aqua3S

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Enhancing Standardisation strategies to integrate innovative technologies for Safety and Security in existing water networks

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Centre for Research and Technology Hellas

- Located outside Thessaloniki, Greece
  - Five Institutes (**Informatics,** Chemistry, Biology, Transportation)
  - Founded in 2000
  - > 700 researchers and collaborators
  - 1200 research projects
  - 1100 partners
- Annual Turn over ~ € 25M:
  - 30% Industry contracts
  - 60% Research projects
  - 10% State contribution

MKLab - Research Projects & Papers

- Personnel: ~ 80 researchers, post docs, research assistants, developers
- Research Projects
  - Horizon 2020
    - 18 running H2020 projects
      - Coordinating: MindSpaces, V4Design, beAWARE, CUTLER, MOVING
      - Technical/Scientific Mgt: EOPEN, MIICT, CONNEXIONs
      - TENSOR, ROBORDER, ACTIVAGE, PROPHETS, SUITCEYES, SODALITE, DIH^2 , FuturePulse
    - 10 completed H2020 projects
      - InVID (CO), ChainReact (CO), hackAIR, PROFIT, MAMEM, Envisage
      - FP7
    - MULTISENSOR (CO), SocialSensor (CO), WeKnowIt (CO), i-Treasures, PERICLES, REVEAL, USEMP
  - COST actions
    - iV&L Net, MULTIFORESEE
    - National projects
      - 8 running projects
    - Papers
      - 150 Journal publications
      - 500+ conference publications
      - 50 book chapters
      - 10 patents

aqua3S

- **Call:** H2020-SU-SEC-2018
- **Type of Action:** IA
- **Acronym:** aqua3S

Enhancing **S**tandardisation strategies to integrate innovative technologies for **S**afety and **S**ecurity in existing water networks

- **Duration:** 36 months
- **Start Date:** 01 Sep 2019
- **Estimated Project Cost:**€6,853,608.75

