

D6.8 E-Book#2

"Technological and non-technological dimensions of Digital water"

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Executive Summary

Fiware4Water story has started in 2018, when partners from digital and water fields decided to build a project to further explore innovative digital solutions applied to water management and provide evidence based tools and methods.

Reaching the final lane, Fiware4Water partners aimed at presenting digital water as explored through the progress of the 4 Demo cases and 3 Demo networks.

This updated version following the one named *Digital Water for non experts* provides specific scientific and technological focusses.

The project's overview, a scientific presentation, focus on digital water, the European perspective for digital water and Fiware4Water contribution to EU water related policies are still available. In addition, partners proposed to detail the technological solutions developed at the scale of the Demo cases.







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Introduction

Fiware4water *E-book* named Technological and non-technological dimensions of Digital Water is the deliverable n°6.8 of Work Package n°6 dealing with Ecosystem building for Communication and dissemination strategies and activities

Fiware4Water E-book is part of the learning experience on digital water proposed by the project. It completes the webinars and workshop realised during the project.

The content of the E-Book was decided by the partners in April 2021. During the meeting, the decision was made to provide a non-technical content the E-Book to reach out water stakeholders that are not digital experts. Then the E-Book would be updated to include a scientific dimension at the end of the project by adding web-links towards the scientific outcomes. D6.8 presents the final version of the E-Book.

To propose a tailored knowledge to non-expert, the dedicated content of the E-Book comes from a series of 11 interviews with partners that took place between July and October 2021. The purpose of these interviews was to promote the project's outcomes and progress through short video published on social media¹, and to grasp the latest advancement of demo networks and demo cases in a simple language, so water stakeholders can be provided with evidence based tools and methods.

The scientific focus of the E-Book has been directly prepared by the partners.

The on-line version is available on https://www.fiware4water.eu/deliverables#dissemination

¹ All the videos area available on https://www.fiware4water.eu/deliverables#videos



I. Book cover and Introduction





II. Content



III. Fiware4Water overview





IV. Fiware4Water scientific dimension



Scientific dimension of the project

How can FivenetWater contribute to these expected impacts? The best option for us is to power as many types of user cases of usefulness of the FIWARE platform as we can covering hopefully the whole water cycle: water supply, water distribution, weastewater treatment, and also the communication with the customers with Smart Water applications. This is what we're trying to do by looking into the way our demo cases have operated with new technology, managed to communicate, and collaborate with the legacy systems (systems that the utility already has in place). This rush is the best contribution to demonstrate a possibility and a way of transition to digital water for the water utilities.

What are the project's key scientific tenovations? The main innovation of this project is technical. It is related to the information technology, and the population of the HWARE platform with data models for the water sector. Fivare4Water is a new foundation for using real time operational management within the internet of things ara.

For the utilities, we are very happy that we managed to develop a lot of data models with the help of the FIWARE platform, thanks to the innovativn work of all our partners and the cooperation of the water utilities, all parts of Fiware4Water consortium. The key scientific innovation has been recognized by the European Commission. In the latest publication in May, for the working stall documents, Fiware4Water is the only model project for digital water included for their own staff. And this, for me is a very, very happy end. It helps the reputation, and also the impact of the Fiware4Water project.

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V. Learn about digital water



Learn about digital water

Bigital water is a nevel concept completely aligned with the current Industrial Revolution. It covers the digital transformation of the whole water sector, from wastewater management to water distribution systems, or other aspects at the water customer level, for example. The key of this concept is the access to digital data, which contains critical information about the water infrastructure and its underlying complex processes, and will be used to provide a competitive advantage to the water sector for improving management and smart decision making. It is based on five pillars. First, the Cyber physical systems, commonly known as sensors, used to transform the physical world into the digital world. Then, the Internet of Things (IoT), a network of sensors (cyber-physical systems) deployed throughout the water infrastructure. Third, Internet Services, which refers to the online access to the information and its process via, for example, Cloud Computing technologies. The fourth pillar is Big and Small Data Analytics which, based on novel methodologies and algorithms from Data Science and Artificial Intelligence domains, for example, processes the water data to generate valuable insights for improving decision making. And, finally, the Cyber security pillar. Nowadays, it must be present in any Digital Water Solution, since the water infrastructure is digitally operated, and online attacks may result in catastrophic situations involving climate risks or humans losses.

