D1.3 – Mid-term review & progress report

WP1 – Project Management and Coordination

aqua3s project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 832876.

Document Information

GRANT AGREEMENT NUMBER	832876	ACRONYM	aqua3S
FULL TITLE	Enhancing standardisation strategies to integrate innovative technologies for Safety and Security in existing water networks.		
START DATE	1st September 2019	DURATION	36 months
PROJECT URL	www.aqua3s.eu		
DELIVERABLE	D1.3 – Mid-term review & progress report		
WORK PACKAGE	WP1 - Project Management and Coordination		
DATE OF DELIVERY	CONTRACTUAL April 2021	ACTUAL	April 2021
NATURE	Report	DISSEMINATION LEVEL	Public
LEAD BENEFICIARY	CERTH		
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ABSTRACT	This document provides an overview of aqua3S' progress the first half of its lifetime (M1-M20). The work conducted towards the achievement of the project's objectives is being reported and a summary of the project's results so far in terms of scientific and technological achievement is provided. The work conducted so far is also described on a WP-task basis; therefore, dissemination actions and research ethics guidelines are also provided in the respective WPs (WP10 and WP11).		

Document History

VERSION	ISSUE DATE	STAGE	DESCRIPTION	CONTRIBUTOR
0.1	16/03/2021	ToC	ToC creation	Anastasios Karakostas (CERTH), Anastasia Moumtzidou (CERTH), Sofia Kyrampalidou (CERTH)
0.2	16/04/2021	Working version	Input requested from all partners and incorporated in text.	Anastasia Moumtzidou (CERTH), Sofia Kyrampalidou (CERTH), Dimitra Perperidou (DRAXIS), Eleni Ntzioni (DRAXIS), Stefania Giannikou (ICCS), Eleftherios Gounaridis (ICCS), Ellena Rumenova (SVK), Chiara Odorisio

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0.3	23/04/2021	1st draft	Internal review and refinement	Anastasios Karakostas (CERTH), Anastasia Moumtzidou (CERTH), Sofia Kyrampalidou (CERTH)
1.0	29/04/2021	Final version	Final quality check and issue of final document	Anastasios Karaskostas (CERTH)

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ABBREVIATIONS/ACRONYMS

AOI	Area Of Interest
API	Application Programming Interface
BEREC	Body of European Regulators for Electronic Communications
CA	Consortium Agreement
CAP	Common Alert Protocol
CCDS	Crisis Classification and Decision Support
CCTV	Closed Circuit TV
DoA	Description of Action
DSP	Digital Signal Processing
EECC	European Electronic Communications Code
EO	Earth Observation
EU	European Union
FTP	File Transfer Protocol
GA	Grant Agreement
GDPR	General Data Protection Regulation
GIS	Geographic Information System
IA	Innovation Activity
IMA	Impact Making Activity
IMO	Impact Making Objectives
IO	Innovation Objectives
IP	Intellectual Property
IPR	Intellectual Property Rights
ISO	International Standards Organization
JSON	JavaScript Object Notation
KPI	Key Performance Indicators
LoD	Limit of Detection
LWIR	Long Wavelength IR
MIR	Mid-InfraRed
NEGF	Non-Equilibrium Green's Function
NIS	Network and Information Security
NIST	National Institute of Standards and Technology

PIC	Photonic Integrated Circuit
POPD	Protection of Personal Data
PUC	Pilot Use Case
QCL	Quantum Cascade Laser
RI	Refractive Index
SIOC	Semantically-Interlinked Online Communities
SME	Small Medium Enterprise
SoA	State of Art
TAU	Tuning and Analysis Utilities
TCP	Transmission Control Protocol
UA	User oriented Activity
UC	Use Case
UI	User Interface
UN	United Nations
UO	User oriented Objectives
URs	User Requirements
VA	Visual Analytics
VCSEL	Vertical External Cavity Laser
VM	Virtual Machine
WP	Work Package

1. Executive summary

This document provides the reader with an overview of the technical progress of aqua3S within the first half of its implementation (M1-M20: September 2019 – April 2020). In order to do so, the document discusses the progress of each objective set out in the Grant Agreement and to which extent each one of them has been met; as well as the actions taken place within the context of each Work Package (WP) and task; alongside future steps and plans for the upcoming period.

In more detail, aqua3S has 5 **Innovation Objectives** that are focused on the innovative aspect of the project and its attempt to further develop and enhance existing water sensor technologies: (i) Innovative technologies to support and ensure the safety of water networks, (ii) Multi-level semantic enrichment, reasoning and fusion methodologies for intelligent event detection, (iii) Early Warning & Decision Support Systems, (iv) Social interaction with the citizens, (v) Platform development & System Integration. All of the aforementioned objectives are progressing satisfactorily, considering the point in time the project is currently in, as well as the challenges arisen by the Covid-19 pandemic that hurdled the successful development and installation of sensors in water networks for the required collection of data.

The same applies to the 2nd type of objectives that are met within the context of the project – **User-oriented Objectives** that aim at the satisfaction of the users' needs in regard to the aqua3S platform: (i) User requirements, (ii) Pilot design, implementation and evaluation. These objectives have been progressing well throughout the first 20 months of the project by establishing clear and feasible user requirements deriving from the end user partners of the Consortium. These requirements are currently being translated into technical requirements that will be tested and evaluated on-the-field with the pilots that are currently being developed within the context of these objectives. The first testing and evaluation of aqua3S' first prototype has taken place remotely via a tabletop exercises and digital evaluation forms.

Lastly, the 3rd and final type of objectives met within aqua3S are the **Impact Making Objectives**, whose focal point is the assurance of the high impact aqua3S' system will have on the wider public, the involved stakeholders as well as the Consortium: (i) Dissemination and collaboration, (ii) Exploitation and sustainability model. Although dissemination and collaboration activities have been challenged by the Covid-19 travelling restrictions, the achievement of these objectives has been successful so far as the Consortium sought alternative ways to collaborate among themselves as well as with external stakeholders and disseminate the project's results via digital events. Additionally, the first version of the exploitation and sustainability plans are in place and will be further updated until the end of the project.

As far as technical progress within WPs/tasks is concerned, the main achievements and challenges may be found summarized below:

- **WP1 – Management**: Through the first months of the project, this WP ensured its proper set up and coordination for the collaboration of the involved partners. Among others, communication tools, internal procedures, internal reports, results' quality monitoring have been set and communicated to the Consortium for its better understanding on how the project is going to be implemented. The same will apply for the remaining time of the project as this WP runs throughout aqua3S' lifetime. 5 deliverables have been submitted and 4 more are pending.
- **WP2 – User requirements**: This WP has been progressing rather well with the complete set of user requirements to be set and updated alongside use cases that will be used to test and evaluate the 2nd and 3rd prototype of the system at a later stage. Complementary to this, security requirements derived both from the end users as well as the technical partners, and are

currently being compiled and will be in place within the next reporting period. Finally, a preliminary ethics and legal framework has been identified which will be also updated and finalized within the next reporting period. 3 deliverables have been submitted so far and 2 more are pending.

- WP3 – Water safety and security sensors: Significant progress has been made through the first half of the project within WP3 with the selection and customization of the Refractive index (RI) and Ammonia Sensor (MIR) to be almost completed, with the use of satellite data for area monitoring and, finally with the use of social media for crowdsourcing and social awareness purposes. . Some challenges have arisen in regard to the data collection from multiple sensors and sources as the pandemic has postponed the delivery and installation of the sensors selected by the end users. This has hindered the collection of the needed data for the testing and evaluating of the system but will be handled within the next reporting period. 4 deliverables have been submitted so far and 3 more are pending.
- WP4 – Data fusion for event detection: During these 20 months of the project's lifetime, the FIWARE platform has been adopted by the Consortium, related data models have been developed and the aqua3S ontology has been a work in progress mainly focused on the harmonization of aqua3S' related data. Additionally, 5 services have been developed and finalized within the context of this WP (Sensor Measurement Data Service, Sentinel Data Service, Social Media Data Service, Historical Data Service, Binary Large Object Service) and 3 more are organized to be finalized within the following reporting period (Water Network Management Service, the Alert/Anomaly Service and the Demand Service). Moreover, an algorithm for threat detection and localisation in the existing water networks has been developed and a follow-up algorithm will contribute to the real-time monitoring of data coming from the water sensors. Finally, a high-level crisis management preparedness assessment has been conducted which will be used areas of strength and weaknesses of the system. 2 deliverables have been submitted so far and 4 more are pending.
- WP5 – Early warning and Decision Support: Within the context of aqua3S' first prototype, a user-friendly, interactive, 3D platform has been developed that visualizes information coming from sensors, EO (Earth Observation) data, and social media data (i.e., tweets). More functionalities are to be added within the following reporting period and in the context of the system's 2nd and 3rd prototype. Additionally, an Intervention Management Model is currently under progress that will deal with dangerous events (e.g., water contamination). Finally, significant effort has been casted on the crisis classification and decision support module which focused mostly on the flood risk assessment but it will be enhanced in the next reporting period by being able to assess the severity level of the detected crisis relatiy to water quality, forecast the water demand and detect abnormal events and water leaks. 2 deliverables have been submitted so far and 1 more is pending.
- WP6 – Social interaction with citizens: During the first 20 months of the project, this WP produced some guidelines to crisis managers on how to effectively use social media during water crisis based on a thematic qualitative analysis of Facebook posts of 5 use cases. Additionally, desk-top research has been conducted on public warning messages dissemination. This will be further enhanced by interviews with end users within the next reporting period that will support the development of standardized warning messages to be communicated to the public in case of a crisis. The main challenge within the WP was the deployments of first responders' solution and mitigation action, as the availability of the first responder organization was limited due to its resources being allocated to the handling of the pandemic. More progress

is expected to take place within the following period. 1 deliverable is submitted and 2 more are pending.

- **WP7 – System integration**: Significant progress has been made within this WP as the first set of technical requirements of the platform as well as the development roadmap have been delivered. The first prototype of the system has been developed and tested and work is currently focused on incorporating additional functionalities to the aqua3S platform and addressing the comments received by the end-users in order to further progress to the 2nd and 3rd prototypes. Special attention has been casted on the platform's security requirements as well as the integration of each prototype that will further guide the integration of the different technical components within the following reporting period. Covid-19 and its previously mentioned challenges have hindered the complete integration of the components to the system. Consequently, this will be the focal point of attention for the upcoming months. 4 deliverables have been submitted so far and 4 more are pending.
- **WP8 – Pilots, evaluation, training**: Due to the pandemic an on-the-field pilot could not take place in order to test the operability of the system's first prototype. Alternatively, a tabletop exercise based on the 3 scenarios developed by the end users has been conducted remotely. The outcome of the exercise was successful with fruitful feedback provided back to the technical partners that will be used for the 2nd and 3rd prototype of the system. The same approach will be followed for the upcoming pilots' implementation within the next reporting period. The user training is currently under development and will be focused on the provision of a detailed guide on how to use the aqua3S platform. 1 deliverable has been submitted so far and 3 more are pending.
- **WP9 – Standardization and policies**: The current and proposed European legal framework regulating water security has been researched within this period in order to understand the policy requirements that need to be set in order to fully implement aqua3S' innovative technologies. Additionally, issues and gaps for the standardization of digital water and water security have been identified through collaborations with relative groups (e.g., ICT4Water), the organization of a workshop dedicated to standardization and the exploration of relative standards (e.g., EN 15975). Finally, guidance on the responsible application of relative standards and policies is currently under compilation, which is based on a pre-standardisation impact assessment and will stress the importance of having policies in place that are inclusive and lead to whole-society resilience. 1 deliverable has been submitted and 2 more are pending.
- **WP10 – Dissemination and exploitation**: Due to the pandemic, the dissemination of the project's results and the Consortium's collaboration with external stakeholders has been limited to digital events. Even so, the project's impact of these events as well as online (via its website and social media) can be considered strong and solid. Networking activities (such as Fiware4Water, NAIDES, DigitalWater.City, ScoreWater EU projects and formed the DigitalWater2020 group) have also taken place within these months and are expected to increase in number within the reporting period as there will be more results coming from the pilots that could be shared with the public and/or interested stakeholders. Finally, the market analysis and business model have been concluded and the Intellectual Property protection and exploitation plans are currently a work in progress and will be finalized with the end of the project. 7 deliverables have been submitted so far and 5 more are pending.
- **WP11 – Ethics**: Within the first months of the project, all ethics related deliverables have been submitted addressing issues such as recruitment processes, information sheets, informed consents, participants' rights within the context of aqua3S research actions, protection of personal data, anonymity protocols and privacy. In addition to this, the project's results and

progress is still under monitoring by CERTH and TRI in order to ensure that all further actions will adhere to the established rules set in the aforementioned deliverables and that guidance is provided to all partners. 11 deliverables have been submitted so far and 3 more ethics-related deliverables are pending but within the context of other WPs (WP1, WP2 and WP9).

Overall, the project is at a very satisfactory phase regardless of the challenges that have arisen due to the Covid-19 pandemic. Contingency plans are currently in place in order to address any deviations from the original plan and manage to deliver the promised results within the next reporting period and until the project's completion.

2. Introduction

aqua3S is a platform that aims to standardise existing sensor technologies in the water sector by combining them with novel technologies and state-of-the-art detection mechanisms. More specifically, sensors are deployed in water supply networks and sources and are being supported by complex sensors for enhanced detection. Additionally, the collected sensor measurements are being supported by videos from Unmanned Aerial Vehicles (UAVs), satellite images and social media observations from citizens that report water related issues in their locations (e.g., by colorization of water). In this manner, social awareness and interactive knowledge transfer are raised and promoted. Semantic representation and data fusion provide intelligent Decision Support alerts and messages to the public through first responders' mediums, enhancing water the perceived and actual feeling of safety and security among European citizens.

Towards this goal, the project involves 23 partners (4 first responders' organisations, 1 water authority, 5 water utility operators, 1 public security agency, 6 academic and research organisations, 4 technical SMEs, 1 SME focused on dissemination and 1 SME specialized in Ethics and Legal issues) all of which are contributing to the project with their own expertise and who can be found in the table below.

First responders	LHA2, RCM, SVK, WBL
Water authority	AAWA
Water utility operators	AAA., EYATH, SOFYISKA, SUEZ, VVQ
Public security agency	BDI
Academic/Research institutes	CERTH, CENTRIC, FZU, ICCS/NTUA, UNEXE, USTUTT
Technical SMEs	EVERIS, MIRS, DRAXIS, EGM
Dissemination SMEs	WE
Ethics/Legal SMEs	tri

Table 1. aqua3S partners

aqua3S is currently in M20 of its total duration and around half-way towards its completion. This document summarises the progress made so far, following the structure below:

- Section 3 provides the reader with an overview of the project and the project's objectives. The objectives are divided into 3 main categories: Innovation Objectives, User-oriented Objectives and Impact Making Objectives. Each of these objectives are further divided into specific activities that were followed in order to achieve the initial objective. Responsible partners for each objective have provided input on to which extent and with what measures they have progressed towards achieving their goals. Moreover, this section also provides a progress overview of the project as a whole.
- Section 4 provides an overview of the progress of each WP and task in order to report the project's results terms of scientific and technological achievements. Each task responsible partner delves into detail for all the actions taken within their task, their main achievements and future steps. Additionally, a risk management table per WP is compiled in order to keep track of the risks lurking under each WP.
- Section 5 concludes the document while references mentioned throughout the document may be found in the final section.

It should be noted here that since this document is a public document, no further details on EU restricted is provided. Relevant reference to the associated deliverables is made throughout the text in order to refer the reader to the document in which they can find additional information.

3. Overview

This section provides an overview of the progress of the set objectives and their associated activities, as well as a general overview of the project so far.

3.1 Objectives

As mentioned in Section 2, aqua3S' objectives are divided into 3 main categories: innovation objectives (IO), user-oriented objectives (UO) and impact making objectives (IMO). Each one of these categories, are further divided into specific activities that were followed in order for the consortium to be able to achieve the associated objective.

3.1.1 Innovation objectives (IOs) and innovation activities (IAs)

The first category of aqua3S' objectives are the innovation objectives and their respective activities. These objectives are mostly focused on the innovation aspect of the project and its attempt to further develop and enhance existing water sensor technologies.

3.1.1.1 IO1. Innovative technologies to support and ensure the safety of water network

IA1.1 Sensor optimisation for substance detection in water in (near) real time

The IA1.1 addresses the development of sensor technology focusing on water sector to provide continuous real-time monitoring of the water supply networks. Two main types of sensors were selected which are being customized to be integrated into the security platform of the water utility partners: (i) the Refractive Index (RI) sensor and (ii) a mid-infrared (MIR) quantum cascade laser (QCL) based sensor system.

A compact, low-cost device is being prepared together with high level, digital signal processing (DSP) algorithms, to make the Refractive Index (RI) sensor capable to detect events happening to the water composition with high precision, demonstrating high sensitivity to provide alerts when the water pollutants' concentration surpasses critical values determined by the end users. The RI sensor aims to monitor the evaluation of the refractive index of the water samples with remarkably high accuracy that represents a record performance for this type of optical sensors and this level of scanning steps while providing early warning signals in case any of the water substances' concentration will increase above the safe value. The core of the RI sensor is the photonic structures based on asymmetric Mach Zehnder interferometers (aMZIs) that will be integrated onto the photonic integrated circuit (PIC). The vertical external cavity laser (VCSEL) that will be used as light source, the photodiodes (PDs) that will translate the optical signal to photocurrent, the corresponding electronic controllers and the microfluidic system are equally important components of the RI sensor which were optimized in terms of the water composition changing detection. The RI Sensor will be deployed at key points under control of the water utilities in order to detect changes in refractive index indicating the presence of water contaminants in real time and produce an appropriate warning signal.

The mid-infrared (MIR) quantum cascade laser (QCL) based sensor system delivers specific quantitative information about the presence of ammonia in water. The development activities of the MIR-sensor involved carefully arrange processes of selection, customization-optimisation processes of an infrared QCL structure within an augmented gas analyzer specifically built for the aqua3S project and the integration of the vaporizing module that enables the extraction of ammonia in gas phase. The working principle of this sensor involves the QCL emitting in the Long Wavelength IR window, which is able to target the identified NH3 absorption line and a heated photoacoustic cell, permitting the accurate

detection of the spectral signature of the vaporized gases of a water sample. The validation experiments at mirSense's labs demonstrated that the MIR sensor is able to detect NH3 from an aqueous solution by employing an ammonia stripping module.

More information can be found in D3.1, D3.2.