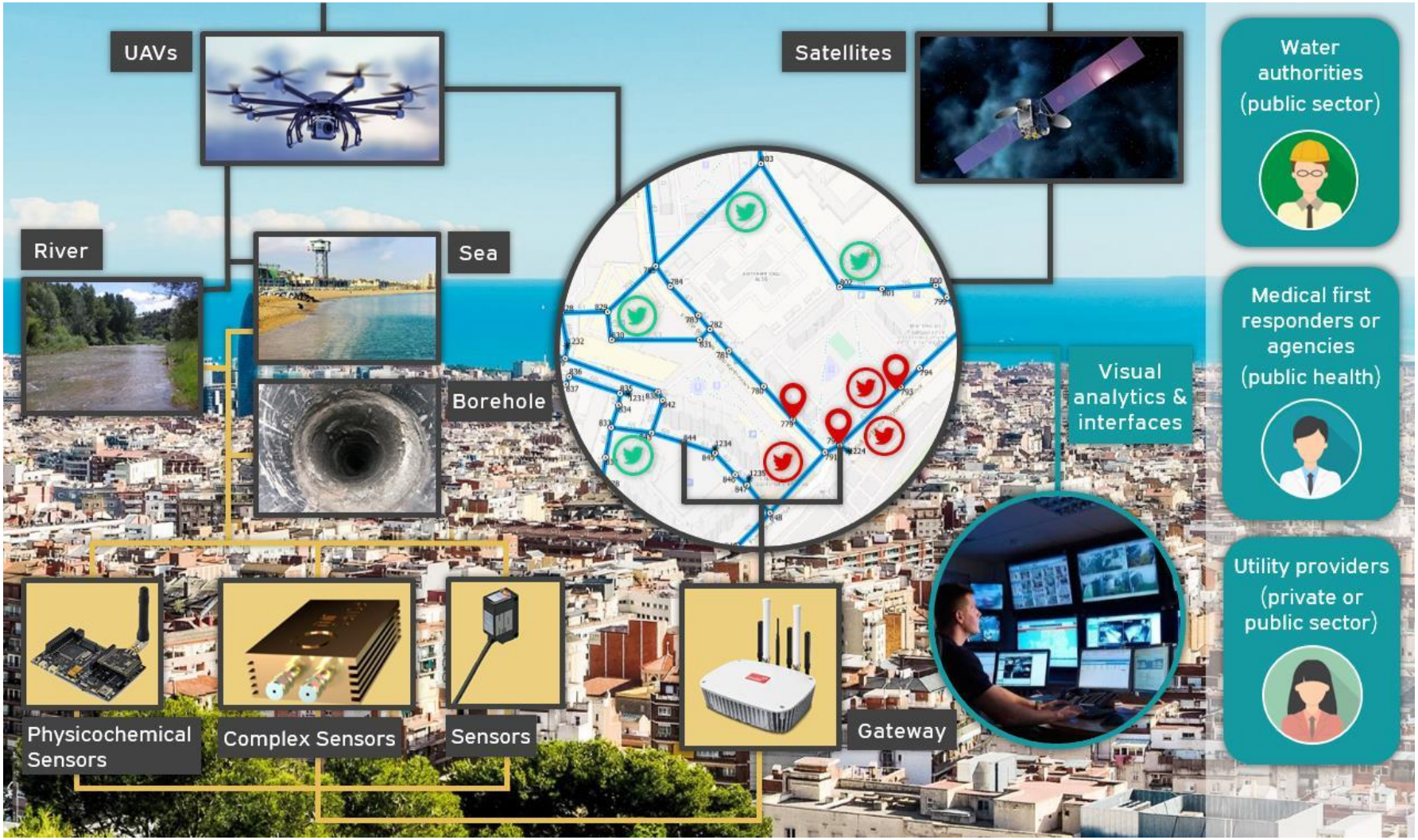
Challenge

- **Exposure** of citizens to potential disasters has led to vulnerable societies that require risk reduction measures
- **Drinking water** is one main source of risk when its safety and security is not ensured
- Although there have been proposed **several technologies** for the analysis of drinking water, there is a gap on how we could **integrate** them in the existing water safety networks
- In order to feel this gap **aqua3S** combines **novel technologies** in water safety and security, aiming to **standardise** existing sensor technologies complemented by **state-of-the-art detection mechanisms**