What are t The Digital Water concept is already impacting the Water sector. Newadays, we can see how the whole water infrastructure is under a critical and necessary digitalization process, which is establishing the basis for the actual Digital Water revolution. In this line we will see, for example, a bunch of smart Decision

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Learn about digital water

Support Systems, or even end to end automation of complex and complicated processes in the Water sector, such as those carried out in a wastewater treatment plan. It will enable the Water sector to successfully cover critical issues such as the water system performance, better water quality, efficient use of the resources, pollution reduction or associated operational cost savings, in such a way that global sustainability aspects are satisfied in compliance with regulations and future economical, social and environmental needs.

In the FIWARE4Water project, we are focused on each of the five digitalization pillars I have explained before. First, we are working on new advanced sensors for improved water data gathering. Second, we are promoting the use, in the Water sector, of an open and advanced digital solution, the FIWARE ecosystem, which is widely used in other domains. We are actually extending its capabilities and functionalities via the development of new components including Big Data and Artificial Intelligence tools, or new data models for standardized and interoperable

communication between services, to1 sensors or external legacy systems, among other actors in the water infrastructure. We are also working on new Smart Applications which, based on novel Machine Learning and other advanced technics, will process the Water data to provide an improved water lifecycle management. And, finally, the cybersecurity aspects, which are always present in our developments.

All these aspects, altogether, will contribute towards the Digital Water concept materialization and its continued evolution.

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VI. The European perspective on digital water

European perspective on digital water

Overvie

The EU plays a leading role in enhancing smart water management [a]. The quality and quantity of water provisions from the Water Framework Directive, including Drinking Water, Floods, Water Reuse, Urban Wastewater Treatment and Groundwater, have been decisive to start the ball colling with regards to integrated water management at both a national and local level. Further provisions concerned with Data Protection, Access to Environmental Information and Open Data have played the same role on the digital side. More importantly, initiatives such as the EIP Partnership on Smart Oties and the Digital Single Market for Water Services Action Flan have shown the increasing ambition and interest of the EU in digital water governance.

As described by the Policy Action Group of ICT4Water [b], digital solutions provide support to water managers when controlling the general cost of operation but requires investments so planning, simulation and digital decision support can be deployed. The role of digitalisation in achieving a more effective relationship with water end-users is also highly relevant i.e. for citizen engagement, seeking to channel the citizen's enhanced awareness into a proactive involvement both in the co-creation and subsequent implementation of water-based policies.

Digital water solutions support integrated water resource management by providing science-based information and knowledge, employed by water managers both for management and forecast tasks and the raising of citizen awareness and engagement. They provide new mechanisms for water governance, widening the possibilities for stakeholders to understand water and societal challenges, and to interact, codesign and co-implement the solutions.







VII. Tour of Fiware4Water Demo cases





VIII. Demo case #1: Water supply system real time operational management, Athens • Greece





IX. Demo case #2: Improving the water supply system, CannesFrance





X. Demo case #3: Intelligent control for wastewater treatment, Amsterdam • Netherlands





XI. Demo case #4: Smart meters and customers, Great Torrington • United-Kingdom







XII. Up-take from Fiware4Water Demo networks





XIII. Demo Network #1: Municipalities, Lower Danube





XIV. Demo Network #2: River Basin Organisation Network





XV. Demo Network #3: Technology providers



With strong technology assets and a close collaboration with members and partners, FIWARE is uniquely positioned to build Smalt Ecosystems, which can be the end goal in the operationalization of digital and smart strategies. It is simple, powerful, Open, standard, domain agnostic and globally adopted; accelerating go-to-market.

