JOINT CALL 2018 WATERWORKS 2017

Closing the Water Cycle Gap
Sustainable Management of Water Resources

Transnational funded projects brochure

DISSEMINATION AND EXPLOITATION OF WATERWORKS2017

The brochure on the Transnational funded projects is part of the Work Package 5 (WP5) of WaterWorks2017 "Communication, Dissemination and Exploitation of the Results". It has been implemented to support the dissemination and exploitation of results achieved by funded projects.

It consists of different tabs, one for each project, allowing for an immediate overview of the main activities planned for each project, the partnership, the contribution to policy and social context, and the expected results and impacts. In order to facilitate the dissemination of the results achieved through research activities, each tab is accompanied by a QR code that allows direct access to the WaterJPI Open Data & Open Access tool where project results and deliverables are stored.

The implementation of the online OD&OA tool represented a challenge for Water JPI Initiative for dissemination of results of the funded projects. It is in compliance with the F.A.I.R. - principles - Findable, Accessible, Interoperable, Reusable.

Summary of the WaterJPI 2018 Joint Call – WaterWorks 2017

The objective of the **Water JPI 2018 Joint Call** was to address research and innovation (R&I) to support the implementation of European Union water policy, in particular on the thematic area **"Closing the Water Cycle Gap"** of the Water JPI Strategic Research and Innovation Agenda (Water JPI SRIA, Theme 5). The main scope of this Joint Call refers to bridging the gap between supply and demand of water, the main driver being the provision of a sustainable water supply, in terms of quality and quantity.

The expected amplitude of the Water JPI 2018 Joint Call was to:

1. Improve use of scarce human and financial resources in the area of water R&I;
2. Reduce fragmentation of water R&I efforts across Europe;
3. Improve synergy, coordination and coherence between national and EU funding in the relevant research fields through transnational collaboration;
4. Improve implementation of R&I programmes in these fields through exchange of good practices;
5. Strengthen international leadership of European R&I in this area making the Water JPI, in collaboration with the European Commission (EC), a privileged and attractive partner for global cooperation in R&I, in the context of the Belmont Forum and other international alliances;
6. Contribute to the implementation of the objectives of Water JPI; and

Contribute to the implementation of the United Nations (UN) Sustainable Development Goals (SDGs), in particular **SDG 6 "*Ensure access to water and sanitation for all*"** and **SDG 13 "*Take urgent action to combat climate change and its impacts*"**, as well as the conclusions of the **COP21 Paris Agreement**.

THEMATIC AREAS ADDRESSED BY THE CALL

Proposals were invited on the topic "*Closing the Water Cycle Gap – Sustainable Management of Water Resources*", under three main thematic areas. Projects should address at least one of the sub-themes and up to the three overall themes, namely:

1. Enabling sustainable management of water resources,
2. Strengthening socio-economic approaches to water management, and
3. Supporting tools for sustainable integrative management of water resources.

Theme 1: Enabling sustainable management of water resources

The overall aim for this theme is to develop new governance and knowledge management approaches.

Sub-theme 1.1 - Promoting adaptive water management for global change.

The aim of sub-theme 1.1 is to increase knowledge and to develop evidence-based methodologies and technologies for monitoring the cumulative impacts of human activities and climate change on the water cycle, but also to develop management options on the water cycle (considering all cycle compartments) and water / ecosystem services. This knowledge must be applicable for the adaptive management of water resources on a regional scale, while enabling downscaling to address local or catchment situations.

Sub-theme 1.2 - Integrative management by implementing Natural Water Retention Measures (NWRM) such as Managed Aquifer Recharge (MAR).

The aim is to increase the knowledge and develop NWRMs such as MAR in a multidisciplinary way, to protect, prolong, sustain and augment freshwater supplies. Evidence of their effectiveness and on the multiple benefits they deliver should be demonstrated.

Sub-theme 1.3 - Mitigating water stress in coastal zones and urbanized deltas

The aim is to develop and demonstrate a comprehensive coastal zone management system based on monitoring and modelling to ensure the provision of freshwater security under a range of conditions including saline intrusion, sediment management, storms, floods and droughts, but also specific coastal water uses.

Theme 2: Strengthening socio-economic approaches to water management

The overall theme is envisaging education and communication initiatives to raise social awareness of consumption habits and water scarcity and to increase the levels of social acceptance and use of recycled water.

Sub-theme 2.1 - Integrating economic and social analyses into decision-making processes

The aim is to increase the knowledge on the effectiveness and efficiency of existing economic mechanisms and policy instruments related to water management, with a special emphasis on implementation of water policies (such as the EU Water Framework Directive) and development of a circular and green economy. The approach should aim to break boundaries between services valuation including more flexible pricing and charging mechanisms, management tools and institutions, and the employment of economic and social sciences to develop best practice management guidelines for efficient water uses, including under extreme events such as droughts and floods.

Sub-theme 2.2 - The reuse of water

The aim is to develop integrative methods and cost-effective technologies for the implementation of acceptable and sustainable solutions on a large scale for different reuse cycles, spanning from irrigation, via livestock drinking water, to human consumption. Furthermore, goals include assessments of social acceptance for the use of recycled water and the development of integrated approaches combining technological solutions with social-psychological acceptability, economic viability and appropriate governance approaches. Research into the removal of emerging contaminants must consider the cost of the technology vs yield and realistic options for reuse of the recovered water.

Sub-theme 2.3 - Connecting science to society

The aim is to increase understanding of the role of socio-economic approaches to water uses in hydrological cycles. Knowledge building should address stakeholders' and public awareness of water challenges and values, and how perception of policy measures and technological solutions are formed and how stakeholders can be steered towards desirable behaviour. Local and/or regional context (attitude, social norms, cultural context, etc.) should be taken into consideration. The value of improved water stewardship overall should be considered by developing sustainable business models.

Sub-theme 2.4 - Promoting new governance and knowledge management approaches

The aim is to develop innovative water management tools and approaches suitable for decision-making based on an analysis of the limitations of current practices. These approaches should involve the broad participation of stakeholders (including public monitoring, communication and education), multidisciplinary research, and short and long-term water cycle scenarios to support decision-making and the integration of water policy into other policy fields. In effect, governance capacities for implementation of water policies at the local and regional levels should be enhanced.

Theme 3 : Supporting tools for sustainable integrative management of water resources

This theme aims to complement the actions developed under the European Strategy Forum for Research Infrastructures (ESFRI) and other European initiatives. Emphasis should be on establishing networks and information sharing among existing research facilities/field labs, analytical methods, monitoring tools and programmes, access to databases and platforms, exploring the use of big data solutions and establishing reliable hydrological standards. Across the globe, there is a large body of knowledge, methodology and data related to hydrology and the water cycle that has the potential of being beneficial for a wide range of the world's regions. The alignment of water-related research and sharing of data and results will serve to avoid duplication of research, support progress based on previous finding, and thus facilitate the establishment of water management policies addressing rapid climatic changes.

The coverage of the Call was defined in accordance with the principles of the Water JPI SRIA, as follows:

- All societal forms of water use are within the scope of the Joint Call;
- All aquatic ecosystems subject to impacts as described in the Water JPI SRIA are within the scope of the Joint Call.

Call & Evaluation Process

The aim of the Water JPI 2018 JC is to enable transnational, collaborative research development and innovation projects addressing questions relating to priorities identified in the Water JPI SRIA Theme 5, in order to reconcile water supply and demand, both in terms of quantity and quality, and in terms of space and time. The co-funded transnational and multidisciplinary Joint Call for R&I proposals Water JPI 2018 Joint Call on Closing the Water Cycle Gap was launched on the 19th of February 2018 with a total of **19.3 M€** being allocated for this call by **20 FPOs from 18 countries**, including a co-funding contribution from the EU of € 5.9 M€.

Between the 22nd of May and the 3rd of July 2018, the two-step eligibility check (general and national eligibility checks) of all 105 pre-proposals submitted and the Step 1 evaluation of the 74 eligible pre-proposals by 62 external reviewers were concluded.

With the conclusion of the Step 1 of the evaluation process, the WaterWorks2017 Call Secretariat (CS) invited 48 proposals to proceed with the submission of the full-proposal, based on the results of the evaluation and the FPOs financial resources. The final decision of Step 1 evaluation was jointly made by the Call Steering Committee (CSC) members at the meeting on the 3rd of July 2018 in Paris (France).

Step 2 of the evaluation process for the 45 submitted full-proposals consisted on evaluating and ranking of the full-proposals by an Evaluation Panel (EP), composed of 20 independent experts.

The EP meeting was held in Paris on the 12-13th November 2018 to discuss the full-proposals, their ratings and reach a Consensus Report (CR) for every proposal.

Following the ranking of the 45 proposals prepared by the Independent EP, the WaterWorks2017 CSC composed of the FPOs, met on 14th November 2018 in Paris (France) to select the final group of proposals to be cofounded. The CSC followed the ranked list of proposals and selected the first 18 proposals. The 18 proposals represent about 40 % of the 45 full-proposals submitted to Step 2.

All the projects had a 4-year duration during which they have submitted two reports: one mid-term report and one final report, which can be assessed by the funding organisations that participated in the call. Many project's publications are available on the WaterJPI Open Acess Open Data platform.

PRESENTATION OF THE TRANSNATIONAL CALL "CLOSING THE WATER CYCLE GAP"

WaterWorks2017 is a joint project initiated by the Water JPI and co-funded by the European Commission through the Horizon 2020's Societal Challenge 'Climate action, environment, resource efficiency and raw materials'.

The Water Joint Programming Initiative (JPI) "*Water challenges for a changing world*" is an inter-governmental initiative launched in December 2011 to contribute to the coordination of national efforts in water research and innovation and therefore reduce the existing fragmentation in Europe.

The availability of water in sufficient quantities and adequate quality is indeed a public issue of high priority; the Water JPI addresses then a pan-European and global environmental challenge.

In addition to funding collaborative projects, the Water JPI mobilises skills, knowledge, and resources for the implementation of additional activities such as the networking of research teams, foresight, mapping, and international cooperation. The Water JPI's long-term objective is to strengthen Europe's leadership and competitiveness on water research and innovation.

The Joint Programming Initiative actively cooperates with the European Commission to provide the European society with the maximum return of research and innovation investments, to respond to the grand challenge of "***Achieving Sustainable Water Systems for a Sustainable Economy in Europe and Abroad***".

Through its Framework Programme, the European Commission facilitates transnational collaboration in research and innovation and supports the implementation of sectorial policies. WaterWorks2017 has benefitted from the support of the Horizon 2020's Societal Challenge 'Climate action, environment, resource efficiency and raw materials', whose aim is to achieve a resource – including water – efficient and climate change resilient economy and society, the protection and sustainable management of natural resources and ecosystems, and a sustainable supply and use of raw materials. To this end, Societal Challenge 'Climate action, environment, resource efficiency and raw materials' called for systemic innovations or system-wide transformations through a trans-disciplinary perspective, the co-creation of knowledge, and the co-delivery of outcomes.

The overarching aim of WaterWorks2017 is to address research and innovation to support the implementation of EU water policy, on the thematic area "Closing the Water Cycle Gap – Sustainable Management of Water Resources".

WaterWorks2017's objectives are: (I) To support the implementation and the development of the Water JPI on priorities identified in its SRIA; (II) to pool financial resources from participating national and regional research programmes towards the definition and implementation of a co-funded transnational and multi-disciplinary call for research and innovation proposals; (III) to consider additional resources with a view to implementing a joint call for proposals resulting in grants to third parties without EU co-funding through a Thematic Annual Programming action – TAP Water action; (IV) to overcome the fragmentation of European water-related Research, Development and Innovation activities while avoiding overlaps with ongoing actions co-funded by the European Commission and/or the Member States; and (V) to seek synergies with international research programmes beyond Europe with the participation of legal entities from international partner countries and/or regions.

WaterWorks2017 started in January 2018 and ended in December 2023. It brings together eighteen countries such as: Belgium (French-speaking community), Brazil, Cyprus, Egypt, Estonia, Finland, France, Ireland, Israel, Italy, Netherlands, Norway, Poland, Romania, South Africa, Spain, Sweden, Tunisia (with the support of the European Commision) in an effort to reinforce international cooperation in the area of the sustainable management of water resources.

Joint Call Research & Innovation funded projects

Call Themes:

- **Enabling sustainable management of water resources**
- **Supporting tools for sustainable integrative management of water sources**
- **Strength socio-economic approaches to water management**

Contributions to European policies

Water scarcity and droughts are increasingly frequent in Europe. Recent droughts have not only severely affected southern European regions but also those in the centre and the north in the continent. Moreover, the overexploitation and the deterioration of quality of water resources can aggravate the consequences of droughts and climate change. This situation does not only compromise the availability of water for human consumption; it also jeopardises our social and economic system. Water scarcity strongly impacts the agricultural and industrial sectors as well as the production of energy. Needless to say that water scarcity can trigger huge economic losses and may bring on social conflicts for competing uses of a limited resource.

