Water4All
Water security for the planet

FUNDED PROJECTS BOOKLET
WATER4ALL 2022 JOINT TRANSNATIONAL CALL

Management of water resources: resilience, adaptation & mitigation to hydroclimatic extreme events & management tools

Co-funded by the European Union

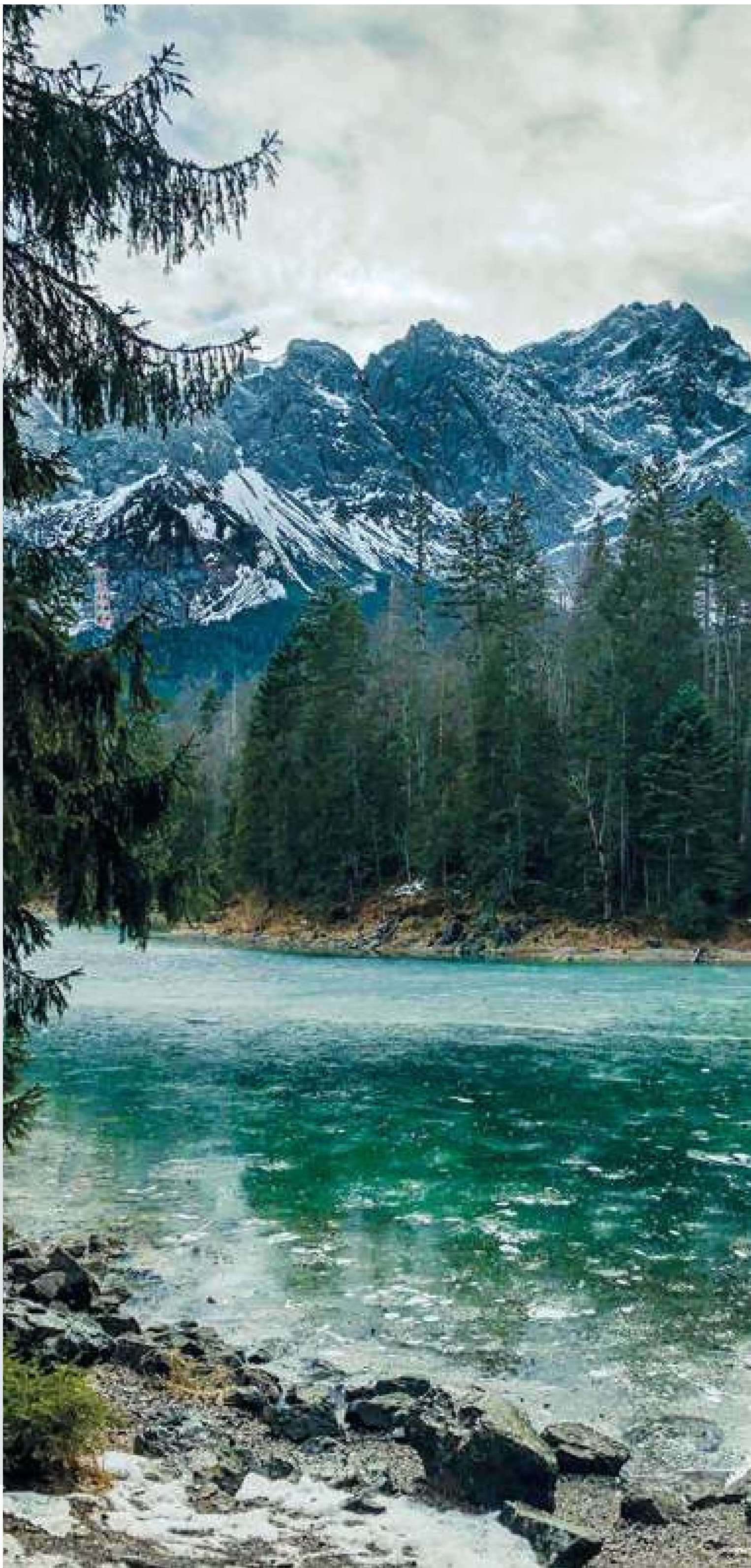
CONTENTS

INTRODUCTION

The Water4All partnership started in 2022 under the auspices of the European Union Horizon Europe programme for research and innovation, to concentrate research and innovation on water in Europe and beyond. Water4All's Vision is to "boost the systemic transformations and changes across the entire research – water innovation pipeline, fostering the matchmaking between problem owners and solution providers for ensuring water security for all in the long term".

Along with other activities, Water4All will implement a series of annual Joint Transnational Calls by pooling national financial resources through the participation of ministries, authorities and funding organisations. These calls primary aim at strengthening the water RD&I collaboration and producing and sharing top class water-related knowledge and data.

The 2022 Joint Transnational Call was the first of these calls. It was implemented by 34 research and innovation funding organizations from 29 countries, with the financial support from the European Commission. At the end of the selection process, 27 excellent RD&I projects were selected for funding with total funding of almost 27 million Euro.



OBJECTIVES OF THE 2022 JOINT TRANSNATIONAL CALL

The increase in the number of hydrological extreme events in the last few decades has motivated the research community to investigate their spatial variability and underlying processes. Evidence suggests that for properly supporting water management and tackling future and emerging challenges, it is necessary to make progress in understanding the spatiotemporal complex systems that drive hydrological events. Approaches for the characterisation of relationships between such complex systems and economic, organisational, policy, social and regulatory conditions need to be developed to bring systemic change.

Water4All's 2022 Joint Transnational Call sought to deliver knowledge, models, approaches, tools and methodologies to better understand hydrological processes at different scales and to respond more efficiently to emerging water issues related to extreme events.

The Call also addressed innovative governance models, and enhanced participation of stakeholders, communities and society at large in water management issues related to extreme events. Addressing governance required participation and engagement of stakeholders in the problem analysis and the identification of relevant knowledge gaps. The co-design of solutions, and the co-management of decisions related to water required activities in the field of communication, public awareness and education.

THEMES OF THE JOINT TRANSNATIONAL CALL

The call focused on solutions for hydroclimatic extreme events, as described in the Water4All Strategic Research and Innovation Agenda. Research & innovation proposals funded under the 2022 Joint Transnational Call address at least one of the following topics:

Topic 1. Resilience, adaptation and mitigation to hydroclimatic extreme events

- 1.1 Addressing knowledge gaps in our understanding of the causes of water scarcity, drought events, seasonal variability in climate impacts to develop adaptation and mitigation measures, taking climate change into account.
- 1.2 Developing and demonstrating innovative (or improved) societally acceptable adaptation and mitigation strategies to cope with hydro-climatic extreme events and their increase in length and duration. This includes floods and droughts, although is not limited to them, adopting a regional or a basin scale wide approach.
- 1.3 Improving resilience and adaptation capacity of water infrastructure (e.g., industrial water facilities, urban networks, wastewater treatment facilities, stormwater management systems and rural systems) to hydroclimatic extreme events.

Topic 2. Tools for water management - in the context of hydroclimatic extreme events

- 2.1 Developing tools (e.g., multi-risk approach, decision support tools, monetary/non- monetary costs valuation) to support the design and implementation of strategies for adaptation and mitigation to hydro-climatic extreme events, especially floods (including “flash-floods”), heat waves and droughts in a catchment to sea perspective.
- 2.2 Generating new methodologies, tools and models for water resources assessment/modelling for water bodies in scarcely monitored /data scarce areas. A combination of physical and digital solutions is expected, and opportunities provided by citizen science should be seized.
- 2.3 “Smartening the water system” and use of innovative digitalization, including improved/new sensors, models, communications and computing technologies.

Topic 3. Improved water governance in the context hydroclimatic extreme events and international contexts

- 3.1 Undertaking an analysis and developing robust Governance models for the management of water resources in the context of extreme events, is critical increasing the decision-making capacity of institutions and involvement of citizens. This should include ways of improving coordination between water managers to increase our capacity to reduce vulnerability to extreme events, as well as effectively respond to them.
- 3.2 Addressing and encouraging international cooperation in the field of water, including management of transboundary water resources and contribution to Water Diplomacy.

AQUIGROW

Sustainable AQUIfer recharge to enhance resilience of GROundWater services under increased drought risk

Abstract

Future climate, trends in population growth and land use changes are likely to exacerbate the risks associated with environmental and human water security in many parts of the world. For instance, the occurrence of drought events is increasing globally, as shown by recent major droughts in Europe and South Africa, which seriously jeopardized secure access to water resources, not only for human consumption and irrigation, but also for industrial uses and ecological functions. Therefore, there is an urgent need to devise methods to increase the resilience of water supply systems in the face of increasing drought risk. Within this context, groundwater is the most effective and scalable option to store water, being less affected by evaporation compared to surface reservoirs. Groundwater storage is even more important in arid and semi-arid regions as well as where swift reductions in snowfall and rainfall are occurring. Groundwater is also superior in terms of quality, being less exposed to contaminants than its surface counterpart, and benefitting from the role of active soils in retaining and degrading contaminants. However, over the last decades, land use changes (e.g., uncontrolled urbanization) and inefficient management have drastically decreased groundwater recharge fluxes, i.e., aquifers' replenishing input. In addition, increased groundwater withdrawals for drinking water supply and irrigation (which can account for up to 80% of total water uses), as well as diffuse pollution from intensive agricultural practices, are putting more and more pressure on aquifers worldwide.

The general objectives of AQUIGROW are to:

I. quantify current recharge fluxes in several study aquifers used for irrigation and/or drinking water supply in Europe, Israel and South Africa;
II. identify critical issues in the sustainable management of these aquifers, both in terms of water quantity and quality, related to current practices, planned land use changes and predicted climate change scenarios;
III. develop numerical tools and management solutions to improve recharge fluxes and their quality, as to increase available groundwater storage and preserve its use especially in times of drought.

Project AQUIGROW will reach these goals by:

I. providing stakeholders with advanced integrated surface-subsurface hydrological models (ISSHMs), incorporating main plant processes (biomass accumulation and water uptake) and complemented by anthropogenic process models (i.e., traditional and precision irrigation and land management practices) assisted by the latest Earth Observation data;
II. testing and deploying managed aquifer recharge (MAR) techniques, including unconventional soil aquifer treatment (SAT), in several pilot sites representative of European, Middle East and African landscapes, to investigate their sustainability in terms of water quantity and quality;
III. identify and assess barriers related to social and cultural acceptance of MAR and SAT and to policy regulatory frameworks and propose ways to overcome them.

The overarching scope of AQUIGROW is to solve primary water-related threats to human and aquatic ecosystem security in the whole range of climates (from arid to semi-humid) included in our test sites and to co-develop approaches for improved water resources management in the future. Our driving principle is the joint management of blue (i.e., water of aquifers, lakes, and rivers) and green water (i.e., soil moisture) resources for identifying and solving critical issues related to hydrological, agricultural, socio-economic and ecological droughts, resulting in a joint framework that can ultimately allow for satisfying the multiple demands of quality water for water abstractions, environmental flows and crop water requirements. The lasting impacts of AQUIGROW will be beneficial to several stakeholders (e.g., water utility companies, irrigation authorities, farmers), with obvious and ultimate benefits for the general public at large.

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Project partners

- CONSIGLIO NAZIONALE DELLE RICERCHE - ITALY
- INSTITUT NATIONAL DE RECHERCHE POUR L'AGRICULTURE, L'ALIMENTATION ET L'ENVIRONNEMENT - FRANCE
- POLITECHNIKA GDANSKA - POLAND
- STELLENBOSCH UNIVERSITY - SOUTH AFRICA
- TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY - ISRAEL

Funding organisations

MUR (ITALY) / ANR (FRANCE) / NCBR (POLAND) / DSI (SOUTH AFRICA) / MOE (ISRAEL)

Duration

3 years

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KEYWORDS

Water and soil pollution,
Hydrology (Water science),
Water-climate interactions,
Irrigation management

CLIMEX-PE

Climate Extremes buffering through groundwater flow-based managed aquifer recharge and public engagement

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Abstract

Mitigating the impact of extreme hydrological events and ensuring a safe water supply for humanity and ecosystems is one of the most significant challenges of our time. The principal water reserves are in the aquifers, as groundwater. The connection of groundwater to surface water bodies and ecosystems makes these reserves vulnerable to extreme events, but they can also buffer the effects of hydrological extremities. However, general knowledge of groundwater is limited. The main goal of the ClimEx-PE project is to incorporate groundwater flow system evaluation, local scale MAR (Managed Aquifer Recharge) techniques, and co-creative public engagement, providing a new and upscaled nature-based MAR (NB-MAR) approach for regional scale mitigation of extreme hydroclimatic events. The research intends to display: 1) the influence of natural extremes on groundwater, 2) the application of NB-MAR to buffer climate events, 3) the impacts on groundwater quantity/quality, 4) the workflow for the involvement of the NB-MAR in society engagement, communication, education, 5) the consideration of groundwater flow systems and their replenishment with excess water in decision-making, 6) the integration of NB-MAR to water policies and develop a sustainable regulatory environment. These goals can improve water management, resilience, and security and contribute to human rights. The project handles groundwater flow systems as the critical missing element of better water management. Different flow systems are naturally buffered against drought and flood. We propose using these natural differences through NB-MAR methods for water replenishment. The project aims to have an impact on multidisciplinary fields.

