Research activities 2021 2022

SMAT Research Center

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Research activities

YEAR 2021

"Interesting times" lie ahead

"May you live in interesting times" is the translation of an ancient Chinese proverb that some people invoke to wish their opponents the advent of difficult times.

We are objectively living in "interesting times" that, despite ourselves, have overturned the perception of general tranquility to which we have been accustomed for over seventy years of peace and growth: everything seemed boringly quiet and consolidated until we were awakened from our sense of well-being first by the climate crisis, then by the outbreak of the COVID 19 pandemic and finally by the energy emergency at the end of 2021 that portends growth trends for which not even analysts were prepared.

Every crisis originates an evolutionary phenomenon and stimulates our ability to react: in this world where new things change rapidly, it is essential to learn on the one hand to adapt quickly and effectively, putting in place all the necessary countermeasures to mitigate the negative effects and on the other hand to seize the opportunities that new scenarios can generate.

In this journey of resilience and evolution, research plays an increasingly irreplaceable role, especially in the field of integrated water service management.

Climate change, emerging pollutants, renewable sources, circular economy, reduction of environmental impact, are just some of the many issues that the SMAT Research Center is called to deal with and that are already addressed in the different research directions that you will find in this booklet, namely Energy, Environment and Climate Change, Analysis and Quality, Water Networks, Supervision and Treatment.

Digitization of networks, artificial intelligence, big data analysis, modeling, carbon footprint, WSP, CRM, are terms and acronyms that must be declined in daily operations to allow SMAT to define innovative projects and respond to the needs of the service and the territory, especially in the implementation of the National Recovery and Resilience Plan (PNRR) which sees us engaged in very challenging achievements.

In order to face these challenges in the best possible way, it will be necessary for the Research Center to "network" locally, nationally and internationally, interfacing with as many experiences as possible and taking advantage of every opportunity to exchange experiences.

"Interesting times" lie ahead, but no less positive.

Armando Quazzo

Research Center Director

Paolo Romano

President

February, 2022

Index

Projects closed in 2021

Index

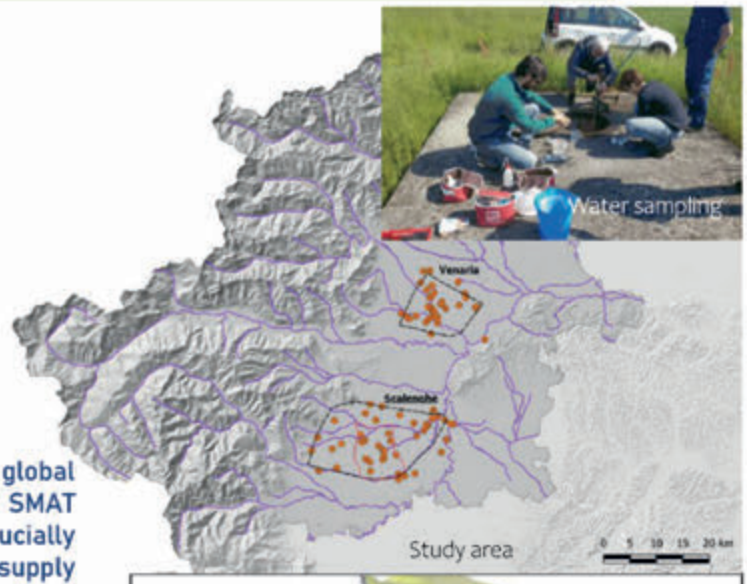
Ongoing projects

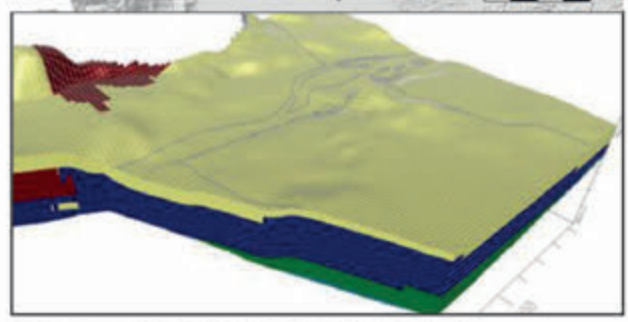
Projects closed in 2021

Energy/Environment/Climate change

INTEGRATED METHODOLOGIES FOR MANAGING AND SAFEGUARD OF GROUNDWATER RESOURCES

Status	Closed
Starting date	March 2019
Duration	30 months
External funding	No
Partners	CNR-IGG, Arpa Piemonte





3D reconstruction of the bodies of groundwater

Groundwater resources represent about 97% of global freshwater resources and almost 70% of the whole SMAT supply (in terms of volume). Therefore, it is a crucially important task to determine and evaluate water supply stability and availability with regard to short and medium-term.

In this research project, the multi-layer aquifer systems of specific interest areas that host wells fields of Regional interest (Venaria and Scalenghe) are investigating. The goal is to obtain significant knowledge for better safeguarding and protecting these well fields, as a support to the strategic developments of SMAT and to the management of the reference territory.

Through a multidisciplinary approach of a kind: (i) geological-hydrostratigraphic, (ii) hydrogeological, (iii) geochemical-isotopic, (iv) statistical, (v) modeling, it has been possible to reconstruct the entire history of the water feeding these important well fields and the detailed groundwater circulation of these areas, distinguishing between features related to natural water-rock interactions and those due to anthropogenic pollution processes, establishing their degree of evolution. Laboratory analyses on stable isotopes of water sampled during monitoring campaigns have been a very powerful and advanced tool for reconstructing water feeding environments, assessing their origin and interactions.

A set of new knowledge and tools have been made available to SMAT and to the served territory, highlighting unknown interactions between groundwater and surface water and providing the best cognitive tools to safeguard and protect the water resource by preventing these criticalities.

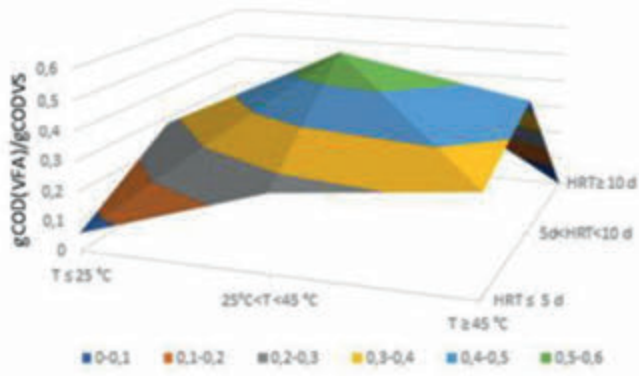
In particular, the following management tools have been made available:

- stratigraphic GEO database: open source queryable stratigraphy collection tool;
- new geological subsurface models;
- a characterization model of the aquifer system that allowed to identify contamination phenomena, the lack of separation between surface and deep aquifers and the influence of surface runoff waters in the feeding of the surface aquifer;
- a numerical flow model that provides insight into possible pollutant transfer pathways and simulates future water scarcity or contamination scenarios.

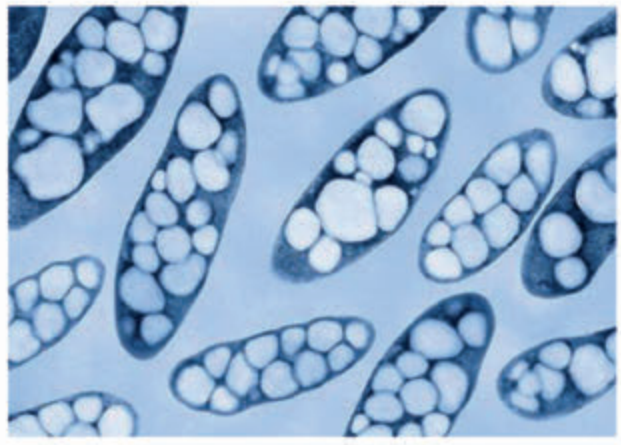
"Reconstruct the history of the water that feeds the well fields in order to define their recharge areas, ensure their qualitative stability over time and define possible pollutant transfer pathways"

BIOPOLYMERS

Status	Closed
Starting date	October 2019
Duration	24 months
External funding	No
Partners	HERA, IREN, A2A, Polytechnic University of Marche



Process technology evolution offered, in addition to a continuous improvement of energetic and contaminants removal performances, the possibility to consider wastewater as a resource rather than a waste.
Several technologies are already well-known in the field of waste water reuse or for electrical and thermal energy recovery by biogas production from sewage sludges. A further step along this way is represented by the recovery of raw materials to be reused as common commercial products with economic and environmental advantages.



Beyond well-known technologies (i.e. phosphorus and nitrogen recovery), several processes have been developed, but still at an experimental stage, dedicated to the recovery of organic substances for biopolymer production with the aim of substituting fossil derived plastics.
The purpose of this research project, in collaboration with HERA, IREN, A2A and Polytechnic University of Marche, is studying the available technologies for biopolymer (more precisely PHA polyhydroxyalkanoates) recovery from urban wastewater treatment processes, and the technical and economic feasibility of the implementation of these technologies in some of the wastewater treatment plants managed by the utilities involved in the project partnership.
Regarding Castiglione Torinese wastewater treatment plant we have analysed several options for the introduction of a PHA production section. Moreover we evaluated the expected production yields, a conceptual design, operational (including biogas and sludge production variation) and capital costs.
The analysis showed the economical sustainability of the process (payback times of 7 to 10 years depending on the scenarios) as soon as regulatory conditions will be favourable for the introduction of this technology in wastewater treatment plants.

"The purpose of this research project is studying the available technologies for biopolymer recovery from urban waste water treatment processes "

TECHNOLOGICAL SCENARIOS FOR BIOGAS USE AT COLLEGNO WASTEWATER TREATMENT PLANT

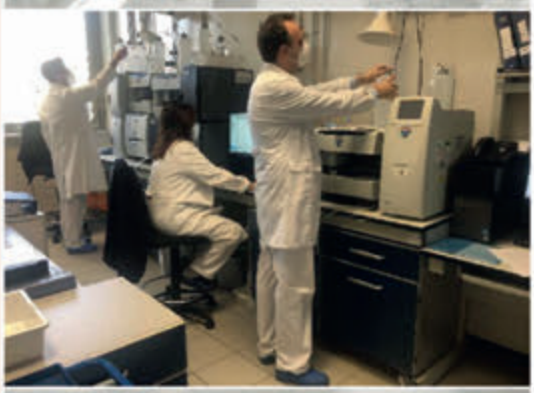
Status	Closed
Starting date	January 2021
Duration	12 months
External funding	No
Partners	//

The Collegno wastewater treatment plant, with a treated load of more than 160,000 population equivalent, is the second largest among those managed by SMAT.
Here, sewage sludges are stabilized through anaerobic digestion aimed at the recovery of biogas, an important resource that allows, in the perspective of circular economy, an important energy recovery from renewable sources.
The aim of the project was a comparative study of different technologies for energy recovery from the biogas produced by the Collegno plant.

Two cogeneration technologies (internal combustion engine and microturbine) and one biogas upgrading technology for biomethane production (membranes) were considered.
The technological scenarios were compared from a technical (plant integration, maintenance, reliability, etc.), energy and economic (investment cost, management costs, savings and revenues also deriving from incentives provided by current legislation) point of view. Finally, from the environmental perspective, emissions and net savings of direct and indirect CO_2 equivalent were calculated.
This analysis highlighted the relevant CO_2 savings that are obtainable through the valorisation of biogas, with no significant differences between the three technologies.
The recent volatility of electrical energy and natural gas costs make the economic comparison very uncertain and strongly dependent on the expected cost of energy in the medium and long term.