IA1.2 Data acquisition from UAVs and Earth Observation data

Activities related to IA1.2 have largely focused on retrieving satellite images from the Copernicus Open Access Hub including Sentinel-1 and Sentinel-2 products in order to identify flood events and water pollution from oil spills by using machine learning techniques. Several methods were evaluated, and this effort was reported in D3.4. Moreover, a FIWARE data model was designed in order for the aqua3S FIWARE-based platform to be able to consume such data and the outcome of their processing. Next activities involve the update of flood detection method, the identification of algae bloom on the water surface and finally the application on object or concept detection techniques for identifying specific entities in the images retrieved from UAVs.

More information can be found in D3.4.

IA1.3 Social media monitoring (and crowdsourcing)

Activities related to IA.1.3 have focused on developing a Twitter collector that retrieved data related to the water quality and flood use cases identified in aqua3S. Additionally, text classification techniques were also developed in order to filter out irrelevant tweets. Moreover, localization techniques were adapted in order to be able to geolocate tweets. Both processing techniques were developed for the Italian language since the number of tweets is considerable in the specific PUC. The aforementioned work was reported in D3.4. Finally, a FIWARE data model was designed in order for the aqua3S FIWARE-based platform to be able to consume twitter data and the outcome of their processing. Next activities involve the development of an event detection algorithm for identifying events both from tweets but also from call complaints which were added as a crowdsourcing source. Finally, text classification and localization techniques will be developed for other languages in order to collect substantial number of tweets.

More information may be found in D3.4.

IA1.4 Data collection from multiple sensors and sources

IA1.4 deals with the deployment of hardware and the customization of software solutions in order for the water distribution and quality measurements of sensor networks and the crowdsourcing and EO data to be centrically collected among aqua3S services. Continuous, real-time and seamless collection of sensor, satellite, UAVs and social media monitoring related data is a main requirement and objective in order to enhance security and safety to existing water networks. Towards this end, certain data structures and adequate communication channels have been determined, custom FTP clients have been developed and integrated with the according FTP/Transformation services and client modules have been built to facilitate the communication of multiple sensors and sources with the aqua3S platform.

More information will be found in D3.7 (due in M28).

3.1.1.2 IO2. Multi-level semantic enrichment, reasoning and fusion methodologies for intelligent event detection

IA2.1 Data harmonization, semantic representation and ontology creation

Activities related to IA.2.1 have focused on developing several models for FIWARE data models, including the Social Media, the Satellite Imagery and the Call Complaints data models in order to ensure harmonization of the data present in the aqua3S platform. Moreover, the first version of the aqua3S ontology was developed that covers crisis representation, and data retrieved from sensors & IoT devices, social media and satellite imagery. The aforementioned work was reported in D4.1. Next activities involve the development of FIWARE models needed both for capturing all the sources used in aqua3S and also the outcome of the processing of the aqua3S modules. Finally, a Knowledge Base will be set up, consume all the necessary data and based on the reasoning rules developed conclusions will be drawn.

More information may be found in D4.1.

IA2.2 Integration layer and Multimodal indexing of heterogeneous data

The heterogeneous data collected for water quality and distribution monitoring through sensor networks, earth observation and crowd-sourcing data collection needs sophisticated solutions in order to be stored and used by other services and for future referencing. IA2.2 deals with the creation of the appropriate indices to allow the querying and efficient retrieval of the stored data. The architectural design of the storage schema takes into consideration the diverse nature of the collected data. FIWARE solutions and the ORION NGSI-LD Broker have been deployed and further developed around new data models to address the needs of the aqua3S platform. Cygnus NGSI-LD Agent has been successfully set up to serve requirements for productive utilization of historical data. Furthermore, a dedicated GeoServer is being used to allow the storage, retrieval and visualization of the data collected from area monitoring satellites given that the GeoServer offers a series of plugins allowing for processing of complicated queries over continuous geo-referencing data. Finally, a WebDAV server has been set up to be used for storing and sharing binary objects, data collected from drones, as well as documents.

More information will be found in D4.3 (due in M24).

IA2.3 Algorithms for threat detection and localisation/ in the existing water distribution networks

An algorithm has been developed to select the optimal locations for sensor placement in order to pick up anomaly signals to identify the possible threats in a WDN. The current analysis is focusing on pressure anomalies, but it will be extended to other types of threats later. Follow up algorithms is under development to analyse the sensor data to underpin the locations of threats.

More information will be found in D4.4 (due in M28).

IA2.4 Crisis management modelling for enhance preparedness

Effective crisis management is of great importance for an organisation, as it reduces risks and ensures the smooth operation of the organisation's activities and thus potential negative impacts on physical, human, and technical environments both in and out of the organization are reduced. To this end, the work carried out focused on conceptualizing and designing a tool to evaluate an organisation's level of preparedness against several hazardous events. To achieve this, input was collected by the project's end users to gain insight on crisis events they have already experienced, and it was used to identify the hazardous events that will be included in the modelling. In parallel, through literature review, the constituent activities referring to the crisis management process were identified. This led to the formulation of hierarchical relationships between crisis management stages (pre-crisis, during crisis, post-crisis) and their key functional areas and activities undertaken. Once the concept was formulated and further refined, the model development was initiated with valuable input received from the project's pilots.

More information will be found in D4.5 (due in M28).

IA2.5 Optimisation and parallelisation of algorithms for threat detection

The aim of IA2.5 is to optimize the software used by the Anomaly Detection Module of the threat detection algorithm (from IA2.3) in terms of serial, as well as parallel performance and efficiency. For this purpose, a benchmarking and profiling suite was developed for the software OWA-EPANET, selected for the Anomaly Detection Module[1]. The profiling of OWA-EPANET has showed the functions and routines of the software that consume the most computing time. The work performed so far is reported in deliverable D4.2 (EU RESTRICTED) and is now concentrated in studying forms of increasing the performance, focusing on these functions and routines.

More information may be found in D4.2.

3.1.1.3 IO3. Early Warning & Decision Support Systems

IA3.1 3D-visualisation of early warnings and the early warning module

A visualization platform is being developed to integrate information collected from sensors or modelling results to provide early warning to end-users.

More information available in D5.1 and will be available in D5.3 (due in M30).

IA3.2 Visual analytics from UAVs and EO data

Activities related to IA.3.2 have focused on developing a dashboard that visualizes tweets, and layers produced from the processing of satellite data. Different libraries including boostrap and mapbox were evaluated for the visualization of the data from the aforementioned sources on a map. Moreover, several functionalities were incorporated such as filtering of historical data, settings menu and infobox. The aforementioned work was reported in D5.1. Next activities involve the incorporation of other data in the map such as call complaints, UAVs, the development of charts for monitoring the evolvement of tweets and call complaints in time and the identification of possible events.

More information may be found in D5.1.

IA3.3 Early Warning & Water Crisis Assessment Algorithms for Decision Support

The algorithm to assess the consequence of potential/ongoing threats in the water distribution network is under development. The outcome will help decision makers better understand the impact of various threats and evaluate the strategies to minimize the impact.

More information may be found in D5.2.

IA3.4 Crisis classification and Decision Support

Activities related to IA.3.4 have focused on the deployment of a flood hazard and risk maps in “near” real-time enhancing the decision support process. Specifically, the obtained information from the analysis of Satellite images, social media posts as well as data from legacy tools (GIS) of the stakeholders (water authorities) fused using machine learning techniques in order to estimate real-time the severity level of an ongoing flood event and delivered updated flood risk maps. Next activities involve the assessment of the crisis severity level based on the sensing data that will be collected by measurements

[1] Available online at: https://github.com/OpenWaterAnalytics/EPANET

for the water quality. Furthermore, algorithms for water demand forecast, detect abnormal water quality events and water leaks will be developed and incorporating into the aqua3S platform.

More information may be found in D5.2.

3.1.1.4 IO4. Social interaction with the citizens

IA4.1 Analysis of social awareness

IA4.1 focused on conducting research to develop social engagement guidelines for water and public authorities to communicate effectively with citizens and communities on social media during water crises. Analysis of a sample of Facebook posts was conducted to develop the guidelines. Additionally, a sample of Facebook and Twitter data were analyzed to develop a novel method for assessing the validity and reliability of soft intelligence extracted from social media for crowdsourced early warning of water crises. This culmination of this research in resulted in D6.1 Social Engagement provides advice to crises managers on how to effectively utilize social media during water crises based on best practices and lessons learnt based on previous studies and empirical research conducted in T6.1.

More information may be found in D6.1.

IA4.2 Warning (message) generation to the public

IA4.2 (through T6.2) is developing a set of standardized warning messages to be generated for end users to disseminate to the public through their social media channels during water crises. At this stage, desk-based research was conducted to identify best practices in public warning. Alignment with the aqua3S ontology was conducted leading to the development of standardized language agnostic framework based on the Common Alert Protocol (CAP0 and in compliance with the Directive on European Electronic Communications Code (EECC) and Body of European Regulators for Electronic Communications (BEREC) Guidelines. Finally, a questionnaire was developed to identify the methods and frameworks used by aqua3S' end users to identify common practices as part of the standardization of warnings. This task will culminate in D6.2 Warning Message Generation.

More information will be found in D6.2 (due in M26).

IA4.3 Deployment of first responder's solutions and mitigation actions

Matching the identification of existing situations with vulnerability assessment of water resources and infrastructure, first responders' solution and mitigation plans for the pilot water utilities will be developed. Those solutions will be included to a plan, for each pilot case study, that provides guidelines for all appropriate stakeholders.

This task is at its very beginning (month 18-36) also because of COVID 19 emergency, as the commitment of task leader' staff in dealing with the emergency did not allow project activities in a constant way. From M20 and on, the starting point will be the existing situation with vulnerability assessment of water resources and infrastructures into the pilot sites. The final plan will be based on existing solutions already available within pilot water utilities, as well as on the best practices found through literature review and on the extensive experience of first responder partners.

More information will be available in D6.3 (due in M34).

3.1.1.5 IO5. Platform development & System Integration

IA5.1 Technical requirements and platform development roadmaps

As a starting step of the construction of the aqua3s platform, the innovation activities related to IA5.1 focus on the translation of the initial user requirements into practical functional and technical ones. From these requirements and through the use of established standards such as ISO 42010 (ISO/IEC/IEEE, 2011) and ISO 25010 (ISO/IEC, 2011) a robust, baseline logical architecture was derived that illustrates a still abstract but global vision of the platform. This high-level layered architecture has been approved by all involved technical partners and provides for the communication between all relevant hardware and software components with additional vertical layers that provide logging and security features. Additionally, a roadmap has been created based on the logical architecture and the requirements that will serve as a guide towards the implementation of the different prototypes. As per the evaluation strategy and the KPI's as outlined in deliverable D1.2 Self-assessment & data management strategy, IA5.1 is considered completed.

More information can be found in D7.1, D7.2, D7.3, D7.4.

IA5.2 System architecture development and security requirements

IA5.2 builds upon the work done in IA5.1 and using the then developed roadmap in order to outline a complete systems architecture for the platform. The architecture is then broken down into separate iterative segments designed to showcase different functionalities and build upon each other. This approach also allows for a continuous feedback to be provided both by end-users and technical partners in order to improve the quality of the project.

In order for the platform to be of any operational use, the systems architecture was designed with a number of guiding principles in mind. First the work done must abide by the laws, policies and regulations of the interested stakeholders. Next the solution design should be done in an interoperable manner defined by the European Interoperability framework (Directorate-General for Informatics (European Commission), 2017). Third the aqua3S project must be independent of specific technologies and therefore it can operate under a variety of technology platforms, allowing for ease of development, maintenance and operation. The architecture should be created with scalability in mind to allow for increase of instances as business needs arise. The architecture must also assure the protection and anonymisation of data by fulfilling the security requirements of: Confidentiality, Integrity, Availability, Accountability, and Non-repudiation.

More information can be found in D7.1, D7.2, D7.3, D7.4.

IA5.3 System security (Cyber security)

A security framework for aqua3S platform has been defined based on the NIST standards (NIST SP 800-53 controls) (National Institute of Standards and Technology, 2018), the NIS Directive and the GDPR (The European Parliament and of the Council of the European Union, 2016). This framework's focus is on security (user security, data security, network security and monitoring of activity) and also to define "friendly compliance" mechanisms based on industry best practices to ensure the security of the aqua3s platform by covering the prevention, detection, response and recovery phases.

Having a technologically agnostic framework for evaluating the solution, it allows for setting criterion to assess security levels in an environment where technology is in permanent evolution.

More information can be found in D7.1, D7.2, D7.3, D7.4.

IA5.4 System integration

Activities related to IA.5.4 have largely been based around the development, testing and deployment of the first aqua3S prototype so far. WP efforts for each prototype have been closely examined and agreed

upon based on deliverables D7.1 and D7.2. Activities related to the first prototype had to be re-examined due to the Covid-19 pandemic and the scope of deployment as well as the scope outlined in D7.3 1st Prototype of aqua3S System had to be reevaluated. Integration on end-user premises, therefore, has been taken out of the scope for the 1st Prototype and functionalities have been tested and demonstrated with simulated data as provided through the end-users.

More information can be found in D7.1, D7.2, D7.3, D7.4.

IA5.5 Interactive User Interfaces

The interactive User Interface (UI) constitutes the environment that enables the users to interact with all the components developed in aqua3S that help users with crisis response and management tasks. During the first year of the project, an initial limited version of the UI for the 1st prototype has been designed and implemented, allowing the users to field test the functionalities, foretaste the fully-featured UI and provide targeted feedback. Subsequently, many steps were taken towards creating a custom interface to the user needs, by highly involving the end users in an iterative process of requirements gathering (questionnaires and multipart visualization workshop to make sure all aspects of the UI are discussed, and all ideas are analysed). The design for next implementation phase includes the majority of the technical components and functionalities produced by combined effort, such as notifications from different modules which produce alerts, as a prominent feature.

More information will be found in D7.8 (due in M30).

3.1.2 User-oriented objectives (UOs) and user-oriented activities (UAs)

The second category of aqua3S' objectives are the user-oriented objectives and their respective activities. These objectives are mostly focused on the users' perspective and their progress towards developing their requirements and pilot use cases in order to successfully test the system.

3.1.2.1 UO1. User requirements

UA1.1 Use case design, stakeholder engagement and user requirements

The seven pilot use cases definition (Italy, Greece, France, Cyprus, Belgium and two pilot use cases in Bulgaria) as well as the first iteration of the Use Cases and User requirements elicitation has been performed within the context of UA1.1. These initial activities required strict collaboration between end users and technical partners of the consortium, with the organization of a dedicated workshop (November 2019). They also led to the first definition of technical requirements, as well as the identification of the instrumentation to be installed on pilot sites, in combination with the existing sensors. After the first pilot (taken place remotely in November 2020) and in the view of the implementation of the second prototype, the second elicitation cycle of the Use cases and user requirements was performed, taking advantage of the experience gained in occasion of the first pilot and to the new gaps and needs identified by the end users after testing the first prototype.

Both version of the URs were reviewed by Trilateral Research to identify any ethical, legal or social issues that may arise. The finalized result of the user requirements and use cases is reported in , Deliverable D2.3– Use Case Requirements v.2 [EU RESTRICTED].

More information can be found in D2.1, D2.3.

UA1.2 Security requirements

Within the context of UA1.2, interviews with technical partners have taken place to identify relevant security issues that pertain to the project and ensure the safeguarding of existing water networks. In addition, research on cyber-attacks relating to water systems and infrastructure/service systems and water operators has been conducted. The preparation of the security requirements questionnaire for End Users and Technical Partners has been initiated and filled in by all end user partners. Following that, a review on the drafted security requirements questionnaire has taken place in order for partners to provide further comments and suggestions. In addition, a literature review on the ethical and human rights impacts arising from security requirements as well as a preliminary identification of the critical security environmental issues has been performed. The work on security requirements analysis is currently in further progress. For this purpose, a clusterization of the requirements and their alignment with the system has been made. Elicitation of hardware or software implementation and initial draft of traceability matrix have also been prepared.

More information will be found in D2.4 (due in M22).

UA1.3 Ethics and legal framework

In order to start the process of finalizing the User Requirements (URs) and Use Cases (UCs), all contributions provided by project partners and uploaded to the project wiki in tabular format have been assessed to identify where ethics and legal issues are present as well as possible mitigation measures where relevant. This process was also informed by the conversations with consortium members independent research and the ethics workshop M10. In doing so, attention was paid to ethical principles, human rights law, overarching water policy and best practice, cyber security, and privacy law among other such areas (for more information on the pertinent ethics and legal areas please see D2.2 – preliminary ethics and legal framework). Additionally, TRI monitored common telcos with both end users and technical partners to gain additional insight from project partners and request additional information. The URs with the additional information on the ethics and legal risks were reviewed by the project coordinator and found to be feasible.

The resultant deliverable (Deliverable D2.3 – Use Case Requirements v.2) was reviewed by Trilateral Research prior to its submission in M18, to ensure that the ethics and legal issues were fully captured within the deliverable.

More information may be found in D2.1, D2.2, D2.3.

3.1.2.2 UO2. Pilot design, implementation and evaluation

UA2.1 Development of the validation scenario and evaluation methodology

This objective focused on the part of the project related to the evaluation and testing of the aqua3S platform, under conditions of hazards, in order to prove and validate its performance with respect to real hazardous situations in existing water distribution networks. Thus, driven by end-users and experts from the water domain, specific pilots are designed and implemented on field. With respect to the actual situation, the first prototype of the platform has been tested, achieving good results and giving a feedback on the required implementations. This activity focused on the development of the tests that were needed in order to demonstrate the efficiency, feasibility and performance of the aqua3S technologies applied in drinking water risk management for simulated events.

More information can be found in D8.1.

UA2.2 Field demonstrations, testing and training

The aqua3S platform will be tested on-the-field with respect to real use case scenarios of risk and hazards, through the construction of a pilot in which a crisis scenario will be simulated, with the purposes related to monitoring of safety and security of drinking water networks, using sensor data and social media and models.The 1st aqua3S prototype has been tested in November 2020 through the form of a tabletop exercise. Scenarios developed by all involved end users (AAA, AAWA, LHA2, SOFIYSKA, SVK) were tested through simulating daily operations and crisis emergencies using the aqua3S platform. All user requirements related to the 1st prototype of the system have been met and the team is currently working on the 2nd prototype of the system.

More information will be found in D8.2 (due in M28) and D8.3 (due in M36).

3.1.3 Impact-making objectives (IMO) and impact-making activities (IMA)

The third and final category of aqua3S' objectives are the impact-making objectives and their respective activities. These objectives are mostly focused on dissemination and communication of the projects' results and knowledge sharing with other relevant initiatives. Additionally, special focus is given on the exploitation of the results both within and beyond the project's lifetime as well as standardisation and policies.

