Part C

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Joint Programming Initiatives

Water Challenges for a Changing World

(Water JPI)

2018 JOINT CALL

Closing the Water Cycle Gap – Sustainable Management of Water Resources

"Closing the Water Cycle Gap with Harmonised Actions for Sustainable Management of Water Resources"

"WATER HARMONY"

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1. EXCELLENCE

1.1. Introduction

Despite the fact that over 70% of the world surface is covered with water, only <1% is accessible for human consumption. Water becomes even more precious when considering its uneven distribution over the globe; its frequent “misuse” through unsustainable use and wastage further exacerbate the issue. Such practices amplify the negative impacts on natural, environmental, geographical and social conditions, which are already under increased pressures from Climate Change. Emerging micropollutants (MPs) and their discharges, even at trace concentrations, contribute to accumulation in the aquatic environment with potentially detrimental consequences to both aquatic ecosystems and human health. Man-kind faces a self-inflicted impending crisis as a result; Europe is no exception to this widening gap between the demand and supply of water.

Four targets in the UN SDG 6 directly address the above challenges: ensure equitable access to safe and affordable drinking water, improve water quality, substantially increase water-use efficiency and implement integrated water resources management. The EU Directives, UNECE/WHO Protocol on Water and Health and UN’s Transboundary water convention highlight the same challenges. The EU Directives further emphasise the need to allocate water and water-related funding more efficiently, improve drought risk management, consider additional water supply infrastructures and foster water efficient technologies and practices..

Numerous national and transnational initiatives have led to a better understanding of needs and opportunities in the water sector. Nevertheless, competencies in Europe and beyond remain fragmented and under-utilised. Many leading scientific communities across the globe are engaged in finding innovative and cost-efficient solutions to these water related issues. However, their resources are irrationally utilised and the potential for synergies are heavily underutilised due to insufficient communication. Even though the scientific community values dissemination, results remain hidden until publication has been achieved towards the end of a given research project. This process does not efficiently utilise the power of synergy in partnerships. There is also an under-utilised potential in achieving common goals, largely due to inadequacies in communication between stakeholders in the scientific community, the public and in political & administrative leadership.

The ambition of the **Water Harmony** project is to unite competent researchers, end-users, policy makers and the public to develop and jointly demonstrate best practices that are potentially valuable for Europe and beyond by addressing **SDG 6 “Ensure access to water and sanitation for all”,** maximising synergies and rationalising resources and efforts.

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

The role of quality and quantity of water stretches far beyond our health and well-being; shortcomings in quality and quantity impart high social and economic costs. The water sector is a major economic player (1% of GDP) with an annual turnover in the EU of about 80 billion Euro, providing around 500 000 full time-equivalent jobs[1] and a yearly investment of 7 billion Euro. It has an average growth rate of 5% per year, compared to 2.5% per year average growth rate for the EU economy[2].

Water scarcity is an increasingly frequent and worrying phenomenon that affects at least 11% of the European population and 17% of EU territory[1]. Cyprus, Bulgaria, Belgium, Spain, Italy and Malta are currently consuming upwards of 20% of their long-term supplies every year. Competition for water between sectors and regions poses a growing risk to the economy, communities and the ecosystems they rely on.

Since 1980, the number of droughts in Europe has increased and as has the severity, costing an estimated €100 billion[3] over the past 30 years. The extent and number of people affected by droughts during the same period experienced an increase of almost 20%. These trends appear to remain stable into the immediate future. A modelled localisation of water scarce basins show that the number of river basins challenged by water scarcity is expected to increase by up to 50%[4], assuming a ‘business as usual’ scenario wherein public, industrial and agricultural water consumption increase up to 16% by 2030.

[1] EUROSTAT 2010 - Workshop Greening the economic and social governance of the EU
[2] The European Technology Platform for Water, http://wsstp.eu/about-us/water-vision/
[3] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52012DC0672
[4] http://www.climwatadapt.eu/

The presence and fate of pharmaceuticals, personal care products, micro-plastics and other emerging contaminants have become a great concern in recent years. A revision of the EU Drinking Water Directive was adopted in 2018 to include these concerns[5], which may include 50 or more new priority substances. Since current conventional water and wastewater treatment plants are not designed to remove these MPs, urgent need of technological advances in wastewater treatment processes are required in order to prevent pollution of source water and drinking water systems. The above efforts to secure the quality of water supply pose a challenge to the scientific community. In this context, the 11 000 large-scale water suppliers covering 80% of the supply in Europe and the 85 000[5] smaller plants have bigger challenges related to securing the quality, due to access to specialists.

EIP Water[6] points out the current inadequacies in the water sector across the public and private sector, non-governmental organisations and the public. It also focuses on the need to stimulate creative and innovative solutions that contribute significantly to tackling water challenges at the European and global level. EU studies indicate that cost-effectiveness and cost-benefit analyses are rarely used by Member States to prioritise investments under the RBMP process[1], when, for example, even ecosystem services including water supply provided by EU's natural heritage sites are estimated to be worth around €200-300 billion per year[7]. It is an observable fact that intangible assets and values are under-utilised parameters in most water infrastructure development initiatives. Such considerations may positively influence coordination mechanisms in allocating financial resources to priority issues[8] addressing water scarcity.

1.3. Objectives and overview of the proposal

Main objective: Closing the water cycle gap by harmonising global good practices of sound and smart water management concepts that address emerging challenges and mobilise stakeholders. I**ncluding <u>4 sub-objectives</u>:**

- Demonstration of sound and adaptive **approaches to modern water management** concepts that use BigData and technological advancements addressing challenges concerning global environmental and societal changes;
- Validation of **innovative technologies** that enable safer, secure and economically more feasible use and reuse of water, alongside addressing challenges with emerging pollutants;
- **Increase public engagement** to sustainably address the water challenges that connect sciences and society by using modern, harmonised and shared approaches;
- **Facilitate policy decisions** favouring actions that rapidly close the demand-supply gap in the water sector by providing scientific backgrounds, visualisation tools and social mobilisation of policy makers.

Relation to the scope of the call (*ASCA from Spain does not participate in activities on sub-themes 2.1 and 2.3*)
The Water Harmony project addresses all three themes of the Call and covers the following sub-themes:

<u>Sub-theme 1.1: Promoting adaptive water management for global change</u> by developing evidence-based methodologies and technologies for monitoring and managing impacts on the water cycle at the catchment level, with applicable practice in the pan-European area and beyond. (WP1)

<u>Sub-theme 2.1: Integrating economic and social analyses into decision-making processes</u> will be achieved by enhanced focus on economic mechanisms and policy instruments that promote prioritisation in public investments in the water sector, e.g. holistic Cost Benefit analyses with of intangible benefits. (WP5-6).

<u>Sub-theme 2.2: The reuse of water</u> is one of the project's main technical components where cutting-edge research will be employed to secure safer and economic use and reuse of water (WP2).

<u>Sub-theme 2.3: Connecting science to society</u> is important in social mobilisation and in increasing awareness among the stakeholders, including policy makers (WP3-5)

<u>Sub-theme 2.4: Promoting new governance and knowledge management approaches</u>: The project provides real-time information, facts, scenarios via various channels to stakeholders and decision makers (WP4-6).

<u>3 - Supporting tools for sustainable integrative management of water resources</u>: Water Harmony brings 10 research organisations and two industrial partners to the development of Best Practices for harmonised actions. WP6 has an objective to disseminate results to thousands of practitioners and decision makers via the global networks involved in the project and their respective partners (WP1, WP3-6).

[5] http://ec.europa.eu/environment/water/water-drink/pdf/SWD_2016_428_F1.pdf
[6] https://www.eip-water.eu/about/basics
[7] http://ec.europa.eu/environment/nature/natura2000/financing/docs/ENV-12-018_LR_Final1.pdf
[8] http://ec.europa.eu/environment/water/blueprint/pdf/SWD-2012-382_EN_impact_assessment_part2.pdf

1.4. Research methodology and approach

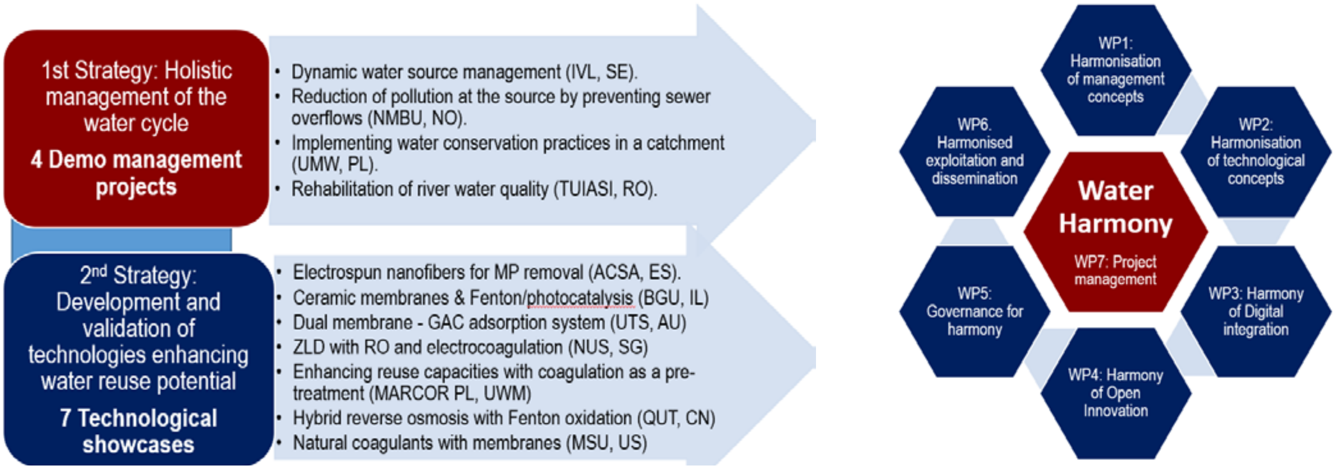

Figure 1. Oragnisation of Work: Demo/Showcase studies (left) and Work Packages (right))

Reconciling water supply and demand is a challenge and the gap continues to widen, as noted in the introduction. The gap increases water stress, which is the pressure on the quantity and quality of water resources. The Water Harmony project's ambition is to demonstrate innovative technologies and management concepts that close the water cycle gap., via 2 strategies: (i) the source water quantity and quality for water supply issues will be addressed through holistic management of the water cycle; and (ii) innovative technologies promoting water reuse concepts creating additional water sources as source water for water supply, replenishment of water resources and for internal industrial reuse reducing the pressure on drinking water supply, that treat water efficiently and economically to its required benchmarks.