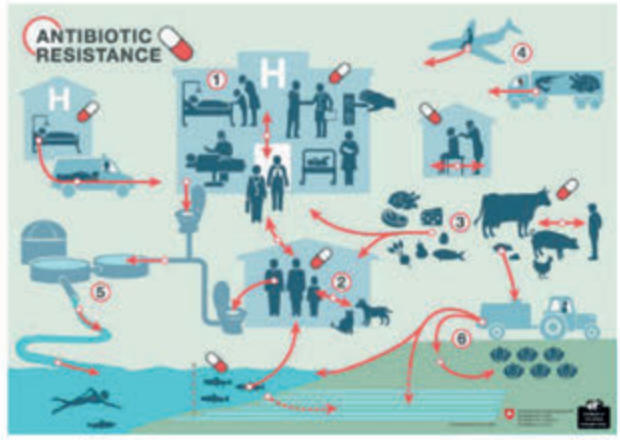
"The aim of the project has been a comparative study of different technologies for the energy recovery of the biogas produced by the Collegno plant"

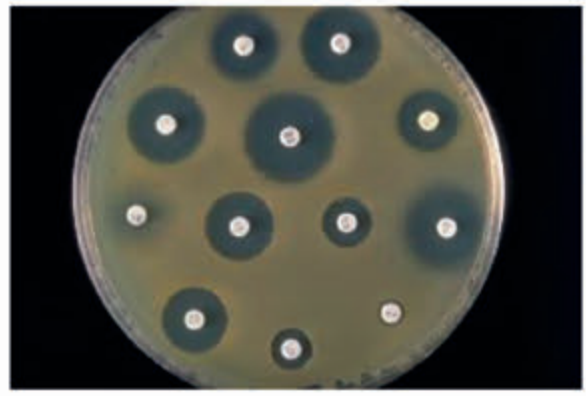
Analysis/Quality



ANTIBIOTIC-RESISTANCE IN THE INTEGRATED WATER CYCLE

Status	Closed
Starting date	February 2018
Duration	30 months
External funding	No
Partners	University of Turin





According to the World Health Organization, antibiotic resistance is a major global Public Health problem of this century. Antibiotic-resistant bacteria (ARBs) have been detected in a variety of aquatic environments, while antibiotic resistance genes (ARGs) can be transferred from one bacterium to another and between various levels of organisms in the food chain, spreading into the natural environment and to drinking water resources. ARGs have been detected in numerous environmental matrices including sediment, lake and river water, drinking water, soil, and effluent from wastewater treatment plants.
These data underscore the important role of the urban water cycle in the deployment of ARBs and ARGs.

During the first phase of the project, an in-depth bibliographical research on the subject was carried out and methods were developed to carry out sampling and extract DNA from the matrices used in the study. During the second year of activity the research of antibiotic resistance in some purification and drinking water plants with different characteristics has been carried out.
Samples were concentrated and subjected to DNA extraction to monitor and quantify, by using real-time PCR, the presence of sequences coding for resistance to the most common antibiotics (e.g. genes for resistance to tetracyclines and sulfonamides). The data of the monitoring carried out on inflows and outflows of sewage treatment plants and in surface waters are in agreement with those found in similar studies (also showing increasing values).

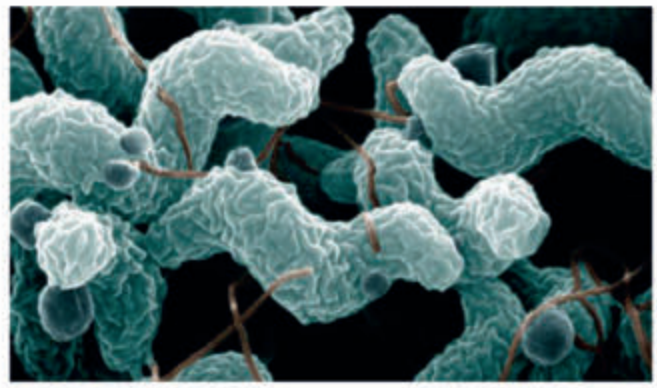
Purification/potabilization treatments have generally confirmed a reduction of bacterial load and molecular targets researched, but treated waters have still shown the presence, albeit in low concentration, of microorganisms and genes coding for antibiotic resistance and the need to continue to monitor the phenomenon in treated water and drinking water to track the fate of antibiotic resistance in the environment.
On the other hand, from the health point of view, at the moment the phenomenon of acquired antibiotic resistance is not of specific concern for human health, since the bacteria involved, which acquire this ability, are generally non-pathogenic environmental bacteria.

"Antibiotic-resistant bacteria have been detected in a variety of aquatic environments, and genes for antibiotic resistance can be transferred from one bacterium to another even in the natural environment"

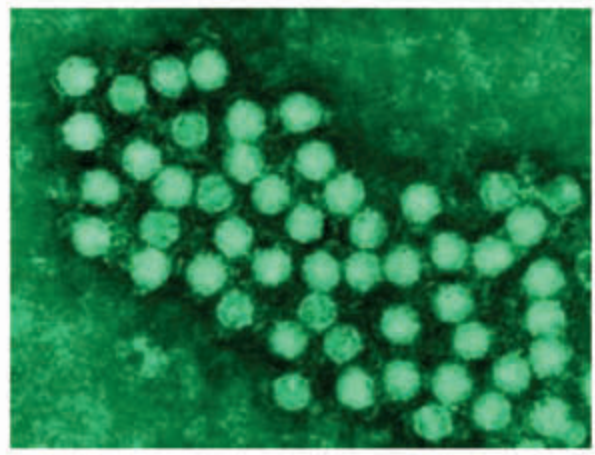
COD: LRC_2017_12

MICROBIOLOGICAL INDICATORS IN DRINKING WATER

Status	Closed
Starting date	November 2020
Duration	6 months
External funding	No
Partners	University of Turin



The assessment of the microbiological quality of water environments to determine whether they are hazardous to public health, should be carried out with controls aimed at verifying the absence of pathogenic microorganisms.
However, detection and quantification methods, which are not available for all pathogenic microorganisms, are often complex, expensive, with poor recovery efficiency and long response times; for these reasons, so-called 'indicator microorganisms' have been identified.
The objective of the project was to carry out an evaluation of the representativeness of the indicators in the detection of pathogenic microorganisms and/or in the identification of the state of hygienic quality of water, in order to identify possible thresholds of "acceptable" concentrations for the chosen microbiological indicators (cut off).



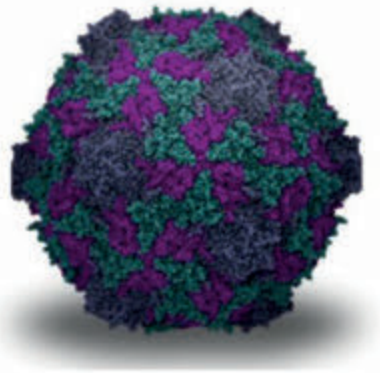
An extensive literature review was carried out, from which it was found that only about 13% of the publications on microbiological indicators of water quality also concern water intended for human consumption, as it presents the substantial absence of pathogens and therefore the lack of correlation with indicator microorganisms. Only in a few studies involving water for other uses, such as irrigation or recreational use, cut-off values have been identified for indicators of microbiological risk to human health (in particular, E.coli values as an indicator of fecal contamination in irrigation water), but these values are not applicable for drinking water quality assessment.
A possible approach that can be used to identify cut-offs for pathogenic microorganisms and indicators could be the quantitative microbiological risk assessment (QMRA), an extremely complex process that associates the acceptable risk of occurrence of hydrodiffusive disease (assumed by WHO at one case in a million), with the evaluation of the effectiveness of applied countermeasures (drinking water treatments). Again, the major limiting factor in the verification and use of the mathematical model is the failure to detect pathogens in the water and thus also the difficulty in demonstrating the effectiveness of the removal or containment treatments applied.
In conclusion, at present, with the available data from self-monitoring, which show good quality of water resources used and water delivered, it does not seem possible to produce quantitative reference values for microbiological indicators, nor to favor a single indicator microorganism for the overall assessment of the microbiological quality of drinking water delivered.

"The project evaluated the representativeness of the indicators in reporting pathogenic microorganisms, and identify threshold values of acceptability of indicator concentration in water"

COD: LRC_AC_2017_14

COMPARISON OF SAMPLING AND CONCENTRATION TECHNIQUES FOR ENTEROVIRUSES DETECTION IN DRINKING WATER

Status	Closed
Starting date	September 2017
Duration	48 months
External funding	No
Partners	University of Turin



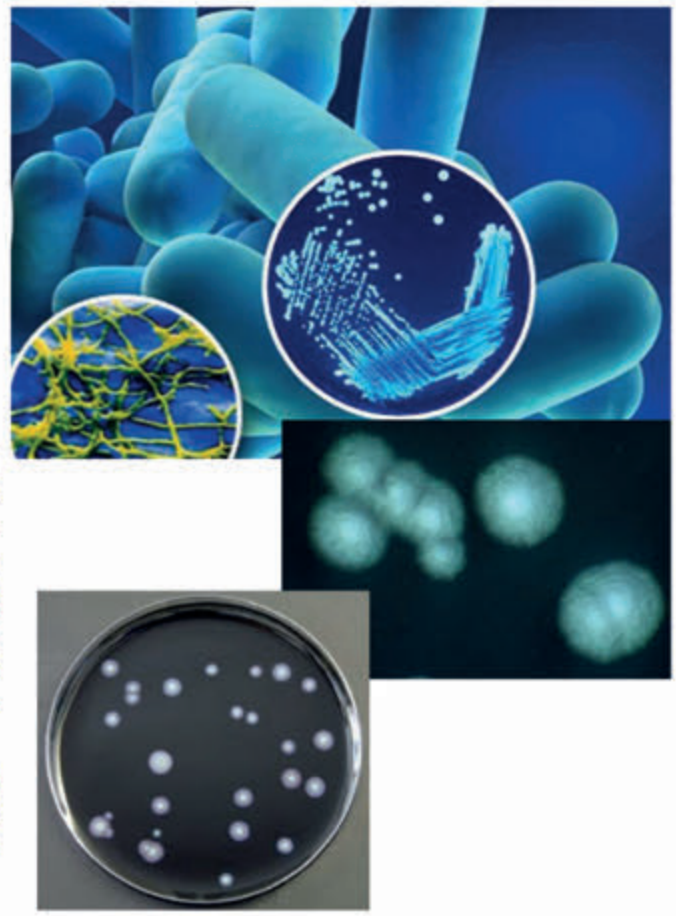
Enteroviruses are ubiquitous and cause a wide variety of diseases, some of them particularly severe, such as poliomyelitis, hepatitis, myocarditis, meningitis. However, a large proportion of Enterovirus infections develop asymptomatically, especially in children, thus promoting the environmental spread of these etiological agents.
Enteroviruses show high survival capacity in the environment and resistance to drinking water treatments and have been detected in significant concentrations even in drinking water intended for human consumption.
In the Legislative Decree 31/2001 and further amendments for this parameter is prescribed the mandatory absence in drinking water.

The specific objective of this project was to compare different sampling methodologies and sample concentrations for Enterovirus detection in drinking water.
Given the low concentrations of viruses in natural and drinking water, and the consequent need to analyze large volumes of water, it is necessary to concentrate the sample to obtain a sufficiently high number of viruses in the volume subjected to instrumental analysis (in q-pcr). The most commonly used concentration methods, usually through concatenated sequential steps, are tangential ultrafiltration, adsorption/elution with electropositive or electronegative membranes, organic flocculation, and coprecipitation with PEG. During the course of the project, concentration tests were performed by varying these techniques, their combination, and operating parameters.
Mengovirus, specifically a genetically modified strain that is non-pathogenic to humans, has been identified and used as a surrogate microorganism for Enteroviruses as an indicator of the effectiveness of the concentration process. Only the tangential ultrafiltration applied using two supports (membranes) in the first concentration phase and an additional device (cassette) in the second concentration phase, optimizing the arrangement of the components of the system used (to reduce the "dead" volumes of the system), allowed to obtain repeatable recoveries of the indicator (target) used.
The best operating condition identified has a duration of about three hours for the first concentration and about two more hours for the second concentration step; the concentration process has been confirmed as the most delicate process of the whole complex analytical chain that characterizes the research of viruses in water.