- (I) Natural scientific field: it produces datasets, models, and recommendations to disentangle
- i) trends of climate-hydrological extremes,
- ii) their impact on groundwater bodies,
- iii) the climate buffering role of groundwater flow systems and its better exploitation.
- iv) Knowledge on the buffering capacity of aquifers is generated.
- v) Returning to society: a) monitoring tools for indicators; b) open access guides, events on the buffering capacity of groundwater flow and NB-MARs; c) a decision support tool.

(II) Socio-legal field: the project aims

- i) to elaborate materials that inform future NB-MAR projects to support the goals of local/regional sustainable water management;
- ii) to develop guidelines by the cooperation of scientists, communication and educational experts using evidence-based assessment of efficiency;
- iii) to produce a) stakeholder value propositions for NB-MAR solutions, b) briefing documents for policymakers with communication guidelines for NB-MAR solutions, c) digital, customizable communication packages;
- iv) to create a method to integrate environmental, agricultural, industrial, and public service provision policies on water.

The proposal connects to Themes III, VII, V; Topics 1,2,3. Mostly, it connects to Theme III, addressing knowledge gaps by involving groundwater flow systems in understanding the connection between groundwater, surface water and extreme events, the management of water schemes and the recharge of aquifers (1.1). It develops an innovative understanding of how underground flow influences the quality/quantity of water processes (1.2). It proposes a nature-based water replenishment approach and intends to create a new methodology regarding groundwater's buffering role (2.2). It proposes a governance model (Theme VII) based on dashboard indicators to reduce vulnerability to extreme events (3.1), to reach more efficient citizen and stakeholder awareness and support the proposed strategy for mitigation and adaptation to hydroclimatic events (2.1). The dashboard can be applied to transboundary water resources and help with water diplomacy (1.3, 3.2). Regarding infrastructure (Theme V), the results help decision-makers reveal necessary adaptation steps to mitigate water infrastructure resilience.

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- UNIVERSITAT DE BARCELONA - SPAIN
- UNIVERSITEIT UTRECHT - THE NETHERLANDS
- UNIVERSITY OF ZARAGOZA - SPAIN (SELF-FUNDED)

Funding organisations

NKFIH (HUNGARY) / EPA (IRELAND) / AEI (SPAIN) / NWO (THE NETHERLANDS)

Duration

3 years

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KEYWORDS

Ecosystem services provided by catchment areas,
Resilience aspects,
Environmental sciences (social aspects),
Information & awareness-raising,
Open data

DATASET

Groundwater salinization and leaching assessment tool: a holistic approach for coastal areas.

Water4All
Water security for the planet

Abstract

Coastal areas are invaluable ecosystems with pivotal resources for economic and societal development. Salinization processes of freshwater resources from both natural and anthropogenic sources are the most alarming and widespread issues in coastal areas, in Europe and worldwide. Recent studies show that these issues will be further exacerbated due to the ongoing climate changes and more frequent hydroclimatic extreme events. Moreover, increasing urban sprawl in coastal area, where 2.15 billion people are already living, triggered radical changes generating a severe demand for natural resources, exacerbated by a lack of planning and management.

The overall goal of DATASET is to develop an efficient tool to assist in protection and regulation of water resources use and management in coastal aquifers. To do so DATASET aims at achieving the following objectives:

- Develop and apply a method to create vulnerability maps throughout a holistic assessment of coastal aquifers coupling the evaluation of agricultural leaching and salinization processes in a single methodology to improve water governance aimed at early warning, prevention, and mitigation of groundwater quality degradation in the present and future conditions, accounting for impacts of climate change and hydroclimatic extreme events.
- Promote a paradigm shift in water management, through internet access to data and models, dissemination of management tools for planning and societal implication and their transfer to stakeholders.
- Promote social awareness on the importance of groundwater and its sensitivity to climate change and hydroclimatic extreme events from stakeholders and decision makers to end users.

DATASET deals with the "Topic 2. Tools for water management - in the context of hydroclimatic extreme events" and specifically with the subtopic 2.2: Generating new methodologies, tools, and models for water resources assessment/modelling for water bodies in scarcely monitored/data scarce areas. A combination of physical and digital solutions is expected, and opportunities provided by citizen science should be seized. DATASET relies on five pillars:

- Easy: To ensure DATASET easy applicability, the methodology will retain the GIS overlay index structure with parameters, rates, and weights. The key features of the aquifer system will be represented through thematic maps in GIS using raster format and then overlaid producing vulnerability maps representing the spatial aggregation of weighted parameters.
- Open: Data availability is a major drawback in building a groundwater vulnerability assessment map. However, over the past 20 years, several continental and global scale models have been developed. DATASET aims to evaluate the suitability of these models' products as potential input to the implementation of groundwater vulnerability assessment, through a deep quality check of input data and datasets, reducing the dependence on local data.
- Reliable: To address model reliability and uncertainties, the weights and rates classification will be achieved using artificial intelligence algorithms trained and tested using water quality data.
- Flexible: The operator will be able to choose whether to produce a vulnerability/risk map only for salinization processes, only for agricultural leaching, or considering both processes in a single assessment. Operators will have the opportunity to turn specific parameters on/off and choose the correct sets of weights and rates based on the final evaluation objective.
- Dynamic: The possibility to access climate data including precipitation, temperature, and evapotranspiration from freely available datasets, both for historical or future period, will allow to forecast the impacts of climate change and hydrological extreme events on groundwater resources which could negatively influence water availability and quality. Then, the possibility to model different land use scenarios will offer the chance to easily identify those areas where to apply specific remediation actions to counteract negative impacts.

Project coordinator: **Micol MASTROCICCO**

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- POLITECHNIKA GDANSKA - POLAND
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Funding organisations

MUR (ITALY) / ANR (FRANCE) / CNPQ (BRAZIL) / NCBR (POLAND)

Duration

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KEYWORDS

Vulnerability mapping, Water-climate interactions, Hydrology, Groundwater, Salinization, Agriculture, Coastal Aquifer, Water and soil pollution, hydroclimatic extreme events, Increasing population.

DEMOTAPE

Designing multi-knowledge protocols to transform transboundary policies for hydroclimatic extremes

Water4All
Water security for the planet

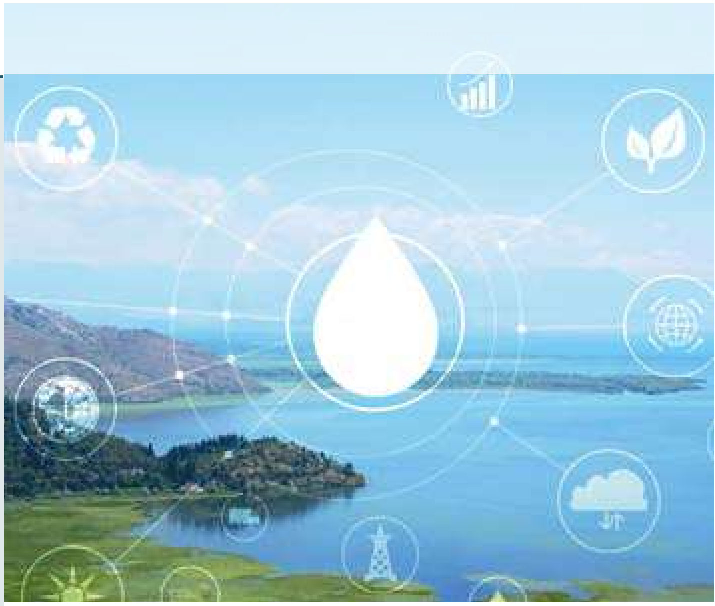
Abstract

The purpose of the project is to design and apply an integrated knowledge framework to enhance international water cooperation on hydroclimatic extremes.

Transboundary river basins suffer from a lack of institutional capacity as well as face challenges of technological capacity to better mitigate and adapt to floods and droughts.
The project aims to better link recent developments in environmental intelligence to inform transboundary water diplomacy with a particular attention towards impacts on infrastructure and livelihoods.

Multiple data streams from ground-based, satellite and citizen sources are brought together using existing models and tools for an environmental intelligence protocol, synthesising the connections of data generation and analysis with policy support systems. This protocol is tested and adapted with local stakeholders of the Brahmaputra River basin and the Maas/Meuse River basin.

The project seeks to advance deliberative decision-making through participatory knowledge system generation that can empower and equip stakeholders for more adaptive and equitable decision-making. The project informs strategies of water diplomacy and international cooperation policy by employing socio-technical experiments including living policy labs and learning workshops that allow for new, transformed evidence-based approaches to deal with hydroclimatic extremes.



Project coordinator: **Naho MIRUMACHI**

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Project partners

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- UNIVERSITY OF GENEVA - SWITZERLAND
- WAGENINGEN UNIVERSITY AND RESEARCH - THE NETHERLANDS

Funding organisations

EPSRC UKRI (GREAT BRITAIN) / BMBF (GERMANY) / SNSF (SWITZERLAND) / NWO (THE NETHERLANDS)

Duration

3 years

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KEYWORDS

Flood Management,
Water policy,
Water management,
Water supply,
Water scarcity management

DIME

Developing innovative solution for mitigation of drought effects

Water4All
Water security for the planet

Abstract

The scarcity of water resources is expanding worldwide due to the continuous growth of the imbalance between the availability and utilization of freshwater. This motivates researchers to find new water-saving methodologies and water management tools responding to future demands.
The general objective of this project consists of the development of novel and low-cost material based on alginate and biochar functionalized with metal oxides and its application for the treatment of contaminated water, to support the implementation of strategies for mitigation of hydro-climatic extreme events, especially droughts in the catchment of different sources of irrigation water. Also, the material will be investigated for water saving and soil fertilization. The influence of this new material on bean crops will be studied, bean being widely used food due to their high protein content and vitamins.
The specific objectives of the research are:
Preparation and characterization of cost-effective new superabsorbent materials based on alginate and biochar functionalized with metal oxides.
Assessment of the efficiency of recycling and reusing the superabsorbent material.
Evaluation of the removal efficiency of organic pollutants from polluted water (including desalinated effluent) using the superabsorbent material.
Testing the attenuation of antibiotic resistance genes and bacteria by the new adsorbent from greywater effluents using established molecular methods (qPCR and c sequencing).
Assessment of the impact of the superabsorbent material on the physical, chemical, and biological properties of soil and its effects on growth-development, yield, and crop quality in agricultural plants under current and predicted climate change scenarios.
The current project is pertinent to the work program topic, contributing to the management of water resources by adaptation and mitigation to hydroclimatic extreme events and management tools by preparation of new materials that will be used for water decontamination thus increasing the water reserve that can be used for irrigation. Also, these superabsorbent materials can be used to store and gradually release water during droughts.
The project, by its objectives, fits the following topics of the call:

- Topic 1. Resilience, adaptation, and mitigation to hydroclimatic extreme events – by developing a mitigation strategy to cope with hydro-climatic extreme events, especially drought.
- Topic 2. Tools for water management - in the context of hydroclimatic extreme events – by developing tools (e.g. superabsorbent material, multi-risk approach) to support the design and implementation of strategies for mitigating droughts in a catchment to sea perspective.

In addition, following the influence of the superabsorbent materials prepared in the project on bean cultivation under current and future climate change conditions of temperature and CO2 concentration in the atmosphere will provide knowledge on how the proposed solution will perform today and in the foreseeable future. (This is also addressed in Topic 2).
Because the countries involved in the project (Romania, Italy, Moldova, Turkey, India) have different climates, it can also fit with Topic 3: Improved water governance in the context of hydroclimatic extreme events and international contexts - Addressing and encouraging international cooperation in the field of water, including management of transboundary water resources and contribution to Water Diplomacy.
The novelty of the project: i) the material prepared; ii) 3 simultaneous applications of the same material: pollutants removal, swelling, and drought stress mitigation under current and predicted climate change scenarios for crop cultivation as model plant bean crop and soil properties; iii) the application of the material prepared for the elimination of ARGs and ARBs.

Project coordinator: **Maria - Loredana SORAN**
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- RAIT88 SRL - ITALY
- TECHNICAL UNIVERSITY OF MOLDOVA - MOLDOVA
- UNIVERSITY OF CUKUROVA - TURKEY

Funding organisations

UEFISCDI (ROMANIA) / MOE (ISRAEL) / MUR (ITALY) / NARD (MOLDOVA) / TUBITAK (TURKEY)

Duration

3 years

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KEYWORDS

Water saving,
Plant growth,
Agriculture,
Irrigation management

ECCO

Enhancing resilience in a changing climate through comprehensive urban flood design

Abstract

The general objective of ECCO is to enhance climate adaptation by providing metrics design values for present-day and future climate pathways for heavy precipitation, urban flooding, and compound events leading to urban flooding from a range of impact types.