12 partners have jointly initiated the proposal by considering their individual strengths, needs and strategies. The proposal was developed by integrating individual and jointly undertaken rigorous research approaches and methodologies to a unified and harmonised action, through an iterative improvement process. The project objectives and activities are based on shared common interests of the partners that overlap with the Water JPI 2018 ambitions, creating a broader engagement through the synergies it creates.

Two strategies that close the water cycle gap will be demonstrated via 4 innovative management demo projects and 7 cutting-edge technological showcases (*Fig. 1, left*). This section introduces the strategical approaches as solutions, and § 3.1 describes an implementation strategy via 7 Work Packages *(WPs, Fig. 1, right).*

1st Strategy: Holistic management of the water cycle

Sound water resource management with holistic and dynamic surveillance and control can utilise existing water resources and infrastructure in a more optimised way, increasing the availability in quantities and reducing pollution potential. The use of BigData and advanced models on hydrology, hydrogeology, virtual sensors and dynamic process control can help reduce pollution of raw water sources and optimise water supply chains. There is a strategic emphasis on actively promoting the involvement of stakeholders and dialogues between politicians.

Management Demo 1: Dynamic water source management (IVL, SE).

Sandviken is a municipality situated 190 km north of Stockholm, and will demonstrate a novel approach to optimise drinking water production in both short- and long-term scale. The municipality uses both surface water and groundwater as raw sources for water supply. Short-term wise lake water levels and groundwater aquifers shift, affecting the quantity of water available from each source and the abstraction portfolio. Internal processes in both lake and groundwater affect the quality of the raw water mix, superimposed with climate changes (CC) effects. A modelling approach aiming to capture each the quality and quantity of both sources both short- and long-term forecasts will determine systemic changes while optimising the quantity and quality of the surface and groundwater mix. This will result in a safe, sustainable and optimised drinking water production. Integrated hydrological and hydrogeological systems with on-line sensors, alongside process data from the drinking water treatment plant and weather data, will be used in the hydrological modelling. The models will include chemical substance transport in groundwater/soil. The expected results will be an improved approach to water distribution to the citizens of Sandviken. The result will be a sustainable, resilient to CC through increased site-specific resilience knowledge.

Management Demo 2: Reduction of pollution at the source by preventing sewer overflows (NMBU, NO).

This demo project will be located in Asker municipality, 30 km from Oslo. The project will demonstrate how pollution in a catchment, in this case caused by reduced sewer capacity and increased precipitation due to Climate Change, can be reduced by using intelligent sewer control. Increased frequency and volume of precipitation is a result of Climate Change, resulting in overloaded sewers that pollute water resources directly and indirectly through overflows, floods and leaking sewers. Existing water quantity modelling will be enhanced to water quality modelling, enabling more optimised rehabilitation prioritisations of sewers and quantification of pollution in the catchment. Innovative concepts to document water quality in sewers and hydrological models combined with rain gauges and meteorological data will be used. Novel water quality sensors suitable for sewers, including virtual sensors, will be provided by DOSCON AS and modelling of the sewers will be provided by ROSIM AS, both as sub-contractors. NMBU will carry out the integration of results to develop holistic concepts to minimise sewer overflows by implementing dynamic controls on existing sewer capacities.

Management Demo 3. Implementing water conservation practices in a catchment (UWM, PL).

Loss of water and deterioration of water quality in surface and ground water is a challenge in several parts of Poland. This demo project will include activities to reduce water usage in agricultural, industrial and domestic practices together with pollution reducing initiatives in the Łyna river catchment (7126 km^2 300 000 people), near Kaliningrad. The river is the source for drinking water supply and the recipient of wastewater as well as the overland flow from agricultural area, with a surface runoff of 0.8 km3/year. The water withdrawal for the crop production needs is estimated as 400 mm. A multi-scale knowledge base of existing environmental conditions in the catchment and relevant socio-economic data and agricultural practices will be created. Surveys will be conducted to identify the knowledge gaps and water quality and pollution database will be enhanced. A prototype monitoring concept enabling unmanned rapid analysis with long term operation without servicing using low sample volumes and low battery consumption will be developed. The data and the models will enhance the knowledge on governing hydro-biogeochemical processes in the soil - surface water interface in the field for the catchment of the Łyna river enabling the impacts of the water conservation actions. This will be achieved by designing, deploying and operationalizing a nested GIS-enhanced environmental data collection network, and provide models that can be used in decision making to facilitate region and nation-wide water conservation measures.

Management Demo 4. Rehabilitation of river water quality (TUIASI, RO).

This demo will focus on water management and water supply challenges caused by deteriorating water quality and quantity levels due to Climate Change. Most stretches of the Danube river are still seriously polluted with agricultural, industrial and domestic sources. Despite the many projects that have studied the Danube’s status, there remains a requirement for functioning and economically feasible surveillance and pollution management concepts. The demo site will be located on the Sulina channel in the Danube delta, in the stretch between the cities Tulcea and Sulina. The demo site is a sink for partially or non-treated wastewater while also being a drinking water source for 200 000 people. Documentation on water quality and quantity status and scenarios developed based on water quality and quantity models will be used to close the communication gaps between the public organisations (NGOs) and the county political and administrative authorities. Innovative concepts developed in the showcases will be demonstrated to local stakeholders to convince them of the cost-benefit relationships in improved management strategies for water by demonstrating feasible concepts which closes the supply-demand gap.

2nd Strategy: Development and validation of technologies enhancing water reuse potential

Water reuse is a key component in water circularity. Without it, the gap between the supply and demand of water continues to grow. It is imperative that innovative efforts provide technologically and economically feasible options for reuse of water as drinking water, while minimising waste by-products (ZLD-Zero Liquid Discharge). This combined focus will prevent pollution and enhance internal reuse of industrial wastewater, thereby reducing the pressure on precious drinking water sources.

MPs are repeatedly found in groundwater and surface waters, and their number is grown at an alarming rate. With concentrations ranging from a few ng/l to µg/l and the ability of easy penetration due to their low molecular weight, MPs can affect human and animal health through e.g. endocrine disruptions. Today’s wastewater treatment plants (WWTP) have no MPs-dedicated treatment. Many MPs are poorly biodegradable. In the absence of dedicated treatment, MPs are released into receiving water bodies and soon find their way back into water sources. At present, most MPs are not removed at water treatment plants. Thus, it is important to develop innovative methods that remove MPs during the treatment process.

Technology Showcase 1: Electrospun nanofibers for micropollutants removal (ACSA, ES).

This technological showcase will be located in a WWTP in Barcelona, and has an ambition to develop innovative compact filters made of electrospun nanofibers able to remove MPs. The filters have significantly higher water permeability than conventional membrane processes for water reuse (e.g. agriculture irrigation). Hence, they require relatively low applied pressures, thereby reducing the carbon footprint of treatment technologies. The polymeric nanofiber membranes will be loaded with antibacterial agents such as metal or metal oxide nanoparticles (Ag, CuO, etc) or quaternary ammonium salts. Suitable pairings will be made between polymeric materials (polyacrylonitrile (PAN), polyethersulphone (PES), polyvinylidene fluoride (PVdF), polyamide (PA)) and antibacterial agents, depending on the target. Silver nanoparticles have low toxicity but embedded silver nanoparticles area vary efficiency against both Gram-positive and Gram-negative bacteria, biofilms and viruses. Natural or synthetic polymeric nanofiber removal ability of microplastics, antibiotics and pesticides will be tested. A continuous and stable electrospinning process that allows for the fabrication of a large surface of nanofibers, and a concept to produce layers of nanofibers of different thickness will be developed. LEITAT technological centre will be subcontracted to carry out technical tests.

Technology Showcase 2: Ceramic membranes mobilising fenton reaction and photocatalysis (BGU, IL)

This innovative concept will be tested and verified at a pilot plant situated at the Sede Teiman WWTP, IL and will receive secondary effluents after an activated sludge process. Membrane filtration and AOP (Advanced oxidation processes) are often viewed as competitive technologies for MP retention, mainly because polymer membranes are prone to radical degradation. However, impregnated ceramic membranes create a bifunctional system that can retain the organic matter and disintegrate MPs. This is in effect a two-stage approach: In the first stage, an upper separation layer removes up to 95% of the organic matter (e.g. humic and fulvic acids). Subsequently, those low-molecular weight MPs that manage to squeeze through the membrane encounter a catalyst that can disintegrate them into harmless compounds. The membranes will be coated with a catalytic layer using two different approaches. The membrane rack will be mounted on a support frame that can be lifted for various inclination angles. It will allow to perform the experiments on Fenton and on photocatalysts. The filtration will be performed in inside-out mode to allow for natural sunlight or artificial irradiation. The setup will be continuously monitored for transmembrane flux, pH and temperature. The retention/degradation of organic matter will be monitored by aggregate parameters (TOC/ COD). The Multi Criteria Analysis will check for ammonia, pH, and UV absorbance.

