MOTREM: Integrated Processes for MOnitoring and TReatment of EMerging Contaminants for Water Reuse

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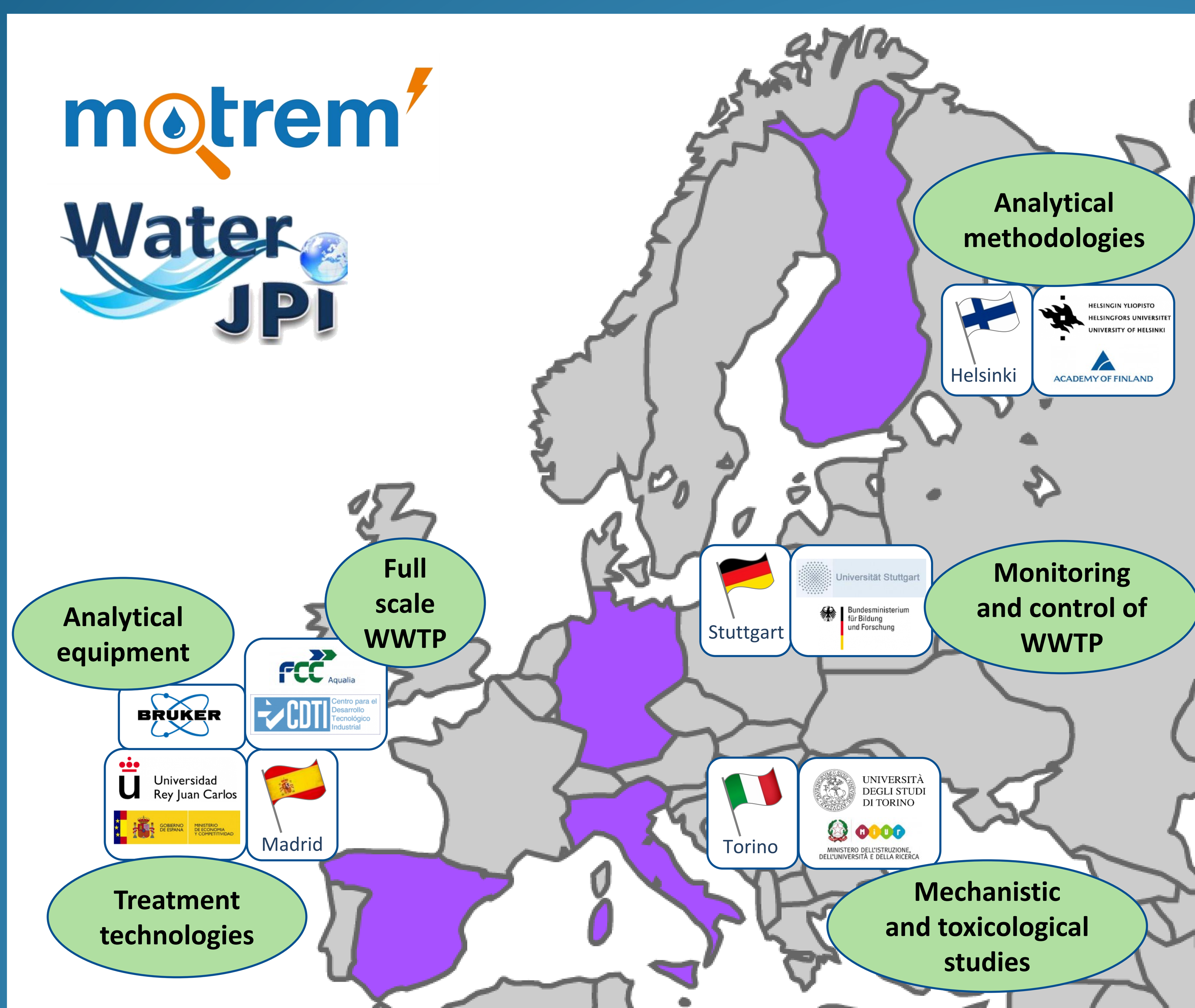
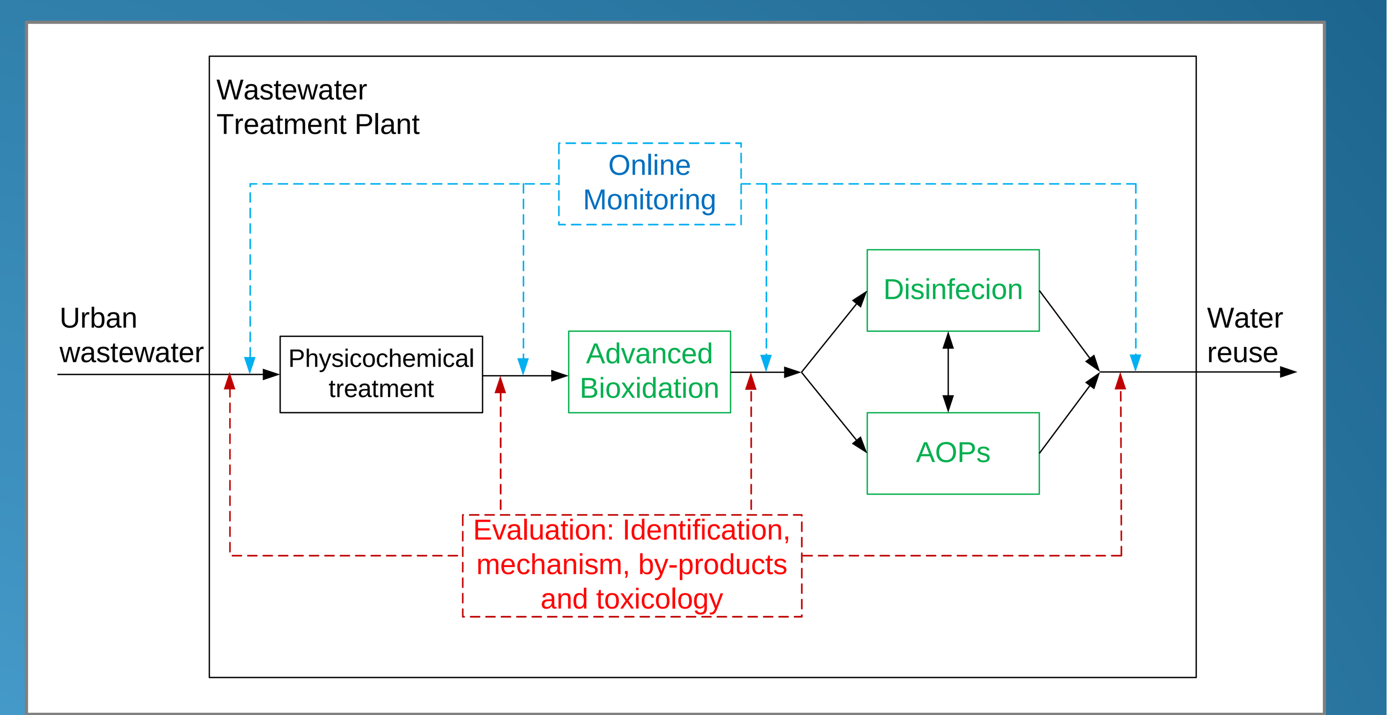
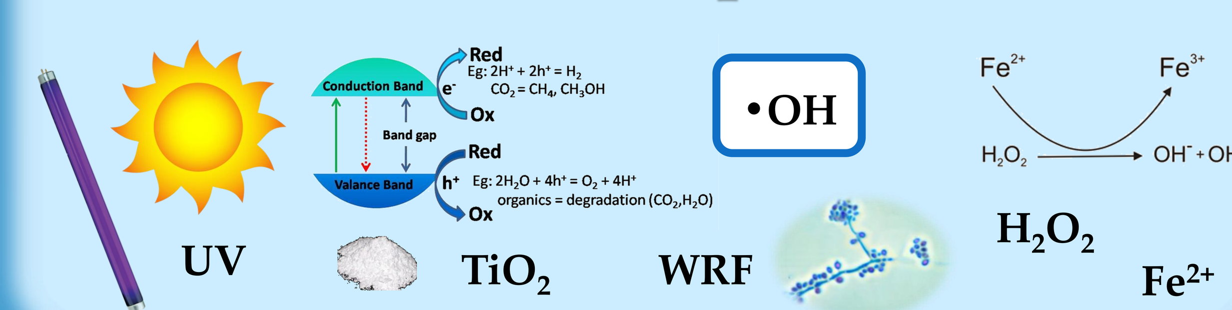
Consortium & Expertise



Conceptual Diagram



New treatment processes



New monitoring strategies

ECs selection

Sampling WWTPs

Influent parameters	Tortosa	Mérida	Benquerencia
Population equivalent, PE	50000 (design) 31915 (real)	115000 (design) 58469 (real)	285000 (design) 112500 (real)
average Q, m^3/day	6649	13545	7500
average COD, mg/l	539	508	1650
average BOD_5, mg/l	288	260	900
average SS, mg/l	254	167	450
Sewer system	Combined	Combined	Combined
Industrial or agricultural areas	Agri-food industry (olive oil)	Only 3% industrial (same characteristics as the urban WW)	50% industrial influent (high variability)

10 representative emerging contaminants (ECs) for monitoring of municipal WWTP were selected based on:

- Current and forthcoming legislation,
- Frequency of occurrence in municipal WWTP,
- Expected concentration levels,
- Elimination in conventional & advanced treatment.
- Analytical feasibility.

Chemical	CAS	Acronym	Reason
Atrazine	1912-24-9	ATZ	Target
Caffeine	58-08-2	CFN	Indicator
Carbamazepine	298-46-4	CBZ	Indicator/Target
Diclofenac	15307-79-6	DCF	Target
Estron	53-16-7	EST	Target
Ibuprofen	51146-56-6	IBP	Indicator
Simazine	122-34-9	SMZ	Target
Sucralose	56038-13-2	SCL	Indicator
Sulfamethoxazole	723-46-6	SMX	Target
Triclosan	3380-34-5	TCS	Indicator/Target

Complete analytical method were developed for the rigorous determination of these substances based on:

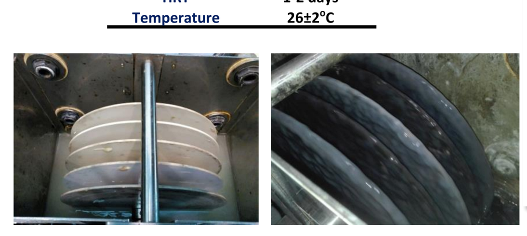
- Standard extractions cartridges.
- Use of isotopically labelled internal standards.
- GC-MS/MS, LC-MS/MS, LC-TOF/MS analytical equipment.

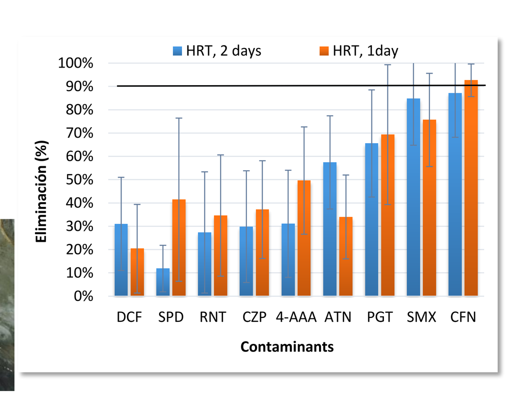
ECs removal

Efficient Biodegradation of ECs with ABOP

Fungal biodegradation in continuous Rotating Biological Contactors (RBCs)

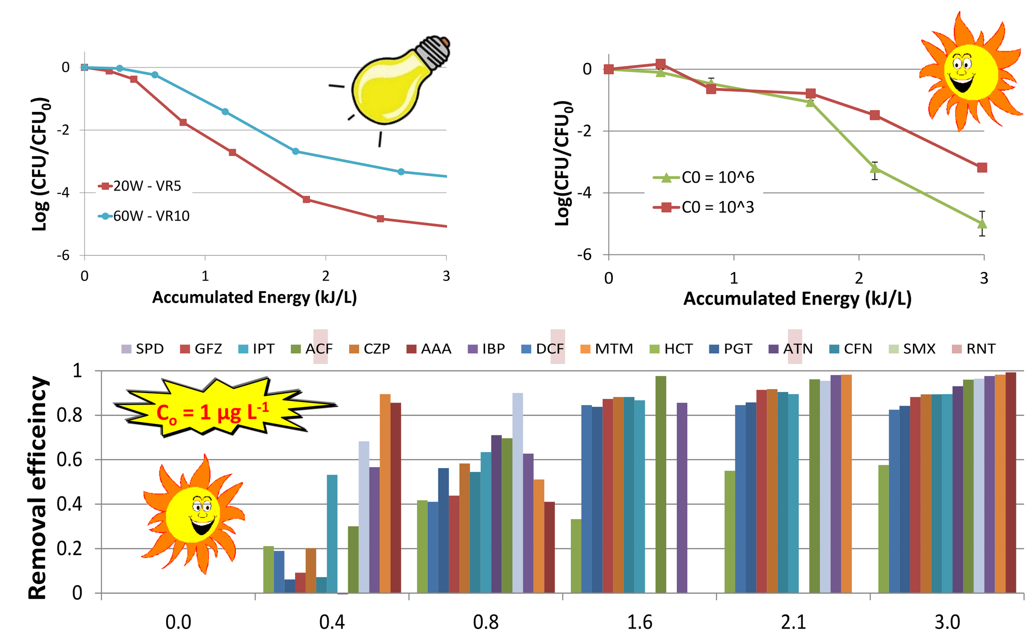
Units	1 (5 discs each)
Total volume	24.5 L
Disc diameter	30 cm
Disc area	1.42 m^2
Disc submerged	40% (10 L)
Rotation speed	20 rpm
HRT	1-2 days
Temperature	26±2°C



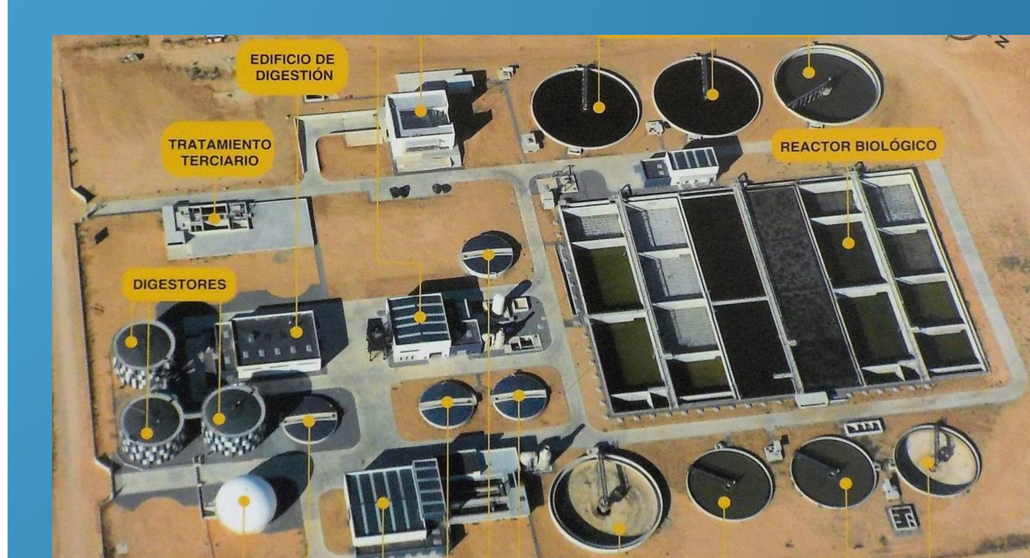


C-TOC Reduction ≈ 80%
$N-NH_4^+$ Reduction ≈ 90-95%

Efficient Removal of ECs during Photochemical Disinfection

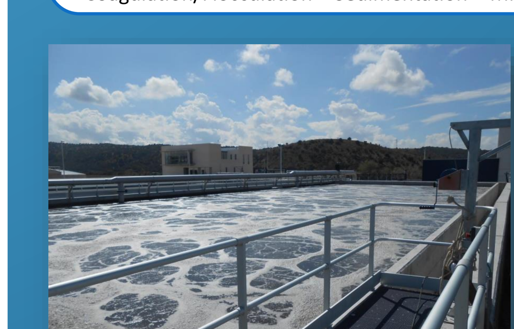


Full Scale WWTP



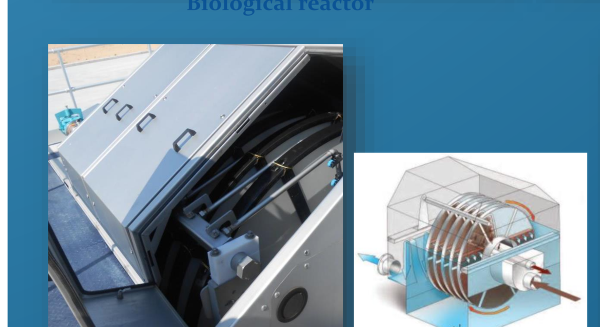
Location: Toledo (Spain)
Population equivalent: 270,000 PE
Design flow: 36,000 m^3/day
Influent: Urban WW
Biological process: Activated sludge
Effluent discharge: Tajo River
Tertiary treatment: 270 m^3/day (irrigation and internal industrial use)
Coagulation/Flocculation – Sedimentation – Microfiltration (discs) – UV

Influent:
COD = 820 mg/l
BOD_5 = 450 mg/l
SS = 490 mg/l



Biological reactor

Secondary clarifier



Microfiltration (8 discs) (10 µm)

UV reactor (16 lamps)

2017 Activities:

- Full scale implementation of selected treatment process and monitoring strategies.
- Evaluation of their impact on ECs removal and antiobiotic resistances (collaboration with STARE project)

www.motrem.eu

ACKNOWLEDGMENTS

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PROMOTE: PROtecting water resources from MObile TracE chemicals

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Background

Surface water and groundwater are the two major sources for drinking water in Europe. Their quality may be affected by the release of industrially produced chemicals. If these chemicals or their transformation products are poorly degradable (persistent) and highly polar (mobile), then these chemicals are of specific concern with respect to drinking water quality. We denote such compounds 'persistent mobile organic chemicals' (PMOCs) [1]. For PMOCs dilution may be the major mechanism of concentration decrease in water cycles, because they have a high potential to break through natural or technical barriers. This is particularly likely in partially closed water cycles which we encounter in all densely populated regions (Fig. 1). PROMOTE is a recently launched research project under the European Union Joint Programming Initiative "Water Challenges for a Changing World" (Water JPI) that focuses on PMOCs.

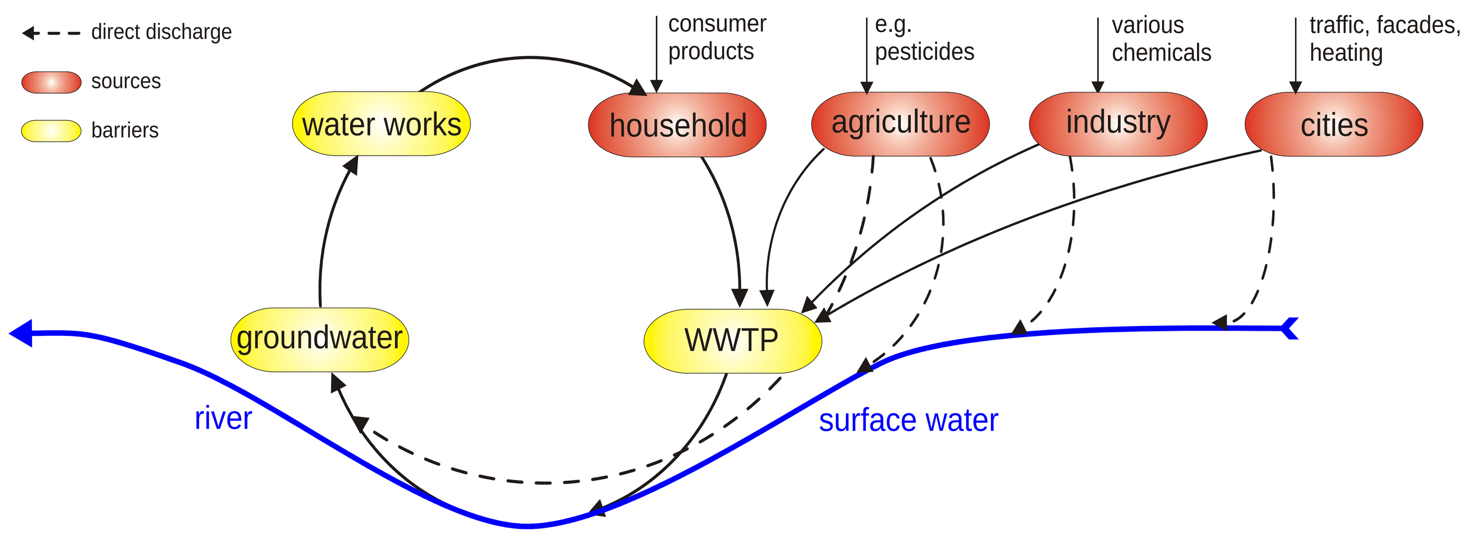

Figure 1. Partially closed water cycle

Hypothesis

There is a polarity gap (Fig. 2) of highly polar organic chemicals (potential PMOCs) that are produced and emitted into the environment, but for which current analytical methods are not suitable. Thus, monitoring data are lacking and ultimately protection of human health via regulation may be insufficient [1].