"The project was aimed at identifying the most sensitive and efficient technique to concentrate Enteroviruses in the different matrices of the integrated water cycle"

LEGIONELLA

Status	Closed
Starting date	May 2019
Duration	30 months
External funding	No
Partners	A2A, Hera, IREN



The EU Directive 2020/2184 concerning the quality of water intended for human consumption also includes Legionella among the microbiological parameters, since, as also expressly indicated by the WHO, it is the waterborne pathogen that produces the highest health burden in Europe. This is a microorganism for which the parametric value has been set at the point of use, i.e. in domestic systemsFor the management of the risk of legionellosis, the directive refers to individual member states and their legislation.
The project partners, as managers of water services, have all been directly involved in specific monitoring to assess the presence of legionellae in the sources of supply, along the drinking water supply chains and in the water supplied.

The results obtained have shown that even where the presence of legionellae has been found in water resources, mainly of surface origin, at the exit of the treatment plants has never been found, highlighting that the processes applied are always effective. In domestic systems, on the other hand, even in drinking water supply chains where no legionellae had ever been found, they were sometimes found to be present at points in internal networks. Analyses carried out specifically to evaluate conditions particularly favorable to the development of Legionellae also in the aqueduct network, did not show a direct correlation between bacterial growth and temperature, while an inverse correlation was evident between the development of microorganisms and the absence or low values of residual disinfectant; risk mitigation strategies and operational proposals were also defined in case of detection of the presence of Legionellae in the aqueduct network.
Essential information sheets on legionella have also been prepared for managers and citizens to encourage correct, usable and clear communication on the subject, trying to mitigate the proliferation of fake news on social media.
Finally, possible internal and external communication strategies were identified and agreed upon, with the aim of providing information and operational guidance on Legionella in the event of a crisis/emergency.

"The monitoring carried out by the IWS managers have shown that the presence of legionellae has never been detected at the outlet of the drinking water plants. "

EARLY WARNING SENSORS

Status	Closed
Starting date	Decembre 2019
Duration	18 months
External funding	No
Partners	A2A, Hera, Iren

The project, dedicated to the "online" monitoring of the microbiological features of water matrices, was essentially aimed at sharing the experience of the participating companies. It foreseen the experimentation of advanced online instruments which could support water managers in handling quality issues in the integrated water system according to national regulations and in view of implementing Water Safety Plans and improving the technical quality indicators required by the Italian Regulatory Authority ARERA. Building on the knowledge acquired in the online monitoring field, the companies have focused on extensive technology scouting for innovative sensors. Each company elaborated a pilot monitoring project and selected an analyzer for a performance evaluation in order to share the results with the rest of the consortium. SMAT acquired a latest generation sensor for the automated analysis of the microbiological load through the ATP technology, namely the indirect measurement of the microbial concentration by luminescence.

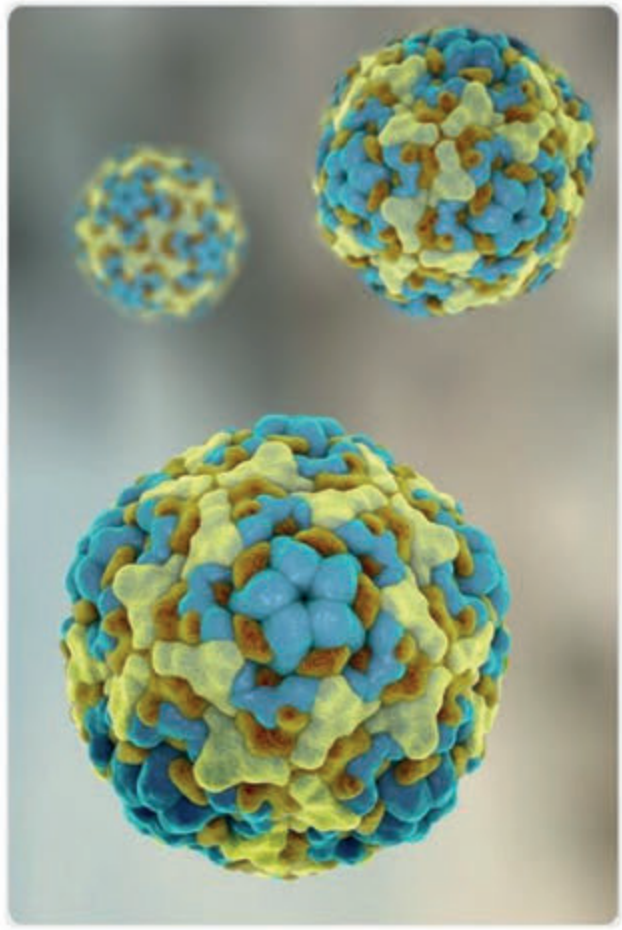
The instrument has been tested on water exiting from the Po river drinking water plant and from the power plant of the well field of La Loggia, on water kiosks and under in -plant operating conditions, with the following results:

- the system is able to identify the intervals of oscillation of the bacterial load characteristic of each type of water and identify for each of the alarm thresholds;
- the system is capable of detecting changes in water quality that fall above the defined alarm threshold (approximately 1 LOG above the basal level);
- the system cannot discriminate between living (and therefore potentially pathogenic) and dead organisms and can therefore not be considered an online biomonitoring tool: the resulting alarm must therefore be considered generic and needs to be further investigated by the laboratory;
- a strong influence of inorganic microparticulate (Fe/Mn) in the water on bacterial counts and overall instrument performance was detected;
- the system is suitable for the classification of water deriving from the various phases of a plant, in line with information already provided by other online monitoring systems (e.g. turbidimeter);
- the system is not suitable for microbiological monitoring at Water Kiosks.

"Online monitoring of microbiological characteristics of aqueous matrices and experimentation of advanced instrumentation for the management of quality aspects of the IWS"

ENTERIC VIRUSES IN THE DRINKING WATER CHAIN: EMERGING PATHOGENS AND NEW VIRAL INDICATORS OF CONTAMINATION

Status	Closed
Starting date	October 2019
Duration	24 months
External funding	No
Partners	Italian National Institute of Health



Based on current regulations, waterborne enteric viruses are not routinely measured. However, several studies have highlighted that both surface and groundwater supplies may contain viral pathogens even in the absence of traditional faecal indicators, thus representing a major public health concern.

The project is aimed at evaluating the presence of traditional and emerging enteric viruses in springs, wells, surface water and drinking water along the drinking water chain in the Greater Turin Metropolitan area. The analysis were carried out to evaluate both the presence of different well-known enteric viruses (Norovirus, Adenovirus, Enterovirus, HAV) and the presence of emerging viruses (HEV, Saffold virus, Salivirus, Aichivirus, Bocavirus, Sapovirus). Within this research project it was aldo evaluated the presence f non-pathogenic Pepper Mild Mottle Virus (PMMoV), that could be considered as a quality indicator of water supply chains.

Molecular analysis extended to approximately 70 samples, each examined for 11 enteric virus groups, in addition to the indicator virus PMMoV.

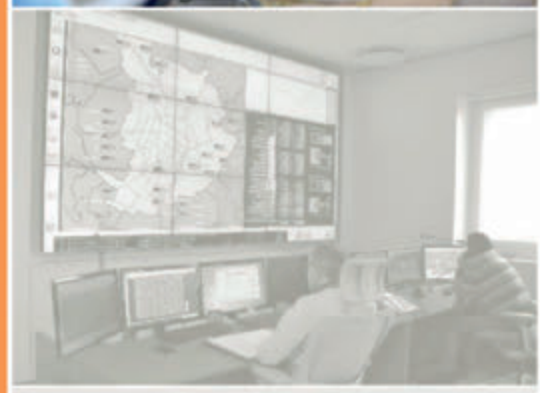
The results denote the total absence of viruses in purified drinking water and wastewater, while showing a heterogeneous picture of positivity to the different viruses in raw water, particularly surface water, where they were detected: Adenovirus were detected in the 75% of the samples; Norovirus GI + GII and Enterovirus in the 58% of the samples, Bocavirus in the 50% of the samples. Aichivirus, Salivirus and HEV were detected in only one sample.

The raw wastewater samples shown high viral contamination and the simultaneous presence of different viruses. Higher contamination percentages were associated to Salivirus and Bocavirus (94% of the samples); Norovirus GI + GII (89% of the samples); Aichivirus and Sapovirus (79% of the samples); Adenovirus (63% of the samples). HAV and HEV were found in few samples (5% and 15% of the samples respectively). Pepper Mild Mottle Virus was founded in all the raw wastewater samples.

The results of this study confirm that viruses are ubiquitous and persistent in raw wastewater, but can be reduced or eliminated by wastewater treatment. Urban rivers are possible sources of human viral pollution. However, advanced water supply network and wastewater treatment plants can effectively remove all viral pathogens, thus providing an excellent barrier for human health safety and environmental protection of water ecosystems.

"To assess the presence of classical and emerging enteric viruses in water intended for human consumption of the drinking water supply chain in the Turin area"

Water networks



ACOUSTIC SIGNALS MULTI-CORRELATION TO LOCALIZE BURSTS IN WATER DISTRIBUTION NETWORK

Status	Closed
Starting date	February 2020
Duration	18 months
External funding	No
Partners	//

Bursts localization in water distribution networks represents one of the still unsolved problems for water industry.

Even in the hypothesis of being certain of the presence of a break along a pipe, it is necessary to know exactly the position of the break in order to start the excavation necessary for the repair of the pipe affected by the break.

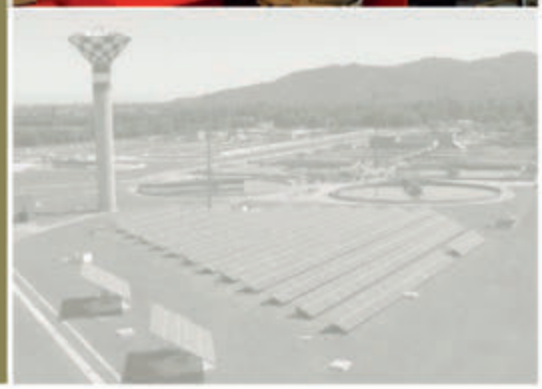
One of the traditional technology for burst localization consists in the characterization of the noise along pipe network using noise loggers; then, in order to precisely pinpoint the break, it is possible to install two accelerometers straddling the potential break, connected to a device that allows to correlate the two signals and precisely identify the break. Alternatively, it is possible to detect the noise along the suspect pipeline by geophone until the point where the noise is characterized by greater intensity is identified.

Due to the development of more efficient transmission systems and remote data calculation and visualization logics, it was possible to test a system capable of correlating an indefinite number of accelerometers by sending the detected data to a remote server which takes care of calculating the correlations between all monitoring stations.

This technology allowed to keep part of the distribution network under control through a daily check of the real state of the infrastructure so as to be able to intervene in a timely manner in the event of an anomaly.