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XVI. Socio-political and citizens engagement







XVII. Technological and scientific focus







Demo Case #2

Cannes

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scientific focu

Water supply system real time operational management

The platform was integrated with several new applications, aiming to provide decision support on optimal sluice gates (flow regulation structures) settings, early warning for high turbidity events, forecasts on turbidity level, and estimations of water supply volumes.

The optimal operation and scheduling of the sluice gates was supported by an application following a "grey-box" approach that estimates the sluice gates openings for a target flow. Furthermore, two deep neural network models were built to forecast the turbidity level at the two most downstream sensors of the system under study, using as predictors turbidity measurements from the most upstream sensors. Finally, an application was developed that provides one-day ahead forecasts of the total daily water supply volumes, with focus on the annual and weekly seasonality of water outflows, during periods of exceptional demand. Fiware4Water delivers a fully functional Fiware-enabled system architecture, which can easily be extended to cover other applications, taking advantage of the connectors developed. Similarly, third-party applications, models, tools and services can take advantage of the installed Fiwareenabled infrastructure to communicate seamlessly in a bidirectional way, following Fiware standardization protocols and not ad-hoc approaches, which lead to fragmented and isolated solutions.



Drinking water supply system improvement

The management of the drinking water supply system of SICASIL (Mixed Water Union of Municipalities Supplied by the Siagne and Loup Canais) which covers eight municipalities, including Cannes, is delegated to SUEZ, a private water utility. Cannes is located in the south east of France and is a touristic city known for its sunny climate, beaches and its famous Film Festival. Cannes basin has a population of 181,000 permanent inhabitants but reaches 500,000 during the peak season – making water management in this water scarce environment very challenging.

The objective of this demo case was to improve the whole system management by developing these services:

- Forecast water resources availability
- Forecast water demand
- Detect water leaks
- Detect abnormal water quality events

For these four business issues, scientific models have been developed, based on Machine Learning (ML) techniques; therefore, no water physico-chemistry equations were used. The TRL of these four models is at least 8 because they have been successfully tested on several areas of interest of the French Demo Case, but they still need to be tested on other territories to justify a TRL of 9. Nevertheless, the scientific models developed in the Fiware4Water project are of industrial quality.





Demo Case #2 Cannes Drinking water supply system improvement France Multi-parameter probes (nano::stations) have been installed in the drinking water distribution network to monitor water quality and develop the abnormal water quality detection model. The four services have been developed by integration of Big Data models where the deployment of Machine Learning models, based on the Big Data tool Spark, uses FIWARE components, Orion Context Broker and Cygnus (figure below). igure: Online implementation of the functional architecture fic fricu FIWARE Demo Case #2 Cannes Drinking water supply system improvement France Perspectives beyond F4W project life: Some possible perspectives of the functional architecture implemented for the French Demo Case: Use of a context broker to ensure data exchanges between the numerous IT applications existing within the IT system of an operator managing a drinking water supply system: SCADA, data historian, hydraulic model, clients complaints, interventions management, GIS, etc. Data exchanges between a public client (municipality or water union) and its private delegate. For example, the municipality provides open data that its delegate can use; conversely, the operator sends the municipality data related to the operation of the site. · Data exchanges between different stakeholders involved in the functioning and operation of a Smart City IT application: e.g. a municipality and its various delegates, a water utility, a street lighting operator and a parking operator. Data exchanges between a local agency of a water utility and the sites (i.e. the contracts) it manages. Data from the different sites are consolidated at the local agency level. · Data exchanges between a regional agency of a water utility and the local agencies it covers. Data from the different local agencies are consolidated at the regional level. Back to the fist FIWARE



Demo Case #3 Amsterdam Netherlands



Waternet's wastewater treatment plant (WWTP) Amsterdam West has a capacity of 1 Million population equivalent and serves the city of Amsterdam. Almost half of the Waternet climate footprint is determined by nitrous oxide emissions from the WWTPs. Nitrous oxide is a potent greenhouse gas formed during the biological nitrogen removal. Thus, minimising of nitrous oxide emissions is considered to be of key importance in reaching climate goals. The objective of the demo case is to demonstrate the

integration of the Fiware4Water architecture (F4W) using FIWARE in the legacy system with better use of real-time plant data and the use of data-driven Artificial Intelligence (AI) smart applications in practice, to achieve a more optimal plant control with respect to its nitrous oxide emissions and energy consumption.