WaterWorks2017 aims to offer innovative solutions and pathways to "**enable the sustainable management of water resources**" in order to manage imbalances between water demands and the supply capacity of the natural system (Theme 5 of the Water JPI's SRIA 2.0). Projects funded by WaterWorks2017 cover all the different research and innovation recommendations listed in the SRIA, including the management of surface and groundwater in urban and agricultural areas, to pollution removal approaches in drinking water, governance, and economics. Through the implementation of different activities and the funding of research and innovation, WaterWorks2017 intends to contribute to the overall objective of **European water policy**: "To ensure access to good quality water in sufficient quantity for all Europeans, economic sectors and the environment, and to ensure the good status of all water bodies across Europe. The priority is to move towards a water-efficient and water-saving economy" (Water scarcity and droughts, European Commission). WaterWorks2017 also responds to the objectives set out in the **8th Environment Action Programme**, which calls for the transition towards a climate-neutral and resource-efficient economy.

More specifically, the work performed by WaterWorks2017 aims to support the following pieces of legislation:

- **The Water Framework Directive**, which promote sustainable water use through the protection of water resources and the mitigation of the effects of droughts. In addition to the development of River Basin Management Plans (RBMPs), some Member States have also adopted Drought Management Plans for vulnerable river basins, which include both organisational and technical adaptation solutions.
- The **European Green Deal**.
- The 2021 **European Strategy on Adaptation to climate change**.
- The 2020 **Circular Economy Action Plan**.
- The European **Urban Wastewater Treatment Directive**.
- The European **Drinking Water Directive**.
- The European **Floods Directive** (25/2018).
- The **Regulation on minimum requirements for water reuse for agricultural irrigation**.

Fianlly, WaterWorks2017 can support the **United Nations Sustainable Development Goals (UN-SDGs)**.

As part of the final part of the project, WaterWorks2017 partners will work on the wide dissemination of results to the European policy-making community through a dedicated communication campaign both on the Water JPI's website and social media.

THE WATERWORKS2017 PARTNERS

AEI	Agencia Estatal de Investigation (Spain)
AKA	Suomen Akatemia (Finland)
ANR	Agence Nationale de la Recherche (France)
ASRT	Academy of Scientific Research and Technology (Egypt)
CDTI	Centro para el Desarrollo Tecnológico Industrial (Spain)
CIP[1]	Centrul Proiect Internationale (Moldova)
CONFAP	Brazilian National Council for the State Funding Agencies (Brazil)
EPA	Environmental Protection Agency of Ireland (Ireland)
ETAg	Sihtasutus Eesti Teadusagentuur (Estonia)
F.R.S-FNRS	Fund for Scientific Research -FNRS (Belgium, French-speaking community)
FORMAS	Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Sweden)
IenW	Ministerie van Infrastructuur en Waterstaat (Netherlands)
IRESA	Institution de la Recherche et de L'enseignement Superieur Agrocoles (Tunisia)
ISPRA	Italian National Institute for Environmental Protection and Research (Italy)
MHSER	Ministry of Higher Education and Scientific Research (Tunisia)
A.E.I.	Agencia Estatal de Investigacion (Spain)
MINECO[2]	Ministerio de Economía y Competitividad (Spain)
MIUR	Ministero dell'Istruzione, dell'Università e della Ricerca (Italy)
MoE-IL	Ministry of Energy (Israel)
NARD	Agentia Nationala Pentru Cercetare si Dezvoltare (Moldova)
NCBR	Narodowe Centrum Badan i Rozwoju (Poland)
NWO	Nederlandse Organisatie Voor Wetenschappelijk Onderzoek (Netherlands)
RCN	Research Council of Norway (Norway)
RPF	Research Promotion Foundation (Cyprus)
UEFISCDI	Unitatea Executiva Pentru Finantarea Invatamantului Superior, A Certetarii Dezvoltarii Si Inovarii (Romania)
WRC	Water Research Commission (South Africa)

1 Replaced by NARD due to full takeover on 02/03/2018
2 Replaced by AEI due to partial takeover on 01/08/2018

LIST OF THE 18 FUNDED PROJECTS

ATeNaS

To ally technology, nature and society
for integrated urban water management

Duration: 01/04/2019 to 30/06/2023
Total Grant: € 518 671
Website: www.atenasjpi.eu

PROJECT PARTNERS

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AKA, Finland
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OA&OD

CONTEXT & OBJECTIVES

The access to good quality water resources worldwide, increasing stress on water resources due to climate change and resource overuse, have become important drivers for setting Sustainable Development Goals tackling water issues (SDGs 3, 11, 13 & 14). Cities are increasingly in the focus of water related challenges because a number of their inhabitants rapidly increases in many regions, and the pressure on land is high, due to people's aspirations, environment misuse and poor spatial and socio-economic planning. Additionally, aging of urban population, poverty of the proportion of society, and high accumulation of assets, make cities vulnerable to many aspects of water cycle disruption. Decades of conventional urban water management, targeted ultimately at water provision and draining, led to decline of groundwater resources, deterioration of surface waters, drying out of headwaters and related ecosystems. ATENAS aimed to improve water management in cities through restoring natural, regulatory interaction between biota and hydrology, namely diversion of urban runoff to supply city ecosystems using Nature-Based Solutions (NBS). The goal has been achieved by stimulation of communities participation, co-design of NBS and shared responsibility for the blue-green infrastructure.

MAIN ACTIVITIES AND RESULTS

ATENAS established living labs in a gradient of urban pressures to embrace a range of challenges related with water cycle gap:

1. Lyon (France) living laboratory focused on the self-purification of excess organic matter in a representative peri-urban river, resulting from the leakage from the aging combined sewer system and runoff from agricultural land;

2. Malmi | Vantaa | Kivistö (Finland) living lab took a challenge of planning NBS that secure water cycle, including retention and habitat preservation in densely build up areas;

3. Łódź (Poland) living lab deals with drop of ground waters and problem of sustaining rivers and greenery under increasing climate and land development pressure.

Further, the project was developed in five complementary steps:

1. Online data-based identification of NBS available on the market, selection of options best adapted to the social, economic and ecological contexts of three cities: Łódź (Poland), Helsinki (Finland) and Lyon (France), collaborative and participatory evaluation of pros and cons of different solutions, and creating fast implementation track in each city;

2. Modelling-based analysing the specificity of rainwater run-off in each city – areas being its sources and accumulation places for optimal allocation of NBS;

3. Development of handbook for implementation of selected NBS, including monitoring of their effectiveness and estimation of cost-efficiency;

4. Based on FCM and SNA, interviews, NASCANVAS analysis overview of up-scaling options with focus on who, how and where can contribute to closing water gap, and what are conditio sine qua non;

5. Social animation, and MCDA application for building a critical mass of human capital: skills, interest and enthusiasm needed for continuation of the project beyond its end.

The tangible results of the project, having socio-economic impact and use, include the NBS implementations in Lyon and Łódź, and advanced design of large scale, low-impact development scenario for Malmi and Kivistö. The City of Łódź struggled with idea of establishing a network of rainwater gardens and small infiltration basins for over 4 years. The main handicap was lack of good, replicable examples with transparent information on pros and cons. ATENAS provided relevant knowledge and demonstrated the way to set up the NBS starting from social agreement, through analysis of legal and economic constraints, up to implementation and monitoring schemes.

Lyon tested on a real scale the social, regulatory and technical conditions required to build an innovative NBS called "porous ramp" to demonstrate the possibility of locally amplifying the self-purification process of a waterway. The pilot solutions were discussed with water companies, implemented, and monitored against their efficiency. The demonstrated positive impact on water resources opened the way to multiplication of NBS and thus upscaling. Additionally, artificial wetland construction and river restoration action demonstrated the power of holistic approach. In the Helsinki metropolitan region, ATENAS helped to carry on the broad scale assessment of land development options, engaging a number of stakeholders and led to establishing scenarios respecting ecological, social and economic aspects of the area.

IMPACT STATEMENT

ATENAS tackled several cross-cutting issues from the area of social, ecological and economic domain. Its main focus was to build social capital locally. Project scanned local communities identifying experts, leaders and activists interested in NBS. It networked all the parties for evaluation of local conditions and optimization of solutions with reference to both water cycle gap and well-being of humans and nature.

In Lyon ATENAS developed and tested the porous ramp as an innovative approach to water quality problems in rivers. In cooperation with water syndicate and sanitation company, and acknowledging expertise of angler society, the porous ramps have been initially established and later modified to meet requirements of resistance to high flows and fish habitat improvement.

In Łódź, ATENAS contributed to set the path for multiplication of small NBS, understanding the risks related to setting up NBS and their maintenance, and problem-solving option.

ATENAS also completed the overview of pros and cons of different NBS solutions together with the list of barriers and constraints, to allow local authorities making conscious choice of solutions, and developing the realistic maintenance plans.

In Helsinki metropolitan area, SYKE improved NBS planning methodologies, making scientific advancements in multi-criteria decision analysis use in NBS planning, the application of Green Factor for Districts tool in the evaluation of NBS alternatives, and in modelling tools to apply them in the selection of NBS for different types of areas. The results have a long-term impact as contributed to setting up local spatial plans.

The impact of the activities was both immediate: through implementations, spatial plans, development and dissemination of know-how, and long-term: established standards, procedures to deal with ecosystem-service trade-offs, knowledge base and expertise, as well as stakeholder networks.

BLOOWATER

Supporting tools for the integrated management of drinking water reservoirs contaminated by Cyanobacteria and Cyanotoxins

Duration: 01/04/2019 to 30/06/2023
Total Grant: € 834 423
Website: www.bloowater.eu

PROJECT PARTNERS

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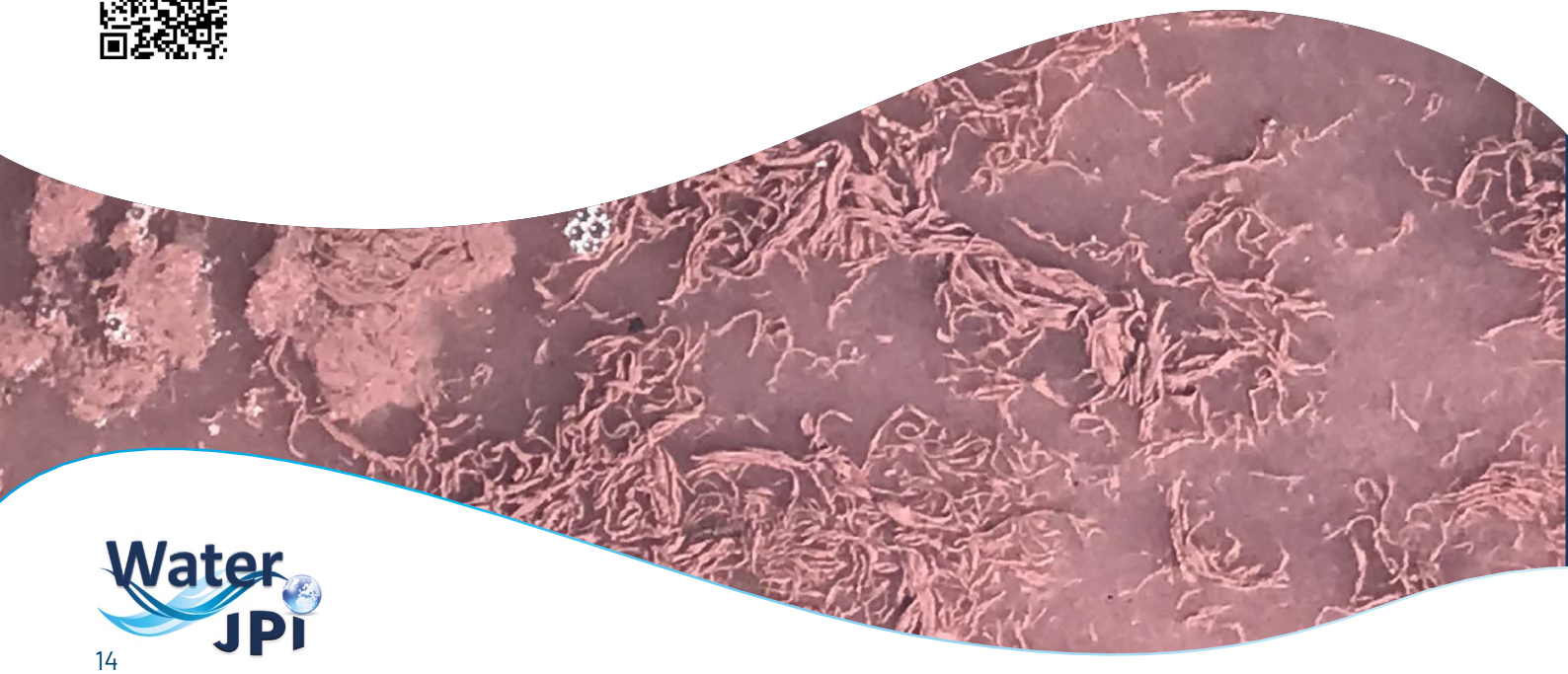
OA&OD

CONTEXT & OBJECTIVES

Cyanobacteria, known as blue-green algae, can rapidly multiply and form blooms, under favourable environmental conditions, and release toxic secondary metabolites into the water during their senescence and death. The presence of toxins from Harmful Algal Blooms (HABs) in drinking water reservoirs can pose serious risks to human health and activities. Effective risk assessment and management strategies need to be planned considering all possible routes of exposure for human populations. This project aimed to develop a low-cost methodological approach to mitigate the effect of cyanotoxins based on the integration of monitoring techniques and treatment of drinking water affected by toxic blooms. To this purpose, four lakes between Italy and Sweden, have been identified as study areas for the sampling and testing of cyanobacteria and cyanotoxin monitoring and forecasting models. A satellite/drone integrated methodology has been defined to implement and test a monitoring system based on water and airborne data.
The technologies, tools and strategies developed during the project will contribute to improvements in managing drinking water services for all, improved integrated water management and strengthen resilience to climate related-hazards like algal blooms.