3.1.3.1 IMO1. Dissemination and collaboration

IMA1.1 Dissemination of project results

With the project running its 2nd year of activities and within the context of IMA1.1, Water Europe has made use of a number of channels and has developed several promotional materials that can ensure the successful dissemination and promotion of the project's results. Through the social media channels and their frequent updates, the website, the newsletter, the promotional posters and brochure and the expected project's video, it is certain that aqua3S has made its presence felt so far and will keep standing out with its online activities. The aqua3S partners have also contributed to the successful dissemination of the project with their participation in multiple digital events.

More information may be found in D10.1, D10.2, D10.3, D10.5.

IMA1.2 Collaboration

aqua3S partners are seizing available opportunities to disseminate and promote the project through their participation to online events, webinars and workshops, as well as the organization of targeted aqua3S events. At the same time, aqua3S project is part of the ICT4Water cluster and the synergy group DigitalWater2020, a group of four other sister projects: Digital Water City, Fiware4Water, NAIADES and SCORE Water that offer great opportunities for collaboration, networking and further visibility of the project.

More information will be found in D10.10 (due in M36).

3.1.3.2 IMO2. Exploitation and sustainability model

IMA2.1 Market analysis and existing business models

Market Analysis along with Intellectual Property Rights (IPR) are the foundation upon which any exploitation plan is build. The market analysis is a very critical component in the positioning of any new product, tool, brand, etc. To that end aqua3S developed the first version of the market analysis during the 1st year of the project and updated it in the second year. The market analysis entails information such as the market size and growth, market trends, competitors, business models, the added value of

aqua3S etc. The information from the market analysis were also used for the development of the Exploitation Plan.

More information can be found in D10.4, D10.6.

IMA2.2 Exploitation plan and Intellectual Property (IP) protection for the proposed tools

During the 2nd year of the project the technical work undertaken by the partners that develop aqua3S has progressed. Hence the timing for starting to map the Intellectual Property Rights and feeding them into the Exploitation Plan was, as also foreseen in the time plan in the DoA, rather good. To achieve the above, partners were engaged in an exercise that documented the Exploitation Responsibilities and Exploitation Rights of the partners. For that a supporting document was developed and circulated to the partner to provide their feedback. That was subsequently used to create the first versions of the IPR and Exploitation Plan deliverables. The updated versions will be provided towards the end of the project.

More information can be found in D10.7. Additional information will be found in D10.8 (due in M21), D10.11 (due in M36), D10.12 (due in M36).

3.1.3.3 IMO3. Standardisation, strategy and policy-making

IMA3.1 Policy framework and Information Management

The work carried out to achieve this objective consisted of a deep analysis of the concept of water security and how it is dealt by the European regulation and international framework. This analysis has not been limited to the current regulation but also on ongoing and future initiatives, which may lead to new EU directives related to water security. In parallel, a survey amongst key stakeholders of the water sectors has been performed to further highlight eventual gaps in the current water security regulation. Both activities contributed to understand the current policy requirements and make policy recommendations (D9.1), focusing in particular on the aspects strictly related to aqua3S' innovative technologies. Next steps will consist of disseminating these outcomes and of supporting the uptake of aqua3S results.

More information may be found in D9.1.

IMA3.2 Standardisation, strategy and policy-making

During the first period, major focus was casted on standardization. Firstly, as digitalization is an extremely important aspect within the water community and while having in mind the EU Digital Water strategy, the focal point of the research conducted was on standardization issues related to digitalization. In this case, these issues correspond to data models and architecture. EGM coordinated the "Data models group" within the Digital Water 2020 Group (coordinated by the ICT4Water cluster), through which standardization in models and semantics in water within the context of the ETSI standard SAREF4WATER was promoted. Additionally, standardization for the overall architecture of the project was also promoted through the FIWARE related approach, and most specifically via the implementation of the NGSI-LD standard. To discuss and promote a common standardized approach, aqua3S (with the coordination of EGM) organized common meetings with many EU related water projects and in particular using the results of the Fiware4Water project focusing on these standards. With the webinars

organized (e.g., Webinar on data models, March 3 2021[2]) and the active promotion of the discussion with the Fiware foundation in the water domain solid impact on the market was achieved by the project.

Moreover, current water security standards and previous work on market interest for improvement were researched. A key liaison with the CEN TC 164 but also the CEN TC 230 and TC 318 was established. A dedicated webinar was organized on March 29th where the project interacted with the market forces and presented several contexts for consideration expressed by standardizers, industries and the European Reference Network for Critical Infrastructure Protection organisation. As a result, awareness on standardization needs for water security and safety was raised and a follow-up market feedback gathering will be organized. Finally, contributions were also provided to a book accepted for publication on Springer, entitled: "Improving water quality and security with advanced sensors and indirect water sensing methods".

3.2 General progress

Apart from the aforementioned objectives and their associated activities, the project is also progressing well as a whole on a WP/task basis. The tables that follow showcase the deliverables that are successfully submitted until now (Table 2) and the milestones (Table 3) that can be considered as achieved.

No.	Deliverable	Leader	Dissemination level	Due month	Status
D1.1	Project management and quality assurance plan	CERTH	PU[3]	3	Submitted
D10.1	Plan for communication and dissemination.	WE	PU	3	Submitted
D10.2	Corporate identity and logo	WE	PU	3	Submitted
D1.7	Report on cumulative expenditure no.1	CERTH	CO[4]	4	Submitted
D1.2	Self-assessment & data management plan v1	CERTH	PU	6	Submitted
D2.1	Use cases requirements v1	AAWA	CO	6	Submitted
D10.3	Project Website	WE	PU	6	Submitted
D11.1	H - Requirement No. 1	CERTH	CO	6	Submitted
D11.2	H - Requirement No. 2	CERTH	CO	6	Submitted
D11.3	H - Requirement No. 3	CERTH	CO	6	Submitted
D11.4	POPD - Requirement No. 4	CERTH	CO	6	Submitted
D11.5	POPD - Requirement No. 5	CERTH	CO	6	Submitted

[2] Available online at: https://ict4water.eu/dw2020-webinar-data-models-with-the-fiware-platform-for-the-water-sector/
[3] Public
[4] Confidential, only for members of the consortium (including the Commission Services)

No.	Deliverable	Leader	Dissemination level	Due month	Status
D11.6	POPD - Requirement No. 6	CERTH	CO	6	Submitted
D11.7	POPD - Requirement No. 7	CERTH	CO	6	Submitted
D11.8	POPD - Requirement No. 8	CERTH	CO	6	Submitted
D11.9	POPD - Requirement No. 9	CERTH	CO	6	Submitted
D7.1	Technical requirements and platform development roadmap	EVERIS	CO	8	Submitted
D2.2	Preliminary ethics and legal framework	TRI	PU	10	Submitted
D3.1	MIR sensor customization	MIRS	CO	12	Submitted
D7.2	aqua3S system architecture definition	EVERIS	CO	12	Submitted
D7.3	1st Prototype of aqua3S System	EVERIS	CO	12	Submitted
D10.4	Market Analysis Report v1	DRAXIS	PU	12	Submitted
D7.4	System security v1	EVERIS	EU_RES[5]	13	Submitted
D3.4	Mid-term report on data collection from multiple sensors and visual content	CERTH	PU	14	Submitted
D4.1	The aqua3S ontology and semantic reasoning support	CERTH	PU	14	Submitted
D8.1	Pilots' implementation and 1st prototype evaluation report	AAA	CO	14	Submitted
D1.8	Report on cumulative expenditure no. 2	CERTH	CO	16	Submitted
D4.2	Report on benchmarking, profiling, optimization and parallelization of algorithms for threat detection v1	USTUTT	EU_RES	16	Submitted
D2.3	Use case and requirements v2	EYATH	EU_RES	18	Submitted
D3.2	Customization of RI sensor and microfluidic unit v1	ICCS	EU_RES	18	Submitted
D5.1	Report on the basic visual analytics techniques for the early warning module v1.	UNEXE	CO	18	Submitted

[5] Classified Information: RESTREINT UE (Commission Decision 2015/444/EC)

No.	Deliverable	Leader	Dissemination level	Due month	Status
D9.1	Policy framework and Information Management	AAWA	PU	18	Submitted
D10.5	Brochure and Infoboard	WE	PU	18	Submitted
D3.3	Final package of MIR and RI sensors	FZU	CO	19	Submitted
D1.3	Mid-term review & progress report	CERTH	PU	20	Submitted
D5.2	Report on the crisis assessment and classification techniques for decision support v1.	CERTH	CO	20	Submitted
D6.1	Social Engagement Guidelines	CENTRIC	PU	20	Submitted
D7.5	2nd Prototype of aqua3S System	EVERIS	CO	20	Pending
D10.6	Market Analysis Report v2	DRAXIS	PU	20	Submitted
D10.7	Exploitation plan v1	DRAXIS	CO	20	Submitted

Table 2. Submitted deliverables

No.	Description	Leader	Due date	Means of verification	Status
MS1	Project setup and platform development roadmap	CERTH	M6	MS1 marks the successful initiation of the project work and establishing of the project identity. It includes: (i) the initial project management and quality assurance plan; (ii) the 1st iteration of the self-assessment and data management plan; (iii) the design of use cases and initial user requirements; (iv) the initial communication and dissemination plan, including the corporate identity and aqua3S logo. Deliverables contributing to MS1: D1.1, D1.2, D2.1, D10.1, D10.2, D10.3"	Achieved
MS2	1st Prototype	CERTH	M12	MS2 stands for the completion of the first development cycle of the project and deploys the 1st version of the aqua3S platform by integrating the basic developments for all tools including: (i) the technological requirements and development roadmap; (ii) MIR and RI sensors customization; (iii) aqua3S system architecture. Furthermore, during the	Achieved

				MS2 a preliminary ethics and legal framework is delivered as well as the project website and the 1st version of Market Analysis plan. Deliverables contributing to MS2: D2.2, D3.1, D7.1, D7.2, D7.3, D10.4	
MS3	2nd Prototype	CERTH	M20	MS3 stands for the completion of the second development cycle of the project and demonstrates the readiness to launch the Field Demonstrations. It deploys the 2nd version of the aqua3S platform by integrating enhanced developments for all the tools motivated by the 2nd round of user requirements and the mid-term review & progress report. Specifically, it integrates: (i) the final package of MIR and RI sensors; (ii) techniques for data acquisition and fusion from multiple sensors and visual content; (iii) the aqua3S ontology; (iv) the 1st version of optimization and parallelization algorithms for threat detection; (v) an initial version of visualisations/ visual analytics for the early warning module and decision support tools encapsulating crisis assessment and classification functionalities; (vi) the 1st version of system security report; (vii) the outcome of the 1st round of pilot implementations and evaluation report. Additionally, the social engagement guidelines and the policy framework and information management reports are delivered in the context of MS3. Finally, dissemination and exploitation actions such as publishing brochures and infoboard, the 2nd version of market analysis report, the 1st version of exploitation plan and intellectual property plan are taken place. Deliverables contributing to MS3:D1.3, D2.3, D3.2, D3.3, D3.4, D4.1, D4.2, D5.1, D5.2, D6.1, D7.4,	Achieved (except D7.5)

				D7.5, D8.1, D9.1, D10.5, D10.6, D10.7, D10.8.	
MS4	Operational aqua3S prototype testing	CERTH	M28	MS4 marks the period preparation for the deployment of the final version of the aqua3S system. It includes the revised versions of self-assessment and data management plan and security requirements report. Also, the final versions of the majority of the tools are integrated to the system, such as: (i) social media crawlers and monitoring techniques from visual content; (ii) the integration layer and multimodal indexing; (iii) the anomaly detection tool; (iv) the crisis management tool; (v) the optimization and parallelization algorithms for threat detection. Moreover, the final versions of the following reports are delivered: (a) the warning messages generation report; (b) the 2nd version of the system security report; the outcome of the 2nd round of pilot implementations and evaluation report. Finally, in the content of MS4 the aqua3S video is created and demonstrated. Deliverables contributing to MS4:D1.4, D2.4, D3.5, D3.6, D3.7, D4.3, D4.4, D4.5, D4.6, D6.2, D7.6, D8.2, D10.9	Pending
MS5	Final System demonstration and testing	CERTH	M36	MS5 marks the successful completion of aqua3S and finalisation of the aqua3S system. It integrates the final advanced developments of all the modules including: (i) the early warning and decision support module; (ii) the interactive user interface; (iii) the outcome of the field demonstrations and system testing. Additionally, user training actions are implemented as well as the final versions of the reports are delivered including: a) the public final activity report; b) the research ethics and legal framework report; c) the emergency	Pending

				response plans; d) the water security standardisation strategy report and guidelines for responsive applications of water security standards and policy; e) dissemination and exploitation reports. Deliverables contributing to MS5:D1.5, D1.6, D2.5, D5.3, D6.3, D7.7, D7.8, D8.3, D8.4, D9.2, D9.3, D10.10, D10.11, D10.12, D10.13	

Table 3. Milestones status

It should be noted at this point that MS3 is only considered as "Achieved apart from D7.5" as most of the components are already developed; however, their integration into the aqua3S system in order to form its 2nd prototype and its on-the-field testing has been postponed due to the implications of Covid-19 (be it both in travelling restrictions as well as in the installation of the sensors on the end-users' premises). Consequently:

- The final package of the MIR (ammonia) and RI (refractive index) sensors have been submitted through deliverable D3.3.
- Techniques for data acquisition and fusion from multiple sensors and visual content have been submitted through deliverable D5.1.
- The aqua3S ontology and the semantic reasoning framework have been submitted though deliverable D4.1.
- The first version of the optimization and parallelization algorithms for threat detection has been submitted through deliverable D5.1 and will be further updated throughout the next reporting period.
- An initial version of visualisations / visual analytics for the early warning module and decision support tools encapsulating crisis assessment and classification functionalities have been submitted through deliverable D5.1.
- The first version of the system's security report has been submitted through deliverable D7.4 and will be further enriched with the security requirements that will follow in the upcoming period.
- The outcomes of the 1st round of pilot implementations (through the form of tabletop exercises) as well as their evaluation report have been submitted through deliverable D8.1. Additional iterations of this deliverable will follow in the next reporting period.
- The social engagement guidelines have been submitted through deliverable D6.1.
- The policy framework and information management report have been submitted through deliverable D9.1.
- The brochure and infoboard have been submitted through deliverable D10.5
- The 2nd version of the market analysis and the 1st version of the exploitation plan have been submitted through deliverables D10.6 and D10.7.

As showcased in the Gantt Chart below, the project is halfway through its course; therefore, the analysis on the work conducted on a WP-task basis that follows reports both the work done so far, as well as, the plans for the upcoming months.

WPs and tasks	Start	End	Dur
WP1 - Project Management and Coordination	1	36	36
T1.1: Project Management and Coordination	1	36	36
T1.2: Project Administration, reporting and Financial Management	1	36	36
T1.3: Quality Assurance and Risk Management	1	36	36
T1.4: Scientific and Technical management	1	36	36
T1.5: Data Management	1	36	36
T1.6: Research Ethics and Data Protection Monitoring	1	36	36
WP2 - User Requirements	1	36	36
T2.1: Use case design	1	6	6
T2.2: Stakeholder engagement user requirements	3	18	16
T2.3: Security requirements	3	22	20
T2.4: Ethics and legal framework	3	33	31
WP3 - Enhanced sensing for the water security and safety	3	28	26
T3.1: Sensor selection and customization	3	24	22
T3.2: Area monitoring using UAVs and satellite data	6	28	23
T3.3: Crowdsourcing and social media monitoring	3	28	26
T3.4: Data collection from multiple sensors and sources	6	28	23
WP4 - Multi-sensor semantic data fusion for intelligent event detection	4	28	25
T4.1: Data harmonization, semantic representation and aqua3S ontology	1	20	20
T4.2: Integration layer and Multimodal indexing of heterogeneous data	3	24	22
T4.3: Algorithmsfor threat detection and localisation in the existing water networks	3	28	26
T4.4: Crisis management modelling in the existing water networks	3	28	26
T4.5: Optimisation and parallelisation of algorithms for threat detection	3	28	26
WP5 - Early Warning & Decision Support Systems	3	30	28
T5.1: 3D-visualisation of early warnings and the early warning module	3	30	28
T5.2: Visual analytics from UAVs and EO data	3	30	28
T5.3: Early Warning & Water Crisis Assessment Algorithms for Decision Support	3	30	28
T5.4: Crisis classification and Decision Support	3	30	28
WP6 - Social interaction and communication with the citizens	6	36	31
T6.1: Analysis of social awareness	6	20	15
T6.2: Warning (message) generation to the public	6	26	21
T6.3: Deployment of first responder'ssolutions and mitigation actions	12	36	25
WP7 - System Integration	1	30	30
T7.1: Technical requirements and platform development roadmap	1	8	8
T7.2: System architecture development and security requirements	1	12	12
T7.3: System security (cyber security)	6	28	23
T7.4: System integration	5	30	26
T7.5: Interactive User Interface	7	30	24
WP8 - Pilot implementation, evaluation and training	6	36	31
T8.1: Development of the validation scenario and evaluation methodology	6	36	31
T8.2: Field demonstrations and testing	10	36	27
T8.3: User training	12	36	25
WP9 - Policies, Information Management & Standardisation	1	36	36
T9.1: Policy framework and Information Management	1	36	36
T9.2: Standardisation, strategy and policy-making	1	36	36
T9.3: Guidance for responsible applications of water security standards and policy	1	36	36
WP10 - Impact Creation, Dissemination and Exploitation	1	36	36
T10.1: Communication and dissemination actions	1	36	36
T10.2: Networking activities	1	36	36
T10.3: Market analysis, industrial requirements and business models	3	20	18
T10.4: Exploitation plan and Intellectual Property (IP) protection for the proposed solutions	3	36	34
WP11 - Ethics Requirements	1	36	36

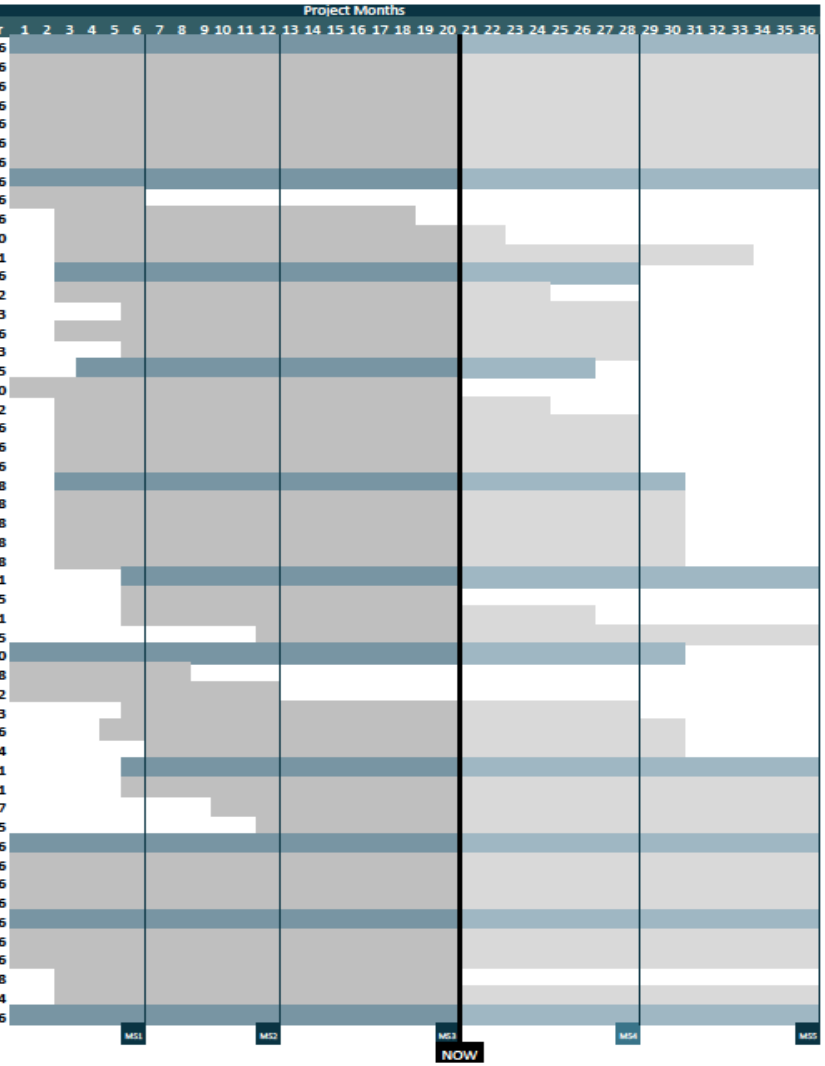

Figure 1. aqua3S Gantt Chart

4. Work carried per work package

4.1 WP1 - Project Management and Coordination

Leader	CERTH	Contributors	VVQ, WBL, DRAXIS, CENTRIC, FZU, MIRS, AAWA, EYATH, UNEXE, AAA, BDI, 3S, ICCS, SOFYISKA, EVERIS, WE, TRI, SVK, RCM, LHA2, USTUTT, EGM
Start month	1	End month	36
Objective	The aim of this WP is to manage the project to time and budget; to co-ordinate the activities; to monitor and adjust the implementation plan if necessary; to monitor the data management and the ethics.		

