WATER JOINT PROGRAMMING INITIATIVE

WATER CHALLENGES FOR A CHANGING WORLD

2018 JOINT CALL
Closing the Water Cycle Gap

“Tools and criteria for URBAN groundWATer management”
“URBANWAT”

1. EXCELLENCE

1.1. Introduction

The World's population has reached 7 billion and cities have become the main human living space. Cities around the world face the challenge of impact managing on the environment and the stresses on infrastructure. As a result, sustainable cities concept is a global movement, with the major objective of making cities greener and healthier places, with sustainability involving economic viability, social stability, and wise use of resources while protecting the environment. The sustainability of natural resources, such as groundwater resources, is one of the greatest dares of the European Union and it constitutes a social, economic and technological challenge. The groundwater management in urban areas is under increasing pressure due to the global population growth. Subsequently, new water sources and a better knowledge for its management is needed to cope with this situation. Upward urbanization, the fast socio-economic development, waste and degradation of water resources make it imperative to rethink conventional concepts to change from an approach to manage different aspects in isolation of the urban water cycle to an integrated approach backup by all stakeholders. For instance, integrating the impact of certain pollutants throughout the cycle and their behavior it is of paramount importance to define the potential uses of the alternative resources of water. Then, in urban areas **some problems** arise which must be taken into account for a correct management of water resources as: (1) Increased urbanisation; (2) Increased number and quantities of contaminants and some of them unknown; (3) Complexity of the flow paths between superficial and subsurface infrastructures; and (4) Increased water resource demand and water quality.

Often, urban areas must pump water resources to cover various aspects of the growing urban water demand and as a strategic resource to cover demand at specific times, such as droughts, accidents, etc. These considerations lead one to wonder whether urban groundwater can be safely used, including its potential use as drinking water. Urban aquifers can contain a wide range of pollutants which there are not included in the lists of priority pollutants due to the existing regulatory gap. Many of these pollutants are organic contaminants never detected before because of analytical difficulties (*e.g.* very polar compounds). This project aims to determine and prioritize the detection of this known and unknown pollutant by using "target" and "non-target" methodologies based on the use of high-resolution mass spectrometry available at the CSIC. The knowledge of the movement of contaminants in groundwater is crucial to ensure the good management of such resource. For that purpose, this project proposes the development and (real-life) testing of environmental-friendly encapsulated DNA nanoparticles specifically used for hydrological tracing. Once the conceptual model of the system to be investigated is defined, it will allow applying remediation systems to reduce contaminants in groundwater and to evaluate the ecotoxicological risk. This project also aims to identify microbial fecal indicators as well as known and emergent and new viral pathogens in groundwater samples by applying metagenomic-based techniques with the purpose of gaining knowledge in the potential risks related to the future use of these resources as irrigation or drinking waters. The comparison between the use of classical and new biological indicators to trace the origin of fecal pollution with the use of encapsulated DNA nanoparticles may represent a very interesting output of this project. Moreover, modeling process allow to quantify the hydric and mass balance and simulate different scenarios for planning the sustainable use of groundwater resources and address global changes such as climate change. On the other hand, in recent years, some technologies have emerged with the aim to retrofit into the existing urban drainage infrastructure to improve water efficiency and expand a city's capacity to manage storm water and flooding. These blue infrastructures aim at reducing peak flow, i.e. in flash floods, by increasing infiltration of storm water runoff. On the other hand, storm water runoff contains several kinds of pollutants and enhanced infiltration of these waters may cause substantial groundwater pollution. Then, the soil water plant continuum has an important role in attenuating pollution.

URBANWAT project aims to work on detection of substances, study potential water filtering in urbanized settings, develop ultrasensitive tracing technology and environmental water flow paths and e.g. calibrate an urban GW model (modelling the 'urban' water cycle). To achieve this, the URBANWAT project proposes two complimentary scales of research: theory/lab scale and real city scale. In the first case, URBANWAT makes use of a full-scale testing and demonstration facility called 'WaterStreet' at TUDelft. Complimentary, this project has chosen Barcelona city as pilot area. The quality of Barcelona aquifers has deteriorated due to several sources of pollutants both organic and inorganic. In recent years, the urban area of Barcelona is betting on improving groundwater management with the aim of increasing groundwater uses. In addition, the pumping of these waters may be necessary or useful to cover several aspects of the growing urban water demand and as a strategic resource to cover demand at specific times, such as droughts, accidents, etc.

1.2. State-of-the-art and relation to the work programme

Call topic: The **project is framed** within one of the five themes of the "Strategic Research and Innovation Agenda (SRIA)" in the theme number 5 "Closing the water cycle gap improving sustainable water resources management". JPI topics closely relate to the current environmental and natural water resource problems and its management, requiring the development of new tools and criteria for innovative water management strategies. Indeed, the URBANWAT project aims to develop a tool and a set of criteria to integrated management of aquifers in urban areas and in such it will contribute to ensure a good state of the groundwater system in urbanised areas. The development of this project will constitute a way to identify strong links and interactions between the availability and quality of water resources and socio-economic development in order to launch long-term water resource planning and governance policies. These facts promote a substantial improvement in groundwater management in urban areas facing global changes together with the involvement of all the stakeholders. In this way, the knowledge of the effectiveness and efficiency of existing economic mechanisms is increased and water management policy instruments are given. This will provide managers with a series of management guidelines for efficient uses of water, including in extreme weather events and it will support improved decision-making to ensure the long-term availability of water resources.

State of the art: Urban water management is under increasing pressure due to the global population increase and in particular as a result of the increase in population in urban areas and the need for new sources of supply arises. The quality of the Barcelona aquifers has been strongly deteriorated, due to several sources of emission of both organic and inorganic pollutants, same as other European cities. Currently, the groundwater is used for urban uses such as parks and gardens irrigation, street cleaning, etc., but in recent years, the city of Barcelona is betting on the improvement in the management of the use of groundwater with the objective of extending its uses. Urban aquifers can present a wide range of pollutants (Howard et al., 1996[1]; Barrett et al., 1999[2]; Vázquez-Suñé et al., 2005[3], Jurado et al., 2012[4]). Apart from the "known" pollutants, a large number of polar organic compounds that are still unknown and can be anticipated to occur as micropollutants in the aquatic environment and can pass through wastewater treatment plants, leach through the ground. To these must be added products from the transformation of the originals, either prior or in situ in the groundwater through different degradation processes. These transformation products (TPs) are usually ignored in the targeted analysis, essentially due to the lack of authentic patterns essential for the creation of quantitative methods. Viruses are attractive tracers of short travel times in aquifers because they have unique genetic signatures, are detectable in trace quantities, and are mobile in groundwater (Hunt et al., 2014[7]). The detection of viruses in groundwater samples requires previous concentration steps which at the moment do not dispose of standard and easy to apply protocols. Metagenomic techniques emerged as techniques which allow us to know which viruses, known and new, are present in a determined water sample. Detection of viruses have been also used as Microbial Source Tracking tools (Bofill-Mas et al., 2013[8]). Overall, there are few studies reporting the occurrence of viruses in urban underground water samples. In recent years, the use of nanoparticles as hydrological tracer got increasing attention and the first results show enormous potential for applicability in environmental

[1] Howard, K. W. F. and Israfilov, R. (2002) Current problems of hydrogeology in urban areas, urban agglomerates and industrial centres, Series IV: Earth and Environmental Sciences – Vol. 8, Kluwer Academic Publishers, Dordecht, 500 pp.
[2] Barrett, M.H., K. M. Hiscock, S. Pedley, D.N. Lerner, J. H. Tellam and M. J. French (1999) Marker species for identifying urban groundwater recharge sources: a review and case study in Nottingham, UK Water Resources. Vol. 33, nº 14, pp 3083 – 3097.