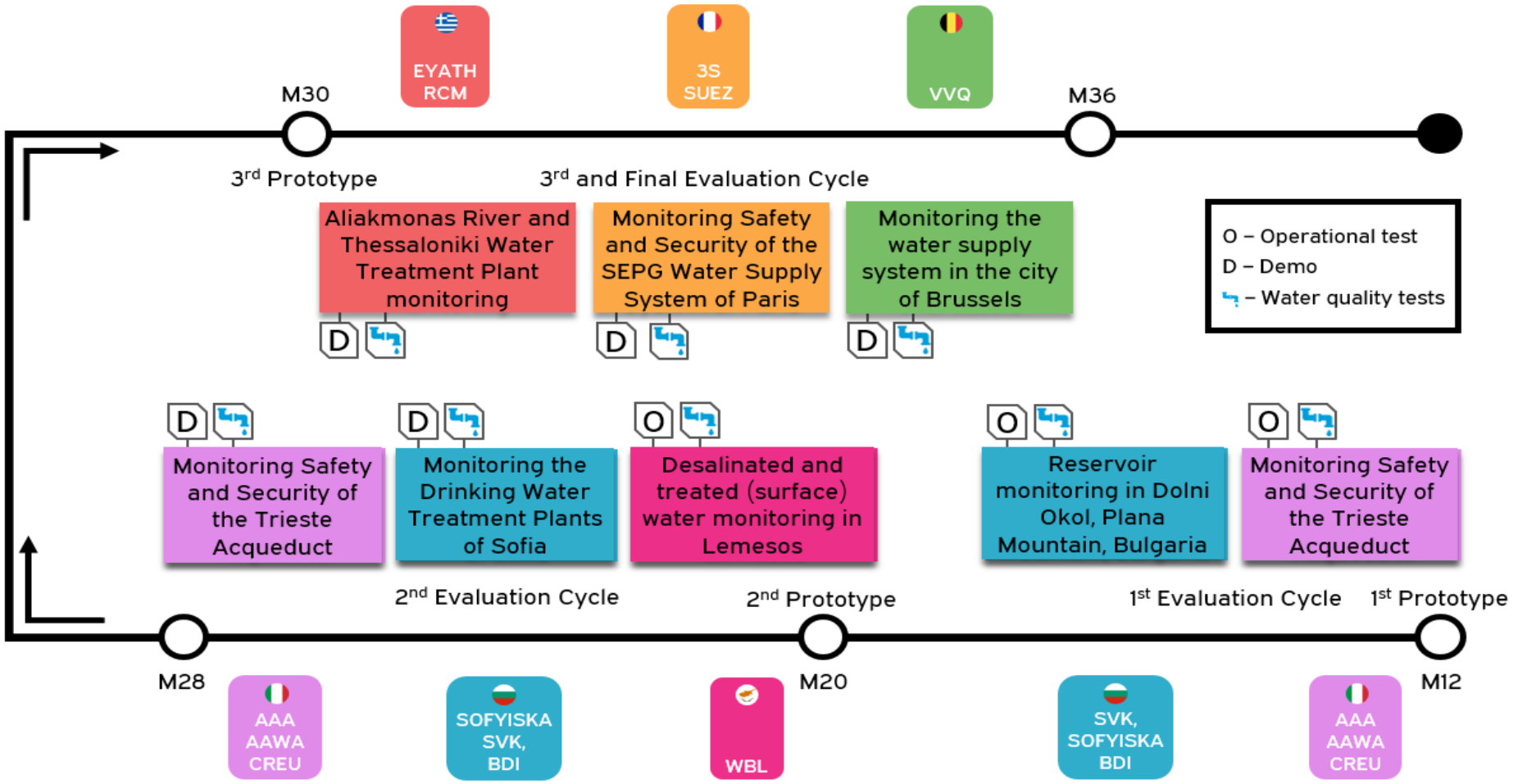
Concept

- aqua3S integrates a series of state-of-the-art technological achievements from multidisciplinary fields, namely of the era of **sensors technology, IoT, semantic reasoning, high-level analytics, decision support systems, crisis management** and **situational awareness** focusing on water sector
- The orchestrated aqua3S system will consist of
  - (a) a combination of high precision key point **spectroscopic sensors** and widely spread **refractive index sensors** deployed at fixed points throughout existing water distribution network of a district of interest,
  - (b) **air quality networks** complemented by a fleet of **unmanned UAV, IoT and satellite** images as part of an interoperable modalities to detect, assess, evaluate and locate harmful substances within existing utility water networks.
- The data obtained from aqua3S' sensor networks and those from the existing infrastructure of the utility networks themselves will be processed by the innovative threat detection algorithms and high-level multimodal **fusion techniques**
- Practitioners from water, medical sector, first responders and utility providers will be enabled to employ the aqua3S's **Early Warning** and **Decision Support System**

Concept


UAVs
Satellites
River
Sea
Borehole
Visual analytics & interfaces
Water authorities (public sector)
Medical first responders or agencies (public health)
Utility providers (private or public sector)
Physicochemical Sensors
Complex Sensors
Sensors
Gateway