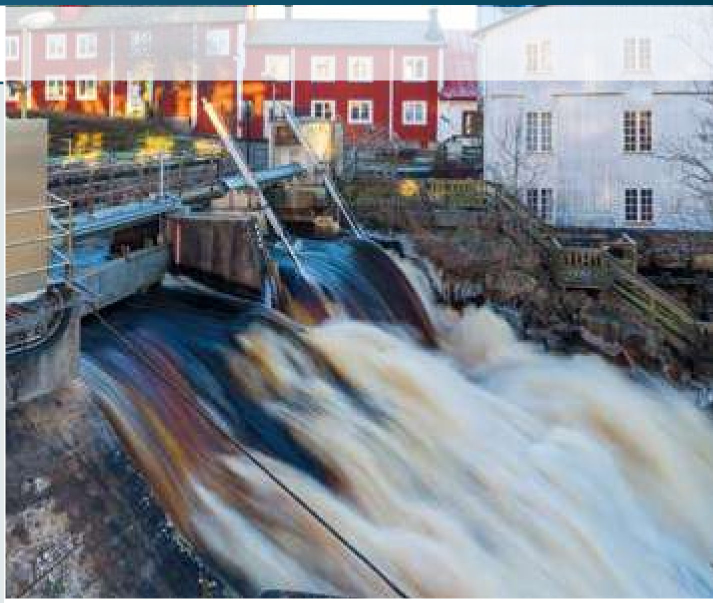
ECCO emphasises knowledge transfer and has a strong component in meeting user needs within the area of water management for proper planning and infrastructure design in a changing climate.

The project will focus on the following research questions:

- How can we provide robust intensity-duration-frequency (IDF) values for any point in the Nordic-Baltic region (WP2)?
- How can heavy rainfall statistics, antecedent moisture conditions and temporal precipitation sequences be used in urban flood modeling to give more realistic and reliable design flood estimates (WP3)?
- How can we expand our knowledge of the frequency of compound events that cause flooding and further develop methods to estimate the risks and impacts of such events (WP4)?
- And across all of the above, how can we make this information accessible to users through metrics that enable optimal uptake and implementation (WP1)?

ECCO will address subtopics 1.1 (knowledge gaps) and 2.1 (tools) of the call.
Concerning sub-topic 1.1, we will particularly address knowledge gaps associated with compound events (see WP4), but also the complexities associated with extreme precipitation, antecedent moisture conditions and flooding (see WP2 and WP3).
Sub-topic 2.1 will be addressed by both providing a large-scale tool for gridded IDF values, providing design precipitation in arbitrary locations where adequate observational time series are not available (see WP2) and by aiming to deliver end-user friendly compound design metrics.

We will also establish benchmark studies to support the development of a tool for design flood analyses (see WP3).



Project coordinator: **Anita Verpe DYRRDAL**

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Project partners

- DANISH METEROLOGICAL INSTITUTE - DENMARK
- KOMMUNERNES LANDSFORENING - DENMARK (SELF-FUNDED)
- LATVIAN ENVIRONMENT, GEOLOGY AND METEORO-LOGY CENTRE - LATVIA
- NORWEGIAN WATER RESOURCES & ENERGY DIREC-TORATE - NORWAY
- TECHNICAL UNIVERSITY OF DENMARK - DENMARK
- UNIVERSITY OF TARTU - ESTONIA

Funding organisations

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Duration

3 years

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KEYWORDS

Urban water management,
Learning,
Development and adaptation

GREENADAPT2EXTREMES

Green adaptation pathways for resilient basin futures under increasing extreme floods and droughts

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Water security for the planet

Abstract

In Europe, the frequency and severity of flood and drought events, together with their negative impacts on society and ecosystems, have increased over recent decades, and this trend is projected to continue in the future. Risks connected to extreme floods and drought present a high level of complexity and interconnectedness, posing a challenge to risk management. While efforts are in place to achieve sustainable management of water-related risks, the scale of recent catastrophic events shows that new approaches and methodologies are needed to manage hydroclimatic risks both in the short and long-term.

Nature-based solutions (NbS) offer an important strategy to achieve water-secure, climate-resilient societies and promote nature conservation. However, while NbS are potentially viable risk reduction and adaptation strategies for both flood and drought risks, knowledge gaps remain about their potential and limits under extreme floods and droughts as well as regarding their cost-effectiveness, co-benefits and trade-offs. A thorough understanding of how NbS can contribute to the effective management of dynamic multi-risks linked to extreme droughts and floods under changing climate conditions is paramount.
Tributary catchments, often overlooked in favour of large riverine systems, offer much potential to develop innovative and sustainable solutions: while they also experience catastrophic impacts, they are often less regulated compared to larger rivers. In such settings, adaptation decisions can benefit both upstream or local communities and downstream areas and communities.

Taking up these challenges and opportunities, the "Green adaptation pathways for resilient basin futures under increasing extreme floods and droughts" (GreenAdapt2Extremes) project aims at co-creating transformative adaptation pathways based on NbS. It will focus on the catchments of three highly flood and drought-prone tributary rivers: the Dora Baltea (Italy), the Geul (Netherlands) and the Erft (Germany). Importantly, the project will center on the involvement of stakeholders in all activities, beginning with the co-creation of "visions for resilient basin futures", where stakeholders will be able to express their ambitions, needs, values and preferences for desirable future(s). These will form the basis for every subsequent activity of the project.

Green adaptation pathways will be co-created with stakeholders in a transdisciplinary setting at the catchment scale, building on an analysis of:

- I. current and future drought and flood risks, and
- II. the co-benefits, potential, limits and social acceptability of NbS.

The pathways will also be informed by our analysis of suitable multi-level governance of risks and adaptation. The future decision space mapped through the green adaptation pathways will help improve the protection from floods and droughts for people, ecosystems and economic sectors. A participatory, mixed-methods approach (supported by existing information and local knowledge) will be adapted to the specific conditions of each case catchment.

Planned dissemination and international networking activities will facilitate knowledge transfer and cross-boundary learning, but also support the evaluation of the transferability and upscaling potential of the project's approach, methods and solutions.

In doing so, GreenAdapt2Extremes is relevant to multiple of the call's topics and themes, notably "Topic 1: Resilience, adaptation and mitigation to hydroclimatic extreme events" (sub-topics 1.1 & 1.2), "Topic 2: Tools for water management - in the context of hydroclimatic extreme events" (sub-topic 2.1), and "Topic 3: Improved water governance in the context hydroclimatic extreme events and international contexts" (sub-topics 3.1 and 3.2). Further, it directly contributes to Theme III "Water for the future: sustainable water management" and Theme VII "Governance".

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Funding organisations

BMBF (GERMANY) / MUR (ITALY) / NWO (THE NETHERLANDS)

Duration

3 years

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KEYWORDS

Floods, Droughts,
Vulnerability,
Risk Assessment, Nature-based Solutions,
Adaptation,
Pathways,
Multi-Level Governance

GROUNDEDEXTREMES

Understanding and governing groundwater to reduce risk of hydrological extremes

Water4All
Water security for the planet

Abstract

Hydrological extremes are expected to occur more frequently and become more severe, making drought and flood risk management essential for adaptation.

The GroundedExtremes project ("Understanding and governing groundwater to reduce risk of hydrological extremes") aims to investigate groundwater and hydrological extremes, and design improved groundwater management as a powerful adaptation strategy to both droughts and floods, avoiding long-term unintended consequences and unwanted trade-offs. The GroundedExtremes project is built around knowledge exchange and transferability concepts and is organised along two axes:

- 1) three work packages (WPs) and
- 2) four case studies.

WP1 analyses physical groundwater drought processes (i.e., development, duration, and recovery) and drivers such as climate, land use, groundwater abstractions, and subsurface characteristics. It also explores potential futures through stress tests.

WP2 investigates drought management and groundwater governance and maps the involved actors to assess the arrangements that contribute to dealing with extremes. WP3 studies adaptation measures using a socio-hydrological model that integrates the drought drivers and physical processes from WP1 and the actor mapping and policy analysis of WP2 to model how combinations of drought adaptation measures can result in different future groundwater conditions using storylines. Solutions are assessed with a view to potential trade-offs and consequences on flood risk.

Groundwater hydrological behaviour and adaptation strategies are explored in four regions in Europe with different physical, societal and water governance contexts. These regions are: Tierra de Barros aquifer (Spain), Dijle and Nete catchments (Belgium), Overijssel and Achterhoek (Netherlands), and Kalmar County (Sweden).
An approach of cross-case study collaboration and learning is applied by focusing on differences and similarities, thus enabling general recommendations to be given from local adaptations. Key to the project is the involvement of local stakeholders, which guide the modelling and ground the adaptation measures investigated and the proposed storylines in reality.

GroundedExtremes is a 3-year (April 2024 - March 2027) project involving nine international partners and funded by the Water4All partnership.

Project coordinator: **Anne VAN LOON**
VRIJE UNIVERSITEIT AMSTERDAM - THE NETHERLANDS

Project partners

- VRIJE UNIVERSITEIT BRUSSEL - BELGIUM
- WAGENINGEN UNIVERSITY & RESEARCH - THE NETHERLANDS
- UNIVERSIDAD COMPLUTENSE DE MADRID - SPAIN
- UNIVERSITY OF OSLO - NORWAY
- UNIVERSITY OF GOTHENBURG - SWEDEN
- KWR WATER RESEARCH INSTITUTE - THE NETHERLANDS
- UNIVERSIDAD DE SEVILLA - SPAIN
- CHALMERS UNIVERSITY OF TECHNOLOGY - SWEDEN

Funding organisations

NWO (THE NETHERLANDS) / FORMAS (SWEDEN) /
RCN (NORWAY) / AEI (SPAIN) / FWO (BELGIUM)

Duration

3 years

Contact

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KEYWORDS

Hydrology (Water science),
Water management,
Political systems and institutions,
Governance,
Water system modelling

INTERLAYER

The complex interlink of safeguarding water availability and quality to mitigate and adapt to hydroclimatic extremes in Europe

Water4All
Water security for the planet

Abstract

INTERLAYER main objective is to develop cumulative adaptation strategies in the complex interlink between surface and groundwater management, using water retention measures to reduce water runoff and fill-up groundwater storages, to minimize hydroclimatic extreme events' impacts in water quantity and quality. INTERLAYER will tackle eight (8) Specific Objectives, contributing to address the Call Topics 1, 2 and 3, as follows: Call Topic

- (CT) 1.1: INTERLAYER will address knowledge gaps in our understanding on how surface water and groundwater interrelate in the advent of extreme precipitation, water scarcity, drought events and seasonal variability in four European watersheds and contribute to the development of innovation adaptation and mitigation measures taking different climate scenarios into account;
- CT1.2: INTERLAYER will demonstrate improved societally acceptable adaptation and mitigation strategies, as it will focus on the refinement of water retention measures at regional (DK, RO) and watershed scale (AT, PT/SP) to promote both slow hydrology to protect against flooding and guarantee the availability and quality of water (simultaneously at surface and groundwater level);
- CT1.3: INTERLAYER will contribute to the improvement of adaptation capacity of water infrastructure, particularly related to stormwater management in rural systems;
- CT2.1: INTERLAYER will develop a decision support tool for the adoption of best practices that have additive results in water quantity and quality retention both at surface and in the aquifers (to be applied in regional or watershed contexts). INTERLAYER results will contribute to the validation of the practices thus contributing to future payments for ecosystem services to be adopted;
- CT2.2: INTERLAYER will develop a hydrological (near) real time groundwater-surface water model including scarcely monitored areas (Guadiana Watershed PT/SP);
- CT2.3: INTERLAYER will further develop and make use of (near) real time monitoring and modelling to create a digital twin of the shallow and deep groundwater storage for monitoring recharge capacity of surface storage of discharged streamflow and overall water balance;
- CT3.1: INTERLAYER will take advantage of DK experience in governance practices involving co-creation and co-design and will ensure that best practices are passed on and adopted in other European contexts (PT/SP);
- CT3.2: INTERLAYER will develop and kick-off a living lab in one of the driest Transboundary (PT/SP) Watersheds in Europe – the Guadiana - taking advantage of the DK experience and governance models.