[3]Vázquez-Suñé, E., Sánchez-Vila, X., and Carrera, J. (2005) Introductory review of specific factors influencing urban groundwater, an emerging branch of hydrogeology, with referente to Barcelona, Spain, Hydrogeol. J., 13(3), 522–533.
[4] Jurado, A., Mastroianni, N., Vàzquez-Suñé, E., Carrera, J., Tubau, I., Pujades, E. and Barceló, D. (2012). Drugs of abuse in urban groundwater. A case study: Barcelona. Science of the Total Environment, 424, 280-288.

studies[5],[6]. However, real-world testing, especially in the complex urban water systems has not been done. Taking advantage of the ideal conditions of WaterStreet, a series of tracer tests will be carried out using different types of tracers such as conventional tracers, viruses and nanoparticles.

On the other hand, it should also be borne in mind that when a natural environment is urbanized, an important part of the surfaces is waterproofed causing the water that previously infiltrated, now runs on the surface and it is necessary to collect it. As a consequence of this waterproofing, the natural water cycle is altered, resulting in higher runoff volumes and higher peak flows. It also prevents rain from infiltrating the ground and recharging aquifers. In recent years, it has increased the use of Urban Systems of Sustainable Drainage so that the hydrological response of an urbanized area is as similar as possible to the one it had in its original state. To these disadvantages, we must add the contamination of that water. Rainwater drags pollutants suspended in the air and when a waterproof soil runs through the surfaces, which are often contaminated by oils and fuels of vehicles, remains of industrial activities and all kinds of substances. **Phytoremediation** is an emerging technology used to remove, degrade, or contain contaminants located in the soil, sediments, groundwater, surface water, and even the atmosphere (Chappell, 1997[7]). In the last time, numerous efforts have been dedicated to investigating the feasibility of phytoremediation technology for removal of contaminants from soil and water (Kumar et al., 2018[8]; Trapp and Karlson, 2001[9]).

City scale

In the last decade, great efforts have been made to investigate the groundwater of the city of Barcelona through projects promoted by the Catalan Water Agency and by the City Council of Barcelona. Since 2006, several field campaigns were carried out in which apart from analyzing chemical and isotopic compounds, some organic compounds were also analyzed, some of them considered "Emerging Organic Pollutants" (Tubau et al., 2010[10]; Lopez-Serna et al., 2013[11]). As a result, of all these studies, there is a problem associated with the generation of a large volume of data to be managed. Another result is a numerical flow model that it that should be updated and improved by integrating all the vectors involved and the pollutant cycle.

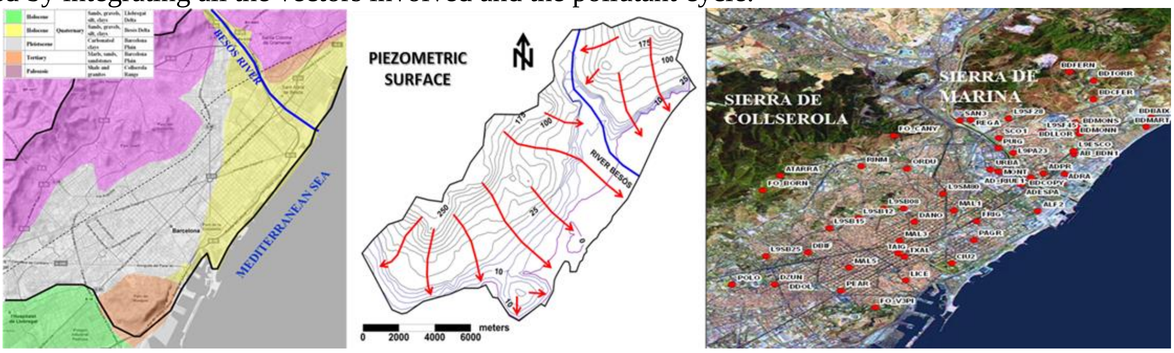

Figure 1. Schematic description of the hydrogeology of Barcelona, piezometric map of the study area and distribution of wells and piezometers sampled in the 2006-2007 campaign.

[5] Liao, R., Yang, P., Wu, W., Luo, D., Yang, D. A DNA Tracer System for Hydrological Environment Investigations (2018) Environmental Science and Technology, 52 (4), pp. 1695-1703. DOI: 10.1021/acs.est.7b02928

[6]Foppen, JW and TA Bogaard (2018): Application of nanoparticles tagged with synthetic DNA in Water treatment/Water management. Chapter 11 In "Fabrication and Application of Nanomaterial". Ed. Sulalit Bandyopadhyay (in prep).

[7] Chappell, J., 1997. Phytoremediation of TCE Using Populus. Status report prepared for the US EPA Technology Innovation Office under a National etwork of Environmental Management Studies Fellowship

[8] Kumar, N., Kulsoom, M., Shukla, V., Kumar, D., Kumar, S., Tiwari, J., & Dwivedi, N. (2018). Profiling of heavy metal and pesticide residues in medicinal plants. Environmental Science and Pollution Research, 1-6.

[9] Trapp, S., Karlson, U., 2001. Aspects of phytoremediation of organic pollutants. Journal of Soils and Sediments 1, 37–43.

[10] Tubau, I., Vázquez-Suñé, E., Carrera, J., González, S., Petrovic, M., de Alda, M. J. L., & Barceló, D. (2010). Occurrence and fate of alkylphenol polyethoxylate degradation products and linear alkylbenzene sulfonate surfactants in urban ground water: Barcelona case study. Journal of Hydrology, 383(1-2), 102-110.

[11] López-Serna, R., Jurado, A., Vázquez-Suñé, E., Carrera, J., Petrović, M., & Barceló, D. (2013). Occurrence of 95 pharmaceuticals and transformation products in urban groundwaters underlying the metropolis of Barcelona, Spain. Environmental Pollution, 174, 305-315.

Open-air lab-Waterstreet

The Dutch Waterboard Delfland, The EU project VPdelta and TUDelft initiative of The Green Village developed the WaterStreet, a full-scale, open-air, laboratory for experiments, research and demonstrations. Entrepreneurs, researchers and policy makers collaborate to develop new, innovative products to cope with urban water problems as response to climate and socio-economic changes. The WaterStreet offers a flexible facility to test, improve and show-case innovative products related to urban water management. Examples are semi-permeable roads, autonomous filtering drainage systems, smart water collectors, etc. In this way, WaterStreet contributes to accelerate development of innovations (the step from laboratory to real-world testing is often a critical point) and its acceptance in society. In such, the WaterStreet aims to contribute to sustainable cities. The WaterStreet is situated at The Green Village, part of the campus area of Delft University of Technology.

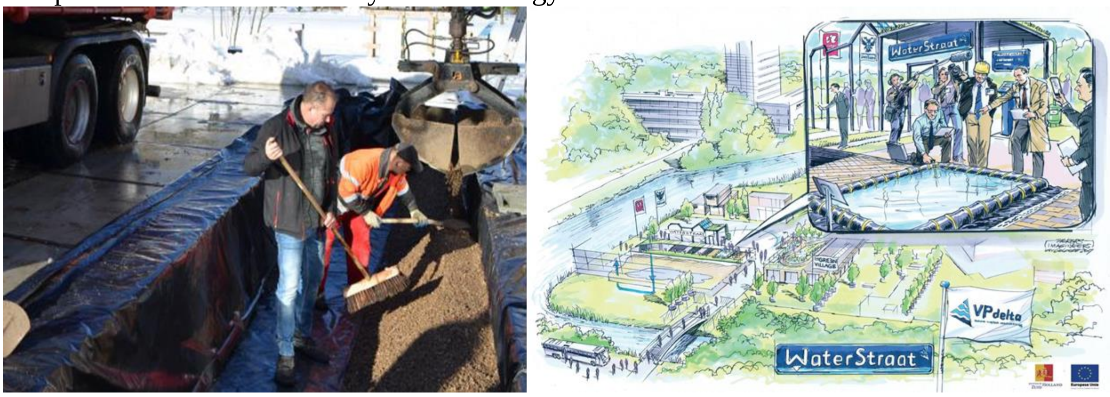

Figure 2. Construction and scheme of facilitiesWaterstreet.