4.1.1 Tasks

Task 1.1: Project Management and Coordination (M1-M36) [Leader: CERTH]

This task's goal is to coordinate and plan the activities needed for the appropriate management of the project. aqua3S was successfully kicked off in September 2019 with the kickoff meeting hosted by the project coordinator – CERTH in Thessaloniki Greece. During this meeting, each WP's scope and goals have been clearly defined and the interaction between all eleven WPs has been established. Following that meeting, 7 more meetings took place (both physically and virtually due to Covid-19 travelling restrictions) which can be found in the table below.

Type of meeting	Participants	Host	Venue	Date	Scope
Kick Off Meeting	Consortium Members	CERTH	Thessaloniki, Greece	25-26/09/2019 (M1)	Kick off of the project – definition of scopes and goals, ways of operation, plans for action for the upcoming months.
End Users Workshop	Consortium Members	AAA	Padova, Italy	17/12/2019 (M4)	User requirements – definition and refinement of the initial user requirements and use cases.
2nd Remote Plenary Meeting	Consortium Members	Remote-CERTH	Remote participation	03-04-05/03/2020 (M7)	Plenary meeting – presentation of progress so far and plans for the upcoming period.

Type of meeting	Participants	Host	Venue	Date	Scope
Ethics Workshop	Consortium Members (split into 2)	Remote-TRI	Remote participation	03-04/06/2020 (M10)	Ethics requirements and guidelines – provision of guidelines to all involved partners with interactive exercises via Mural.
Tabletop exercises	Consortium Members	Remote-CERTH	Remote participation	29/10 & 03/11 (M13-M14)	1st pilot – remote operational test of the system's functionalities based on formulated scenarios of 3 Pilot Use Cases (PUC1, PUC6, PUC7)
3rd Remote Plenary Meeting	Consortium Members	Remote-CERTH	Remote participation	05-06/11/2020 (M14)	Plenary meeting – presentation of progress so far and plans for the upcoming period.
Visualization Workshop	Consortium Members	Remote-CERTH	Remote participation	02/02/2021 & 05/02/2021 (M17)	Platform design – discussion on the design of the aqua3S platform between technical and end user partners in order to align expectations with capabilities.
Standardization Workshop	Consortium Members and external stakeholders (e.g., DG HOME)	Remote-EGM (assisted by WE)	Remote participation	29/03/2021 (M19)	Market needs on Water security standardization – discussion on EU actions on standardization, industry views and legal framework on water security.

Table 4. aqua3S meetings

Apart from the aforementioned meetings, weekly end user and technical telcos took place in order to align efforts and work carried out within WPs. For the enabling of the communication among partners, CERTH has also set up and kept updated a collaborative management tool (wiki) as well as WP-dedicated mailing lists for all involved partners. Moreover, explicit guidelines on the deliverables' compilation and submission process have been established and communicated to all partners containing specific deadlines and guidelines for all involved parties' successful cooperation.

Task 1.2: Project Administration, reporting and Financial Management (M1-M36) [Leader: CERTH]

This task's goal is to support the administrative and financial management of the project. More specifically, during the first 20 months, CERTH has initiated 4 internal reporting periods, where partners were requested to provide input on their technical progress in terms of their task as well as their financial expenditures. The process on how to fill in these reports were explained in detail in a dedicated call to all partners. These reports were kept under close monitoring by CERTH in order to ensure that progress is inline with the current expenditure. Financial figures will be reported within the context of the first periodic report that is scheduled to be initiated in May 2021. Moreover, within the context of this task the Consortium Agreement among partners was reviewed, finalised and signed by all involved parties and will be kept updated by CERTH (in cooperation with all beneficiaries) if the need arises. Finally, all indicated payments within the Consortium Agreement have been distributed to the Consortium by CERTH in due time.

As this task runs throughout the lifetime of the project, it will handle any administrative and/or financial matter that will arise and will be led by CERTH.

Task 1.3: Quality Assurance and Risk Management (M1-M36) [Leader: CERTH]

This task's goal is to ensure the high quality of the project's deliverables and results, as well as identify and successfully handle any risks that arise and jeopardise the implementation of the project. Deliverables D1.1 and D1.2 have provided the Consortium with:

- the guidelines that will be followed by the Consortium partners to ensure high quality research, development and reporting;
- the measures to be taken in case of detection or prognostication of quality flaws;
- the quality assurance responsibilities all Consortium have;
- the development of risk assessment strategy and corrective action procedures;
- the strategies and indicators for all WP leaders to measure their progress and the quality of their results.

Specific quality assurance guidelines for the compilation of the project's deliverables have been set and include 4 types of reviews before their submission:

- 2 internal reviews (both from technical and end user partners)
- 1 security review (in case the document's dissemination/classification level is Consortium Confidential or EU restricted)
- 1 final quality check conducted by the coordinator in order to ensure the compliance of the deliverable with the established guidelines before submission.

In regard with the risk management taking place within the project, a dedicated risk inventory has been created per WP in order for all partners to be able to report any risks they can identify within their WP. Each identified risk is followed by an evaluation (high-medium-low) of the likelihood of arising and the severity of its impact. Appropriate mitigation measures are also introduced by the partner identifying

the risk and are further discussed (if need be) with the coordinator. This risk inventory is also found within this deliverable, under each WP reporting section.

Task 1.4: Scientific and Technical management (M1-M36) [Leader: UNEXE]

Task 1.4 monitors the quality of the scientific and technological outcomes to ensure the project meets the requisite scientific and technical quality standards and addresses potential deviations from the plan. Discussions between the Scientific and Technical Manager and the technical partners have taken place through regular weekly meetings. The deliverables were also peer reviewed internally by consortium members before sending out to external reviewers to ensure the outputs have met the top standards.

Task 1.5: Data Management (M1-M36) [Leader: EVERIS]

This task's goal is to develop plans that provide information on all data collected/generated throughout the project's lifetime. This is with special focus on: the proper handling of collected and generated data during and after the project's lifetime; the type of data that will be collected, processed or generated; the methodology and standards applied on these data; the sharing of these data (how will they be made openly accessible); the protection and reuse of these data. This information can be found in the project's Data Management Plan (D1.2) that was submitted in M6 and will be kept updated throughout the project's lifetime.

The aqua3S platform will be directly connected to receive information from the water network and other sources like social media and satellite. This in itself makes the platform vulnerable to attacks and data security issues. Therefore, data privacy and data security are of the highest priority since sensitive information will be gathered.

Finally, special attention is paid to the proper handling of EU Restricted data that is needed for the implementation of the project. Explicit guidelines on the handling of such type of information according to the European Commission Decision 2019/1962[6] and 2015/444[7].

Task 1.6: Research Ethics and Data Protection Monitoring (M1-M36) [Leader: TRI]

This task's goal is to monitor and develop the ethics and data management protocols within the project. With respect to this task, TRI has established a recruitment process of research subjects, data collection processes and human research procedures (information sheet and informed consent forms). In doing so, TRI has conducted enquiries with the aqua3S consortium regarding their research processes (including in relation to internal ethics committees and competent authorities. Project meetings and deliverables have been monitored for compliance with research ethics and data protection compliance.

TRI has also acted as an internal touchpoint within the project, providing guidance to consortium partners where requests on research ethics and data protection issues were made. Continuous review of best practices in relation to research ethics and data protection has been conducted, in order to inform the consortium's approach to the project, particularly where issues such as new issues resulting from the transition to online pilots during the coronavirus pandemic have arisen. Deliverable 1.6 will be provided for M34 and will provide research ethics guidelines and recommendations regarding aqua3S' compliance with national and EU regulations, this will include recommendations regarding the appropriate steps to obtain the necessary approvals by or provide data breach notifications to national or local data protection authorities.

[6] Available online at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019D1962
[7] Available online at: https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32015D0444

4.1.2 Risks

No.	Description	Likelihood	Impact	Mitigation Measures
1.1	**Meetings** - no physical meetings can be organised given the current covid-19 situation and travel restrictions imposed on all partners	High	Low	As no physical meetings are to be organised for the foreseeable future, aqua3S will host/organise/attend the upcoming plenary/technical meetings via an online platform, so the consortium can keep progressing with the project's goals and objectives.
1.2	**Payments** - some payments may be delayed due to the amount of personnel that has access to the coordinator's premises	High	Mid	All payments will be scheduled in a pro-active manner in order to avoid or mitigate any delays. However, in the unfortunate case of a delay due to occupational capacity in the coordinator's premises, all partners will be informed in due time.
1.3	**Expenditure** - some partners' spending might not be in accordance with the GA	Mid	High	The coordinator has established an internal process of reporting every 6 months in order to monitor the partners' expenditure being conducted in accordance with the GA. In case a misalignment is identified, the coordinator will work with the involved partner in order to amend the mistake.
1.4	**Partner contributions** - delays might occur in partners' contribution; be it in deliverables, reports or other.	Mid	Mid	Detailed timeplans are provided to partners well in advance in order to be able to assess and agree to it. In this manner, both the coordinator has a clearer image of what to expect from whom and partners have time to plan their schedules.
1.6	**Results** - failure to provide results in accordance with the project's objectives.	Low	High	WP leaders are advised to set up weekly telcos among involved partners in order to keep to keep in frequent touch with their task leaders and monitor the progress of each task and its results. In this manner, minor deviations from

No.	Description	Likelihood	Impact	Mitigation Measures
				the established plan can be successfully tackled in due time.

Table 5. WP1 risk management

4.2 WP2 - User Requirements

Leader	BDI	Contributors	VVQ, WBL, AAWA, EYATH, AAA, 3S, SOFYISKA, WE, TRI, SVK, RCM, LHA2
Start month	1	End month	36
Objective	The aim of this WP is to engage the end-users in an effective process to design the use cases; to determine the specification of the aqua3S platform based on the user requirements; to consider, from an early stage of the project, the ethical and legal requirements of the envisioned platform, formulating the appropriate framework.		

4.2.1 Tasks

Task 2.1: Use case design (M1-M6) [Leader: AAWA]

The goal of this task is the creation of a set of the use case scenarios (UC) and the first list of user requirements (UR) for each of the seven pilot use cases (PUC) of the project, as well as a clear definition of the extension of each PUC. The task required a strict collaboration between end user partners responsible for the PUC implementation (PUC1: AAWA, AAA and LHA2; PUC2: EYATH; PUC2: 3S; PUC4: WBL; PUC5: VVQ; PUC6: SOFYSKA; PUC7: SVK) and technical partners.

The approach followed consisted of several different activities which took place during the first six months of the project, including :

- a survey of the state of art of each PUC in terms of the legacy tools based on the catalogue provided by CERTH;
- discussions, in occasion of the weekly end users telcos, between end users and technical partners about the legacy systems and end users' needs and expectations of the aqua3S platform;
- inclusion of the draft of the User Requirement list and its update on the wiki, in order to be accessible by all partners and to let the technical partners insert their comments and requests to clarifications.
- Once the Consortium reached a common understanding about the end users' needs, the technical partners started to work on simplified forms describing to the end users their current and proposed technical solutions to be integrated in the aqua3s platform to satisfy these requirements.
- End user partners acquired and read the descriptions of the various components of the platform provided by the technical partners and, in occasion of the next set of end user telcos, they assisted to some presentations set-up by the technical partners to further explain these tools.
- In occasion of the end users workshop (held in Padua, Italy, the 17th of December 2019), the list of the UCs and URs from the previous steps was presented and discussed to reach a consolidated version;

- during the weekly telcos after the meeting in Padua, the end users confirmed and formalized the final list of URs and UCs defined during the workshop;
- the list of URs and UCs, as well as the more defined description of the scenarios, was included into D2.1 (submitted in M6). Task 2.1 is completed in M6, however its ideal continuation is represented by the activities of Task 2.2, in particular the update of the initial list of user requirements.

Task 2.2: Stakeholder engagement user requirements (M3-M18) [Leader: EYATH]

This task's goal was the extraction of user requirements from the use case scenarios. It initiated a full requirement analysis study for the definition and mapping of the final user requirements and use cases.

Within this task all the necessary procedures took place among end-users and technical partners towards the update and calibration of the Use Case design and for the elicitation of the final User Requirements. This task was based on the initial URs established at the first phase of the project (first prototype) as well as their documentation in Deliverable D2.1 "Use cases requirements v1" (M6). As a result, it has led to the definition of clear, realistic and feasible User Requirements, which were mapped down and verified by both end-user and technical partners. These procedures also included the review of URs for potential ethics, legal and societal impact concerns.

All the work realized during Task2.1 has provided the end-users with a deeper comprehension of the aqua3S platform potential and has proven to be substantial to achieve the next development cycles of the 2nd and 3rd prototype implementation. The main obstacle to this procedure has been the imposed Covid-19 restrictions and working conditions that limited the potential of conducting a common stakeholder workshop due to the difficulties to have on board so many people from several competent national authorities of the seven different PUCs. Furthermore, there have been concerns that the depth of such conversations would be too poor and limited over an online session.

The next steps which are closely connected to the user requirements are the following:

- The additional discussions and clarifications to be made by the end-users and technical partners on the visualization requirements. This outcome will be presented at deliverable D7.8 Interactive User Interface (M30) and will be evaluated in the pilot related deliverables D8.2 Pilots' implementation and 2nd prototype evaluation report (M28) and D8.3 Field demonstrations and final system evaluation (M36).
- The security requirements' definition that will examine both the hardware/software security and the security of generated information within the aqua3S solution such as the security requirements related to PUCs implementation and Use Case scenarios and will be consolidated in the Safety Requirements Report D2.4 for the M22).

Task 2.3: Security requirements (M3-M22) [Leader: BDI]

The goal of the task T2.3 is to identify, analyze, and assess user security requirements taking into account software and hardware technologies that will be applied in the project.

During this period the security requirements organized in 6 main groups (access control; data confidentiality; data integrity; data protection; trace and record; and log files) were developed. The MoSCoW (M - Must have S - Should have C - Could have W - Will have) prioritization technique was applied for each requirement in every of the 6 groups. Assessment of the applicability of the developed and assessed requirements is currently in the application process. Traceability matrix with respect to monitor which security requirement in which tool/element of the aqua3s system is implemented is

developed. The traceability matrix is a living document and will be updated during the course of the project.

Task T2.3 serves as a basis for the alignment of security requirements between end users and their reflection to the use cases; provision of a basis for common understanding of the security issues from operational and technological point of view; cooperation with the architectural development of the aqua3s system (T7.2); and further implementation of available and applicable security techniques and technologies (T7.3).

The next steps that will be carried out are related to the assessment of the user security requirements; the identification of the applicable technologies to achieve these requirements; the development of the tractability matrix between the security requirements and the developed tools; and the final assessment of the system from the security point of view, and in close cooperation with T7.2, and T7.3. The outcomes will be reported in D2.4 (due in M22).

Task 2.4: Ethics and legal framework (M3-M33) [Leader: TRI]

This task's goal is to consider the ethical and legal requirements both for the developed system and for the ongoing compliance of the project. Following a series of one-on-one conversations with the project partners with TRI, the extant and potential ethics, societal and legal issues were examined. This involved the research of legal and ethics related literature and combining this with analysis of the project data flows and structures as well as their related use patterns. In order to sensitise the project partners to the relevant ethics and legal frameworks and principles, and to benefit from their insights on where ethical issues might arise as the project solution interacts with end-users' processes and systems, two half day ethics workshops were arranged for M9 with all project partners in attendance. Though these workshops were originally to be held face-to-face, they were carried out on-line due to the ongoing coronavirus pandemic.

Following this, the preliminary ethics and legal framework (D2.2) was produced in M10, setting out the relevant legal frameworks and principles pertinent to the project, and identifying the privacy, social and ethical risks and technical/operational solutions and mitigation measures. This deliverable provided initial guidance for the project and will be used as the foundation for final ethics and legal framework (D2.5), which will act to capture the subsequent developments that occur within the project and provide more specific device tailored to the specificities of the ultimate project solution. Supporting this, TRI has engaged with a number of experts in the area of the right to water to gain their insights, have continually monitored the project meetings and deliverables to identify issues and have acted as an internal project touchpoint for partners requesting additional guidance on ethical, societal and legal issues.