Technology Showcase 3: Dual membrane - GAC adsorption hybrid system (UTS, AU)

Membrane processes or GAC adsorption alone can not achieve the anticipated removal efficiencies of MP from wastewater. This showcase will study the operational optimisation of the dual membrane hybrid system, which combines the microfiltration–granular activated carbon adsorption hybrid system with nanofiltration. A system will be evaluated for the removal of microorganisms and water reuse through tests with real wastewater at the Homebush Bay Sydney WWTP. Previous research show that hybrid systems of microfiltration and GAC are not efficient enough to remove MP, while systems supplemented with nanofiltration obtain very good results. However, these three processes need to be optimised to obtain best overall technical and economic performance. Removal rates of various MPs will be documented and operational guidance on process combinations depending on targeted MPs will be developed. Although the primary aim is to use the concept for water reuse systems, the potential for use in drinking water production will also be studied.

Technology Showcase 4: Zero Liquid Discharge with RO and electrocoagulation (NUS, SG)

Internal reuse of industrial wastewater reduces the pressure on drinking water sources and supply. RO has become a popular process in this context, but the management of produced brine is a common challenge due to its high salt, organic and other pollutant content. The zero liquid discharge (ZLD) concept is probably the only sustainable way to manage this challenge. ZLD systems may include a membrane process – used to recover water and to further concentrate brine – followed by thermal treatment. In such systems, a high-water recovery rate is difficult to achieve due to the early onset of membrane scaling and fouling. Brine pre-treatment is therefore necessary to protect the membrane and facilitate ZLD. Preliminary evaluations indicate that electrocoagulation and nanofiltration processes are quite efficient in removal of hardness and organic removals, while coagulation and adsorption processes can remove organic removal. NUS will carry out lab and pilot scale tests in Singapore to study the process optimisation, and perform a cost analysis to determine the feasibility of applying these technologies with a ZLD system.

Technology Showcase 5: Enhancing reuse capacities with coagulation preteratment (MARCOR, UWM PL)

The food industry requires pure water for production use and washing purposes, creating an enormous pressure on precious drinking water sources in some regions. Water reuse is the only sustainable strategy, but the treatment plants' capacity and economy are discouraging bottlenecks. MARCOR is a microSME that successfully provides solutions for dozens of dairies in Poland using their patented[9] solution; a combination of evaporation, RO and ion-exchange. The capacity of the process is to a greater degree governed by pre-treatment, and this technological showcase intends to develop and validate the use of coagulation in harmony with other processes to maximise capacity at the lowest possible energy and operational cost. The concept will also be applicable in small water and wastewater plants, and in emergency water supply situations where high levels of water reuse maybe required.

Electrocoagulation is a promising method that can compete with conventional coagulation, but suffers from energy consumption as its bottleneck. Another polish patent[10] documents the possibility of using the galvanic cell principle in electrocoagulation by using Cu/Al alloy and Cu/Fe macro-galvanic couples with aerated sacrificial anodes.

Technology Showcase 6: Hybrid reverse osmosis with fenton oxidation (QUT, CN)

Reverse Osmosis (RO) can produce ultrapure water, however, this process is costly, especially if designed to remove MPs. Advanced oxidation in combination with RO may provide an overall improved performance. This technological showcase will be demonstrated on a pilot plant located at the Beijing 2020 Olympics site of Zhanjiakou, which is 200 km from Beijing (China). The climactic conditions require the production of artificial snow, and the Beijing Olympics have decided to use domestic wastewater from the site to produce ultrapure water for use in snow production. QUT is leading projects funded by national authorities and will enter the Water Harmony platform to share and discuss the results. The experiments will serve as a demo for several other Chinese cities, while also creating a benchmarking concept for European countries and beyond.

Technology Showcase 7: Natural coagulants with membranes (MSU, US)

Natural coagulants are gaining interest among a vast user group due to their non-toxic nature and affordability. However, their treatment efficiencies do not match current needs, especially in relation to MP removal. Thus, the main objective of the proposed work is to evaluate coagulation by these plant-derived materials as a standalone treatment process and as a pretreatment for membrane separation for the removal of selected MPs. We will employ conventional coagulants for benchmarking and evaluate both ultrafiltration and microfiltration membrane technologies as polishing steps that follow coagulation. A range of natural coagulants will be screened based on literature review including chitosan, Moringa Oleifera, Nirmali seeds, Jatropha Curcas seeds, and tannin. The study will generate data on the optimal coagulant dosing that optimizes the filterability of treated water and MP rejection. The tests will be conducted in a crossflow filtration system with flat sheet polymeric (PVDF, PES) membranes of a range of pore sizes. Preferred coagulants and membranes will be selected as the output of this activity.

Information management and realising the power of BigData (Lead: Deltares, NL, assisted by NMBU)

The Water Harmony project will carry out 11 research activities in 10 countries, mobilising a large group of researchers over 30 months. A large amount of data will be collected. Surveillance, data and information play key roles in management and improvement of the selected demonstration site services. The utilisation and cross integration of these elements into modelling and monitoring systems will serve to enhance the current status of operational and forecasting systems. This may be achieved through the fusion or integration of existing data sets and monitoring networks.

Closing the gap between demand and supply of water depends on the sound understanding of current pressures, impacts, and trends within the water paradigm both at local and macro scales. Utilizing all possible sources of information and optimising such data through fusion and synthesis of available products can be achieved by researches and through monitoring programs. The education and mobilisation of the citizenry can be realized through the dissemination of pertinent and interesting monitoring and modelling information using mechanisms such as web portals and mobile application or products. The synthesised products can subsequently be further enhanced through the inclusion of BigData, participatory monitoring, and citizen science.

The data obtained from participatory monitoring and citizen networks can be utilised to enhance existing databases and products resulting from in-situ monitoring, remote sensing, and modelling efforts. Data fusion provides a pathway through which various data elements, that can be utilised in conjunction to derive new or improved information. Such efforts can utilize variables and proxies at different spatiotemporal scales so as to

[9] Patent No 213725 (2017), Polish patents
[10] Patent No 227874 (2017), Polish patents

achieve comprehensive and increasingly accurate products. Many such fusion algorithms are well developed and documented, open source, and widely available. BigData also plays a key role in such synthesis techniques, allowing the derivation of nuanced relationships to be derived through the analysis of large data sets, often resulting in unknown or underappreciated networks.

According to the requirements of the system, Deltares can assist in the utilization of integration frameworks and systems such as the open source framework OpenDA. The OpenDA software package provides a library of tools and computational framework for data-assimilation state updating and automated calibration as well as other methods for the inclusion of data products into models and operational systems. These improved model results, as well as synthesised data sets, provide a wealth of information to researchers and operators looking to increase the efficacy and safety with which water resources are utilised. This can be in the form of real time predictions, maps, trend analyses and much more. Deltares will demonstrate the use of historical and operational data when providing these information, mainly through the four demo projects where applicable and feasible.

All Case studies will involve political and administrative decision makers in their dialogues and disseminations to secure that the best practices on sound water management help close the gaps between water demand and supply. Singapore has unique experience in managing public perceptions in the use of reused wastewater as drinking water. In Europe, even the use of reused wastewater or sludge in farms remains a challenge due to public perceptions. NUS will share experience from Singapore on how to improve perceptions and attitudes among the public. Investment decisions in the public sector must always compete with sectors for education, health and care for elders. Therefore, there is an increasing need to elaborate the Cost-Benefits of investments in the water sector in a more justified way. NMBU will develop tools for holistic Cost-Benefit Analyses (CBA) that include intangible benefits in decision-making tools for infrastructure investments, which will strengthen the willingness to invest in the water sector by the public sectors. CBA will be used in public and political consultations, especially in Romania. Life Cycle Assessments (LCA) are vital in evaluating the seven technologies independently and comparatively against conventional methods. NMBU will carry out LCA analysis using SimaPro software.

The CBA and LCA tools together with comparative analyses of treatment efficiencies will provide a basis for comparison of the innovation generated from seven technological showcases, and will provide the user with a selection of tools or best technologies tailored to a given condition. The four management demo projects will be analysed by Deltares using the above tools.

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

Emerging pollutants and MPs may accumulate in the water environment and cause largely unknown long-term impacts. On the other hand, an important and critical activity in closing the gap between the demand and supply of water is water reuse - an area that also faces challenges with the same emerging pollutants. Many research groups are studying the status, fate and removal of these pollutants. Project partners will consolidate the knowledge into a State-of-the-Art report that will be supplemented with own, cutting-edge research activities. **ACSA (ES)** will develop cutting-edge compact filters made of electro-spun nanofibers that are able to remove MPs, including micro-plastics, at significantly higher water permeability than conventional membrane processes for water reuse. The process requires relatively low applied pressures, thus reducing the carbon footprint of treatment technologies. MPs can be eliminated from effluents using adsorption on activated carbon, membrane filtration and advanced oxidation processes (AOPs). However, they require heterogeneous catalysts, which is a disadvantage in related photosynthesis processes and complicates the reactor design. **BGU (IL)** will be studying a novel concept on eliminating these disadvantages. **IVL (SE)** will be demonstrating the dynamic balance in the use of groundwater and surface water by using an innovative approach to advanced models related to hydrogeology, hydrology and water treatment processes. Many quantitative models exist for sewers, but there are no qualitative models covering detailed networks. **NMBU** will be developing such a model to estimate pollution loads in the sewer system, which will be and will be a cutting-edge development/technology. **UWM** will be presenting a water conservation concept with a new procedure in quantifying the impacts; a state-of-the-art rapid nutrient analysis system that enables early warning systems and low battery consumption. **MARCOR** and **UWM** will be extending their newest patents to further improve concepts by using pre-treatment with coagulation and innovative electrocoagulation. Four leading universities from the US, AU, CN and SG join the consortium with their own funding to generously share their cutting-edge research on removal of MP by using innovative integration of conventional treatment processes with improved operational and economical feasibilities. **UTS (AU)** will demonstrate their work on the use of natural adsorbents for simultaneous removal of MPs in combination with membrane processes. **MSU (US)** will study the hybrid effects of natural coagulants and membrane processes in the removal of MPs. **QUT (CN)** is working on the production of ultra-pure water from domestic wastewater to produce artificial snow for the Beijing 2022 Olympics. They bring innovative concepts that use a combination of oxidation and membrane processes. **NUS (SG)** will contribute with the removal of MPs through membrane processes combined with electrocoagulation for the ZLD concept. The Innovation camps and the citizenry sciences (**DETARES**) will increase the ownership by dialogue **(TUIASI)** with the public and decision makers through novel approaches (i.e. serious games, online result and scenarios, economically feasible innovations etc.).