1.3. Objectives and overview of the proposal

The general objective of the proposal is to improve existing tools and criteria for groundwater management in urban areas to ensure the sustainability of urban water resources and define their potential uses, from an integrative approach. In this way, it is committed to the circular economy of water, trying to make the hydrological cycle circular, efficient and sustainable, thereby improving quantitative and qualitative aspects. Taking into account the main objective, URBANWAT will work on detection of substances, study potential water filtering in urbanised settings, develop ultrasensitive tracing technology and environmental water flow paths and e.g. calibrate an urban GW model (modelling the 'urban' water cycle). For this, several specific objectives have been defined:

1. Identification of the origin, concentration and dynamics of known and emergent pollutants (inorganic, organic and microbiologic), using new analytical methods and evaluation of their behavior, in particular, of organic contaminants and their related transformation products. Study of the contamination movement using a novel encapsulated DNA nanoparticles.
2. Parametrization of preferential flow paths in soil hydrology and groundwater recharge using a full-scale experimental facility (waterstreet) to define different scenarios and quantitative data to be introduced in the developed models to city scale
3. Evaluation of the ecotoxicological and microbiological risk associated to the differents uses of groundwater and proposal of innovative remediation measures to improve water quality.
4. Integration of the vectors of the hydrological cycle investigated in a flow and transport model for pollutants as a management tool which will help in the new plans of uses and integrated management of aquifers to assess of uncertainties related to climate change mitigation, climate adaptation strategies.
5. Application and validation of the obtained developments to the definition of the sustainable use of resources demonstrating their replicability in other cities.

1.4. Research methodology and approach

URBANWAT project propose an inter/multidisciplinary methodology based on innovative approaches to improve tools and criteria for groundwater management in urban areas. These approaches will be applied in Barcelona city like a pilot area and then, we will apply them in the full-scale testing and demonstration facility called "WaterStreet"

at TUDelft. The technology to be used can be easily transferred to other countries in Europe facing the same environmental problem. In conclusion, URBANWAT actions have a European added value.
The organic, inorganic and microbiological analysis will be done by CSIC and UB. The main aim is to know the current water quality and to produce a hydrological and hydrogeochemical mapping of water bodies for further assessment of their quantity and quality. We will capitalise on our recent and on-going research in close collaboration with authorities, which gives us free access to the different fully operational water monitoring networks across the city in Barcelona. We shall undertake monitoring of piezometric levels and in-situ general water quality parameters including pH, Eh, temperature, EC, etc, across the piezometric control network, which is fitted with integrated automatic systems with sensors that continuously monitor water quality. We shall evaluate the seasonal variation by undertaking two sampling campaigns (winter/summer). All the aqueous samples will be collected in High-density polyethylene (HDPE) and glass containers, depends on the analysis. The different aqueous samples will be analysed at CSIC for the determination of anions, cations, tracer and isotopes $^{2}H/^{18}O$ (WS-CRDS) and $^{34}S/^{18}O$ (ThermoQuest TC/EA). CSIC has developed a generic extraction for organic contaminants that consists of four cartridges connected in series (Oasis HLB, Bond Elut PPL, Oasis MAX and Oasis MCX) that are eluted separately. Currently, it is well known that there are thousands of contaminants that potentially can be present in groundwater. Its detection, confirmation of identity and correct quantification constitute one of the greatest challenges of modern analytical chemistry. For this purpose, high-resolution mass spectrometry (HRMS) with Orbitrap or time-of-flight analyzers (TOF) will be used, which has a huge potential for screening analysis thanks to the particular characteristics of this technique, which allows the acquisition of the full mass spectrum ("full-scan"), with high sensitivity and sufficient resolution to obtain a robust mass accuracy.
In terms of microbiological analyses, the UB team will optimize concentration techniques by comparing already in use concentration techniques developed by the research group and based on organic flocculation (Calgua et al., 2008[12]) with new rapid methods which permit analyses of larger volumes based on ultrafiltration and which are easy to standardize. The possibility to concentrate different types of microbes (bacteria, viruses and protozoa) will be evaluated as well as the efficiency and applicability of the method. Microbiological analyses will be focused in microbial fecal indicators viable *E. coli* quantified by a Most probable Number ISO method, and human and animal adenovirus and polyomavirus through quantitative PCR assays already developed by the group (Bofill-Mas et al., 2013[13]) as well as by description of occurring known and new viral pathogen through application of metagenomic tools including targeted and direct approaches. Also, new viral pathogens will be described to occur through the application of metagenomic tools including targeted and direct approaches. Also, diverse bacteriophages with DNA and RNA genomes (MS2, PP7, Phi X 174), together with conventional tracers will be used in pilot area in TUDelft in comparison with DNA-tagged nanoparticles to be evaluated as contamination tracers. The most challenging aspect of application of DNA-tagged nanoparticles for determining flow transport is the development of strict protocols for application, sampling and analysis of the tracer. By comparing the environmental-friendly and ultrasensitive DNA-based tracers with conventional tracers, standards and protocols can be made. Lastly, to mimic the different transport characteristics of contaminants like viruses and bacteria, the DNA-tagged nanoparticles will need to be adjusted (re-designed) in order to optimize it use for specific contaminant tracing.

1.5. Originality and innovative aspects of the research (ambition)

In the water environment, there are a large number of polar and medium polar pollutants, which are still unknown (regulatory gap or analytical problems). Currently employed conventional analytical systems (target analysis) do not effectively to identify the tens of thousands of organic chemicals produced and used by man that can reach groundwater nor do the products coming from the transformation of the originals. URBANWAT proposes the use of HPLC instruments coupled to high-resolution mass analysers (HPLC-HRMS) for the determination of target and non-target compounds and/or transformation products ("suspect screening"). On the other hand, it is intended to use an innovative, robust, and environmental-friendly nanoparticle tagged with synthetic DNA to trace contaminant movement and travel times of water in natural systems. Moreover, we use multi-trace information in a travel-time

[12] Calgua, B., Mengewein, A., Grunert, A., Bofill-Mas, S., Clemente-Casares, P., Hundesa, A., ... & Girones, R. (2008). Development and application of a one-step low cost procedure to concentrate viruses from seawater samples. *Journal of virological methods*, *153*(2), 79-83.
[13] Bofill-Mas, S., Rusiñol, M., Fernandez-Cassi, X., Carratalà, A., Hundesa, A., & Girones, R. (2013). Quantification of human and animal viruses to differentiate the origin of the fecal contamination present in environmental samples. BioMed research international, 2013.

based model approach to capture dynamics in hydrological pathways. The exceptional property of DNA-tagging is the infinite number of unique tracers that can be produced and their detectability at extreme low concentrations. Second, progress in nanoparticle design makes it possible to influence surface characteristics of the nanoparticle and as such replace standard *E. coli* or bacteriophage tracers currently used assessing micro-biological contaminant transport. Such tracers give the water sector a unique tool for in-situ mapping of transport of contaminants and pathogenic microorganisms in water systems. The project also aims to produce an improved method for viral concentration from large volumes of water and to provide a list of potential newly emerging viral contaminants by application of metagenomics in groundwater samples which could suppose a problem regarding the use of this water for irrigation or as a drinking water supply. Additionally, we propose to test and analyse the use of selected infrastructures to analyse fate and transport of selected contaminant in the soil-plant continuum and gather further insights in the behaviour of such systems as a remediation system. In this way, the urban groundwater will be investigated using a set of tools, which will include innovative technologies that will provide practical information regarding the implication of and the risks associated with the groundwater quality for the environment and humans.