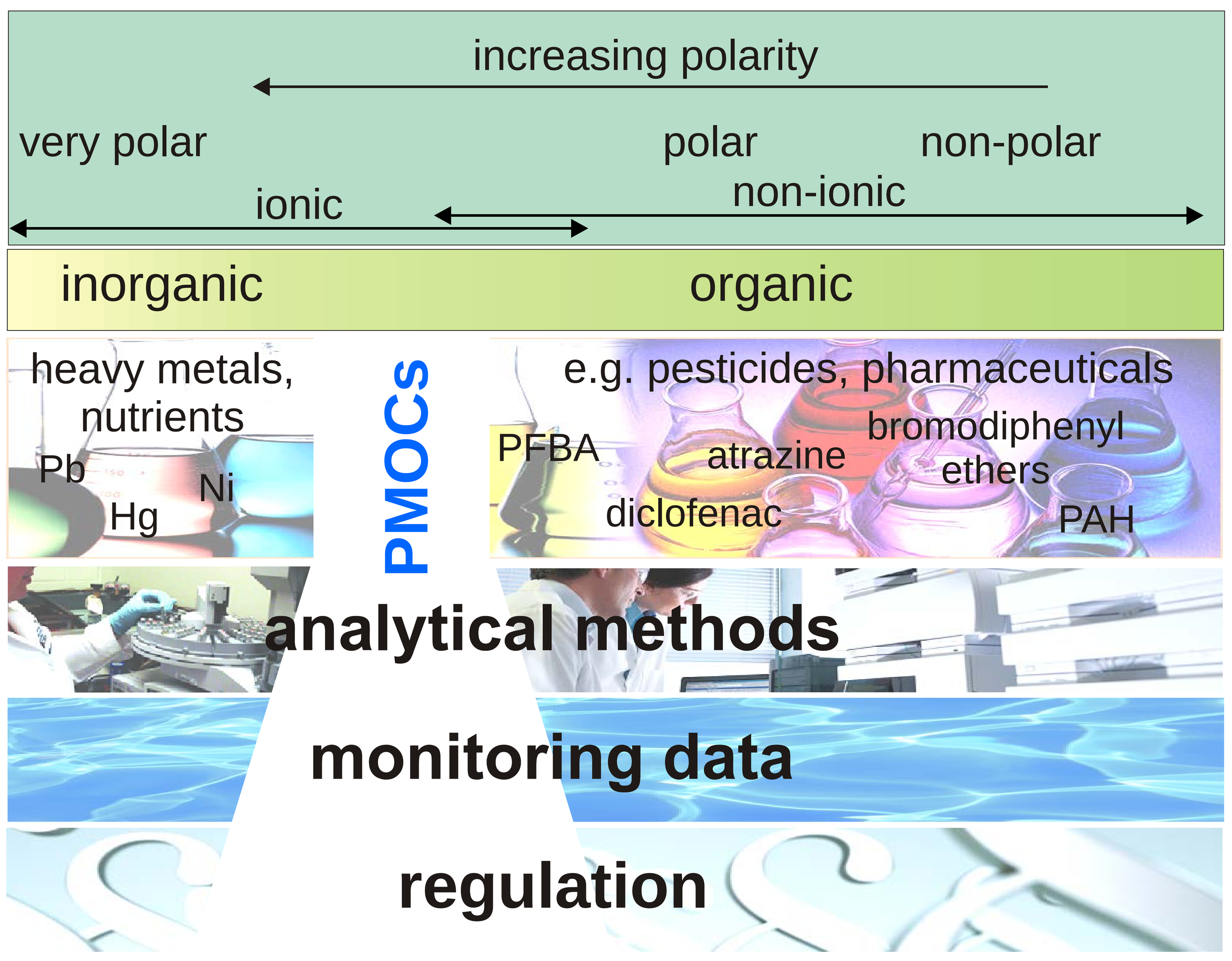

Figure 2. Polarity gap of highly polar organic chemicals

What do we want to PROMOTE?

- Analytical methods to detect and to quantify PMOCs (WP1)
- Tools to identify PMOCs from data submitted in the REACH process (WP2)
- Understanding of transformation processes leading to PMOCs (WP3)
- Knowledge on environmental occurrence and sources of PMOCs (WP4)
- Advanced techniques for the removal of PMOCs from drinking water (WP5)
- Drinking water quality
- Link between chemicals policy and water policy

Overarching aim

PROMOTE aims at clarifying the question whether there is a need as well as the potential to improve the protection of drinking water resources by chemicals regulation with respect to PMOCs. Therewith, PROMOTE links European chemicals policy (REACH) with water policy (WFD).

Work plan

The work plan including all work packages (WP) and their interactions is depicted in Fig. 3.

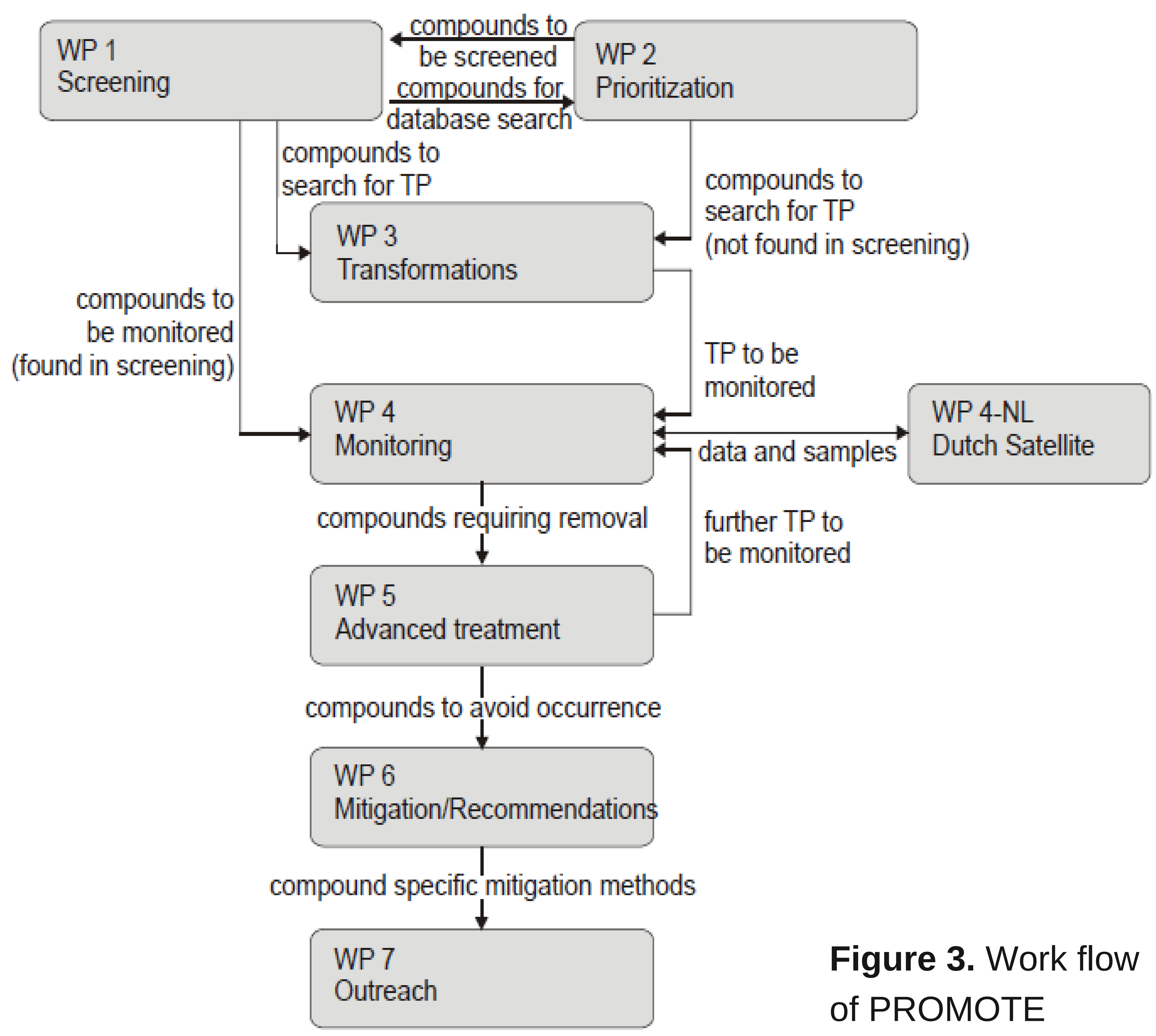

Figure 3. Work flow of PROMOTE

Reference

[1] Reemtsma T., Berger U., Arp H.P.H, Gallard H., Knepper T.P., Neumann M., Quintana J.B., de Voogt P. (2016) *Mind the gap: Persistent and mobile organic compounds – water contaminants that slip through*, Feature Article, Environ. Sci. Technol. *50*, 10308-10315.

Acknowledgments

European Union Joint Programming Initiative "Water Challenges for a Changing World" (Water JPI) with financial support by the Bundesministerium für Bildung und Forschung (Germany, 02WU1347A/B), Forskningsrådet (Norway, 241358/E50), Ministerio de Economía y Competitividad (Spain, JPIW2013-117), Office National de l'Eau et des Milieux Aquatiques (France, IC2MP project PROMOTE)

StARE

Stopping Antibiotic Resistance Evolution: a focus on wastewater

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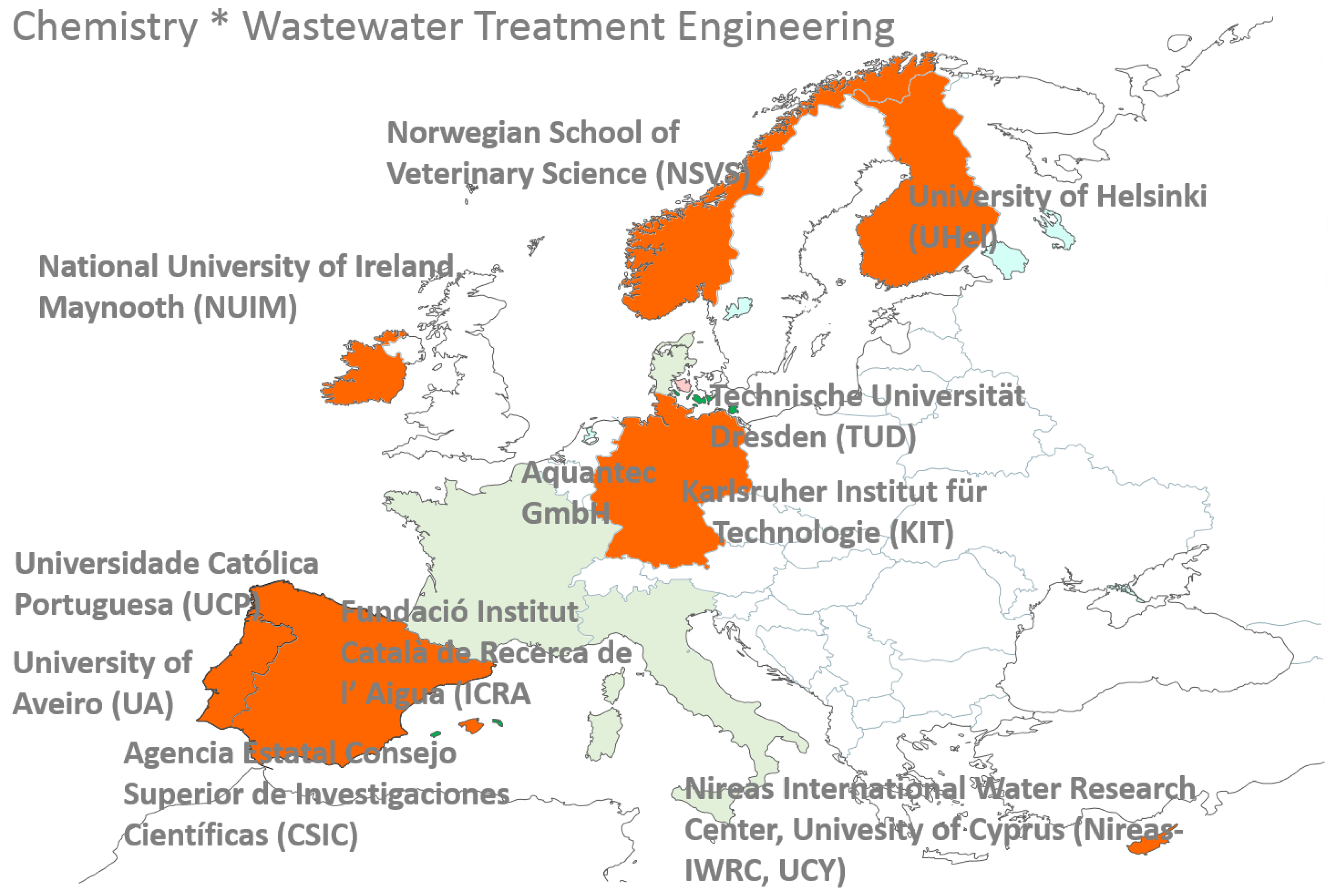
[9]Catalan Institute for Water Research (ICRA), Spain
[10]Technische Universität Dresden, Germany
[11]Karlsruhe Institute of Technology (KIT), Germany

https://stareeurope.wordpress.com/

Consortium

Consortium: 7 countries, 11 institutions
Expertise: Microbiology * Molecular Biology * Bioinformatics *Analytical Chemistry * Wastewater Treatment Engineering



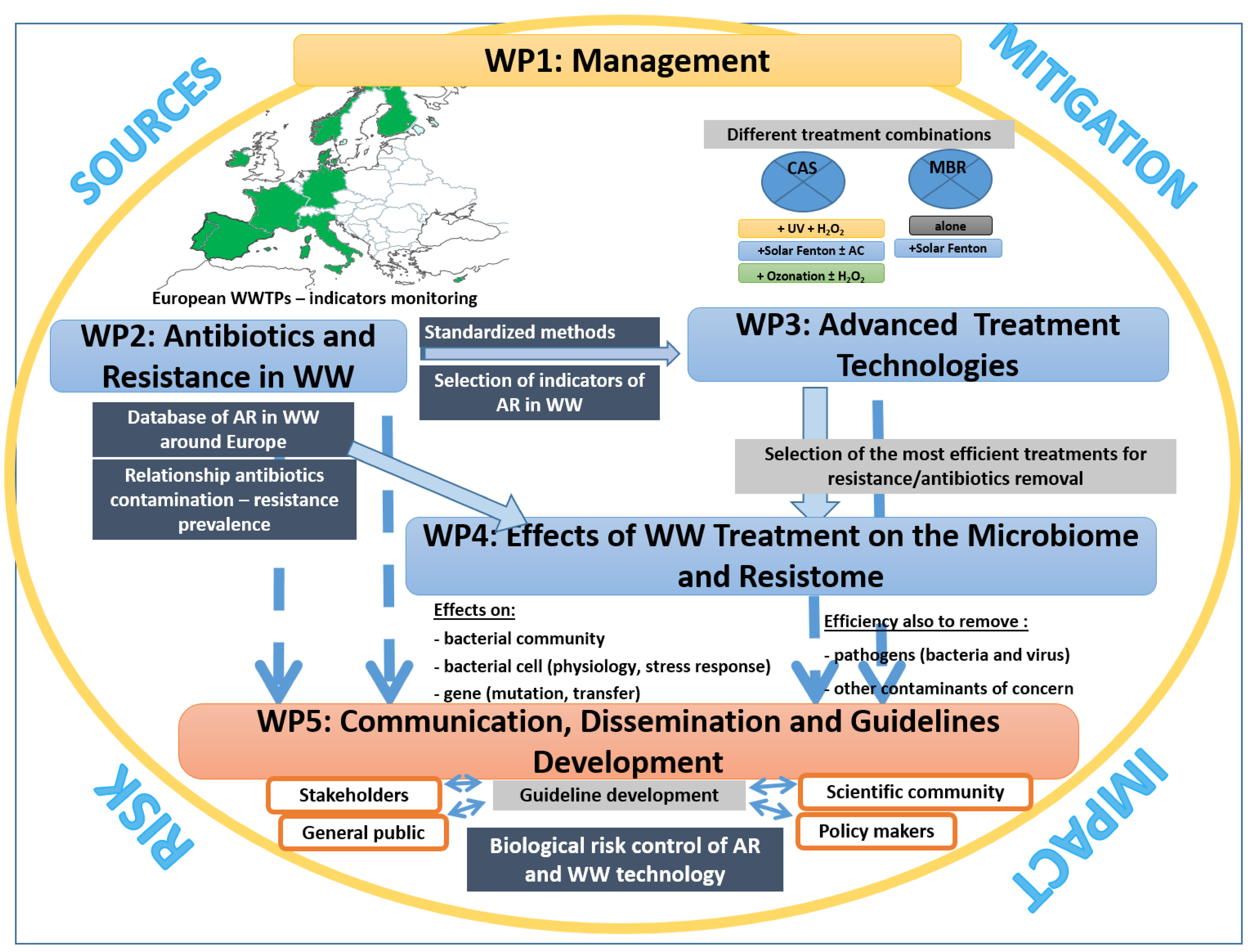
Objectives & Outcomes

- **First overview of the occurrence of Antibiotics (A) and Resistance (ARB&ARG) in European Wastewater treatment plants (UWTP)**
  - Implement **harmonized (advanced) protocols** to measure A & ARG
  - Develop **simplified and cost-effective protocols**
  - Launch a **public database** on A&ARB&ARG
- **Improvement of wastewater treatment processes for the removal of A&ARB&ARG**
  - Develop **cost-effective wastewater treatment** processes
  - **Minimize the impacts of ARG dissemination** from UWTP

Impacts: scientific and societal relevance

- Assess the **relationship between ARB&ARG occurrence** in the **environment with the level of contamination** with A
- Assess the **impact of UWTP** discharges on the propagation of **A&ARB&ARG** and propose mitigation measures
- Propose possible routes of **transmission of ARB&ARG** and assess associated **human-health risks**
- Contribute to the **upgrade of relevant policies in relation to water quality**
- Work with wastewater treatment companies on the development of **technologies** that can contribute to the **protection of the water resources, the environment and human health.**

Organization



Ongoing Synergies

With other projects (e.g.):
- ANSWER (H2020-MSCA-ITN-2015/675530)
- NEREUS COST ACTION ES1403
- MORTREM (2013 Water JPI Pilot Call)
- Norman WG5 on Wastewater reuse and contaminants of emerging concern

With wastewater treatment companies (e.g.):
- ADVENTECH - Advanced Environmental Technologies- www.adventech.pt/pt/;
- EUROMARKET http://www.euromarket-cy.com).

Future perspectives

- **Synergies** and efficient networking among partners is essential to achieve **high-impact results**
- StARE scientists and members from wastewater management entities responsible for 1) **guidelines and policy development** and 2) **wastewater treatment technologies** are in close collaboration in almost all the participating countries for knowledge and experience exchange and capacity building.

Funding

This project has been financed through the National Funding Agencies of the partner countries, in the frame of the collaborative international consortium Water JPI/0001/2013 - STARE – "Stopping Antibiotic Resistance Evolution of the Water Challenges for a Changing World Joint Programming Initiative (Water JPI) Pilot Call

http://jpi-trace.eu/

Tracking and Assessing the Risk from Antibiotic Resistance Genes using Chip Technology in Surface Water Ecosystems (TRACE)

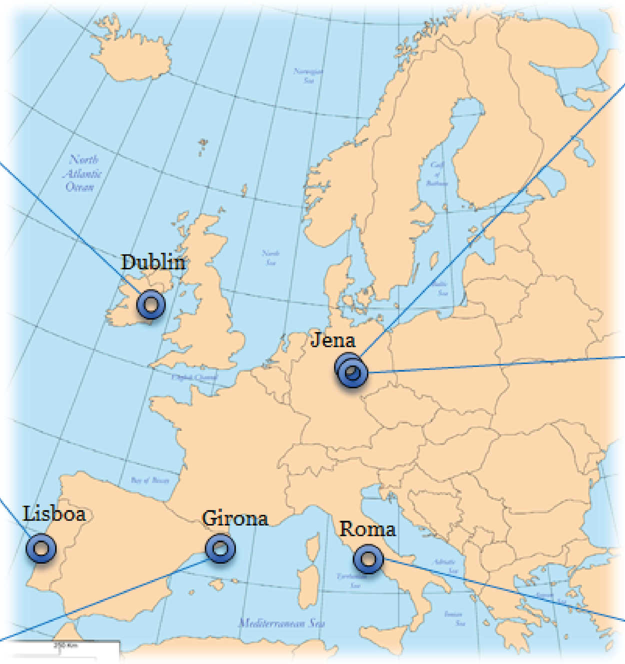
Overall OBJECTIVE

- Understand the sources and behaviour of antibiotic resistance in natural surface waters and infection routes

Expected OUTCOME

- Novel on-site detection technology as a chip-based solution to detect a panel of antibiotic resistance genes (ARG) for waterborne microorganisms, allowing time- and cost-efficient evaluation of AR patterns and the associated risk for human health

Partners



UCD Dublin
• Risk assessment

Universidade Nova de Lisboa
• Probe design & optimization
• Lab tests

ICRA
• Antibiotic pollution
• ARGs quantification/screening
• Selection of target ARGs

Leibniz-Institut für Photonische Technologien (ipht jena)
• DNA chip design & test
• Chip optimization

Food Analytik & Consulting
• Identification of marker organisms and sequences
• one-target assay