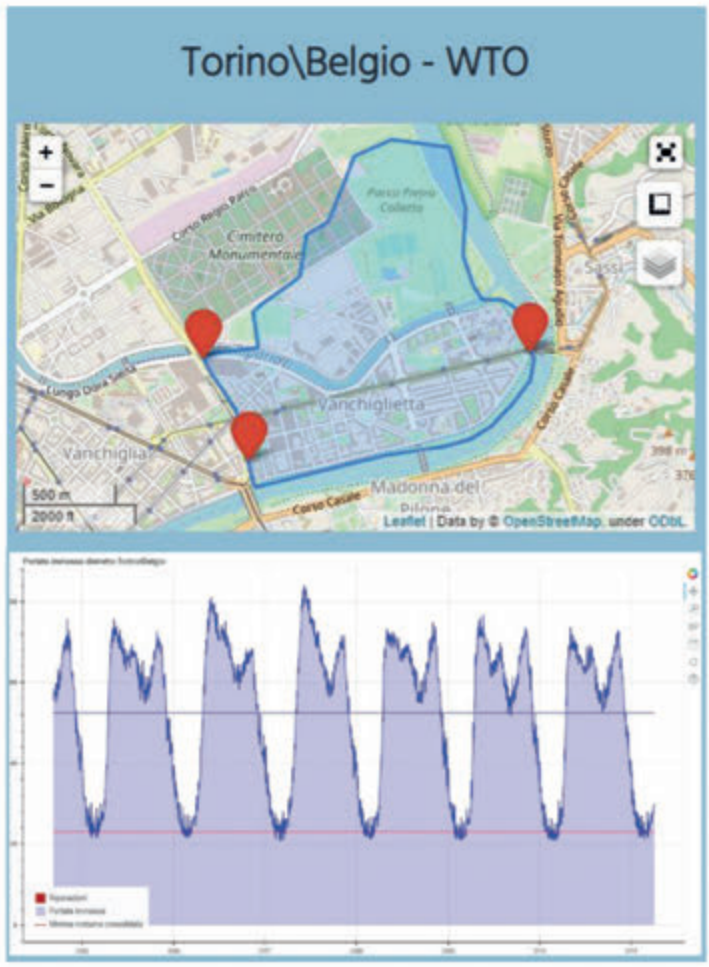
"Bursts localization in water distribution networks represents one of the still unsolved problems for water industry"

Supervision



INNOVATIVE PLATFORM FOR REMOTE MONITORING OF DISTRICT METERED AREAS

Status	Closed
Starting date	February 2020
Duration	12 months
External funding	No
Partners	//



The realization of district metered areas (DMAs) in water distribution networks into represents the first step in reducing network losses (European Commission Guidelines).
In fact, a DMA, which consists of an area of the distribution network isolated from the rest of the network by closures or connections equipped with a flow meter, allows you to keep under control all the parameters that describe the proper functioning of the whole system.

This result is achieved by remotely monitoring all the measures relating to the DMA. By crossing the hydraulic measurements with other parameters already present in the other databases, for example the repairs carried out on the network, it is possible to increase knowledge on the efficiency of the district and therefore have an additional tool for optimizing network management.

The platform that was implemented with this project allows to operate as previously described, as well as to have a tool that can be used by the control room staff for real-time analysis of the network status by accessing cartographic and temporal data via browser.

The platform is powered by various company databases, including SCADA, the maintenance management system, as well as domestic consumption data.

"The realization of district metered areas (DMAs) in water distribution networks into represents the first step in reducing network losses"

Treatment

INNOVATION IN WASTEWATER TREATMENT PROCESSES

Status	Closed
Starting date	September 2018
Duration	36 months
External funding	No
Partners	//

The project, implemented in collaboration with the Plant Management Service and the Chemical-Biological Laboratory of Castiglione T.se wastewater treatment plant, studied and tested innovative solutions for improving performances and management of wastewater treatment processes.

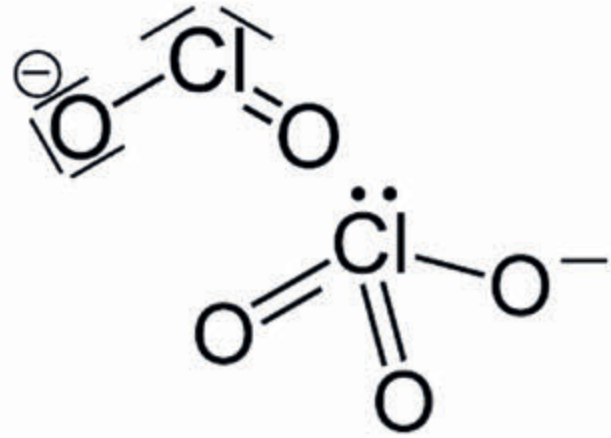
The main objectives were performance enhancement in terms of contaminant removal, energy use reduction, sludge production reduction and chemical consumption optimization.

In the project framework we evaluated and proposed the introduction of an intermittent aeration regulation logic at Castiglione Torinese wastewater treatment plant, in order to achieve a further improvement of treatment performance and energy savings for aeration and mixed liquor recirculation.
Based on the analysis results, SMAT decided to implement the proposed regulation logic, that has been installed, in the first three modules of wastewater treatment in Castiglione Torinese plant, between the spring and the summer 2020.
Besides an interesting electrical energy saving, this innovation allowed to obtain a remarkable performance increase of nitrogen removal (during 2021 total nitrogen removal exceeded 83%) far beyond law requirements with a considerable environmental advantage.
Moreover, this configuration, by turning off mixed liquor recirculation, offered the possibility of implementing biological phosphorus removal in the tanks once used for denitrification, which is an important requisite for future introduction of a nutrient (phosphorus and nitrogen) recovery section as struvite.

"We studied and tested, in laboratory and in the field, innovative solutions for improving performances and management of wastewater treatment processes"

CHLORATES AND CHLORITES

Status	Closed
Starting date	March 2019
Duration	24 months
External funding	No
Partners	A2A, Hera, Iren



The entry into force of new limits for chlorites and chlorates, provided for by the European Drinking Water Directive, poses a serious challenge to water operators relying on disinfection. The project, implemented in collaboration with partner companies A2A, HERA and IREN, aims to find solutions to reduce disinfection by-products (DBPs), through operational protocols for better plant management, preparation of specifications for the purchase of more stable chemical products, as well as search for innovative technologies for the reduction of DBPs.

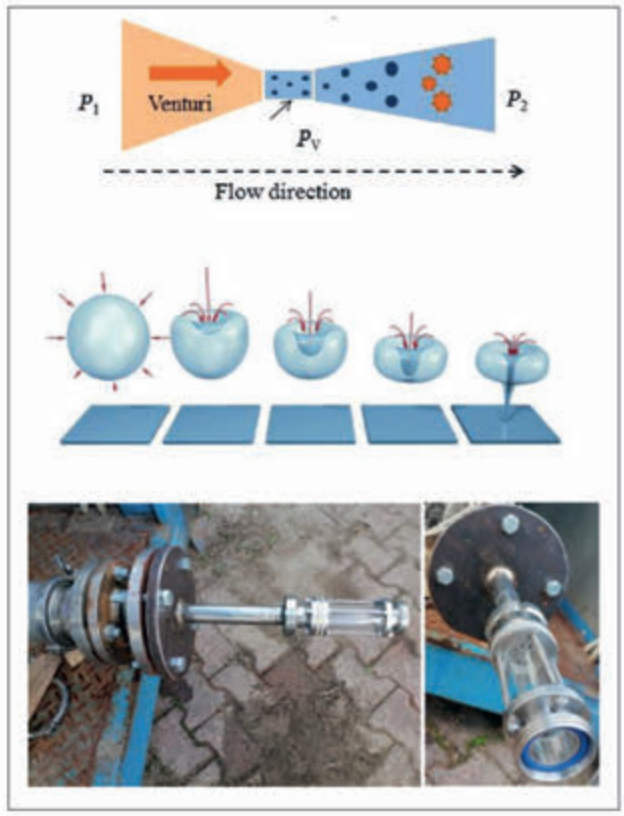
The initial literature review allowed systematizing consolidated good practices. Specifications for the purchase of sodium hypochlorite from partner companies and other water service operators were analysed and compared, in order to assess any consequences in terms of quality of supplies and by-products of disinfection downstream of the treatment and in order to formulate shared requirements for the supply phase.

Towards the identification of control and mitigation actions, some sample plants were selected for an analysis of the process adopted and the hypochlorite management and use practices, with the aim of correlating the solutions adopted at plant level with DBPs concentration data (any critical issues with high chlorate concentrations or virtuous situations in the absence of exceeding legal limits). Finally, some technological solutions for the reduction of disinfection by-products have been identified and evaluated, namely innovative systems for the onsite hypochlorite production showing a good potential in terms of environmental impact and reduction of DBPs concentration.

"The new limits for DBP pose a serious challenge to water operators exploiting surface water sources, for whom disinfection practices are indispensable"

BIOENPRO4TO – SMART SOLUTIONS FOR SMART COMMUNITIES

Status	Closed
Starting date	June 2019
Duration	36 months
External funding	Yes (Piedmont Region)
Partners	SEA Marconi, Polytechnic University of Turin and other 13 partners



Hydrodynamic cavitation is a physical-chemical phenomenon induced by a pressure variation obtained through a hydraulic system, which determines in the fluid the formation of microbubbles (or "cavities").

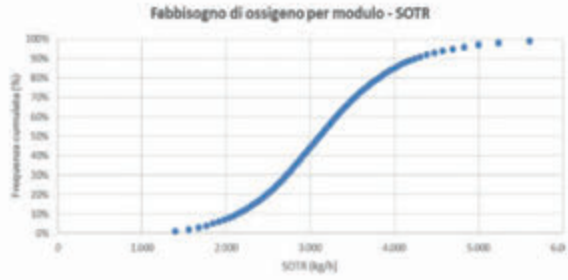
When imploding upon a subsequent pressure increase, these in turn induce a series of highly energetic phenomena. Of particular interest is the study of hydrodynamic cavitation applicability in drinking water disinfection, using its principles to compromise microbial cell integrity.

Within the framework of this project, SMAT aims to move from lab scale hydrodynamic cavitation to a real scale implementation of the technology for drinking water production.
Following an in-depth study of the state of the art and a critical analysis of the experimental results conducted in the laboratory, we moved on to the design of the cavitation reactor to be applied in the small pilot plant. SMAT has designed and installed the pilot plant at the Po river drinking water treatment plant.
The pilot plant is fed by water taken from the Cyclofloc of biological type, whose qualitative characteristics are compatible with the disinfection potential of the reactor.
The entire circuit consists of a water storage tank, a screw pump, a recirculation bypass and a cavitation reactor with free outlet. Upstream of the reactor is a constriction in the pipeline that induces the cavitation phenomenon.

"SMAT has designed and installed the pilot cavitation plant in its facilities and tested its effectiveness."

CASTIGLIONE TORINESE WASTEWATER TREATMENT PLANT AERATION DIFFUSER SYSTEM DESIGN

Status	Closed
Starting date	January 2021
Duration	10 months
External funding	No
Partners	//



Biological oxidation tank aeration is considered one of the most important energy costs in wastewater treatment.

In order to ensure a constant and optimal efficiency of the air diffusion systems serving the biological oxidation tanks of Castiglione T.se treatment plant, we planned the complete replacement of the diffusers (currently over 59,000 units) and of the air distribution network at the bottom of the tanks.

This research project was dedicated to studying the best air diffusion technologies on the market and analysing their respective strengths and weakness from the point of view of efficiency, durability and maintainability. The optimal sizing of the new aeration diffuser system of Castiglione T.se plant was later studied.
The assessment of the real oxygen demand of the process (also by the use of a mathematical model of the treatment process), of the correct number, size and technical characteristics of the diffusers to be installed, is very important for energy saving purposes. In fact, the oxygen transfers efficiency (SOTE) and the pressure drop at the diffuser (DWP), and therefore the flow rate and pressure of the air to be blown, depend on these parameters.