1.6. Clarity and quality of transfer of knowledge for the development of the consortium partners in light of the proposal objectives

URBANWAT relies on a solid base of previous projects of all partners. This project will provide the background knowledge on of the current state and the evolution and distribution of the quality of the groundwater of an urban area such as Barcelona base on the general chemistry, tracers, CECs and microbiology and will provide unconventional methods to improve the emerging contaminants detection. URBANWAT will use an innovative method to measure the mobility of pollutants. Building on this existing research potential, it represents an opportunity for close collaboration between partners and further advancing each partner's own research objectives as follows: CSIC possesses a high level of expertise in risks assessment and management related to groundwater quality, especially on the occurrence of emergent contaminants in the water cycle, and flow and transport modeling. However, at the same time, CSIC will benefit from the knowledge of the other partners as UB, CNRS and TUD and vice versa. UB together CSIC will determine the groundwater quality and the distribution of some pollutants by the WP 1 and 2. Based on the results of the WP1 and WP2, CSIC will able to identify the origin and behaviour of pollutants present in the hydrological cycle using statistical methods, besides to evaluate the transformation of polar compounds applying HRMS (Exactive orbitrap technology) technology. Once the quality of groundwater is known, the distribution of its pollutants and the behaviour of these, it is vital to trace contaminant movement and travel times of water in natural systems. For it, TUD will develop and test innovative encapsulated DNA nanoparticles for hydrological tracing. Knowing these aspects is crucial so that CSIC can develop a numerical flow and transport model which allow quantifying the water and mass balance and that it constitutes a tool to guarantee the good management of the groundwater in urban zones. Finally, once a robust conceptual model of the urban area has been defined, it is time to propose appropriate remediation techniques for this type of system that allows improving both the quality and quantity of groundwater. In this case, CNRS propose to analyse the role of the soil water plant continuum in attenuating pollution. For it, CNRS will carry out several laboratory experiments using different kind of plants to test and analyse the use of selected infrastructures to assess the fate and transport of selected contaminant in the soil-plant continuum and gather further insights in the behaviour. The results obtained from these experiments will provide generalise information transferable to other groups, public administration very interested in the results of this project, and thus is of high interest on the European level. The synergism between the partners will represent a significant income to develop the proposed research activity program. The **UB** lab has just finalised the coordination of a Water JPI project entitled METAWATER in which knowledge in the presence of microbes in several types of irrigation water has been obtained as well as development and optimization of metagenomics techniques and bioinformatics analysis for analysis of microbes by application of metagenomics. Some of the outputs of this project will be useful in URBANWAT. Also, VIROCLIME project, a EU funded project in which UB lab act leader in several WPs, provided tools for microbial source tracking of water samples. Thought the participation in this consortium the UB will gain knowledge in the use of DNA containing nanoparticles which could be incorporated as a routine technique in this laboratory. The group from the **CSIC** are coordinating the Water JPI "AWARE" project, and has previously coordinated the national SCARCE project as well as the European GLOBAQUA project. The focus of all these projects is the relationship between CECs and water scarcity. By participating in the URBANWAT project, CSIC will improve the understanding. The **CNRS team** works on water resource management at basin scale, water resource models as a tool for forecasting studies, water preservation, savings and reuse through technological innovation, and on contaminants and human risk assessment, mining pollution and environment-health issues. The CNRS team is in charge of different national (ANR AWARE, ANR IMAP, ANR ANSES, AERMC) and European projects (SUDOE-4KET4Reuse, UNESCO-sida). The group of **TUD** is one of the few groups in the world actively working with DNA-based tracers for environmental tracing. Furthermore, the TUD has an excellent track record in public-private collaboration and Transfer of Knowledge. The TUD is one of the PI's in the DOMINO project (JPI funded) working on monitoring for dike stability using Fibre Optic cable and strongly included end-users like Waterboards in the final design of the Fibre Optic based monitoring system. This project will improve the research of TUD as it will test the applicability of their DNA-based tracing technology developed recently at city scale.

1.7. Quality of the consortium partners and collaborative arrangements. Capacity of the consortium to reinforce a position of leadership in the proposed research field

The URBANWAT consortium is composed of 4 partners from 3 different countries. The URBANWAT consortium consists then of an interdisciplinary team from 3 European countries (Spain, France and the Netherlands) and 4 research organisations (CSIC, UB, CNRS and TUD) that have an extensive expertise in the field of groundwater management in urban areas and have been previously involved in several European and national R&D collaborative projects. Moreover, the **consortium is supported** by Catalan Water Agency (ACA), Barcelona Council (BCASA), Barcelona Regional (BR) (a public agency for strategic planning, urban planning and infrastructure), EUSAB-The City Council of Sant Adrià del Besòs, Foundation International Course on Groundwater (FCIHS), Barcelona University (UB) and Polytechnic University of Catalonia (UPC) for an ensuring a good transfer of the knowledge to the stakeholders. These organisms have an essential role in the management of water resources in the area of Barcelona and they will be taking part to training, participatory and dissemination activities envisaged by this project.

1. **Spanish Research Council (CSIC):** It is formed by Groundwater group and Environmental Chemistry Group. **Role:** CSIC, leader of the project, will be strongly involved in the project management and coordination of partners and tasks. Due to its strong expertise and competences in hydrogeochemistry, groundwater management, numerical modelling, developing multiple methodologies for the analysis of emerging contaminants will be responsible and strongly committed to the implementation of WP1 and WP3. In addition, CSIC experts will contribute to the WP4 and WP 5 focused on flow and transport numerical modelling and the evaluation of ecotoxicological risk, led by project partners. During the whole project duration, CSIC will contribute significantly to communication activities and will have a strong impact on project visibility by leveraging on CSIC communication media. CSIC experts will play a strong role in project result dissemination both in scientist and in academic activities.

2. **Laboratory of Viruses Contaminant of Water and Food, belonging to the Department of Genetics, Microbiology and Statistics of the University of Barcelona (Spain) (UB). Role:** UB, expertise in evaluating the presence of viral pathogens, also emergent ones, in water and food and to evaluate the risk that it may suppose for exposed humans. It will be responsible and strongly committed to the implementation of WP2 using new methodologies to microbiological sampling and analyses. In addition, UB will actively collaborate in the communication and dissemination activities.

3. **Centre National de la Recherche Scientifique (France) (CNRS). Role:** CNRS is expertise in quantifying and predicting how the climate change and increase of human activities affect water resources in the Mediterranean and tropical regions. Its participation as partner in this project is vital to develop the WP5 focused on the proposal of the remediation to reduce the runoff water contamination. CNRS will able to participate in dissemination activities to show results obtained from the WP that they lead.

4. **Department of Water management of Delft University of Technology (Netherland) (TUD). Role:** TUD, expertise in innovative hydrological measurement and monitoring techniques such as DNA and DNA-tagged environmental nanoparticles as well as quantification of preferential flow paths in soil hydrology and groundwater

recharge. TUD will lead the WP6 and will bring in a full-scale experimental facility called "WaterStreet" which enables testing rainwater sewage filtration urban waste water.

