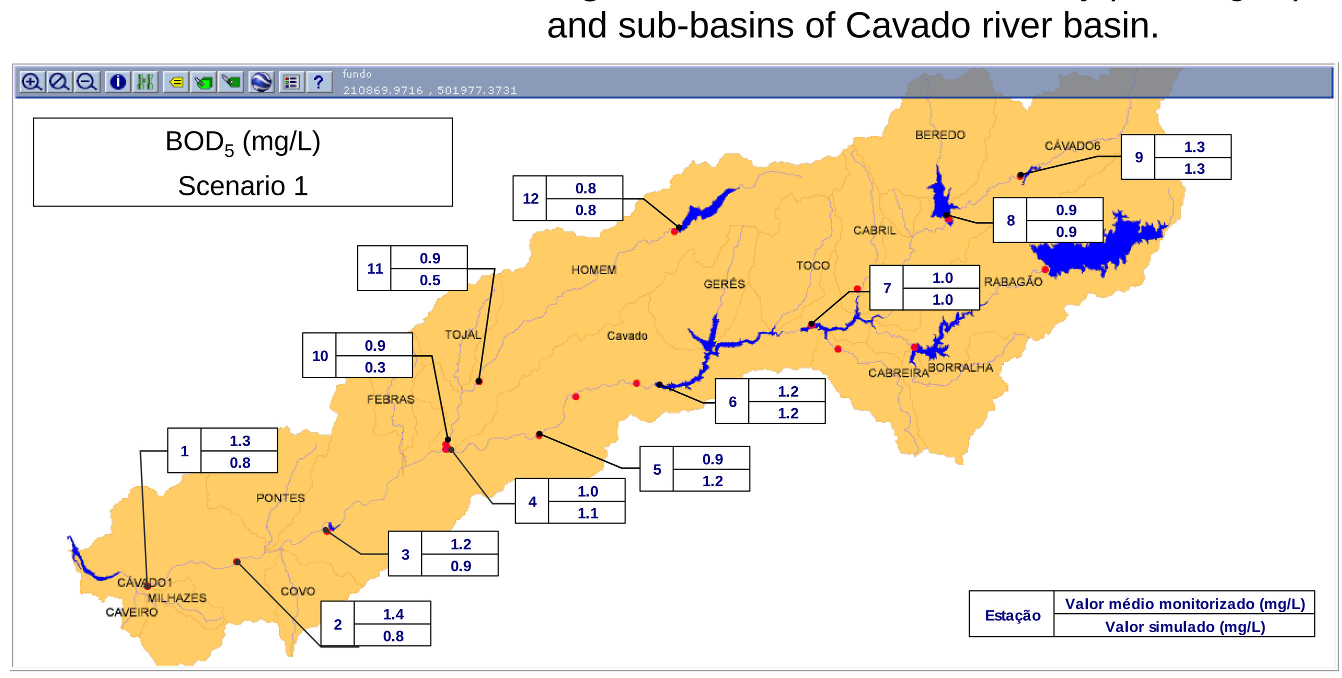

Figure 2: Results of water quality model calibration in river Cavado used for the implementation of the early warning system for catchment safety planning.

RESULTS

The implemented early warning tool constitutes a robust and efficient technological platform to support the operational implementation of catchment safety plan. Forecasts of water quality along the main rivers allow predicting that this new tool will be extremely effective and important to achieve the objectives of keep in a safety operational status the main water treatment plants installed within the basins. Figure 3 presents illustrative results obtained with the water quality model for some scenarios that are being worked out in order to support the risk analysis tasks at this phase of the development of the catchment WSP. The impact of the rupture of one of the most important WWTP (Frossos) was simulated and results at two different locations (Areias de Vilar WTP and Barcelos city) for coliform bacteria (CB) concentrations are presented at the upper graph of Figure 3. The lower graph presents the seasonal expected variation in CB concentrations for one of those locations considering constant pollutant average discharges and monthly averages of river discharges.

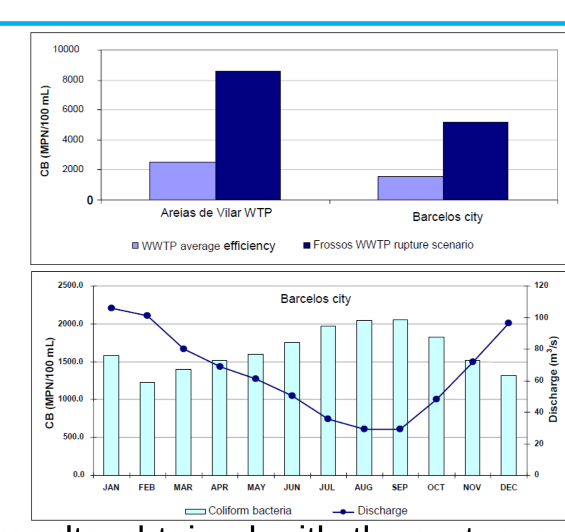

Figure 3: Illustrative results obtained with the water quality model for scenarios that are being worked out in order to support the risk analysis for catchment WSP implementation.

CONCLUSION

In the next years, the use of all the potentialities of this platform in practical situations under different water management problems constitutes a major challenge for the evaluation of the developed tool. Moreover, water authorities once decide to use this kind of management tools will certainly see improved their analysis capabilities, strengthening their technological skills for the adoption of more sustainable water management policies.

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