The results of the study were of fundamental importance for the preparation of the design and tender documentation, needed for awarding the upcoming works for the renewal of the aeration network of Castiglione T.se plant.

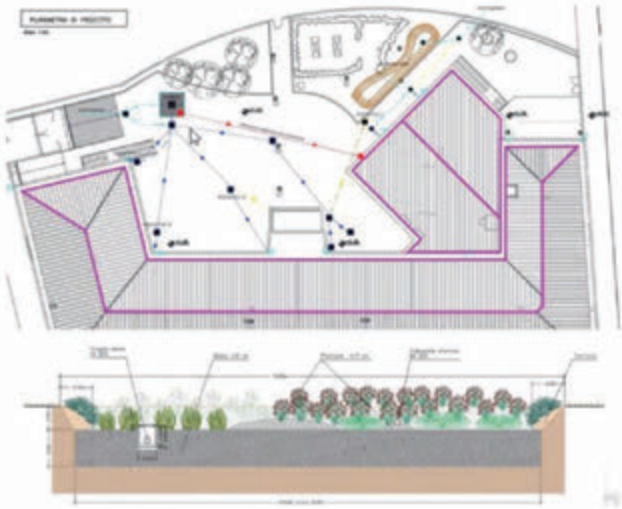
"Biological oxidation tank aeration is considered one of the most important energy costs in wastewater treatment"

Ongoing projects

Energy/Environment/Climate change

CITY WATER CIRCLES (CWC)

Status	Ongoing
Starting date	April 2019
Duration	30 months
External funding	Yes (Municipality of Turin)
Partners	Municipality of Turin



Climate change induced hydrological risks are making central European cities increasingly vulnerable against urban floods and at the same time make the water scarcity problem worse. Coupled with growing drinking water consumption and consequently rising amounts of wastewater to be treated, this threatens the safety of future water supplies.
In this framework, the City Water Circles - CWC project (funded by the EU under the Interreg Central Europe program) aims to help municipalities to reform outdated urban water infrastructure systems via applying a circular economy approach, which offers many economic and environmental benefits. This will be achieved by the project by promoting a water saving culture, including the use of non-conventional water resources and by taking the lead in adopting urban rainwater harvesting and utilisation as well as greywater recovery measures on city level.

Through a circular economy and Nature-Based Solutions (NBS) approach, models of urban cooperation are being developed to promote, within those urban areas that are most vulnerable to the impacts of climate change, a culture of resilience, water conservation, efficiency, and reuse.
The project involves 11 partners from 6 countries, as well as the implementation of 5 pilot case studies. The partners are developing, thanks to an important work of involvement of local stakeholders, a set of innovative methods and tools (cutting-edge technological solutions and NBS, smart governance tools exploring new cooperation and financing schemes) replicable at European level.
The Italian pilot, installed at the Open 011 - Casa della Mobilità Giovanile e dell'Intercultura in Turin - is aimed at introducing a green roof technology to create an outdoor roof garden and will cover an area of about 170 square meters including an aeroponic test cultivation in a greenhouse.

SMAT's role in this project includes:

- the participation in the works of the Stakeholder Group Italy, as Stakeholder Group Leader;
- the support to the preparation of strategies and policies for the circular management of urban water in the Turin area;
- technical assistance for rainwater reuse, related sampling and monitoring in the site identified for the Italian pilot, located at the Open011 site.

"Urban cooperation models to improve water efficiency and reuse with an integrated circular economy approach"

ASSESSMENT OF GREENHOUSE GASES EMISSIONS

Status	Ongoing
Starting date	April 2020
Duration	24 months
External funding	No
Partners	Polytechnic University of Turin

The project led to the creation of a data mining and processing tool to assess the carbon footprint of SMAT's plants and premises. The applied methodology is based on national and international guidelines, namely the ISO 14064-1, which includes the requirements set by the GHG Protocol and the IPCC Guidelines. Nevertheless, given the complexity of wastewater treatment processes and the dynamic nature of mechanisms ruling GHG emissions from the plants, there is still a high degree of variability in the estimated emission factors and additional measurements of emission flow of GHGs are necessary to estimate the carbon footprint of wastewater treatment systems with sufficient accuracy.

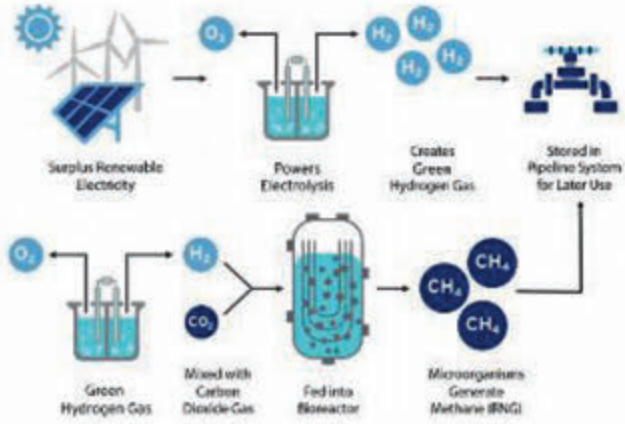
To this purpose, the Department of Environment, Land and Infrastructure Engineering (DIATI) of Turin Polytechnic designed and built an experimental apparatus for capturing the off-gas emitted from activated sludge tanks, in order to measure sufficiently low concentrations of CH_4 and N_2O in different operating conditions.

The apparatus consists of a floating flow chamber that captures off-gas and a system of pipes and valves, where the flow is conveyed to a chromatography gas analyser. In treatment tanks that work in anaerobic or anoxic conditions, the system works with a flow of air generated by a compressor, which acts as a gas carrier. Starting from July 2021, various measurement campaigns were carried out. The preliminary results show a significant spatial and temporal variability of the presence of CH4 and N2O in the off-gas emitted by the treatment process, related to temperature and process conditions. Before the end of the project, additional data will be collected and correlated with the plants' monitoring data.

"Direct measurements of GHG emissions are essential to estimate the carbon footprint of wastewater treatment systems with sufficient accuracy"

HYDROGEN PRODUCTION AND METHANATION

Status	Ongoing
Starting date	June 2020
Duration	36 months
External funding	No
Partners	Polytechnic University of Turin



"Power-to-gas" is a promising approach as a solution to the lack of programmability of renewable energy sources, especially photovoltaic and wind power. This is the possibility to convert the renewable source energy over-productions into combustible gas (therefore transforming the electrical energy into chemical energy) that can be stored and transported.
An example is the electrochemical production of hydrogen which is, however, an energy vector with a still limited diffusion because of the lack of infrastructures.

Until hydrogen economy will be fully developed, combining "green" hydrogen with biogenic CO_2, to produce renewable methane enables the use of natural gas distribution grid for storing and transporting, in chemical form, the excess of renewable energy in case of overproduction.
With this perspective, wastewater treatment plants represent an excellent location for power-to-gas installations, for at least a couple of reasons:

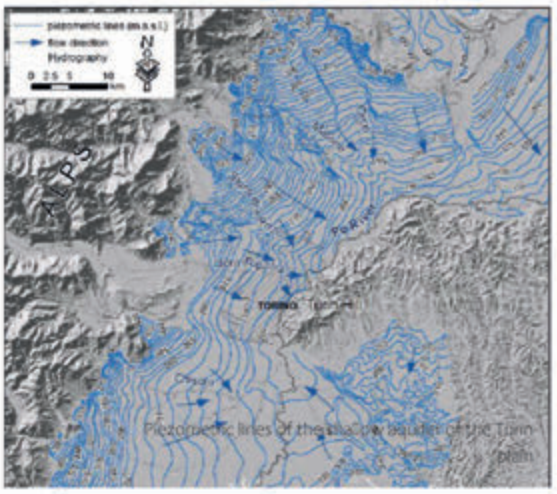
- in plants equipped with anaerobic digestion, CO_2 in biogas could be combined with hydrogen in order to produce additional renewable methane (biological methanation).
- besides hydrogen, also oxygen is generated from water hydrolysis, which can be favourably used for the aeration of aerobic biological processes of water treatment.

In the framework of the project, we set up a laboratory reactor and we started testing biological methanation of hydrogen, aiming at the optimisation of operative process parameters, and at the assessment of the energetic yield and technical-economic feasibility of the solution.

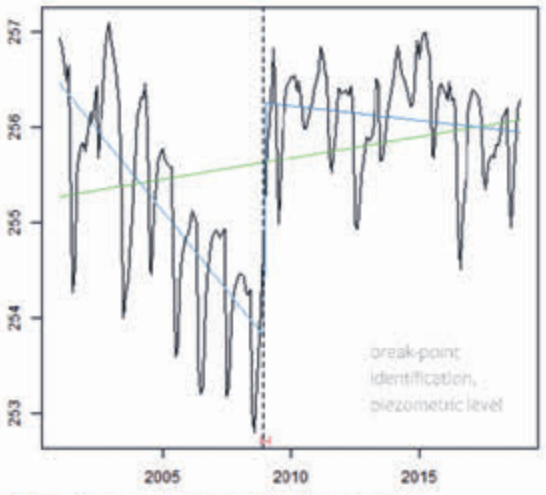
"Wastewater treatment plants represent an excellent location for power-to-gas installations"

GROUNDWATER LEVELS PREDICTION AND CORRELATION WITH METEOROLOGICAL AND ECONOMIC VARIABLES

Status	Ongoing
Starting date	June 2020
Duration	30 months
External funding	No
Partners	CNR-IGG, CNR-IRCRES



Piezometric lines of the alluvial aquifer of the Turin plain



Groundwater leves are the most important hydrological information for the monitoring of the aquifer quantitative state. Piezometric levels of the groundwater real-time monitoring network managed by ARPA Piemonte were analysed considering ISPRA guidelines developed to evaluate the quantitative state of the bodies of groundwater.
In the area managed by SMAT, the analysis performed over the monthly timeseries highlighted a characteristic behavior in the whole area, with a sharp piezometric level rise in 2008-2009, showing a counter-trend break point respect to the previous years. Indeed, the overall temporal trend of the piezometric leves of the study area is characterized by a decreasing trend in 2000-2008 period, a sudden break point with a rise in the levels in 2008, followed by another decreasing trend.

This behavior is common in the whole area managed by SMAT, except for those piezometers located in the Stura di Lanzo river basin. Different hypothesis were developed to explain this characteristic behavior, but there has been no real investigation.
The goals of this project can be summerized as follows:

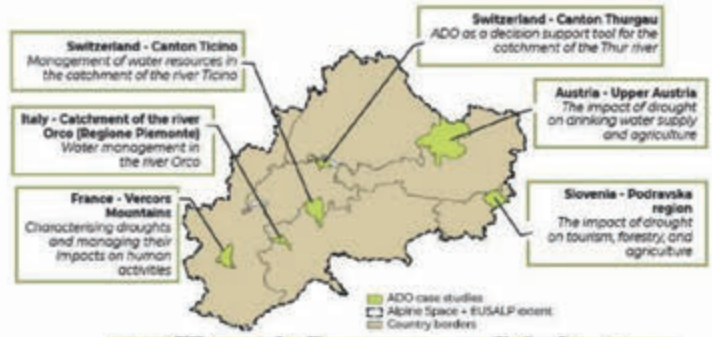
- to find the cause of this break-point, probably due to a combination of higher precipitation amounts and lower groundwater extractions due to the economic crisis that stopped most of the water-intensive activities;
- once we will identify the fields that influence this piezometric level counter-trend, we will build a statistical model to forecast the groundwater level evolution.

The analyses performed in this first year of the project identified: (i) a correspondence between the annual rainfall regime and the response of the aquifer, (ii) a correspondence between the structural break (statistically significant) of piezometric levels and the time series of electricity consumption data by macro-sector over the area of the Metropolitan City of Turin.
Correlation analyses are underway that will allow reconstruction of the weights that these two components have on the trend of the historical series of piezometric levels.
All the analysis are developed considering a monthly time scale, in order to have a forecast useful for monitoring the groundwater level evolution for environmental safeguard purposes.