INTERLAYER will contribute to the water diplomacy as it will integrate technicians, researchers and farmers in the co-creation and co-design for shared transboundary problems. Higher level policy and decision makers will be included in the co-creation and co-design in a later stage in an attempt to "secure contamination from past" management malpractices and litigation. INTERLAYER novelty is related to shared interdisciplinary knowledge on the complex interlink of generating resilience to hydroclimatic extreme events to minimize flood risk and maximize water availability and quality. INTERLAYER will develop and demonstrate novel water retention technologies that favour slow hydrology entrance in the system for adaptation of European river basins to hydro-climatic extreme events and simultaneously obtain resilience in agricultural productive land, the adjacent ecosystems, and downstream cities. Hydro-climatic water balance models will be demonstrated to describe the spatio-temporal exchange of water within the river basins between highland and lowland and between shallow and deep groundwater, in response to suggested changes in terrain, drainage and land-use practices. It will provide country specific overviews of key actors for implementation of change and suggested guidelines, serving as front runners for the adoption of water retention methods for slow hydrology.

Project coordinator: **Miguel POTES**

UNIVERSIDADE DE ÉVORA - PORTUGAL

Project partners

- GEOLOGICAL SURVEY OF DENMARK AND GREENLAND - DENMARK
- INSTITUTUL NATIONAL DE CERCETARE-DEZVOLTARE PENTRU GEOLOGIE SI GEOECOLOGIE MARINA-GEOECOMAR - ROMANIA
- KOBENHAVNS UNIVERSITET - DENMARK
- METEOGRID, S.L. - SPAIN
- REGION HOVEDSTADEN - DENMARK
- UNIVERSITAET FUER BODENKULTUR WIEN - AUSTRIA

Funding organisations

FCT (PORTUGAL) / IFD (DENMARK) / UEFISCDI (ROMANIA) / CDTI (SPAIN) / FWF (AUSTRIA)

Duration

3 years

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KEYWORDS

Habitat and species restoration and rehabilitation,
Spatial development and architecture, land use, regional planning,
Ecosystem services provided by catchment areas,
Ecosystem-Based Approach,
Fresh water biodiversity, Flood Management, Surveillance of zones under humanitarian risk (migratory flow, drought)

ISOSCAN

Isotope-aided assessment and forecasting of hydroclimatic extremes in Scandinavia with stakeholder co-design

Water4All
Water security for the planet

Abstract

Extreme snowpacks are closely linked to extreme hydro-meteorological events. Large snow cover, for example, can be related to for example flash-floods during rain-on-snow events, while on the opposite low snowcover can lead to droughts. Both extremes have major socio-economic impacts.

There is a lack of more solid evidence on the causes and impacts of extreme seasonal snow cover on a Scandinavian scale, and beyond. Uncertainties arise from the water amount and variability of the snowpack, and from the lack of suitable calibration data for hydrological models, in particular for hydrological extremes.

Being tuned to the present, many current models will not be able to adequately represent future extremes. Water isotopes in precipitation and the snowpack have a large, but hitherto barely exploited potential to improve estimates of the water amount and physical processes contributing to runoff.

The overall aim of ISOSCAN is to advance forecasts of hydroclimatic extremes across Scandinavia from novel water resource assessment and model constraints, using new water isotope data from non-traditional sources, co-designed with citizen scientists and stakeholders.

ISOSCAN will realize the overall aim through 4 specific objectives:

- (1) by developing a scalable, effective citizen science framework that involves recreational nature users, including tourists and locals, to overcome the lack in spatiotemporal isotope data in Scandinavia;
- (2) by obtaining spatially and temporally resolved water isotope data obtained from a range of sources, from literature to fieldwork using a citizen science framework during winter and precipitaiton, soil, groundwater and water bodies during summer across Scandinavia;
- (3) by utilizing the novel stable water isotope dataset to improve estimates of the snowpack, and physical process representations in a hydrological model; and
- (4) by disseminating co-designed outcomes and the improved hydrological model capability.

This work is expected to lead to a better hydrological process understanding to stakeholders, contributing to mutual learning between citizens and scientists, as well as contributing to stewardship and behavioural changes.

Thereby, ISOSCAN contributes towards preparedness against hydroclimatic extremes, such as years with extreme low or high seasonal snow packs, that will have widely differing consequences for stakeholders, including locals, tourists, and water resource managers. ISOSCAN thus addresses the WATER 4 ALL Topic 2, whilst contributing partly to Topics 1 and 3.

Project coordinator: **Harald SODEMANN**

UNIVERSITETET I BERGEN - NORWAY

Project partners

- OULUN YLIOPISTO - FINLAND (SELF-FUNDED)
- SVERIGES METEOROLOGISKA OCH HYDROLOGISKA INSTITUT - SWEDEN
- SYDDANSK UNIVERSITET - DENMARK
- WILD LAB PROJECTS - NORWAY

Funding organisations

FORMAS (SWEDEN) / IFD (DENMARK) / RCN (NORWAY)

Duration

3 years

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KEYWORDS

Meteorology, Hydrology (Water science),
Cryosphere,
Dynamics of snow and ice cover, Sea ice,
Permafrost and ice sheets,
Travel and tourism,
Citizen cooperation and reporting

LANDEX

Improving landscape resilience by integrating measures to adapt and mitigate hydrological extremes

Water4All
Water security for the planet

Abstract

It is critically important to protect society from the effects of floods and droughts, which will occur more frequently in future due to climate change. LandEX aims to improve landscape resilience to hydroclimatic extremes – both floods and droughts – by spatially optimising a suite of adaptation measures in the landscape. Knowledge gaps addressed by LandEX include:

I. How different (Nature Based Solution; NBS) measures can increase water retention in the landscape and, thus, mitigate floods and droughts at the same time;

II. How their spatial location determines their effectiveness at the landscape level, and

III. Potential synergies between a network of different measures distributed throughout the landscape to mitigate both floods and droughts.

LandEX uses the concept of hydrological connectivity to design spatially-explicit adaptation scenarios which retain water from wet periods to be available during dry periods. To quantify scenario effectiveness at the regional scale, LandEX uses connectivity-based spatially distributed hydrological modelling. This approach is tested in 5 study areas in northern and southern Europe. LandEX works closely with local and regional stakeholders, as it is crucial to co-design such adaptation scenarios to ensure their feasibility and adoption and to incorporate them into regional spatial planning.
LandEX aims to achieve the following objectives, addressed in specific Work Packages (WP):

- WP1: Investigate in each study area (i) the current hotspots for flood and drought occurrence; (ii) how existing flood and drought mitigation measures perform and/or why they are not effective, both technically and socioeconomically; and (ii) potential synergies of (NBS) measures to mitigate both floods and droughts, using the concept of water retention landscapes.
- WP2: Co-design spatial adaptation scenarios of feasible and potentially effective suites of measures in the landscape, in close collaboration with local stakeholders.
- WP3: Quantify the effectiveness of the adaptation scenarios (from WP2) on floods and droughts using spatially explicit hydrological models.
- WP4: Develop a tool to support managers in optimising landscape resilience to hydroclimatic extremes and to visualise scenario outcomes through an online map interface.
- WP5: Stimulate co-learning between the 5 study areas by enabling exchange of experiences with different sets of innovative adaptation measures.

While building on previous experience within the consortium (e.g. modelling, stakeholder relations), LandEX contributes to important innovation: we explicitly seek measures that can work for both floods and droughts in a synergistic way, so that their combined effect is more than the sum of their parts. This is highly needed, as only a limited number of measures can be implemented in an area. In addition, our approach focuses on using NBS to affect hydrological connectivity: i.e. measures that slow the flow of water in the landscape can retain water from wet periods to be available during dry periods. Quantifying the effectiveness of multiple measures is not often done in a spatially explicit way, while by doing so, their (spatial) interactions and feedbacks are taken into account, which is needed to detect synergies between different types of measures at various locations in the landscape. We use spatially-explicit hydrological models to assess the effectiveness of multiple configuration of measures. Finally, the co-creation of the spatial adaptation scenarios by groups of multiple stakeholders incorporates the socio-economic feasibility of the measures and helps overcome institutional barriers.

LandEX consortium partners have great experience with floods and droughts, mitigation measures, including NBS, hydrological modelling and stakeholders participation in projects. In addition, consortium partners have collaborated in earlier and ongoing projects.

Project coordinator: **Jantiene BAARTMAN**

WAGENINGEN UNIVERSITY - THE NETHERLANDS

Project partners

- AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS - SPAIN
- FCIENCIAS.ID - ASSOCIACAO PARA A INVESTIGACAO E DESENVOLVIMENTO DE CIENCIAS - PORTUGAL
- KUNGLIGA TEKNISKA HOEGSKOLAN (KTH) - SWEDEN
- NIBIO - NORSK INSTITUTT FOR BIOOKONOMI - NORWAY

Funding organisations

NWO (THE NETHERLANDS) / AEI (SPAIN) / FCT (PORTUGAL) / FORMAS (SWEDEN) / RCN (NORWAY)

Duration

3 years

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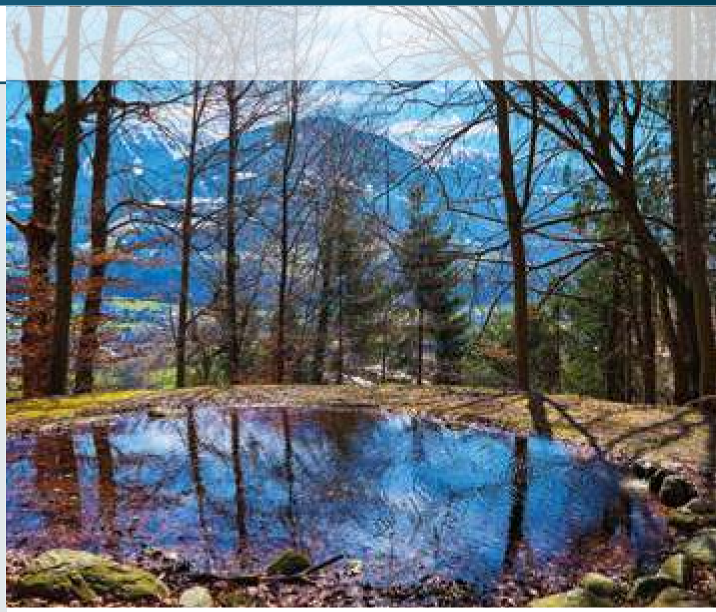
KEYWORDS

Landscape resilience
Co-design spatial adaptation scenarios
Hydrological modelling
Floods & droughts
Mitigation measures
Nature-based solutions

MARSURE

Hybrid managed aquifer recharge as an adaption tool to ensure a resilient and healthy groundwater resource

Water4All
Water security for the planet



Abstract

Managed aquifer recharge (MAR), the purposeful recharge of water to aquifers for subsequent recovery, is used globally to replenish overexploited groundwater resources and prevent saltwater intrusion. Due to water shortage accelerated by climate change, there is a growing interest in using unconventional water resources for MAR, such as reclaimed water or surface water impaired by wastewater discharges. This, however, raises major concerns related to the pollution of our drinking water resources. The primary aim of MARSURE is to extend the application of MAR by combining it with pretreatment processes to prevent groundwater contamination by organic micropollutants, nutrients, metals, pathogens including antimicrobial resistant-bacteria (Hybrid-MAR).
The primary output will be next-generation hybrid-MAR technologies that allow using a greater range of source water resources for MAR without compromising the quality of groundwater aquifers. Thereby, the research supports a circular water economy with more water reuse and less use of non-renewable water resources. The hybrid-MAR will provide stakeholders with documentation for the safer use of MAR as a sustainable climate change adaptation option, specifically addressing droughts, incidents expected to occur with higher frequencies and longer durations.
Scientific aims are to

- 1) determine the best pretreatment technologies for specific source waters focusing on ultrafiltration, ozonation, UV-based advanced oxidation processes, and powdered activated carbon;
- 2) define how pretreatments affect the removal of chemical and microbial pollutants in the following MAR;
- 3) identify means to stimulate metabolic and cometabolic degradation processes and avoid spreading of antibiotic resistance;
- 4) establish a model framework highlighting sites most vulnerable to droughts at the regional scale and the potential for implementing hybrid-MAR at those sites; and
- 5) to evaluate, through modelling, the positive effect of implementing MAR at catchment scale on the available groundwater resource.

MARSURE addresses the call (subtopic 1.2) by developing and testing new hybrid-MAR technologies to be implemented in adaptation strategies to cope with extreme droughts. The cross-European perspective is ensured by having the research centered around three joint regions, each with its characteristic climatic, geological, and hydrological conditions and different water qualities relevant for MAR: The Berlin and the Lower Franconia regions in Germany and the Motril-Salobreña region in Southern Spain. In addition, a joint field site will be established near Poitiers, France, with large-scale outdoor monolith facilities for testing developed MARSURE technologies. The broad regional approach enables us to study the potential of MAR as an adaptation measure to climate change-induced water scarcity and drought events. Thereby we can bridge the knowledge gaps in understanding how pretreatment and MAR can positively impact groundwater quantities in drought-vulnerable areas during different projected climate change scenarios (subtopic 1.1). Finally, MARSURE addresses subtopic 1.3 by including the Berlin region where the developed hybrid-MAR can be implemented, e.g., at industrial water facilities or stormwater management systems, to improve urban water infrastructure's resilience and adaptation capacity. Stakeholders involvement, including water authorities, MAR system operators, water suppliers, consultancies, legislators, environmental interest organisations, utility providers, and the scientific community in general, is of utmost importance to achieve maximal impact. These will be approached in different ways, mainly connected to biannual project meetings.