1.6. Clarity and quality of transfer of knowledge for the development of the consortium partners

The Water Harmony project brings together a large team of scientists working independently of each other in parallel towards a common goal *(Fig 2)*. Most partners have gained their strongest strengths through long experience in specific research areas or unit processes, while most treatment processes often combine with several other processes (adsorption and membrane, coagulation and membranes, etc). Water Harmony establishes a forum where the specialists can share knowledge and receive mutually beneficial advice. Some partners are engaged in BigData and modelling (NMBU, IVL, Deltares) and will present feasible concepts that can benefit other partners within this project and beyond. Some partners focus on water resource management (IVL, NMBU, TUIASI, UWM) while others focus more on treatment processes (QUT, UTS, MSU, BGU, ASCA, NUS). The project creates a sustainable consultative forum among leading specialists and their junior scientists (PhD students, PostDocs etc). As a result, partners envisage increased international mobility and co-supervision through the network. Early introduction and consultation on the innovative processes each partner is working on creates both synergies and could possibly also initiate innovative hybrid process concepts.

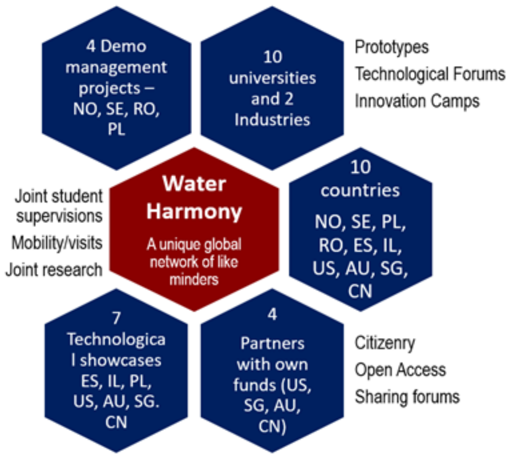

Figure 2. Partners, countries, componets, funding etc)

Partners will share research results and knowledge from recently completed and ongoing projects; several examples are relevant for the tasks in the proposed project. NMBU has completed a project where holistic modelling of sewers and WWTPs covering both water quality and quantity (Regnbyge3M-Holistic optimisation of sewers, WWTPs and recipients (funded by NFR), Innovanett - Innovative quantification of water pollution loads in sewers (NFR)). IVL has had several projects on hydrogeology and hydrology. IVL is a partner of the H2020 project NextGen - Towards a Next Generation of Water Systems and Services for the Circular Economy, who will be sharing their innovative ideas on Circular Economy from 29 European partners. DigiDrick- Digitalisation of drinking water treatment plant for safer water production (funded by Swedish Research Council, Vinnova) will show the use of BigData in water treatment processes. BGU has experience in several infrastructure projects with Mekort (National water company of Israel). UWM has experience with monitoring natural habitats and development of innovative rapid sensor for phosphates[11]. Deltares is involved in several relevant EU H2020 projects (Sophie, Ecopotential, ODYSSEA, INFORM, SWITCH-ON, etc) and a lead partner in the OpenDA (www.openDA.org) software which will be used in the project for data management in view of citizen involvement. UTS is leading projects concerning on-site remediation of MP from stormwater for reuse, high quality water reuse through developing of membrane hybrid system, RO systems with near ZLD, all funded through www.crccare.com. MSU has completed and have several ongoing projects related to membrane processes[12]. NUS has a strong collaboration with the water and wastewater industry and leads the SEMB Corp-NUS lab on water technologies[13]. UWM will be using its patent[14] in wastewater treatment. >10 joint research papers, 10 master/phd co-supervisions, 30 visits to and between the partners are intended deliverables.

[11] Patent 123782 from 2106, Polish patent,
[12] https://www.egr.msu.edu/~tarabara/past-projects.html & https://www.egr.msu.edu/~tarabara/current-projects.html
[13] https://www.eng.nus.edu.sg/sembcorp/
[14] Patent 227874: Electrocoagulator for wastewater treatment, Patent of the Republic of Poland

1.7. Quality of the consortium partners and collaborative arrangements.

The consortium of the Water Harmony project is unique and will be the first opportunity for all the partners to come together. Each partner has a long record of accomplishments in mobilising research funding through national, bi-lateral and international funding. Therefore, the new consortium provides opportunities to all partners and increases their competitiveness, alongside creating synergies that secure sustainability. Partners of the consortium has nationally leading competence and significant roles in the research arena in their specific research areas of contribution to the project. Their competence can be documented by the numerous patents and publications in leading research journals. For example, Prof Kalinowski (UWM) holds 11 patents/applications[15] on innovative water quality detectors. Prof Ng (NUS) holds 17 patents[16] on membrane processes and catalysts. Prof Tarabara (MSU) holds 4 patents[17] on hydro cyclones combined with membranes and on mercury removal. Prof Vigneswaran (UST) holds a patent[18] on recovery of metal oxides, which can be useful in removal of MP. Prof Bi (QUT) holds 34[19] patents on various technologies for removal of MP and process optimisation in wastewater treatment. Dr Gitis (BGU) holds 3 patents [20] on membranes and bubble generators related to wastewater treatment. Prof Cretescu (TUIASI) has 13 patent[21] applications related to environmental protection. Dr Maletskyi (NMBU) is involved in 3 patents[22] on water treatment. Prof Ratnaweera is the inventor of the DOSCON dosing control system[23], used in Norwegian and Chinese WWTPs.

Forming a consortium where the partners jointly develop and demonstrate innovative solutions will enhance the competence and competitiveness of each partner and pave the way for new and long-term collaborations with international funding possibilities. The project creates a unique possibility to validate concepts at multiple sites, strengthening the value of various patent and publication concepts. Each of the technological showcases will receive a unique opportunity to benchmark their technologies with a comparable LCA and CBA analysis, and be part of a toolbox where the user can select the most appropriate combination for their needs.

Partners shall consider the local conditions and design any research and dissemination activities accordingly, to ensure platforms for synergies and common goals. In particular: (a) local water and wastewater quality and legislations (b) access to raw materials and need for recovered resources (c) priorities of the local industries as innovation champions (d) the possibility international mobility for graduate students.

2. IMPACT

2.1 Impact of the proposal

Many research groups work on MP, but research is mostly fragmented. Water Harmony will strengthen the coordinated approach to research and actions on preventing MPs by creating a true transnational platform of scientists from 10 countries. The project aims to provide solutions suitable for all partner countries and beyond, demonstrating its transnational value. The project creates a knowledge-sharing platform among leading researchers with various backgrounds and specialisations, creating a unique possibility for synergy and a possibility to exchange and create Best Practices. The work is a direct contribution to the anticipated revisions in the EU Drinking Water Directive on watch list pollutants, which will soon be included in national regulations. Thus, the project is coherent with national and EU funding priorities. With its seven technological showcases and four demo projects Water Harmony leads European R&I into a true demonstration of tools enabling the bridging of the gap between water supply and demand via quality and quantity enhancements. As noted in the introduction, the ambition of the project is to unite competent researchers, end-users, policy makers and the public to develop and jointly demonstrate best practices that are potentially valuable for Europe and beyond by addressing SDG 6 "Ensure access to water and sanitation for all", maximising synergies and rationalising resources and efforts. The project also addresses the COP21 Paris conclusions on strengthening the ability of countries to deal with the

[15] http://pracownicy.uwm.edu.pl/kalinow/patents/index.html
[16] http://6gc.prevailing.us/inventor/NG-HOW-YONG
[17] https://patents.justia.com/inventor/volodymyr-tarabara
[18] US, China, Korea Patent 10-0715093
[19] 104445863A, 106442526A, 101560015, 102502950A, 102225827A, 104122117A, 201785243U, 105776444A, etc Chinese patents
[20] https://patents.justia.com/inventor/vitaly-gitis
[21] http://www.researcherid.com/rid/O-8359-2017
[22] https://worldwide.espacenet.com/
[23] https://www.doscon.no/en/about/

impacts of climate change, i.e. reduced and increased precipitations, dealing with removal of increasing natural organic matter[24], etc. The projects relation to the thematic areas are noted in §1.4.

The collaboration initiated by Water Harmony will create new research partnerships between 12 partners. Furthermore, it will provide SME's and utility owners of 10 countries the opportunity to learn and influence on this unique Coordinated Action on closing the gap in water supply and demand in their own contexts. The 10 university partners will have increased staff and student mobility, research collaboration and joint research & publications, co-supervision of student research and potential research as mid-term impacts. The new institutional partnerships created by the project will lead to long-term collaborations with sharing of knowledge and joint efforts beyond the water sector. The consortium sees the increased potential for regional (EU, NATO) and national funding with partners, a process that has already started. The LCA and CBA concepts, Innovation camps, clustering, citizen sciences and BigData are some focus areas utilising international and EU research methodologies and priorities.

Water Harmony stretches beyond the minimum consortium requirement to a unique 12 partner – 10 country consortium including US, AU, CN, IL and SG, creating a cluster of leading research groups that add value to the WaterJPI concept. Each partner will be disseminating the results of this unique consortium to water utilities and national research arenas, multiplying the impact of the project results. Local challenges will be addressed with internationally reviewed solutions in a much stronger and broader way than the current common practice of international publications and conferences. The project mobilises communication with the public, creating an ownership to the R&I process.

The project responds very well to the expectations of the FPO's promoting transdisciplinary research through its involvement of 10 countries and 7 cutting-edge research actions in parallel to 4 applied approaches, multiplying the mobility of researchers within the consortium. It also creates a sustainable research network that will work together to promote joint research ad international cooperation in the water sector, during and beyond the project lifetime.