"Piezometric levels are the main hydrological indicator for monitoring the quantitative status of groundwater bodies"

ALPINE DROUGHT OBSERVATORY (ADO)

Status	Ongoing
Starting date	January 2021
Duration	18 months
External funding	No
Partners	Piedmont Region, Arpa Piemonte



The Alpine Drought Observatory (ADO) project is a European project funded within the Interreg Alpine Space program.
The overall goal of this project is to provide a platform for drought monitoring and forecasting with specific indicators for the Alpine Space region, which will help improve drought preparedness.

The results of the ADO project may be used to better implement policies for drought management and to create coordinated governance tools for more efficient use of water resources (e.g., resolving conflicts of interest and protecting sensitive ecosystems).

Specifically, the ADO project aims to achieve the following objectives:

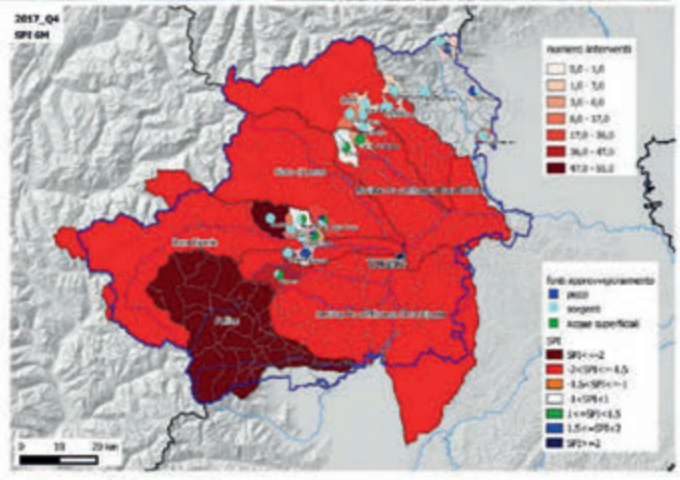
- improve current drought monitoring and forecasting for the Alpine region;
- improve the understanding of drought impacts in the Alps;
- improve drought management practices (better coordination of drought governance and minimization of conflicts among water users) as well as the improving of drought prevention.

In this framweork, SMAT participates in the Italian case study referred to the Orco River Basin, which focuses on the management of water resources in a basin where multiple water uses and significant management methods are present and coexist.
In particular, the SMAT Research Center, within the activities foreseen in WP5 (Case Studies, Drought Management, and Policies), is supporting the Piedmont Region, in synergy with ARPA Piemonte, in the critical data analysis and identification of crisis events of the water supply system in the study area.
This collaboration will see the drafting of the shared document "Recommendations and guidelines to improve drought management", which is one of the deliverables of the project, as well as of interest to Piedmont Region in the context of Climate Change Adaptation Strategies.
Moreover, the specialized contributions requested to SMAT take into consideration the knowledge of the dynamics related to the groundwater resources intended for human cunsumption, as well as the concrete experience in the research of alternative sources of supply, also in relation to the multiple uses of the reservoirs of water, in coherence with the regional Water Protection Plan.

"Create an online platform for monitoring and developing guidelines for the implementation of proactive drought management models in Alpine regions"

BOTTOM-UP APPROACH TO MANAGING WATER SCARCITY RISKS UNDER CLIMATE CHANGE SCENARIOS

Status	Ongoing
Starting date	July 2021
Duration	24 months
External funding	No
Partners	Arpa Piemonte



Drought is a phenomenon determined by a condition of reduced water availability defined as the deviation from the average climatic conditions of a given location of interest.
The persistence of weather conditions that cause the absence of precipitation (meteorological drought) affects the state of the water resource, leading to water scarcity that, when it reaches a severity such as to require a series of management procedures for the failure to meet demand, leads to a water crisis that potentially affects all socio-economic sectors.

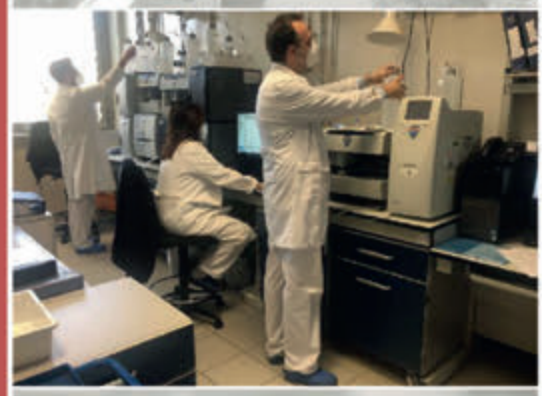
In the last twenty years, the national and regional territory has been affected by numerous water crises, which have affected the main sectors of water use, exacerbating conflicts between these sectors in different territories and requiring the implementation of emergency procedures for the management of impacts.
The ongoing climate crisis amplifies drought phenomena that cause and/or aggravate water crises and, in this context, the SMAT Research Center, in collaboration with ARPA Piemonte, is carrying out a research project for the prediction and management of water crises in climate change scenarios.
Through an innovative bottom-up approach based on risk analysis, the project is articulated as follows:

a. Identification of crisis events for the drinking water supply
b. Analysis of meteorological data and drought indicators (and definition of critical thresholds)
c. Calculation of the probability that these critical thresholds will be met (or exceeded) under climate change scenarios (using an ensemble of forecasts/scenarios)
d. Definition of potential impact mitigation actions

During these first months of work, a critical analysis of the interventions of SMAT's "Water Emergency" service has been carried out, identifying, on a municipal scale, the events correlated to scarcity phenomena. This index was compared with drought indicators calculated by ARPA Piemonte, mapping this information together with information on supply sources.
From the quarterly scale analyses, it can be seen that the supply system went into crisis, with a certain time lag, following an enduring drought (strongly negative 6- and 12-month SPIs) in municipalities mainly supplied through springs or surface resources (2017 event) and mostly located in the central-northern part of the study area.
The 2021-2022 period is currently under study, with supply anomalies that have also affected municipalities fed by groundwater resources.

"Predicting and managing water crises under climate change scenarios through a bottom-up approach based on the risk analysis of non-supply for drinking water use"

Analysis/Quality



CALLISTO: COPERNICUS ARTIFICIAL INTELLIGENCE (AI) SERVICES AND DATA FUSION WITH OTHER DISTRIBUTED DATA SOURCES AND PROCESSING AT THE EDGE TO SUPPORT DIAS AND HPC INFRASTRUCTURES

Status	Ongoing
Starting date	January 2021
Duration	36 months
External funding	Yes (Horizon 2020)
Partners	16 international partners

Driven by the vision of the European Commission Destination Earth initiative, CALLISTO will develop AI solutions to combine data from heterogeneous sources (including Copernicus satellite data) and exploit them for (1) EU's Common Agricultural Policy (CAP) monitoring, (2) surface water quality assessment, (3) sensor journalism, and (4) land border change detection.

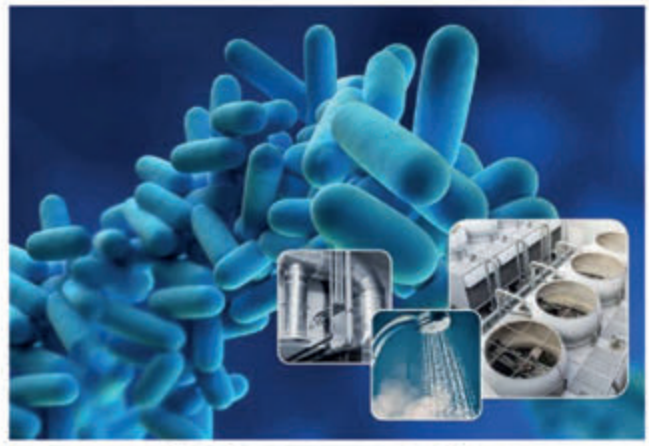
When surface water is exploited for drinking purposes, treatment plants managers need to monitor any possible change in the chemical, biological and physical status of the resource. Therefore, they are constantly looking for accurate, high spatial and temporal resolution sensors for water quality variables.

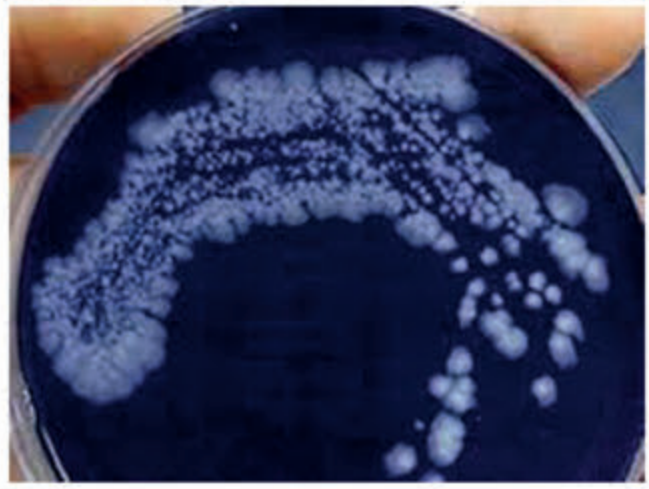
Optical remote sensors can aid in fulfilling these needs by measuring changes in the light back-scattered from water surface. Space-borne remote sensing data provide insight in the spatial variability of water quality parameters, while in situ remote sensing sensors, mounted on autonomous pointing systems, allow depicting temporal variability. During the first year of the project, satellite sensor data have been collected and processed for two water reservoirs (the Blankaart in Belgium and SMAT Lagoon on Po River in Italy). Hyperspectral autonomous radiometers have been deployed at Blankaart providing continuous measurements of the water surface in order calibrate atmospheric correction algorithms for data processing and improve the accuracy of water quality products. During the second year of CALLISTO, the trained algorithms will be tested on SMAT lagoon and integrated with sampling and online monitoring data, in order to setup up the best possible strategy for water quality monitoring, exploiting cutting edge technologies.

"Satellite sensor data have been collected and processed through atmospheric correction algorithms, in order to improve the accuracy of water quality products"

LEGIONELLA RISK ASSESSMENT IN WORKPLACES

Status	Ongoing
Starting date	October 2021
Duration	6 months
External funding	No
Partners	//





Legionella, as expressly indicated also by the WHO, is the waterborne pathogen that produces the highest health burden in Europe.

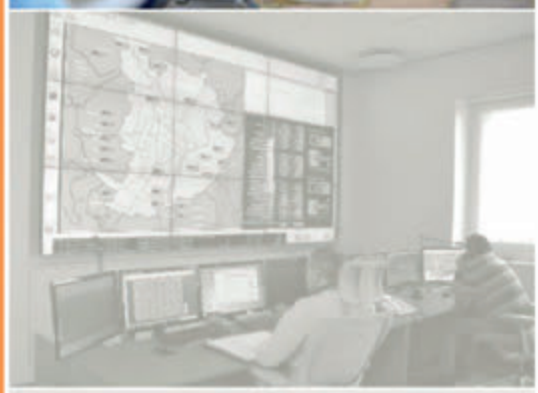
As part of the prevention of legionellosis, risk assessment is the first step to identify and evaluate the critical aspects in order to be able to proper manage them, identifying the most suitable preventive and corrective measures useful to reduce the risk.

With regard to the risks deriving from Legionella infection in community areas, the Official Guidelines issued by the Italian Health Ministry represent the most important national regulatory reference; they provide information for tourist-accommodation facilities, spas and health facilities.