MAIN ACTIVITIES AND RESULTS

The project work plan encompassed five work packages.

In WP1 the aim was to design and develop a monitoring system of bloom occurrences in terms of frequency, composition and intensity. The monitoring strategy was based on the integration of remote and proximal sensing technology and in situ data sampling. The choice and definition of the main parameters functional to modelling from the satellite system and in situ sampling have been addressed as well as the choice of the sensor mounted on an unmanned aerial vehicle (UAV), the suitable satellite platform and the in-situ sampling protocol.

Even though the techniques evaluated have shown promise, their current limitations confirm the need for further calibration and integration with multi-spectral drone data. However, multispectral drone data acquisition later did allow us to identify and isolate cyanobacteria on the lake surface. WP 2 had the goal of evaluating the possibilities of using both Process Based (PB) and Machine Learning (ML) models to forecast the occurrence of cyanobacteria blooms, in order to estimate probabilities of bloom occurrence that could serve to alert water utilities of the potential for an upcoming event.

Unfortunately, both modelling approaches were not able to simulate the timing of algal blooms with an accuracy that would be sufficient to support operational forecasting.

However, a negative result is still of value, and this was one of the first comprehensive evaluations of both PB and ML models for use in operational forecasting and will no doubt be of use for others.

The WP3 objective was the study, development and validation of sustainable and efficient technologies for the treatment of water affected by cyanobacteria toxicity.

The WP4 purpose was the development of an integrated, decision support system /geographical information system (DSS-GIS) for the water cycle management of waters affected by cyanobacteria. The first action of this work package was the definition of a comprehensive set of data that needs to be collected concerning the areas identified for the participating countries. In parallel, an identification of the stakeholders (social, political, technological needs etc.) that influence water management at local, national, and international level was done.

The WP5 encompassed project management, coordination of the work, effective communications and dissemination of results.

IMPACT STATEMENT

The project's objective was to develop forecasting tools and treatment systems able to contribute to the improvement of the integrated management of water resources. In this first phase of the project, the impact analysis confirms the interest for the technological solutions proposed by the project, that would provide modular solutions to a more complex phenomenon. This has been confirmed by the interest shown by both Regional Agencies for the protection of the environment (ARPA), both the Natural Park of Albano and Acquambiente managing the water service in the Marche region.

The original goals of WP2 were to evaluate the possibilities of using either process based (PB) or machine learning (ML) modelling approaches to simulate the probabilities of cyanobacteria bloom occurrences that could negatively affect drinking water supplies. The result of testing these methods showed that both ML and PB approaches did show promise in prediction of algal blooms.

The results obtained in WP3 could support the scientific knowledge in terms of removal performances with real scale validation of alternative treatment configurations for cyanotoxins and cyanobacteria abatements. The obtained data is particularly important according to the new drinking water regulation European Directive 2020/2184 to support the risk assessment in water supply systems. Moreover, the project output could support the evaluation of the possible mitigations also to be included in the Water Safety Plans redaction with relevant potential impact for the water utilities.

EnTrugo

Enhancing Trust in government through effective water Governance strategies

Duration: 01/07/2019 to 30/06/2023
Total Grant: € 942 613

PROJECT PARTNERS

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WRC, South Africa
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FORMAS Sweden

OA&OD

CONTEXT & OBJECTIVES

Drinking water shortages in Cape Town, water quality threats posed by mining industries in Norway, social risks caused by hydropower dams in Sweden and droughts provoked by infrastructure developments in the Netherlands. The requirements on water governance to successfully provide for urgent societal water needs is rapidly increasing. To deal with these challenges, trust in governments, as one of the main actors, is key. However, these governments face a decline in trust, putting pressure on their legitimacy. The EnTruGo project (Enhancing Trust in Governments for effective water governance) therefore focusses on how trust between people influences trust in governments and vice versa, and aims at developing effective strategies for enhancing trust in governments.

To rebuild trust, legislatures and state agencies have launched various democratic innovations to strengthen service delivery; including initiatives such as citizens' assemblies, e-governance, multi-stakeholder platforms, and direct democracy. A wide range of studies have shown that trust can develop in these contexts but can also lead to increased distrust. Therefore, the aim of the EnTruGo project is to explore how interpersonal trust develops through democratic innovations characterised by public participation and stakeholder processes impact trust in government as guardian of water resources.

MAIN ACTIVITIES AND RESULTS

The trust in government is essential since it contributes to effective, sustainable and legitimate water governance, including water use as well as catchment management. The research was conducted at both national scale and in case studies nested in diverse governance environments in Europe (The Netherlands, Norway and Sweden), mirrored by one South African case. In so doing, this project aimed to enrich the theoretical understanding of public trust and how it relates to interpersonal trust that can be promoted through democratic innovations.

This leads to the following objectives, that has been focal points for this project:

i. To evaluate the status of trust in government institutions tasked with water management, including the key factors that shape public trust in government as guardian of water resources;

ii. To evaluate the impact of democratic innovative approaches on public trust in government and the wider implications of such trust dynamics for sustainable water governance;

iii. To identify governance strategies to enhance trust in government as a guardian of water governance actions.

EnTruGo showed through a systematic literature review that trust is widely studied in water governance, however, it also shows that it is a dispersed field and lacks theoretical development. Aiming to understand trust government in the context of water governance, EnTruGo builds upon these findings and shows in involved countries that trust in water governance authorities is relatively high compared to general trust in government but is under pressure. This is also felt by water managers working on current water issues. In local contexts trust remains under pressure, and stakeholder participation as very limited impact on trust in government. This is mainly as trust in government is impacted by a generalized feeling of trust, trust tendencies within groups that participants are part of and general functioning of the government.

Following our main question: to what extent do democratic

innovations contribute to trust in government? We can now say that they do impact trust. More specific, they impact trust in government from those involved. However, the broader public is not impacted and also for those directly involved, trust is impacted by other governance contexts, relations with social groups and societal developments. These are the factors that need to be taken into account when trying to understand the interrelation between interpersonal and institutional trust.

IMPACT STATEMENT

The research set out to enrich the theoretical understanding of public trust and how it relates to interpersonal trust that can be promoted through participatory innovations. The insights gained from this inquiry provide a foundation for recommending strategies to enhance trust in government and, ultimately, increase the effectiveness, sustainability and legitimacy of water governance. The project has supported awareness raising and capacity building among those part of the project in the respective countries.

We worked to achieve societal impact primarily through the following means:

- In Sweden: notably among Sámi organizations, including herding communities, about the national licensing review process launched by Swedish government.

- In the Netherlands: awareness among communities in the east of the country and governmental organisations involved in water governance. This has found its way into citizen initiatives and new research project, for instance into trust in another highly contested water governance issue in the same region.

- Norway: the re-orientation of local communities and stakeholders' concerns within a framework of trust (or lack thereof) in water governance and state policies.

- South Africa: Impact was mainly on the level of water managers. Our examination of the interpersonal trust relations of organizations involved in a government led participatory platform aimed at fostering integrative catchment management demonstrates that the building of interpersonal (and inter-organizational) trust relations among the organizations can lead to better decision-making processes and water governance outcomes.

EviBAN

Evidence based assessment of NWRM for sustainable water management

Duration: 01/07/2019 to 30/06/2023
Total Grant: € 1 002 050
Website: www.eviban-project.com

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OA&OD

CONTEXT & OBJECTIVES

Nature-based solutions (NBS) can play a key role in mitigating impacts of and/or adapting to water management challenges by increasing the freshwater availability, mitigating pollution of water resources, and providing resilient measures for managing stormwater. However, the lack of comprehensive evidence on the reversibility, flexibility, cost-effectiveness, and feasibility, and/or long-term sustainability of NBS as compared with grey approaches are barriers to mainstreaming of NBS and their full incorporation within (re) insurance schemes. EviBAN aims to address this by developing new knowledge on how natural water retention measures (NWRM) can optimally be used to achieve multiple management objectives.

The main objective of EviBAN is to increase the knowledge on how NBS can be used for the management of water resources to counter negative impacts of climate change, anthropogenic activities, and societal change, and how NBS should be optimally used under different conditions to contribute to progress towards SDGs. Through integrating results from diverse case studies in South Africa, France, Finland, and Norway, EviBAN will develop a toolbox for adaptive water management suited for different conditions with respect to climate change, anthropogenic activities, and societal change in Europe and beyond.

MAIN ACTIVITIES AND RESULTS

EviBAN combined experimental and modelling results with qualitative governance and social information to help water managers chose the most sustainable way forward. EviBAN developed and compiled a toolbox for assessing natural water retention measures (NWRM) in stormwater and groundwater management contexts. The methodology for assessing technical and economic aspects of NWRM was based on combining environmental simulation and optimisation models. Model development was built on existing and new experiments at the case study sites of the project partners. Extension to social-ecological aspects of NWRMs and NBSs was realised with a governance assessment tool. An overarching methodology was the integrated sustainability assessment to systematically identify sustainable management options based on performance and optimisation of NWRMs according to selected sustainability criteria for their evaluation.

The project used case studies in Norway, Finland, France, and South Africa to demonstrate NWRMs for stormwater management and managed aquifer recharge. In Finland and Norway, stormwater management experiments and model studies focused on urban hydrology and NWRM performance under current and future climatic conditions. Joint modelling addressed the optimisation of NWRMs in terms of designing low impact development (LID) tools in study sites of the two countries.

In the French case study, infiltration, and further treatment in the soil of the effluent from the local wastewater treatment plant was used to protect the water quality in the sea. The infiltration and soil aquifer treatment exhibited positive impact on effluent water quality and local oyster production as well as coastal groundwater resources.

Managed aquifer recharge was the case in South Africa where the groundwater resources are threatened by lack of water in dry periods. Hydrological modelling was tailored to study how infiltration during periods with heavy rain can be used to supplement the groundwater and increase the available water resources in dry periods.

The results on governance assessment showed the relevance of including local representatives as all water management measures need to be adapted to local conditions and include the priorities of local stakeholders to be sustainable. The main outcomes of the tool developments in EviBAN were: A governance assessment tool; optimisation tools that were flexibly coupled with stormwater and river basin modelling systems; and an integrated sustainability assessment (ISA) tool. These tools can be adapted to a specific case and examples of their application, as well as studies of different water management solutions using existing general tools or tools for a specific area, were included to have a toolbox for adaptive water management that is useful for local water managers, policy makers, consultants, and scientists.

IMPACT STATEMENT

Knowledge and innovations were developed during EviBAN by strength of the collaboration between scientific institutions, companies, stakeholders, and policy makers that were useful for the development of the adaptive water management toolbox. EviBAN promoted monitoring and modelling works through several case studies and the results provided a better understanding in water management, water governance, hydrological, hydrogeological, and geochemical processes and forecasted effectiveness of management options for stormwater management and managed aquifer recharge solutions. A governance assessment tool provided a systematic assessment of the conditions, drivers, and barriers to NBS for water management in different governance contexts which was a simple aid for users that want to get an overview in a specific case or area before implementing NBS for water management.

Stakeholder interviews were done in the EviBAN cases in Norway, Finland and South Africa making connection between project partners, interested parties, stakeholders and policymakers, a real cross-cutting issue. The development of the integrated sustainability assessment (ISA) provided a framework to review proposed sustainability objectives, assessment criteria and indicators considering experiences and recommendations about current policies and activities towards achieving the UN Sustainable Development Goals (SDGs) under a range of climate, anthropogenic activity, ecosystem, and societal conditions that strengthened the socioeconomic approaches to water management.