2. IMPACT

2.1. Impact of the proposal

The, URBANWAT project will contribute to the following overall impacts of the JPI: (1) **SOCIAL:** The participation of the groundwater organism in this project, especially in the results diffusion task, allows establishing a water policy more effective implementing a close horizontal dialogue with stakeholders interested in clean and healthy water; (2) **ECONOMIC:** The reuse of groundwater safely constitutes a vital complement to water regulations and they can assist in allocating water between competing user demands. Mitigation measures and short-term solutions to overcome emergency situations as water scarcity, which will reduce costs; (3) **TECHNOLOGICAL:** Improvement of the techniques for managing of water resources with interoperability of databases, groundwater quality, risks and modeling. Optimization of concentration and viral detection in groundwater samples. The use of new technologies for the identification of a greater number of organic compounds and for the study to measure temporal and spatial patterns of water and pollutants with encapsulated DNA nanoparticles promises a breakthrough in the investigation of groundwater; (4) **ENVIRONMENTAL:** The integrated models of the entire water cycle, including all compartments and water use have yet to take into account scenarios of water demand and predict the impact of global change (including climate). Water resource observations, experimental work and modeling are required to better understand hydrogeological processes and their connection, and to analyse and forecast the effectiveness of management options. This will support improved decision-making to ensure the long-term availability of water resources and to enable the integrated management of water resources at the national and global scale; (5) **POLICY:** Regulatory measures are essential tools to ensure compliance with environmental standards for water quality and quantity. Understanding the mechanism leading to improved water management will lead to better policy design and adaptation it will help in the new plans of uses and integrated management of aquifers and it will ensure the good state of this groundwater masses management.

The main barriers that this project would be related to the modeling task where some predictions cannot be verified, since in practice it is not possible to obtain a measurement at all points of the modeled domain, this will be overcome by developing models for different scenarios and evaluating the sensitivity of the models.

2.2. Expected outputs

The main tangible result will be an integrated approach for urban groundwater management using monitoring, measuring and modeling, like an integrated numerical modeling of the water cycle and their contaminants to better manage the water resources in urban areas, innovative tracers to really measure, and finally to have a better monitoring of urban water systems due to improved analysis protocols. Moreover:

- A **platform and web portal** (WPS) to promote the application of the Barcelona model across any European country to serve as an operational tool for managers and policy makers, with the aim to reduce pressures through management actions. Standardised **protocols** for sampling and analysing samples from the involved vectors to be monitored. This protocol will be designed together with the public authorities and will be a useful tool for other urban areas.
- To provide **a panel and network** between public bodies and stakeholders.
- An improvement of the scientific and technical knowledge on groundwater management in urban areas through **publications** (At least 4 publications). **Communications in meetings or congress** to discuss the research set-up, experiments and lastly the results of this project (at least 4)
- **Short courses** (around scientific conferences focusing on the new generation of young researchers (at least 2). **One on-line workshop** for for local stakeholders (waterboards, city water managers, interested general public, etc.
- **Mobility activities**/stays between investigators, students etc.
- **Two workshops** in Barcelona and TUDelft to discuss the project with potential end-users and other stakeholders, identify additional needs or requirements from them and intensify collaborations and disseminate the results.
- **PhD works** (At least 2 PhD work). **Technical reports** related with this project (At least 5).
- **Training academic activities.** We will develop and give training courses on Urban Water Management focusing on innovative contaminant monitoring techniques. These courses and workshops could be given at UPC, UB,

TUDelft and at scientific conferences. Moreover, we will participate in classes of International course in groundwater and Master in groundwater organised by FCIHS**.** In addition, an on-line course will be developed.

- A **flow and transport model** of hydrological cycle in the urban area of Barcelona, simulating different scenarios

2.3. Exploitation and communication activities (measures to maximise impact)

The exploitation of the results generated in the research from this proposal will be structured in three main phases: Awareness, Results and past-project, and it will be achieved in a number of ways and. First of all, scientific data from the research conducted will be disseminated to the scientific community in **scientific publications**. Given the novelty of the research topics and the methodologies being employed, we expect these publications to be of a high scientific impact. Secondly, during the course of the project we also expect the realization of Master's and PhD Degree Thesis, in the context of the research proposed. Moreover, research data will also be presented in **national and international congresses, meetings, conferences and workshops** as another way of dissemination to the scientific community, to governmental agencies, stakeholders. In addition, the results will be disseminated in press conferences and, if possible, on radio and TV programs through the Audiovisual Department in CSIC. Furthermore, at the end of the project, all relevant information and results will be available to the public, via this website. In addition, **institutional communication channels** within each of the partners' organizations will be used for additional dissemination of the results obtained. In addition, this project will have own **website and account in the main social networks** like twitter, LinkedIn to disseminate the progress of the project.

On the other hand, part of the communication plan will **target the "non-scientific public"**. Local groundwater management as ACA, BCASA, EUSAB and BR have shown interest in the development of this project through letters of support its and they will disseminate the results to the users of this water resource using their dissemination tools as website, social media. The participation of these entities in the diffusion task, allows establishing a water policy more effective implementing a close horizontal dialogue with stakeholders and social tensions will be avoided, as they will be participants in this project. In addition, they commit to making better use of the results, ensuring that they are used for decision making to influence policy making. Moreover, other types of institutions have also sent us their support for the development of this project helping in the communication task disseminating the results by their communication channels and offering us the opportunity to carry out informative activities in its facilities like FCIHS and UPC.

Expected results: 1) Website of the project; **2)** Account in different social networks to perform dissemination tasks, for example: twitter, LinkedIn, etc; **3)** At least 5000 visits to the institutional website like CSIC, UB, etc consulting issues related to this project; **4)** At least 20 demands of information; **5)** At least 4 scientific articles published; **6)** 4 Congresses attended; **7)** 2 Workshop organized; **8)** 1000 Brochures; **9)** 4 appearance in media; **10)** 4 seminars in academic institutions.

Indicators of progress: 1) Number of visitors to the website and the demands of information received through the web will be indicators of success; **2)** Number of activities planned; **3)** Number of articles published; **4)** Number of Congresses attended; **5)** Number of workshops organized; **6)** Number of appearances in media; **7)** Number of seminars.

2.4. Market knowledge and economic advantages/return of investment

The previous experience and data acquired from previous and this project supports the viability of the objectives defined in the project and the confidence on the methodological and scientific advances expected and also in the capabilities in the consortium for developing the proposed actions for the implementation and dissemination of the results of the study. URBANWAT offers a scientific basis for improving the management of groundwater in urban areas. It is important to bear in mind that regional/national guidelines on urban groundwater management are insufficient for complete risk assessment. For instance, organic microcontaminants have been largely overlooked. The project results will be used to support the local and regional policies/regulations implementation establishing regulations and guidelines which not only will increase groundwater quality but it will expand the use of these waters. The water supplying infrastructures need great investment efforts, and consequently require guarantees of availability of water both in terms of quantity and quality. In the first case, we are talking about mass balance, the hydrological

cycle; and in the second case, about chemical balance, the contaminants' life cycle. The aim is not only being sure that there will be enough available water for a certain period of time, but more in general to know how these resources should be managed in order to ensure their future availability, to preserve their quality and to avoid environmental damages. Mitigation measures to overcome emergencies as water scarcity, the pollution depletion will reduce the costs. In urban areas often, some structures have affected when the water table increases being necessary to pump. The pumped waters could be a suitable resource if proper management is carried out.
Moreover, the definition of the current urban groundwater quality will be of a great help for engineers to develop technologies directed to the elimination of contaminants that can pose a risk to human health and ecosystems. This is relevant because the development of technologies able to remove all kind of pollutants in a cost-effective way seems out of reach now. The development of this project turns into: (1) a growth in the available water resources; (2) an improvement on their physical and chemical quality; and (3) in the case of the supplying water, this cause a reduction in the supplying and treating cost and, thus, also in the consuming cost of water.