To meet the objective, one of the seven parallel treatment lanes at WWTP Amsterdam West is made available as a fullscale research lane for the F4W project. In this research lane additional sensors are deployed and integrated, and an onsite research facility is built to gain more insight in the wastewater treatment process. Furthermore the F4W architecture is deployed and integrated in the WNT legacy system, including real-time F4W WWTP AI smart applications and F4W data models. Finally intelligent real-time AI control is implemented. The F4W AI smart applications deployed are software (soft) sensors for determining the influent flow per





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Intelligent control for wastewater treatment

lane, for prediction of the influent flow and for determining the airflow per lane. The soft sensors are virtual sensor, whose output is based on (AI) calculation of multiple observed measurements. Next to the soft sensors an Al smart application for (near) real-time data validation is deployed. The implemented Al control model has a control objective to minimize nitrous oxide emissions and energy consumption whilst meeting effluent water quality targets. From the Amsterdam demo case it can be concluded that F4W architecture can be integrated in a water utility legacy system with AI smart applications running in (near) real-time. Furthermore it is possible to use real-time AI control for optimizing nitrous oxide emissions and energy for wastewater treatment plants in practice. The methodologies, approaches, and developed technologies in the Amsterdam West WWTP demo case present a successful baseline to guide other water utilities for future digitalization processes. The demo case has also boosted the knowledge and research about the formation and reduction of nitrous oxide emissions from WWTPs. It is therefore directly contributing to the acceleration of the twin - green and digital - transition, which is seen as a necessity in order to reach the climate goals by 2030.





Demo Case #4 Great Torrington United kingdom

Smart meters and customers

South West Water (SWW) provide cleaning drinking water for 1.5 million customers across the South West of England; treating water from large impounding reservoirs and rivers and pumping this supply across a vast network to the customers tap. The stewardship of water resources has always been paramount but is increasingly challenging with Covid-19 and climate change. One of the best ways to do this is by helping customer use less water and also by reducing leakage from the network. The benefits also include lower customer water bills and reduced energy usage from treatment and pumping.

From previous studies, SWW understand that making customers more aware of their day-to-day water consumption drives positive behavioural changes and reduces overall consumption. A customer who is billed for water based on a meter will use on average 45% less than a customer who does not have a meter. However, even with a meter a customer can only view their water use over a 5month period which if the typical meter read frequency. Smart meters provide a daily read-out present an opportunity to increase this frequency and give customers a near real time view of water use. Although prevalent in the energy utility market, smart meters are scarcely using in the water industry due to technology constraints such as battery life (no energy at source) and signal strength.



Demo Case #4 Great Torrington United kingdom

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Smart meters and customers

Recognising the potential smart meters can offer, South West Water initiated a pilot and installed over 100 domestic smart meters and a sigtox mast were installed in a region called Great Torrington. Fiware enabled technology was built to collect, store, and analyse water consumption data and a number of micro-services were developed including: A customer smart phone application allowing customers with a smart meter to view their daily usage, compare their use against others and set consumption reduction targets, An automated leakage detection and high consumption tool which presents SWW with sensor and data driven alarms, A machine learning tool to cluster customers into groups of similar water use behaviour to help SWW target customers with water efficiency campaigns

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Smart meters and customers

The smart phone application was co-designed with the Great Torrington Water Forum which includes local residents in the area engaged with the pilot. The prototype app can be see in the figures below.

SWW expect that increased visibility of water use behaviour will help reduce water consumption, reduce overall demand on resources and treatment requirements, and help our customers reduce their annual water bill. We will also use the data to manage our water distribution system more efficiently by responding faster to events on the network (e.g. bursts, and discoloration events), predicting short term water demand, and better understanding leakage at household and area level.