All tools applied and developed in EviBAN support achieving sustainable management of water resources and/or sustainable water

FLUXMED

Strategies for increasing the water use efficiency of semi- arid Mediterranean agrosilvopastoral systems

Duration: 01/01/2020 to 30/06/202
Total Grant: € 539 024
Website: www.fluxmed.eu

PROJECT PARTNERS

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OA&OD

CONTEXT & OBJECTIVES

Climate change projections point to an amplification of changes in global precipitation patterns and trends, with further drier trends for the Mediterranean area. These trends will have dramatic consequences on water resources for both managed and natural systems. To face the water crisis, there is a need to develop stronger international cooperation in water research and enhance the resilience of these systems to climate change. The aim of FLUXMED is to develop innovative methodologies to increase the social-ecological WUE of managed ecosystems along the Mediterranean biome and climate types. The main goals are: 1) the development and implementation of new methodologies for evapotranspiration measurements and estimate; 2)the improvement of eco-hydrologic monitoring in ephemeral rivers and wadis; 3) the identification of the impacts of contrasting vegetation and crop types on the soil water balance,surface run-off, and water use under current and past Mediterranean climates; 4) the prediction of future climate scenarios on soil water balance, runoff, and water use; 5) the development of a set of land cover change strategies for climate change scenarios that optimise the water uses and increase system resilience; and 7) the improvement of the water resources management and planning systems for the optimization of the water infrastructure under the climate change scenarios.

MAIN ACTIVITIES AND RESULTS

The main results of the FLUXMED project are: 1) the development of a network of environmental and hydrological monitoring sites in different areas of the Mediterranean; 2) the implementation of different eco-hydrological models capable, also through the assimilation of satellite sensor data, of modelling different ecosystems of the Mediterranean under current and future scenarios.

Despite some delays, the distributed eco-hydrological model of UNICA has been integrated with the water resources management system used by ENAS to manage water resources in Sardinia. The Flumendosa water supply system has been simulated and the business-as-usual scenario have been compared with future scenarios derived by changing the water demand, the land use and using as climate input the different climate global models. Moreover, in Tunisia, the monitoring and the modelling activity have been used to develop a system that provides irrigation recommendations to farmers. The tool is called CITRIG and is available both as web interface and on app, it has been developed through a bottom-up and participatory process involving different stakeholders and farmers. To date, 150 farmers are using this system and a new version of the software who consider real time weather data will be launched in the coming months. Thanks to the FLUXMED project it was possible to restore the monitoring system of three existing experimental sites and to create two completely new ones.

From a pure scientific point of view, the impact achieved by the project is very high and this clearly emerges from the number of publications (16) in high impact factor peer review journals.

Very important, but more difficult to quantify, are the impacts deriving from the transfer of knowledge between researchers and farmers, forest and water service managers, and stakeholders in general. Thanks to the FLUXMED project, it was possible to teach Tunisian farmers how to optimise the water management in citrus orchards. UNICA and Forestas evaluate some possible climate change adaptation measures for better forest management in Sardinia. Thanks to the collaboration between UNICA, CESBIO and CYL the first eddy covariance monitoring station of Cyprus has been installed, and a protocol to monitor the flux of CO2 for the entire ecosystem have been developed. The results of the eco-hydrological modelling performed by UNICA (in which multiple land uses and climatic scenarios were evaluated) were used as input of the water management software (WARGI) used by ENAS. Helping ENAS in measuring the resilience of the water management systems offers an opportunity to tackle global water challenges by providing a systemic and transformative approach to delivering water supply services in a more sustainable, inclusive, efficient, and resilient manner. The results obtained in Sardinia will be presented to the water resources managers of the other countries involved, with the aim of spreading this practice in other countries.

IMPACT STATEMENT

The project is providing several positive and social economic impacts. The project is supporting the request of innovative solutions of the UN SDG6, providing new techniques and methodologies for increasing the water-use efficiency of water-limited Mediterranean regions, which are suffering water scarcity. Considering that future climate change scenarios are predicting a decrease in water resources availability; the project worked to attenuate climate change impacts and support the UN SDG 13.

Based on those scenarios, the existing water resources, which are based on water input (surface and groundwater) that will not be any longer available, needs to reviewed as to include the climate change effect on both CO2 budget and water resources use of vegetation and water resources availability to vegetation growth, which can impact on species type (in drier climate more resistant species should survive) and their spatial distribution (less water implies less density).

The activities that the consortium has done investigated and developed several innovative methodologies that integrate new knowledge and allowed to develop water resources and environmental planning also for future climate change scenarios.

The project's economic impact is significant for agricultural development and its sustainability because the project aims to increase the system efficiency and decrease the costs. The role of the involved stakeholders has been very important for the project progress.

The project offers and will offer to the stakeholders the scientific approach and results for defining the planning and management strategies for both current and future climates. In this sense, the project results are the keys for the development of the water resources and environmental planning systems.

iAqueduct

An integrative information aqueduct to close the gaps between global satellite observation of water cycle and local sustainable management of water resources

Duration: 11/06/2019 to 29/02/2023
Total Grant: € 882 631
Website: www.itc.nl/about-itc/scientific-departments/water-resources/iaqueduct

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OA&OD

CONTEXT & OBJECTIVES

The past decades have seen rapid advancements in space-based monitoring of essential water cycle variables, providing products related to precipitation, evapotranspiration, and soil moisture. Whilst these data effectively characterize water cycle variability at regional to global scales, they are less suitable for sustainable management of local water resources, which needs detailed information to represent the spatial heterogeneity of soil and vegetation. The following questions are critical to effectively exploit information from remotely sensed and in situ Earth observations (EOs): How to downscale the global water cycle products to the local scale using multiple sources and scales of EO data?

How to explore and apply the downscaled information at the management level for a better understanding of soil-water-vegetation-energy processes? How can such fine-scale information be used to improve the management of soil and water resources? iAqueduct aims to close the gaps between satellite water cycle products and local information necessary for sustainable management of water resources, and will address the abovementioned scientific questions by combining medium-resolution Copernicus satellite data with high-resolution (cm) unmanned aerial system (UAS) data, in situ observations, analytical and physical-based models, as well as big-data analytics with machine learning algorithms.

MAIN ACTIVITIES AND RESULTS

The iAqueduct project included six closely connected work packages (WPs):

WP1 generated global soil moisture data at resolutions of 25km and 1km. At field scale, the UAS thermal/optical images have been successfully applied to detect soil moisture at 16cm resolution. Furthermore, the multi-step downscaling approach has been developed to downscale coarse satellite products from the scale of km to cm.

WP2 developed a workflow to bridge the gap between field and laboratory spectral observations, which is then further applied to derive soil property maps with UAS hyperspectral imageries.

WP3 revealed the bimodality of soil water retention curve at Alento site, and evaluates how the difference in soil hydraulic properties induced by PTFs will propagate to the simulation results of soil states and surface fluxes.

WP4 innovated an information theory-based evaluation framework to show how plants adapt to long-term growing conditions and optimize root water uptake to minimize the risk of water stress. And, the soil-plant model

STEMMUS-SCOPE has been ran over 170 Fluxnet sites;

WP5 implemented catchment-scale ecohydrological models over Alento catchment (e.g., using TETIS model) with coarse satellite soil moisture products and the downscaled 1km products, which reproduces the spatial patterns of important state variables than just focusing on discharge at the outlet.

WP6 disseminated and communicated generated knowledge, data, and tools to water managers, companies, and farmers for actual sustainable water management of their responsible domains.

IMPACT STATEMENT

iAqueduct enables the understanding of the space-time variability of EO data (e.g., regarding soil physical characteristics, soil moisture, and evapotranspiration fluxes) from the in situ/plot scale, to field and regional, and to global scales, for sustainable integrative water management under climate change. iAqueduct translates scientific data and knowledge into tailored water

productivity information, facilitates a science–policy–business–society interface to allow for continuous dialogues and interactions across different scales and levels, influencing stakeholders towards desirable behaviours for sustainable water management.

Via the explicit inclusion of water management and decision making under uncertainty, iAqueduct partner (SLU) coupled the biophysical model into an agent-based model to simulate a smallholder farmer system, to study how each farmer's choice of water source (renewable on farm ponds; less renewable groundwater) affect yield and economic gain of the single farmer and the community; and how these previous experiences affect the farmers' choice regarding water management and use.

This work is a vivid example on how to translate scientific knowledge to stakeholders (i.e., those make the strategic decisions around water management), combining natural sciences and social sciences, for their decision making with the understanding of uncertainty.

IN-WOP

Mind the Water Cycle Gap: Innovating Water Management Optimisation Practice

Duration: 01/07/2019 to 30/06/2023
Total Grant: € 705 637

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OA&OD

CONTEXT & OBJECTIVES

Water resources management increasingly relies on integrated models to analyse the socio-economic benefits of the scarce resource. These integrated models offer great potential in enabling more sustainable management of water resources. Currently these advances in modelling are however in many cases not exploited because their outputs are evaluated using multi-objective optimization on pre-maturely aggregated objective functions that cancel out the potential advantages of these integrated models in unpredictable ways. In the context of Integrated Water Resources Management (IWRM), many-objective approaches offer greater opportunities for handling the many non-aggregated objectives that arise from sectoral integration. In the face of climate change and growing water scarcity the expansion of the solution space and the identification of innovative strategies for water management issues that many-objective approaches have on offer is of great relevance. The virtues of many-objective approaches have barely reached current practice in water management in Europe and beyond. To realize their promise, this research operationalizes many-objective approaches for water management and contrasts them to existing practices. This project develops, operationalises, and incorporates many-objective optimization in existing regional water management models in close collaboration with local stakeholders and water managers. We apply both existing multi-objective methods, and, collaboratively with local stakeholders, develop many-objective approaches and compare and contrast the strategies that emerge from both as a concrete contribution to practice.

MAIN ACTIVITIES AND RESULTS

The overarching aim of this project is to investigate the contribution of many-objective optimization approaches to Integrated Water Resources Management. To achieve this aim, the project adopts a comparative perspective where we complement existing IWRM models for 3 case study areas (Lake Como, Italy; Seine River, France; and Merguellil Basin, Tunisia) with many-objective simulation optimization formulations. We compare the solutions found for these novel many-objective optimization formulations with solutions identified previously to assess the degree to which pre-mature aggregation of performance metrics in one or more composite objective functions (i) negatively affects the identification of innovative solutions; (ii) reduces the alignment with interests and preferences of the various stakeholders; and (iii) are ethically more defendable. We also aim to disseminate these findings to operational water managers and policymakers in our case study areas and countries and beyond.

For the Lake Como case study, it is shown that explicitly including ethical considerations in a many-objective optimization formulation improves marginalized objectives that are not explicitly considered in the optimization problem and enriches the solution space by generating more compromise solutions mitigating the conflicts between the operating objectives than those obtained using a traditional optimization.

Similarly, for the Seine River case study, the novel optimization setup enriches the solution space, enabling decision-makers to select and justify hedging policies that balance their own priorities across the various objectives. Moreover, in the face of potential future climatic conditions, the novel policies improve geographical equity and result in a more balanced treatment of conflicting objectives.

In the Merguellil case study, the novel many-objective simulation optimization setup resulted in highlighting how largescale management interventions, coupled with extensive groundwater recharge can foster more equitable sharing of the scare water resources. However, this can only be realized by simultaneously also improving the control on illegal groundwater extraction.

Considering the results in the three cases, we conclude that many-objective optimization can indeed result in more innovative solutions, which are better aligned with stakeholder preferences and interests, and are ethically more just. Moreover, in each of the three cases, the key stakeholders involved in the research are engaging with their local IN-WOP partners in follow-up research to mainstream the research results.

IMPACT STATEMENT

The overarching aim of this project is to investigate the contribution of many-objective optimization approaches to Integrated Water Resources Management, with a particular attention for the role of ethically informed objectives within the optimization. The main vehicle for real-world impact is through the three case studies.

Lake Como Watershed, Italy: The results of the IN-WOP project along with synergies created by this project with other ongoing initiatives in the same case study have stimulated interests and reflections by the local stakeholders and authorities about the importance of Integrated Water Resources Management approaches to explore synergies and trade-offs across multisector interests.

The Seine River, France: The R package airGRiwrm has been developed especially for the realization of the integrated hydrological model of the Seine river basin. It is based on the airGR package and extends its functionalities to semi-distributed models including human influences and management.

The dashboard for assessing the risks of not reaching the objectives set downstream of the Seine reservoirs is available online at http://irmara.g-eau.fr. Using real time data from the reservoirs, it provides a synthetic view of the most at-risk objectives given a chosen climate, the volume present in the reservoirs and a reservoir management mode. This interactive tool allows the reservoir manager to assess flood and drought risk and their expected evolutions until the end of the century.

The Meguellil Basin, Tunisia: The research project could make a significant contribution to the understanding of the actual and future situation of the different water demand sectors from one hand and the surface and groundwater resources from another hand, particularly in arid regions where water is a valuable and limited resource.