3. IMPLEMENTATION

3.1. Overall coherence and effectiveness of the work plan

WP	WP Title	Time (month)	WP Description
WP1	**Inorganic chemical, CECs sampling and analyses of groundwater**	**1-20**	This WP includes: (1) periodic measurement of piezometric levels, insitu parameters (pH, T[a], C.E, Eh, etc.) and installation of continuous measurement sensors in control piezometers; (2) Hydrochemical sampling and analysis (anions, cations, traces, CECs); (3) in Quartely sampling of groundwater for the determination of PMOCS a group pertaining to CECS by conventional methods (target) and unconventional methods (non-target); (4) Integration of the data in a geospatial database and their exploitation (H2020 FREEWAT FREE and open source tools for WATer resource management www.freewat.eu); (5) Expansion and improvement of an existing platform to integrate all data from a geo-spatial database; (6) Mapping of the pollutants identified in the water cycle to know their distribution. **Deliverables: D1.1** Protocol for groundwater sampling; **D1.2** Report on current groundwater quality; **D1.3** Report on occurrence of PMOCs in groundwater; **D1.4** Assessment of PMOCs degradation in groundwaters
WP2	**Microbiological sampling and analyses of groundwater**	**1-30**	This WP includes: (1) Optimization of viral concentration and detection methods for identification of viruses in groundwater samples (2) Analysis of samples collected in the points 1, 2, 3 and 4 described above for Classical Fecal Indicators (E. coli and Intestinal enterococci), human and animal viral indicators as well as relevant viral pathogens (3) Metagenomic analysis of selected groundwater samples for new and emergent viral identification. (4) Risk assessment studies on the presence of vpathogenic viruses in groundwater as for their application for irrigation or drinking. **Deliverables: D2.1** A SOP of an optimized method for viral concentration from groundwater samples; **D2.2** Report: presence and loads of classical fecal indicator bacteria, human and animal viral indicators as well as relevant viruses in groundwater collected; **D2.3** A SOP of an optimized viral metagenomic analysis for groundwater samples; **D2.4** A report of the different viruses found in groundwater collected at different sites and times during the year by applying metagenomics analysis.
WP3	**Identification of the origin**	**13-25**	This WP includes: (1) Univariate statistical analysis and bivariate analysis to identify the geochemical processes that control the

	and behaviour of contaminants present in the hydrological cycle		anomalous concentrations of solutes in groundwater and determine their quality and possible uses; (2) to develop new analytical methodologies combining polar chromatography with HRMS for the determination of PMOCs in groundwater; (3) to evaluate the transformation of polar compounds. **Deliverables: D3.1** Statistical report/geochemical processes; **D3.2** Report related to the developing an analytical methodology for PMOCs determination; **D3.3** Report polar transformation compounds.
WP4	**Application of environmental-friendly DNA-tagged nanoparticles for measuring mobility of pollutants.**	**1-30**	(1) Use of an innovative, robust, and environmental-friendly nanoparticles tagged with synthetic DNA to trace contaminant movement and travel times of water in natural systems (developed by Delft University of Technology); (2) Development of a flow and transport model of the hydrological cycle to quantify the water and mass balance and the perspectives of changing the balance in different scenarios; (3) Simulations of the different scenarios that allow planning the sustainable use of underground water resources and address global changes such as climate change. **Deliverables: D4.1** Report: artificial DNA tracer; **D4.2** Report: Comparison between the use of different tracers; **D4.3** Flow and transport model/Simulations
WP5	**Proposed remediation of runoff water contamination and evaluation of the ecotoxicological risk**	**1-30**	(1) Analyse the role of the soil water plant continuum in attenuating pollution testing and analysing the use of selected infrastructures to analyse fate and transport of selected contaminant in the soil-plant continuum and gather further insights in the behaviour of such systems; (2) evaluate the ecotoxicological risk **Deliverables: D5.1**: list of soil-water-plants continuum that will be tested; **D5.2**: Development of the experimental setup; **D5.3:** Role of flow rate on retention efficiency; **D5.4**. Parametrization of the removal efficiency in the different scenarios for the chemical and microbial contaminants tested
WP6	**Testing real-scale test facility Delft University of Technology.**	**12-30**	Transfer the methodology developed for its application in the other cities. Validation of the methodological tools obtained during the development of this project. **Deliverables: D6.1** Report about the WP progress. Different phases of testing; **D6.2** End of project show-casing the results of project

Descrip. Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
WP1						D1.1											D1.2			D1.3 D1.4										
WP2										D2.1												D2.2						D2.3		
WP3																		D3.2			D3.3				D3.1					
WP4															D4.1														D4.2 D4.3	
WP5							D5.1		D5.2										D5.3					D5.4						
WP6																					D6.1									D6.2
Milestone	M1	M2 M3 M4		M5			M1					M4 M6	M1		M7 M14 M16				M1 M12	M4 M8 M9 M13				M15 M16	M1 M10 M11		M4		M9 M14 M15	
Progress Monitoring																														
Mobility Schemes								**X**							**X**						**X**						**X**			
Dissemination (D) and training (T) activities										**D**	**T**		**D**	**T**			**D**	**T**			**D**	**T**			**D**	**T**			**D**	**T**

Chronogram

3.2. Appropriateness of the management structure and procedures, including quality management

Decision-making and monitoring the project progress

Coordination between partners/tasks is essential for final success. Effective coordination is ensured by the managerial structure (project work plan) and one person of CSIC will be exclusively dedicated to this project. The technical and financial coordination of the project is the responsibility of CSIC who has extensive experience in managing the coordination and participation of projects financed nationally with FEDER, national and EU funds (FP7, LIFE, INTERREG, H2020). **Principal functions:** (1) Monitoring of project; (2) Monitoring of the Communication and Dissemination Plan; (3) Decision on important aspects in technical, economic and administrative management; (4) Decision on dissemination and exploitation of results; (5) Responsible for high-level decisions on conflicts between partners; (6) Management of the overall status of the project budget, ensuring appropriate changes to ensure effective and transparent management of all partners. Two levels of project management are established and therefore 2 committees for decision-making:

Steering Committee: The supreme authority of the project is the Steering Committee which liaises with the European Commission through the Project Administration office. The committee is formed by 1 representative from each of the partners, who is appointed by each individual partner's management body. This will ensure that decisions affecting the project are made with the knowledge and input of all the partners. An effort will be made by each partner to ensure that this representative remains for the duration of the project and should not be changed frequently. All decisions related to changes in the partnership, in the allocation of funds and tasks and major changes of the project strategy must be authorized by the Steering Committee. The steering committee meets regularly every half a year. Decisions are accepted with a majority over 2/3 of all partners present in a meeting and all of the partners must be present for a decision. Decisions of the steering committee are sent to the project officer in the European Commission. Another of the main tasks of the Steering Committee will be the monitoring of the project progress guaranteeing the achievement of the project objectives, deadlines and financial allocations.