Project coordinator: **Jens AAMAND**

GEOLOGICAL SURVEY OF DENMARK AND GREENLAND - DENMARK

Project partners

- BERLINER WASSERBETRIEBE - GERMANY
- KATHOLIEKE UNIVERSITEIT LEUVEN - BELGIUM
- TECHNISCHE UNIVERSITÄT MÜNCHEN - GERMANY
- UNIVERSITY OF BORDEAUX - FRANCE
- UNIVERSITY OF GRANADA - SPAIN
- UNIVERSITÉ DE POITIERS - FRANCE

Funding organisations

IFD (DENMARK) / BMBF (GERMANY) / FWO (BELGIUM) / ANR (FRANCE) / AEI (SPAIN)

Duration

3 years

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KEYWORDS

Water-climate interactions,
Water recycling and re-use,
Pollution (water, soil),
Waste disposal and treatment

MEGAWAT

Megadroughts in the water towers of Europe - from process understanding to strategies for management and adaptation

Abstract

Climate change is increasing the frequency of megadroughts, i.e. multi-year extreme droughts such as the dramatic decade-long drought that has hit central Chile since 2010, leading to a state of emergency and dramatic consequences for water resources, ecosystems and the economy. A surge of recent research has responded to the increase in extreme events worldwide, raising awareness of the major disruptions associated with them. Megadroughts are rare and much is still unknown about their drivers, future occurrence and impacts. Most recent research efforts have focused on identifying past events from a variety of paleo records, and understanding their broad climatic causes. The recent, satellite-era megadroughts and their impacts have been investigated only in lowlands, and little is known about their consequences in mountainous regions and about the role that the mountain cryosphere, and glaciers in particular, play in compensating for lack of rainfall and excess evapotranspiration. Europe has experienced megadroughts in the past, and is experiencing droughts and heatwaves with increasing frequency, as testified by the recent heatwaves and droughts of 2003, 2018 and 2022, each more amplified in their consequences than the one before.

The main goal of this project is twofold. First, we address fundamental gaps in our knowledge of the hydroclimatic causes of extreme droughts, to provide a new understanding of meteorological droughts and their impact on land-surface interactions and the water cycle of Europe's water towers, focusing on cascading and compound effects. Second, we develop and demonstrate new adaptation strategies to cope with the extreme length, extent and intensity of future megadroughts.

We focus on Europe's mountains and their downstream areas, and adopt a catchment/basin scale approach to identify megadrought impacts and seek fundamental solutions to water management. Europe's mountains represent its water towers, with the capacity to buffer droughts initially thanks to their storage of water in the form of snow, glaciers and permafrost. Once those storage elements have been substantially depleted however, as in a drought of increasing length, the system will reach a threshold, or tipping point, after which the droughts will be amplified and the functioning of the water-ecosystem is jeopardised.

We build on current research characterising megadroughts in mountain regions worldwide to identify extreme droughts that have happened in Europe in the instrumental period. We then use weather system and trajectory diagnostics to understand the atmospheric processes involved in such events, and use this novel understanding to develop new GCM future simulations that provide extreme drought storylines using ensemble resampling. We will downscale these scenarios to the very high spatio-temporal resolution needed for hydrological impact studies (e.g. 250 m, hourly) and create a novel open access database at Europe-wide scale. We will then use a state-of-the-art, hyper-resolution land-surface model to simulate the cryosphere-hydrosphere-biosphere response to the most extreme droughts of the instrumental past, and to future megadroughts across Europe. We will investigate how persistent precipitation anomalies are amplified as a function of catchment characteristics and memory, and identify the mountain dependent European regions most vulnerable to megadroughts. We will examine the role of glaciers and the mountain cryosphere in buffering extreme droughts and identify cryosphere-biosphere tipping points and thresholds. The new understanding of catchment response to climate anomalies will be used to develop stress-test scenarios for the European mountains under unprecedented, but plausible future drought conditions. Finally, we will provide innovative solution-based adaptation and water resources management strategies.

Our project responds to this timely call by addressing Topic 1 and 2.

Project coordinator: **Francesca PELLICCIOTTI**

INSTITUTE OF SCIENCE AND TECHNOLOGY AUSTRIA - AUSTRIA

Project partners

- CONSIGLIO NAZIONALE DELLE RICERCHE - ITALY
- EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZUERICH - SWITZERLAND
- FUTUREWATER SL - SPAIN
- SWISS FEDERAL INSTITUTE FOR FOREST, SNOW AND LANDSCAPE RESEARCH, WSL - SWITZERLAND
- UNIVERSITEIT UTRECHT THE - THE NETHERLANDS

Funding organisations

FWF (AUSTRIA) / SNSF (SWITZERLAND) / CDTI (SPAIN) / NWO (THE NETHERLANDS)

Duration

3 years

Contact

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KEYWORDS

Cryosphere, dynamics of snow and ice cover, sea ice, permafrost and ice sheets, Climatology and climate change, Mountain areas, Hydrology (Water science), Water resources

MEWS

Managing events and extremes in water supplies

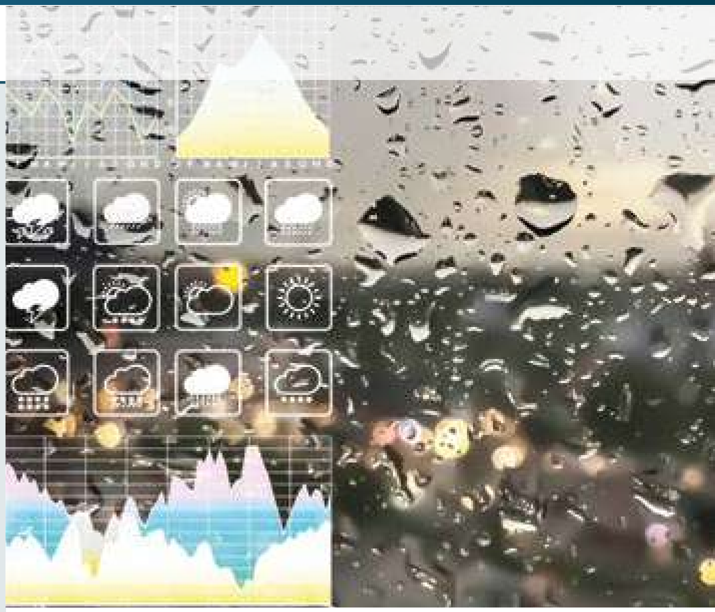
Water4All
Water security for the planet

Abstract

The increasing frequency of hydro-climatic extreme events poses serious risks to the quality and quantity of drinking water stored in the surface water supplies upon which the majority of Europeans depend. Extreme precipitation can add large inputs of nutrients and dissolved organic carbon (DOC) to a water supply, the effect of which depends on the load, the processing of materials and the time of transport to the location of water withdrawal. On the other hand, droughts and extreme lack of precipitation can both reduce water availability, and also water quality. In this case, the biogeochemical processes regulating materials already in a reservoir play a prominent role, as do the processes that regulate internal mixing and thermal structure. The final impact of extreme events on the water quality are regulated by the complex combined effects of watershed hydrology, reservoir hydrodynamics and biogeochemistry.

The goal of this project is to develop a freely available open source 3D reservoir modelling system that can simulate the longitudinal and lateral transport of nutrients and DOC that enter reservoirs and which can promote algal blooms and impact water quality.
Model simulations will increase knowledge of the complex regulation of the extreme events on drinking water quality, and how this may change in a future climate. Workshops with the stakeholders from 3 major water supplies in 3 different countries from 3 different climate zones that serve millions of consumers, will provide stakeholders with the knowledge and tools to better manage the impacts of hydro-climatic extreme events, both in terms of long-term planning and short-term event mitigation.

The project consortium includes European groups that have been involved in the forefront of lake and reservoir model development during the last 3-4 decades and have expertise in modelling complex hydrodynamics, algal blooms and DOC concentration and transport. The consortium also has extensive experience working with and within drinking water utilities.



Project coordinator: **Don PIERSON**

UPPSALA UNIVERSITET - SWEDEN

Project partners

- BOLDING & BRUGGEMAN APS - DENMARK
- CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS - FRANCE (SELF-FUNDED)
- HELMHOLTZ-ZENTRUM FUR UMWELTFORSCHUNG GMBH - UFZ - GERMANY
- ISRAEL OCEANOGRAPHIC AND LIMNOLOGICAL RESEARCH LIMITED - ISRAEL

Funding organisations

FORMAS (SWEDEN) / IFD (DENMARK) / BMBF (GERMANY) / MOE (ISRAEL)

Duration

3 years

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KEYWORDS

Climatology and climate change,
Water management,
Water-climate interactions,
Numerical analysis, simulation, optimisation, modelling tools

MORE4WATER

p. 21

Combined monitoring and forecast for a sustainable management of water resources and timely adaptation to drought

Water4All
Water security for the planet

Abstract

MORE4WATER project aims at developing a novel technology that uses efficient real-time monitoring for improving the forecast of water availability and, consequently, the management and governance strategies of water distribution and transmission networks (WNs) and irrigation systems (ISs).
The proposed technology will allow drastically reduce the impact of water drought and prepare for the next generation of WNs and ISs which must be more monitored, more controlled, more efficient, sustainable, and "smart".
The natural recipients of such innovation activities are the stakeholders.
Accordingly, the MORE4WATER project derives from four concerns. The first one is that a large part of freshwater is contained in groundwater and a much smaller part in freshwater lakes, with most of the freshwater (approximately 70%) used in irrigation systems. The second concern is that approximately half of the world's population is currently subject to severe water scarcity for at least some part of the year. The third one is that meteorological droughts (periods of persistent low precipitation) – one of the effects of climate change – exasperate deficits in the water supply. This leads to social tensions among potential users and calls upon public authorities and service operators to adopt delicate decisions concerning the allocation of resources involving both knowledge of highly complex technical data and socio-economic assessments. The fourth concern is the heterogeneity of the physical, political, and socio-economic contexts of the transboundary water resources which makes hard their management.
The strategy of the project to counter the above concerns is divided into four actions.
The first action is to tune "user-friendly" models for simulating and forecasting the water elevation in aquifers and lakes based on the combined use of global atmospheric datasets (reanalysis) and ground measurements executed by smart and distributed sensors. Such a model, called AQUILA, simulates the water table elevation of AQUIfers and the level of Lakes, focusing on the key regulating mechanisms: groundwater recharge for the former, and precipitation and evaporation for the latter. At the same time, a wireless sensor network capable of acquiring local ground measurements and monitoring WNs and ISs is developed.
The second action is to define innovative criteria for managing both WNs and ISs to ensure increasing available water in the long term. Such criteria, in the framework of the digital transition of such systems, address leakage reduction, pressure control, and energy efficiency within a comprehensive methodology. In particular, attention is focused on an appropriate leakage reduction strategy – and then the refinement of more efficient technologies – which is the most environmentally-friendly and cost-effective method for acquiring "new" water resources (or better not to waste a large part of the existing freshwater!).
Within the third action, applying the model for the monitoring and timely adaptation to drought may strongly enhance the implementation of the existing legal frameworks for the management and equitable sharing of transboundary water resources, including aquifers.
The fourth action includes proactive dissemination, communication, inter-sectorial collaboration, and exploitation of the project result. Accordingly, the proposal relates to Topics 1, 2, and 3.
All the consortium partners (University of Perugia, UNIPG, in Italy, Instituto de Telecomunicações, IT in Portugal, Universidade do Vale do Itajai, UNIVALI, in Brazil, ACEGASAPSAMGA, AAA, and TUCEP in Italy) have previous experience in projects linked to MORE4WATER project. Moreover, several activities demonstrate the consolidated academic and scientific collaboration between consortium partners.

Project coordinator: **Silvia MENICONI**
UNIVERSITÀ DEGLI STUDI DI PERUGIA - ITALY

Project partners

- ACEGASAPSAMGA - ITALY
- FUNDACAO UNIVERSIDADE DO VALE DO ITAJAI - BRAZIL
- INSTITUTO DE TELECOMUNICAÇÕES - PORTUGAL
- TUCEP – TIBER UMBRIA COMETT EDUCATION PROGRAMME - ITALY

Funding organisations

MUR (ITALY) / FAPESC (BRAZIL) / FCT (PORTUGAL)

Duration

3 years

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KEYWORDS

Water distribution,
Irrigation management,
Water-climate interactions,
Global and transnational governance,
international law, human rights,
In-Situ Instruments / sensors

NEWATER

Natural based and low Energy consumption unconventional solutions for the management of water sources

Water4All
Water security for the planet

Abstract

NeWater aims to develop innovative and efficient water systems for any representative EU region based on energy and cost-efficient hybrid biological, physical, and nature-based solutions and on digital technologies enabling system monitoring, control and decision support. To ensure the replication potential, the NeWater system validation will be carried out through 4 Water Labs representing different relevant areas (agricultural, rural, urban and industrial) in large-scale operational environments.