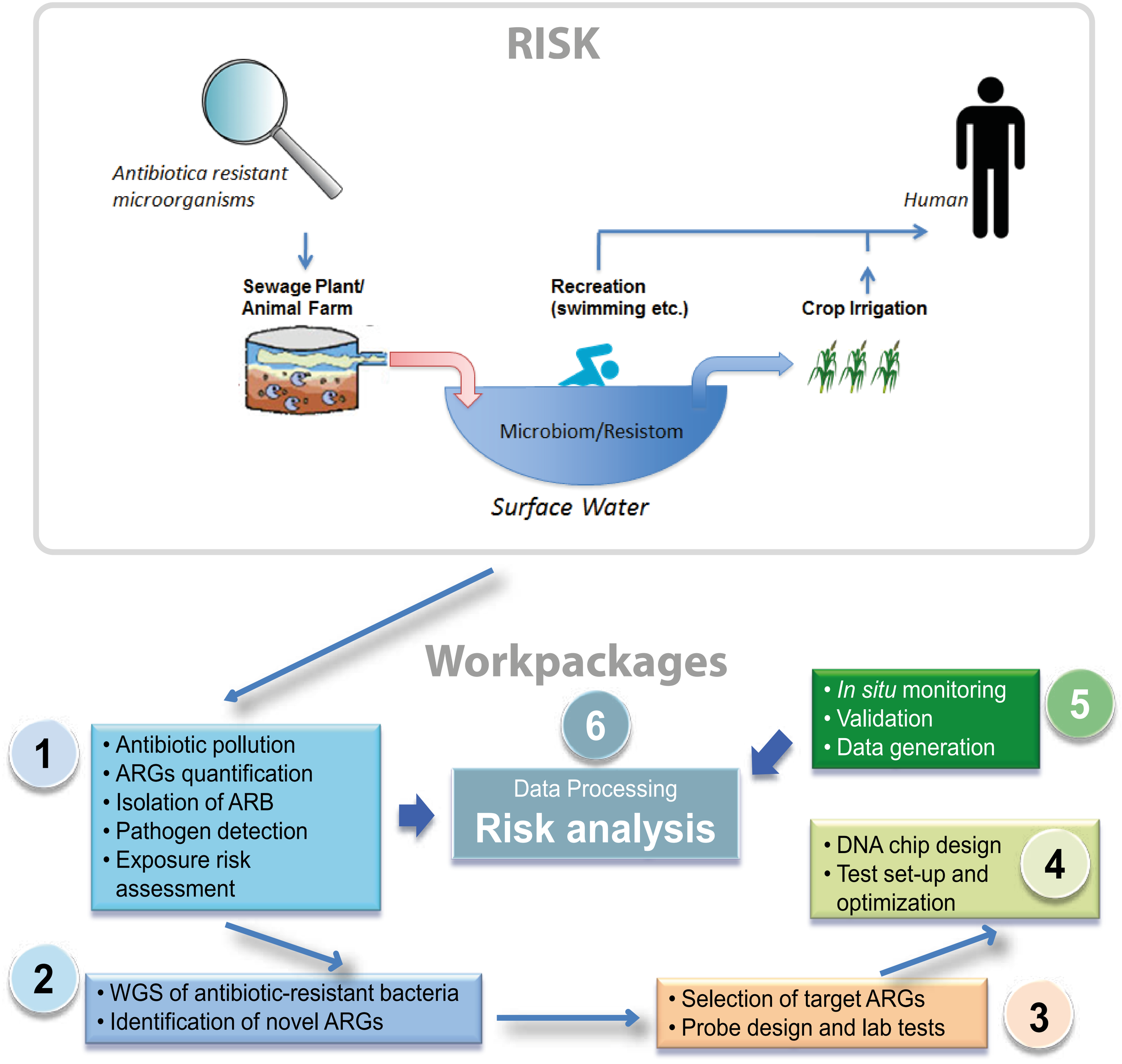
Sapienza Università di Roma
• ARB isolation and characterization

Know-how

- Molecular characterization of antibiotic resistant bacteria
- Characterization of the environmental resistome
- Chemical analysis of antibiotics in environmental samples
- Environmental diagnostics
- Plasmonics
- Nanodiagnostics
- Point-of-care diagnostics
- Risk Analysis

TRACE combines microbial ecology with photonics/nanotechnology and bioanalytics

OUTLINE



Social Impact: Risk Management Strategy

Scientific and Technology Impact: On-site Detection Technology

Study sites

River Ter, Spain

River Saale, Germany

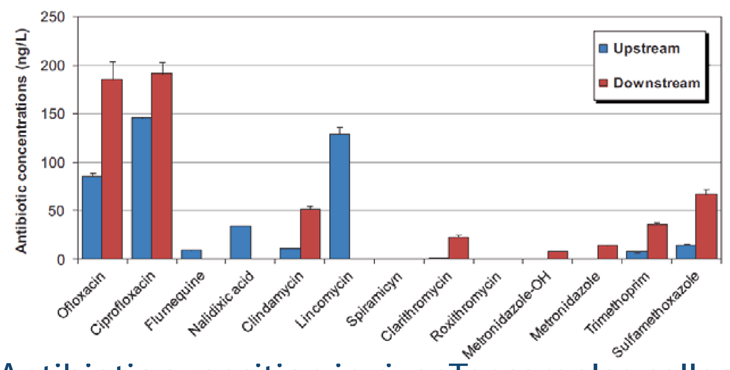
Ostia beach, Italy

Lake Lütsche, Germany

Water Sample

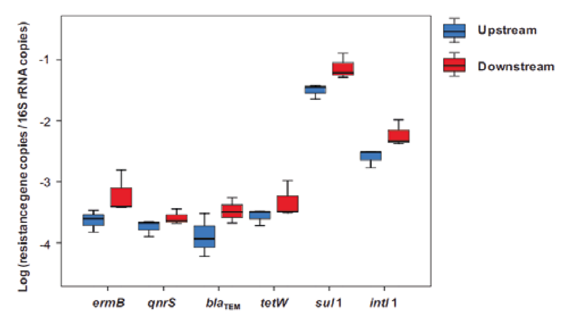
Selection of candidate ARGs

Antibiotic pollution

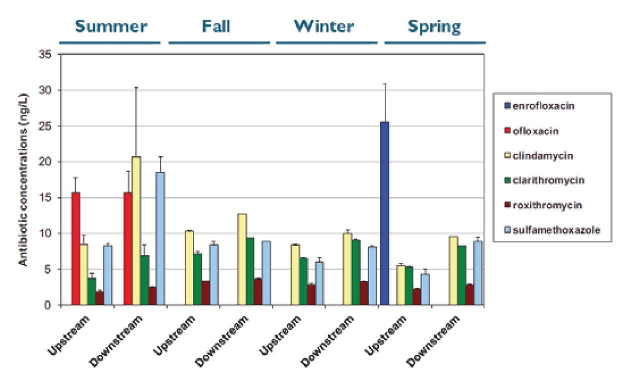


Antibiotic exposition in river Ter samples collected upstream and downstream sites

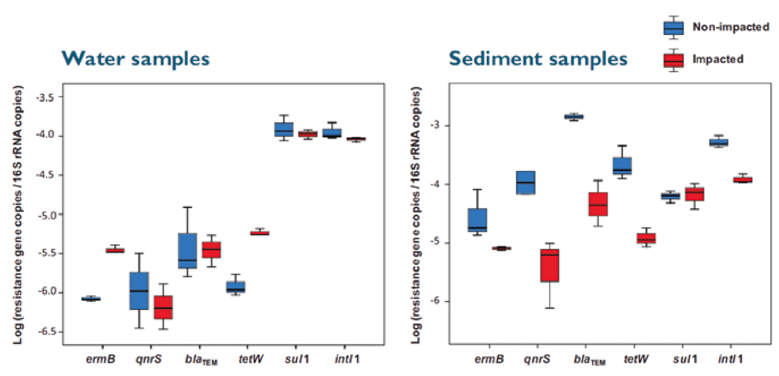
ARG quantification



Relative concentration of ARGs in river Ter



Seasonal change of the antibiotic exposition of the River Saale

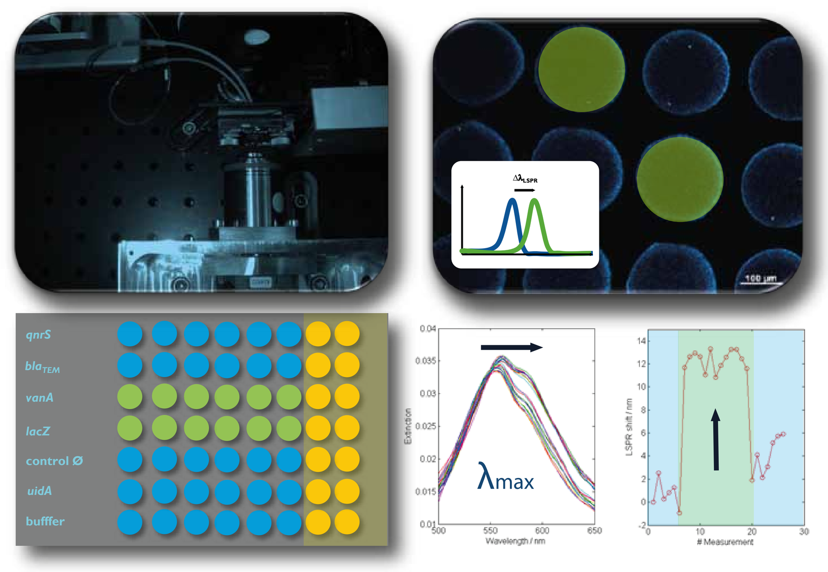


Relative concentration of ARGs in river Saale

On-site Detection Technology

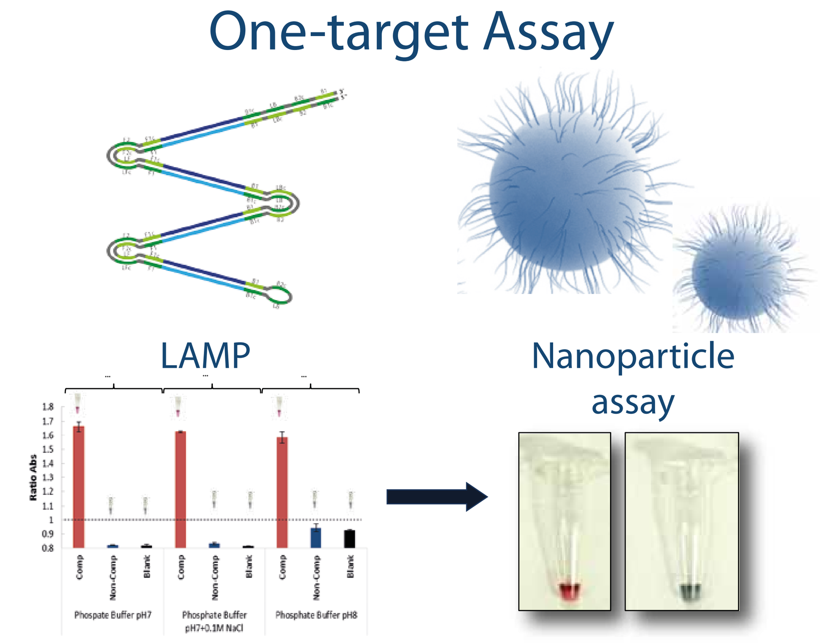
- multiplex assays
- robust and simple
- inexpensive equipment
- no specialised lab
- easy interpretation
- portability

Multiplex Microarray Chip



Plasmonic microarray-based system with microfluidic chamber and optical readout

One-target Assay



Simple semi-quantitative colorimetric assay for point-of-need

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Water JPI
WATEUR Tackling EUropean Water Challenges

Accelerated Water Purification during Artificial Recharge of Aquifers – A tool to restore drinking water resources (ACWAPUR)

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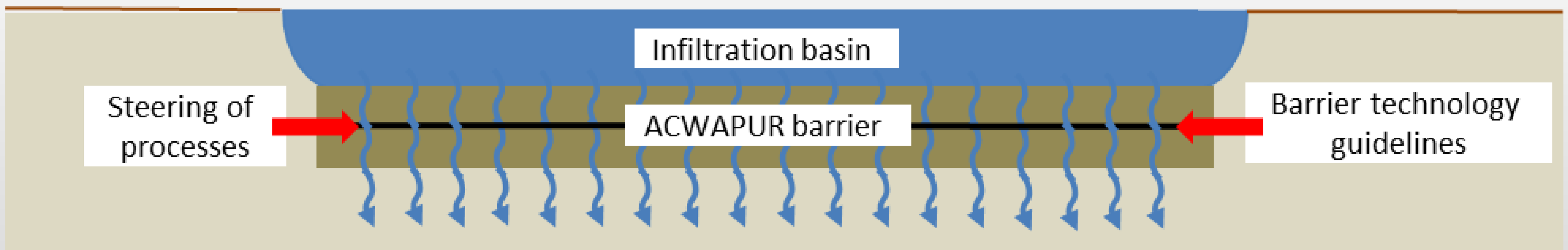
OBJECTIVES AND OUTCOME

•to develop new technological applications, and management tools and guidelines to prevent leaching of pathogens, inorganic nutrients, organic pollutants, and their degradation products to underlying aquifers during Managed Artificial Recharge (MAR).

•ACWAPUR will improve the effectiveness of MAR through the development of tailored and reliable barriers preventing the intrusion of organic chemicals, inorganic nutrients, and pathogens into groundwater aquifers.



•The research will result in prototype MAR-barrier systems that can be established and operated with low energy consumption, without use of chemicals, and at low cost, ready to be exploited at both existing and new MAR facilities

THE ACWAPUR CONSORTIUM

The project brings together a consortium of research institutions with highly complementary expertise:

GEUS, Denmark :	Microbial degradation of organic pollutants
SLU, Sweden:	Inorganic nutrient cycling
CNR-IRSA, Italy:	Fate of pathogens, including spreading of antibiotic resistance
UPC, Spain:	Modelling of contaminant fate
CSIC, Spain:	MAR technologies, access to field sites

An End-user Board with stakeholders is associated to the project to ensure rapid transfer of innovative solutions and technologies to the public and private market

STRENGTHENING OF CONSORTIUM

The consortium may be strengthen by having partners with specific expertise within.

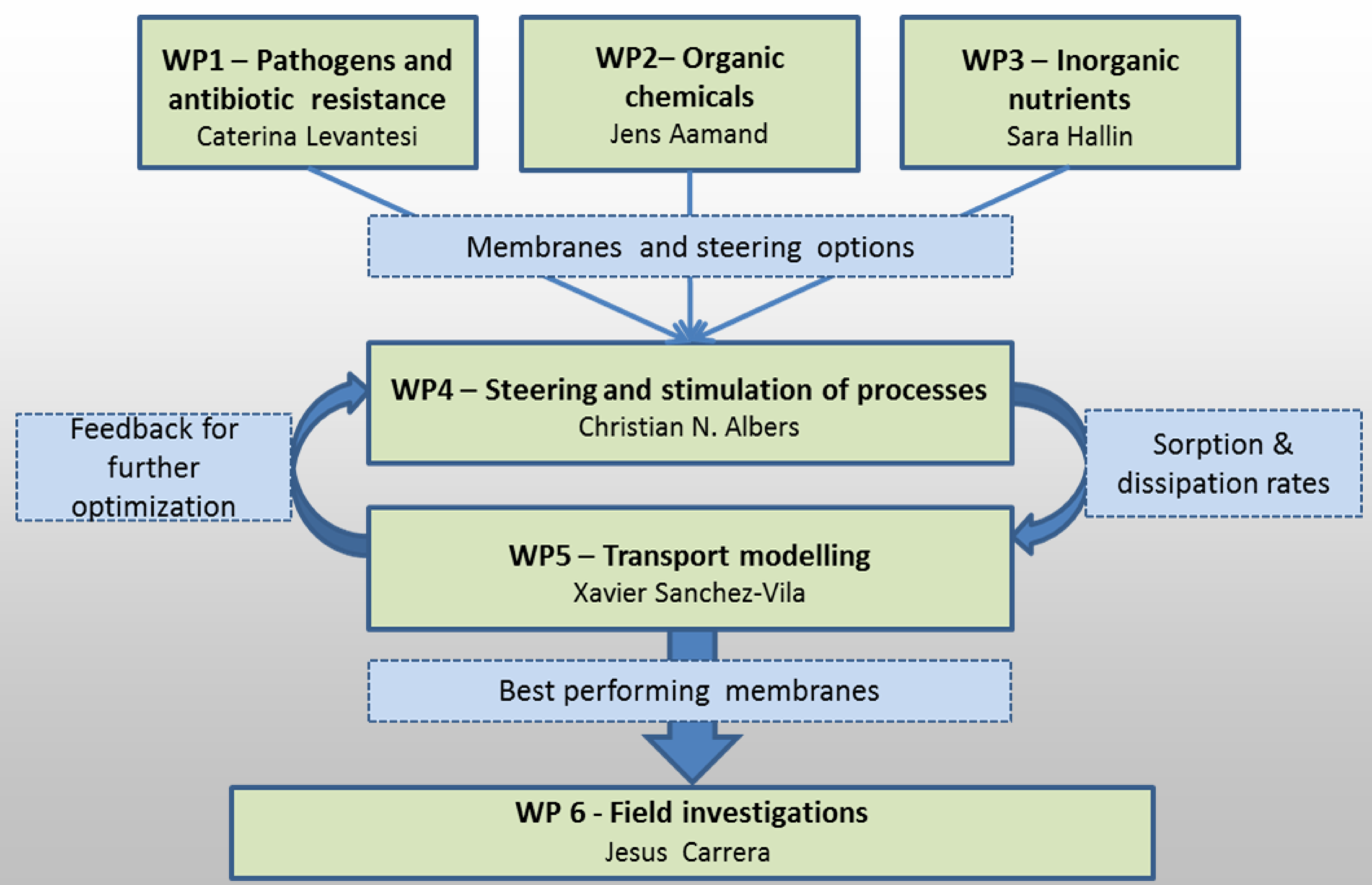
- Growth of plants
- Molecular microbiology

IMPACT AND LINKS TO SRIA

- ACWAPUR will promote competiveness in the water industry by developing market oriented solutions as also mentioned in subtheme 3.1 of the SRIA.
- ACWAPUR provides solutions to restore overexploited aquifers and is thereby improving sustainable water resource management as also mentioned in theme 5 of the SRIA
- The ACWAPUR outcome will support water managers implementing the Water Framework Directive and other water management strategies.

OUTPUT IMPROVEMENT

- Joint workshops for several JPI projects to a broader audience of stakeholders including water managers, waterworks personnel, consultants, regional authorities, water supply industry, and other interested parties
- Additional funding opportunities for invitation of stakeholders to international meetings



Project structure of ACWAPUR

IMPLEMENTATION OF ACWAPUR

The project is structured in 6 well-integrated work packages. WP1, WP2, and WP3 aims at exploring the 'black box' of MAR, providing in-depth knowledge about factors controlling the fate of pathogens/antibiotic resistance, organic chemicals, and inorganic nutrients during artificial recharge.

The knowledge gained will be exploited in WP4 to identify measures for optimal management and control of artificial recharge processes including the design of the most effective barriers.

In WP5, the research results will be integrated in mathematical modelling to evaluate technology performance and give feedback for further optimisation if necessary.

Based on the results from the modelling, the best performing barriers will be selected for further testing at field scale in WP6.

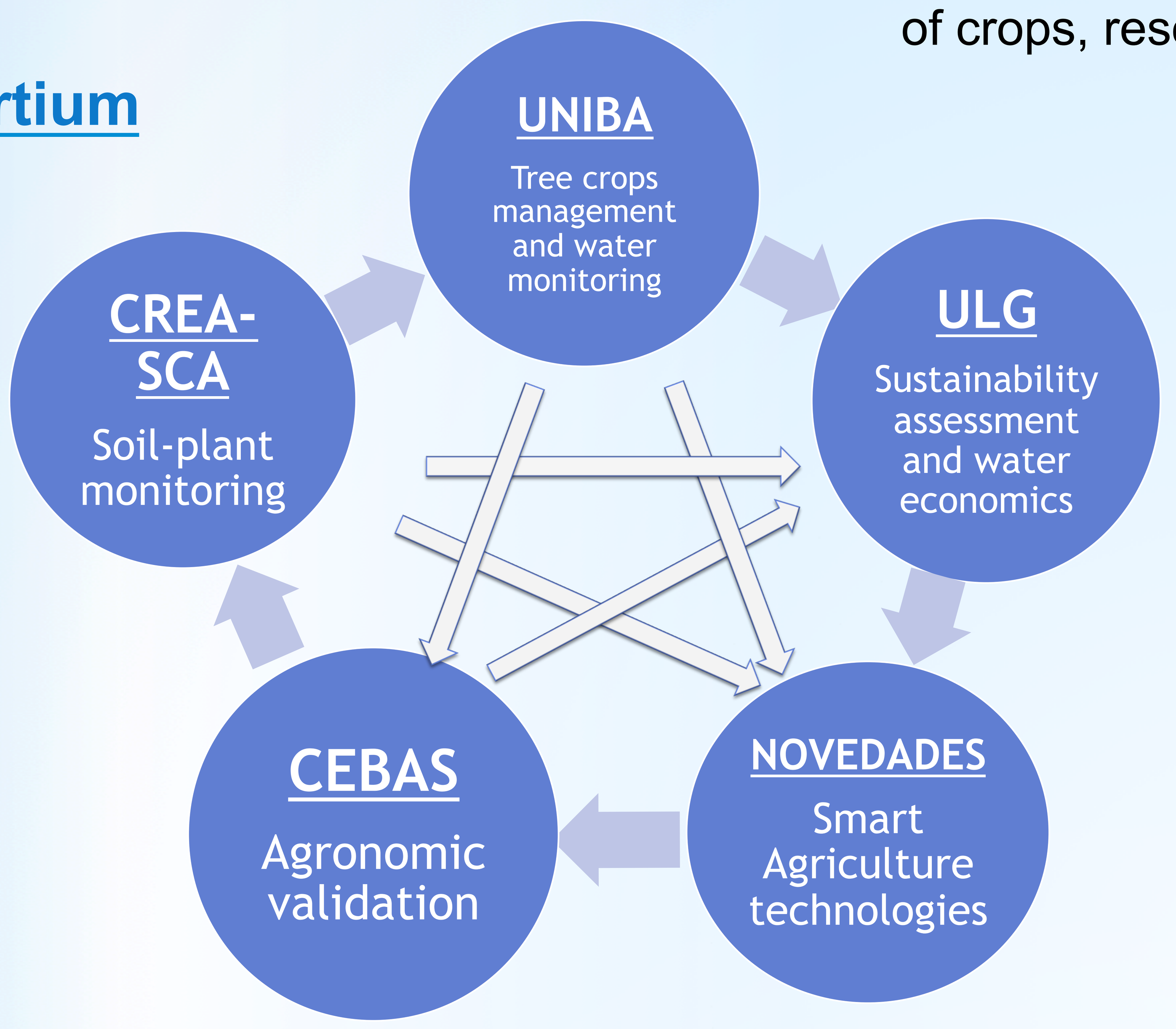
LOW-COST WATER DESALINATION AND SENSOR TECHNOLOGY COMPACT MODULE

G.A. Vivaldi, F. Pedrero Salcedo, E. Nicolas, M. Moretti, T. Dogot, A.M. Stellacci, S. Camposeo

Aim

The **aim** of **DESERT** project is to create an innovative concept as **a smart system combining sustainable technology on water treatment and water quality sensors**, tuned to the local situation. **DESERT** project introduces a new vision of agriculture. Each partner of the consortium proposes innovative activities and new methodologies in terms of unconventional water treatments, irrigation and fertilization of crops, resource conservation.