XVIII. The EU added value in a nutshell

XVIII.1. From a Architecture/Data/Ontology/API/Legacy links/Standards perspective



European added-value in a nutshell

From a Architecture/Data/Ontology/API/Legacy links/Standards perspective

- There is a huge demand of standardization of data models in the water sector.
- FIWARE architecture can be translated into the water sector without major work in an easy way.
- We observe an increased demand of ML/AI services in the water sector and integrated in FIWARE.
- Digital twin is another key factor to be considered in the future water sector.
- The security management in critical water infrastructure us a MUST but can be managed through the adoption of Data Space architecture.
- The ETSI NGSLI-LD a well as the Smart Data Models program have consequently improved the excellence and capacity building of the European partners involved in.
- F4W-RA is free to use, open interoperable an data harmonized of water management services at both European and pan-European level.
- F4W-RA leads a cost reduction as well as a prevent the redundancies in the Smart Water services





XVIII.2. From a Smart Applications and Devices perspective







XVIII.3. From the demonstration of Fiware4Water in the Real (Water) World perspective



European added-value in a nutshell

From the demonstration of Fiware4Water in the Real (Water) World perspective

- The feasibility to implement FIWARE-enabled solutions for the water sector, and moreover, in a variety of diverse, demanding, real world situations, covering a wide range of water challenges and contexts.
- The implementation of FWARE-enabled solutions fully operational conditions, integrated with the existing operational systems of water utilities.
- The solutions serve as living paradigms of fully operational systems where legacy system, new sensors and new smart applications are fully integrated under the umbrella of FIWARE technology (a framework initiated and supported by the EU).
- The benefits for water utilities are also enormous: (a) integration of new sensors and other part of legacy systems in a straightforward way, (b) integration of new services, tools and applications with the legacy system using the operational FIWARE-enabled systems delivered by the project.
- The use f the soft sensors and Al control model were well received by WaterNet wastewater technologists and process operators.
- The integration od new application in the existing legacy systems (used by the operators on a daily basis) allowed the operators to get familiar with new application easily an without additional training.
- The work on the AI digital twin and AI control model will be continued by WaterNet with a number of projects partners after the end of F4W.





XVIII.4. From a socio-political impact and end-user engagement perspective



European added-value in a nutshell

From a socio-political impact and end-user engagement perspective

- Supranational digital water solutions are most effectively employed when interacting with local communities
- Policies based in digital data are always fairer, better explained and achieve grater levels of acceptance. Digital solutions extend the transparency and efficiency of the decision making process
- Citizen scientists would be far more relevant if, before being asked to contribute to the collection of data, they were actively engaged in the issue at hand
- Knowledge transfer, cooperation and collaboration between local communities in numerous member states of the EU and beyond.
- The dissemination of supranational challenges and solutions to a hitherto uninformed public.
- Enhances the role of local communities in international issues.
- Due to it international nature, F4W has contributed to the achievement of SDG 6.3 within the framework of the United Nations Environment Programme.





XIX. Materials & references





XX. Disclaimer

Quote

Amorsi N., Deveughele S., Echeverria L., Elelman R., Kossieris P., Makropoulos C., Nanu C., Pocock J., Polychniatou V., Siauve S., Tejado A., Vamvakeridou-Lyroudia L., van der Helm A. (2022), *Fiware4Water, technological and non-technological dimensions of Digital water*, E-Book, Deliverable No.6.8, Horizon 2020 research and innovation programme under Grant agreement No.821036, May

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Conclusion

F4W Deliverable n°6.8 is the final version of the E-Book targeting de water stakeholders as well as experts on Digital Water. Over the course of the project, it has become obvious that raising awareness on digital water still needs to be tackled. The multiple benefits of digital need to be explained in a tailored way for water stakeholders, which was the aim of the first version of the E-Book.

In this final version, the scientific and technological focus are also presented based on the latest deliveries of the partners' activities.

Added-value for the European commission

The e-book is e-document that presents the different dimensions of digital water. The different parts of the document are tailored to non-experts and experts. It goes from the raising awareness to the latest development on Digital water. The e-book explains digital water, the related issues and provides evidence based solutions for water utilities.