MARadentro

Managed Aquifer Recharge: Assessing the Risks of Recharging Regenerated Water

Duration:17/05/2019 to 01/06/2023
Total Grant: € 939 231
Website: www.maradentro-jpi.eu

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OA&OD

CONTEXT & OBJECTIVES

Severe shortage in good quality water reserves is a global problem that will increase with a growing world population. Managed Aquifer Recharge (MAR) contributes to replenish depleted aquifers and restore ecological services in freshwater ecosystems. However, risks related to the presence of pathogens and emerging anthropogenic pollutants in groundwater have raised question about using reclaimed water for MAR. The MARadentro project aimed to assess and mitigate those risks, while enhancing the benefits of MAR in ensuring human health and environment protection through the development of cost-effective and effective barriers with permeable reactive layers. These barriers integrate biotic and abiotic processes to enhance pathogen retention and inactivation, along with pollutant adsorption and degradation by making available a broad range of sorption sites and a sequence of redox states. The effectiveness of MAR with reactive barriers was validated by upscaling from lab and pilot experiments to field scale studies. Transport modelling, risk assessment, economic balance and establishment of recommendations to stakeholders and authorities in the water sector guaranteed the smooth implementation of the MAR concept and the positive public response to water reuse. The transfer of the knowledge gathered in MARadentro to policy makers will help in EU regulation on MAR.

MAIN ACTIVITIES AND RESULTS

The project was implemented in a pilot 6-system MAR located in Palamós (Girona, Spain) and built next to the city wastewater treatment plant (WWTP). The pilot MAR system receives the treated wastewater effluent from the facility and is implemented with reactive barriers composed of natural materials to stimulate the removal and retention of inorganic nutrients, chemicals of emerging concern (CECs), pathogens, and antibiotic resistance genes (ARGs). The 6 systems were dismantled during the project to categorize the waste of the barrier material at the end of its life cycle. Further, the reactive barrier MAR concept was actually applied at the field scale under the leadership of Aqualia, which implemented it in Medina del Campo (Spain). The prototype consists of the 300 m2 recharge area divided into two independent ponds of 150 m2 each.The operation of the two ponds is intermittent, i.e. periods of recharge alternate with periods of non-recharge (dry). For the correct control of the operation and efficiency of the system, continuous meters for water column pressure, temperature and conductivity have been installed in the ponds.

The removal efficiency of CECs observed was very broad and depended on the physicochemical properties of the CEC, mainly solubility (S), dissociation constant (Ka), and octanol-water partition constant (Kow). Likewise, the organic carbon (OC) content turned out to be a key parameter controlling the absorption of CECs, being the anionic forms those that have the greatest potential to be transported during MAR.

Nutrients removal was very sensitive to operation. Under continuous recharge, ammonium, which is high in the Palamós WWTP, remained high after MAR. But this was dramatically reduced under pulsed recharge. This implies that actual operation of the system needs to be adapted to the conditions of each WWTP.

The barriers displayed an outstanding capability for the removal of antibiotic resistance, which was normally well above 95 % in terms of absolute abundance and, perhaps more important, over 90% in prevalence. The ARG removal efficiencies, 95-100%, match those provided by current state-of-the art membrane and oxidation technologies.

Pathogens reduction was between 3 and 5 log units (i.e., between 99.9 and 99,999% removal).

Based on their OC content, biochar, compost, and woodchips were the most suitable barrier materials. In the pilot MAR scale, the removal performance of CECs with the reactive barrier was higher than that of the 1st

+ 2nd WWTP treatments. For example, the removal of ketoprofen was 16% in the WWTP, 52.2% in the sand, and 81.8% in the compost-based reactive barrier. A very high removal of microplastics was also achieved, 74%. The dismantled barrier material did not pose an ecological risk, since the CECs concentrations determined were 3 orders of magnitude lower than those of the WWTP sludge.

Based on these results, we developed mathematical models that allow predicting the behavior of contaminants and pathogens and their dependence on barrier composition and operation.

IMPACT STATEMENT

The main impact of MARadentro has been the provision of a new technology for replenishment of deficient water resources based on MAR. MARadentro impact has occurred in several fronts, besides the scientific impact:

- Conceptual and numerical models have been developed to monitor the evolution of the water quality throughout the infiltration process, to understand and predict the fate of pollutants and pathogens during MAR. These models could be widely applied to other MAR scenarios to replicate our prototype of reactive barrier-based MAR system.

- According to the economic analysis performed we foresee that the lower cost in comparison to other suitable treatments (e.g. desalinization) will facilitate the market replication of MAR into the water sector.

- Related to EU environmental policies, the results on retention of pathogens, CECs and ARGs during MAR may impact the regulations that the EU Joint Research Center (JRC) is preparing on water quality requirements for MAR. In fact, our results and active communication with Spanish regulators have helped in revising Spanish regulations regarding MAR.

- The MARadentro procedures to prevent clogging by introduction of plants to the recharge basins may also have practical implications in the sense that clogging (one of the main operational issue of MAR systems) is virtually eliminated. Therefore, we expect the industry to adopt this procedure.

- The outcomes of MARadentro can improve the chances for economic development of all economic sectors, as a result of an increase on water availability and increased resilience to water stress conditions.

- We have promoted the positive perception to water reuse and MAR by the general public, and thus, the social acceptance, key to make MAR be developed as a very suitable tool to alleviate water stress in the current climatic emergency that we are facing.

NATWIP

Nature Based Solutions for Sustainable and Resilient Water Management in the Anthropocene

Duration: 01/04/2019 to 30/06/2023
Total Grant: € 961 474
Website: www.natwip.solutions

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OA&OD

CONTEXT & OBJECTIVES

NATWIP intends to contribute to closing the water cycle gap by focusing on water management challenges in landscape areas that have been neglected because they lie in the transition zones between the urban and the rural, commonly referred to as peri-urban areas, where the potential offered by nature-based solutions (NBS) is explored. The overall purpose is to exchange learning experiences among the partnership and promote the debate between science and society in order to increase awareness among practitioners and users on the application of NBS to manage different hydrological challenges such as water scarcity, pollution, and risks related to extreme events like flood and drought in peri-urban areas.

4 specific objectives defined in NATWIP are: 1) Review of internationalexperiences to identify barriers, lessons learned and challenges in the implementation of different NBS to deal with water management in the peri-urban; 2) Designing a methodological framework as a tool to analyze the potentials, content and benefits of NBS in peri-urban, considered from sustainability perspective; 3) Applying the methodological framework at multiple case study sites with an aim to compare situations and draw generalizations; and 4) Creating a common narrative for implementing NBS for water in the peri-urban, through best practices guidelines and policy recommendations.

MAIN ACTIVITIES AND RESULTS

With respect to the first objective, international experiences on NBS for water in the peri-urban

were reviewed through a systematic literature review (SLR) of 160 peer-reviewed articles. Additionally, a series of interviews were conducted with key experts involved in NBS in the different partner countries. A scientific paper containing more detailed analysis of the findings of the SLR was published and an executive summary of the review published on project website. Additional activities connected to review of international experiences were also conducted in S. Africa and India. These activities have helped build knowledge on the current status of NBS for water management in the peri-urban and the barriers, lessons learned and challenges facing their implementation seen through the sustainability lens.

A methodological framework for assessing implementation of NBS in peri-urban contexts for addressing water challenges has been produced under the second objective. This framework is partly derived from the findings of the SLR, complemented by an additional SLR and review of experiences. A scientific paper describing the framework is already published. The methodological framework represents a ready-to-use tool for assessing the sustainability of any planned, ongoing or completed NBS for water management in the peri-urban.

Action for achieving the third objective included application of the assessment framework produced above to nine different case studies in the partner countries. This has resulted in publication of nine case study briefs on NATWIP website and a comparative analysis of the cases published as a scientific article. Both these outputs help build knowledge about NBS practices for water in the peri-urban seen from sustainability perspective.

Finally, the common narrative under the fourth objective is created in the form of a Handbook for Practitioners, and a series of photo stories based on the different case studies, all published on NATWIP website. A Policy Brief is also under preparation. These results would enable implementation of sustainable NBS for water in peri-urban areas, in turn promoting circular economy as well as

blue-green economy where more efficient water management through naturally oriented water cycle will be combined with green infrastructure to promote socio economic development in peri-urban spaces.

IMPACT STATEMENT

NATWIP helps strengthening socio-economic approaches to water management by developing and sharing knowledge on NBS in peri-urban areas; proposing the innovative "NATWIP assessment framework" as a management tool and the "Handbook for Practitioners" and the "Policy Brief" as best practices guides on this theme. More importantly, the NATWIP assessment

framework has set forth standards and norms for evaluating the sustainability of NBS projects, in turn defining a way forward for reaching SDGs. Also, through the project outputs published on its website (www.natwip.solutions) and its open access publications, the project has been able to raise societal awareness about different kinds of NBS for water in the peri-urban, and their value for sustainable development.

Further, its outputs like the Natwip assessment framework and the Handbook for Practitioners has helped define ways and means for enhancing acceptance and incorporation of NBS for water within policy and

action instruments, as well as social acceptance of the new practices. The "Natwip assessment framework" has been developed

as a supporting tool for sustainable integrative management of water resources in peri-urban areas as well as other contexts. Further, the project has helped create local knowledge-based networks around NBS for water and facilitated knowledge sharing around these issues among partner institutions and their local networks. The nine case studies in the partner countries have helped create context-specific knowledge that could be possibly adapted to regions beyond the study areas.

NEWTS

Nudges for Economics of Water Tariffs

Duration: 01/05/2019 to 30/06/2023
Total Grant: € 534 886

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OA&OD

CONTEXT & OBJECTIVES

NEWTS project addresses the issue of household water demand management. The scientific aim is to provide a socio-economic assessment of green nudging policies, focusing on the proper understanding of the tariff system by the households, taking into account adjustments in the pricing policy that nudges may generate (in view of their effects on water demand functions). From an operational point of view, it consists in developing a micro-simulation model, based on econometric estimates of household water demand functions, to assess the socio-economic returns of mix policies, combining nudges and pricing instruments, and identify financially sustainable Demand Side Management policies to improve current water utility tariffs. From a policy point of view, the project targets some improvements in local pricing policies for public drinking water and sanitation services (that face well-documented difficulties), local water Demand Side Management policy (one should not nudge without knowledge of potential impact of behavioural interventions on water demand functions ...), and local water-price setting (by imputing social sciences methodologies into the public decision making process and highlighting actual trade-offs).

MAIN ACTIVITIES AND RESULTS

The program is designed around various methodologies. The effects of nudges on household water consumptions are examined through the realization of controlled experiments, in the lab and in the field, with randomized controlled trials in Cape Town (SA), Gijón (Spain), Saint Paul (France) and Sfax (Tunisia). Econometric estimations of residential water demand are carried out to measure basic water needs, price-sensitivities of demand and perceived prices of water. Econometric exercises are implemented before and after the nudging campaigns, to infer the effects of behavioural interventions on the latter factors and identify the transmission channels through which nudges modify the water demand functions of the households. This knowledge about the water demand functions, as provided by econometric analysis, combined with databases used for their estimation enables (i) to assess the socio-economic performance of the water tariff; (ii) to infer the effects of nudges on this socio-economic performance; (iii) to identify optimal policies (for some well-defined decision criteria of local public decision-makers).

The evaluation process is carried out through a scoreboard and the use of relevant indicators, in accordance with the objectives of EU Water Framework Directive (affordability, incentive effect of pricing, equity, economic welfare and cost recovery (quality of the funding)). In fine, all of these elements articulate to form a Decision Support Tool that can be used to inform decision-making about water utility policy.

Lab experiments and Spanish in-the-field experiment have been carried out. Some preliminary results concerning the impact of Behavioural Interventions on domestic water demand functions have been produced for the site of Cape Town (based on 2016 nudging campaigns). An Evaluation Framework (consistent with the EU WFD) has been set and implemented into a micro-simulation model (prototype) that has been used for demonstration and exploratory purposes (with Reunion Island data). Despite the effects of Covid-19 pandemic and of some specific unexpected events that disrupted many aspects of the research process, the output and the collected data for SA and Spanish study sites allow for achievement of the scientific objectives of the project.

IMPACT STATEMENT

The project has produced results in each of the three major areas of expertise around which the consortium is organized. The later refer to behavioural economics with some important insights relating to the contents and the conduct of nudging policies, econometrics of water demand with some empirical results concerning the effects of nudges and methodologies for measuring the overconsumptions, and evaluation of public policy with the setting of innovative indicators and the development of the

micro-simulation model (prototype) for assessing the socio-economic performance of the water pricing policy. All of these results and methodologies are expected to have a significant impact both in the short and long run.