Consortium



Objectives

1 - To integrate in a low-energy and high-efficiency compact module, two solar powered equipment for desalination and fertigation

2 - To develop an innovative system (**QUANTUM**) for real-time water monitoring in order to optimize water and fertilizers application;

3 - To monitor and evaluate the short-term evolution of crop nutritional status, soil salinity, yield and fruit quality and safety, optimizing the water and fertilizers needs and the energy costs at farm level;

4 - To evaluate the effect, in medium-term, and evolution of the soil status by monitoring sensitive indicators of soil fertility and by computing synthetic indices of soil quality;

5 - To model the "value of irrigation water" by combining physical, biological and environmental factors to derive water-crop production function.

Outcomes

1 - DESERT technology, treatments and fertilization equipment;
2 - QUANTUM on-line water monitoring system;
3 - DESERT technology validation in greenhouse and open field;
4 - Soil quality indices;
5 - Economical and environmental evaluation of DESERT technology.

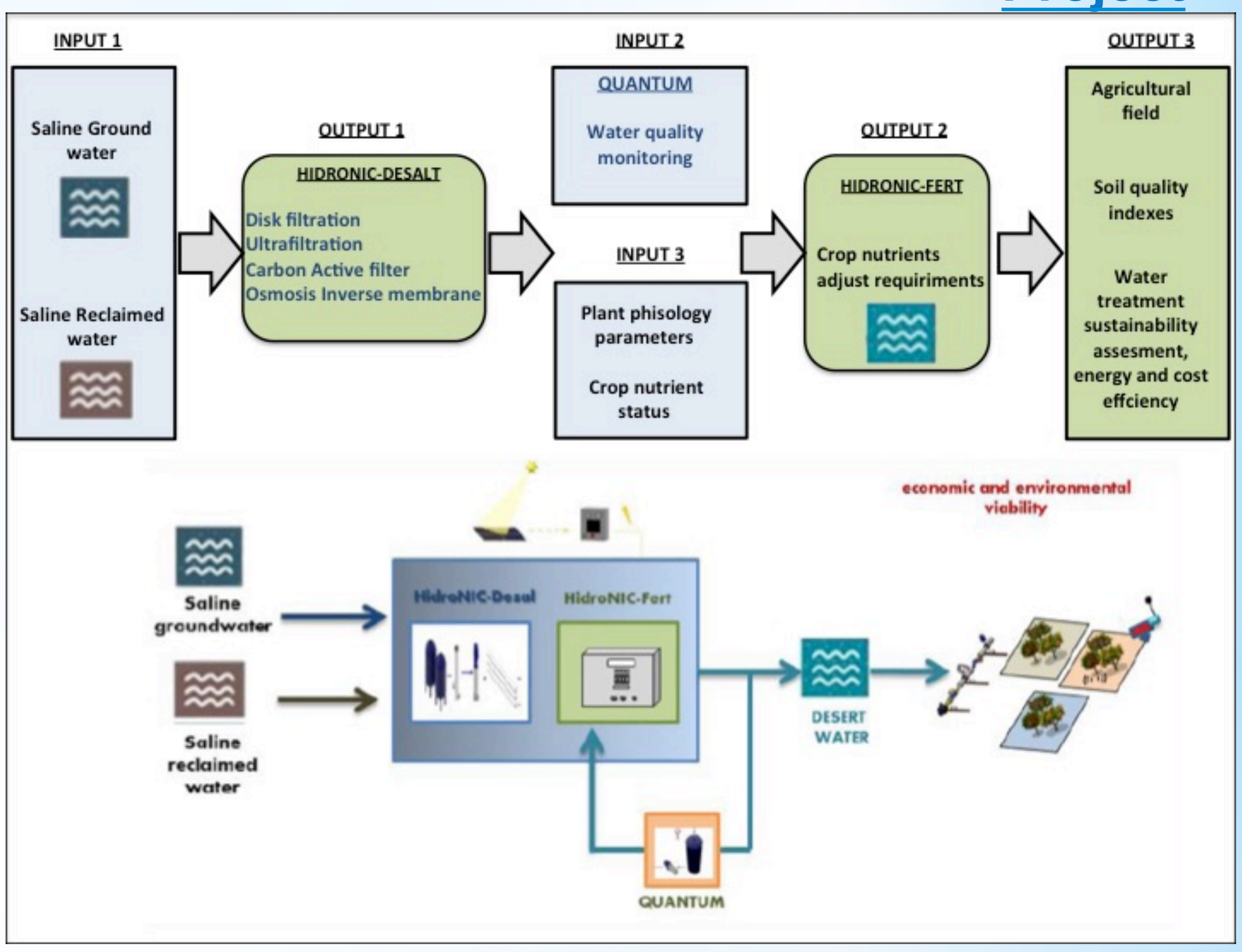
Expected impacts: science, technology, policy.

1 - Science: Agronomic and physiological response of crops irrigated with reclaimed water
2 - Technology: New tools will be developed in order to improve wastewater reuse
3 - Policy: to propose new threshold for wastewater reuse in agriculture

Can the outcome be increased with some collaboration?

DESERT consortium is available to collaborate with research centers, Universities and Companies with the following expertises:
- Sensors for water monitoring;
- Software developers;
- Wastewater treatment process;
- Monitoring of emerging pollutants;
- Environmental evaluation of wastewater reuse in agriculture.

Project



How can the RDI community be more effective in the field of emerging pollutants

-There is a lack of studies of emerging pollutants on fruit trees;
-To test how different agronomical practices (irrigation method, substrate, climatic conditions..) can reduce contaminants in crops and environment;
-To evaluate if there are any plant species that are able to degrade contaminants;
-To improve experiment in open field and real farm (vegetables and fruit trees);
-To enforce interdisciplinary research towards assessing emerging pollutants functional role in improving risks for human health.

How to make use of the RDI results in emerging pollutants

- Improving a comunication strategy at all levels;
- Developing more accurated previsional models in order to predict food contamination when plants are irrigated with reclaimed water;
- Developing interdisciplinary international platform to monitor and address present and future emerging risks for human health.

Limits to go further in your Project?

- Italian funding's it is not already available and there could be some delays in reaching some deliverables;
- Low budget available to develop algoritms for the most important species;
- Not uniform regulation of wastewater reuse whitin Countries involved.

Ideas about how alignment can be achieved more effectively for a higher impact

According with our research the wastewater reuse in agriculture is site-specific. For this reason we believe that each area needs spefic regulation in terms of wastewater threshold value for reuse in agriculture. Moreover, in order to achieve more effectively alignements **we propose interdiscilinary collaboration** making available **our experiment platforms** in Italy and Spain.
We offer different agricultural system irrigated with reclaimed water: hydroponic and soil crops in green-house, horticultural and tree crop species in open field combining different treatment technologies in a small prototype powered with solar energy.

Agriculture and water research platform

WaterWorks2014

MeProWaRe

Novel **Me**thodology for the **Pro**motion of Treated Waste**wa**ter **Re**use for Mediterranean Crops Improvement

A. Pollice[1], J. De Las Heras[2], G. Rodrigues[3], N. Lamaddalena[4], R. Saliba[1]

Gaps & solutions

Actual gaps in TWW reuse	MeProWaRe solutions
Lack of trust & involvement	Build trust through involvement
Lack of reuse know-how and specific methodologies	Provide a novel reuse methodology
Strict & different legislations	Contribute to the harmonization of legislations
Reuse type	Direct reuse for Med. crops

Test site 1
Italy
(CIHEAM IAMB)



Test site 2
Spain
(UCLM)



Test site 3
Portugal
(ISA LEAF)



Project structure

Production of experimental data

WP1: Water quality monitoring (IRSA)
T1.1 Define common monitoring protocol
T1.2 Water quality monitoring

WP3: Irrigation and agronomic practices (UCLM)
T3.1 Design of experiment
T3.2 Irrigation tests
T3.3 Sampling and analyses

Test site 1 Italy (CIHEAM IAMB) | **Test site 2** Spain (UCLM) | **Test site 3** Portugal (ISA LEAF)

WP2: Modelling tools (ISA LEAF)
T2.1 Calibration of SIMDualKc model
T2.2 Calibration of RZWQM (Root Zone Water Quality Model) and Hydrus
T2.3 Model application with data from the 3 sites

WP4: S/h' participation and socio-economic evaluations (IRSA)
T4.1 S/h' understanding of the problem (cognitive mapping)
T4.2 Econ./environmental impacts of water reuse (cost/benefit, WFS)
T4.3 Communication/dissemination

Data management

Objectives

- Demonstrate the positive effects of TWW reuse
- Assess pollutants' transfer through irrigation
- Customize water inputs to crop irrigation and nutrient requirements
- Provide support to treated wastewater pricing
- Identify the main barriers hampering the effective communication between the scientific community and the main stakeholders
- Contribute to the compliance of the national regulations to the EU legislations on natural resources management

Expected outcomes

- Novel methodology for adapting irrigation water characteristics to crop needs
- Better knowledge of evapotranspiration, nutrient requirements and migration of pollutants through the soil
- Reuse technical guideline for olives and grapevines
- New wastewater quality standards for reuse in irrigation
- Recommendations to harmonize the different reuse regulations

SRIA

- Adaptive water management (5.1.2)
- Mitigating water stress in coastal zones (5.1.5)
- Integrating and connecting socio-economic analysis with ecological issues (5.2.1 & 5.2.2)
- Promoting new knowledge management approaches (5.2.3)

Impacts

- Technological solutions for TWW reuse
- Novel management and mitigation measures
- Economic impact of reuse
- Environmental protection policy
- Standardization of reuse legislations

Limitations

- Legislation
- Acceptance
- Stakeholder's involvement/awareness
- Cost competition with freshwater

Towards a more effective RDI community

Community members ⟷ **Permanent topic-based platforms** ⟷ RDI results

Potential collaborations & alignments

Integrated approaches dealing with environmental protection , sustainable water resources management, and crops improvement in water-scarce areas

Workshop on Alignment of On-going Projects "Emerging Pollutants, including Pathogens"
Federal Ministry of Agriculture, Forestry, Environment and Water Management,
Stubenring I, A-1012 Vienna, Austria
November 30th 2016

[1]National Research Council - Water Research Institute, Italy - **Coordinator**
[2]UCLM, University of Castilla – La Mancha, Spain
[3]ISA LEAF, Instituto Superior de Agronomia Universidade de Lisboa, Portugal
[4]C.I.H.E.A.M. – Mediterranean Agronomic Institute of Bari, Italy

Water 2014 Works

PIONEER_STP

The Potential of Innovative Technologies to Improve Sustainability of Sewage Treatment Plants

INTRODUCTION

In the recent years the water sector has been witnessing the birth of a growing number of initiatives dealing with an in-depth revision of the baseline concept of sewage treatment plants (STP), which has relatively remained unchanged since the discovery of Activated Sludge (AS) process 100 years ago. These initiatives are driven by the new legal and economic challenges, targeting the recovery of resources from wastewater, the production of effluents suitable for reuse (e.g. minimising the concentration of emerging pollutants (EPs)) and the reduction in energy consumption, sludge surplus and environmental impacts.

MAIN OBJECTIVE

To assess the impact of innovative units (nowadays at lab- or pilot-scale or in their early stages of industrial implementation) on the global plant efficiency and sustainability, taking into account nutrients, energy, EPs, greenhouse gases (GHGs) and cost/benefit balances.

Sub-Objectives

- Develop 4 Unit Technological Solutions (UTS), two of them focused on energy recovery from valuable organic matter (UTS1&2) and two on nutrients removal/recovery (UTS3&4).
- Combine the UTS into different plant layouts (using a superstructure-based optimization framework)
- Assess the STP in terms of technical, environmental, energetic and economical aspects
- Optimize the STP by plant-wide modelling and simulation

THE CONSORTIUM

Principal Investigator	Institution	Country
Juan M. Lema	University of Santiago de Compostela	Spain
Francesco Fatone	University of Verona	Italy
Gürkan Sin	Technical University of Denmark	Denmark
Elzbieta Plaza	Royal Institute of Technology	Sweden
Jose R. Vazquez-Padin	FCC Aqualia	Spain

THE AMBITION

The holistic evaluation of the innovative technological solutions for wasteater treatment (WWT) by considering the whole STP in terms of energy, mass (C, nutrients, EPs, GHGs) and cost balances. The generation of a singular modular tool able to describe the best STP layout from a combined economic and environmental point of view.

METHODOLOGY

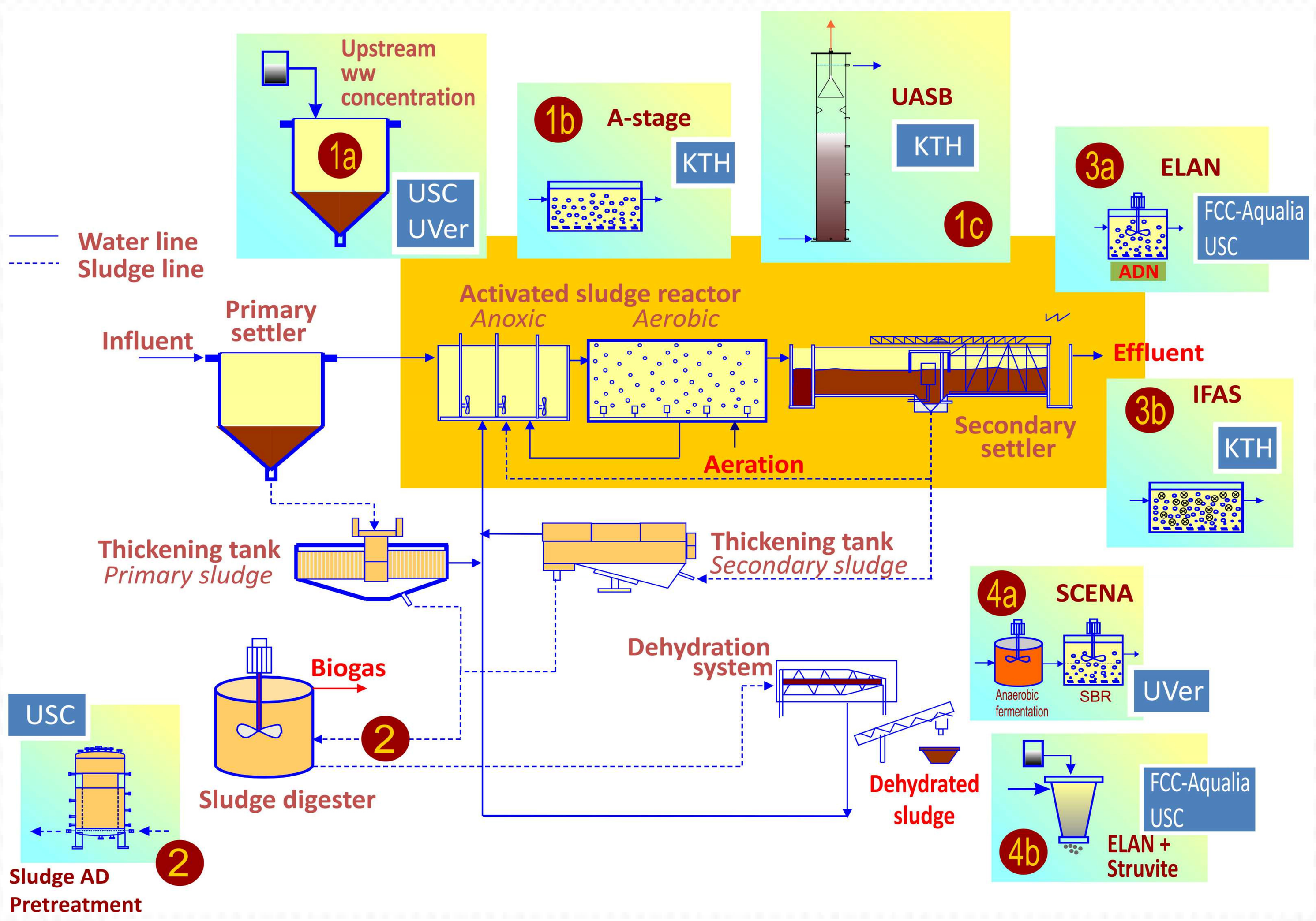


Fig. 1. Innovative treatment units in Pioneer_STP

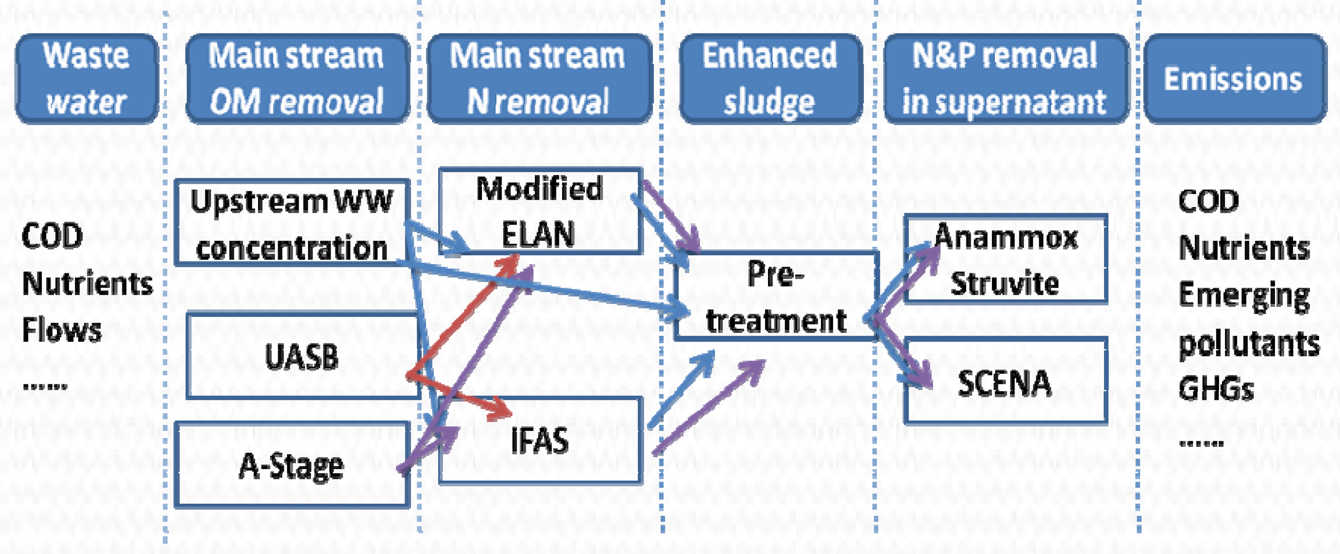


Fig.2. Superstructure definition of design space for novel STPs

Postition in Plant Layout	Technology	Main Target
UTS 1. Pre-Concentration	- Enhanced primary sedimentation with additives - High rate activated sludge (HRAS) - Anaerobic Treatment	Improve the Energy balance: a) ↓ organic load in the water line b) Recovery methane in the water line
UTS 2. Sludge Line	Thermal pre-treatment	↑ Energy production during sludge Anaerobic Digestion
UTS 3. Mainstream Water Line	Modified ELAN process IFAS anammox	N removal ↓ oxygen demand
UTS 4. Centrate from the AD	SCENA (N removal / P hyper-accumulation) ELAN followed by struvite precipitation	N removal P recovery
Superstructure based optimization	Mathematical multicriteria optimization	Define sustainable plant layouts

PROGNOS

Predicting In-Lake Responses to Change Using Near Real Time Models

Providing Information to Enable Adaptive Water Management in a Changing World

http://prognoswater.org

Scientific Team

Don Pierson, Uppsala University, SE
Eleanor Jennings, Dundalk Inst of Technology, IE
Elvira de Eyto, Marine Institute, IE
Erik Jeppesen & Dennis Trolle, Aarhus University, DK
Karsten Bolding and Jorn Bruggeman Bolding & Bruggeman ApS, DK
Raoul-Marie Couture & Isabel Seifert-Dähnn, NIVA, NO
Gideon Gal, Israel Oceanographic and Limnological Research, IL

Participating Utilities

Stockholm Vatten AB, SE
Lake Research Department, UFZ, Magdeburg, (Karsten Rinke PhD), DE
Oslo Kommune Vann og avløp, NO
Irish Water (Dr Brian Deegan), IE
Israeli Water Authority (Dr Doron Markel), IL

High frequency automated monitoring of weather, lake physical properties, chemistry and biology.

Monitoring

Assimilate monitoring data to provide optimal model setup and best possible simulation results

Simulate changes in water quality using models driven by short term weather forecasts or longer term climatological data.