4.2.2 Risks

No.	Description	Likelihood	Impact	Mitigation Measures
2.1	Delay on response time from end-users reflecting in small delay in URs mapping and analysis	Low	Low	Regular contact and work with end-users at individual online meetings and calls
2.2	Clear understanding of the needs for security and required levels (i.e., too ambitious or too low).	Low	Low	Regular contact and work with end-users and technical partners in order to identify their specific needs.

Table 6. WP2 risk management

4.3 WP3 - Enhanced sensing for the water security and safety

Leader	CERTH	Contributors	DRAXIS, CENTRIC, FZU, MIRS, AAWA, EYATH, UNEXE, AAA, BDI, 3S, ICCS, SOFYISKA, EVERI, TRI, SVK, USTUTT, EGM
Start month	1	End month	28
Objective	The aim of this WP is to customise and deliver existing commercial multiple sensors in key points in the water network, providing continuous real-time monitoring of the whole water systems. Furthermore, tasks which support processes for acquire, analyse and deliver data obtained from UAVs, satellites and social media will be also considered as essential goals of WP3.		

4.3.1 Tasks

Task 3.1 Sensor selection and customization (M3-M24) [Leader: FZU]

This task's goal is to select and customize two main types of sensors to be integrated into the security platform of the water utility partners, delivering real time alerts and quantitative information about the presence of the water contaminants. In particular, the **refractive index (RI)** sensor which aims to monitor the evaluation of the refractive index of the water samples whereas **the mid-infrared (MIR)** sensor that combines an optimized infrared QCL and heated photoacoustic cell, permitting the accurate detection of the spectral signature of vaporized ammonia in a water sample. The development activities of these sensors can be summarized as:

Refractive index (RI) sensor

- Selection and optimization of a photonic chip consisting of an asymmetric Mach Zehnder interferometer for calibration purposes, design of control electronics (ongoing activity) that will allow the system to perform the individual functions required by a set of electronic devices and other subsystems and integration of a microfluidic system (ongoing activity) which will allow the water sample to be pumped in the photonic sensing via tubes, where the refractive index of water is constantly monitored.
- Initial validation experiments demonstrating that the aMZI-based RI sensor can detect with high accuracy the refractive index changes due to the different composition of real water samples.

MIR spectroscopic sensor

- Selection and customization of the NH3 laser (Optimization of the QCL design, fabrication and tests of the optimized QCL), development/study of vaporization processes (ongoing activity) appropriate to convert aqueous ammonia to molecular ammonia in gas phase, design and manufacturing of the analyzer and design and realization of a computer control program.
- Initial validation experiments for the detection of molecular ammonia gas phase following two different vaporization methods: (i) vaporization of a liquid within CEMLAB technology and (ii) a customized ammonia stripping process.

It should be noted at this point that lock-down measures introduced both in France (MIRS) and Greece (ICCS) affected the manufacturing process of the two sensors and their field deployment in the first

prototype of aqua3S. In addition, the two institutes were quoted an additional delay by their suppliers due to Covid-19 outbreak.

The steps to be followed for the further advancement of RI sensor include the updated design of its control electronics, successful integration of the microfluidic unit in a waterproof packaging and an updated software version for the control of its different components. On the other hand, MIR sensor's advancements will incorporate customization of ammonia stripping solution for remote sensing/field deployment, further enchantment of the QCL performance based on predictive NEGF simulations and tests of the sensor using real water samples provided by water utility partner.

Task 3.2: Area monitoring using UAVs and satellite data (M6-M28) [Leader: CERTH]

The goal of this task is to use Earth Observation (EO) data along with data from UAVs and CCTVs for identifying and localizing water pollutants (including oil spills and algae bloom), flood detection and objects can be linked with water pollution by using visual processing approaches.

During this period, CERTH has created documents providing the technical details (i.e., requirements, input, output, technologies used) of the modules that process the data from satellite, UAVs and drones. Moreover, the end user partners (SVK, AAWA, EYATH, WBL) defined the areas of interest (AOI) and provided information about related past pollution incidents identified in their AOI and shared datasets, including videos and images. CERTH implemented machine learning methods for identifying pollutants (i.e., oil spills) on the water surface. Several methods were used including Support Vector Machines and Deep Neural Networks. Apart from the identification of water pollutants, the change detection of areas using satellite data in regards to water, and thus flood detection, flood delineation, water delineation and water depth algorithms were developed. Through the aforementioned work, CERTH has addressed partially at least the following evaluation strategies "detection and localization of oil spills, algae bloom and floods events by considering satellite data over the areas of interest", "conduction of experiments on benchmark datasets, external data collections or collected aqua3S data to perform quantitative evaluation in terms of precision, recall, F-score or IoU (Intersection over Union)", and "reporting of the performance of the change (flood) detection, algae estimation, oil spill prediction and object detection modules" (D3.4).

Moreover, an automatic product downloading procedure of EO data from Copernicus Open Access Hub for downloading EO data (i.e., Sentinel -1 and Sentinel-2 products) from all the AOIs on the daily basis was integrated. This procedure is easily configured and can be adjusted to different areas of interest. Additionally, the module for processing the EO products for each available and required by the end partners procedure (e.g., oil spill detection, flood detection) was created. Moreover, a MongoDB was set up for keeping all the initial metadata and the metadata produced after the processing.

Furthermore, the Satellite Imagery FIWARE data model has been designed in cooperation with ICCS, implemented in the json NGSI-LD format in order to store EO data into the Orion-LD Context Broker and made public in the FIWARE GitHub[8]. The entities comprising the model are EOSatellitePlatform, EOProduct, EOInstrument, EODataHub, EOAnalysis, and EOGeoDataLayer. Within the context of this activity, corresponding payload examples were also created and uploaded in the repository.

[8] Available online at: https://github.com/smart-data-models/dataModel.SatelliteImagery

Finally, during this period TRI reviewed the issues arising from the use of UAVs and satellite data, and monitored for ethical, legal and societal issues that could be related to the use of UAVs in area monitoring, as well as the suggested practice in relation to aqua3S.

The next steps involve the implementation of other algorithms for pollution detection (i.e., algae detection), update of the algorithm for flood detection and finally incorporation of a concept detection or/ and object detection procedure that handles the data retrieved by UAV and CCTV images. In case it is required, FIWARE data models that capture information from the UAVs and CCTVs will be designed and implemented.

Task 3.3: Crowdsourcing and social media monitoring (M3-M28) [Leader: CERTH]

This goal of this task is to collect social data from citizen observations on open social media sources such as Twitter, in line with the end user requirements that can be used for detecting areas in the water network of unsatisfied citizens with the water quality. These tweets are processed in an automatic way so that irrelevant information (i.e., information not related to water quality and floods) is removed. Finally, event detection is applied in order to identify events by considering spatially and temporally close tweets.

During this period, CERTH has created a document providing the technical details (i.e., requirements, input, output, technologies used) of the modules that collect process the social media. Moreover, the end users (Sofiyska, VVQ, AAWA, WBL, SVK) have defined in English, Italian, Greek, Bulgarian and French a list of keywords which are relevant to the six aqua3S use case pilots and cover the scenarios of floods, droughts and water quality, and also identified the social media that are mainly used in their countries. These keywords have emerged after close cooperation between CERTH and end-user partners representing the pilots. Next, a social media crawling module has been implemented, which collects in a real-time manner public tweets that contain any of the keywords defined by the end users partners. CERTH has also implemented a dedicated user interface that displays the collected and analyzed tweets and can be used both as annotation tool and for demonstration purposes. This tool was used by the end user partners (AAWA, Sofiyska, WBL and SVK) for providing manual annotation of the collected tweets by characterizing them as relevant or irrelevant to the use cases examined in the project. Each end user partner annotated the tweets provided in their native language and a part of English tweets and eventually provided a paragraph that underlined the criteria used for the annotation. It should be noted that for the specific use cases (i.e., water quality and floods/ droughts), the crawler has retrieved significant number of tweets only for the Italian and English languages, due to higher activity on Twitter in the respective countries. By considering the annotated tweets, and after applying text pre-processing techniques, text classifiers were build using State-of-the-Art methods e.g., word2vec in order to filter out irrelevant tweets that even though they contained keywords identified by the end users; their content was eventually not relevant. In order to further improve quality of the retrieved tweets, CERTH has collected refined search criteria from the end users based on the initial results and keywords that were resulting to irrelevant content were removed. Furthermore, CERTH has modified the Social Media Crawler to fix bugs related to the search criteria and integrated the localization service for the English and Italian language into the crawling procedure in order to geo-locate tweets. Through the aforementioned work, CERTH has addressed partially the following evaluation strategy “collection of public social media posts in real-time that are relevant to water safety and security and to further improve the quality of incoming information by automatically estimating their relevancy to the topics of interest” (D3.4).

Furthermore, within the context of designing the Social Media FIWARE data model that represents the social media data in the Orion-LD Context Broker, CERTH has conducted a thorough study of the

attributes of posts coming from different social media platforms in order to propose a model that can potentially capture information from several social media platforms. Also, in order to incorporate in a user-friendly and useful way the social media data into the aqua3S platform, CERTH has proposed to the end users alternative ways of their visualization, including pins on a map and several types of charts.

Finally, TRI has conducted interviews with the technical partners (i.e., CERTH, CENTRIC) involved in the crowdsourcing and social media monitoring in order to identify the active ethical and data protection considerations, and also TRI has reviewed and made research on the ethical and privacy issues related to the use of crowdsourcing and social media monitoring.

The next steps involve the implementation of the event detection algorithms for identifying possible events in Twitter, and Call Complaints as the latter was identified as a useful additional source by the aqua3S consortium. Moreover, CERTH will continue with the development of other text classification techniques for the PUCs that have sufficient number of tweets, with the development of localization modules for other languages (i.e., Bulgarian, French, Greek) and finally with the implementation of the complete pipeline of the Social Media Crawler so that it involves all the aforementioned procedures, i.e., tweet crawling, text preprocessing, text classification, and localization.

Task 3.4: Data collection from multiple sensors and sources (M6-M28) [Leader: ICCS]

The main goal of Task 3.4 is the implementation of the solutions for heterogeneous data collection from multiple sensors and sources, stemming from Task 3.1 (sensors), Task 3.2 (satellites) and Task 3.3 (crowdsourcing and social media monitoring).

Towards this direction ICCS has been in frequent interaction with end users in order to gather pilot necessary information and to agree on the handling of the sensor data, the structure of the incoming data as well as the appropriate communication channel. Specifically, ICCS successfully completed relevant communications and actions in order to collect data from the RI and FZU/MirSense sensors and built a client module that facilitates the communication of sensors with Orion-LD. Additionally, ICCS successfully completed the relevant communications with AAA and SVK for the first prototype by agreeing on the handling of the sensor data, the structure of the incoming data as well as the adequate communication channel type, and integrated the AAA and SVK FTP sites with the FTP/Transformation Service developed. In view of the second prototype, ICCS continued communication with AAA in order to agree on the structure of the incoming sensor data as well as the appropriate communication channel of the new market sensor acquired by AAA to be included in the second prototype. Furthermore, ICCS continued communication with Sofiyska, LG Sonic, WBL and EYATH in order to agree on the structure of the incoming sensor data as well as the appropriate communication channel and developed custom FTP clients with the purpose of retrieving sensor data from the FTP sites of SVK and AAA. Finally, ICCS provided CERTH with a Python code that parses and transforms the JSON for direct integration of the satellite and social media data into the aqua3S platform.

Main obstacles identified are delays in the supplies of sensors due to the pandemic. In view of the second and third prototype, future steps include the finalization of the relevant communications with Sofiyska, LG Sonic, WBL, AAA and EYATH in order to agree on the structure of the incoming sensor data as well as the appropriate communication channels, and the initiation of the interaction with VVQ and 3S. Additionally, it will be investigated whether other partners in future PUCs are interested in acquiring any additional commercial sensors with respect to integration with the aqua3S platform. Finally, ICCS will keep on working on the integration and optimization of the data collection and harmonization processes.

4.3.2 Risks

No.	Description	Likelihood	Impact	Mitigation Measures
3.1	Delays in the supplies of sensor due to the pandemic	High	Mid	Use of simulation data to simulate real-life environment
3.2	Limited number of tweets concerning the use cases in Greek and Bulgarian, due to low activity of Twitter users in the respective countries.	High	Mid	Further refinement of the search criteria and/or creation of synthetic tweets for demonstration pilots, for the problematic languages.
3.3	Limited annotated data with oil spill incidents in surface water.	High	Mid	Augmentation of data to improve training of the model and consequently the predicting capability.

Table 7. WP3 risk management

4.4 WP4 - Multi-sensor semantic data fusion for intelligent event detection

Leader	ICCS	Contributors	CERTH, DRAXIS, FZU, MIRS, UNEXE, 3S, USTUTT, EGM
Start month	1	End month	28
Objective	The objectives of this WP are firstly to deliver knowledge management, representation and linking of the collected data, to support interoperability and semantic reasoning for decision-making in all use case scenarios; secondly, to describe the framework of the integration (middleware) layer and multimodal indexing of heterogeneous data; thirdly, to present the aqua3S algorithms for threat detection and localisation in the existing water networks as well as their functionalities in terms of optimisation and parallelisation and finally to introduce a crisis management modelling in the existing water networks.		

4.4.1 Tasks

<u>Task 4.1: Data harmonization, semantic representation and aqua3S ontology (M1-M20) [Leader: CERTH]</u>

The goal of this task is to harmonize all the collected and produced data within aqua3S.

During this period, CERTH has collected relevant user requirements from end user partners (e.g., AAWA), and expected available data in order to define the coverage of the ontology. Also, CERTH made an extensive research on related ontologies that could be reused in order to capitalize on established and standardized vocabularies. Specifically, CERTH has searched for state-of-the-art ontologies pertinent to the aqua3S ontology for the domains of crisis representation, sensors & IoT devices and social media, and has developed a high level crisis ontology for water domain crises. The ontology was based mainly on the ISO 15975 parts 1 and 2, as this choice fits the use cases optimally. Additionally, the ontology was extended with sensor measurement capabilities via means of reusing the SAREF and SAREF for water ontologies. Furthermore, social media data were added to the ontology by reusing the SIOC ontology. Moreover, an incident scheme was added to the ontology as means for semantic reasoning and correlation between analyses components and the overall crisis. Overall, the ontology was being developed on a modular way, adding more data sources as they mature, while adopting international

standards whenever possible (e.g., spatial and temporal representation). It should be noted that DRAXIS has also contributed to the development of the crisis part of the ontology, and ICCS participated in the discussions related to the adoption and expansion of existing ontologies and how these will be used in the Integration layer. Through the aforementioned work, CERTH has addressed partially the following evaluation strategy "relevance of the ontology is determined by its ability to realize the relevant user requirements" (D4.1).

Given that the aqua3S consortium decided on adopting the FIWARE platform, this task contributed in the harmonization of the data related to aqua3S by leading or aiding in the development of related FIWARE data models (i.e., models related to data retrieved from different sources such as social media, satellite data and call complaints).

Within this context, CERTH has designed and implemented the FIWARE model for Social Media posts (in cooperation with the outcomes of T3.3) and, for Satellite Imagery (in cooperation with task T3.2). Regarding the Social Media model, it is published in the FIWARE GitHub[9], and the entities comprising the model are SMPost, SMUser, SMCollection, SMAnalysis, and SMRefLocation. Corresponding payload examples were also created for each entity and uploaded in the repository. In addition, CERTH initiated the development of the Call Complaints FIWARE model after considering the requirements of the end users (i.e., WBL, VVQ). Furthermore, CERTH has utilized the Social Media and Satellite Imagery FIWARE models in order to produce the related owl files and made the connection of these model-specific ontologies to the aqua3S ontology. Finally, CERTH has designed the reasoning Scenarios based on the existing data sources (i.e., satellite data, sensors, single tweets).

During this period, ICCS has supported CERTH by expanding the NGSI-LD compatible harmonization service layer, which was developed by ICCS for the first prototype, to include a variety of sensors as well as independent systems in view of the 2nd prototype. EGM has also proposed options to integrate Device and Sensor models in a contextualized information representation and introduced NGSI-LD data representation and links to existing ontologies.

The next steps involve the implementation of the remaining FIWARE models that are required for harmonizing all the information reaching and produced by the aqua3S modules, such as Call Complaints, Risk Assessment, and Hazardous Events. Then, the respective owl files will be created and based on the reasoning scenarios already developed, along with the new ones that will developed in the following period, the Knowledge Base will be populated with data found in the Orion-LD Broker. Finally, by considering the reasoning rules that will be developed, conclusions will be drawn that consider all available data.

Task 4.2: Integration layer and Multimodal indexing of heterogeneous data (M3-M24) [Leader: ICCS]

The main goal of Task 4.2 is the indexing and storing of the heterogeneous data collected in Task 3.4 in order to be used by other aqua3S services as well as for future referencing. Towards this goal, FIWARE solutions and the ORION NGSI-LD Broker have been deployed for the needs of the 1st prototype of aqua3s as well as for testing and integration purposes and have been further developed around new data models to address the needs of the 2nd prototype. Cygnus NGSI-LD Agent, a GeoServer and a WebDav Server have been successfully set up to serve requirements for productive utilization of satellite, drone, social media, and historical data. In more detail, within the context of Task 4.2 ICCS developed a Python module that handles connections to Orion-LD by establishing NGSI-LD Client Layers

[9] Available online at: https://github.com/smart-data-models/dataModel.SocialMedia

for the upload of sensor measurements, satellite data and social media data to the Orion Context Broker. In addition, the following services have been developed and finalised:

- Sensor Measurement Data Service: (RI / MirSense etc) ICCS provided Python code that parses and transforms RI Sensor and MIR Sensor data for direct insertion into the Orion Context Broker
- Sentinel Data Service: ICCS provided CERTH with a Python code that parses and transforms the JSON for direct data insertion to the Context Broker
- Social Media Data Service: ICCS provided CERTH with a Python code that parses and transforms the JSON for direct data insertion to the Context Broker
- Historical Data Service: ICCS successfully set up Cygnus in the DEMO and VM environment.
- Binary Large Object Service: ICCS successfully developed and deployed the storage and retrieval solution. A WebDAV server has been set up and tested in the DEMO and VM environment to be used for storing and sharing binary objects and documents.

Furthermore, the GeoServer has been successfully set up in the DEMO and VM environment, and the analysis for the development of the following services has been initiated:

- Water Network Management Service
- Alert/Anomaly Service
- Demand Service

Finally, using a variety of simulated data, ICCS debugged and tested the Orion-LD/Cygnus-LD stack, as well as tested and optimised the data parser and client layers.