Technical Committee: All partners will be integrated through a technical manager designated by the beneficiary. Their functions are: **(1)** Management of the execution of the preliminary, implementation and dissemination activities; **(2)** Ensure compliance with the technical objectives of the project; **(3)** Report to the Coordination Committee the results achieved, deliverables, and monitoring actions; **(4)** Guarantee the monitoring of the actions according to the foreseen schedule and within the estimated budget and propose corrective actions in the event that the time and cost are outside the established limits; **(5)** Actively participate in technical meetings to manage progress. At least four general technical meetings have been established, in addition to the meetings necessary to achieve each of the implementation actions.

On the other hand, the fluid communication between partners and action leaders will be on-going during the development of project tasks. In case of conflict that may arise about the implementation of the project or other matters related to the project itself, the following steps will be taken: **1)** The parties will try to resolve the conflict issue between them in a friendly and informal way; **2)** If this attempt fails, the question will be discussed during the first scheduled meeting of the General Assembly, or if the issue is urgent, an ad hoc meeting of the Steering Committee will be convened by CSIC as coordinator; **3)** The issue will be evaluated by the Steering Committee and partners will try to solve the problem by consensus. However, if consensus cannot be reached, decisions will be taken by majority vote. If the issue cannot be resolved through the vote of the Steering Committee, or in a case where one of the parties is not in the position to accept the vote, the Coordination committee will be sought in order to resolve the conflict.

Communication Plan

A strategic plan and targeted measures for communicating about (i) the action and (ii) its results to a multitude of audiences, including the media and the public and possibly engaging in a two-way exchange will be set. The coordinator will be in charge of coordinating communication activities within the URBANWAT partnership. This in general will target the "non-scientific public". The whole communication framework will be based on the following assumptions: **1)** demonstrating the contribution of the URBANWAT research to Europe; **2)** account for public spending by providing tangible proof showing how European collaboration has achieved more than would have otherwise been possible, in scientific excellence, contributing to competitiveness and solving environmental/societal challenges; **3)** showing how the outcomes are relevant to our everyday lives, by creating jobs, introducing new technologies; **4)** making better use of the results, by ensuring they are used by decision-makers to influence policy-making and by industry and the scientific community to guarantee follow-up.

Financial management strategy

The majority of the costs involved in the URBANWAT project are **personnel costs**. We can differenciate between permantent position and non permanent position. The permanent positions will be financed by each partner and the personnel costs have been calculated according to the individual personnel rates supplied by each partner. Total full cost of the project is 1,014,004.51€ of which 295,922.48€ will be financed by the partners and the total requested funding for the EU is 718,082.03€. Of the overall budget, more than 76% is related to personnel costs (28% permanent positions+48% non permanent positions), 4% to equipment, 4% to travel and subsistence, 8% consumables, 1% to subcontracting and 7% to other costs (including disseminations costs, capacity building costs and overheads).

CSIC	**COST (€)**	**JUSTIFICATION**
Equipment	10000	Software licences, laptop field work, laptop for modelling.
Travel/Subsistence	12500	For Project meetings, participation in conferences, workshops to disseminate project activities, 2 workshop in Delft, field work
Consumables	15500	Lab material like solvents, patterns, glass material, maintenance contracts, chromatographic columns, field work materials (containers, acids, filters, etc)
Other costs	25000	Costs for fees conferences + fees for open access papers + traductor service + costs for sensors + cloud service +dissemination material (website, brochures, merchandising, etc) + dissemination activities (workshops, seminars, classes, etc)
UB		
Equipment	19000	A commercial concentration device for water concentration will be evaluated for concentration efficiency improvement and standardization
Travel/Subsistence	3000	Assistance to consortium meetings and at least 1 national or international meeting for results dissemination of at least one member of the team
Consumables	9000	Reagents and kits for water concentration, nucleic acids extraction, PCR detection and metagenomics analysis will be required as well as laboratory plastic consumables
Other costs	6000	Laboratory staff is needed for water concentration method improvement assays, sample collection and analysis. Small laboratory equipment and externa sequencing expenses, dissemination activities and publications
CNRS		
Equipment	8000	Laptop for column monitoring, laptop for the PhD student and injection pump for the column experiments
Travel/Subsistence	15000	Workshop conferences, project meetings
Consumables	25000	Chemical substances, lab materials (tubing, filters, …),
Subcontracting	15000	Chemical analysis
Other costs	6000	Fees conferences, fees for open access papers, dissemination material
TUD		
Equipment	2500	Laptop PD
Travel/Subsistence	15000	Cost field experiments, scientific conferences and meetings
Consumables	30000	Lab materials related to synthetic DNA and qPCR analysis, Nanoparticle preparation, design and characterisation and column experiments
Other costs	5000	Cost for conference fees, publications, organisation Workshops in TUDelft and WaterStreet

Milestones (M.X Milestone name (month number))

M.1 Steering committee meeting (M1, M7, M13, M19, M25); **M.2** Administrative permits (M2); **M.3** Kick-off meeting (M2); **M.4** Technical committee meeting (M2, M12, M20, M27); **M.5** Communication Plan (M4); **M.6** Website (M12); **M.7** Conceptual model defined (M15); **M.8** Groundwater sampling/analysing (M20); **M.9** Chemical and Microbiological analysis (M20, M30); **M.10** Statistical analysis (M25); **M.11** Evaluation of polar transformation compounds (M25); **M.12** HRLCMS methods established and validated (M19); **M.13** Established extraction methods of PMOCs from groundwaters (M20); **M.14** Results presentation of tracer test (M15, M29); **M.15** Flow and transport model presentation (M24, M29); **M.16** Remediation method presentation (M15, M25).

3.3. Risk management

Risk 1. Lack of coordination. Coordination between partners/ Actions/ Tasks is essential for final success. The Coordinator, CSIC, which has experience in coordinating R&D projects, will ensure the necessary respect for interdependencies. **Impact:** High **Probability:** Very Low. **Contingency plan:** Effective coordination is ensured by the managerial structure and through the Project Work plan. One person of CSIC will be exclusively dedicated to this project and in addition, technical expert assistance will be subcontracted to guarantee effective project management.

Risk 2. Under-resourced actions. Required resources have been carefully estimated in the project proposal. However, some specific tasks could suffer from scarceness or over budgeting. **Impact:** Medium **Probability:** Low **Contingency plan:** Resource expenditure will be carefully monitored throughout the project by the project manager. If needed, resources will be redistributed among actions. All participants are prepared to temporarily commit more resources to the project, if required. Corrective actions will be taken by the Steering Committee without hesitation whenever necessary.

Risk 3: Discrepancies and conflicts. The fluid communication between partners and action leaders will be on-going during the development of project tasks. **Impact:** Low **Probability:** Low. **Contingency plan:** In case of conflict that may arise about the implementation of the project or other matters related to the project itself, it will take the steps described in section 3.2.

Risk 4. Follow-up of the overall planning. Tasks are not completed on time, causing delays in other tasks. The high dependency on preparatory works (analysis, environmental conditions) to implement the pilot site makes the project to be subjected to economic changes which could be a cause of delay. **Impact:** High **Probability:** Medium. **Contingency plan:** Prompt coordination of the project will assure the timelines of deliverables. But, an extensive buffer period for technical activities has already been expected and included in the project proposal.

Risk 5. Lack of visibility. Dissemination activities do not achieve sufficient results. **Impact:** High **Probability:** Medium. **Contingency plan:** The effectiveness of dissemination activities will be constantly monitored through qualitative and quantitative indicators. All partners will be actively involved in dissemination tasks. To ensure a high number of expression of interests and visitors of the website, the consortium will be very active in dissemination from the very beginning of the project.