2.2 Expected outputs

Expected Outcomes and impact of the research

- Improved use of scarce human and financial resources in the area of water research and innovation by sharing knowledge, building competences, rational utilisation of scare finances and facilitating increased funding;
- Reduced fragmentation of water R&I efforts across Europe and beyond by bringing research environments together to consolidate best practices, share knowledge and develop harmonised actions to achieve objectives;
- Enhanced synergy, coordination and coherence between national and EU funding in relevant research fields through transnational collaboration, by extending R&D&I activities from completed/ongoing R&D&I projects;
- Improved implementation of research and innovation programmes in these fields through exchange of good practices, which is a key objective reflected in all WPs of the project through 6 joint project meetings;
- Increased student mobility between the partners (>30 visits among partners) and >10 co-supervision of master and PhD students, which will be mainly funded from other sources (National funding, Erasmus+, etc).
- At least 6 pilot plants and prototypes and 4 patent applications
- At least 10 research papers with more than one partner from the consortium
- Strengthened international leadership of European R&I makes the Water JPI, in collaboration with the EC, a privileged and attractive partner for global cooperation: Participation of 4 self-funding international partners;
- Contribution to the implementation of the objectives of the JPI on Water - sharing knowledge, promoting innovation, public-private partnerships, increased stakeholder ownership and governance with transparency;
- Contribution to the implementation of SDG 6, SDG 13 and other EU/UNECE/WHO tools related to water;
- Protecting humans against known and unknown health risks (emerging pollutants with unknown impacts);
- Supporting better water allocation and water use control measures using modelling tools;
- Sharing of knowledge, data and harmonised actions, prompting interoperability;
- Maintaining water quality and quantity with physical and cyber security of water infrastructure and services.

2.3 Exploitation and communication activities (measures to maximise impact)

The results of the project will be continuously disseminated via a webpage and presented at workshops and conferences of WSSTP, IWA, EWA and at national seminars. The consortium will look for opportunities to

[24] http://folk.uio.no/rvogt/CV/Publications/Critical%20Review%20-%20Vogt.pdf

continue research initiated in this project through the unique international network this project represents. Self-financing international partners have offered to host researchers from the consortium, which will be funded through other sources. Partners will actively search for other ongoing and planned projects where this consortium can play a synergetic role for the benefit of Europe and beyond – for the water sector. Some of the innovative research may have a commercial potential, which the relevant partners will jointly evaluate.

Water Harmony utilises several innovative approaches such as innovation camps, citizenry sciences, Additionally, through the development and deployment of citizen science applications and media outreach, the citizenry of the EU and beyond will be able to view and utilize the products which are developed through the consortium's efforts. Periodic updates and newsletters generated and distributed through electronic means will also help to raise and maintain awareness of the project's developments as well as the efforts of consortium partners and state of demo and exemplar sites.

Acknowledging the importance of safe data storage and appropriate accessibility, the Water Harmony project intends to participate in the EU's Open Research Data Pilot process. A detailed Data Management Plan will be developed and agreed upon at the inception of the project, and will be included in the consortium agreement. Water Harmony DMP will define the handling of research data during and after the end of the project, what data will be collected, processed and/or generated, which methodology and standards will be applied, whether data will be shared/made open access and how data will be curated and preserved (including after the end of the project). Additionally, it will also include background and foreground IP and the rights to IP developed during the project.

2.4 Market knowledge and economic advantages/return of investment

The Water Harmony project develops technologies addressing emerging national and EU legal requirements related to MP, where potentially 100 000[5] treatment plants must invest in suitable technologies. After realising the shortcomings of current solutions, as well as the national needs and market potential, the partners have launched their cutting-edge R&I. The industrial partners (ACSA and Marcor) have identified commercialisation potentials and the partners have ambitions to apply for patents. Three subcontractors with commercial ambitions are associated with the project. The project will benchmark the technologies developed together with existing solutions using LCA, CBA and comparison tools for performance that will enable mobilising investors. The Water Harmony project seems, at present, to be the largest cluster of R&I on MP removal, thus having a unique advantage over its competitors. The main industrial partner in the consortia, ACSA (ES) states that having a diverse portfolio of innovative technologies is a recognised advantage to increase their competitiveness in public tender processes. The research partners consider Water Harmony as a stepping stone for commercialisation of their results. UWM and NMBU will be involved in development of novel sensors with a commercialisation potential. IVL will receive a validation of their concept, a result that can be promoted in other municipalities. BGU's innovative ceramic membranes with catalytic coatings etc. are highly attractive for commercial actors, after validation.

3. IMPLEMENTATION

3.1 Overall coherence and effectiveness of the work plan

WP No	WP Title	Duration (months)	Starting Month	End Month	Lead partner
WP1	Harmonisation of management concepts	24	01	24	IVL
WP2	Harmonisation of technological concepts	24	01	24	NMBU
WP3	Harmony of digital integration	27	03	30	Deltares
WP4	Harmony of Open Innovation	18	19	30	ACSA
WP5	Governance for Harmony	24	07	30	TUIASI
WP6	Harmonised exploitation & dissemination	24	07	30	UWM
WP7	Harmonised project implementation & management	30	01	30	NMBU

WP1. Harmonisation of management concepts:

F4 management concepts addressing cross-cutting challenges with integrated technological and advanced modelling concepts will be carried out. The ambition is to iteratively optimise the concepts with broader stakeholder participation. Gained experience and evidence generated from the demo projects will be leveraged in order to build public confidence in the feasibility and safety of management approaches.

A1.1 Implementation of technological demo-projects: Design, implementation and verification of four demonstration projects managed by NMBU (NO), IVL (SE), UWM (PL) and TUASI (RO).

A1.2. **Best Practices Knowledge Base** will be established through documentation of the demonstration projects' technical set-up and operational performance: CBAs, LCAs; environmental impacts; health and safety. A methodology suitable to develop and update a Best Practices Guideline will be agreed upon. A common identity will be provided to network members and ontology-based data integration will be carried out.

A1.3. Open Network: An online platform for sharing of best practices will be established to foster synergistic collaboration between experts, plant operators, policy makers, institutions, agencies, and other organisations experienced in systematic reviews and guidelines production. .

WP2. Harmonisation of technological concepts:

7 technological showcases will be designed, implemented and verified in ES, IL, PL and together with non-Water JPI funded supplementary cases in US, AU, CN, SG. Throughout the process, information will be shared and discussed in scientific and operational forums: The ambition is to rationally implement and maximise synergies.

A2.1. Implementation of technological showcases: Design, implementation and verification of 7 showcases.

A2.2. Technological discussion forums: 4 discussion forums will be organised in Barcelona (ES), Negev (IL), Olsztyn (PL) together with the project kick-off meeting in Oslo, with physical & online participation. Concepts, progress and challenges will be presented, reviewed and discussed.

A2.3 Joint supervision of master/PhD projects and short mobility visits

A2.4. Open Network: Similar to A1.3, but for technological solutions.

WP3. Harmony of digital integration

The 11 showcases and demo projects will create an enormous information and database which can be used not only for the direct presentations but also to derive scenarios, predictions, and solutions market place for utility owners with benchmarking with conventional solutions (LCA, CBA, treatment efficiencies) and will create a showcase of the power of BigData and novel Data Science techniques applied in practice.

A3.1 Status assessment: Prepare an inventory of the current operation and forecasting capabilities. This includes taking stock of the data available at hand, including the spatial and temporal resolutions thereof, and to outline an optimization plan. Operational capacities and model errors and deficiencies will be determined to identify in which manner observational data can be utilized within the operational or model system

A3.2 Schematization and variable mapping with data production: A mapping scheme of variables and model processes to proxies which exist in current data sets will be executed and a prioritizaed. Identified synthesis requirements will be executed and qualitatively validated. Additional ascription of error and uncertainties to observational and synthesized data must be executed to determine integration capacities for phase 3.4**.**

A3.3 Citizen science applications. Develop applications and implement them to improve or supply the proxies required and to highlight areas where fusion can be applied on complementary, competitive, or cooperative data sets. Citizens engagement is mobilised through *serious games* etc.

A3.4 Data integration into modelling and operational systems through optimization of the parameterization process or systemic updates utilizing observational and synthesized data products. This will include utilization of integration frameworks and systems such as OpenDA and others.

A3.5 Presentation of data : system predictions, maps, trend analyses showcasing the management demo cases.

WP4. Harmony of Open Innovation

Innovative technologies in removal of MPs for safer and economical use and reuse of water will be developed and evaluated through two Innovation Camps[25] at case-study sites in Israel and Spain. Innovation Camp is a collective process of solution seeking through reframing with selected participants. The process leads to the creation of a range of new perspectives, which can then be tested and improved with real world stakeholders.

A4.1. Camp Preparation: The goals, vision and strategic direction, conceptual framework, will be identified. The challenges will be described with challenge-owners. A common Camp indicators will be developed.

A4.2. Face-to-face Camping will be conducted at 2 Negev (IL) and Barcelona (ES): The discussion process on emerging insights on challenge(s), problems and issues are, followed by a constant reframing & redefining.

25 Innovation Camps Methodology Handbook, EU, 2017

A4.3. 6-week prototyping: Paper-prototyping, focused conversation, simple design-based techniques, and role-plays continue using virtual interaction

A4.4. 6-month full prototyping & evaluation: A Go/No-go gateway will be organised to determine the ways a pilot project can be set-up to realise improved results in practice.

WP5. Governance for Harmony

Promoting public engagement and investments in the water sector. TUIASI will lead this WP where the results of the project will be communicated to political and administrative decision makers. The need to prioritize investments in the water infrastructure, facts and scenarios, holistic Cost-Benefit analyses including intangible benefits, better and active use of real-time monitoring and early warning facilities, active participation in forums where decision makers are involved etc. are selected activities.