The main obstacles causing slight delays in the progress of the Task 4.2 are several bugs identified in the adopted FIWARE solutions, as well as delays in the development of new data models to cover the needs of the aqua3S platform. In view of the second and third prototype, next steps include the development of the Water Network Management Service, the Alert/Anomaly Service and the Demand Service, the successful integration of new sensor data, as well as the finalization and optimization of the integration layer and multimodal indexing. Finally, upcoming action point is also the preparation of Deliverable D4.3 (Integration layer and multimodal indexing of heterogeneous data), due August 2021.

Task 4.3: Algorithms for threat detection and localisation in the existing water networks(M3-M28) [Leader: UNEXE]

This task will address the real-time detection of disturbances in water systems. A sensor placement algorithm has been developed based on Jacobian matrix-based method and validated with an ideal case study. A follow-up algorithm will analyse the real-time monitoring data from sensors and the existing SCADA system, combining the Events Recognition System, to detect the anomalies in the networks and localise the issues. The first version will be able to capture the leakage events, based on pressure sensor data, while the second version will further identify the malfunction of system components.

Task 4.4: Crisis management modelling in the existing water networks (M3-M28) [Leader: DRAXIS]

This task's goal is to develop a tool to support stakeholders responsible for water infrastructure in assessing their preparedness level against a series of hazardous events. Preparedness refers to both infrastructural capacities (e.g., a warning system) but also to organizational arrangements supporting response. At first, the interrelations arising through the literature review of the SoA of crisis management modelling and the requirements of the project's pilots were explored. Based on the outcomes of this process, as well as the pilots' input on a structured questionnaire, the three macrostages of a crisis (i.e., pre-crisis, during crisis, post-crisis) started to be formulated. Moving on, the crisis management tool's target audience was identified, its purpose was further defined, the desired

key outputs and results were defined, and the conceptual design of the tool was initiated. In addition to this, the linkages between the various hazardous events and their impacts started to be explored. Key functional areas and activities for each of the three crisis stages as well as the hazardous events to be included have been identified. Also, the type of input provided by the user was decided (no numerical data as an input). The structured macrostages accompanied by their key functional areas were presented to the end user partners and their feedback was requested through the distribution of an excel spreadsheet. This information will be the content populating the tool that will be developed. The first conceptualization of the tool was presented in the end users' telco and feedback was requested from the end users. The refinement of the tool's content was based upon the feedback provided by the end user partners of the project and the insights they shared for the three crisis macrostages. The design of the tool and the formulation of visual examples in the form of mockups were initiated in order to be presented in the project's pilots to highlight the usability and applicability of the tool.

The main achievement of the work carried out is the formulation of an overarching high-level crisis management preparedness assessment that can be used to identify areas of strength and weakness to enhance an organisation's level of preparedness. The main difficulty encountered refers to linking the crisis management process to the various hazardous events to be included in the tool. Finally, future steps include working on formulating the detailed background interrelations that will lead to the finalization of the model.

Task 4.5: Optimisation and parallelisation of algorithms for threat detection (M3-M28) [Leader: USTUTT]

The aim of this task is to optimize the software used by the threat detection algorithms (from Task 4.3) in terms of serial, as well as parallel performance and efficiency.

A benchmarking and profiling suite was developed for the software OWA-EPANET, selected for the Anomaly Detection Module of the threat detection algorithms[10]. The code performance has been profiled using two different tools, the TAU Performance System and the Intel VTune Profiler. The results pointed out the functions and routines that are the most time-consuming.

The work is now concentrated in studying forms of increasing the performance, focusing on the routines outlined by the profiling.

4.4.2 Risks

No.	Description	Likelihood	Impact	Mitigation Measures
4.1	Bugs identified in the adopted FIWARE solutions	High	High	Quick troubleshooting or adaptation of an adequate workaround until a permanent fix is in place.
4.2	Delay in the development of services for not yet developed data models.	High	High	Concrete time and resource planning in order to have the data models on time.
4.3	The tool is not straightforward in its use	Mid	Mid	Visual examples in the form of mockups will be presented to the users to get their feedback on the

[10] Available online at: https://github.com/OpenWaterAnalytics/EPANET

				conceptualized tool and adjust the approach where needed, before the implementation.

Table 8. WP4 risk management

4.5 WP5 - Early Warning & Decision Support Systems

Leader	UNEXE	Contributors	CERTH, FZU, ICCS
Start month	3	End month	30
Objective	This WP consolidates methods and techniques enable to visualise data obtained for heterogeneous sources, to assess and classify water crisis events and to enhance decision making processes in a unified framework. A system will integrate functionalities which are serving both the pre-emergency and emergency crisis phase.		

4.5.1 Tasks

Task 5.1: 3D-visualisation of early warnings and the early warning module (M3-M30) [Leader: UNEXE]

This task creates the front-end visualisation environment for the DSS platform with access to all of the modules included in a particular deployment at the Case Studies. The first prototype has been developed to demonstrate the possible functionalities and visualisation of early warning information within a network. The system integrates multiple spatial temporal data and presents them through a user-friendly interactive 3D visualisation platform. The prototype is being reviewed by the end-users to further improve the design and functions to tailor.

Task 5.2: Visual analytics from UAVs and EO data (M3-M30) [Leader: CERTH]

The goal of this task is to design and develop Visual Analytics (VA) interface that ensures the digestibility of data/information presented to the end-user. Specifically, the VA interfaces enables the operator to manipulate information obtained from UAVs, Twitter and EOs whilst also providing a number of pre-determined visualisations and 'alerts'.

During this period, CERTH has created a document that describes the technical details (i.e., requirements, input, output, technologies used) of the module. Moreover, CERTH studied thoroughly the lists of requirements provided by the end-users (AAWA, AAA, EYATH, WBL, VVQ, Sofiyska, SVK) in order to be able to address their needs. Based on these requirements, CERTH designed the first mockup of the VA module. The first and basic version of the module was developed using the Bootstrap v4 library.

Moreover, CERTH has incorporated the 1st version of style guide and bootstrap theme for the UI that was defined from DRAXIS in order to ensure a uniform look and feel of the platform. Also, CERTH has continued with importing data from the different sources. Specifically, single tweets were included as pins on the map (T3.3), layers produced from processing of satellite imagery that indicate the existence of water pollutants or floods on the map (T3.3), and hazard maps (T5.4) that provide assessments for the severity level by considering the aforementioned sources. An updated version of the dashboard was developed that was based on the mapbox library for showing data on top of a map.

Description of the VA dashboard developed and its capabilities at that stage were reported in the confidential deliverable D5.1 “Report on the basic visual analytics techniques for the early warning module v1” that was submitted on M18 which was led by UNEXE and supported by CERTH.

Finally, CERTH initiated the development of various functionalities integrated in the module, like filtering historical data, settings menu and infobox. Through the aforementioned work, CERTH has addressed partially the following evaluation strategy “integration of high performant visual analytics platform with data from Twitter (texts, photos, multimedia etc.), satellite images and drone captured data, all visualized as map-based incidents or graphs specifically for social media.” It should be noted that the VA's data flow has been defined in collaboration with UNEXE partner.

The next steps involve putting on the map data from the following sources, i.e., drones, UAVs, Call Complaints and also events produced after processing tweets and call complaints. Also, tweets and complaints will be also monitored in a graph chart that will show the evolvement in time in an easier way. Moreover, further improvement on the functionalities will be realized, for example regarding the visualization of historical data, in order to cover the user needs. Finally, the VA module will be connected to the aqua3S platform so that is consumes data from the Orion-LD Broker.

Task 5.3: Early Warning & Water Crisis Assessment Algorithms for Decision Support (M3-M30) [Leader: UNEXE]

This task will develop an Intervention Management Model (IMM) to deal with the response to pipe bursts or contamination. The IMM is under development and two submodules have been designed. The first submodule will evaluate the impact of bursts/contamination or impact, while the second submodule will further analyse the effectiveness of various combinations of intervention measures in order to minimise the disruption of incidents.

Task 5.4: Crisis classification and Decision Support (M3-M30) [Leader: CERTH]

The goal of this task is to provide assessments for the severity level of the evolving crisis based on the data with multimedia content obtained and analyzed in real-time from heterogeneous sources.

During this reporting period, CERTH has created a document that describes the technical details (i.e., requirements, input, output, technologies used) of the Crisis Classification and Decision Support (CCDS) module. Moreover, CERTH has closely collaborated with end user partners (i.e., AAWA) in order to specify the users' requirements related to the module. CERTH has reviewed the literature for flood susceptibility and flood hazard assessments using Machine Learning methods and remote sensing data and social media data. Furthermore, CERTH collaborated closely with AAWA in defining a crisis classification algorithm for flood, and AAWA provided water related GIS data and other relevant socio-economic GIS layer for their area of interest. CERTH consumed data from satellite image and GIS data provided by AAWA and built a machine learning model for assessing the flood hazard level that was evaluated on a testing dataset. The results of the proposed approach were compared with the legacy flood risk assessment approach and maps in the particular region of interest. Through the aforementioned work, CERTH has addressed partially the following evaluation strategies “Data acquisition process to collect data from sensors, metadata (outcomes of the analysis components) as well as from other external resources (e.g., risk maps, data for socio-economical assets etc.)”, "estimation of the crisis severity level", and "quantitative evaluation against the baseline system and comparison in terms of precision accuracy and response time".

Moreover, CERTH conducted a literature review for risk assessments in water quality and forecasting methods for water demand using Machine Learning techniques in order to address the user

requirements defined by 3S. Within this content, CERTH has specified the parameters for Forecasting Water Demand and Data Imputation techniques. Finally, ICCS has collaborated with involved partners in order to exchange information regarding data provision requirements.

The main obstacles were the lack of annotated datasets in terms of the assessment of flood events as well as the limited number of available satellite images that contain flood events in the region of interest. By the aid of end-user (water authority – AAWA) both hinders were overcome. For the former, the datasets were annotated using an automated rule-based approach and for the latter, the region of interest was expanded in order to cover contingency regions with flood events.

As for the future plan, the Crisis Classification module will encapsulate functionalities that enable the assessment of the crisis severity level based on the sensing data that will be collected by measurements for the water quality. Furthermore, algorithms for water demand forecast, detect abnormal water quality events and water leaks will be developed and incorporating into the aqua3S platform.

4.5.2 Risks

No.	Description	Likelihood	Impact	Mitigation Measures
5.1	Lack of annotated datasets in terms of flood hazard	Mid	Mid	Use a rule-based approach provided by AAWA, to annotate automatically the datasets that are generated from the analysis of Satellite images
5.2	Few Satellite images (Sentinel-1) with flood events in the Region of Interest to analyse	Mid	Mid	In order to evaluate the reliability and performance of the developed machine learning models for flood risk assessment, available satellite images from other regions will be used. Collaboration with AAWA to resolve this issue
5.3	Resolution of 0.5m for the provided GIS data makes the hazard and risk assessment algorithms demanding in terms of computational memory and time.	Mid	Mid	Possible countermeasures for mitigation could be: (a) Apply data sampling to reduce the size; (b) usage more powerful machines in computational resources;
5.4	Lack of geolocation information in social media posts (tweets). This reduces or eliminates the capability of the algorithm to estimate the impact of flood and vulnerability of people due to social media posts locally.	Mid	Mid	If the available geolocation is at city-level, we estimate overall risk assessment for the rest tweets; otherwise, if it is at finer level (e.g. specific area, address) the local estimation of risks could be provided.

Table 9. WP5 risk management

4.6 WP6 - Social interaction and communication with the citizens

Leader	CENTRIC	Contributors	CERTH, WBL, AAWA, EYATH, UNEXE, AAA, BDI, ICCS, SOFYISKA, SVK, RCM, LHA2
Start month	6	End month	36
Objective	This WP delivers the methods and techniques to raise the social awareness of possible water supply issues, to generate and populate public alerts and warning messages as well as to deploy the first responders' solution and mitigation plans for the pilot water utilities.		

4.6.1 Tasks

Task 6.1: Analysis of social awareness (M6-M20) [Leader: CENTRIC]

The goal of this task is to provide social engagement guidelines for water and public authorities to communicate effectively with citizens and communities on social media during water crises. To develop the guidelines, a thematic qualitative analysis of Facebook posts was conducted in five cases: 2029-2020 UK Winter Floods, US Flint Water Crisis, South African Cape Town drought, the Czakja Wastewater Treatment Plant malfunctions in Poland and the FSO Nabarima oil spill prevention in the Gulf of Paria. Additionally, a sample of Facebook and Twitter data were analyzed to develop a novel method for assessing the validity and reliability of soft intelligence extracted from social media for crowdsourced early warning of water crises. Overall, this deliverable provides advice to crises managers on how to effectively utilize social media during water crises based on best practices and lessons learnt based on desk-based and empirical research.

A few obstacles were encountered during the development of the social engagement guidelines which were overcome through the following actions. Due to a limited number of water crisis cases that generate sufficient social media data to make valid inferences, a scoping study was conducted to identify cases and trial keywords on Facebook and search engines. As Facebook is the most widely used social media platform both by end users and public audiences, difficulties in accessing Facebook data were circumvented by utilizing CrowdTangle, a platform provided by Facebook for research. Due to the global scale of the cases to avoid Eurocentric conclusions, multi-lingual data was collected that proved problematic for translation. Double verification of translations was conducted using two commercially available translation software packages to validate multi-lingual data.

Task 6.2: Warning (message) generation to the public (M6-M26) [Leader: CENTRIC]

The goal of this task is to provide a set of standardized warning messages to be generated for end users to disseminate to the public through their communication and alert channels. In this task, desk-based research was conducted to identify best practices in public warning dissemination. Alignment with the aqua3S ontology was conducted leading to the development of standardized language agnostic framework based on the Common Alert Protocol (CAP), which was identified to be the gold standard model for developing warning messages. Furthermore, the framework was developed to comply with the Directive on European Electronic Communications Code (EECC) coming into effect in June 2022 as well as the Body of European Regulators for Electronic Communications (BEREC) Guidelines. Finally, a questionnaire was developed to identify the methods and frameworks used by aqua3S' end users to identify common practices as part of the standardization of warnings as well as to advance the state of the art to this end.

The primary obstacle encountered in this task was the impact of Covid-19 on recruitment that led to the prioritization of effort to T6.1 during this period. Existing staff were allocated to assist in the development of the aqua3S standardized warning message framework and additional staff have now been hired to progress this task to completion in the next period. Next steps will be to conduct the questionnaire with end users to identify the current methods used for disseminating warnings to the public, develop standardized warning messages and translate them into the pilot country languages and develop the warning message generator.

Task 6.3: Deployment of first responders' solutions and mitigation actions(M12-M36) [Leader: LHA2]

This task's goal is to identify solutions and mitigation actions to be implemented by first responders in case of a crisis event affecting water supply network. The starting point will be the existing situation with vulnerability assessment of water resources and infrastructures into the pilot sites. The final plan will be based on existing solutions already available within pilot water utilities, as well as on the best practices found through literature review and on the extensive experience of first responder partners.

The work carried out in this task has been limited to starting the literature review (M12). Due to the Covid-19 pandemic, the commitment of task leader' staff in dealing with the emergency did not allow project activities in a constant way. The little time available was dedicated to the development of the first prototype for the PUC1. Starting from the end of April, LHA2 is expected to dedicate more time on the progress of this task. External staff is planned to be appointed in order to support the implementation of the activities, if necessary.

The plans for the upcoming period include: (i) identification of the existing situation with vulnerability assessment of water resources and infrastructure (M20); (ii) identification of existing first responders' solutions and mitigation plans for each pilot sites (M20); (iii) development of first responders' solution and mitigation plans for the pilot water utilities (M28); and (iv) development of the plan with guidelines for all relevant stakeholders (water users, emergency responders, law enforcement agencies, water utility staff, community leaders and local media) (M34).

4.6.2 Risks

No.	Description	Likelihood	Impact	Mitigation Measures
6.1	Low variation of cases that generate sufficient social media activity on public pages and groups on Facebook.	High	Low	Focus on water quantity and surface water quality issues that may have a higher degree of public attention.
6.2	Changes to Facebook ToU and platform interface limits types of data collected.	High	Mid	Use of Facebook's social media monitoring and research tool, CrowdTangle, to obtain data.
6.3	Covid-19 placing restrictions on institutional recruitment activities that impacted resourcing allocation to aqua3S.	High	Mid	Allocation of current staff to ongoing research and development activities.
6.4	Due to Covid-19 pandemic, reduced availability (or not available at all) of internal staff	High	Mid	Enrol external staff to support internal staff.

No.	Description	Likelihood	Impact	Mitigation Measures
	(emergency dept.) to develop project activities.			

Table 10. WP6 risk management

4.7 WP7 - System Integration

Leader	EVERIS	Contributors	CERTH, WBL, DRAXIS, CENTRIC, FZU, MIRS, AAWA, EYATH, UNEXE, AAA, BDI, 3S, ICCS, SOFYISKA, SVK, RCM, LHA2, USTUTT, EGM
Start month	1	End month	30
Objective	This WP aims a) To plan the technological roadmap; b) To specify the entire architecture of the platform; c) To define and implement the security framework, especially to face potential cyber-attacks; d) To proceed with the integration of the utilities, mechanisms and tools (developed in WP3-WP6) comprising the overall aqua3S platform; (e) To specify and develop really interactive user interfaces following a User-Centred approach.		

4.7.1 Tasks

Task 7.1: Technical requirements and platform development roadmap (M1-M8) [Leader: EVERIS]

This task was aimed at developing the aqua3S roadmap that should be followed by the involved technical partners, outlining functionalities to be developed and technologies to be used during the multiple iterations that this project will go through.

The aqua3S roadmap breaks down the aqua3S development in three increments (prototypes) with different time horizons. This approach ensures the feasibility of bringing together innovative technologies and allows for flexibility in terms of introducing new functionalities based on the needs of the different end users. The results themselves of these iterations serve as a validation towards this chosen methodology.

The first prototype's focus was the development of the initial backbone of the platform and demonstration of capability to collect and provide sensors and sensor measurement information in the correct manner (D7.3). The proof of communication and interoperability in this initial stage of the project also serves to minimize the apparent risk of integrating future functionalities and technologies.

The second and third prototypes are long term actions. The objectives of the second prototype are to develop and demonstrate the next evolution of the platform's capabilities, brought together by the different technical partners. Constructing upon the confidence built from the previous stage but also allowing for further validation and for flexibility of evolution where needed (D7.5).