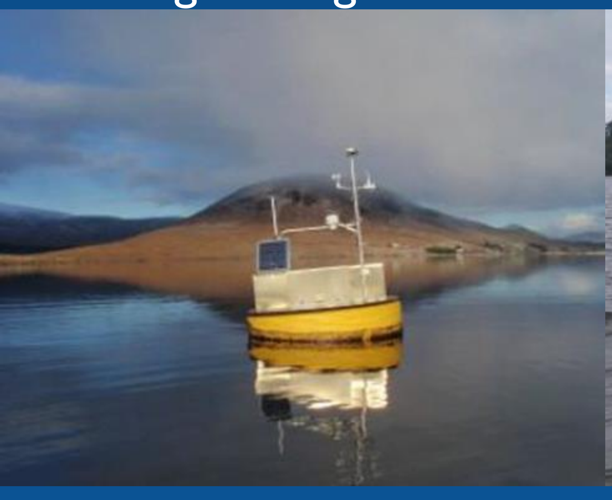
Modelling

Adaptive Management

Optimize choice of water source and treatment in response to ongoing and anticipated changes in source water quality

PROGNOS Monitoring

Lough Feeagh Ireland



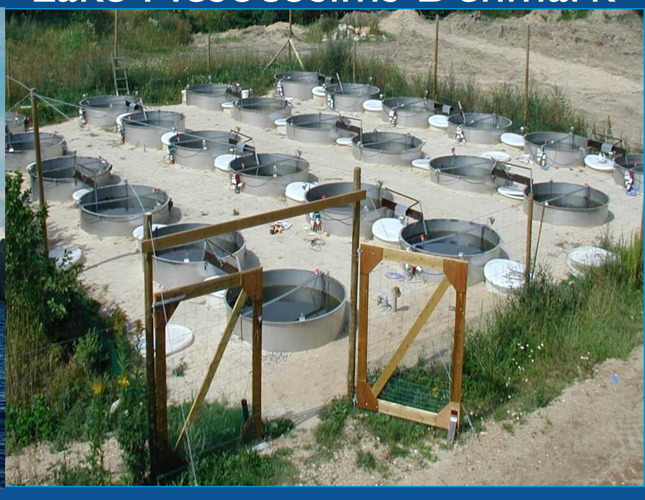
Lake Mälaren Sweden

Lake Langtjern Norway

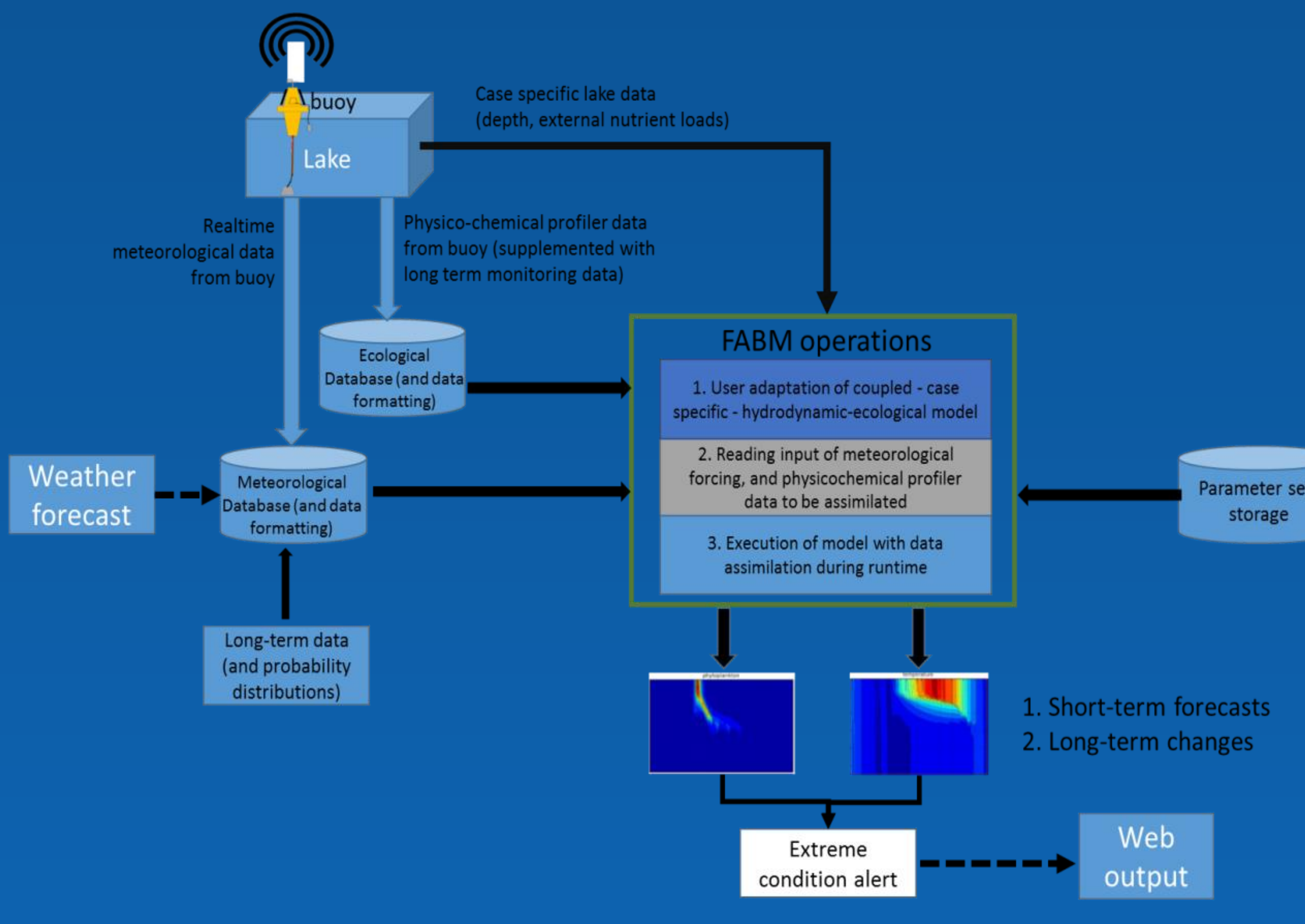
Lake Kinneret Israel

Lake Erken Sweden

Lake Mesocosims Denmark



PROGNOS Modelling System



Objectives

- Demonstrate the value of High Frequecy (HF) water quality monitoring to provide information to support water managment decisions
- Couple HF monitoring data to water quality models in order to provide short-term water quality forecasts.

Innovation

- A system to provide forecasts for adaptive water management
- Developing methods of data assimilation into models
- Developing methods to routinely process data, run simulations and produce forecasts
- Cost benefit analysis working with information from major water supplies

Benefits

- Information to optimize water withdrawal and use
  - Reduce treatment cost and chemical usage
  - Improved use of HF monitoring data
- Development and strengthening of European SMEs involved in water monitoring and decision support
- Improved knowledge on how climate regulates water quality

Challenges

- Including watershed response into water quality forecasts
- Developing and communicating estimates of forecast uncertainty
- Repressiveness of weather forecasts to local processes

Synergies

- Water quality simulations with longer time windows
  - Medium term seasonal forecasts
  - Future climate scenarios

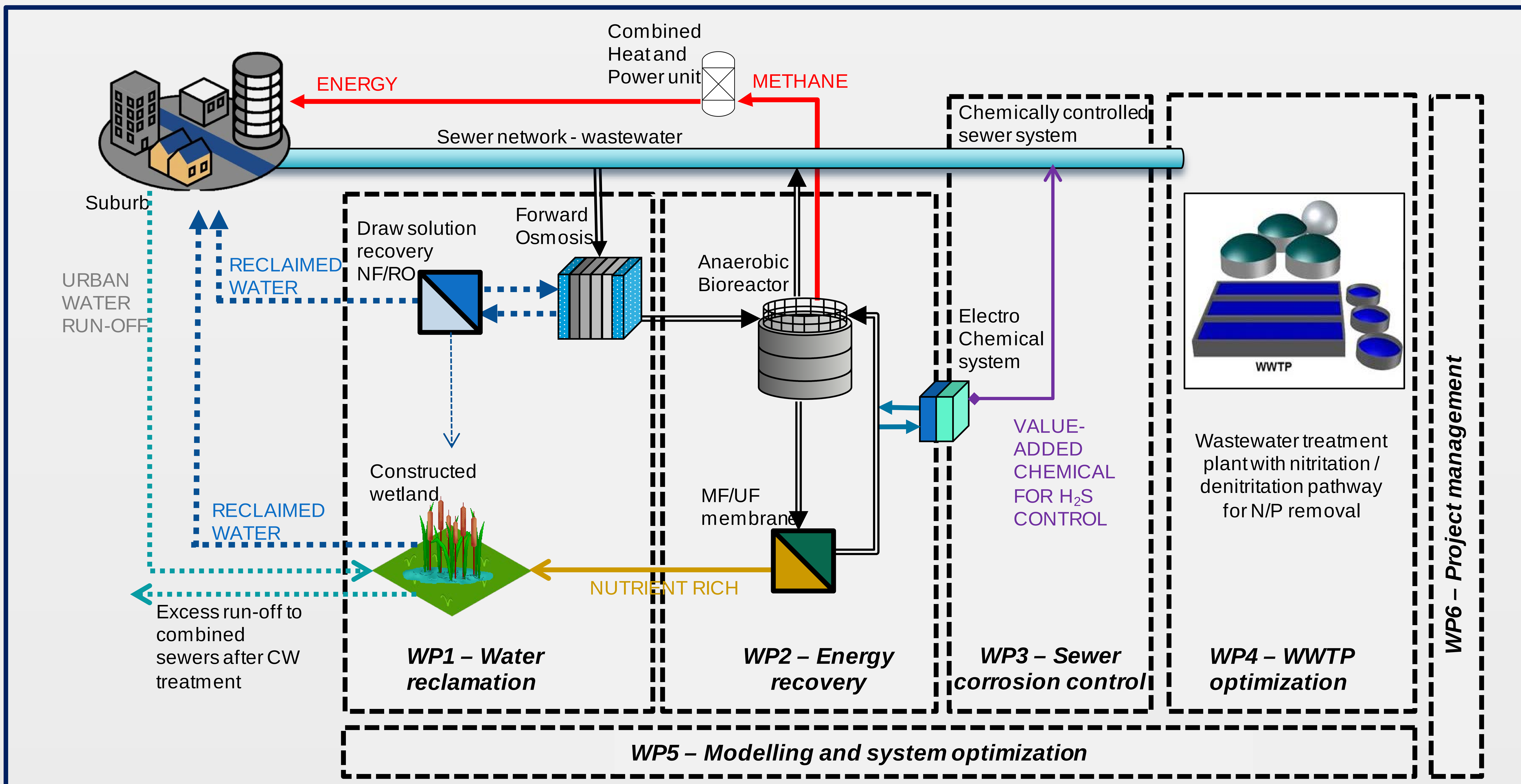
Possible Collaborations

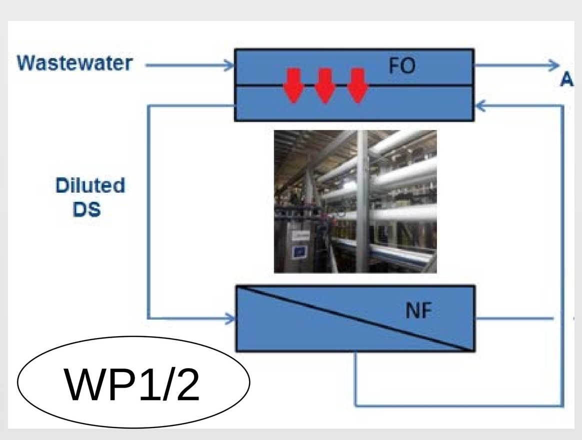
- Other Water JPI project reliant on weather forecast information
- Climate JPI projects involving water quality
- The Inter-Sectoral Impact Model Inter-comparison Project

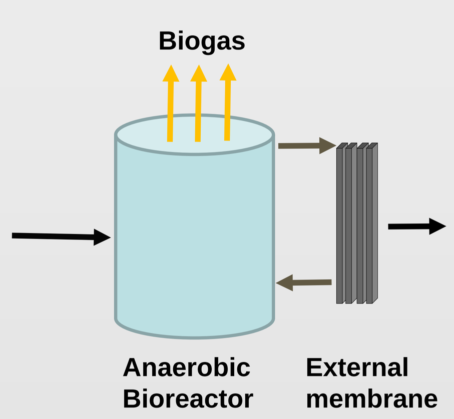
WATINTECH: Smart Decentralized Water Management through a dynamic integration of technologies

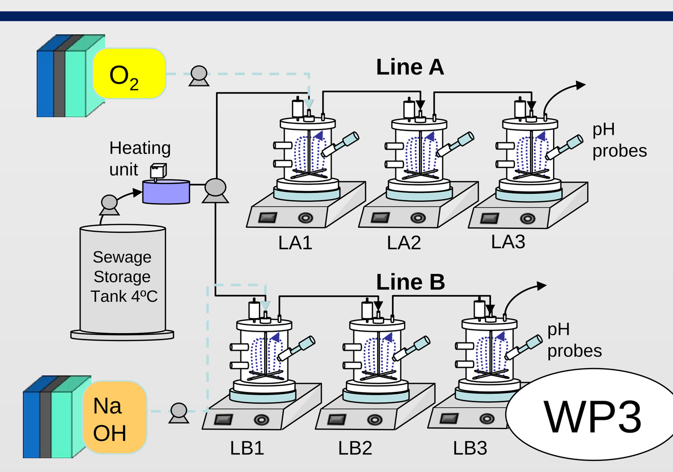
ACCIONA AGUA S.A.
UNIVERSITÀ DI CATANIA
DENMARK TECHNICAL UNIVERSITY, DTU
UNIVERSIDADE NOVA DE LISBOA, NOVA.ID.FCT
CATALAN INSTITUTE FOR WATER RESEARCH, ICRA

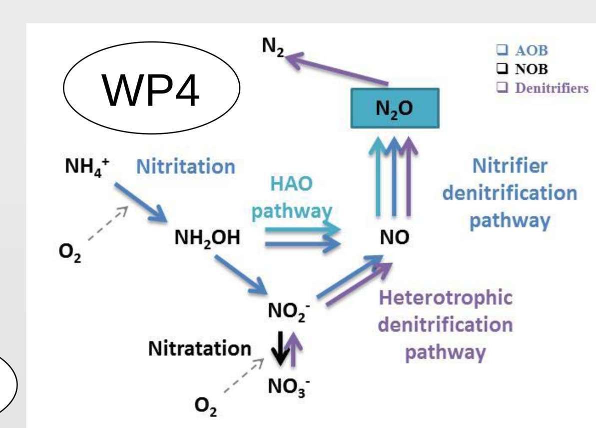
The main goal of the project is the development of effective decentralised wastewater treatment-water recovery units that, besides locally reclaimed products (water, energy and value-added products), will allow a better control of wastewater infrastructures under variable weather events, easing the pressure on the centralised systems, thus expanding their asset life-time and reducing the treatment costs.

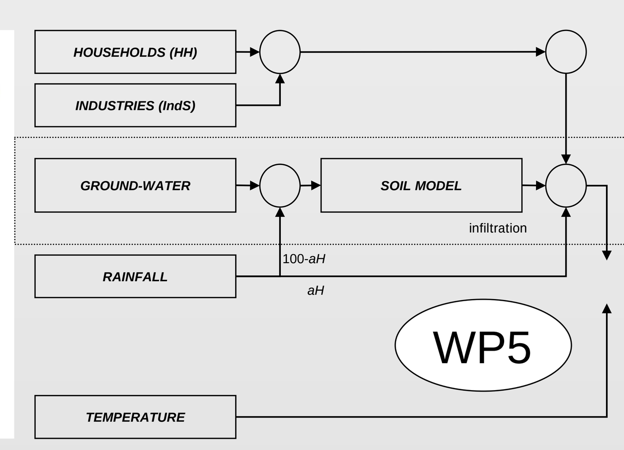












- Technical and economic evaluation of long-term FO filtration of real wastewater.
- To select a specific draw solution for the FO+AnMBR process.
- To evaluate the viability of using a CW for alternative treatment of urban run-off and reclaimed water. Impact of evapotranspiration rates, salinity and nutrient-rich effluents.
- To optimize energy recovery of an AnMBR treating wastewater concentrated with FO.
- To study the application of an electrochemical unit coupled to the AnMBR to minimize sulphide inhibition of methanogenesis and generate value-added chemicals used to control sulphide formation in sewers.
- To optimize the nitritation/ denitritation pathway in the WWTP downstream to remove nitrogen and phosphorus in the presence of wastewater with a low chemical oxygen demand (COD) content.
- To develop a set of mathematical models describing some of the innovative processes to foster their integrated optimization.
- To develop a multi-criteria DSS based on the developed models and knowledge acquired for planning of integrated centralised/decentralised urban water systems.

Synergies

FRAME	WATINTECH project could serve as a case study for the developed evaluation procedure
MOTREM	Advanced Oxidation Process developed by MOTREM project could be complementary for the decentralised wastewater treatment process proposed by WATINTECH project
Pioneer_STP	WP4 could cooperate with Pioneer_STP project on N removal process under lack of COD conditions

The work described in this project has received funding from MINECO - Ministry of Economy and Competiveness, Spain, and from the other national agencies in the frame of the collaborative international consortium WATERJPI2015 WATINTECH of the Water Challenges for a Changing World Joint Programming Initiative (Water JPI) 2015 call. irodriguezroda@icra.cat

WE-NEED

WatEr NEEDs, Availability, Quality and Sustainability

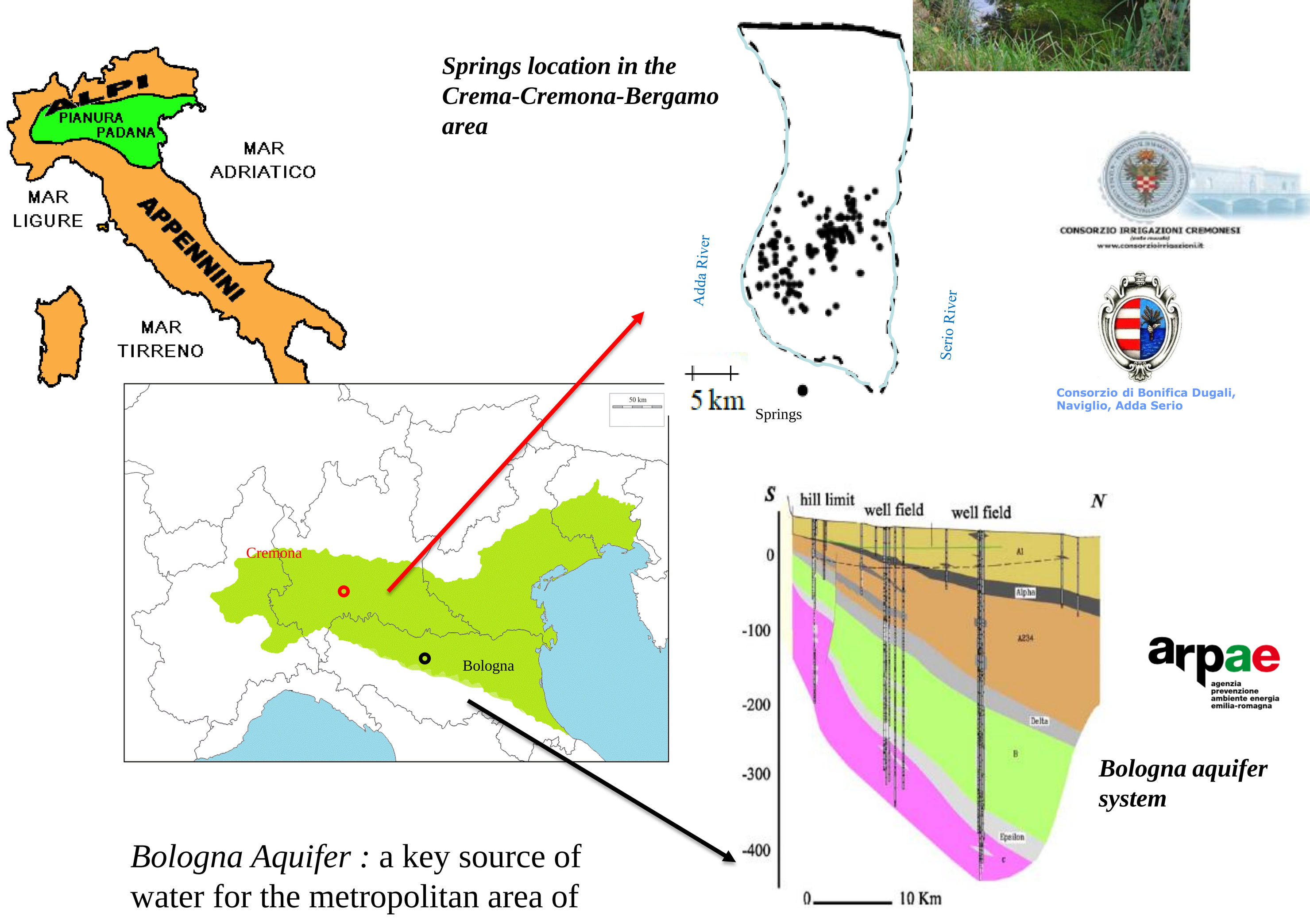
Monica Riva (Coordinator)	**Politecnico di Milano - Italy**	**Polimi**
Brian Berkowitz	Weizmann Institute of Science - Israel	Weizmann
Susana Loureiro	Universidade de Aveiro - Portugal	UAVR
Daniel Fernandez-Garcia	Universitat Politecnica de Catalunya - Spain	UPC

GOAL: Develop new management strategies to assist the sustainable use/protection of Groundwater resources (springs – wells)

KEYWORDS: Management/Protection of Groundwater Resources – Sustainability - Risk Assessment – Relevant Studied Cases (real scenarios) - Multiscale

WATER QUANTITY : Over-exploitation of Groundwater Resources
WATER QUALITY: Regulated and Emerging Contaminants

Cremona/Crema Aquifer: located within the northern part of the Padana Plain, in the so-called *Springs Belt*. Natural high-quality water springs are the main supply to agriculture and a key environmental driver.



Bologna Aquifer : a key source of water for the metropolitan area of Bologna.