A5.1. International organisations: Presentation of the project and results and discuss implementation options with the UNECE/WHO Protocol on Water and Health.

A5.2. Online Society on Water & Resources Circularity – ResearchGate, LinkedIn groups

A5.3. Policy Lab. Co-creation tools and methods are used and experimented with to develop policies with those who are directly involved with the challanges. Policies and tools are developed through short cycles based on rapid problem analysis, development of solutions, prototyping and testing. The engagement of stakeholders in the problem analysis as well as in the design of solutions is a key feature of the process.

A5.4. Lobbying – Best practices among partners will be utilised for the dialogues with political administrations.

WP6. Harmonised exploitation and dissemination:

The project will employ a user-orientated approach. The majority of the products will be online open-access tools (searchable databases, decision trees, models and publications), also via open repositories. Relevant stakeholders will be invited for meetings. Dissemination will be interactive & multilingual, multimedia, and user-centred .

A6.1. Preparation of a detailed communication and dissemination plan in close consultation with users of the project's results, including policy makers at EU, Member States, river basin managers, water utility managers.

A6.2. Design and implement dissemination tools. The main tool will be an interactive website supported by social media. The website will be operational for sharing news and the project's progress. All reports will be summarised in a key message targeting a broader audience. We will widely advertise this website.

A6.3. Publications in scientific journals and conferences. The project has an ambition to disseminate results via national, regional (WSSTP, EWA conferences) and international conferences (IWA, etc.). Major results will be published in high quality peer reviewed periodicals and presented at international scientific meetings.

A6.4. Popular scientific publications: will be implemented and an outreach component to increase scientific literacy and to transfer scientific results to the public. We will actively use media to communicate with the public and educational institutions. Press and television teams will be invited to selected events.

A6.5 Development of outreach activities: The interdisciplinary approach provides a great opportunity for educational activities. Global change is a subject of growing interest and we recognise the importance of conveying our work and enthusiasm for the subject. Speaking opportunities to disseminate will be sought.

WP7. Project management

Sound project management. NMBU will coordinate WP7 with regular project meetings and follow-ups, reporting to EU-Water JPI to secure sound and transparent financial and administrative procedures.

A7.1 Project inception meeting will be held in Oslo with the presence of all partners (travel costs for non JPI for the inception meeting and for at least one more site visit are included in NMBU's budget).

A7.2 Drafting and signing of the consortium agreement

A7.3 Develop online tools and mobilse use. The project webpage will have an internal area which will be dedicated for project management issues and all communication among the project partners..

A7.4 Project steering group meetings and Annual project meeting to present, discuss and agree on necessary actions to mediate any deviations

A7.5 Biannual periodic meetings annual reporting to JPI on physical and financial progress.

A7.6 Final project meeting

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

The Water Harmony JPI project will be led by Prof Harsha Ratnaweera as the coordinator. Prof Ratnaweera has 26 years of experience as a project manager and currently leads a research consortium at NMBU that collaborates with 45 universities from 30 countries through 6 projects (www.waternorway.org). The following specialists are appointed for dedicated tasks: Dr Maletskyi (NMBU): logistics coordinator; Dr El Serafy (Deltares): Digital integration; Prof Glinska-Lewczuk (UWM): Dissemination; Prof Cretescu (TUIASI): Dialogue with public and politicians; Dr Ejed (IVL): Coordination of demo projects; Dr Gitis (IL): coordination of technological show cases; Dr Garcia (ACSA): industrial innovations and IPR; Dr Marjanowski (MARCOR): Market analysis; Prof Tarabara (MSU): Coordination of the inputs from non-JPI funded partners. A steering committee consisting of all 12 partners will be established through a consortium agreement, which has clear objectives responsibilities, rights and IP conditions (background/foreground IPs, ownership to the IPR of the project results). Project management will be mainly conducted through an active webpage, webinars and annual project meetings with physical and web participation. MS Project will be used as the progress management tool, administrated by Dr Malestskyi (PMI-certified). Financial management will be done using NMBUs accounts management system (agresso) which is used for EU project accounting, which requires periodic reporting satisfying the EU H2020 requirements. The whole consortium will be collectively responsible via the consortium agreements. Formal documents will be archived at NMBUs formal archive, P360 system.

	Deliverables		**Milestones**
1.1	Mid-term reports from 4 demo projects produced	1.1	Novel online sensor patent applied
1.2	Best practices guide produced for demos.	1.2	
1.3	Open network functional	2.1	Tech forum operational
2.1	Mid-term reports from 7 showcases produced	2.2	10 supervisions completed
2.2	Tech forums held in IL, PL, ES, NO	2.3	10 mobility visits completed
2.3	Technology validation reports	2.4	10 research papers submitted
2.4	Open network functional	2.5	30 staff visits completed
3.1	Implementation framework	3.1	Assessment report outlining the current capacities
3.2	Report outlining the mapping of state variables	3.2	Lessons learnt and recommendations report
3.3	Proof of concept for select demo/case site studies		
3.4	Proof of concept for sites -operational capacities		
3.5	A report detailing the outcomes lessons learnt		
4.1	1st Innovation camp in Israel conducted	4.1	1st Innovation camp completed
4.2	2nd Innovation camp in Spain conducted in	4.2	2nd Innovation camp completed
5.1	LinkedIn, Researchgate, Mendeley operational	5.1	Online societies are fully operational
5.2	Policy labs with public		
5.3	Policy labs conducted		
5.4	Report on best practices on political dialogues		
6.1	Development of dissemination & communic. plan	6.1	Dissemination & communication plan published
6.2	Webpage promoted among stakeholders	6.2	Scientific publications x10 submitted
6.3	At least 10 scientific publications submitted	6.3	Pop scientific articles published
6.4	Presentations at UNECE PWH & SDGs meetings	7.1	Inception meeting
7.1	Inception report	7.2	Bi annual project meetings x5
7.2	Signed consortium agreement	7.3	Project steering group meetings x7
7.3	Webpage developed	7.4	Consortium agreement signed
7.4	Minutes of meetings x7	7.5	Webpage operational
7.5	Final report	7.6	Project completed

3.3 Risk management

- Risk: Inadequacies in unified quality and inter-operability of data, willingness to share data. (remedy: **R1**: Open access, harmonised actions, large transnational teams will improve the conditions and create motivation);
- Risk: Public acceptance of the use of reused water is still a challenge, limiting the usage of concepts. (Remedy: **R2**: Singapore has tackled this perception (NEWater) remarkably, and NUS will be sharing their experiences);
- Risk **R3:** Political willingness to invest in water initiatives may weaken in a context of needs in schools, elderly care, roads etc, due to inadequate (Remedy: **R4**: CBA including non-tangible values will be promoted)
- Disturbances of peace or natural catastrophes, prohibiting implementing pilots or meetings. (Remedy: **R5** consider moving the activity to another location/country)

3.2a Gantt diagram. “1.1” refers to WP1 Activity 1, as noted in the beginning of §3

Month/ WP+Activity	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	31	32	33	34	35	36
1.1 tech impl	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
1.2 Best practices								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
1.3 Open network								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
2.1 Implement.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						
2.2 Tech forum					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
2.3 Supervis./mob.													X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
2.4 Open network								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
3.1 Status		X	X	X	X	X																														
3.2 Schematics						X	X	X	X	X	X	X	X	X	X																					
3.3 Citizen sci.									X	X	X	X	X	X	X	X	X	X	X	X	X	X														
3.4 Data integr												X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							
3.5 Data presen																					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
4.1 Prep		X	X	X	X																X	X	X	X												
4.2 Camping								X	X	X	X	X	X											X	X	X	X	X								
4.3 Prototyping														X	X	X													X	X	X	X		X		
4.4 Evaluation																X	X	X															X	X	X	
5.1 International O											X												X												X	
5.2 Online society			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
5.3 Policy lab											X																									
5.4 Lobbying															X	X	X	X								X	X	X	X	X	X					
6.1 Dissem plan	X	X																																		
6.2 Design tools	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6.3 Publications																	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6.4 PopSci								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
6.5 Outreach														X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.1 Kickoff	X										X																									
7.2 Consort agrm		X																																		
7.3 Online tools		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
7.4 Steering group	X					X						X						X						X					X					X		
7.5 Proj. meetings	X					X						X						X						X					X					X		
7.6 Final meeting																																				X
Deliverable	7.4	6.1 7.1	5.1 7.2			2.2 3.1	7.4	2.2 4.1 6.2		1.3 2.4	5.1		3.2 7.4		2.2		1.1 2.1	5.3	7.4			3.3	5.1	1.2	2.2 4.2 7.4		3.4				2.2 7.4		3.5 5.3		5.1	7.5
Milestone	7.1 7.3	7.4 7.5	6.1			7.2 7.3	5.1		6.3			7.2 7.3	6.2		3.1 6.3		4.1	7.2 7.3	6.2		6.3	1.1		7.2 7.3	6.2			6.3		7.2 7.3		2.2 2.3	3.2 6.2	4.2 6.2	2.4 7.3 7.5	2.5 6.3 7.6
Progress Monitrng					x						x						x						x						x					x		
Mobility Schemes													2.3					2.3				2.3					2.3					2.3				
Risk Management			R5									R1						R2			R3				R4										R5	

3.4 Potential and commitment of the consortium to realise the project

The project brings together a team of extremely motivated scientists and practitioners that are hungry for research results through project achievements, and the opportunity to share and create synergies via a collegial forum. The demo-sites and showcases are the fruits of each project partner’s dreams, as the project initiates technologically sound conceptual sketches the partners’ have long hoped to realise one day. WaterJPI thus provides the funds that initiate the conceptualisation and validation of these ideas, where a big team of colleagues will function as critics as well as mentors and motivators with diverse viewpoints. Water Harmony designs a global network within the framework of the EU WaterJPI by placing and creating a unique value every partner (and those outside and tangential to the project) understands; the partners will be placed in an ideal position to form a highly competitive consortium that can aim to secure new funding for the future. Consequently, all partners see a great potential and value in the project for their respective institutions, in tandem with the proudness that comes from contributing towards closing the water supply and demand gap - one of the biggest challenges in our time, in our field of profession. Internationalisation ambitions and relevant associations with EU research are strategies of all partner organisations.; the project creates an unparalleled synergy that none of the partners can afford to miss. Despite the limited budgets available for enhanced physical meetings, modern web-conferencing technology will enable significantly frequent interactions and create a closeness among the partners that even a few years ago would be considered infeasible. Thus, in our view, we have considered all potential weaknesses and challenges, and still find the Water Harmony project to be a logical direction to focus our collective research activities; towards newer heights, by contributing in a unique way to close the gap between the supply and demand of water.