Therefore, the NeWater solutions will close the cycles of material, water, and energy at a regional level, thus reducing the current water and energy consumption. High efficiency in wastewater treatment plants (WWTP) will be attained (i.e. 90% in P recovery or 50% reduction of operation costs of WWTP)) and smart water services will be developed for the use of such recovered resources in relevant public and economic activities in the region:

- Lab 1 (UPORTO, PT): Explore the uniquely synergistic relationship between WWTPs and hydrogen production that is both positive for the environment and partially subsidise hydrogen production via electrolysis and increase its commercial viability (2€ per kg of H2; 'H2 under 2' goal): i) WWTPs supplies recycled water to hydrogen facility; ii) hydrogen facility sells oxygen to the WWTP. Oxygen will be used for ozone generation towards the advanced treatment of the ultrafiltration (UF)/reverse osmosis (RO) retentate streams generated during the production of recycled water with enough quality for PEM electrolysers.
- Lab 2 (BGU, IL): Advanced wastewater effluent desalination for ultrapure water for hydrogen production (Lab 1) and irrigation water for agriculture; activation of nanocomposite hydrochar produced from wastewater sludge for nutrient recovery from desalinated concentrate.
- Lab 3 (UNIBAS, IT): will be devoted to treat wastewater by the potentiality of natural material (e.i., clay, activated carbon, wood chips) acting as adsorbed for filtration treatment of contaminants at different operational conditions. Natural material used to purify water for agriculture water irrigation.
- Lab 4 (ICRA, ES): Decentralised NBS reclamation of greywater (kitchen and sink) for edible plant production by means of a vertical wall. Recovery of water, nutrients, energy reduction and local stakeholders' involvement (neighbourhood/citizens/city hall/questionnaires).

SAPIENZA will provide the key drivers to support the upscale and potential replicability of NeWater innovation based on E-LCA, LCC-A, CBA, s-LCA and eco-efficiency analysis; social innovation indicators will be set up with their related governance and legal frameworks to complete the market uptake strategies adapted to each of the key stakeholders' category outside the scope of the project.

The current proposal aims to develop innovative and efficient water systems for EU and no-EU regions based on energy and cost-efficient hybrid biological, physical, and nature-based solutions (NBS), interlinked technologies between partners. It also aims to develop new value chains and business models addressing new market opportunities derived from the innovative water system and related services and jobs in diverse sectors (water, agriculture, chemicals, or public services). As such, the proposal relates directly to the Call (Resilience, adaptation and mitigation to hydroclimatic extreme events) regarding Improved water availability and optimization of water quality and quantity for all uses in Europe while maintaining ecosystem needs (i.e., recovery of energy, nutrients, and reuse of wastewater for reuse and energy production).

Project coordinator: **Antonio ZUORRO**

SAPIENZA UNIVERSITÀ DI ROMA - ITALY

Project partners

- BEN GURION UNIVERSITY OF THE NEGEV - ISRAEL
- FUNDACIO INSTITUT CATALA DE RECERCA DE L'AIGUA - SPAIN
- UNIVERSITY OF PORTO - PORTUGAL
- UNIVERSITÀ DEGLI STUDI DELLA BASILICATA - ITALY

Funding organisations

MUR (ITALY) / MOE (ISRAEL) / AEI (SPAIN) / FCT (PORTUGAL)

Duration

3 years

Contact

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KEYWORDS

Waste water recycling,
Hydrogen,
Environmental sciences (social aspects)

PREVIR

Towards an early-warning tool predicting enteric virus contamination in coastal watersheds

Abstract

Enteric viruses arising from human sewage spill-over into water catchments represent a threat to human health through water-using food production or water-based recreational activities. Despite continuous efforts in wastewater treatment and microbiological monitoring of water bodies, viral contamination of food during production still occurs in Europe, with adverse health effects on consumers and economic consequences on food producers. Filtering large amounts of their growing waters, shellfish are both a food, and a sentinel of the microbial quality of their environment. Shellfish contamination by norovirus, an enteric virus, is indeed the most frequent setting in viral foodborne outbreaks in Europe and an important global problem as well. Importantly, while this contamination is known to be affected by rainfall, the exact impact of weather events, and especially extreme hydroclimatic events, is not known. Additionally, shellfish farmers and stakeholders using water for recreation require information to enable adaptation to the events.

Here, we aim at contributing to the safe and sustainable use of water, especially for shellfish production, by

I. acquiring new knowledge of the viral contamination in catchments, and

II. co-developing an early-warning tool helping end-users to mitigate the impact of this contamination upon extreme hydroclimatic events.

b) Indeed, although water quality and quantity are known to affect the transport or persistence of infectious enteric viruses, the impact of extreme hydroclimatic events on the viral contamination of watersheds is not well understood. Thus, we identified key scientific and technological questions that were only partially addressed by previous studies. How do floods and droughts alter the dynamics, diversity, and infectivity of enteric viruses in water catchments up to shellfish beds? Can the contamination of shellfish be predicted from water quality, meteorological or other parameters, under normal conditions and during extreme events? Finally, how does this translate to an infectious risk? By answering these questions, we will generate new knowledge that we will use to develop process-based and machine-learning models of viral contamination and viral infectious risk in shellfish and coastal waters. Through contacts already established with stakeholders and the organization of dedicated workshops in multiple countries, we will co-construct an early-warning tool answering the needs of European end-users.

c) The project addresses the second topic of the call "Tools for water management – in the context of hydroclimatic extreme events", by developing an early-warning, decision-support tool, based on new data and risk models, that will help the shellfish industry and coastal communities to enforce mitigation measures against contamination by enteric viruses. It adopts a catchment-to-sea perspective, necessary for this anthropogenic contamination diffusing from land to sea through watersheds. It will focus on the impact of floods, storms and droughts to ensure adequate adaptation of the mitigation strategies to climate change and increasing frequencies of these extreme events. Moreover, through building new models and using advanced computing technologies like neural networks, it will also contribute to smartening the water system. Our trans-European consortium gathers complementary expertise in environmental virology, virus epidemiology, water quality and modeling, that will be enriched through our contacts with stakeholders, to contribute to the management of the water resource contamination by enteric viruses.»

Project coordinator: **Marion DESDOUITS**

INSTITUT FRANCAIS DE RECHERCHE POUR L'EXPLOITATION DE LA MER - FRANCE

Project partners

- BIOCEANOR - FRANCE
- ERASMUS UNIVERSITAIR MEDISCH CENTRUM ROTTERDAM - THE NETHERLANDS
- ECOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE - SWITZERLAND
- MARINE INSTITUTE - IRELAND

Funding organisations

ANR (FRANCE) / NWO (THE NETHERLANDS) / SNSF (SWITZERLAND) / EPA (IRELAND)

Duration

3 years

Contact

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KEYWORDS

Viruses,
Biological systems analysis, modelling and simulation,
Microbiology,
Water quality monitoring

RESCUE

Resources in coastal groundwater under hydroclimatic extremes

Water4All
Water security for the planet

Abstract

Freshwater resources in coastal regions are under enormous stress due to population growth, pollution and climate change. The last years of extended drought have suddenly left several European coastal regions with protracted water shortages.
The RESCUE project aims to use research and innovation to improve water security in these regions, by applying novel physical and numerical workflows to identify freshwater resources in previously unexplored coastal deep and offshore aquifers. These aquifers could provide a crucial strategic resource for freshwater at times of increased need.
Our rationale is rooted in recent scientific research undertaken by the project partners, which have highlighted that deep (>400m to few km) onshore aquifers, and their offshore extensions, can potentially provide additional water for human consumption, farming and industrial uses, as well as representing a significant cost-saving input to desalination. The overarching strategic aim of RESCUE is to build knowledge of deep, onshore and offshore low salinity aquifers in European coastal areas, in order to evaluate novel water resources and help secure a steady supply of water to both population and industry in times of hydroclimatic extremes.
We will achieve our objectives by combining academic expertise in offshore groundwater, hydrogeology, geophysics, resources, big data science, outreach and public engagement, with applied industry know-how in deep freshwater resources exploitation and its socio-economical aspects.

RESCUE will work on existing geological, hydrogeological and geophysical databases, with the innovative contribution of Oil & Gas data and new geodata acquisition, to build new large-scale models for deep and offshore water resources in the target European Mediterranean coastal regions. Further data will arise from engagement with stakeholders and citizens. Supercomputing capabilities allow integration of physical data analysis with digital solutions, testing the limits of large-scale modelling on UK databases. Finally, we will perform cost-benefit and sustainability analysis of extracting these resources, while our outreach team will engage stakeholders and analyse public perception of potential follow-up exploitation projects. This project will benefit from complementary activities and synergies with the EU COST Actions (OFF-SOURCE), UK EPSRC IAA and GCRF grants, EU JPI Oceans and grant CASE NO. 19/3720 (Norwegian Ministry of Foreign Affairs) in which the RESCUE partners are currently involved.

The RESCUE project is relevant to:

- Topic 1-Resilience, adaptation and mitigation to hydroclimatic extreme events, subtopic 1.2-Developing and demonstrating innovative (or improved) societally acceptable adaptation and mitigation strategies to cope with hydro-climatic extreme events and their increase in length and duration; and
- Topic 2-Tools for water management - in the context of hydroclimatic extreme events, subtopic 2.2-Generating new methodologies, tools and models for water resources assessment/modelling.The project addresses the Theme III field of interest within the SRIA of Water4All: Water for the future: Sustainable water management; and the cross-cutting issue 6: International cooperation.

Success in addressing these themes will be facilitated through the following enablers: The digital revolution (big data, remote Earth observation); Existing/future research infrastructures; Technologies enabling more efficient water management; Changes in people's awareness and vision towards natural resources.

Our results and globally applicable workflows will ultimately support policy makers to develop novel strategies to counteract the effects of increasingly frequent climatic extremes, such as prolonged dry spells, which are expected to intensify in upcoming decades. Our universal approach will have applicability both in developed and developing nations, thus also supporting the implementation of the UN SDG 6: Clean water and sanitation.

Project coordinator: **Michele PIPAN**
UNIVERSITÀ DEGLI STUDI DI TRIESTE - ITALY

Project partners

- ISTITUTO NAZIONALE DI OCEANOGRAFIA E DI GEOFISICA SPERIMENTALE - ITALY
- L-UNIVERSITA' TA' MALTA - MALTA
- RUDEN AS - NORWAY
- UNIVERSITY OF DERBY - UNITED KINGDOM

Funding organisations

MUR (ITALY) / MEEE (MALTA) / RCN (NORWAY) / EPSRC UKRI (UNITED KINGDOM)

Duration

3 years

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KEYWORDS

Water resources,
Hydrology (Water science),
Natural resources exploration and exploitation,
Environment, resources and sustainability

SMARTWATER4FUTURE

Coupled urban-rural water infrastructure management under hydroclimatic extremes with decision support system

Water4All
Water security for the planet

Abstract

a) General objectives:
We aim to develop new and improved tools for risk assessment, integrated modeling of flooding from urban drainage systems coupled with river catchment and recipients (rivers, lakes, wetland and sea) under Hydroclimate extremes, supported by historical data and on-site monitoring instant data. Sustainable Life Cycle Assessment (LCA), providing holistic decision support toolkit to help water utilities to manage the water and wastewater systems for safe distribution, collect and treatment of water and wastewater from inlet to recipient in regard to the water quantity and quality under the extreme stressors such as intense precipitation and huge temperature variations.

b) Scientific and/or technological aims:

- 1 - To establish an extensive database with historical data, predicted meteorological data of future scenarios, and high-resolution data for regional and global climate change and definition of hydroclimatic extreme events. Thus improving resilience and adaptation capacity of water infrastructure (e.g., industrial water facilities, urban networks, wastewater treatment facilities, stormwater management systems and rural systems) to hydroclimatic extreme events.
- 2 - Development of methodology for quantification of ecosystem services of wetlands with respect to hydrological functions, including hydrological modeling and LCA analysis of the coupled urban-rural water regime provided for both normal operation, extreme events (floods and droughts), and different future climate projection scenarios with ecosystem services incorporated.
- 3 - Development of a smart water management and decision support system for future urban-rural water management under the challenges of climate change/variability and intensified extreme hydroclimatic events.

c) Relevance to the call: The project SmartWater4Future will address the call Topic 2. Tools for water management - in the context of hydroclimatic extreme events, targeting on floods, droughts and water pollution risks. Specifically:

- Subtopic 1.3 Improving resilience and adaptation capacity of water infrastructure (e.g., industrial water facilities, urban networks, wastewater treatment facilities, stormwater management systems and rural systems) to hydroclimatic extreme events.
- Subtopic 2.1 Developing tools (e.g., multi-risk approach, decision support tools, monetary/non- monetary costs valuation) to support the design and implementation of strategies for adaptation and mitigation to hydro-climatic extreme events, especially floods (including "flash-floods"), heat waves and droughts in a catchment to sea perspective.
- Subtopic 2.3 "Smartening the water system" and use of innovative digitalization, including improved/new sensors, models, communications and computing technologies.