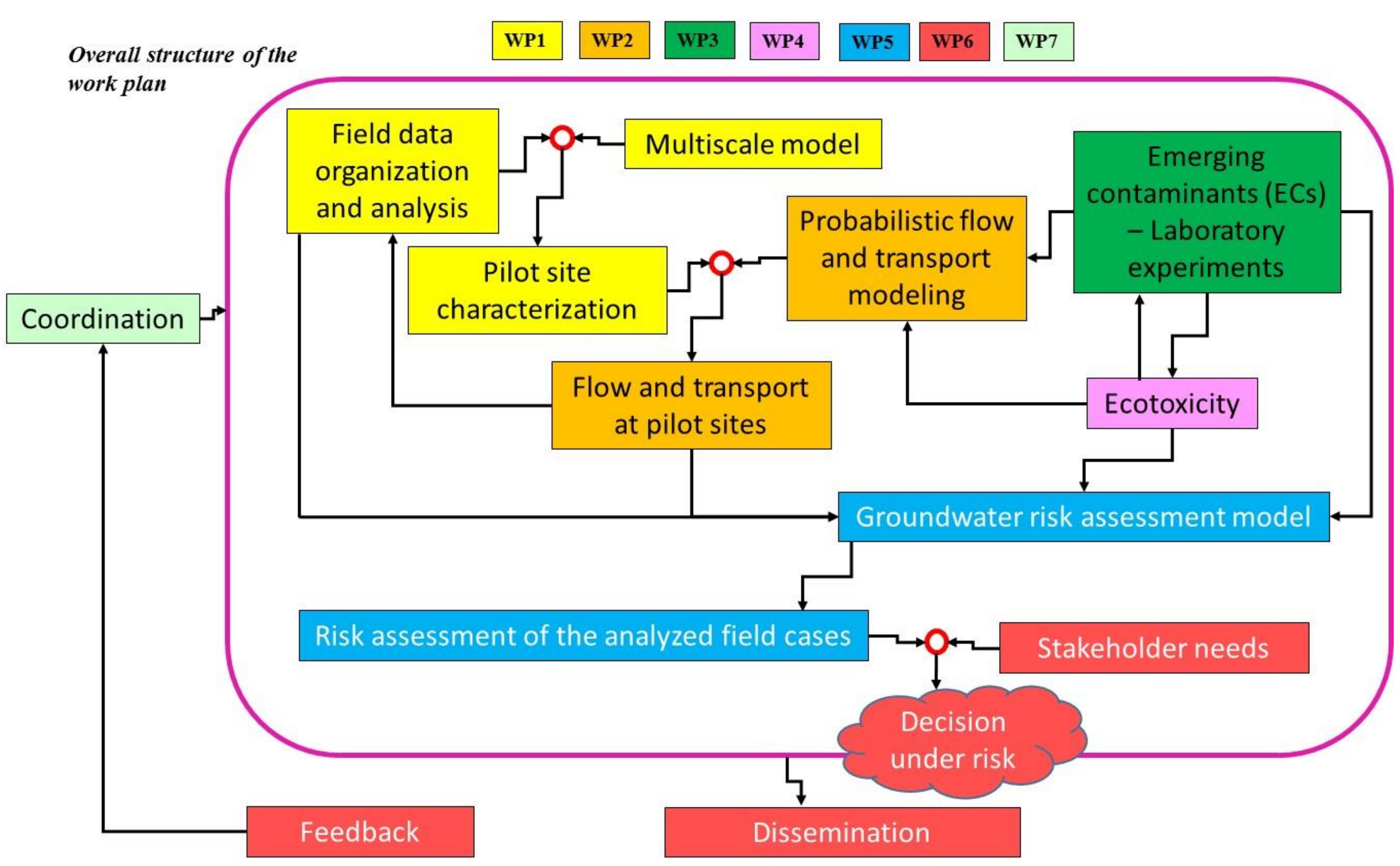
Scientific/Application-oriented objectives:

- Develop methods/models that analyse/incorporate **uncertainty quantification** and **its propagation across observation scales** (as grounded on direct observations/experiments at diverse scales of interest).
- Provide quantitative understanding and **process-based models** of the hydrogeological system and geochemical behavior of reactive chemical species **in relevant scenarios**.
- Include these results within a **decision making** framework for the **sustainable use of water**, preserving historical heritage, and producing acceptable risk to existing ecosystems.
- Assessment of the contaminant-specific **vulnerability** of the aquifer systems.
- Physically-based **risk assessment** and water management protocols.

Start day: 20 April 2016 – Duration:3 years

		Lead Partner	Participating Partner
WP1	Data collection and multiscale characterization	Polimi	UPC, UAVR, Weizmann
WP2	Probabilistic flow and transport modeling	UPC	Polimi, Weizmann
WP3	Fate of ECs - laboratory experiments and modeling	Weizmann	UAVR
WP4	Ecotoxicology	UAVR	Weizmann
WP5	Multidisciplinary risk assessment and decision making	Polimi	UPC, UAVR, Weizmann
WP6	Dissemination of results, communication with stakeholders/general public	Polimi	UPC, UAVR, Weizmann
WP7	Project management	Polimi	

Overall structure of the work plan



Innovation

(1) **Statistical Scaling**. Models to describe aquifer functioning under the influence of uncertain parameters and processes defined at diverse spatial scales.

(2) Characterization of the **fate of EC in aquifers.**

(3) Quantification of the effect of **multiple sources of uncertainty** (hydrogeological settings, aquifer architecture, abstraction rates, sources and loads of contamination,..) on sustainable management and protection of the groundwater bodies.

(4) Application of Stochastic groundwater models in **real-relevant hydrogeological studies**.

(5) Probabilistic Risk assessment (incorporating health implications). Decision making under Risk.

Expected impacts

(1) Quantification of the uncertainty linked to evaluation of environmental **impacts of groundwater extraction and contaminant dynamics** (through modeling, delimitation of data requirements, and innovative experimental analyses).

(2) Provision of an **understandable and ready-to-use platform for risk analysis and management under uncertainty** (relying on data acquired and rational use of modeling options and capabilities).

(3) Increase our level of confidence by **reducing uncertainties** regarding new substances that require regulation.

(4) Offer improved risk assessment and management practices with an overall effect of **reducing future costs** associated with over-exploitation/contamination of groundwater.

MINISTERO DELL'ISTRUZIONE, DELL'UNIVERSITÀ E DELLA RICERCA
FCT Fundação para a Ciência e a Tecnologia
GOBIERNO DE ESPAÑA MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD
Ministry of National Infrastructures, Energy and Water Resources

Treatment of emerging pollutants with advanced oxidation processes and adsorption

UNIVERSITY OF OULU

UNIVERSITY OF EASTERN FINLAND

UNIVERSITY OF JYVÄSKYLÄ KOKKOLA UNIVERSITY CONSORTIUM CHYDENIUS

KAJAANIN AMMATTIKORKEAKOULU UNIVERSITY OF APPLIED SCIENCES

Advanced oxidation processes in wastewater treatment (AOPI)

University of Oulu, Research Units of 1) Sustainable Chemistry and
2) Environmental and Chemical Engineering, FI-90014 University of Oulu, Finland
3) University of Eastern Finland, School of Pharmacology and Toxicology, FI-70211, Kuopio, Finland

AOPI project aims at providing new information on the use of advanced oxidation processes in the treatment of industrial wastewaters (from food and pharmaceutical industry)

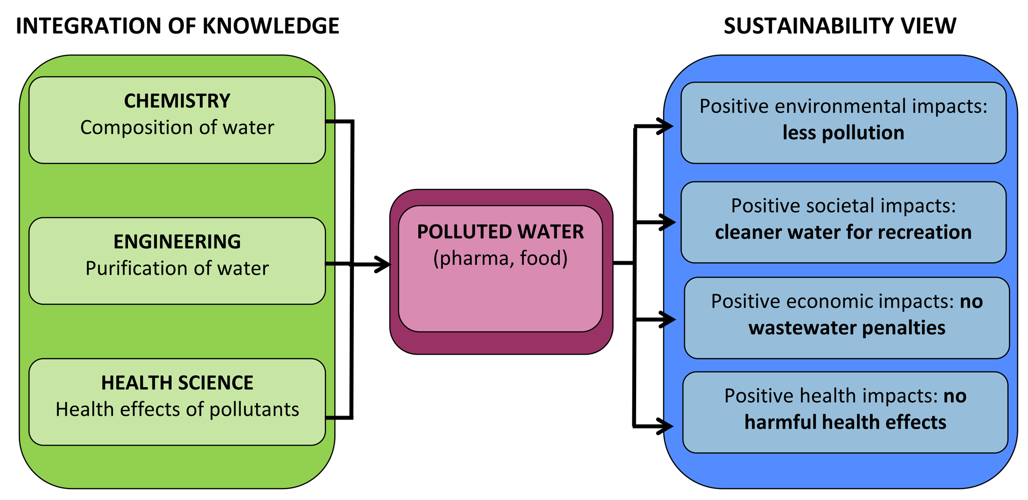


Figure 1. Integration of knowledge within AOPI project from the viewpoint of chemistry, engineering and health sciences.

Objectives:

1) Determination of the compositions of wastewaters in pharmaceutical and food industry

2) Evaluation of health effects of selected industrial effluents and possible reaction by-products of the wastewater treatment process

3) Development of a hybrid method for the treatment of food and pharmaceutical industries' wastewaters by photocatalysis and catalytic wet air oxidation

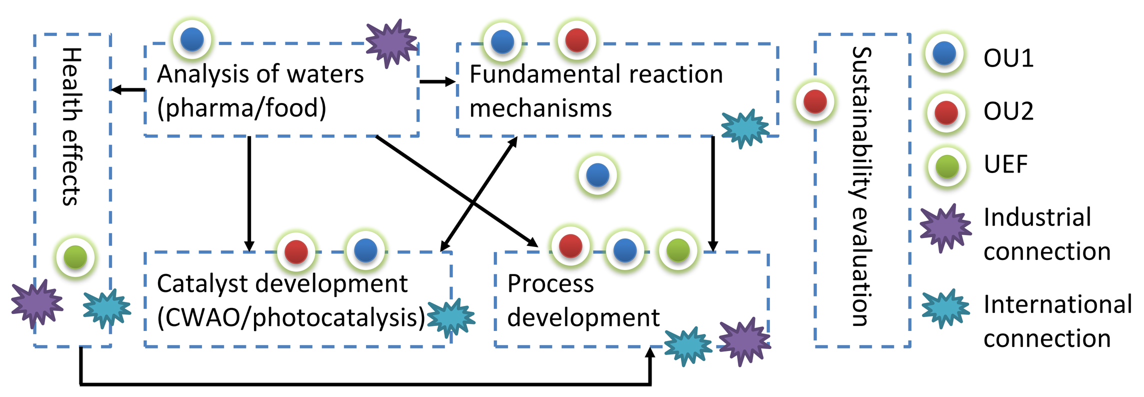


Figure 2. Project description; connections between themes, responsible groups and international connections.

Table 1. Selected model compounds for advanced oxidation processes and toxicity studies.

Compound	Typically used
Bisphenol A	Plasticizer
Phthalic anhydride	Plasticizer
Diuron	Pesticide
Perfluorooctanoic acid (PFOA)	Fluoropolymers (for non-stick surfaces)

GeoSorbents

1) University of Oulu, Research Unit of Sustainable Chemistry, FI-90014 University of Oulu, Finland
2) Kajaani University of Applied Sciences, FI-87101 Kajaani, Finland
3) University of Jyvaskyla, Kokkola University Consortium Chydenius, Unit of Applied Chemistry, FI-67100, Kokkola, Finland

In GeoSorbents project novel geopolymer based water treatment materials are developed from low-cost clay minerals and industrial side-products with industrial partners

Geopolymers: three-dimensional cross-linked inorganic polymers with an amorphous, semi-, or polycrystalline structure
Prepared by establishing a reaction between aluminosilicate raw materials and alkali metal hydroxide and/or silicate or phosphoric acid solution

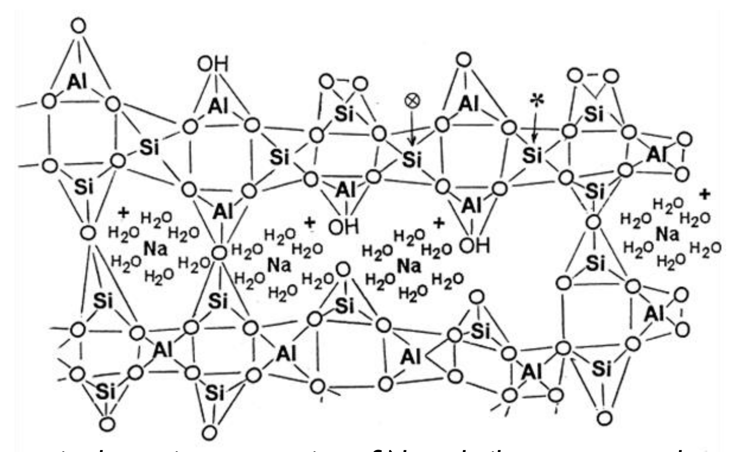


Figure 3. The semi-schematic presentation of Na-polysilate type geopolymer.

The specific developed materials can be used for the removal of toxic metals and metalloids, sulfate and ammonium nitrogen from industrial and municipal wastewaters, mine waters and landfill leachates

Figure 4. Prepared geopolymer based materials.

Table 2. Examples of prepared geopolymer based materials.

Geopolymer	Used for
Metakaolin	Ammonium removal from municipal ww and landfill leachates
Blast-furnage-slag	Ni(II), As(III), and Sb(III) removal from a spiked mine effluent
Ba-modified blast-furnage-slag	Sulfate removal from model solution as well as mine water

Increasing the outcomes of the projects:
- Collaboration with other projects (funding programmers, e.g. AKVA from Academy of Finland)
- Knowledge of the project to the industry

Limits to go further
- Projects are ending => new project applications needed
- Need for industry partners

Effectivity of RDI community in the field of emerging pollutants
- Networking events
- Knowledge from the projects to the politicians, ministry, EU
- Also project have to be active!

How the alignment can be achieved more effectively for a higher impact
- Project databases available for large audience

How to make use of the RDI results in emerging pollutants
- Collaborations with industry, politicians
- Project webpages
- New consortias
- Knowledge spreading

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AKVA

ACADEMY OF FINLAND

Leverage from the EU 2014–2020

European Union
European Regional Development Fund
European Social Fund

Acknowledgements: The authors gratefully acknowledge the Academy of Finland for providing research funding, AOPI project (263397) within the research program for Sustainable Governance of Aquatic Resources (AKVA) and Finnish Funding Agency Tekes for providing research funding, GeoSorbents project (4684/31/2014).

Science with Arctic Attitude

Ilkka T. Miettinen*, Antti Simola** and Timo Huttula***
*National Institute for Health and Welfare, Kuopio, Finland; ** VATT Institute for Economic Research, Helsinki, Finland; *** Finnish Environment Institute, Jyväskylä, Finland

Aquatic Contaminants – Pathways, Health Risks and Management (CONPAT)

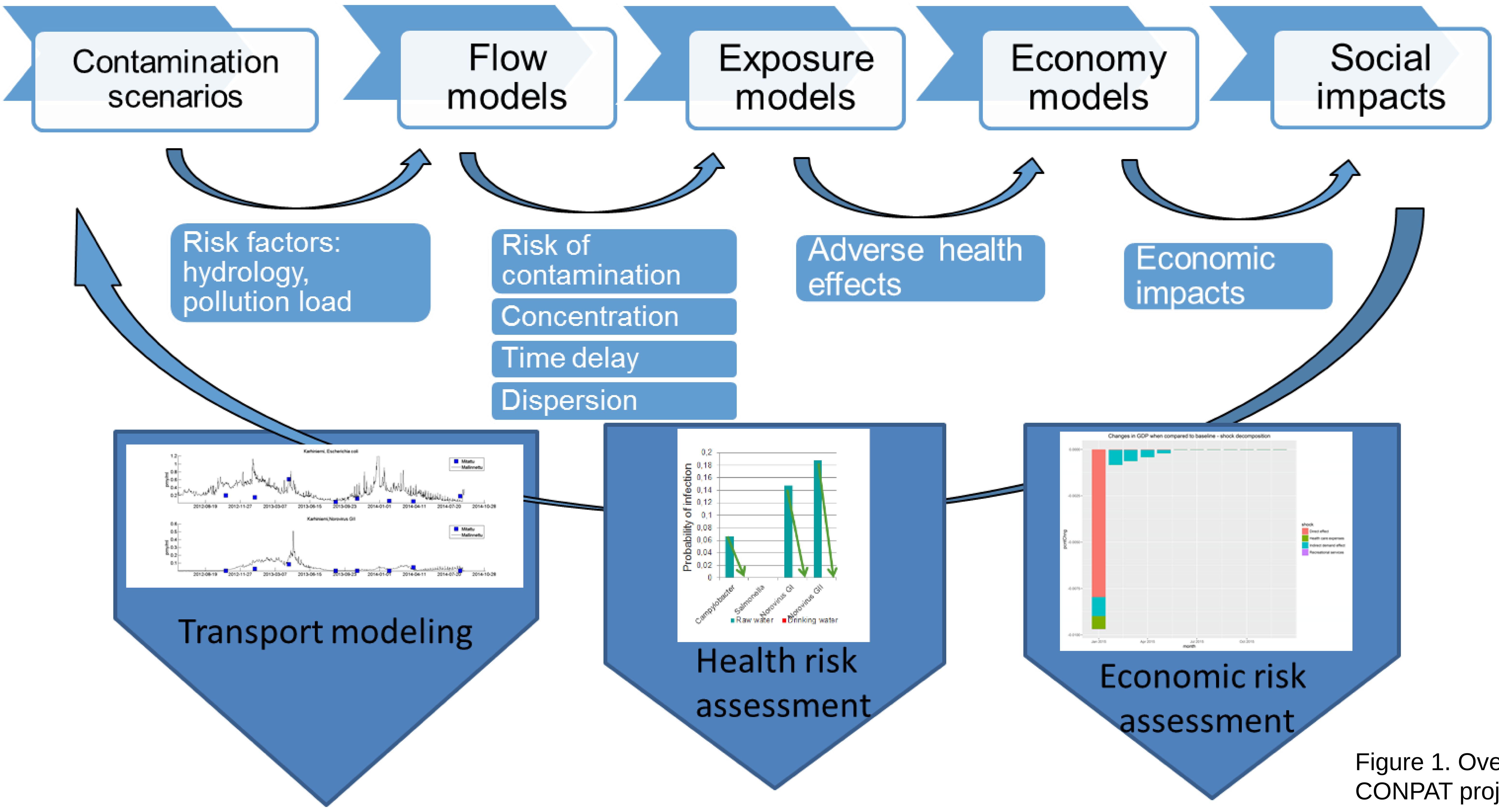


Figure 1. Overview of CONPAT project

Consortium

National Institute for Health and Welfare
- Microbiological analyses
- Health risk assessment

Finnish Environment Institute
- Analyses of chemical pollutants
- Transport modelling of microbes and chemicals

VATT Institute for Economic Research
- Assessment of economic effects

Objectives

CONPAT-consortium (Fig.1) aims to study the sources, behaviour and fate of microbial and chemical contaminants and model their transport in a water course. Subsequently, the effects of the contaminants to the human populations are assessed, and economic costs of the harmful effects and of mitigation of these effects are predicted. The overall objective is to create scientifically sound and socially responsive knowledge and tools for predictions and risk assessments regarding behaviour of contaminants and effects in water courses and in drinking water systems.

Impacts of the CONPAT project

The project results in knowledge which can be used to improve the sustainable use of aquatic resources and on securing the drinking water supplies. It establishes interdisciplinary links between water cycles, water contamination, risk assessment, risk communication, costs of mitigation actions and social effects.

Links to SRIA

Theme 2. Developing safe water systems for citizens

CONPAT: risk assessment and risk management of emerging pollutants

Collaboration

Limits for collaboration: CONPAT project will close by the end of the year 2016.

CONPAT team welcomes co-operation with other research institutes and universities in planning of future Water JPI and H2020 projects.

Usage of RDI (CONPAT) activities
- Leading-edge analytical tools for detection of microbial and chemical pollutants
- Transport modeling of emerging microbes and chemical in surface and ground water environments
- Human risk assessment of pollutants
- Economic assessment concerning pollution effects and mitigation actions
- Assessment of social effects (risk communication) due to pollution

Management of emerging pollutants
- Application of modern detection methods
- Modelling of pollution (fate of pollutants) in aquatic environments
- Risk assessment

Contact and more info
- Consortium leader dos. Ilkka Miettinen: ilkka.miettinen@thl.fi
- Consortium web page: http://en.opasnet.org/w/CONPAT

SYKE VATT ACADEMY OF FINLAND AKVA

Project funded by the Research Council of Norway Project contract n. 244460

https://youtu.be/EtlvuGKI3I0

POLLUTION AND ECOSYSTEM ADAPTATION TO CHANGES IN THE ENVIRONMENT (PEACE)

Luca Nizzetto[1], Didier Baho[1], Eva Leu[2], Francesco Pomati[3], Jannicke Moe[1], Jostein Starrfelt[4], Dag Hessen[4], Jon Norberg[5]

https://youtu.be/EtlvuGKI3I0

1. A "PEACE philosophy"

This project focuses on ecological responses **in freshwater ecosystems induced by realistic exposure to mixtures of emerging contaminants. End-points of our analysis are** changes in structures and functioning **of the ecosystems,** resilience **boundaries and** adaptation.

2. Research questions

- Does exposure to diffuse chemical contaminants affect the way by which aquatic ecosystems respond to environmental changes?
- Have historically polluted ecosystem already developed adaptations to cope with degraded environmental conditions?

3. Consortium and expertise

[1]**Norwegian Institute for Water Research** (NO): Environmental chemistry, freshwater ecology, phytoplankton taxonomy
[2]**Akvaplan-niva** (NO): Phytoplankton physiology and photophysiology
[3]**EAWAG** (CH): Scanning flow cytometry, functional ecology.
[4]**University of Oslo** (NO): Freshwater ecology and biogeochemistry
[5]**Stockholm Resilience Centre** (SWE): Theory of complex adaptive systems.