3.4. Potential and commitment of the consortium to realise the project

URBANWATER joins institutions from the water sector (CSIC, TUD and CNRS) and institutions from the chemical sector (CSIC) and a group with strong background in environmental microbiology (UB). This alliance has been a pre-requisite to meet the objectives of this call. In addition, the consortium consists of partners that are experienced in the field of urban groundwater management as field studies, lab experiments, flow and transport modelling, develop new methodologies for organic analyses, microbiology analyses, novel monitoring techniques to evaluate the preferential flow paths. Interdisciplinary is well established, and transdisciplinary approaches needed to achieve the goals are implemented. The partners had close contact over the last years, and exchanged opinions on the subject. Due to the involvement of the partners in EU-wide activities, like specific forums, workshops, congresses and projects related to this field, they have access to the most recent developments in the field. The structure of the groups is focused on rapid adoption of novel technologies and the utilization of the most modern equipment. The senior scientists in the project have long lasting experience in research projects, committees and EU wide activities, and they are also involved in reviewing such topics on the international level. All project partners are very well connected not only with international academic and scientific institutions but also with companies and administration in the water fields. This is why the consortium has the maximum chance of a successful outcome.

4. DESCRIPTION OF THE PARTICIPATING RESEARCHERS

Partner Num	Research Team Members	General Description
P 1 Carlos Ayora Ibáñez	Enric Vázquez Suñé, Researcher at CSIC	Expert in the characterization of permeable media and the human impact by means of hydraulic, hydrochemical and environmental isotope data. https://www.researchgate.net/profile/Enric_Vazquez-Sune
	Laura Scheiber Pagès, Postdoc at CSIC	Posdoctoral researcher at CSIC. Expertise in aquifers characterization, groundwater quality and management, environmental and radioactive isotopes data. https://www.researchgate.net/profile/Laura_Pages
	Rotman Criollo, Postdoc at CSIC	Expert in analysis and management of data, the design and the development of databases and tools to optimize hydrogeological analysis. https://www.researchgate.net/profile/Rotman_Criollo_Manjarrez
	Antoni Ginebreda, Research Professor, Environmental Chemistry Department, CSIC	His research interests are focused on all quality aspects of the water cycle, including the relationships between chemistry and ecology, ecotoxicology, wastewater treatment and risk assessment and the fate of organic contaminants in the aquatic environment. https://www.researchgate.net/profile/Antonio_Ginebreda
	Sandra Pérez Solsona, Researcher, CSIC	Her work is focused on studying the occurrence, distribution and degradation of pollutants in aquatic systems. High resolution mass spectrometry techniques such as the hybrid techniques UPLC-Q ToF-MS and UPLC-Q exactive-MS for the structural elucidation of novel transformation products and metabolites and also LC-QqQ-MS and LC-QLIT-MS for the sensitive trace determination of parent compounds and their TPs in the water cycle are employed. https://orcid.org/0000-0002-3179-3969
P 2 Silvia Bofill	Rosina Girones, Full Professor, UB	Environmental Virologist, partner and coordinator in European Projects, last one METAWATER, a Water JPI project. Team leader of the Virus Contaminants of Water and Food Laboratory. Member of the Management Committee of the Health-Related Water Microbiology specialist group in IWA, and a member of the WHO Water Quality and Health Technical Advisory Group. https://www.researchgate.net/profile/Rosina_Girones
	Miquel Calvo, Associate Professor, UB	Professor from the Statistics Section of the Faculty of Biology. He has published methodological papers in Mathematical Statistics and Statistical Bioinformatics. Expert in experimental design and data analysis, he has signed papers with several research groups in top journals of Pathology, Genetics and Virology.
P3 Linda Luquot	Elena Gomez Hernandez, Professor, (MU)	Characterization of pharmaceutical contaminants and data analysis.
	To be hired PhD student, CNRS	Columns experiments and data analysis
	To be hired PostDoct. researcher, CNRS	Batch and columns experiments, data analysis.
P 4 Thom Bogaard	Jan-Willem Foppen Associate professor at IHE Delft	Hydrologist, ample experience in water quality, groundwater flow and E.Coli transport modelling and expertise in water tracing using synthetic DNA. https://scholar.google.nl/citations?user=9aoknJIAAAAJ&hl=nl
	Sulalit Bandyopadhyay Post-doc at TUDelft	Expert in synthesis, characterization and functionalisation of nanoparticles and experience in development of nanoparticle hydrological tracers. https://scholar.google.nl/citations?user=bkArQaMAAAAJ&hl=en
	To be hired Post-doc researcher	Nanoparticle design, setting up tracing protocols for hydrological tracing using DNA-tagged nanoparticles

5. CAPACITY OF THE CONSORTIUM ORGANISATIONS

Partner		General Description
P1 (CSIC)	**Role and main responsibilities in the project**	Coordinator of this project. WP1, WP3 leader and participation in WP4 and WP5. Also, we will contribute in dissemination and training activities. Study of organic and inorganic contaminants.
	Key research facilities, infrastructure, equipment	HRMS: LC-q-Exactive –Orbitrap MS and QToF-MS 550r
	Relevant publications and/or research/innovation products	Nödler, K.; Licha, T.; Barbieri, M.; Pérez, S. Evidence for reversible and non-reversible sulfamethoxazole biotransformation products during denitrification. Wat. Res. 46 2131-2139, 2012. Jurado, N. Mastroianni, E. Vazquez-Suñe, J. Carrera, I. Tubau, E. Pujades, C. Postigo, M. Lopez de Alda, D. Barceló (2012) “Drugs of abuse in urban groundwater. A case study: Barcelona”. Science of the Total Environment 424 (2012) 280-288.
P2 (UB)	**Role and main responsibilities in the project**	WP2 leaders and participation in WP5 and dissemination activities. Responsibilities in the microbiological part of the project. Analysis of the presence of bacterial indicators, viral indicator viruses and viral pathogens in groundwater.
	Key research facilities, infrastructure, equipment	Scientific and Technological Centres (genomic analysis), biosafety 2 facilities, microbiology laboratories, metagenomics data storage capacity.
	Relevant publications and/or research/innovation products	According to Shangai ranking, UB is between the best 200 universities in the world: http://www.shanghairanking.com/ARWU2018.html
P3 (CNRS)	**Role and main responsibilities in the project**	WP5 leader and participation in dissemination activities. Study the role of soil-water continuum in attenuating pollution and contaminants.
	Key research facilities, infrastructure, equipment	Laboratory equipment for chemical analysis
	Relevant publications and/or research/innovation products	Halm-Lemeille M.P., Gomez E. Pharmaceuticals in the environment. Environmental Science and Pollution Research 23, 4961-4963. Doi : 10.1007/s11356-016-6248-6.
P4 (TUD)	**Role and main responsibilities in the project**	WP4 leader to develop nanoparticles tagged with synthetic DNA to determine contaminant flow paths. Coordinate experiments in real-scale experimental facility called Waterstreet (WP6)
	Key research facilities, infrastructure, equipment	Large-scale urban street facility. State of art computer facilities and software licenses for project task. Large experimental and analytical lab facilities (The Waterlab).
	Relevant publications and/or research/innovation products	Foppen, JW and TA Bogaard (2018): Application of nanoparticles tagged with synthetic DNA in Water treatment/Water management. Chapter 11 In “Fabrication and Application of Nanomaterial”. Ed. Sulalit Bandyopadhyay Foppen, JW, J Seopa, N Bakobie, TA Bogaard (2013) Development of a methodology for the application of synthetic DNA in stream tracer injection experiments. Water Resources Research, Vol. 49, 5369–5380, doi:10.1002/wrcr.20438, 2013 https://www.vpdelta.nl/nl/proeftuinen/urban-delta/waterstraat