Project coordinator: **Ronny BERNDTSSON**

LUNDS UNIVERSITET - SWEDEN

Project partners

- EIDGENOESSISCHE TECHNISCHE HOCHSCHULE ZUERICH - SWITZERLAND
- KONYA TEKNIK UNIVERSITESI - TURKEY
- STIFTELSE CSDI WATERTECH - NORWAY
- ULUDAG CEVRE TEKNOLOJILERI ARGE MERKEZI SANAYI VE TICARET LIMITED SIRKETI - TURKEY
- UIT THE ARCTIC UNIVERSITY OF NORWAY - NORWAY

Funding organisations

FORMAS (SWEDEN) / SNSF (SWITZERLAND) / NCBR (TURKEY) / RCN (NORWAY)

Duration

3 years

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KEYWORDS

Integrated management of water,
River hydrology,
Urban water management,
Water-climate interactions

SPRINGINESS

Management of rainwater runoff in urban areas for tackling extreme hydroclimatic events

Abstract

SPRINGINESS will improve and ease the application of blue-green infrastructure (BGI) to manage extreme hydroclimatic events and to provide safe water source for reuse from rainwater.

The project will provide key know-how for the design and implementation of BGI (supplemented with physical-chemical treatment if needed), for mitigating sewer overloading, environment pollution and for boosting water reuse within an urban area.

The aim of the project is to develop tools to manage stormwater retention and reuse, to overcome climate-change-related water instabilities in urban space using BGI with a university campus as an implementation area. This will be achieved using an innovative approach combining the evaluation of human exposure routes, and the application of hydrological model and modelling of water management (STORM model) upgraded with a new module for proxy contaminants of rainwater. In close collaboration between researchers and water sector professionals a new strategy for the application of BGI in urban areas for rainwater management will be offered.

The project will address the call topics by proposing BGI-based solutions for water retention and its safe reuse within the urban landscape and the protection of the environment and the sewer system against extreme hydroclimatic events, by proposing models for safe rainwater management using BGI and upgrading existing models (STORM) with new modules, and finally by providing guidelines for the design, application and funding (in CZ, PL, PT and D) for BGI for rainwater management.

Project coordinator: **Tereza HNATKOVA**

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE - CZECHIA

Project partners

- INGENIEURGESELLSCHAFT PROF. DR. SIEKER MBH - GERMANY
- IPR AQUA, S.R.O. - CZECHIA
- UNIVERSIDADE DO PORTO - PORTUGAL
- UNIVERSITY OF LODZ - POLAND

Funding organisations

TACR (CZECHIA) / BMBF (GERMANY) / FCT (PORTUGAL) / NCBR (POLAND)

Duration

3 years

Contact

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KEYWORDS

Urban water management,
Hydrology (Water science),
Hydrology,
water and soil pollution,
WWS Water and waste systems

STARDUST

Ultra-sensitive optical sensor system for simultaneous, in-situ detection of multiple pesticides in surface and ground waters

Water4All
Water security for the planet

Abstract

Hydro-climatic extremes, such as droughts and floods, have increased due to climate change and could lead to severe impacts on socio-economic, structural, and environmental sectors.
Soil water assessment models have shown that pesticides are transported into waterways because of intense rainfall events. Current monitoring methods are not suited to the detection of such water quality impacts, which can deplete invertebrate populations and impact biodiversity and ecosystem health very rapidly. Many surface- and groundwaters are used as sources of drinking water, and therefore the occurrence of chemicals is problematic for water treatment facilities. Rapid, real-time sensing technologies do not exist yet but are urgently needed to address this. In October 2022 revisions to the priority pollutant Annex to the Water Framework Directive (WFD), saw the addition of noenicitinoid and pyrethroid pesticides, showing that pesticides are of growing concern.
The STARDUST project aims to develop a first-of-its-kind, integrated optical system combined with smart spectral data processing methodology, for multiplexed monitoring of pesticides in surface and ground waters, and to understand the impact of extreme hydroclimatic events on water quality in the context of pesticides occurrence.
We will develop a sensor based on surface-enhanced Raman spectroscopy fully integrated with microfluidics targeting the detection of pesticides, pesticide mixtures, and metabolites in surface and ground waters. Secondly, we will use rainfall forecasts to identify sampling times for passive sampling and citizen scientist co-created events, to gather samples that are specifically linked to rainfall events. This will build on existing monitoring programmes, but, more critically, will identify the climate-related water quality impacts. The results of passive sampling will identify target pesticide compounds to be addressed with the developed novel sensor and a database of detected pesticides will be compiled and shared publicly.

The STARDUST project translates several technological advances into an innovative solution for discrimination between safe and contaminated water continuously and in real time. We envision that in the long run, any strategies for mitigation of the hydro-climatic extreme events will need to rely on digitalization and sensors. The proposed activities will benefit a wide range of "problem owners" and society by responding to the need for continuously clean water (SDG 6). Pesticide detection is only one of the existing problems. The proposed solution is also applicable to other harmful compounds adding value and impact.

STARDUST primarily targets the topic 2 of the call by proposing physical and digital solutions for "smartening the water system", but also contributes to the topic 1 as the development will be carried out in the context of adaptation and mitigation strategies to cope with hydro-climatic extreme events, and both experts on the analysis of surface and ground waters are involved.

Project coordinator:

Karolina MILENKO-KUSZEWSKA
SINTEF AS - NORWAY

Project partners

- DUBLIN CITY UNIVERSITY - IRELAND
- INSTITUTUL NATIONAL DE CERCETARE DEZVOLTARE PENTRU FIZICA MATERIALELOR - ROMANIA
- INSTYTUT CHEMII FIZYCZNEJ POLSKIEJ AKADEMII NAUK - POLAND
- NATIONAL INSTITUTE FOR RESEARCH AND DEVELOPMENT IN MICROTECHNOLOGIES - ROMANIA
- TECHNICAL UNIVERSITY OF DENMARK - DENMARK

Funding organisations

RCN (NORWAY) / EPA (IRELAND) / UEFISCDI (ROMANIA) / NCBR (POLAND) / IFD (DENMARK)

Duration

3 years

Contact

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KEYWORDS

Optical sensors, Hydrology,
water and soil pollution,
Microfluidics,
Spectroscopic and spectrometric techniques,
Integrated management of water

SWMOF

A smart process for water harvesting from air and water distribution based on eco-friendly MOFs

Water4All
Water security for the planet

Abstract

The climate change prospects for the Mediterranean region points towards a general rise in temperature with more and longer periods of higher temperatures. Furthermore, changes in precipitation and distribution of water are expected. Indeed, the Mediterranean is one of the most vulnerable regions to climate change and is predicted to become even warmer and drier than it already is. Forecasts indicate a Mediterranean temperature will increase between 2 to 4ºC and a decrease in rainfall between 4% to 30% by 2050. In the Mediterranean region, more than 70% of water resources are used for agriculture.

The Mediterranean area is composed mainly by scattered small villages, where the conditions of water availability and distributions are poorly efficient. Water distribution systems in small villages typically have higher rates of water losses (around 5% or 10% higher) than big cities. The main reason is that the lower concentration of population makes water loss interventions less efficient. Hence, it is urgent to take actions to preserve the water availability and to optimize the water distribution in those regions.

At a planning level, reducing water losses will contribute to reduce or stabilize future water withdrawals and therefore guarantee water supply partially. For this means, recent technology breakthroughs such as the Internet of Things and Artificial Intelligence (AI) can allow achieving higher standard of efficiency on water distribution systems.

Thus, one of our objectives is to apply the cutting-edge developments on control system, real-time optimization and AI on the water distribution system in order to operate it close to the optimal while integrating efficiently water harvesting technology, as here proposed, into the distribution system.
One pillar of this work is the development of a smart water distribution system to optimize the water distribution and do real-time prediction of the water demand in accordance with the local requirements; also, able to recognize abnormal consumption and problems.

On the other hand, Mediterranean water resources are limited and often of low quality, fragile and unevenly distributed in space and time.
Access to safe drinking water is one of the United Nations "Millennium Development Goals". Most approaches for generating new sources of fresh water focus on desalination techniques. Even though it is expected that shortage of surface and/or groundwater will increase with extension of arid regions, where often considerable amounts of water are present in the air that can be utilized as an alternative drinking water resource.

The possibility to extract water from air has been known since ancient times. Cost effective adsorption of atmospheric moisture and low dependency on ambient relative humidity and temperature must be the breakthrough characteristics of an effective technology enabling the utilization of this invaluable water resource.

Therefore, the other pillar of this work is the development of the mentioned water adsorption technology to produce water from the air moisture through eco-friendly adsorbent and energy-integrated process design. Indeed, our second objective is to develop an innovative concept to extract water from atmospheric air by adsorption processes, harvesting the recent developments in porous material science, and integrate it in the water supply systems, as main or complementary water source.

Project coordinator:

Alexandre Filipe PORFÍRIO FERREIRA
UNIVERSIDADE DO PORTO - PORTUGAL

Project partners

- CHRISTIAN-ALBRECHTS-UNIVERSITAET ZU KIEL - GERMANY
- EINDHOVEN UNIVERSITY OF TECHNOLOGY - THE NETHERLANDS
- NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU - NORWAY
- UNIVERSIDADE FEDERAL DA BAHIA - BRAZIL
- UNIVERSIDADE NOVA DE LISBOA - PORTUGAL

Funding organisations

FCT (PORTUGAL) / BMBF (GERMANY) / RCN (NORWAY) / NWO (THE NETHERLANDS) / FAPESB (BRAZIL)

Duration

3 years

Contact

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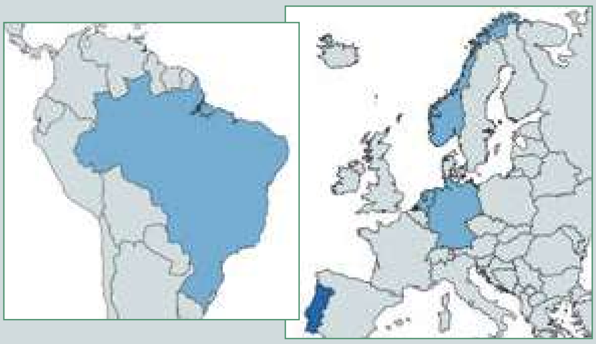

KEYWORDS

Water distribution,
SMA Smart maintenance systems,
Water harvesting,
Water supply

TREASURE

Treasuring groundwater and reclaimed water for drought adaptation

Water4All
Water security for the planet

Abstract

Drought may not be as visible as flooding but, as a natural hazard, it contributes to several risks that persist over long periods of time affecting social and economic development and causing profound environmental changes. This project addresses droughts as a current and an emerging challenge, from the hydrological, environmental and governance perspectives.

The concept of the project TREASURE is to minimize the effect of water scarcity under drought conditions by properly allocating groundwater and reclaimed water resources. Allocation will be determined by a sound hydrological knowledge of the system that will serve to test adaptation actions deriving from participated and inclusive governance activities. Artificial Intelligence (AI) models are proposed as promising tools to inform agents, stakeholders, and general citizenship on the actual state of the system and test the suitability of the proposed actions.

Our goal is to evaluate the potential of groundwater and reclaimed water sources as management alternatives to minimize drought impacts on both human water supply and environmental functions. It intends to fully incorporate both water sources into the water cycle while considering the hydrological idiosyncrasy of each basin, their drought record (past and future) and their overall water needs, whether human or environmental, managed though a well-documented governance project. In this sense, it proposes drought management based on data-driven models (AI) that value these alternative water sources and interrelate all the aquatic compartments: rivers, aquifers, wetlands, plus treated wastewater resources while reducing the effects of droughts and increasing water security.

As its relevance to the call, our project will deliver knowledge, models, and social involvement to efficiently face the challenge of managing water resources under drought or water scarcity scenarios. Adaptation actions will emphasize the potential of groundwater and reclaimed water to achieve a sustainable development (Topic 1). Also relevant, governance will be explored as a means to enhance the society capability to fulfil its water demand in the context of future drought events (Topic 3), yet the final decision-making capacity must rely on a sound knowledge on the overall water cycle. Data-driven models, developed by AI, contribute to this understanding, and they will be fostered as a computing technology and a digital solution to support decision-making processes (Topic 2). The novelty of this proposal lies then in the recognition of the critical role that groundwater and reclaimed water can play on mitigating the effects of droughts, and in the use of AI methods to solve the puzzle of water management under water scarcity conditions.