RainSolutions

Research-Based Assessment of Integrated Approaches to Nature-Based Solutions

Duration:01/04/2019 to 31/03/2023
Total Grant: € 1 499 965
Website: www.rainsolutions.net

PROJECT PARTNERS

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CONFAP, Brazil
ETAg, Estonia
EPA, Ireland
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NWO, The Netherlands
UEFISCDI, Romania
Self-funded, Spain

CONTEXT & OBJECTIVES

Climate change, increasing urbanization, and industrial development cause increasing problems with floods, droughts, and pollutant release. Nature-Based Solutions (NBS) are cost-effective green techniques to simultaneously provide environmental, social, and economic benefits and improve resilience against flooding, water scarcity, and pollutant transport. The objectives of the Water JPI project "Research-Based Assessment of Integrated Approaches to Nature-Based Solutions (RainSolutions)" are (a) to identify stakeholder and urban ecosystem needs to inform planning/design; (b) to review and capitalize upon existing experiences of good practices; (c) to simulate the impact of climate variability and existing urban infrastructure on NBS within scaled pilot laboratory and field installations; (d) to develop an integrated indicator system for the evaluation of key NBS in terms of closing the water quantity and quality gap addressing also socio-economic aspects; (e) to map ecosystem services delivered by NBS for an evaluation of the best technology to implement in different urban contexts to support sustainable water management; (f) to create a NBS planning and design framework supported by machine learning to generate recommendations; and (g) to disseminate the self-sustainable web based framework in collaboration with national stakeholders and communicate the project impact.

OA&OD

MAIN ACTIVITIES AND RESULTS

RainSolutions project has among other things developed a prototype geo-spatial model to select and allocate

nature-based solutions (NBS) in urban spaces. The model combines a geographical information system with multicriteria analysis to develop high resolution maps with options for NBS placement in urban areas. The general objective of this work is to answer the question of "Where to allocate what type of NBS" from the large scale to the microscale. This objective is reached by a spatial analysis model that identifies priority areas in demand for NBS, based on local problems that could be solved through these measures. Afterwards, the model evaluates the possible allocation of NBS at the microscale according to local characteristics and constraints. The prototype geo-spatial model was applied to a subregion of Amsterdam.

A second important cross-cutting socio-economic and capacity

developing result from RainSolutions is indicators for the evaluation of the societal benefits of NBS particularly in

socio-economic challenging neighbourhoods. The exemplified indicators are developed for regional, metropolitan, urban, street, and building scale and comprise aspects such as air quality, urban regeneration, participatory planning and governance, social justice and social cohesion, public health and well-being, and potential for economic opportunities and green jobs.

A third important cross-cutting socio-economic and capacity developing result is the development of an integrated framework for nature-based technologies assessment. The framework contains a toolbox type repository of tools, methods, technologies, and standards/ guidelines developed in in the project. The aim is to customize all this information to support urban planners, consultants, and other stakeholders/end-users in making decisions concerning the planning and design of

nature-based technologies at various scales. The central part of the framework (open access) is a decision support type tool that enables selection of optional intervention strategies by using multiple criteria based on wide-ranging benefits and costs identified.

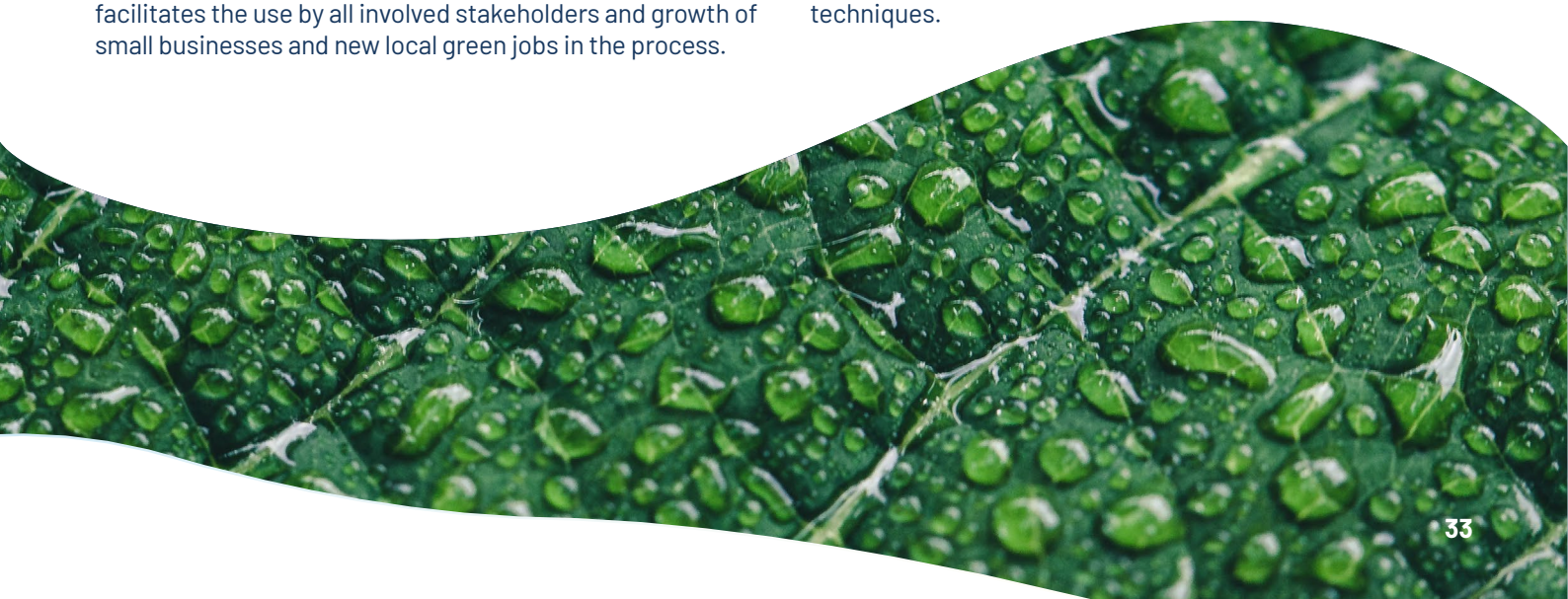
Consequently, both basic and practical research results are achieved. As well, RainSolutions collaborators have indicated research gaps in, e.g., nature-based technologies for urban areas. In view of this, it is expected that new research will be initiated to fill these identified gaps (e.g., lack of decisive information about stormwater retention and removal capacity of selected nature-based technologies). The use of the above open access

nature-based technologies tools will allow both researchers, authorities, and industrial users to use advanced tools for optimization of type and location of nature-based technologies projects and evaluation of economic, environmental, and social impact.

IMPACT STATEMENT

The output of the project is of scientific, innovative, and societal nature. RainSolutions delivers new knowledge and related tools and guidelines for innovative planning and assessment of NBS as part of sustainable water systems. Targeted innovative knowledge products have been developed for the different audiences informing them about the benefits of NBS and the proposed evidence-based framework. The open access platform facilitates expert knowledge exchange. A reference framework for future NBS facilitates the use by all involved stakeholders and growth of small businesses and new local green jobs in the process.

Benefits are via substantially improved quality of life and well-being due to innovative NBS used which, in turn, will help reduce the risk of flooding and droughts whilst restoring urban ecosystems and adding to the amenity value of the urban environment. The NBS, however, depends on climate and socioeconomic setting. The project results show a large variety of the use and techniques of the NBS. The common denominator is that climate change is affecting all participating countries and the future use of these techniques.



RECOWATDIG

Strategies for increasing the water use efficiency of semi- arid Mediterranean agrosilvopastoral systems

Duration: 11/04/2019 to 30/06/2023
Total Grant: € 725 287
Website: www.recowatdig.pwr.edu.pl

PROJECT PARTNERS

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OA&OD

CONTEXT & OBJECTIVES

RECOWATDIG project proposes innovative, transdisciplinary approach, by enabling an access to the potential water resources, currently neglected, i.e. water contained in high-moisture fermentation products. Moreover, project is aiming to achieve high synergy by integrating the water recovery with improved heat balance of the valorisation process and additional utilization of the valorisation by-products to provide sustainable, green energy both for the own needs of the installation as well as to the local energy systems. Furthermore, project proposes to apply the hydrothermal carbonization (HTC), thus bringing the potential for synergy, due to positive effects in terms of dewaterability and sanitization.

MAIN ACTIVITIES AND RESULTS

The main goal of the project was to develop a multi-stage process of post-fermentation processing to solid hydrochars and first of all, treatment of the separated water, i.e. its purification by many methods in order to reuse it in agriculture. An important goal was to determine the final method of water purification that meets the requirements of water useful for agriculture. The parameters of the components of the digestate conversion treatment processes were estimated from the research, which enabled the production of usable water for agricultural purposes (using membranes) and solid by-product (hydrochars), which could be used as a solid biofuel.

The techniques and processes proposed in the project may contribute to the development of effective technologies that will reduce water scarcity through the use of water recovered from wet by-products of anaerobic fermentation of organic waste in agriculture and wastewater treatment plants, as well as other branches of industry, which use anaerobic digestion for wet waste processing. The implementation of the project confirmed that it is possible to use digestates, process them, obtain valuable products, and thus reduce the amount of waste produced, which is in line with the idea of a circular economy. As part of the work carried out in the project, design guidelines were developed and a preliminary design of a self-sufficient, multi-stage water recovery system from highly hydrated fermentation products for agricultural purposes was developed, including a hydrothermal carbonization module, a leachate treatment module after dewatering, a drying module, and a CHP installation using gasification, gas turbines and heat exchangers for heat recovery.

Based on the conducted tests, a significant reduction of pollutants contained in leachates was demonstrated as a result of treatment using a cascade system of flat membranes. Based on the analyses of the produced hydrochars, it was found that dried hydrochar could be used as a fuel, providing heat necessary for its drying and HTC process, along with some surplus electricity that could be sold to the grid.

Overall, positive energy balance is encouraging. The plant sized for a typical municipal waste sorting plant in Poland, producing biogas from wet sorted fraction of municipal solid waste, could achieve internal return rate of 11.4% with NPV 10 550 722 EUR by investing in the installation developed within the scope of this project. Such installations are even easier to be applied for agricultural biogas plants. In Poland, over 3.3 million tons of digestate is produced annually. This means that wide application of such technology would result in generating additional 400 GWh of green electricity per year as well as 350 million liters of agricultural water per year.

IMPACT STATEMENT

The project contributes to the practical implementation of the UN Sustainable development goals, namely SDG6 (Clean water and sanitation) and SDG13 (Climate action). If implemented on a large scale, the technology developed within the scope of this project would enable the recovery of valuable water for agricultural purposes and at the same time increase generation of green electricity, since biomass can be considered carbon neutral fuel within its complete life cycle. In Poland, over 3.3 million tons of digestate is produced annually. This means that wide application of such technology just in Poland would result in recovery of 350 million liters of agricultural water per year, generating additional 400 GWh of green electricity per year, which is enough for 200 000 households. Using the replacement emission factor for biogas plants in Poland (758 kg of CO2 saved by replacing 1MWh of electricity from Polish grid by 1MWh of electricity from biogas plant) this would result in reducing CO2 emissions in Poland by approx. 300 thousand tonnes per year. It is important to state, that the electricity generation from valorised digestate is additional electricity, apart from electricity generated from biogas, so significant effect of synergy could be expected. Use of digestate and chemical energy recovered from HTC liquid could increase generation of electricity of a typical biogas plant by 40%, for the same amount of the substrate used.

In the future, such installations could also become a source of precious hydrogen after some retrofitting, which is considered a fuel of the future, essential for decarbonisation of transportation sector across the EU.

REFORMWATER

Reducing the effects of forest management on inland waters

Duration: 01/04/2019 to 30/06/2023
Total Grant: € 936 820
Website: blogs.uef.fi/reformwater

PROJECT PARTNERS

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OA&OD

CONTEXT & OBJECTIVES

Lakes and other freshwater ecosystems are showing increased brownification in the boreal zone. This creates a challenge for industries and settlements which utilize freshwater sources because the organic matter has to be removed from the water. Peatland forestry has decreased water quality in the Nordic countries where 62-72% of the land area is covered but forests of which up to 25% are on drained peatlands. Since there is increasing pressure for using forest resources for industry and/or energy production, there is a need for comprehensive analyses of the environmental effects of peatland forest harvesting. In this project, the aim was to compare standard management practices to less invasive practices to try to reduce the harmful effects of peatland forest management on inland waters given the increased demands for tree biomass and climate change.

MAIN ACTIVITIES AND RESULTS

The research in the REFORMWATER projects was based on field and laboratory experiments for testing the effects of different forest management techniques (continuous cover forestry (CCF) or clear-cut) on dissolved organic matter and nutrient loading to aquatic systems. We investigated how these different forest management techniques affect the dissolved organic matter quality and its bioavailability for microbes and the consequent CO2 emissions from aquatic sources (including groundwater, ditch water and river water). In addition, we investigated novel ways to reduce the amount of nutrient loading to waters using biochar. The biodegradation of dissolved organic carbon (DOC) was studied by incubating water samples collected from peatland forests managed with rotational harvesting and CCF and changes in the DOC quality were characterized related to the degradation rate of DOC. We also investigated the possibility of using biochar for reducing the DOC and nutrient load from managed peatland forests using adsorption experiments in the laboratory and mesoscale column experiments. The experimental results were used for parameterizing a process-based model (peatland simulator SUSI) which was used to evaluate the effects of ditch cleaning on DOC and nutrient release and tree biomass growth.