4. DESCRIPTION OF THE PARTICIPATING RESEARCHERS

Partner Number	Research Team Members	General Description
Coordinator (NMBU, Harsha Ratnaweera)	**John Morken** Associate Professor, NMBU	25 years of research on anaerobic treatment, biogas production and purification; Life Cycle Assessment in waste management. Project leader of 6 industrial projects, involved in 29 industry-oriented projects.
	Zakhar Maletskyi Postdoctoral fellow, NMBU	Conducting research on membrane technology for water and wastewater treatment and reuse of water and resources from wastewater. Project manager and principal investigator in 2 Living Lab and 1 R&D projects.
	Vegard Nilsen Assistant Professor, NMBU	Researcher on quantitative microbial risk assessment; water transportation and management; flood management and climate change resilience. Board member Norwegian Water Society.
Partner 1 (IVL, PI, Helené Ejhed)	**Ewa Lind** Project developer and Researcher at IVL Swedish Environmental Research Institute	Has more than 10 years of work and research in geology, geochemistry and hydrogeology in Sweden, Faroe Islands and Norway. Specialized in climate change effects on soil stability, geohydrology, surface waters and transport of pollutes in soil and water. Works in field with practical application of soil probing and management of ground water.
	Anders Björk Project manager and Researcher at IVL Swedish Environmental Research Institute	Coordinator for the Swedish strategic research agenda for process intensification. Expert in acoustic measurement technology and multivariate analysis in number of projects, including major work in FP7, and EU-RFCS and several national projects.
	Ida Westerberg Project manager and Researcher at IVL Swedish Environmental Research Institute	Has more than 10 years of work with applied and academic research i hydrology in Sweden for authorities and companies internationally i Great Britain, Switzerland, Central America and Africa. Specializing i analyses of data and model uncertainties, works in fields wit Hydrological measurements.
Partner 2 (Deltares, Ghada El Serafy)	**Giorgio Santinelli** Advisor/Researcher, Deltares	Worked on management and analysis of Coastal Morphology data in various European countries. Analysed in-situ observations and satellite images from coastal waters worldwide.
	Sandra Gaytan Aguilar, Researcher/Advisor, Deltares	Experience in model validation, uncertainty and sensitivity analysis for water quality. Working on application of observational sensor data in water quality information strategies, and on the integration of data into numerical models for operational information services.
	Alex Ziemba, Junior researcher, Deltares	Actively involved in an ongoing H2020 research program in the context of pre-processing and utilization of Earth Observation data in ecological models for the assessment of ecosystem services within protected areas.
Partner 3 (UWM, Lech Smoczyński)	**Katarzyna Glinska-Lewczuk** Prof., Head of Department of Water Resources, Climatology and Environmental Management, UWM	Researcher in Hydrology/Hydrochemistry of freshwater ecosystems., Stream and wetland restoration. Coordinator in OPTIFERT project (7 FP EU: 286772). PI of 3 national grants. Main contractor in 8 grants. Co-developed "Optifert sensor", a sensor for measuring nitrate content in soil. Member/Vice-Chairman in 6 committees/board/teams in Poland, and supervisor of 2 programmes through the Royal Inspectorate of Environmental Protection in Olsztyn.
	Boguslaw Pierozynski, Associate Professor, UWM	Works with Applied electrochemistry/renewable energy sources. Electrochemical purification of wastewater and drinking water.
	Slawomir Kalinowski, Associate Professor, UWM in Olsztyn	Works with construction of automatic analytical systems, construction of equipment for electrocoagulation of wastewater, development of flow analytical and detection methods, electrochemistry of membranes.

Partner 4 (ACSA, Beatriz Corzo Garcia)	**Meitxell Gracia Longares** Project manager RDi, ACSA	Research area within waste management. Work experience in 4 different countries in Environmental related departments. Founding partner and CEO of “Barcelona Design Platform”. Collaborator in the publication of the book "Hamburg: Parks und Plätze einer lebenswerten Stadt"
	Nigel Bax Innovation Coordinator, ACSA	Works on applications of additive manufacturing to improve processes, data driven solutions for efficient leak detection, ROV solutions for high pressure pipe maintenance. Led initial research project into innovation models.
Partner 5 (TUIASI, Igor Cretescu)	**Gabriela Soreanu** Lecturer at Environmental Engineering and Management Department, TUIASI	Majors in environmental engineering and monitoring, wastewater and air treatment, energetic valorisation of biomass, modelling and optimisation of chemical and environmental processes. Chair of organising conference committee, CSA2015 Joint International Conference, Iasi, Romania. Editorial board member of Nanotechnology for Environmental Engineering (Springer journal). Academic responsible for Erasmus agreements (Université de Sherbrooke, University of Leon).
	Maria Harja Associate Professor at Chemical Engineering Department, TUIASI	Works on chemical engineering with applications in environmental protection, including water treatment and industrial waste valorisation. Involved in several research projects as team member. Academic responsible for Erasmus agreements (Ecole Nationale, Superieure de Chimie de Rennes, Slovak University of Technology in Bratislava, Complutense University of Madrid)
Partner 6 (BGU)	**Vitaly Gitis** Senior lecturer, BGU	Israeli engineering educator. Achievements include patents pending for Nanoscale probes for the evaluation of the integrity of ultrafiltration membranes. Named Best Instructor in Environmental Science, The Hebrew University of Jerusalem, 1998-1999; scholar Graduate scholar, Ian Karten Foundation, 1996-1999. Conducts research on membrane filtration, advanced wastewater treatment, heterogeneous catalysis (CV is enclosed). Author of 70 papers, 3 patents and 1 textbook. Consultant to Mekorot Israeli national water carrier Ltd. Head, Water Energy Nexus research group at Ben Gurion University of the Negev
Partner 7 (UTS)	**Saravanamuthu Vigneswaran** Distinguished Professor (UTS)	Focuses on alternative water supplies, membrane and separation technologies, water and waste water treatment processes, environmental technologies (CV is enclosed). Obtained over $6 million in competitive funding since 2008. H-index of 42 and 7400 citations. Published over 350 research articles, reviews and book chapters. Vigneswaran was involved in 4 FP6 and FP7 projects. He is a member of several consortiums: Australian National Centre of Excellence for Desalination, Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE). Holds several international awards, including Google Impact Challenge Technology Against Poverty Prize (2017), IWA Global Project Innovation Award in the Applied Research Category (2012).

Partner 8 (QTU, Xuejun Bi)	**Lihua Cheng,** Director of International cooperation base for urban water environment pollution control in Qingdao	Works on combination of high-efficiency pre-treatment and aerobic process for papermaking wastewater secondary treatment, pollution prevention and control, and ecological restoration of artificial water system in Qingdao High-tech Zone. Project coordinator of Sino-German science and technological corporation project, and ERASMUS+ programme "Harmonising water related graduate education". Principle investigator of National Key Research and Development Program of China; 40 publications.
	Zhixuan Yin, Assistant of the Dean of School of Environmental and Municipal Engineering, QUT	Researcher with focus on nutrients removal and resource recovery from wastewater, wastewater Reuse. Principle investigator of National Major Science and Technology Program for Water Pollution Control and Treatment, and National Key Research and Development Program of China; 130 publications. Project coordinator of International Science & Technology Cooperation Program of China.
	Xiaodong Wang, Researcher, QUT	Developed new approach for surveillance and control of wastewater treatment systems based on data mining and process modelling techniques, which can be used to solve the restrictions for achieving advanced control in wastewater treatment processes. Project engineer at DOSCON AS (A Norwegian company for water treatment process control), and manager of projects in China.
Partner 9 (MARCOR, Jan Marjanovski)	**Jan Marjanovski** President, MARCOR	Owner and president of MARCOR company (Poland). Works with physiochemical methods of water treatment and metal corrosion prevention in water (CV is enclosed) During 45 years of practice designed about 250 iron and manganese removal plants, 200 water treatment plants for heating boilers, 16 wastewater recovery installations in the dairy industry.
Partner 10 (MSU, Volodymyr Tarabara)	**Volodymyr V. Tarabara** Professor, MSU	Conducts research on colloidal and interfacial processes in aqueous media; synthetic membranes and membrane separation processes (CV is enclosed). Obtained over $12 million in competitive funding (of which > $2 mln corresponds to personal effort). H-index of 22 and >2100 citations. Published 69 research articles, reviews and book chapters. PI/co-PI on two U.S. NSF Partnership for International Research and Education (PIRE) projects with the total funding of > 7 mln. Co-Editor-in-Chief of the Encyclopedia of Membrane Science and Technology, John Wiley & Sons, 2013. Holds several international awards: Fulbright U.S. Scholar award (2014), Paul L. Busch award (2011), John K. Hudzik Emerging Leader in Advancing International Studies & Programs award (2010).
Partner 11 (NUS, How Yong Ng)	**How Yong Ng** Professor, NUS	Leads research on membrane processes and electrocoagulation for water reuse and desalination (CV is enclosed). Obtained over SGD22 million in competitive funding since 2004. H-index of 38 and 4112 citations by Google Scholar. Published over 110 papers in top journals. Collaborates with Sembcorp Industries Ltd. working on electrocoagulation combined with membrane processes for brine treatment and zero liquid discharge. Has a strong leadership record: Director-Designate, NUS Environmental Research Institute; Director, Sembcorp-NUS Corporate Laboratory; Deputy Head (Administration), Department of Civil & Environmental Engineering, National University of Singapore.