As regards to workplaces, the reference legislation is the consolidated text on health and safety at work, which classifies legionella among the biological agents to be evaluated. This project aims at defining a methodology for carrying out risk assessment in the workplace to be progressively applied to all SAMT sites; it starts from the collection of the information useful for providing an in-depth knowledge of the system, up to the identification of the main critical issues and the most suitable solutions to prevent and contain the risk.

"Risk assessment is fundamental in the prevention of legionellosis in workplaces"

Water networks



TURIN URBAN DRAINAGE SYSTEM MODELING AND ANALYSIS OF CRITICALITIES

Status	Ongoing
Starting date	December 2020
Duration	24 months
External funding	No
Partners	DIATI – Polytechnic University of Turin

The last analysis of Turin's urban drainage system dates back to about 50 years ago.
Since then, three events have occurred that have greatly changed the hydraulic situation: (i) increase in waterproofed urban soil in exiting areas, (ii) the construction of new urbanized areas and (iii) climate change.

The urban change that the town has undergone in the last 50 years is evident, with a sharp increase in the waterproofing of the surfaces and the growth of the drainage areas. In several areas of the Turin area, the situation is so compromised that the establishment of new residential and / or industrial areas could be fatal for the urban drainage system.
Another key aspect is the imminent construction of the new Turin median collector. This is a work destined to have a strong impact on the structure of the urban outflow and which, if properly harmonized with the hydraulic context of the existing network, can make a fundamental contribution to making the Turin drainage system safe in future decades.
Finally, there are climate changes, which are evident to everyone in daily experience. In particular, the increase in very intense events, precisely those that most create problems for the drainage network.

Faced with this picture, an accurate and complete analysis of the current network is therefore urgent, of how it will respond to the growing pressure in the coming years, of what actions can be taken to mitigate the risks of flooding and breakdowns and how it can hydraulically interact with the new median manifold. This study will deal with answering precisely these questions.

"An accurate and complete analysis of the current network is therefore urgent, of how it will respond to the growing pressure in the coming years, of what actions can be taken to mitigate the risks of flooding"

FEASIBILITY STUDY FOR THE PROVISION OF A REMOTE MONITORING SERVICE FOR LEAKAGE DETECTION IN THE WATER DISTRIBUTION NETWORK

Status	Ongoing
Starting date	November 2021
Duration	6 months
External funding	No
Partners	DigiSky, ESA, EnelX, e-Geos

The ever-increasing availability of satellite data acquired by various space missions, often made available to users in an open and free way, combined with the growing ability to transform these data into information, makes it possible to create innovative services useful in different framework.

The approach currently used for the assessment of water losses in distribution is expensive because it must be carried out step by step to cover the whole distribution network.

For this reason SMAT is joining a feasibility study, promoted by DigiSky together with ESA and EnelX, in collaboration with e-Geos which will handle the processing of satellite data; the goal is to evaluate the effectiveness of these systems in detecting losses in the distribution network.

The proposal intends to integrate two different technologies; active satellite remote sensing, used to monitor subsidence phenomena through the use of Synthetic Aperture Radar (SAR) on the one hand and aerial thermographic remote sensing to monitor the presence of surface thermal anomalies on the other. The service to be developed is a dedicated web platform on which to converge the monitoring data that will be used for water loss detection.

"The satellite data, combined with the data acquired from aerial systems, will be processed in order to identify water leakages in the water distribution network"

MONITORING AND REMOTE CONTROL OF WASTE WATER NETWORK CONNECTED TO CASTIGLIONE TORINESE WASTE WATER TREATMENT PLANT

Status	Ongoing
Starting date	December 2021
Duration	24 months
External funding	No
Partners	DIATI – Polytechnic University of Turin

The project aims to analyze and improve the management of the waste water network (WWN) connected to the waste water treatment plant located in Castiglione Torinese.

The WWN analyzed in this study allows the transport of wastewater produced by users distributed in 48 municipalities in a safe and controlled manner.

It is intended to improve the management of the WWN, consisting of three main channels, (North, West and South), in addition to the channel that collect Turin waste water, through an approach that allows to know the status in real time of all the physical variables involved in order to guide the operational management choices using a scientific-based methodology.

It will be possible to obtain this result through the use of data collected by flow and water level monitoring stations that will be installed along the channels. These data will be integrated with the results of mathematical modeling of the whole system. Mathematical modeling will also allow verifying the functionality of the system by simulating particular situations in order to predict any critical issues.

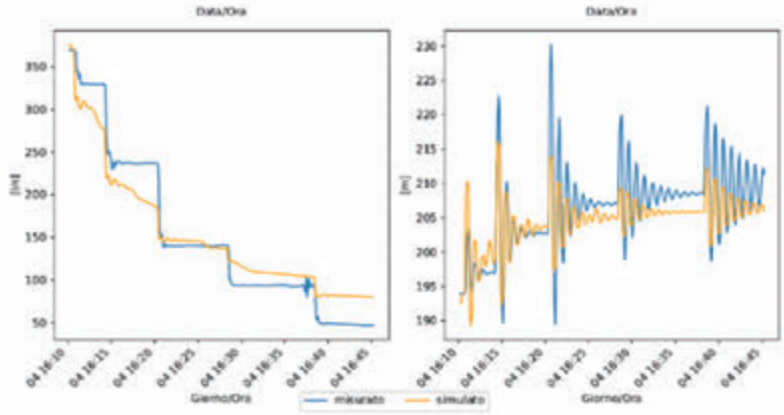
The project will be developed in collaboration with the hydraulics research group of the Politecnico di Torino, which will deal with aspects related to mathematical modeling, and will involve, in addition to the Research Center, which is entrusted with the coordination of the various activities, the Operating Centers. and Central Technical Services.

"The project aims to analyze and improve the management of the waste water network that allows the transport of wastewater produced by users distributed in 48 municipalities in a safe and controlled manner"

Supervision

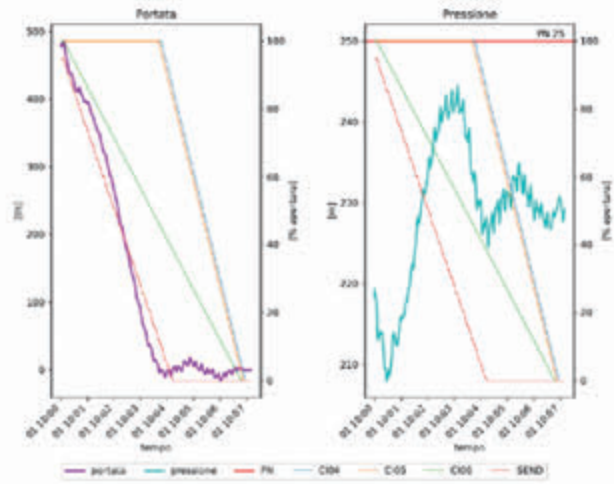
DESIGN OF AN INTELLIGENT AUTOMATION FOR THE MANAGEMENT OF THE SUSA VALLEY AQUEDUCT

Status	Ongoing
Starting date	May 2021
Duration	12 months
External funding	No
Partners	//



The new Susa Valley aqueduct is designed to meet the water needs of the area by supplying a significant quantity of water of high natural quality.

The project involves 27 municipalities, from Bardonecchia to Caselette, through the construction of 96 km of pipelines with a flow rate of 600 litres per second. This is a highly technologically advanced plant which, through a sophisticated remote control and remote monitoring system, features a high level of automation.



The Susa Valley Aqueduct safety system was developed in this project. It consists of the automatism that governs the system for shutting down the various sections of the aqueduct main line in the event of a pipe break.

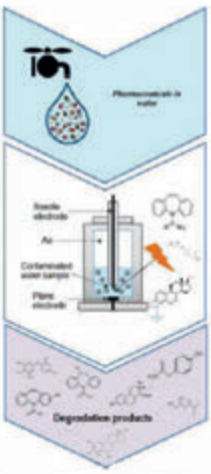
The automatism consists of two phases. The first phase concerns the detection of the conditions that determine the start of the out-of-service procedure. These conditions must be defined for each site, and updated according to the condition of use, since they depend on the deviation between the usual behaviour of the physical and hydraulic quantities and the possible anomalies resulting from a rupture. The second phase is represented by the definition of the choice of the valves to close and the sequence to adopt, in order to avoid dangerous pressure drops, and the verification of the maximum and minimum pressure resulting from pressure transient (i.e. water-hammer effect).

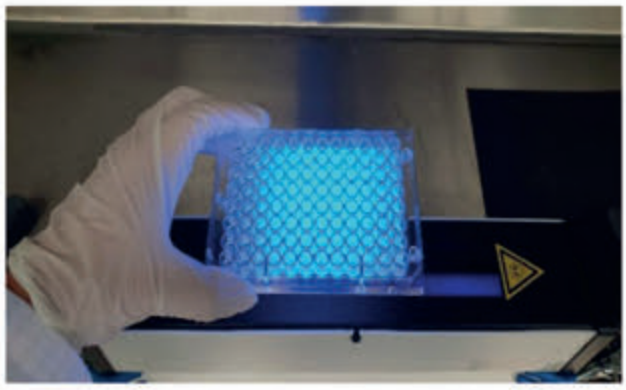
"The new Susa Valley aqueduct is a very technologically advanced plant with a high level of automation"

Treatment

AQUALITY: INTERDISCIPLINAR CROSS-SECTORAL APPROACH TO EFFECTIVELY ADDRESS THE REMOVAL OF CONTAMINANTS OF EMERGING CONCERN FROM WATER

Status	Ongoing
Starting date	October 2017
Duration	60 months
External funding	Yes (Horizon 2020)
Partners	Univ. Torino, Aalborg Univ., CNRS (Francia), Plataforma Solar del Almeria, Panespistinio Ianninon, et al





AQUAlity is a multidisciplinary and cross-sectoral research project funded by European Union under the Horizon 2020 program and the Marie Sklodowska Curie Actions – Innovative Training Networks (Project N. 765860). Its main research aim is to find new sustainable hybrid treatment processes for the removal of emerging contaminants (e.g., PFASs, pesticides, pharmaceuticals, endocrine disruptors, etc.) such as oxidation processes using solar energy (sun driven), combined with membrane filtration systems (graphene, high flux ceramics, etc.) within the concept of Innovation for Circular Economy.

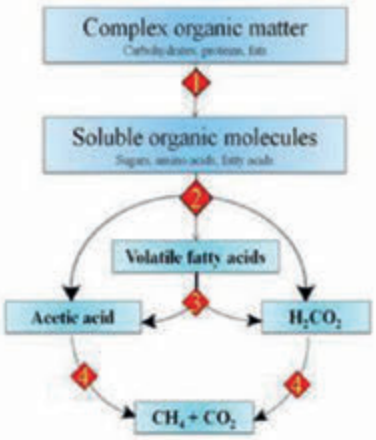
In 2021, a non-target screening of surface water samples taken from different locations in Italy and Greece was carried out, in collaboration with the University of Ioannina (Greece), the University of Alessandria (Italy), and the University of Turin (Italy). The aim of this study was to evaluate and understand the holistic quality status of European water bodies. Analyses were done using High Resolution Mass Spectrometry (HRMS) highlighted the presence of a wide variety of compounds, including pharmaceuticals, pesticides/herbicides, PFAS and personal care products, while elaboration of the data with multivariate statistical analysis tools identified different pollution patterns.

The results obtained highlighted the need of including a non-target approach as the first step in monitoring assessments, in order to evaluate the quality of water sources, prioritize the contaminants to be included in quantification studies and take decisions for treatment needs. Finally, the data obtained were updated in the Digital Sample Freezing Platform (DSFP) of NORMAN Network allowing the performance of a wide-scope retrospective screening for thousands of environmentally relevant suspect contaminants and their transformation products. This attempt allows for a user friendly visual assessment of the spatial distribution of substances of potential interest, and indicate possible sources of pollution.