Transnationality among partners from Spain, Italy, Portugal and Brazil includes diverse hydrological and socio-economic idiosyncrasies under similar hydro-climatic event threats. This is taken as an opportunity to compare data and experiences, and to test the expertise of each partner to contribute to the management of water resources and it adaptation the future critical scenarios.

Project coordinator: **Josep MAS-PLA**

FUNDACIO INSTITUT CATALA DE RECERCA DE L'AIGUA - SPAIN

Project partners

- FUNDACAO UNIVERSIDADE DO ESTADO DESC UDESC - UNIVERSIDADE DO ESTADO DE SANTA CATARINA - BRAZIL
- UNIVERSITAT DE GIRONA - SPAIN
- UNIVERSITÀ POLITECNICA DELLE MARCHE - ITALY

Funding organisations

AEI (SPAIN) / FAPESC (BRAZIL) / MUR (ITALY)

Duration

3 years

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KEYWORDS

Water cycle,
Water management,
Artificial intelligence,
Environmental stressors

TWIN-WATERS

Digital tools for sustainable water resources management: integrating impact of climate change, land use, and optimised solutions

Water4All
Water security for the planet

Abstract

Global warming induced by anthropogenic climate change has intensified the hydrological cycle and water quality challenges and the resulting extreme climatic events bring considerable impacts on both societies and ecosystems.
These challenges include pollution entering our aquatic environments, such as rivers and lakes, from urbanized and agricultural environments leading to increased eutrophication, harmful algal blooms, and high pathogen loads.
Consequently, such challenges negatively impact on our drinking water supplies, ecosystem services and, ultimately, human health and well-being.

Through our consortium, we will bring together cutting-edge knowledge and technology development to inspire, smarten and digitise our water management approaches across Europe and more globally.
Our consortium partners bring state-of-the-art digitalisation in the water industry, advanced water quality sensing and monitoring, risk warning and advanced computation with AI and machine learning combined with process-based modelling.

Our aim is to develop new digital tools for sustainable management of water resources by integrating the impact of climate change, land use, and optimised solutions with receiving waters, transforming our water management approach at a landscape scale.
In particular we will advance the application of urban flood control, 3D technology applications, advanced sensor development and process-based modelling, citizen science engagement and the use of AI for water quality prediction.

Twin-Waters targets Topic 2 in Water4All call to smarten our water system by developing practical tools and models with a combination of lab experiments and digital innovations.

Project coordinator: **Jing LI**
LUND UNIVERSITY - SWEDEN

Project partners

- UNIWERSYTET PRZYRODNICZY WE WROCLAWIU - POLAND
- UNIVERSITY OF THE WEST OF ENGLAND, BRISTOL - UNITED KINGDOM

Funding organisations

FORMAS (SWEDEN) / NCBR (POLAND) / EPSRC UKRI (UNITED KINGDOM)

Duration

3 years

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KEYWORDS

Digital tools, Microbial risk, Toxic algal blooms, Sensor, Satellite service for water quality monitoring, Open-source microscope, Water resources management, Freshwater ecology

WAMA-WADIT

Water management and adaption based on watershed digital twins

Water4All
Water security for the planet

Abstract

In this proposal, we aim to study and understand the effect that climate extremes (droughts and floods, under current and climate change conditions) have on the behaviour of water management systems, to develop optimized management strategies and operation rules that minimize the effects of climate extreme and of climate change, and that maximize water security. The knowledge and understanding gained will be used to create a watershed digital twin, that may be applied to different watersheds with different conflictual water-related problems. A guide detailing the process required to build digital twins for specific watershed and problems will also be published.

Our proposal, thus, pursues three main objectives: one related to the generation of knowledge, the scientific objective, whose main aim is to advance the knowledge in the climate, hydrological and water management fields; another one focused on technological transfer, the practical objective, whose main aim is to translate the most up-to-date scientific knowledge to the terms used by decision makers, practitioners and managers; and a third objective aiming at developing a tool, the product objective, that provides an easy application of the methodology developed.

Our main scientific objective is to improve the understanding of the effects that drought and floods have on the operation of water management systems (specifically on single and multi-reservoir systems), and how optimal management strategies may mitigate the effect of such extremes. This objective will require that we tackle more specific objectives related to the characterization of climate, hydrology, and reservoirs, the most relevant of which are:

- 1. Analyzing systematic errors on climate and hydrologic predictions
- 2. Including more complete groundwater dynamics models, coupled to the surface hydrology ones
- 3. Incorporate more complex snow dynamics into hydrological modeling, especially over complex systems, as the Mediterranean mountain areas
- 4. Assess the effect that long-term forecasts and projections of extreme events may have on the operation of reservoir management, and how operation rules may be used as anticipatory and adaptation measures to reduce natural hazard and climate change impacts on water management, with a focus on extreme events.

Our proposal tackles issues in topics 1 and 2 of the call.

In topic 1, resilience, adaptation and mitigation to hydroclimatic extreme events, this proposal addresses the three subtopics. We aim at providing answers for knowledge gaps, like including a better error treatment for generating hydrological projections, as well as to better incorporate uncertainty. We also will explore better ways to capture the interaction between surface and groundwater hydrological flows, and to better incorporate snow dynamics. We will consider how to incorporate climate change projections in all these topics (point 1.1). We also aim to develop a methodology that will help end-users to design digital twins where adaptation scenarios, as well as short-term and seasonal forecasts, can be tested and quantified to select optimal strategies (point 1.2). The tool that we will develop will serve to improve the resilience and adaptation capacity of water infrastructure (point 1.3).

In topic 2, tools for water management - in the context of hydroclimatic extreme events, we are proposing to create a methodology and a free and open-source software tool to quantify and evaluate risk, short-term operational decision making and long-term adaptation actions, including hydroclimatic extreme events (point 2.1). The methodology and software tool would also allow to analyze scarcely monitored areas, complementing the lack of information with plausible scenarios, and communicating uncertainties in a robust way (point 2.2).

Project coordinator: **Manuel DEL JESUS PEÑIL**

FUNDACIÓN INSTITUTO DE HIDRÁULICA AMBIENTAL DE CANTABRIA / UNIVERSIDAD DE CANTABRIA- SPAIN

Project partners

- ANTEA FRANCE - FRANCE
- BUREAU DE RECHERCHES GEOLOGIQUES ET MINIERES - FRANCE
- INSTITUT POLYTECHNIQUE DE GRENOBLE - FRANCE
- UNIVERSIDAD DE CÓRDOBA - SPAIN
- UNIVERSITY OF BRISTOL - UNITED KINGDOM
- UNIVERSITÀ' DEGLI STUDI DI TRENTO - ITALY

Funding organisations

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WATER-BIOFIL

Next-generation biodegradable filters for water purification and desalination

Water4All
Water security for the planet

Abstract

Water is the most abundant and indispensable resource on our planet. However, freshwater distribution is very different from region to region, which brings with it a very problematic scenario for drinking water availability, especially following hydro-climatic extreme events.

One viable and low-cost solution to provide direct access to drinking water, refers to implementing Point-Of-Use (POU) systems for water purification and desalination. Yet, before doing so, the issues identified by end-users/ consumers regarding filters disposal and recycling should be properly addressed.

Thereby, the aim of the WATER-BIOFIL project proposal is to design & assemble & test next generation compostable filters, prepared from biodegradable polymers and/or bio-sourced polymers, which can be thereafter integrated in regular POU systems, and further serve their purpose as first-aid tools to cope with hydro-climatic extreme events, while diminishing the environmental impact of hazardous materials.

Considering the proposed aim of the project and the transdisciplinary character of the foreseen activities, the project consortium is joining three renowned RDI entities, from Romania, France and Poland, with expertise in materials science and functional biomaterials (as technology developers), and other three SMEs from Romania, France and Poland (as technology integrators), with expertise on water purification and waste management.

The six Partners are developing complementary activities according to their expertise and skills to ensure further development and/or build-up a multidisciplinary knowledge in a long-term perspective innovation, value creation and assistance in solving societal challenges. The project proposal addresses the required Polish, French, Romanian and EU impacts, with respect to the objectives of WATER4ALL, on ensuring water security for all and reducing environmental hazards.

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Project partners

- ADAM MICKIEWICZ UNIVERSITY - POLAND
- EDAS EXIM SRL - ROMANIA
- MARINE TECH S.A.S - FRANCE
- PRESSEKO SPÓŁKA Z O. O. - POLAND
- UNIVERSITE DE TOULON - FRANCE

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Drinking water treatment, Water scarcity management, Bioremediation, biodegradation,
Bioproducts (products that are manufactured using biological material as feedstock) biomaterials, bioplastics, biofuels, bioderived bulk and fine chemicals, bio-derived novel materials, Chemical engineering

WATERGREENTREAT

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A green approach in the frame of circular economy: robocasted photocatalysts for wastewater treatment and use of reclaimed water in agriculture

Water4All
Water security for the planet

Abstract

The aim of this proposal consists in the obtaining macroporous photocatalysts based on ecogenic metal oxides (ecoMO) (ZnO/CuO) composites through the robocasting technique, but also the evaluation the synergistic effect induced by the presence of microalgae in the removal of specific pollutants for wastewater treatment and the use of regenerated water in agriculture.

The main objectives of the project are the following:

I. green synthesis of photo-catalysts based on metal oxides (ZnO, CuO) nanoparticles (NPs),
II. 3D-printing structures based on ecogenic metal oxides by robocasting,
III. the use of the obtained 3D photocatalytic structures based on metal oxides NPs to remove contaminants such as antibiotics or dyes from the wastewater generated by pharmaceutical/textile industry,
IV. the use of the microalgae to reduce the pollutant species generated during the photocatalysis process, and (v) the assessment of the synergistic effect induced by the 3D photocatalytic structures and microalgae at laboratory/semi-industrial/greenhouse level on synthetic wastewater (by adding drugs/dyes) and in real wastewater (treatment plants).

This project has the following specific objectives:

- 1) Phytosynthesis and characterization of metal oxide, metallic NPs and their composites.
- 2) The use of ecoMO to treat, in laboratory, various synthetic wastewaters (containing organic dyes, drugs, etc.).
- 3) In vitro biological investigations [cytotoxicity evaluation by acute and chronic Aliivibrio fischeri assays (ISO 11348), acute algae (OECD 201) and Daphnia (OECD 202), and zebrafish embryo toxicity assay (OECD 236)]; and the ecoMO bio-impact on terrestrial and aquatic media will be tested.
- 4) The synthetic/real wastewaters (before and after the treatment with robocasted photocatalysts based on ecoMO composites) will be tested as follows: (i) in vivo on plants grown in the greenhouse (didactic and scientific research resort); (ii) in vitro on Aliivibrio fischeri for acute cytotoxicity (ISO 11348 standard) and for chronic toxicity in a high throughput assay adapted to microplates; Daphnia acute tests; and acute toxicity measurement on zebrafish eggs for wastewater qualification (ISO 15088).
- 5) Evaluation of the detoxification efficiency of different composite samples based on ecological metal oxide (ecoMO) nanoparticles and their robocasted photocatalysts by microalgae culture in a treated wastewater environment, but also of the synergistic effect induced by the presence of microalgae on the ecological composite of metal oxide nanoparticles or their robocasted photocatalysts based on ecoMO composites for the removal of certain pollutants.

Upon our knowledge, there are no reports regarding robocasted photocatalysts based on ecoMO composites (ZnO/CuO). In the frame of circular economy, it is necessary to identify and develop efficient technologies for treatment of the residual waters generated by pharmaceutical, textile, etc. industries in order to use the reclaimed water for agriculture. The elimination of the pharmaceutically active compounds (PhACs) and dyes from water generated from pharmaceutical and textile industry is vital for using the reclaimed water in other fields such as agriculture. Thus, reclaimed water obtained through a synergistic effect induced by 3D-printed photocatalytic structures and microalgae can be used in agriculture activities. Moreover, taking into account that the increase of periods with high temperature has the direct effect of decreasing the flow of surface water, which also influences the flow of shallow underground water, the population can be constrains to reduce the crop irrigation. This impediment can be mitigated by reusing treated wastewater in agriculture. Consequently, the outcome of our proposal can improve the resilience and adaptation capacity of wastewater treatment facilities within the frame of hydroclimatic extreme events.

Project coordinator: **Irina-Ionela ZGURA**

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Project partners

- CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS - FRANCE
- MAGYAR AGRAR- ES ELETTUDOMANYI EGYETEM - HUNGARY
- UNIVERSIDAD DE EXTREMADURA - SPAIN
- UNIVERSITATEA DIN BUCURESTI - ROMANIA

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DISCLAIMER

This output reflects the views only of the authors of the RDI projects, and the European Commission cannot be held responsible for any use that may be made of the information contained therein.

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