5. CAPACITY OF THE CONSORTIUM ORGANISATIONS

Partner Number		General Description
Coordinator (NMBU)	Role and main responsibilities in the project	NMBU will provide sound management of the project (WP7) and scientific leadership on innovative technologies for removal of MPs for safer and economical use and reuse of water (WP2).
	Key research facilities, infrastructure, equipment	Wastewater pilot facilities, ceramic BF-MBR plant. Drinking water pilot facilities and RO plant. ICP-MS, UV-VIS GC-MS analysis of CEC, advanced methods of analysis of organics: TOD, PeCOD.
	Relevant publications and/or research/innovation products	Ratnaweera & Fettig: State of the Art of Online Monitoring and Control of the Coagulation Process, Water 2015, 7, 6574-6597 Kulesha, Maletskyi, Ratnaweera: State-of-the-art of membrane flux enhancement in membr. bioreactor, Cogent Eng. 2018, 5:1489700 WQ modelling in sewers, Holistic modelling of sewers.
Partner 1 (IVL)	Role and main responsibilities in the project	WP2 leader and demo project (Sandviken) leader. Dynamic water source selection concept, Big Data, water quality and quantity, Hydrological modelling, surveillance and forecasting data communication, sustainable water utilization.
	Key research facilities, infrastructure, equipment	Lab and analysis for environment such as air, water, soil, sediment and biota. Accredited analysis of well-known pollutants and pharmaceutical residues. Field equipment for all sort of hydrological measurements.
	Relevant publications and/or research/innovation products	Ceola, S., et al. 2016. Adaptation of Water Resources Systems to Changing Society and Environment - A statement by the IAHS. Hydrological Sciences Journal, 61:16, 2803–2817. Westerberg, I. K., et al. 2014. Regional water balance modelling using flow-duration curves with observational uncertainties. Hydrology and earth system sciences, 18: 2993-3013.
Partner 2 (Deltares)	Role and main responsibilities in the project	WP3 leader, and digital integration of cases and demo projects. Introduction and use of OpenDA. Review/QA on hydrological modelling, water quality and quantity modelling, Lead specialists on real-time forecasting systems, data science, Big Data, end user engagement, Serious Gaming, Citizen Science, Date Fusion.
	Key research facilities, infrastructure, equipment	High Power Computing Cluster for model simulation and processing of large data sets. ID-Lab which allows for advance visualizations and demonstrations of interactive technologies.
	Relevant publications and/or research/innovation products	Pasetto, D. et al. (2018). Integration of satellite remote sensing data in ecosystem modelling at local scales: Practices and trends. Methods in Ecology and Evolution, 9(8), 1810-1821. doi:10.1111/2041-210x.13018
Partner 3 (UWM)	Role and main responsibilities in the project	WP6 leader and demo project (Lyna) leader. Responsible for dissemination management. Hydrological/hydrogeological modelling, development of novel rapid sensors for nutrients and MP, Leading research on new electrocoagulation concept.
	Key research facilities, infrastructure, equipment	UV-VIS spectrophotometry, various chromatographic techniques (SPE), equipment for kinetic studies in wastewater, microcolorimetry and SiR, units for coagulation kinetic studies.
	Relevant publications and/or research/innovation products	Koronkiewicz S., Trifescu M., Smoczynski L., Ratnaweera H., Kalinowski S., 2018. A novel aut. flow method with direct-injection photometric detector for determ. of dissolved reactive P in WW samples. Env. Monitoring and Assessment 190(3), 133.

Partner 4 (ACSA)	Role and main responsibilities in the project	WP4 leader and Barcelona demo project leader. Guidance on nano materials and general on market studies, coordination of the Innovation camp together with NMBU.
	Key research facilities, infrastructure, equipment	Own technology to develop different multipurpose nanofibers. Technology validation in a demonstration plant located in one of the WWTP operated by ACSA. Laboratories on-site for water analysis and characterization.
	Relevant publications and/or research/innovation products	Innovation products: RDi internal projects to optimize energy consumption in WWTP related to implementation of algorisms and predictive models. Funded national RDi projects for water purification by developing artificial wetlands connected to bio-electrochemistry technology for energy self-supply in decentralized areas.
Partner 5 (TUIASI)	Role and main responsibilities in the project	WP5 leader and Romanian demo project leader. Will be leading dialogues with NGOs and admin/political leadership related to test area in Danube, Responsible for water quality monitoring in the study area. Student and staff exchange to/from TUIASI.
	Key research facilities, infrastructure, equipment	Laboratories and analysis facilities for environment components such as air, water, soil, sediment and biota. Accredited analysis of well-known pollutants and pharmaceutical residues. Field equipment for all sort of hydrological measurements.
	Relevant publications and/or research/innovation products	Dragoi E. N., Kovács Z., Juzsakova T., Cretescu I., Environmental Assessment of Surface Waters Based on Monitoring Data And Neuro-Evolutive Modelling, Process Safety and Environmental Protection, 120, 2018
Partner 6 (BGU)	Role and main responsibilities in the project	Leader of the technological case in IL. Setup and running a pilot at wastewater treatment plant. Student and staff exchange. Coordination of an innovation camp.
	Key research facilities, infrastructure, equipment	Pilot infrastructure, lab equipment, analytical equipment related to monitoring of membrane processes. Production facilities for ceramic membranes coupled with catalysts.
	Relevant publications and/or research/innovation products	Gitis V., Rothenberg G., 2016, Ceramic Membranes: New Opportunities and Practical Applications. Wiley-VCH Verlag GmbH, ISBN: 978-3-527-33493-3, 408 pages
Partner 7 (UTS)	Role and main responsibilities in the project	Leader of the technological case in AU. Will lead the technological concepts for removal of MPs in drinking and wastewater treatment. Staff and student exchange.
	Key research facilities, infrastructure, equipment	UTS is equipped with advanced analytical and membrane equipment necessary for this research (including lab and pilot scale membrane bio-reactor, micro-filtration, deep bed filtration and reverse osmosis units including the analytical facility.
	Relevant publications and/or research/innovation products	Shanmuganathan, S., Loganathan, P., Kazner, C., Johir, M.A.H., VIGNESWARAN, S. (2017) "Submerged membrane filtration adsorption hybrid system for the removal of organic MP..". Desalination, 401, pp. 134-141. Shanmuganathan, S., Johir, M.A.H., Nguyen, T.V., Kandasamy, J., Vigneswaran, S. (2015). "Experimental evaluation of microfiltration-granular activated carbon (MF-GAC)/nano filt Relevant Patents: AU2013/001036, 2005246937, 2005907166)

Partner 8 (QUT)	Role and main responsibilities in the project	Leader of the technological ase in China. Will add the Being 2022 Olympics context to the Water Harmony project. This program provides a solid foundation, including related facilities, equipment, research staff, etc. Student and dstaff favilities.
	Key research facilities, infrastructure, equipment	The pilot-scale membrane filtration system (6000 m3/d, including UF & RO) for high quality reclaimed water for snow and ice making, as well as the pre-treatment process, which is under construction now and will be fully operated in 2020 in a wastewater treatment plant of Zhangjiakou city, the core area of the winter Olympics, can be relevant in the project.
	Relevant publications and/or research/innovation products	Prof Bi is in charge of National Major Science and Technology Program for Water Pollution Control and Treatment “Recycling of reclaimed water in the core area of the winter Olympics” (No.2017ZX07101-002-06).
Partner 9 (MARCOR)	Role and main responsibilities in the project	MARCOR will implement Technology Showcase 5, using coagulation in harmony with other processes to maximise capacity at the lowest possible energy and operational cost in water and wastewater treatment.
	Key research facilities, infrastructure, equipment	Evaporation, RO and ion exchange pilot units, galvanic cell with aerated sacrificial anodes, access to industrial experimental facilities.
	Relevant publications and/or research/innovation products	Wojdalski J., Dróżdż B., Piechocki J., Gaworski M., Zander Z., Marjanowski J., Determinants of water consumption in the dairy industry, Polish Journal of Chemical Technology, 15, 2, 10.2478/pjct – 2013 – 0025
Partner 10 (MSU)	Role and main responsibilities in the project	The MSU team, will study the hybrid effects of natural coagulants and membrane processes in the removal of MPs.
	Key research facilities, infrastructure, equipment	Programmable jar testers for coagulation/flocculation work. Broad range of membrane testing equipment. Selection of key particle and surface characterization instruments (sizing, zeta potential, adhesion, surface tension). Tarabara laboratory is Biosafety Level 2 certified. All analytical equipment required for the proposed work
	Relevant publications and/or research/innovation products	Amjad, H.; Khan, Z.; Tarabara, V. V. Fractal structure and permeability of membrane cake layers: Effect of coagulation-flocculation and settling as pretreatment steps. Separ. Purif. Technol. 143 (2015) 40-51. Guo, B.; Snow, S. D.; Starr, B. J.; Xagoraraki, I.; Tarabara, V. V. Photocatalytic inactivation of human adenovirus 40: Effect of dissolved organic matter and prefiltration. Separ. Purif. Technol. 193 (2018) 193-201.
Partner 11 (NUS)	Role and main responsibilities in the project	NUS will carry out Technology Showcase 4: Zero Liquid Discharge with RO and electrocoagulation, carry out lab and pilot scale tests in Singapore to study the process optimisation.
	Key research facilities, infrastructure, equipment	Analytical facilities for determination of pharmaceuticals in WW (GC-MS), pilot anaerobic treatment units, laboratory fuel cells, advanced membrane separation units
	Relevant publications and/or research/innovation products	X. Shi, K. Y. Leong and H. Y. Ng*. 2017. “Anaerobic treatment of pharmaceutical wastewater: A critical review”, Bioresour. Technol., 245 Part A, 1238-1244.