The final aqua3S system (D7.7) will be built on top of what has been developed before. It integrates the final changes and developments of the different modules, maximising the value that the end users will be able to gain from the platform.

Task 7.2: System architecture development and security requirements (M1-M12) [Leader: EVERIS]

This task's main focus was to reach a consensus on the technical requirements and technical architecture of the aqua3S platform prototype, by all involved technical partners. The developed

architecture (D7.2) provides a set of principles and sets out a long-term vision to guide the development and evolution of the aqua3S platform through its 3 iteration phases (prototypes).

Particular mention should be made of NGSI-LD and Orion Context Broker which were used in the aqua3S platform. The information architecture is based on the NGSI-LD Information Model as well as a number of data models in the water domain that were already designed in compliance with the NGSI-LD Information Model. The envisioned approach is to keep the data model as simple and concise as possible and expect to extend it during the architecture delivery iterations. The Orion Context Broker plays the role of a "data hub" and provides actual information about all entities and their attributes (sensor location, measurement, water network equipment, etc.) via NGSI LD API. This Restful API enables the performance of updates, queries or subscription to changes of the information.

Of special focus were also the security capabilities of the aqua3S platform in order to ensure secure platform connections, secure exchange, and storage of information in order to face potential cyber-attacks. In this context NIST Security controls (National Institute of Standards and Technology, 2018) have been identified as applicable to the current aqua3S architecture. NIST Special Publication 800-53 provides a catalogue of security and privacy controls for information systems. Specifically, for aqua3S, the analysis was focused on user security, data security, network security, and monitoring.

Task 7.3: System security (cyber security) (M6-M28) [Leader: EVERIS]

This task aims to define and implement a security framework to offer the ability to prevent, detect, and respond to cyber-attacks. During the development of T7.3, the D7.4 has been finished and delivered.

The security framework for aqua3s platform evaluation, has been defined based on the NIST standards (NIST SP 800-53 controls), the NIS Directive and the GDPR. This framework focus on security (user security, data security, network security and monitoring of activity) and also defines some "friendly compliance" mechanisms based on industry common practices in order to ensure security in the aqua3s platform which cover the prevention, detection, response and recovery phases.

The next step in the progress of T7.3 is the development of D7.6. The deliverable covers the evaluation of aqua3s platform based on the framework already defined and the description of evaluation results and recommendations.

Task 7.4: System integration (M5-M30) [Leader: EVERIS]

This task's goal is the preparation of an integration plan for each prototype that will guide the integration of the different technical components. The technical partners will propose a clear definition of the common data model, information exchange protocols and the components interfaces to ensure the harmonised data flow through all the components of the aqua3S platform.

The actions so far relating to this task have been centered on the completion of the 1st and the beginning of the 2nd aqua3S prototypes. The first deliverable within the context of T7.4 is D7.3 - 1st Prototype of the aqua3S System which serves to explain to the end-users and anyone assessing this pilot the process of its deployment, the goals of this stage of the platform and the criteria adopted within that will be used to judge whether these goals have been completed. The deliverable further breaks down the solutions architecture as defined in D7.2 by examining the inputs and outputs of each technical layer and module involved and how the data is passed between them. Due to the working complication which arose from the global Covid-19 pandemic, it was not possible to integrate this pilot in the previously specified pilot sites. Therefore, a distributed environment was proposed, which will allowed all technical partners to contribute remotely to the project. As a result of this, historical and artificial or simulation data was used to compensate for the lack of direct access.

The next deliverable that was produced as part of this task is D7.4 - System security v1 which outlined a general security strategy relying on the well-defined NIST Cybersecurity standards (National Institute of Standards and Technology, 2018), NIS Directive (European Parliament, 2016) and the GDPR (The European Parliament and of the Council of the European Union, 2016). The goal of this deliverable is to adapt these standards to aqua3S, in order to guarantee a minimum acceptable IT security baseline and defining the set of requirements that will be used to evaluate the different prototypes.

Currently, effort is concentrated in the creation of D7.5 2nd Prototype of aqua3S System which will build upon D7.3 by providing additional functionalities and which is expected to use real world data as provided, when deployed, on the planned end-user premises.

Task 7.5: Interactive User Interface (M7-M30) [Leader: DRAXIS]

The goal of this task is to provide the presentation layer of the aqua3S platform which allows the users to have access to the information and to interact with components developed by the various modules of aqua3S. The first step towards designing and developing the 1st version of the UI was to analyze the user requirements and then collect information for the modules providing visualizations to understand the requirements of the UI in order to facilitate these modules. Wireframes and a sitemap were created, which then turned into mockups that were validated with the end users. The UI for the 1st prototype was developed and tested during the tabletop exercises and an issue tracking system was set up to gather feedback. In order to design the UI for the 2nd prototype and address the user needs, a thorough process to gather visualizations requirements was organized and implemented with the participation of the majority of the partners and the results were discussed in a multi-part workshop. One of the outcomes of this process was the detailed mapping of the user roles for the pilot cases, which was used to set up the selected user identity management system. In addition to the visual theme prepared for the 1st prototype, visual examples for graphical components were created and shared.

Two difficulties were encountered so far, the first one being the integration of technical components developed by different teams with -possibly- incompatible technical approaches into the user interface. The technical approach of the UI was selected accordingly in order to accommodate this particular need. The second obstacle that was overcome revolves around the users' difficulty to conceptualize the UI based on theoretical discussion, to provide ideas and requirements before its implementation. With the assistance of other technical partners, visual examples were presented to facilitate the process and get the desired result in order to address as best as possible the users' needs. The main achievements include the creation of a visual theme for the UI to ensure uniformity, the development of the UI for the 1st prototype, arranging an issue tracking and feedback collection system for the 1st prototype, completing the extensive visualizations requirements process for the 2nd prototype and the user roles definition.

4.7.2 Risks

No.	Description	Likelihood	Impact	Mitigation Measures
7.1	Interactive user interface is not intuitive enough	Mid	Mid	Continuous communication with the end users and iterative visualization requirements process will ensure that the UI is easy to use.
7.2	Interactive user interface is not tested on time to implement	Low	High	After each prototype the interface is tested by the users

No.	Description	Likelihood	Impact	Mitigation Measures
	fixes and changes in the predicted timeline			with the tabletop exercises so we are confident we will receive feedback on time. To ascertain this, an issue tracking system is set up specifically for this reason.
7.3	Postponement of the 2nd prototype on premise demonstration due to Covid-19 Pandemic	Mid	High	A continuous communication to provide a back-up plan and other adjustments in case restrictions due to Covid-19 should be setup
7.4	Delay in component or functionality to be on a critical path of not being ready on time	Low	High	Monitoring of the progress for each of the components. Having back-up plans in case any delay of any critical component or critical functionality
7.5	Insufficient time for testing - components are not functioning properly during the PUCs demonstration	Mid	Mid	Enough time have to be allocated for testing in the preparation phase. A backup plan should be also developed with using a dummy data for at least presenting other components which are depending on a component that do not function properly
7.6	Lack of Security Requirements	Low	High	Using the NIST standard as a default security standard
7.7	The security requirements may have considerable impact on the 2nd prototype scope and the solution architecture	Low	Mid	Engaging security experts for working further on the security requirements analysis and security architecture design
7.8	Inability to reach pilot testing sites and deploy aqua3S components on end-user premises (sensor installation)	Mid	Mid	Using dummy data to simulate real-life environment
7.9	Abnormal consumption of memory and not updating the context for specific attributes	Mid	Mid	Temporary solutions were developed to fix the issues. Orion Context Broker will be tested as soon as the new version is published

4.8 WP8 - Pilot implementation, evaluation and training

Leader	AAA	Contributors	VVQ, WBL, MIRS, AAWA, EYATH, BDI, 3S, SOFYISKA, TRI, SVK, RCM, LHA2
Start month	6	End month	36
Objective	The objective of this WP is firstly to manage all preparatory actions for actual implementation of the pilot use cases; secondly describe the application-specific and comprehensive validation framework of aqua3S workflow and platform and finally present the end-users training processes.		

4.8.1 Tasks

Task 8.1: Development of the validation scenario and evaluation methodology (M6-M36) [Leader: AAA]

This task's goal is to carry on all the preparatory steps in order to perform the real time demonstration of the aqua3S pilots. The preparatory phase of the implementation of the pilots, "step 0", requested the end users to identify the gaps (identify when exactly it occurs and the trial contest) to address relevant problems in the pilot in order to find a sociotechnical solution that bridges the gap (goal). Through these gaps, the end users defined the trial context, the research question and the data collection plan, to clearly define the trial objective(s) based on the guidelines provided by CERTH. A validation phase followed which relied on the scenarios/use cases and methodology developed in WP2, aiming at a comprehensive experimental pilot implementation and validation of aqua3S pilots.

With respect to this task, the process of data exchange between the end users was also finalised, with data sharing among AAA, SVK, Sofiyska and ICCS.

Within the context of pilot preparation and for the first tabletop exercise the selected Pilot Use Cases (PUC) that were tested were: PUC1, PUC6 and PUC7, including the following end users respectively: AAWA, AAA and LHA2 for PUC1, Sofiyska for PUC6 and SVK for PUC7. Each end user built a scenario, that depended on gaps, available practitioners (number, role within the organisation etc.), available facilities & equipment. The involved end users developed scenarios defining the participants, their role and the equipment used. The end users, starting from the inputs of trial context, gaps, research question and data collection plan, using the methods coming from trial guidance and management tools, whiteboard, sticky notes, trial action plan, portfolio of solutions, defined the output of the scenario script.

As the information related to the trial context (place, time and participants) had an impact on the formulation of the scenario the end users selected a specific line of action, based on the prerequisites. Specific situations were simulated in order to trigger the gaps, considering which roles were involved, which equipment had to be used and so forth. The scenarios were built considering a specific time plan, including a specified period where every action was planned. A clear identification of the gap was the first step to identify what kind of solution is needed. The outcomes of this task were described by AAA in the Deliverable 8.1: Pilot implementation and 1st prototype evaluation report, which reported the comparative analysis on the validation results of the 1st prototype.

For the next steps, with respect to the updated user requirements that were considered after the first tabletop exercise, considering the new functionalities that will be developed in the platform for the 2nd prototype, the end users will carry on all the activities in order to perform the new tests on the second prototype.

Task 8.2: Field demonstrations and testing (M10-M36) [Leader: AAA]

This task's goal is to test the aqua3s platform through the execution of exercises in which each scenario developed in WP2 will be simulated involving technical partners and end users. In particular, the system will be tested, by running simulations with well-established evaluation protocols during disasters affecting the drinking water supply networks and organised civil protections exercises for supporting drinking water supply risk management, disseminating the aqua3S technologies to the emergency response teams. Based on the results of the trials and evaluations it will be possible to compare the project technology with the current state of the art. Specifically, interviews and questionnaires will be carried out to identify subjective preferences of decision makers.

The end users involved in the simulation scenario envisaged by the First Prototype of the aqua3s platform (AAA-AAWA-LHA2 for Italy and SOFIYSKA-SVK for Bulgaria) completed the formulation scenario based on the guidelines provided by CERTH and related to some of the activities envisaged in WP7 for the First Prototype (Platform development and how to get data from end user's legacy systems). A dedicated questionnaire was developed and translated into the end users' native languages in order to be filled during the tabletop exercise. Prior to their involvement in the tabletop exercise, all participants (both directly involved in aqua3S and the ones joining the project only for the exercise) were requested to read the information sheet provided to them and sign the attached informed consent form. TRI had to evaluate the ethical issues related to the questionnaires. In this context, each partner appointed the participant from their organization, based on different parameters that had to be evaluated during the pilot. During the exercise the participants filled in the questionnaires, identifying user requirements achieved & satisfaction level, KPIs achieved & satisfaction level, system usability and exercise dimension.

The 1st prototype had an overall good evaluation and scenarios were considered realistic. Some minor concerns on the limited variety of functionalities provided were addressed by the fact that this was solely the first prototype of the system; therefore, the second prototype will be a significantly advanced version. The tabletop exercise was also very useful for the user partners, as it provided them with the opportunity to implement the user requirements and to check some other functionalities to be developed (e.g., visualization of historical data). In fact, after the exercise, a big process of UR review started among the partners.

Simultaneously, VVQ installed two online microbiological sensors and a fluorescence sensor in its premises in order to initiate a testing phase that will occur for several months. The use case design was further elaborated by continuing the in-depth assessment of several multi physico-chemical sensors available on the market. Three providers of multi physico-chemical sensors were finally identified for potential application in a distribution network. With one provider, the Modbus TCP/IP signal transmission was successfully tested for his sensor. As for WBL, the end user carried on the procurement procedures for the supply of 3 sets of water quality sensors (8 sensors per set), as well as the preparation works for the installation of the sensors at 3 WBL reservoirs.

Task 8.3: User training (M12-M36) [Leader: SVK]

This task's goal is to provide current and future aqua3S users with a detailed training manual and guidelines. Within the context of this task, an initial training preparation is being conducted including the following tasks:

- Assessing training needs: The first step in developing a training program is to identify and assess needs.
- Setting training objectives: The training needs assessments (organizational, task & individual) will identify any gaps in the current skill sets. These gaps should be analyzed, prioritized, and

turned into the organization's training objectives. The ultimate goal is to bridge the gap between current and desired performance through the development of a training program.

The next steps for the future include:

- **Creating training action plan**: The next step is to create a comprehensive action plan that includes learning theories, instructional design, content, materials and other training elements. Resources and training delivery methods should also be detailed. While developing the program, the level of training and participants' learning styles need to also be considered.
- **Implement training initiatives**: The implementation phase is where the training program comes to life. The training program is then officially launched, promoted and conducted. During training, participant progress should be monitored to ensure that the program is effective.
- **Optional**: Program implementation should consider engagement and learning KPI goals, as well as thoroughly planning the scheduling of training activities and any related resources
- **Evaluate and revise training**: The training program should be continually monitored. In the end, the entire program should be evaluated to determine if it was successful and met training objectives. Feedback should be obtained from all stakeholders to determine program and instructor effectiveness, plus knowledge or skill acquisition.

4.8.2 Risks

No.	Description	Likelihood	Impact	Mitigation Measures
8.1	Difficulty, for VVQ, to find one supplier providing all foreseen sensors. Several suppliers will have to be associated with their potential specific constrains	High	Mid	Limit the number to 2 or 3 suppliers
8.2	Installation of the sensors at three, easily accessible buildings within the unstable Covid-19 context which prevents regular access to external buildings	Mid	Mid	Installation of the sensor at three of VVQ's buildings
8.3	Due to Covid-19, unavailability of Emergency Dept and first responders' staff for the "on field" demonstration may occur for LHA2	High	Low	Alternative options (including remote participation) for the demonstration of the 2nd prototype
8.4	Cultural differences	Mid	Mid	Taking into account the potential learning audience, and developing resources that are not only multilingual, but also multicultural. Also, considering the method of delivery: some cultures benefit more from collaborative group training

No.	Description	Likelihood	Impact	Mitigation Measures
				sessions, while others favor an individual approach
8.5	Different generations of users	Low	Low	Even though younger generations will be the ones to mostly use the aqua3S platform, older users should also be considered when it comes to online Learning and Development.
8.6	Engaging with training online	Low	Low	Constant interaction with end users to be trained on the aqua3S platform in order to ensure their engagement in the process. Online training is a possible choice, taking into consideration that travelling restrictions could hurdle physical meetings and classes.
8.7	Missing or inaccurate feedback from users, leading to false description of the process in the manual and further confusion.	Low	High	Regular end user Telcos focused on the training manual and what would the users like to have at hand. Support from the coordinator as well as other end user partners.
8.8	Missed alarms for potential risks and lack of adequate action which can lead to a crisis due to lack of training with the aqua3S platform	Low	High	Providing training for all end users and user manual available for all.

Table 11. WP8 risk management

4.9 WP9 - Policies, Information Management & Standardisation

Leader	EGM	Contributors	WBL, AAWA, EYATH, AAA, BDI, SOFYISKA, EVERIS, WE, TRI, SVK, RCM, LHA2
Start month	1	End month	36
Objective	The goals of the WP9 are summarized to: a) Identify and explore the current legal framework and relevant standards related to water security and management; b) Develop policy recommendation to improve water security and management; c) Identify the issues with the existing water security standards; d) Identify the political and societal environment in which policy should be implemented; e) Ensure ethics, legal, and societal impacts are brought into prestandardisation assessment		

	processes; f) Develop guidance for the development and implementation of future of water security standards.

4.9.1 Tasks

Task 9.1: Policy framework and Information Management (M1-M36) [Leader: AAWA]

The objective of this task is to explore the current and proposed European legal framework regulating water security to understand the policy requirements that need to be set in place to fully implement the aqua3S innovative technologies.

The activities carried out started with an analysis of the international regulation to clarify the extension concept of 'water security' and its official definition established by the United Nation in 2013. Then, analysis of the most relevant EU regulations related to water security was performed; this analysis was also extended to include some relevant initiatives and outcomes that, even if they are not currently part of the European laws, they are affecting (or can potentially affect) future EU regulation, as well as the ongoing revision of certain directives. Following this step, the work focused on conducting research with key stakeholders to detect existing criticism and issues with the water security legislative environment and identify the political environment for new legislation in this field. This includes an analysis of the political interest in new legislation and the extent to which existing regulation is outdated; considering the current situation and the ongoing pandemic, the best way to perform this research was identified through a survey in the form of an online questionnaire (google form). As final step, the outcomes of these two activities led to a summary of the Policy recommendations presented in D9.1 (submitted at M18)

The future steps will focus of disseminating these results, taking advantage also of the dedicated aqua3S channels. For example, these outcomes were presented in the Standardization Workshop hosted by aqua3S within the context of Water Knowledge Europe 2021 Spring Edition event.

Task 9.2: Standardisation, strategy and policy-making (M1-M36) [Leader: EGM]

This task goal is to identify the current and relevant standards being used by water security authorities, industry, policy makers, health care, and civil protection across the European Union and to identify gaps from Market stakeholders needs.

During the first period, two parallel standardization tracks were the focal point of the conducted work:

- Issues and gaps for standardization in digital water: ICT4Water and Digital Water groups collaborations were established in order to further progress, discuss, enrich and promote aqua3S' data models (e.g., saref4water) and architecture for ICT water network (e.g., with FIWARE architecture and NGSI-LD standards)
- Issues and gaps for water security especially while taking into serious account the rapid development of ICT technologies (e.g., drones, sensors). Key standards were identified with an important focus on EN 15975 standards (security of drinking water – guidelines for risk and crisis management) developed under CEN TC 164. Important and active liaisons with CEN TC 164 and TC 230 and TC 318 were initiated. Additionally, communication with key players in the marketplace and industry associations was also sought after, with the organization of a dedicated webinar for the collection of feedback from the market.