"The objective of this European "training through research" inter-disciplinary and inter-sectoral project is to investigate innovative and hybrid methods to remove emerging pollutants from water"

SLUDGES IV

Status	Ongoing
Starting date	June 2020
Duration	24 months
External funding	No
Partners	Polytechnic University of Turin



The optimisation of sewage sludge treatment processes is a theme of primary importance, not only for the reduction of sludges to be managed, but also for the maximisation of energy and material recovery in a circular economy perspective.

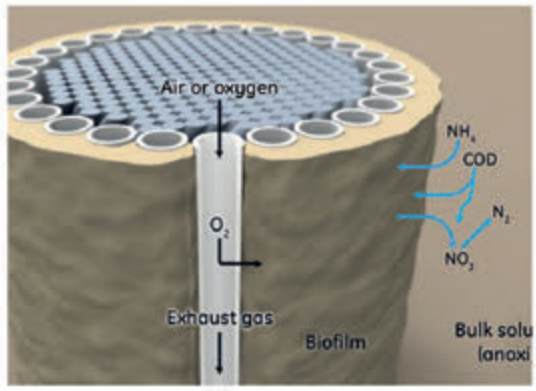
The purpose of this project is a pilot scale experimental test of the performances, in terms of biogas production increase and organic substances recovery, of different 2-stage configurations for primary and waste activated sludge anaerobic digestion.

We are currently investigating the 2-stage anaerobic digestion of primary sludge. In the first stage the primary sludge is subject to an acid fermentation with a limited retention time (3-4 days), with the aim of fostering hydrolysis and acidogenesis (trough the inhibition of methanogenesis) for the production of volatile fatty acids (VFA). These latter are extremely interesting compounds as they can be used for biopolymer production or, in future, as raw feedstock for chemical industry or, more simply, for biological phosphorus removal in wastewater treatment processes.
At the same time, we are performing a pilot scale experimental test devoted to biological pretreatment of waste activated sludge in thermophilic condition followed by mesophilic anaerobic digestion. Notably thermophilic biological pretreatments, as compared to already tested thermo-alkali pretreatments, could achieve comparable methane production increase with thermal energy and chemical savings.

"The purpose of this project is a pilot scale experimental test of the performances of different 2-stage configurations for primary and waste activated sludge anaerobic digestion"

MABR
MEMBRANE AERATED BIOFILM REACTOR

Status	Ongoing
Starting date	June 2020
Duration	36 months
External funding	No
Partners	Polytechnic University of Turin



Biological waste water treatment processes are notoriously energy intensive, especially the aerobic ones that consume oxygen for the oxidation of organic and nitrogen substances. In facts oxygen transfer from gas phase to liquid phase (namely the dissolution) is a relatively limiting factor.
Common aeration systems, based on the production of small air bubbles trough diffusers installed at the bottom of the tanks, are characterised by an oxygen transfer efficiency generally in the order of 20%.

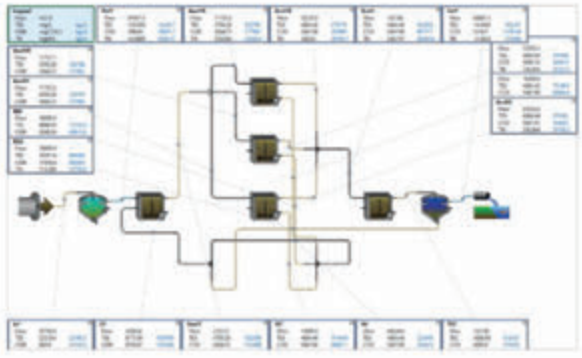
A recent and really promising technological innovation, called MABR (Membrane Aerated Biofilm Reactor), provides for the use of hollow fibre membrane for oxygen transfer in liquid phase. Air is blown inside the hollow fibres immersed in oxidation tanks and oxygen is directly consumed by biomass developed on membrane external surface. By this way there is not more need for producing air bubbles to achieve oxygen transfer, and aeration energy efficiency is greatly increased. Moreover, oxidising conditions develop only inside the biofilm at membrane interface, making possible the denitrification, in anoxic conditions, in the same biological reactor.
In the framework of the project, we set up a laboratory pilot MABR and we started the experimental tests with synthetic wastewater (later we will test real wastewater). The purpose of the research project is the experimental test of MABR technology performances in terms of treatment efficiency and aeration energy efficiency, as well as assessing MABR strengths and possible weaknesses and their applicability to SMAT plants.

"The purpose of the research project is the experimental test of MABR technology performances in terms of treatment efficiency and aeration energy efficiency"

INNOVATIVE WASTEWATER TREATMENT PROCESS MODELLING

Status	Ongoing
Starting date	June 2020
Duration	24 months
External funding	No
Partners	Polytechnic University of Turin

Mathematical models of physical, chemical and biological processes of wastewater treatment are instruments of great importance for plant management, since they give the opportunity to simulate the operation and foresee the plant's behavior in response to changes in operational parameters.
The models (for sure the most renowned is ASM – Active Sludge Model) allow to optimize operational management, in terms of treatment performance, sludge production, energy consumption and chemicals consumption.



During the first phase of the project, we analysed the deammonification process (DEMON) recently installed at Castiglione T.se plant and we identified the best regulation strategies and the actions for potential troubleshooting.
Following the introduction of the intermittent aeration logic and biological phosphorus removal process in wastewater treatment line of Castiglione T.se, it was necessary to update the mathematical model of the classical MLE denitrification-nitrification process, that we developed during past research projects, with a more sophisticated model based on ASM3.
During the second part of the project, we started the sampling campaigns and experimental tests, also based on respirometry techniques, aimed at wastewater characterization (fractioning) and estimation of process kinetic parameters and their variation as a function of operative parameters. Based on these data we will setup and calibrate the model, that will be used for the optimization of the process and for the assessment of control and regulation strategies.

"Mathematical models of physical, chemical and biological processes of wastewater treatment are instruments of great importance for plant management"

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Inauguration of the leachate pipeline of the Chivasso waste water treatment plant

Conference: "The protection of well fields"- SMAT Water Pavilion

Reorganization of the water service in Susa Valley – Valle Susa aqueduct

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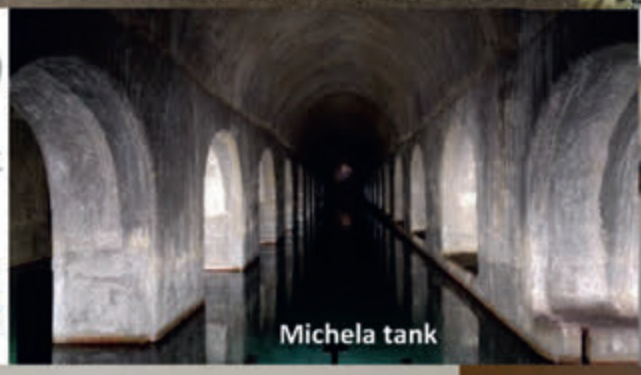
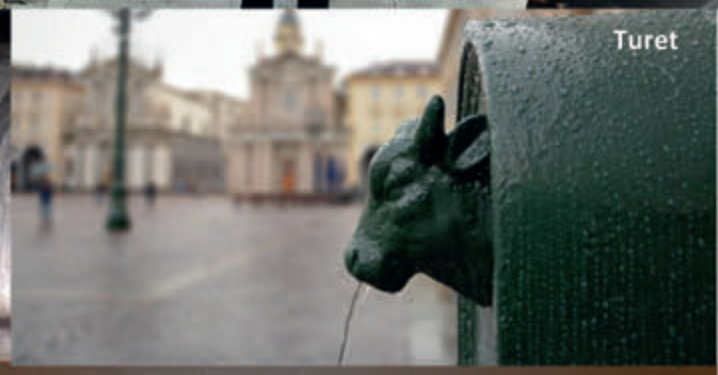


Michela tank



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Smat-ARPA Piemonte agreement on wastewater monitoring for the research of SARS-Cov-2

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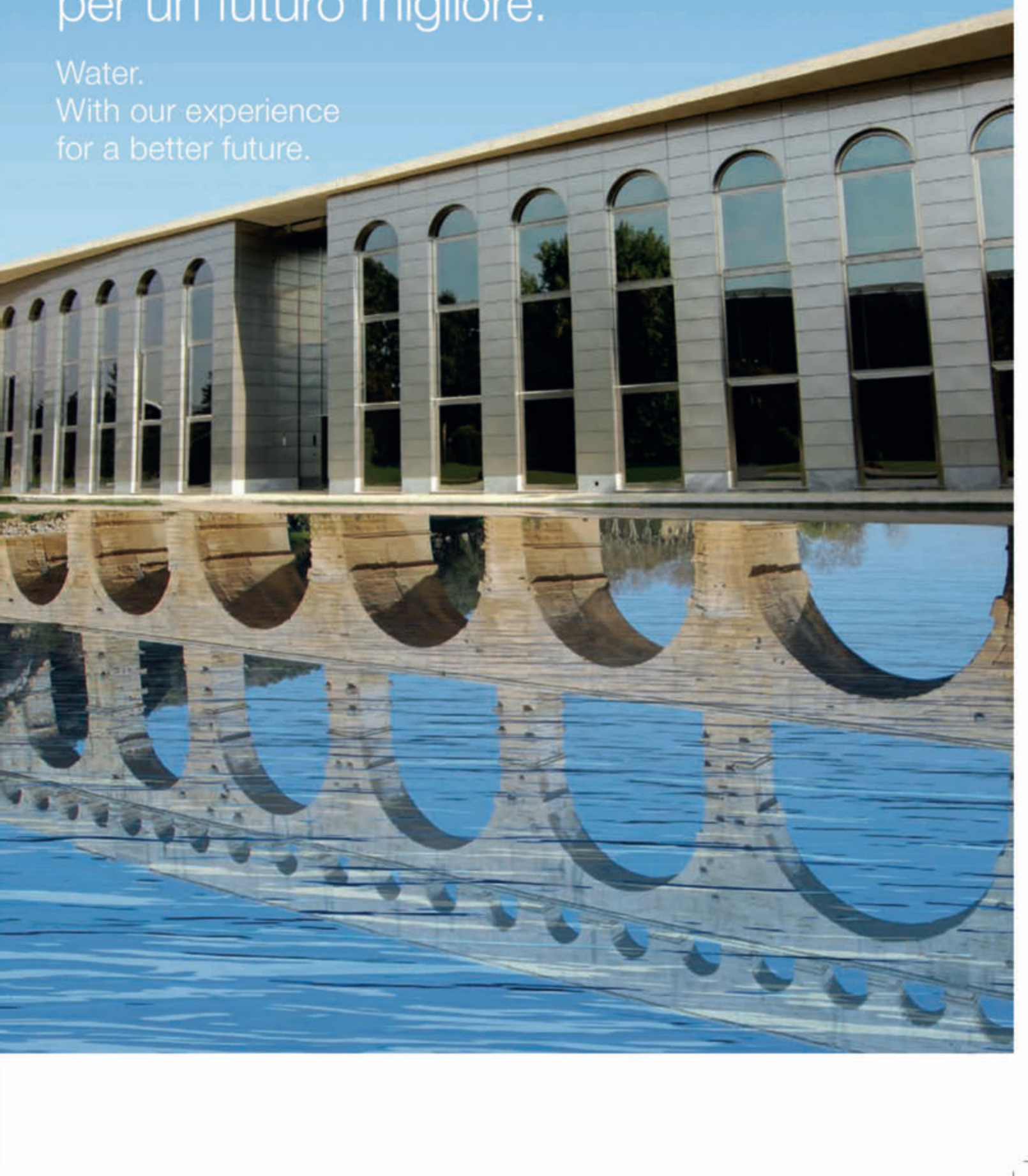

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