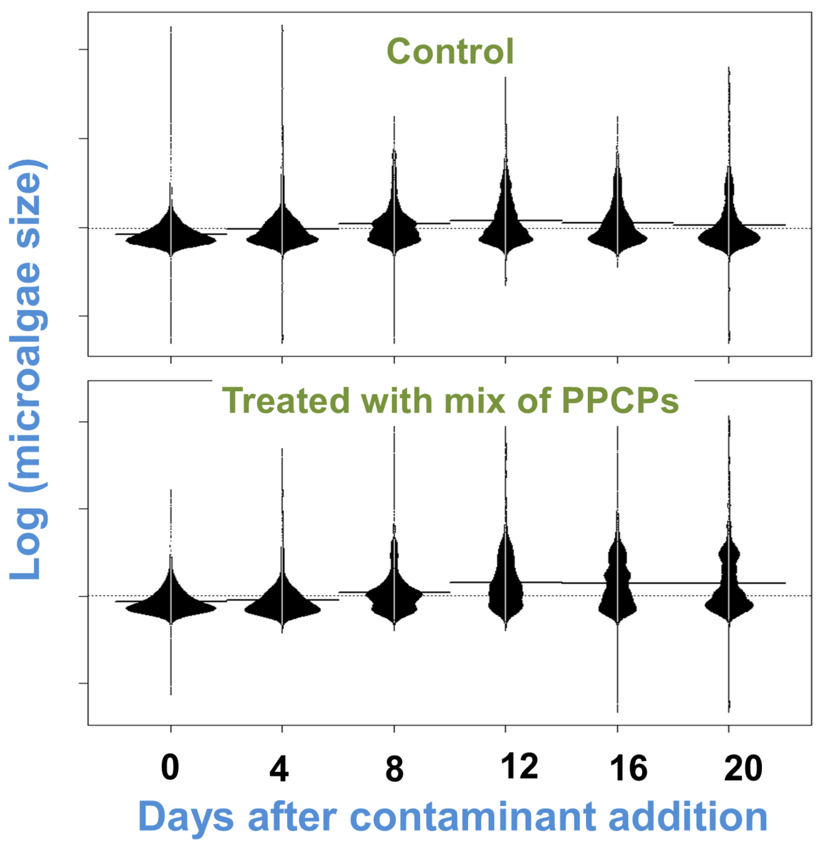
4. Stakeholders

- International scientific community
- National and international environmental authorities
- Water industries (Oslo WWTP actively involved)
- The society (directly involved in the project: local authorities, lake users (e.g. sport and fishing clubs)
- Environmental organizations (e.g. www.pura.no).

5. Overview

In lakes, microscopic algae sustain the food web providing energy that supports the life of superior organisms. Climate change is expected to increase instability of ecosystems and enhance fluctuations in environmental conditions. High response capacity of the community composing the ecosystem is necessary to cope with these changes while preserving ecosystem services and productivity. Many species of algae are highly adaptive and can respond by growing rapidly after disturbance. However, the diffuse burden of chemical pollutants present in many lakes originating from atmospheric depositions, run-off and emission of substances in wastewater effluents can favor species of algae that are more tolerant to chemical pollution to the detriment of more adaptive ones. Hence, pollution may prevent the ecosystem to promptly re-gain structures and functions after extreme events.

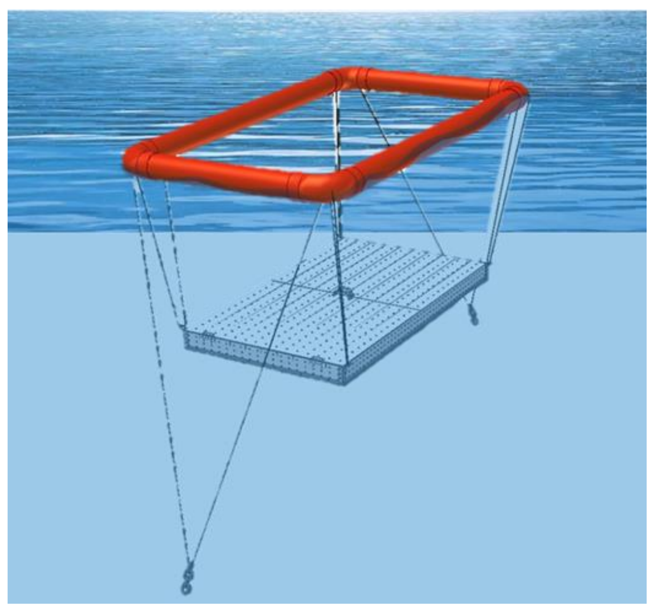
6. Tackling response capacity of ecosystems under combined environmental and pollution stressors

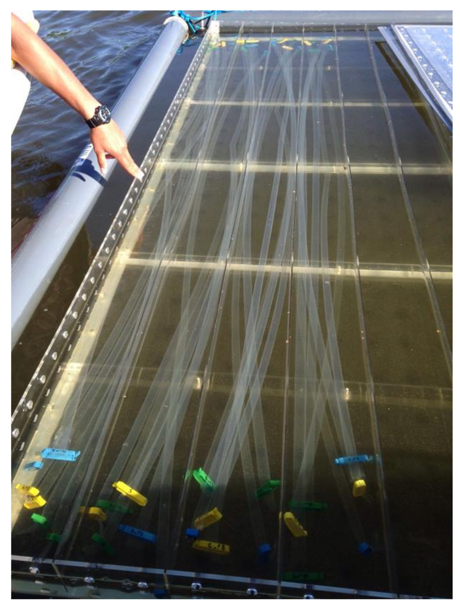


A field experiment has been conducted to investigate if natural freshwater phytoplankton can cope with combined anthropogenic and natural disturbances, such as:

i) diffuse chemical pollutants that are the constituents of everyday life commodities, such as pharmaceutical, personal and house care products;

ii) abrupt environmental changes related to climate change that disrupt stratification patterns in lakes.





7. Have ecosystem evolved to cope better with pollution during the anthropocene?

Experimental activity aimed at addressing long-term adaptation of European freshwater ecosystems to chemical pollution will be conducted. We will use techniques of "resurrection" ecology to seed the re-emergence of ecosystems from sediment core samples under controlled conditions. The aim of the study will be to assess if communities from historically contaminated environments respond differently to pollution stress compared to those from pristine lakes. We plan to use sediments from several European lakes with different inflow of urban waste water effluents.

8. Expected impacts

- Improved understanding of freshwater ecosystem resilience boundaries for diffuse pollution
- Improved understanding of ecological responses to contaminant stressor
- Improved understanding of the real pressure of diffuse pollution (sublethal levels) on ecosystem structure and services
- Going beyond current risk assessment by focusing on holistic analysis of effects rather than reductionistic
- Improving chemical management and regulation in Europe
- Reducing the impacts of pollutants on fresh water ecosystems
- Improve awareness on the actual implications of emerging pollutants in freshwater environments.
- New knowledge useful to counteract the loss of biodiversity and preserve ecosystem resilience
- Relevant to EU-REACH, EU-WFD, Priority substances directive, Urban wastewater Directive, UN-SDG

9. Link to SRIA

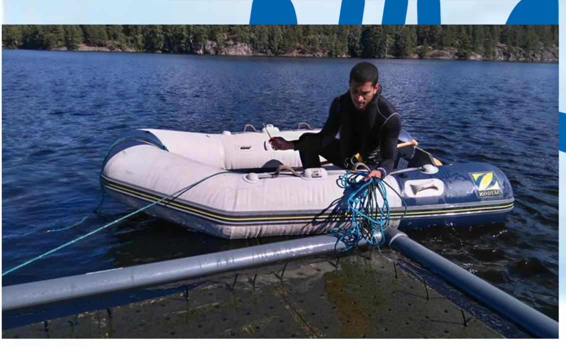
- **Subtheme 1.1:** Developing Approaches for Assessing and Optimising the Value of Ecosystem Services
- **Subtheme 2.1:** Emerging Pollutants and Emerging Risks
- **Subtheme 3.2**: Enhancing the Regulatory Framework
- **Subtheme 5.1:** Enabling Sustainable Management of Water Resources

10. Perceived limitations

- Short term funding perspective (4 years project, no guaranteed financial continuity)
- Available funds insufficient for involving the human resources needed for full exploitation of the project potential
- Need for an official European institutional mandate for more ecological approaches in chemical risk management

11. Value from collaboration

- Overcoming budget limitations and expanding the scopes
- Enhancing holistic perspective and adding analytical endpoints (e.g. addressing evolutionary responses through metagenomic analysis)
- Getting beyond the «local» perspective (i.e. possibility of running studies on ecosystem resilience to pollution spanning over biomes)



Reversible Adsorption Process for aqueous Micropollutants

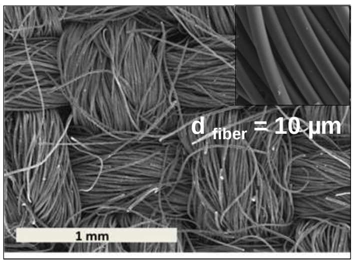
PARME ("Procédé d'Adsorption Réversible de Micropolluants dans l'eau")

Funded by the National Research Agency (France)

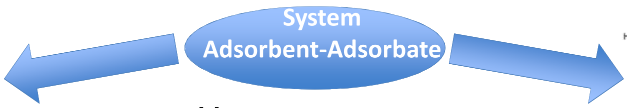
Coordinator : S. DELPEUX, Interface Confinement Material Nanostructures (delpeux@cnrs-orleans.fr)
Partners : LCME (laurent.duclaux@univ-savoie.fr), ENSCR (nicolas.cimetiere@ensc-rennes.fr),
DACARB (spellerin@dacarb.com), AQUALTER (akaddoum@aqualter.com)

Expected objectives and outcomes

The project aims at treating the increasing pollution caused by micropollutants in water by developing <u>**a cyclable process combining rapid and efficient adsorption of**</u> **emerging** water <u>**micropollutants**</u> on activated carbon fabrics (ACF) <u>**and the successive regeneration of this adsorbent through electrodesorption**</u>. **A wide variety of target molecules were studied among industrial rejects** (solvents, plasticizers), **phytosanitary products** (pesticides) **and medicines** (hormones, bioactive molecules).

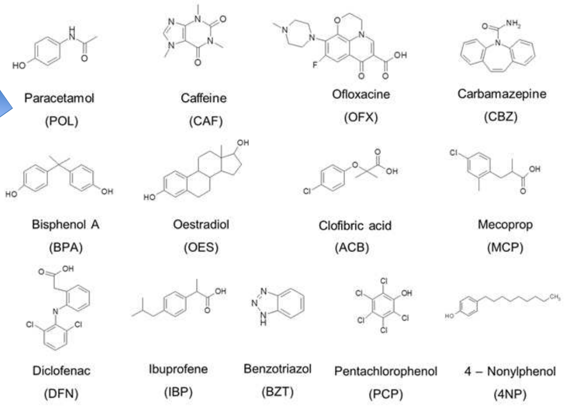


SEM image : ACF (DACARB, France)



Expected impacts:

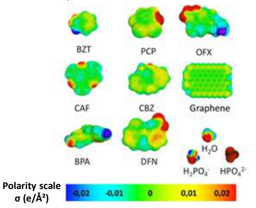
Science: understand and model the adsorption mechanism
Health and environment protection: depollution of underground water or waste water
Water policy: fulfill the water European standards
Technology: Develop a reversible adsorption-desorption process to remove the micropollutants pollution. Transfer of this technology to an industrial scale

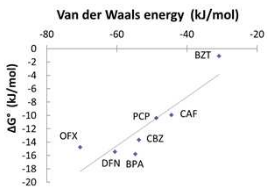


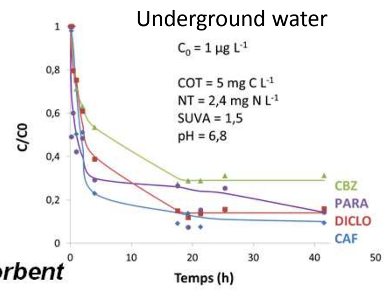
Highlights : ICMN, LCME, ENSCR

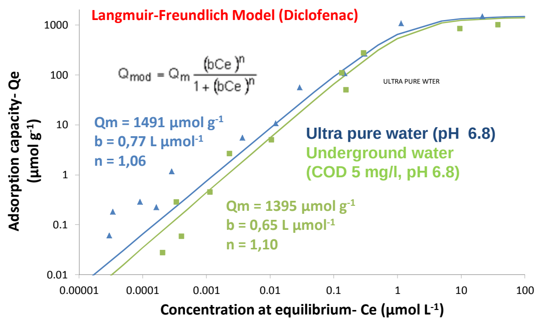
- ***Adsorbent characterization (chemistry and porosity)***
- ***Single and multi components adsorption isotherms and kinetics***
- ***Competition of adsorption with dissolved natural organic***
- ***Extrapolation at trace concentrations***
- ***Modelling at a molecular scale, thermodynamics***

(S. Masson, Ph . D Thesis of University Savoie Mont Blanc, France)









- ***Electrochemical regeneration of the ACF adsorbent***

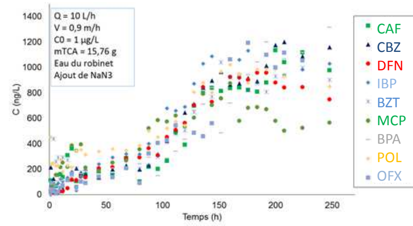
(M. Gineys, Ph . D Thesis of University of Orléans, France)

Mixture of micropollutant in batch	% desorption C_i=1-2 mg/L	% desorption C_i=0.01 mg/L
Diclofenac	0	1.7
Ibuprofen	7.4	0
Ofloxacine	0	2.4
Carbamazepine	0	0
Clofibric Acid	63.7	13.8
Bisphenol A	23.7	0
Mecoprop	23.6	0

- <u>Batch experiment</u> : **regeneration rate** (see table) **depends on molecule type a ACF structural and chemical properties**
- <u>Dynamics pilot studies</u> : **full desorption of all the contaminants at 1 µg/L after some cycles**

- ***Breakthrough curves***
- ***Studies at laboratory and semi- pilot scale***

(H. Fallou, Ph. D Thesis, ENSCR, Rennes, France)



Efficient adsorption of a mixture of 9 contaminants

To go further in the project, in prospects

- **Obtain a rapid and efficient regeneration** in short time cycles
- **Coupling adsorption and other treatment method** (Fenton, Advanced oxidation)
- **Modifying and tailoring the adsorbent** to improve the reversibility
- **Develop other regeneration method** (sponges filters)
- **Transfer the concept to other systems :** metals removal or extraction, industrial effluents

Increase with collaborations

- **Understand the regeneration mechanism in dynamics**
- **Other water treatment methods** (Fenton, Advanced oxidation)
- **Modell and simulate** to determine the role of the physisorption/chemisorption
- **Industrial approach** for water purification

CONTACT :
Sandrine Delpeux : delpeux@cnrs-orleans.fr

- S.Delpeux-Ouldriane et al, Adsorption and Desorption of Emerging Water Contaminants on Activated Carbon Fabrics, International Journal of Environmental Pollution and Remediation, 3 (2015) 55-60
- S. Masson et al, Single, binary, and mixture adsorption of nine organic contaminants onto a microporous and a microporous/mesoporous activated carbon cloth, Microporous and Mesoporous Materials 234 (2016) 24-34
- S. Delpeux-Ouldriane et al , The role played by local pH and pore size distribution in the electrochemical regeneration of carbon fabrics loaded with bentazon, Carbon 94 (2015) 816-825
- M. Gineys et al, Simultaneous determination of pharmaceutical and pesticides compounds by reversed phase high pressure liquid chromatography, Journal of Chromatography & Separation Techniques 6 (2015) 6
- M. Gineys et al, Behavior of activated carbon cloths used as electrode in electrochemical processes, Chemical Engineering Journal, 310 (2016) 1-12
- S. Masson et al, Thermodynamic study of seven micropollutants adsorption onto an activated carbon cloth: Van't Hoff method, calorimetry and COSMO-RS simulations, Environmental Science and Pollution Research, (2016) DOI 10.1007/s11356-016-7614-0
- H. Fallou et al, Adsorption of pharmaceuticals onto activated carbon fiber cloths - Modeling and extrapolation of adsorption isotherms at very low concentrations, Journal of Environmental Management 166 (2016) 544-555

REMANTAS

Enhanced Raman scattering for aquatic media: a new technology for on-site analysis

Coordinator: IFREMER
Partners: BRGM, *Cedre*, Horiba Scientific,
Troyes University of Technology, Paris 13 University

Consortium expertise

Combination of many fields to control all sensor steps:

- Physics, optics and plasmonic,
- Surface and solution chemistry,
- Instrumentation,
- Analytical chemistry,
- Data processing (chemometrics)
- Environmental monitoring

Expected objectives and outcomes

Develop a portable sensor able to detect organic contaminants on-site dedicated to fresh, estuarine and marine waters:

- PAHs,
- VOCs,
- BTEX.

Expected impacts

Allow measurements in environmental conditions to give results quickly and without any sampling steps:

- Monitoring with autonomous instruments,
- On-site results = quick remediation,
- Decrease of contamination risks during sampling and transport,
- On-site identification in case of accidental pollution

Can the outcome be increased with some collaboration?

- Company or start-up specialized in chemical functionalization
- Company or start-up able to be interested in niche market

Limits to overcome

Sensitivity and reproducibility have to be optimized. Needs of specific funding dedicated to optimization and industrialization steps.

Ideas to inscrease RDI community effectiveness

- Communication to companies about environmental analysis needs, to open the market
- Identification of promising technologies for environmental measurements

Higher impact of alignment

Increase the communication of alignment objectives, tools, and levers.

RDI results and emerging pollutants

- Spot-light on some promising and relevant measurement technologies.
- Support the versatile and generic analytical methods able to identify lot's of compounds.

Contact

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DeTER

Detection, Toxicology, Environmental fate and Risk assessment of nanoparticles in the aquatic environment

Eoin Mc Gillicuddy[1,2], Iain Murray[3], David Shevlin[4], Liam Morrison[5], Martina Prendergast[2], Martin Cormican[1,2], Andrew Fogarty[3,6], Enda Cummins[4], Peter Dockery[7], Patrick Dunlop[8], Neil Rowan[3,6], Dearbháile Morris[1,2]

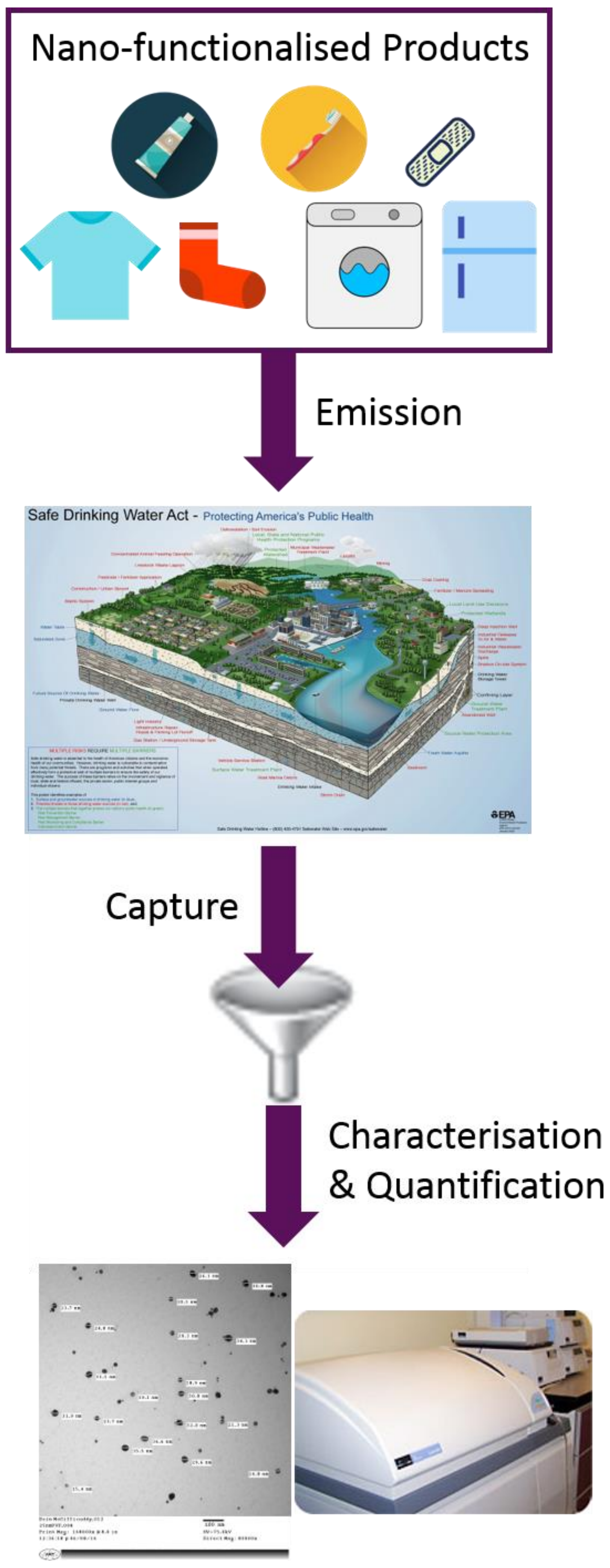
1. Antimicrobial Resistance and Microbial Ecology Group, School of Medicine, National University of Ireland Galway, Galway, Ireland. **2.** Centre for Health from Environment, Ryan Institute, National University of Ireland Galway. Galway, Ireland. **3.** Bioscience Research Institute, Athlone Institute of Technology, Dublin Road, Athlone, Co. Westmeath, Ireland. **4.** School of Biosystems and Food Engineering, University College Dublin, Agriculture and Food Science Centre, Belfield, Dublin 4, Ireland. **5.** Earth and Ocean Sciences, National University of Ireland Galway. Galway, Ireland. **6.** Department of Life & Physical Science, Athlone Institute of Technology, Dublin Road, Athlone, Co. Westmeath, Ireland. **7.** Discipline of Anatomy, School of Medicine, National University of Ireland Galway. Galway, Ireland. **8.** Nanotechnology and Integrated Bioengineering Center, Ulster University, Newtownabbey, UK.

