D3.1 FIWARE-enabled applications for Raw Water Supply

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Executive Summary

Fiware4Water (F4W) intends to link the water sector to the FIWARE smart solution platform by demonstrating its capabilities and the potential of its interoperable and standardised interfaces for both water sector end-users (cities, water utilities, water authorities, citizens and consumers), and solution providers (private utilities, SMEs, developers).

This deliverable reports the smart applications (algorithms and models) developed, in the framework of Task 3.1 (WP3), to support the optimal operation and management of the raw-water conveyance system that serves the metropolitan area of the city of Athens (Greece; Demo Case 1). The demo case part of the system is the "Giona – Dafnoula" aqueduct, with a total length of 131 km. The applications developed aim to support the operational staff of EYDAP (the Athens Water Supply and Sewerage Company that operates the system) in decision making with respect to flow and quality conditions of the conveyance system. In summary, three new applications have been developed to: a) provide advice on optimal sluice gate settings (openings) depending on the flow conditions and needs for water supply, b) provide early warnings for high turbidity events and one-hour ahead forecasts of the level of turbidity at the most downstream part of the system, which are close to the water treatment plants, and finally c) to provide one-day ahead forecasts of total water outflows from the water treatment plants. It is worth to highlight that these applications are innovative both with respect to the modelling approaches to address specific scientific problems, as well as to their operational character. Essentially, this is the first time that such decision support services become available to the operational staff of EYDAP, in an operational context.

Prior to F4W, the regulation of flow across the conveyance system was based on empirical rules. However, this management policy, which is strongly based on operators' knowledge and experience, is neither sustainable nor safe from a resilience perspective. Furthermore, the system is subject to occasional failures, due to undesirable overflows resulting in non-negligible water losses. To support the optimal operation and scheduling of the regulation structures (Λ-type structures) which control the flow in the channel under study, in a systematic and automated way a model has been developed. The model follows a "grey-box" approach, combining physics-driven hydraulic equations, to simulate the flow through sluice gates and over spillways, with data-driven techniques for the estimation of the key parameters (e.g., coefficient of discharge) of the algorithm. The model estimates the new openings of sluice gates for a target flow, given the upstream and downstream water depths and flow, available from sensors on real-time basis. Furthermore, it estimates the time required for the flow to travel downstream, in other words, the response time between the time moment of a control action (either opening or closing the sluice gates) and the time moment when the downstream flowmeter captures this modification.

The project focused also on quality aspects of the raw-water system. Specifically, data-driven models have been developed to provide forecasts of the level of turbidity at the most downstream parts of the system under study, before raw-water reaching the 4 water treatment plants that serve the city of Athens. Specifically, we built two deep neural network models, using Long-short term memory kernels, to forecast one-hour ahead the level of turbidity at the most downstream quality metering stations, using as predictors the level of turbidity at the upstream distant metering stations. The model is accompanied by a threshold-based early warning system that notifies the operators for unusual high-turbidity events which may appear at the 6 water quality sensors existing in the system under study.

Furthermore, taking advantage of data provided by EYDAP, we developed a harmonic regression model to forecast one-day ahead the total daily water outflows from the 4 water treatment plants, and hence enabling operators to regulate the flow in the channel accordingly. The model gives special focus on

the reproduction of annual and weekly seasonality exhibiting in water outflows, as well as their significant variability, during periods of exceptional demand events (e.g., Easter holidays). It is worth mentioning that this model is not foreseen in the description of work of the Grant Agreement of the project, and it is developed as an initiative of NTUA, after the needs of operational staff of EYDAP.

The three above mentioned applications are currently in an operational context, consuming real-time data from the FIWARE Context Broker that has been deployed in the framework of F4W. The outcomes of the applications are available to operational staff of EYDAP via the new web platform that has been also developed in the project and is presented in Deliverable 4.1 ("D4.1: FIWARE4_Raw water supply system real-time operational management" [M35]).

As discussed in Section VI, the developed applications have great potential for further uptake both within EYDAP as well as in other large-scale raw-water conveyance systems in Europe.

Related Deliverables

D1.1: "Requirements from Demo Cases" and D1.2: "Requirements from end-users", which describe the requirements of the smart solutions developed in WP3.

D2.1: Specification of system architecture for water management, cybersecurity and quality monitoring, which provide guidelines to implement FIWARE-enabled architectures.

D4.1: FIWARE4_Raw water supply system real-time operational management, which describes the FIWARE-enabled deployed in Task 4.1 (WP4) for Athens Demo Case.

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CB Context Broker

DW Data warehouse (of EYDAP) – Database that stores the data from the legacy system of EYDAP

EYDAP Athens Water Supply and Sewerage Company

EAV European Added Value

F4W Fiware4Water project

IoT Internet of Things

LSTM Long-Short term Memory

NN Neural network

NTUA National Technical University of Athens

WPL Work Packages Leaders

WTP Water Treatment Plant