Some issues that were identified and will be addressed through the upcoming period are mainly related to the low level of details in the standards which might prevent EU harmonization of better practices. Additionally, some challenges in regard with some contradictory forces were also identified; more

specifically, smaller-scale stakeholders seem to be in need of further assistance on the standardization aspect of water security requesting more detailed guidelines and standards while large-scale stakeholders appear to not be in favor of such detailed documents in order to maintain their advantage and competition.

In the coming period, attention will be paid on the liaison with CEN committees that will assist the consortium with getting a clear grasp of the whole marketplace. Policies and new directives will also be a guiding force in the strategic planning of the project's upcoming actions on standardization.

Task 9.3: Guidance for responsible applications of water security standards and policy (M1-M36) [Leader: TRI]

This task's goal is to conduct a pre-standardisation impact assessment and develop guidance to responsible impact from and applications of any proposed standards or policy to assess their impact is inclusive and offers whole-society resilience. In doing so, TRI has conducted a literature review and research of the considerations necessary to identify whole-society resilience, and identify where the standardization process may interact with these issues. Additionally, interviews were conducted with project partners to identify where standards may help to support their efforts. Moreover, project partners consulted with experts in water security to areas of interest for D9.3. The research conducted to date has also acted to inform the current work on other WP9 tasks, including the development of Policy framework and Information Management questionnaires, and the Water Security Standardisation Strategy.

Building on the standardisation assessment frameworks developed in previous crisis related projects such as ResiStand, initial work has been conducted on the Guidance for responsible applications of water security standards and policy (D9.3), which will be iteratively developed and finalised for M36).

4.9.2 Risks

No.	Description	Likelihood	Impact	Mitigation Measures
9.1	Current situation in Europe due to the Covid-19 emergency could limit the number of in person event to present the results of T9.1	High	Low	Present the outcomes of the pilot trough remote events and digital channels
9.2	Difficulties to get small-scale stakeholders' views when larger-scale stakeholders set the scene	High	High	Market driven events will be maximised by inviting all players to present the issues and get opinions
9.3	Reluctance to influence players in standardisation to make changes	High	High	These issues should be raised publicly and be dealt with at regulatory level to present the important issues that must be addressed

Table 12. WP9 risk management

4.10 WP10 - Impact Creation, Dissemination and Exploitation

Leader	WE	Contributors	CERTH, VVQ, WBL, DRAXIS, CENTRIC, FZU, MIRS, AAWA, EYATH, UNEXE, AAA, BDI, 3S, ICCS, SOFYISKA, EVERIS, TRI, SVK, RCM, LHA2, USTUTT, EGM
Start month	1	End month	36
Objective	This WP is dedicated to the communication and dissemination of aqua3S project.		

4.10.1 Tasks

Task 10.1: Communication and dissemination actions (M1-M36) [Leader: WE]

This task's goal is to develop together with all partners a whole set of communication and dissemination actions, tailored to the needs of aqua3S stakeholders, with the aim to maximise the visibility of the project.

During the reporting period, Water Europe, the WP10 leader took care of updating the website with news and events relevant for the aqua3S network. Also, Water Europe has been updating the social media channels of the project, Twitter and LinkedIn, on a weekly basis with news related to aqua3S partners, but also general news and information related to the project's topic. aqua3S twitter account gained 21.800 impressions during the months of the reporting period and LinkedIn page an average of 952 impressions on a monthly basis and an engagement rate of 7.35 (as presented in the figures below). The performance of the aqua3S social media accounts is particularly increased during the days that news about aqua3S meetings or new project results are disseminated to the followers. At the same time, Water Europe developed three different types of promotional materials: an academic poster and a poster for business-oriented audiences, as well as a brochure on the aqua3S prototype testing that aqua3S partners can use either in print or digital form in their communication and dissemination activities. Furthermore, Water Europe prepared a newsletter template and developed the content for the first aqua3S newsletter which was disseminated to a broad list of EU stakeholders in autumn 2020. Last but not least, Water Europe has established and initiated communications reporting processes with a monthly reporting form sent to partners the first week of the month so that their activities are captured and can be used either for reporting or for dissemination purposes through the aqua3S channels.

The next steps of this task include the preparation and publishing of the first aqua3S video, the maintenance and update of the website and social media channels, as well as the continuation of the communications reporting processes.

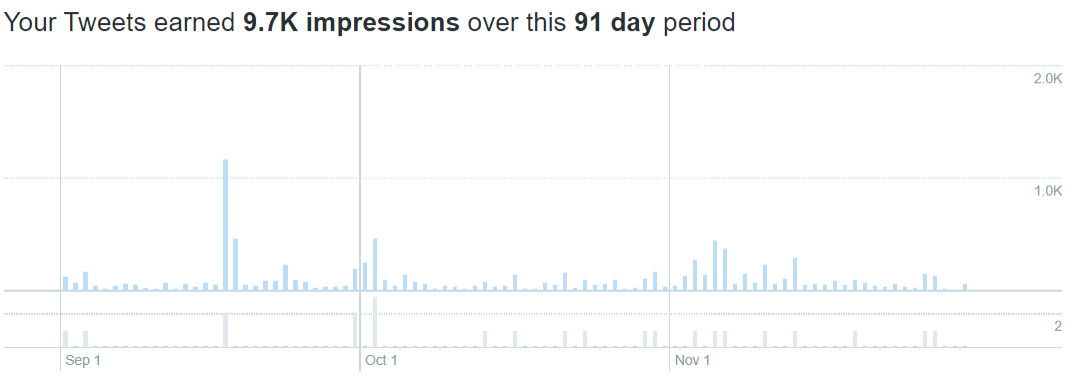

Figure 2. Impressions from September to November 2020

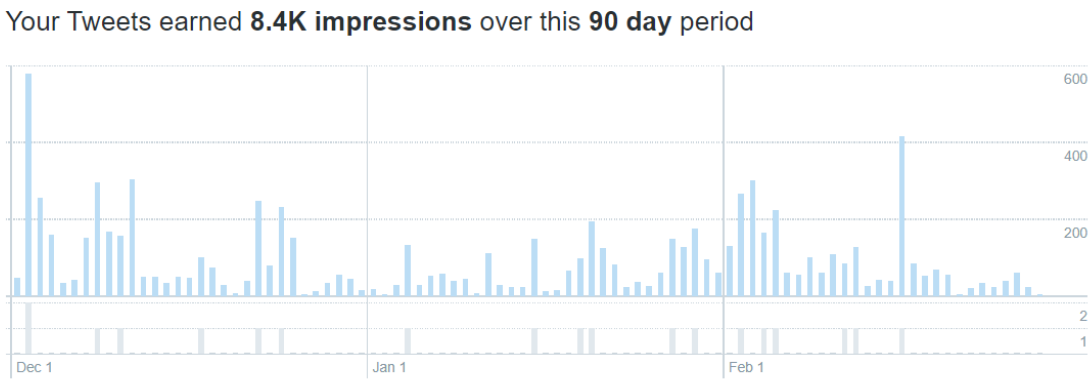

Figure 3. Impressions from December to February 2021

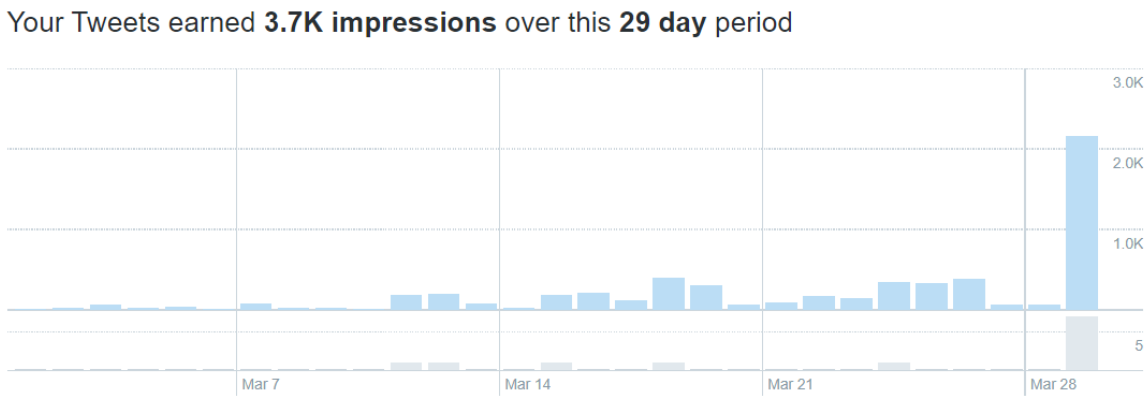

Figure 4. Impressions from March 2021

Company	Total followers	New followers	Number of updates	Engagement rate
aqua3S Your company	151	54	40	7.35%

Figure 5. LinkedIn statistics from end of September to end of March 2021

Task 10.2: Networking activities (M1-M36) [Leader: WE]

This task's goal is to raise awareness and maximize the dissemination of the project's activities and outputs.

During the reporting period, aqua3S partners have disseminated about the aqua3S project through several occasions. Due to the Covid-19 pandemic, though, the networking activities of this period have been all taken place strictly through digital means. Below, you can find a table with some of the reported networking actions of aqua3S partners.

Event	Date	Partner Contributing
2nd Balkan Forum, Thessaloniki	25-26/09/20	EYATH
Green Cities	30/09/2020 - 01/10/2020	EGM
International defence equipment and services exhibition-HEMUS 2020	30/09/2020-03/10/2020	BDI
International Scientific Conference HEMUS 2020	1/10/2020	BDI
3rd Athex Mid Cap	15/10/2020	EYATH
CF SEDSS III conference	27-28/10/2020	BDI
Hellenic-German Round Table and Digital Visit of EYATH SA treatment plants	18/11/2020	EYATH
EO for Water Cycle Science 2020	16-19/11/2020	CERTH
Nicosia Risk Forum 2020	26/11/2020	CERTH
Workshop on e-mobility by HCAP	11/12/2020	EYATH
Digital Water 2020-TF2 Sensors and demonstration	16/12/2020	ICCS
Synergies of H2020 Digital water projects workshop	20/01/2021	CERTH
British Water Real Time Monitoring Focus Group	04/02/2021	CERTH
Webinar on data models	03/03/2021	CERTH
CERIS event on Sendai FWA	10/03/2021	CERTH
Market needs on Water security standardisation	29/03/2021	CERTH

Table 13. Networking activities

Task 10.3: Market analysis, industrial requirements and business models(M3-M20) [Leader: DRAXIS]

The goal of the task is to identify the market that aqua3S belongs to and to analyse the various parameters that will affect its' positioning in that market.

The current and future market size, the rate of growth, the drivers and barriers for entering the market, the political, economic, social, technological, environmental and legal macro forces that shape the specific domain, the competitors' landscape, the potential customers and the potential markets for further expansion, are some of the parameters that were included in the first version of the market analysis. The updated version re-visit most of the above and added on top of that with the main aim being to take advantage of those information and details in the exploitation plan. Understanding the

competition and the ways in which the specific market already operates helped in shaping the business models that seem to be more viable for aqua3S.

The main difficulty that was encountered was the low availability of data in respect to the water safety and security domain. Due to that fact the wider smart water management domain was investigated thoroughly. The main achievement was the development of the 1st Market Analysis Deliverable and its updated version.

Task 10.4: Exploitation plan and Intellectual Property (IP) protection for the proposed solutions (M3-M36) [Leader: DRAXIS]

The goal of the task is to identify the Intellectual Property Rights for the solutions developed within aqua3S project, which is the groundwork for the identification of possible exploitation pathways that can be followed and the development of a business plan.

To identify the IPRs the team documented all **commercially exploitable** and **exploitable components**. The first ones are components that have a direct exploitation market (i.e., the aqua3S user interface), while the second ones are components that contribute towards the development of the aqua3S project (i.e., aqua3S logo), but do not have a direct market exploitation. Both categories of components were added in the IPR supporting document, where partners were requested to provide their input by claiming the "**Exploitation Responsibilities**" and the "**Exploitation Rights**" that they saw fit for their respective organisations. The **responsibilities** of a component, solution, tool, etc. are closely connected with the ownership rights since the one to develop the tool is the one to sustain it, while the **rights** have to do with the willingness to exploit the results of aqua3S after the lifetime of the project by any of the partners. The outcomes of the supporting document with the input from the partners were used to achieve three goals: i) to develop the first IPR plan; ii) to identify any conflicts between partners and address them accordingly; and iii) to provide input for the exploitation plan.

Using the market analysis and the IPR as the foundation the team worked towards identifying the three alternative business models that could be used for the aqua3S solution and under each of those models the different exploitation pathways that can be adopted. An initial marketing and financial plans are also included in the document. As in the case of the IPR the exploitation plan deliverable is an initial version and it will be updated towards the end of the project, based on the progress done.

The main difficulty accounted for the specific task was the clarification and separation of the meanings of "**Exploitation Responsibilities**" and the "**Exploitation Rights**", which led to some minor conflicts, which were easily resolved. Under many circumstances it was misunderstood what ownership and exploitation means, which was nevertheless resolved either with partners separately or in common calls as well. The main achievement is the development of the first versions of the IPR and the Exploitation Plan respectively for aqua3S project.

4.10.2 Risks

No.	Description	Likelihood	Impact	Mitigation Measures
10.1	Confrontation among partners for IPR issues	Mid	High	The technical approach for aqua3S has been carefully discussed among partners during the proposal phase. Furthermore, the signature of the CA also acts as a mitigation

No.	Description	Likelihood	Impact	Mitigation Measures
				measure, while finally open communication and discussion amongst partners can help in resolving any issues that may arise.
10.2	Partners are unable to agree on the exploitation pathways	Mid	High	The exploitation pathways are closely linked with the IPR issues. Although background rights have been identified in the CA there may still be issues with the foreground and hence with the exploitation pathways. Partners are rather experienced, so the although the possibility exists and it can be of great impact, it does not seem that it will be an issue at this point
10.3	Low visits to the website	Mid	Low	With the monitoring forms, we aim to avoid this risk but in case this happens, partners will be requested to contributing with articles on a rotating monthly basis
10.4	People's limitation to participate into physical meetings due to Covid-19	Mid	Mid	Promotion of digital and hybrid events

Table 14. WP10 risk management

4.11 WP11 - Ethics requirements

Leader	CERTH	Contributors	-
Start month	1	End month	36
Objective	This WP's objective is to ensure compliance with the set-out 'ethics requirements'.		

4.11.1 Tasks

This work package set out a number of deliverables covering a number of specific 'ethics requirements' addressing data protection, health and safety procedures and research ethics. From M1-M6, project partners engaged in conversations to highlight the importance of ethics requirements throughout the project, for instance at the Kickoff Meeting and subsequent end user and technical telcos. Following this, project partners participated in extensive efforts to gather the necessary information to complete the 11 ethics requirements deliverables, as well as preparing the information sheets, consent forms and anonymity protocols that underline the project. Research has been conducted on an array of

considerations, including the impacts on privacy resulting from the use of social media crawlers and drones through the review of legislation and legal commentary, groups that are particularly vulnerable to water insecurity (through the review of academic and international humanitarian agencies/committees such as the UN Office for the Coordination of Humanitarian Affairs and the Committee on Economic, Social and Cultural Rights). Following the collection of information from project partners including opinions from ethics boards where appropriate, the deliverables were provided in M6. The resultant deliverables (including the anonymity protocol, information sheets, and consent forms) are available for the consortium to inform their subsequent practice and TRI have acted as an internal project touchpoint for project partners to provide guidance and recommendations where requested.

The finalised deliverables including procedures for identifying/recruiting research participants, informed consent procedures, and the statements on how the principle of data minimisation will be met are grounded on the principles of:

- Lawfulness, fairness and transparency.
- Purpose limitation.
- Data minimisation.
- Accuracy.
- Storage limitation.
- Integrity and confidentiality (security)
- Accountability.

Additionally, these deliverables were also designed to adhere to protect the rights and privacy of participants and the public at large.

4.11.2 Risks

No.	Description	Likelihood	Impact	Mitigation Measures
11.1	Violation of data privacy	Mid	High	Partners that will be directly involved in each of the demonstrations will pseudonymised the data before sharing with the rest of the consortium. Additionally, the participant will be notified about the impact the research may have on their personal data before commencement of any relevant work and via the informed consent form and information sheet. Deletion of data that do not add to the research or are out of scope after the completion of the demo/operational test.
11.2	Data breach	Low	Mid	All data are processed in safe servers in the premises of the

No.	Description	Likelihood	Impact	Mitigation Measures
				involved partners and in case of hard copies of sensitive data (e.g., informed consent forms), they are going to be stored in the secure, locked containers in the premises of the partners.

Table 15. WP11 risk management

5. Conclusion

Overall, progress is reported in all WPs with some tasks being finalized and some tasks being currently in progress. The project is considered to be on a good track taking into account that is only half-way through its duration. During the first 20 months of the project, a lot of effort has been spent on the setting up of the project, the establishment of the finalized list of the user requirements and pilot use cases as well as the development, testing and evaluation of the 1st prototype of the system which can be considered successful and is currently used as a baseline for the development of the two more prototypes to follow.

Additionally, significant effort is identified in the customization of the sensors to be used for the data collection and the pilots' implementation as well as the development of the crisis classification module that is going to be incorporated into the current version of aqua3S platform's user interface and will provide the users with a complete situational awareness picture in order to assist them with their decision-making processes. Moreover, communication with citizens and the use of social media is high on the project's agenda as it has proven to be an effective way to communicate warning messages to the wider public due to their usage rate among citizens.

Covid-19 has hindered some of the set plans according to the Description of Action and more specifically, it has posed some delays to the delivery and installation of the required sensors that were to be installed in the pilots' site. These sensors would have provided the respective WPs with data needed in order to customize the RI (refractive index) and MIR (ammonia) sensors and could be used for the successful integration of these sensors to the 2nd prototype of the system. As an alternative, historical data has been used to this point and will be further complemented with real data when the sensors are delivered and installed in the pilots' sites (for the 3rd prototype). Finally, the pandemic has also hindered the involvement of the first responders' organization as their resources have been allocated to the handling of Covid-19; therefore, more progress on this is expected to take place within the following reporting period.

Conclusively, 2 milestones (MS1 and MS2) can be considered completely achieved; 1 milestone (MS3) can be considered as partially achieved since deliverable D7.5 on the second prototype of the system could not be delivered this month (M20) due to the aforementioned; and 2 milestones (MS4 and MS5) are to be achieved within the following reporting period. 39 deliverables have been submitted so far with the successful collaboration among the project's partners and 30 more are pending.