Concept

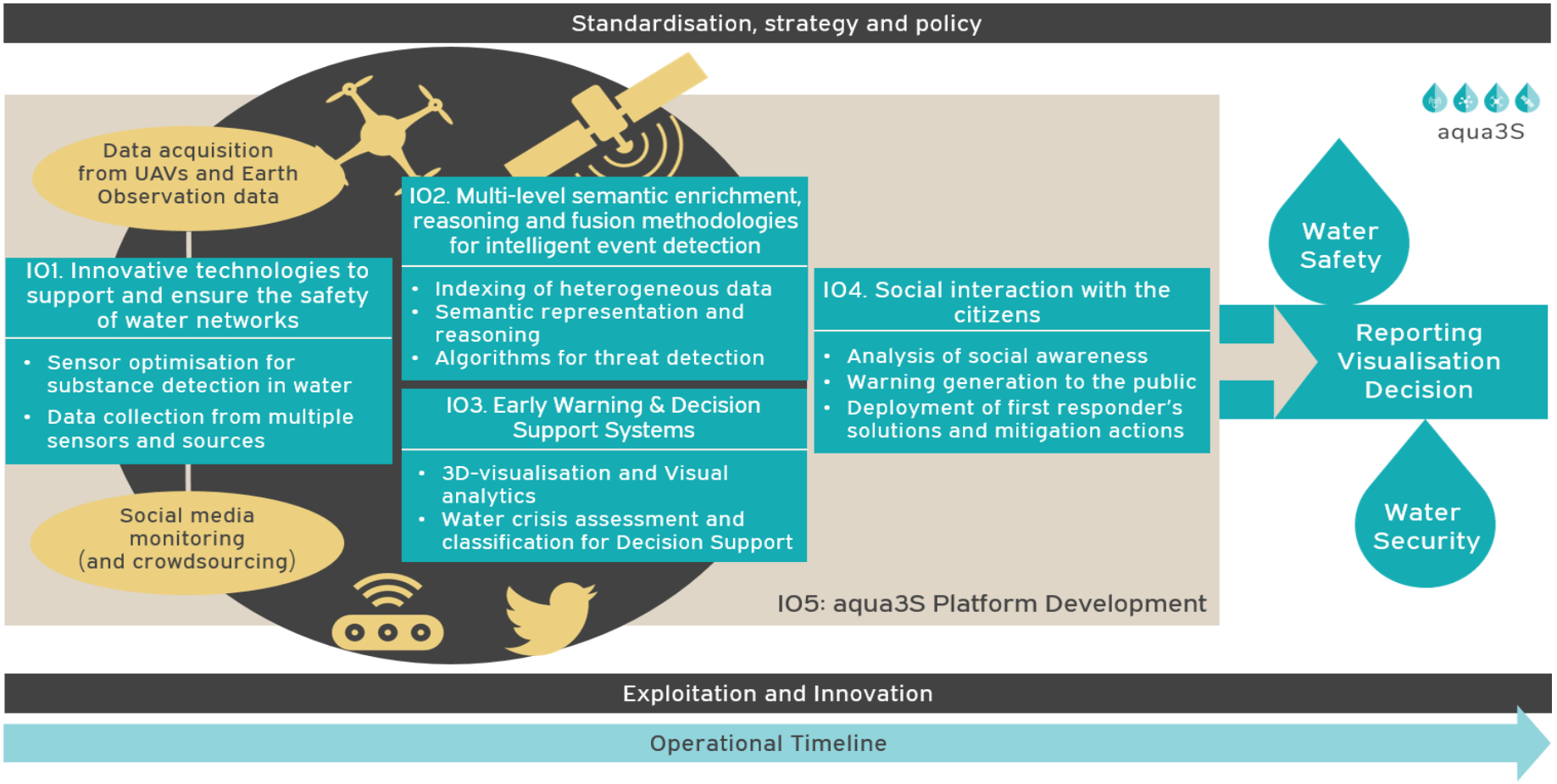

EYATH
RCM
3S
SUEZ
VVQ
M30
M36
3rd Prototype
3rd and Final Evaluation Cycle
Aliakmonas River and Thessaloniki Water Treatment Plant monitoring
Monitoring Safety and Security of the SEPG Water Supply System of Paris
Monitoring the water supply system in the city of Brussels
D
O – Operational test
D – Demo
– Water quality tests
Monitoring Safety and Security of the Trieste Acqueduct
Monitoring the Drinking Water Treatment Plants of Sofia
Desalinated and treated (surface) water monitoring in Lemesos
Reservoir monitoring in Dolni Okol, Plana Mountain, Bulgaria
Monitoring Safety and Security of the Trieste Acqueduct
O
2nd Evaluation Cycle
2nd Prototype
1st Evaluation Cycle
1st Prototype
M28
M20
M12
AAA
AAWA
CREU
SOFYISKA
SVK,
BDI
WBL
SVK,
SOFYISKA
BDI
AAA
AAWA
CREU