Our results revealed that the degradation of DOC was a significant source of CO2 and the majority of the DOC degradation took place within the first days after the DOC was released from peat, and the degradation rate was fastest outside the growing season. The CO2 production was highest in the clear-cut, especially in the water collected from ditches running out of the clear-cut. The field experiments on catchments exposed to clear-cutting and ditch cleaning (aka ditch network maintenance) in Sweden suggest that the catchments have responded to both forest harvest and ditch cleaning, with an increase in inorganic and organic nutrients in surface water.

The amount of total suspended solids increased after clear-cutting and ditch cleaning but when the ditch network maintenance operation was not done, the amount of total suspended solids did not increase compared to unmanaged reference stands.

Our results also indicated that biochar filters can be used for reducing the nutrient and DOC load after forest management operations. The efficiency of biochar to remove DOC and dissolved nitrogen was dependent on the initial concentration of the incoming water, this suggests that the higher the concentration of DOC and dissolved nitrogen in the inlet, the higher the removal.

Simulations with the peatland simulator revealed that increasing nutrient supply by fertilization may be a more efficient means of increasing and maintaining tree growth than lowering the water table by drainage. By avoiding drainage, we can also avoid the exports of suspended solids and nutrients that are caused by drainage. The analyses carried out by SUSI enable the detection of economically unfeasible sites from the ditch network maintenance plans, for example, sites that would only produce adverse environmental effects without any economic gain. SUSI can also be used as a tool for decision-making when designing continuous-cover forestry actions as an option to reduce the adverse effects of peatland management since there is currently little experimental data from continuous-cover management in drained peatlands.

IMPACT STATEMENT

The REFORMWATER project findings suggest that clear-cutting has an adverse effect on DOC and nutrient concentrations. The results also suggest that the partial harvesting used in continuous cover forestry (CCF) may cause less nutrient export than conventional clear-cutting in drained peatland forests. Our scientific findings will likely impact society and the economy by providing more information to land managers and decision-makers about the potential consequences and benefits of changing forest management.

The main societal impact of the project comes from the development of more sustainable methods for managing peatland forests. Currently, the two big dilemmas in peatland forest management are how to reduce the emissions of DOC and nutrients to aquatic systems and how to reduce the greenhouse gas emissions from the decomposing peat which is exposed to aerobic conditions when the groundwater level is drawn down.

Our project is providing new methods and tools such as peatland simulator (SUSI) and biochar. We also investigated the potential of using novel forest management techniques such as CCF. This will reduce the negative environmental impacts of peatland forestry, improves the acceptance of the utilization of peatland forests and creates new business opportunities for the forest bioeconomy sector and its value chain. For example, biochar entrepreneurs.

The experimental infrastructures created by REFORMWATER and maintained by this project have been and will be used for years to come as part of teaching the next generation of foresters as well as professional land managers in Europe. Knowledge of how water quality is impacted by various forestry practices is, therefore, already being transferred. Furthermore, the knowledge gained from performing those experiments is being taught in the classroom in each of the associated countries.

Sense and Purify SPy

Combining remote sensing with in-situ sensing to track the spatial and temporal in fresh and transitional waters

Duration: 01/04/2019 to 30/11/2022
Total Grant: € 595 043

PROJECT PARTNERS

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Funding Organisation
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WRC, South Africa
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Self-funded, Spain

OA&OD

CONTEXT & OBJECTIVES

There is a growing recognition that powerful treatments for wastewater are needed that can process diverse biological and synthetic organic compounds and can be implemented at the point of production. Advanced Oxidation Processes (AOPs) are treatment technologies aimed at degrading and mineralizing recalcitrant organic matter from wastewater through reaction with hydroxyl radicals (.OH). These technologies can treat emerging contaminants, that do not easily decompose using conventional treatments, especially herbicides, pharmaceuticals and personal care products. Sense and Purify is a radically new technology that uses electronically conducting diamond particles within an electric field (wireless electrochemistry) to create hydroxyl radicals throughout the water volume in a highly efficient way that can then destroy pathogens and decompose the vast majority of organic compounds. The technology will effectively remove these compounds locally and at low cost thus protecting health as well as environmental and economic sustainability.

MAIN ACTIVITIES AND RESULTS

Electrochemistry represents a powerful way to decompose and destroy organic pollutants in wastewater in a sustainable way, e.g., it opens the possibility of using sustainable energy produced locally from wind or solar. However, the problem with conventional approaches is that pollutants are decomposed only at the electrode surface, and they must be transported, e.g., using stirring, to the electrode surface. Thus, high throughput processing is hard to achieve especially at scale. Most importantly, in traditional approaches each electrode is physically wired back to a power supply adding complexity when trying to multiplex electrodes to efficiently treat a large volume of water per unit time. SPy has developed a "wireless" electrochemical approach for the mineralization of recalcitrant organics in industrial wastewater. Unlike existing approaches, its key innovation is to use a large number of boron doped diamond, BDD, particles dispersed in the wastewater so that electrochemical oxidation occurs throughout the entire volume of the wastewater sample.

Significantly, when an appropriate electric field is applied, each BDD particle acts as a separate electrochemical cell with hydroxyl radicals being produced on one side and oxygen or water being reduced on the other. This approach minimises the quantity of electricity consumed to degrade the organic pollutants. The eco-innovative SPy technology has significant advantages over traditional treatment processes including lower capital, operations and maintenance costs, reduced energy consumption, higher conversion efficiency, easier operation, better effluent water quality, and lower waste production. To accelerate and enhance its industry relevance, the performance using wastewater samples from the pharmaceutical and food industries, as well as municipal waste, have been tested.

The experiments have been very insightful regarding deployment and operational issues surrounding the prototype reactor.

IMPACT STATEMENT

This programme directly impacts UN SDG Goal 6: Ensure access to water and sanitation for all. The ability to locally produce clean water from wastewater for industry or drinking at low capital and operating cost is very significant. To enhance innovation capacity and integration of new knowledge prototype reactors have been demonstrated for the treatment of production wastewaters from the food (NU) as well as pharmaceutical industries (DCU). We are also impacting on education through a series of measures including school visits, public outreach articles and social media.

The most significant potential socio-economic impact of the Sense and Purify, SPy, technology is that it could:

- Provide a more cost-effective approach to wastewater treatment through lower operating expenses primarily through enhanced energy efficiency using a wireless electrochemical oxidation process.

- Deliver more environmentally friendly wastewater treatment relative to other processes since no additional chemicals need to be added and the active species does not leave a chemical residue.

- Be implementable at source and highly portable.

In complex wastewater samples, such as that found in food processing, the SPy technology does not currently have an adequate operational lifetime. However, for the treatment of very challenging wastewaters produced by the pharmaceutical industry, the technology shows significant promise. The Total Addressable Market, TAM, is approximately €1.1bn with a Serviceable Available Market, SAM, of approximately €200m annually.

SIMTWIST

Simulating tourism water consumption with stakeholders

Duration: 01/06/2019 to 31/12/2022
Total Grant: € 532 500
Website: www.simtwist.eu

PROJECT PARTNERS

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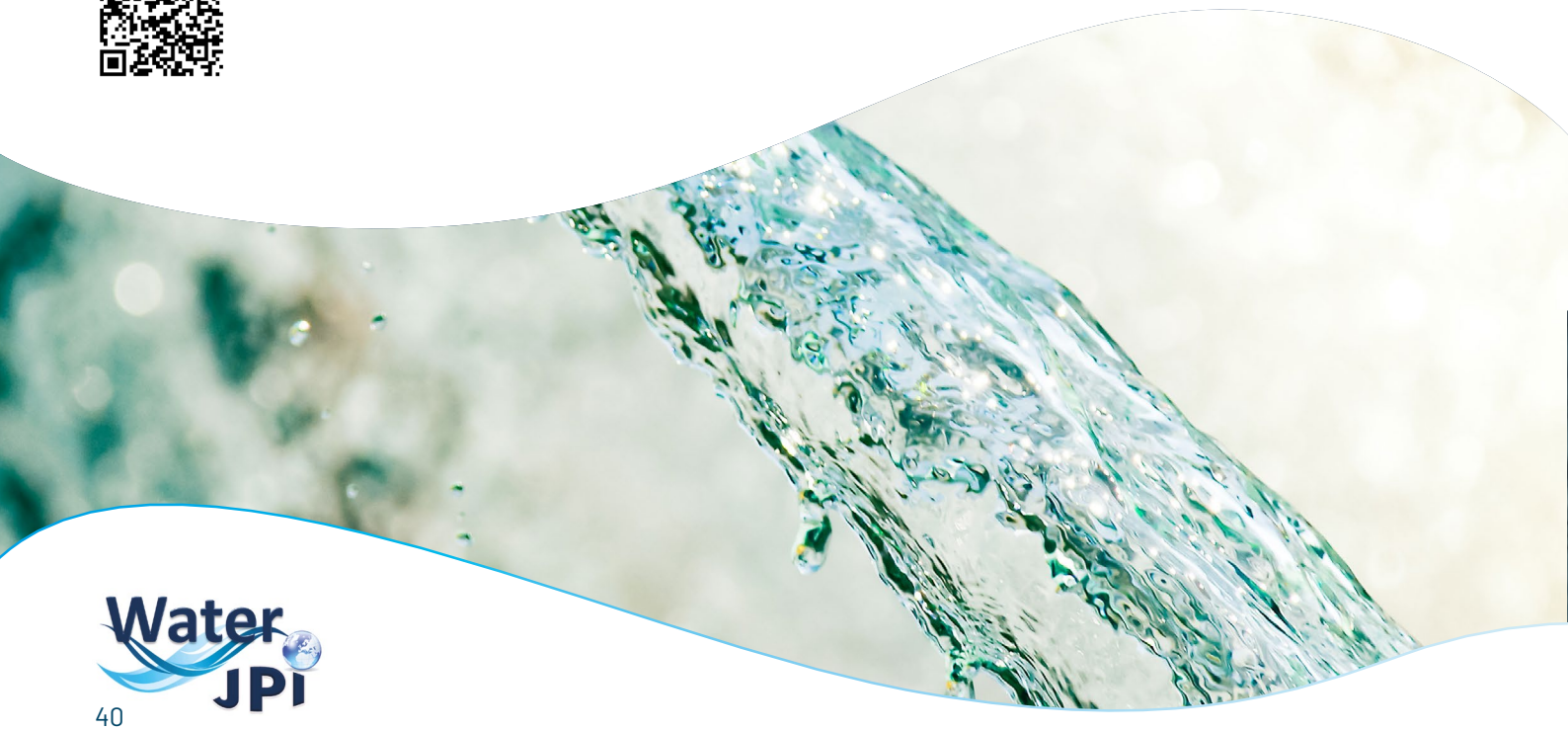
OA&OD

CONTEXT & OBJECTIVES

In tourist destinations around the world, the tourism sector is increasingly adding to local and pressures on water supply systems, in particular in coastal regions. In the Mediterranean region, tourism puts substantial pressure on water supplies and competes with local users. While water demand is projected to increase, water availability will likely decrease. The simultaneous phenomena of climate change and tourism growth pose challenges to both the water utilities and the tourism industry. The SIMTWIST project aimed to 1) estimate tourism`s share in current and future macro level water scarcity in the Mediterranean, and 2) study and simulate water-related behaviour of tourism stakeholders at the micro-level. The ultimate project goal was to inform tourism decision-makers about the effectiveness of a variety of measures to reduce tourism`s water consumption. Benidorm (Spain) and Rimini (Italy) were the project case study areas.



MAIN ACTIVITIES AND RESULTS

We scoped the water systems in both case study areas in terms of water resources, water infrastructure, stakeholders involved and behaviour. Both observed and future projected climate data (temperature and precipitation series) were identified, validated and analysed for the study regions. The water supply systems of the two study cities were analysed and summarised. Information on the water sources and data on the exploitation of water sources were collected, validated and analysed; for the Italian study region, a coupling of hydrological and reservoir modelling was developed for studying and understanding the water availability and water scarcity in present and future conditions. Measures of water consumption were collected and/or monitored at different temporal scales both for sets of single touristic costumers (hotels) and for entire municipalities, analysing and modelling the patterns of water demand driven by touristic activities.

To elicit stakeholders' perspectives on the water system in the case study areas, eleven extensive stakeholder interview sessions were conducted in Benidorm and seven in Rimini. These sessions consisted of a questionnaire and an interview. The questionnaire related to the hydrosocial cycle analysis, producing insights about why, when and how stakeholders are connected and which driving forces and barriers respectively foster and hinder improvements in water governance. Each interview resulted in a graphical representation of the interviewee's perception of the

system, containing its key elements as well as the relationships between them. Combining and integrating these individual concept maps, the project team developed a core system map for each case study area; together with stakeholders, each of these core maps was further developed into a generally accepted system representation. This representation and the results from the questionnaire formed the basis for a serious game, called 'SIMTWIST, the game' in which stakeholders explored and prioritised systemic challenges in various scenarios and evaluated potential solutions.