Objective

- The main objectives of aqua3S are:

- (i) to **create strategies and methods** in order a water facility to easily integrate solutions regarding water safety;
- (ii) to propose **innovative sensor technologies** to support water safety;
- (iii) to **create early warning methods** for water authorities;
- (iv) to create a **complex collaborative system** recording problems and finding new solutions;
- (v) to allow **easy engagement of different authorities** in a water related crisis;
- (vi) to create/use methods estimate the infrastructure **resilience level**;
- (vii) to introduce bottom-up approaches such as **citizen mapping initiatives**, can be an effective way to build large exposure databases;
- (viii) to **model** and **classify** a **crisis event**

Objectives


Standardisation, strategy and policy
aqua3S
Data acquisition from UAVs and Earth Observation data
IO1. Innovative technologies to support and ensure the safety of water networks
• Sensor optimisation for substance detection in water
• Data collection from multiple sensors and sources
Social media monitoring (and crowdsourcing)
IO2. Multi-level semantic enrichment, reasoning and fusion methodologies for intelligent event detection
• Indexing of heterogeneous data
• Semantic representation and reasoning
• Algorithms for threat detection
IO3. Early Warning & Decision Support Systems
• 3D-visualisation and Visual analytics
• Water crisis assessment and classification for Decision Support
IO4. Social interaction with the citizens
• Analysis of social awareness
• Warning generation to the public
• Deployment of first responder's solutions and mitigation actions
IO5: aqua3S Platform Development
Water Safety
Reporting Visualisation Decision
Water Security
Exploitation and Innovation
Operational Timeline

Objectives

- Innovative technologies to support and ensure the safety of water networks
  - **Sensor optimisation** for substance detection in water in (near) real time
  - Data acquisition from **UAVs** and **Earth Observation** data
  - **Social media** monitoring (and crowdsourcing)
  - **Data collection** from **multiple sensors** and sources
- Multi-level **semantic** enrichment, **reasoning** and **fusion methodologies** for intelligent event detection
  - Data harmonization, semantic representation and ontology creation
  - Integration layer and Multimodal indexing of heterogeneous data
  - Algorithms for threat detection and localisation/ in the existing water distribution networks
  - Crisis management modelling for enhance preparedness
  - Optimisation and parallelisation of algorithms for threat detection

Objectives

- Early Warning & Decision Support Systems
  - 3D-visualisation of early warnings and the early warning module
  - IA3.2 Visual analytics from UAVs and EO data
  - Early Warning & Water Crisis Assessment Algorithms for Decision Support
  - Crisis classification and Decision Support
- Social interaction with the citizens
  - Analysis of social awareness
  - Warning (message) generation to the public
  - Deployment of first responder's solutions and mitigation actions
- Platform development & System Integration
  - Technical requirements and platform development roadmap
  - System architecture development and security requirements
  - System security (Cyber security)
  - System integration
  - Interactive User Interfaces

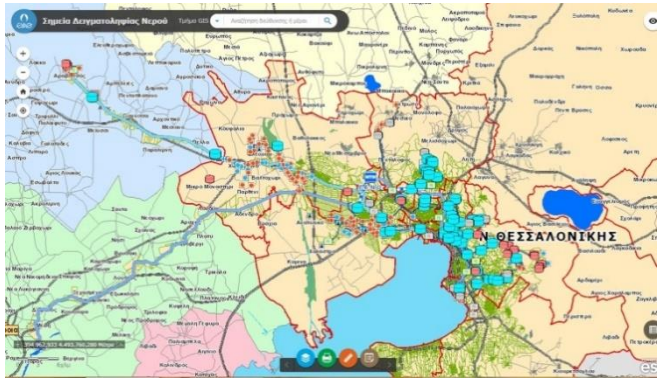
Pilots - Trieste

- Trieste is a municipality located across the borders between Italy and Slovenia
- The water supply system of the city has always been particular, with some critical issues that make the system unique
- The water supply in the city is guaranteed by two water mains
- A system like this is of course very hard to manage, especially from the point of view of the energy consumption

- The case study will be related to the hypothesis of **transboundary pollution**, looking for the effects it may have on the groundwater system of the Isonzo river, where water is pumped with wells, and also on the other backup sources
- Satellite images are analysed to provide estimations of the polluted area and UAVs fly over the Isonzo river to send video streams to the aqua3S platform.

Pilots - Thessaloniki

- A variety of unpredictable events (accidental oil spill at Aliakmonas river, a natural disastrous flooding at the area of one of the main water)
- These events have gravely challenged the company's preparedness mechanisms of emergency response to safeguard the water quality and public health of the city.
- A possible **accidental spill of hydrocarbons** into surface water is likely to be considered. Thus it is of utmost importance to install online monitoring instrumentation at crucial spots of the river flow in order to monitor several parameters combined with an early warning system to be able to anticipate analogous accidents or even deliberate water contamination acts.
- To this direction, cameras on UAVs, TOC on line sensors, polyaromatic via UV technology on line sensors, and oil in water sensors that could be appropriately fine-tuned to monitor aliphatic hydrocarbons of specific range



Pilots-Paris

- The delegation of the drinking water service operation has been entrusted to SUEZ Eau France
- **Hydraulic issues.** The technical infrastructures implemented by SEPG offer many degrees of freedom in water supply management, a DSS allow assessing the water supply autonomy of its territory in real time.
- **(a) Real-time assessment:** The DSS assesses the hydraulic situation over a given forecast period and checks whether the water demand forecasts can be met over a period of several days
- **(b) Real-time hydraulic simulation:** the operator changes system operating parameters (e.g. declares a pumping station unavailable, modifies a water demand forecast, etc.); the DSS then performs a new assessment of the hydraulic situation, as in the first use case.
- **(c) Hydraulic simulation in deferred time**: the operator replays a past hydraulic event and can modify the operating conditions (e.g. declares a pumping station unavailable, modifies a water demand forecast, etc.); the DSS then performs a new assessment of the hydraulic situation, as in the first use case.

Pilots – Lemesos

- The possibility of a terrorist attack and the environmental pollution make water safety more important than ever before.

- **Story:** The main sources of water in our system are desalinated water and treated water (surface water from a dam).
- If (for any reason) the water from the dam is contaminated by a substance that is not removable by the treatment process, this **contamination** shall pass to the reservoirs of the Water Board and shall affect a large number of people.
- If an **early warning system** was installed, then it could detect this kind of contamination. In such a scenario, the Water Board could arrange the early disconnection of the supply from the Treatment Works until the problem is resolved without affecting human health and also the service to the people.

Pilots – Brussels

- The quality of drinking water can be negatively impacted by many human activities, because of unwanted or deliberate pollution. These **pollution events** can take place at the resource (raw water at the catchment), but can also happen closer to the consumer, in the **distribution network**, and also at other locations in between these two extreme stages (e.g. water treatment, water storage).
- In the scenario of Brussels, a pollutant is thrown through the upper part of the reservoir so as to be **contaminated** in a small drinking water reservoir, by throwing a **pollutant** through the upper part of the reservoir.
- By placing well **selected sensors**, this kind of event could be early detected and an alarm through the SCADA system could lead to rapid decision from the supervision operator.
- Sensors are also installed in the distribution network, **closer** to the consumers.
- Messages are automatically generated in a semantic way to be disseminated in the network of VVQ's customers.