These analyses laid the groundwork for an agent-based model. The current version of the agent-based model represents agents in Benidorm's hotel sector and their behaviour in the physical context of the water system.

IMPACT STATEMENT

The project has impact in two distinct ways: through the knowledge that was produced and through the methodologies that were developed and refined. With respect to knowledge: the analysis of the historical water demand, both at city level and for large sets of hotels, has led to substantial advances in the estimation of tourism water consumption. It yielded valuable new insights into the monthly water consumption patterns in hotels and their role in the overall city demand. The preliminary results from the newly installed smart water meters in Rimini and the analysis of the available smart-metered data in Benidorm yielded valuable new insights into the weekly and daily water consumption patterns in hotels, which are related to the timing of water-demanding activities and hotel management practices. These new insights add to scientific knowledge, may help hotels better manage their water consumption, and can inform robust governance models to more efficiently handle peak demand in those cities or districts where hotels represent an important share of customers.

The project's impact is also methodological. The participatory protocol that was developed, including guided interviews and

surveys, concept mapping, workshops and serious games proved successful in engaging stakeholders and fostering social learning. Even though the protocol puts individuals and agents heterogeneity and case specificity centre-stage, the step-wise approach is generic and can be applied to other (coastal mass) tourism destinations.

URBANWAT

Tools and criteria for URBAN groundWATer management

Duration: 01/09/2019 to 31/08/2022
Total Grant: € 718 082
Website: urbanwat.wixsite.com/my-site-8

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OA&OD

CONTEXT & OBJECTIVES

The URBANWAT project addresses the increasing pressure on water resources in urban areas, where half of the global population is projected to reside by 2050. Urban areas are characterized by high water demand and significant pollutant sources, making it crucial to develop improved tools and criteria for sustainable groundwater management. The project aims to ensure the sustainability of urban water resources, assess their potential uses, and mitigate associated risks through an innovative and integrative approach. The research within URBANWAT adopts a multidisciplinary approach, encompassing various aspects of the hydrological cycle. Key objectives include the characterization of the natural state of the hydrological cycle in urban areas, the development of particle tracer technology to determine contaminant flow paths, and the detection of pollutants, water quality parameters, contaminants of emerging concern (CECs), and microorganisms, including viruses.

MAIN ACTIVITIES AND RESULTS

The project has developed new tools and methodologies for the identification, characterization, and management of pollutants in urban water systems. These tools and methodologies have the potential to be used by policy makers, regulators, and industry to improve the quality of urban water and protect public health.

Firstly, we have developed a groundwater data management platform that integrates the data accumulated in this project along with others project.

Furthermore, the involvement of local infrastructure partners plays a crucial role in reaping immediate economic benefits. These partners can allocate resources strategically to address contaminant sources and pathways that pose the highest risks to the local population and the environment. By identifying processes that govern the distribution of contaminants in the urban environment at an early stage, sufficient time is available to develop efficient and cost-effective strategies to mitigate these issues before they escalate to critical levels.

One effective strategy is the implementation of Sustainable Urban Drainage Systems (SUDs) as part of the concept of a " sponge city." This approach enhances resilience to climate change and significantly improves the overall quality of life. The implementation of SUDs facilitates the management of stormwater runoff, promoting infiltration, storage, and controlled release of water, thus reducing the risk of drought and water scarcity. Additionally, SUDs contribute to creating greener cities by enhancing urban landscapes, promoting biodiversity, and mitigating the effects of heat islands.

As a result, the overall health of the urban population improves due to a less polluted environment and enhanced living conditions.

Scientifically, the project has yielded impactful outcomes through synergistic collaboration between working groups, with a particular focus on CECs and viruses. The study has enabled the definition and validation of new technical methodologies, notably in the measurement of CECs and pathogenic contaminants such as viruses in groundwater and wastewater. These robust methodologies have been developed with the aim of providing a future capability for local, national, and international regulatory agencies.

The project has also introduced an innovative, robust, and environmentally friendly approach utilizing nanoparticles labelled with synthetic DNA for tracking the movement of contaminants in water within natural systems such as groundwater and rivers. Rigorous protocols (SOPs) have been designed for the application of these nanoparticles, allowing for qualitative description and quantitative modelling of their behaviour. Consequently, a well-defined set of new colloidal environmental tracers has been developed, enabling comprehensive analysis of transport characteristics not only in porous media but also in surface water. Comparative studies on the transport of viruses and engineered nanoparticles with the environmentally friendly DNA-tagged nanoparticles have further enhanced understanding in the field of colloidal contamination. This advancement contributes to the study of transport phenomena related to viruses, bacteria, and microplastics.

IMPACT STATEMENT

The outcomes of the URBANWAT project have both scientific and socio-economic impacts. The project provides valuable insights into urban groundwater management, informs decision-making processes, and enhances the understanding of pollutant fate and transport.

The knowledge generated contributes to sustainable water resource management in urban areas, supporting the development of strategies for pollution prevention and remediation. Additionally, the project fosters collaborations between academia, industry, and policymakers, facilitating the dissemination and utilization of its findings.

WaterHarmony

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

Duration: 01/04/2019 to 30/06/2023
Total Grant: € 1 500 000
Website: www.waterharmony.net

PROJECT PARTNERS

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OA&OD

CONTEXT & OBJECTIVES

The Water Harmony project closes the gap between the demand and supply in water, related to quality, quantity, circularity, reusability, human safety and economic feasibility. The project demonstrates sound and adaptive approaches to modern water management concepts that use BigData and other technological advancements to address challenges related to 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. With joint and harmonised efforts, bringing 12 partners from 10 countries together, the project intends to increase public engagement to sustainably address the water challenges that connect sciences and society by using modern, harmonised and shared approaches. It also aims to facilitate policy decisions favouring actions that intensify efforts to close the demand-supply gap in the water sector by providing scientific backgrounds and social mobilisation of policy makers.

MAIN ACTIVITIES AND RESULTS

The project was organised as demo cases by 4 partners (NO, SE, PL, RO) and technological showcases by 7 partners (ES, IL, NL, US, CN, AU and SG). They are focused on demonstrating and validating approaches to modern water management concepts that use BigData and technological advancements. The project enhances the dialogue with researchers, end-users, policymakers, and the public to develop and jointly demonstrate best practices that are potentially valuable for Europe and beyond and facilitates policy decisions favouring actions that rapidly close the demand-supply gap in the water sector. They will also contribute to SDG 6 "Ensure access to water and sanitation for all", maximising synergies and rationalising resources and efforts.

The work was planned to be carried out independently by each partner at their locations. These works were planned to be integrated via presentations at project meetings, reviews at technology forums, visits to partner sites and via two Innovation camps with the involvement of partners and external stakeholders.

All partners have achieved their planned targets, often beyond them. Dynamic water source management (IVL, SE), Reduction of pollution at the source by preventing sewer overflows (NMBU, NO). Implementing water conservation practices in a catchment (UWM-PL) was demonstrated as management solutions promoting efficient water supply and pollution reduction. A real-time water quality monitoring of the Danube River was demonstrated by TUIASI-RO collaborating with NMBU-NO.

Electrospun nanofibers for micropollutants removal (ACSA-ES), Ceramic membranes mobilising Fenton reaction and photocatalysis (BGU-IL), Dual membrane - GAC adsorption hybrid system (UTS-AU), Zero Liquid Discharge with RO and electrocoagulation (NUS- SG), Enhancing reuse capacities with coagulation pretreatment (MARCOR, & UWM-PL), Hybrid reverse osmosis with Fenton oxidation (QUT-CN), Natural coagulants with membranes (MSU, US) were demonstrated with publications. Deltares-NL carried out cross-cutting activities es Information management using BigData in collaboration with UWM-PL and IVL-SE.

IMPACT STATEMENT

Stakeholders representing city/regional administration, policy makers, utility owners, NGOs participated in meeting in IL, ES and RO with international partners, in addition to local stakeholder meetings. The focus on wate scarcity, pollution with nutrients and emerging contaminants were addressed at these meeting, conveying good practices and recommendations to follow.

WATERPEAT

Water management for sustainable use and protection of peatlands

Duration: 01/04/2019 to 31/03/2023
Total Grant: € 896 843

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OA&OD

CONTEXT & OBJECTIVES

Peatlands are important in several regions as they contribute to ecosystem services such as drinking water provision, biomass production and flood retention. When peatlands are drained, negative environmental impacts include reduced surface water quality, loss in biodiversity and greenhouse gas (GHG) emissions. Therefore, peatland water management must consider several objectives including ways to: i) reduce water-related environmental impacts, ii) produce crops and biomass, iii) limit subsidence and soil loss, iv) prevent fire during droughts, v) offer viable solutions for restoration and after use of degraded sites. Water management must also consider different type of peatlands, different land use options, climate, and socio-economic settings.

The main objectives of WATERPEAT project were to develop peatland water management for different land use options and environmental protection goals. WATERPEAT project studies looked into different types of peatlands found in peat rich areas of Northern Europe and Indonesia. The work done was based on reviews, remote sensing, fieldwork, modelling and analysis of new data by individual partners and in collaboration. In the joint studies, we crossed traditional boundaries by linking stronger water studies with remote sensing studies and land management. In WEATERPEAT, several recommendations for future peatland management have been discussed, suggested and/or required by authorities and NGOs.

MAIN ACTIVITIES AND RESULTS

In the project, peatland water management was studied in Finland, Norway, Ireland and Indonesia.

On a national level, in Finland, UOulu made a comprehensive systematic review related to peatland restoration and mitigation methods. Additionally, UOULU also made a review of peat hydraulic properties. UOULU also participate in a broad review of peat physical properties imitated by ULeeds. A study was done on newly developed coagulants to treat runoff water from peat harvesting. Studies on water and water quality management were done in a pilot site in northern Finland (Ruukki). A study was also made in Indonesia with the collaboration of UOULU and NIBIO on peatland restoration, remote sensing and hydrology. A new project was also initiated in Indonesia on lowland drainage. A training course was held on drainage.

In Norway, NIBIO established new field sites looked at thelong-term effects of drainage and afforestation on peatland hydrology, and the use of remote sensing of peatland elevation and subsidence. In the drained afforested peatland large water table drawdowns occurred in dry periods in summer even more than 60 years after the peatland was drained. Remote sensing based on Lidar data and/or aerial photographs and digital photogrammetry makes possible high spatial resolution mapping on large areas of terrain level and shape on peatlands and alterations due to peatland subsidence or other reasons.

Limitations for photogrammetric methods are connected to access to historical aerial photographs, quality of old photographs and vegetation that restrains vision to the ground. NIBIO also led part of the remote sensing work carried out in Indonesia with UOULU.

In Ireland, NUIG published a review on the constraints on policies governing peatland management and presented emerging satellite remote sensing technologies as valuable tools in this regard, developed a novel remote sensing technique to monitor peatland restoration, and quantified the impact of peatland rewetting on pore water quality, microbiology and physicochemical parameters in a temperature and humidity-controlled laboratory study. In the project, we tried out different methods to analyse peatland processes such as novel remote sensing approaches, combined data resources from historical data and created new measurement networks for various peatland sites.

The WATERPEAT project work resulted in journal papers, 3

PhDs thesis, 2 newsletters and a course for PhD level candidates. The project results can be used to guide practical water and water quality management in different peatland uses by authorities, land use managers, land users and other stakeholders.

IMPACT STATEMENT

Identifying Pressures: Peatland management for different purposes phase sever environmental challenges which are typically related to biodiversity loss, carbon emission hydrological changes and water quality deterioration. At managed and restored site criteria can be set for minimum peat water table depth (to limit carbon emission), water quality in runoff waters, peat depth and long-term after-use options that range from rewetting for restoration, to agriculture and forestry. The basis for setting these criteria are not always scientifically sound or practically feasible. Some criteria have been set based on what is known or greenhouse gas emission processes, but the impact on water quantity and quality is not well known. Rewetting is seen as a promising way to limit impacts, but not all peatlands can be rewetted due to topographic, hydrological, or other limitations. The WATERPEAT project contributes significantly to understanding peatlands, monitoring them with new methods and analysing effects of e.g. restoration (Finland, Indonesia, Ireland) and land use (Norway).

Developing Solutions: WATERPEAT used satellite remote sensing and airborne radiometric data to monitor the current state of several key peatland restoration indicators. Conceivably, these methods can also be used to monitor any restoration measures employed. The machine learning methodology developed in this study may be used to delineate a catchment's hydrology,

identify plant community structure, and highlight spatial boundaries, while reducing the need for specific ground-based observations. The WATERPEAT project found that water table depth of peatlands may be a significant parameter in releasing inorganic nitrogen, mainly as nitrate, after re-wetting and that this parameter, and not ammonium, may be problematic in some rewetted peatlands.

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