Pilots – Sofia

- **Sofiyska Voda** provides services within the territory of the state capital city of **Sofia** – economic and administrative center of Bulgaria - to more than **1.4 million** people.
- At the moment the monitoring of water quality is aimed at tracking the parameters of potable water upon treatment, storage in reservoirs and in the water supply network. Currently, in the company there is **no system for early warning and registration of the microbiological and / or physicochemical deviations from the water quality in the water sources**.
- In case of possible sudden wastewater discharge at a water source or reservoir level, the response will be reactive, after determining the deviations from the potable water quality. When the pollution is in the water source, it will be registered at the inlet of the treatment plant, and when the pollution is in the reservoir it will be registered in the water network.
- Once a substance is detected, a UAV flies over the open dams to send video streams (real-time) to the user's interfaces.
- The severity level is estimated and messages are sent. Under normal conditions, the deviations from potable water quality are managed using a number of measures and in compliance with procedures for registration of signals and corrective actions.

WPs – research and innovation

1. Project Management and Coordination
2. User Requirements
3. Enhanced sensing for the water security and safety
4. Multi-sensor semantic data fusion for intelligent event detection
5. Early Warning & Decision Support Systems
6. Social interaction and communication with the citizens
7. System Integration
8. Pilot implementation, evaluation and training
9. Policies, Information Management & Standardisation
10. Impact Creation, Dissemination and Exploitation

Evaluation

- Prototype and final system evaluation
- User-oriented evaluation
  - End users
  - External reviewers
  - User Group

Expected results

- Final system dealing with 6 pilots
- Modules
- Operational approaches and guidelines
- Standardization

Exploitation and Dissemination

- Exploitation of results
  - Creation of modules/tools
  - Modules to be exploited by the industrial partners
- Business plan to exploit the final system
- Dissemination of results
  - user and open door days
  - conference and joint workshops
  - demonstration of results in End users
  - publication to scientific conferences and journals

Impact

- **Innovation in**
  - **substance detection in water**
  - **data acquisition from UAVs and earth observation**
  - **social media monitoring**
  - **algorithms for threat detection and localisation/ in the existing networks**
  - **crisis management modelling for enhance preparedness**
  - **crisis classification and decision support**

- **Security of people:** aqua3S improves the way in which water authorities and companies are aware of a problem

- **Emergency working routines and standardization:** The facilitation of innovative technical solutions will allow water authorities and companies to do more focused and productive crisis management

- **Society:** aqua3S will facilitate the information flow to the water authorities, thanks to inclusion of new communication channels apart sensors (e.g. UAV, social media), making possible to inform about an emergency across different devices or services. aqua3S allows access data (information) and emergency services quickly and easily, and it will help us to improve a better understanding among the involved parts.

Consortium

Information Technologies Institute, Centre for Research & Technology Hellas (CERTH)	Greece
Vivaqua (VVQ)	Belgium
Water Board of Lemesos (WBL)	Cyprus
Draxis Environmental S.A. (DRAXIS)	Greece
Centre of Excellence in Terrorism, Resilience, Intelligence & Organised Crime Research, Sheffield Halam University (CENTRIC)	UK
Institute of Physics of the Academy of Sciences (FZU)	Czech Rep.
mirSense (MIRS)	France
Autorita' Di Bacino Distrettuale Delle Alpi Orientali (AAWA)	Italy
Thessaloniki Water Supply and Sewerage Company SA (EYATH)	Greece
Centre for Water Systems, University of Exeter (UNEXE)	UK
Acegas Aps Amga S.p.A (AAA)	Italy
Bulgarian Defence Institute (BDI)	Bulgaria
SUEZ Smart Solutions (3S)	France
Institute of Communications and Computer Systems (ICCS)	Greece
Sofyiska Voda (SOFYISKA)	Bulgaria
Everis (EVERIS)	Spain
Water supply and sanitation Technology Platform (WssTP)	Belgium
Trilateral Research Ltd (TRI)	Ireland
Sofia ViK (SVK)	Bulgaria
Department of Environmental Hygiene and Health Inspection, Region of Central Macedonia (RCM)	Greece
Regione del Veneto Coordinamento Regionale Emergenza Urgenza (CREU)	Italy
Universität Stuttgart (USTUTT)	Germany
Easy Global Market SAS (EGM)	France

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- Thank you!

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