Objectives and Targets

- To develop and implement methods for the detection, characterisation and quantification of silver nanoparticles in water.
- To determine the toxicological properties and environmental fate of silver nanoparticles in the aquatic environment
- To develop risk assessment protocols which can be used to evaluate the environmental fate and likely risk from silver nanoparticles through aquatic pathways

Capture and Detection

The aim of this area of the project is to develop and implement a method for the detection, characterisation and quantification of silver nanoparticles in water.



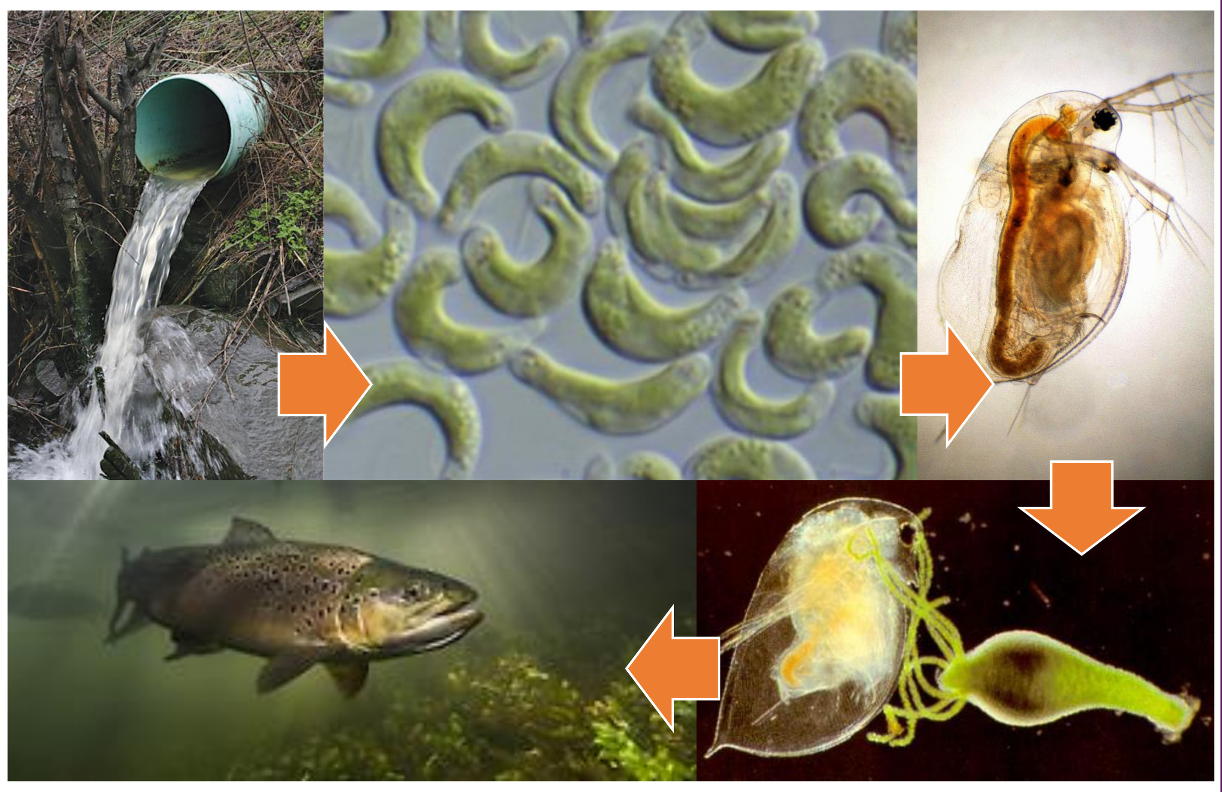
As part of this work package different capture materials and chemical analysis techniques will be investigated to determine their suitability for analysis of AgNPs in natural waters including; ICPMS, SP-ICPMS, TEM and SEM-EDS.

Ecotoxicology

It is widely modelled and assumed that actual concentrations of AgNPs in receiving waters are likely to be low, i.e. in the ng/L range.

Most acute aquatic toxicological assessments lack the sensitivity to evaluate toxicity concerns at this level. This research evaluates AgNP toxicity using acute, chronic and sub-lethal endpoints to evaluate toxicological concerns to the natural flora and fauna of our aquatic ecosystems at environmentally relevant concentrations.

These endpoints include bioconcentration of Ag up the food chain. Bioconcentration of metallic toxicants such as lead and mercury has been shown in the past to be particularly concerning. The experimental design encompasses the classic multi-trophic toxicology test battery assessing acute AgNP toxicity at each trophic level as well as via feeding of upper trophic levels with organisms from lower trophic levels that have been pre-treated at sub lethal concentrations.



Biomagnification

- Detection of Ag uptake at each trophic level following sub-lethal dose (in collaboration with NUIG).

Secondary Consumer

- Acute toxicity assay to higher invertebrates such as *Hydra.*

Primary Consumer

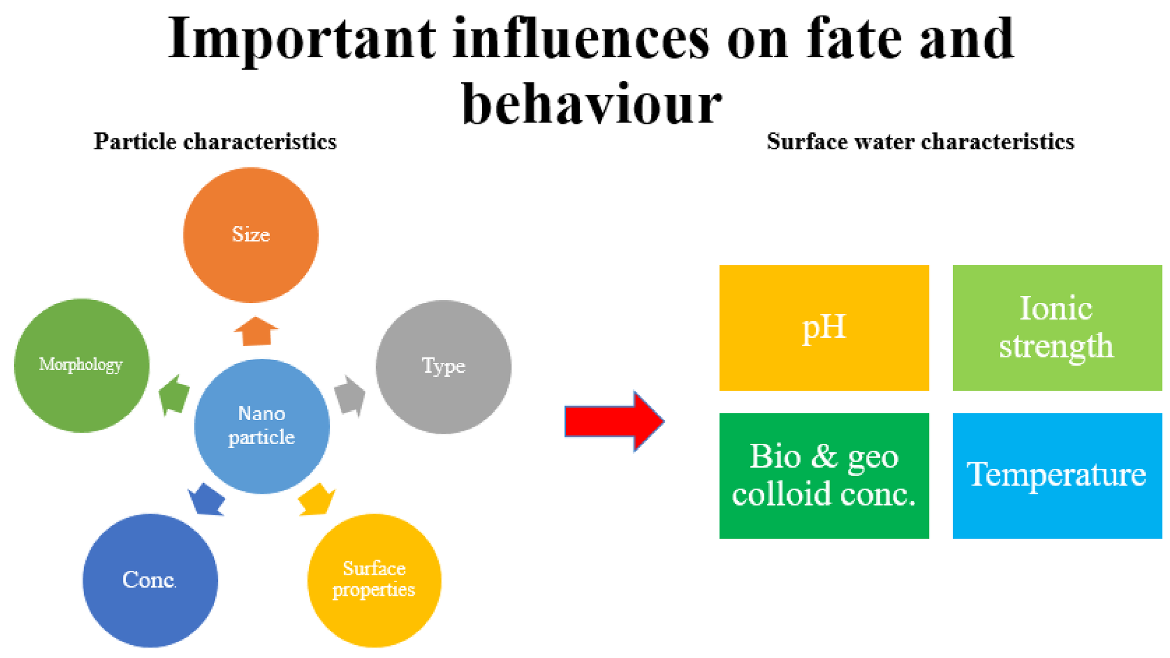
- ISO 6341: 2012 Inhibition of mobility of *Daphnia magna* Acute Toxicity test (with modifications).

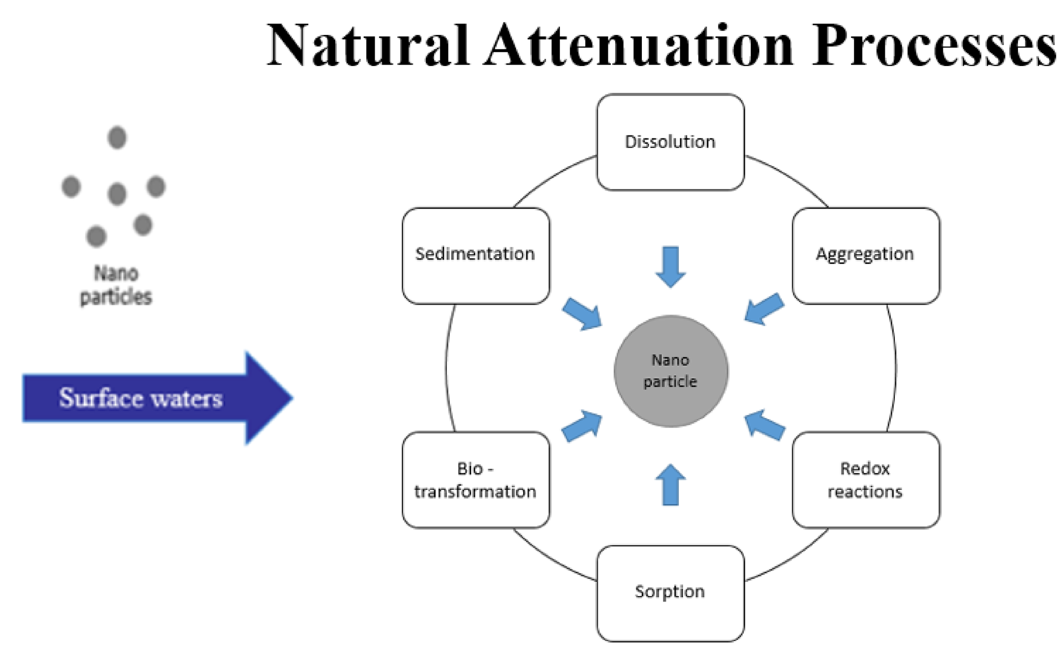
Primary Producer

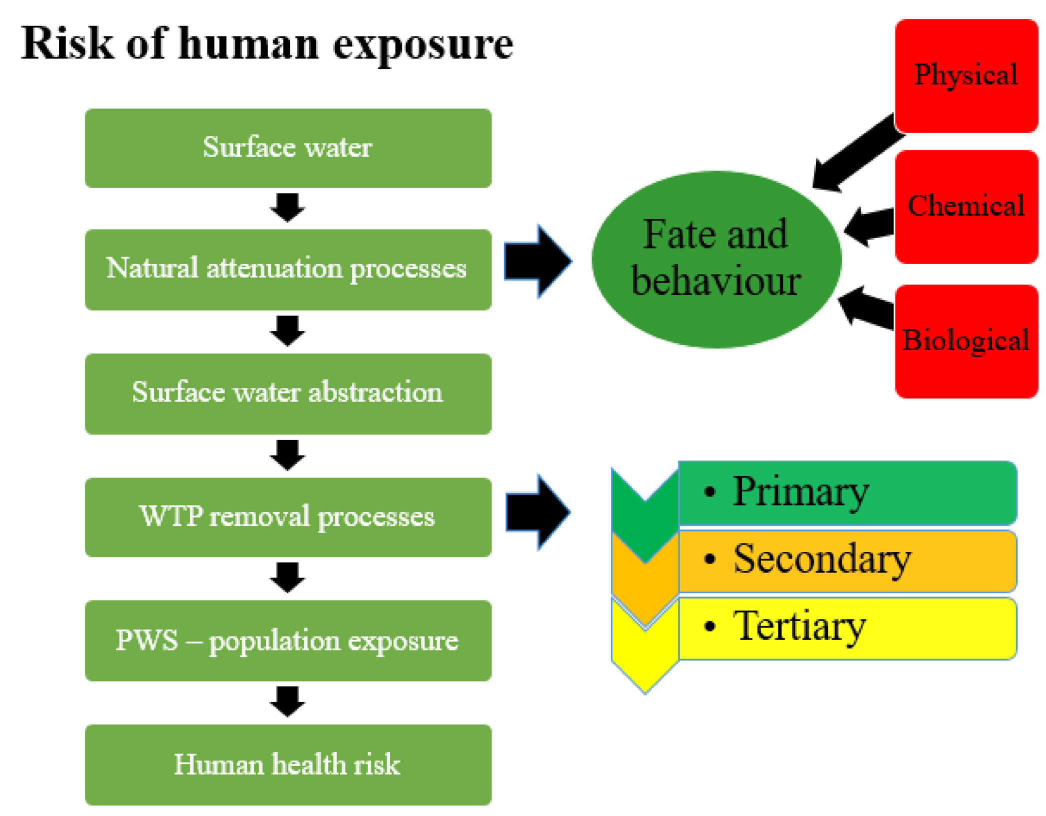
- ISO 8692:2012 *Pseudokirchnerriella subcapitata* freshwater algal growth inhibition test (with modifications, novelties and media comparisons)

Environmental Fate

This research area of the project focuses on the development of risk assessment protocols for the fate and behaviour of AgNPs in aquatic systems. Investigating known processes that are likely to impact on AgNPs, it is envisaged that these can be used to evaluate the environmental fate and likely risk from silver nanoparticles through aquatic pathways.







Knowledge Gaps:

- National inventories for manufacture and use of nanomaterials.
- Real world monitoring data on contamination of water with nanoparticles

Collaborations:

- Relevant industrial partners
- Materials scientists
- Electronic engineers
- Process engineers

Acknowledgements

This project is funded by the Environmental Protection Agency (EPA) – Ireland (2014-HW-MS-1)

Sources, Pathways and Environmental Fate of Microplastics

Anne Marie Mahon [1], Róisín Nash[1] Heather Lally[1], Sinead Murphy[1], John O'Sullivan[2], Michéal Bruen[2], Mark Kelly[1], Noelle Jones[1], Bart Koelmans[3], Ian O' Connor[1]

[1] Marine & Freshwater Research Centre, Galway Mayo institute of Technology, Galway, Ireland
[2] School Of Civil, Structural & Environmental Engineering, University College Dublin, Dublin, Ireland
[3] Aquatic Ecology and Water Quality Management, Wageningen University, Netherlands

www.freshwatermicroplastics.com

Consortium & Expertise

Biologists, Limnologists, Hydrological & Environmental Engineers and Industry Partners collaborating to inform the development and implementation of policy through understanding of the sources, pathways and environmental fate of microplastics in freshwater systems.

Objectives

- Characterisation of microplastic sources with respect to industry, wastewater treatment plants and diffuse sources.
- Describe movement of microplastics from land based sources to aquatic receptors.
- Determine factors affecting dispersal mechanisms in freshwater systems.
- Identify potential pathways and transfer rates for microplastics within freshwater food webs.
- Model critical source areas for microplastics and their potential impact.
- Inform policy and make recommendations for monitoring.

Outcomes and Impacts

- Deliver on national environmental research priorities described in the EPA research strategy 2014-2020.
- Supporting water protection, conservation and management obligations under the Water Framework Directive, Marine Strategy Framework Directive and Floods Directive;
- Provide in-depth knowledge on the specifics of the sources, pathways and environmental fate of microplastics.
- Inform political decisions regarding the possible requirement for inclusion of microplastic monitoring programme under the WFD
- Inform decisions regarding possible regulation of microplastics from various sources.

3 year Project - Kick-Off Meeting January 2017

WP1. Refinement of MP source information
Leader Dr Mahon
Contributions:
Dr Kelly
Dr Jones

WP2. MP movement sources to aquatic receptors
Leader Dr O'Sullivan
Contributions:
Dr Mahon,
Prof Bruen,
PhD Student (UCD)

WP3. Factors affecting MP dispersal in aquatic receptor
Leader Dr Lally
Contributions:
Dr Nash
Dr Mahon
Dr O'Sullivan
PhD students (GMIT & UCD)

WP4. Pathways of MP transferral within Food chain
Leader Dr Murphy
Contributions:
Dr Lally
Dr Nash
Dr Mahon
PhD Student (GMIT)

WP7. Implementation of communication plan
Leader Dr Nash
Contributions:
Dr O'Connor
Dr Mahon
Dr Lally

MP in WWTP model

Data on transport from land to aquatic receptors

Impact of flow, velocity and depth on transport of MPs

Factors controlling MP dispersal

Pathways in food web.

Bio-indicators for monitoring

Communications Plan Website, conference, publications

Conference report communications evaluation

WP6. Recommendations for monitoring of microplastic pollution
Leader Dr Mahon
Contributions Dr Lally, Dr Nash, Dr Murphy

WP5. Modelling
Leader Prof Bruen
Contributions:
Dr O'Sullivan,
Dr Mahon,
Prof Koelmans
PhD student (UCD)

Pressures of microplastic pollution identified

Policy recommendations concerning microplastic pollution in Ireland

Solutions/alternative suggested to reduce microplastic pollution

Passive Sampling as a Screening Tool for Monitoring Emerging Pollutants

Lisa Jones*, Jenny Ronan**, Brendan McHugh**, Evin McGovern**, Fiona Regan*
*Dublin City University, DCU Water Institute, Glasnevin, Dublin, Ireland
**Marine Institute, Rinville, Galway, Ireland
Fiona.regan@dcu.ie
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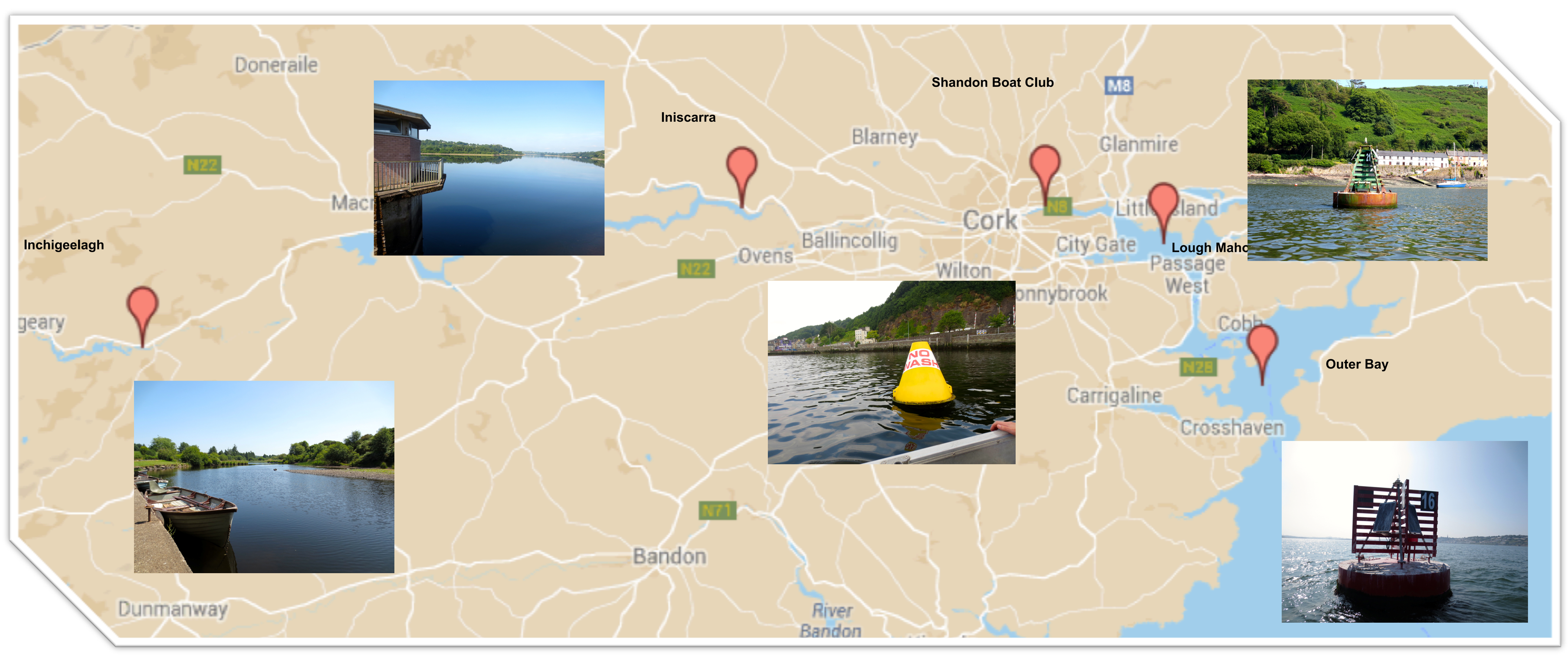
INTRODUCTION

The challenges of monitoring our waters for compliance with WFD and the expansion of the list of organic chemicals that are to be added for monitoring, provides impetus for investigation of alternative monitoring approaches such as passive sampling.
This study focuses on investigating a potential role in the establishment of a capability to utilise passive sampling (PS) to support emerging pollutant monitoring programmes in Ireland. By completing this in the catchment approach, pollutant sources and pathways can be identified allowing for a more targeted approach to monitoring of emerging and priority compounds in water.
There are still many knowledge gaps and caveats in relation to PS and moving towards "compliance monitoring". However, it is evident from this work that, while additional ongoing research is required, there is potential scope for the development of models by which a parameter by parameter assessment of the suitability of passive sampling may be completed in order to evaluate its suitability to support conventional monitoring. There is a need to continue to build passive sampling capacity and continued validation of the models is required to support operational monitoring.



Consortium & Expertise

This project represents an important collaboration between two research centres (Dublin City University & Marine Institute) together with agency (Environment Agency UK and Inland Fisheries Ireland) and industry (TE Laboratory) to assess the potential of passive sampling in monitoring priority pollutants in Ireland. This work is underpinned by a some studies carried out in Ireland already (in DCU and MI) and a vast array of literature in the area of priority pollutant monitoring. The impact of such study may lie in the establishment of a capability to utilise passive sampling in the monitoring programme in Ireland for WFD. Water Framework Directive, WFD, 2000/60: European Commission, Off. J. Eur. Commun. L 327(2000). Polar (POCIS) and non-polar (silicon rubber) passive sampling, grab samples and biota samples were collected at ten sites across Ireland over three years.
All samples were tested for emerging and priority compounds listed in the Environmental Quality Standard (EQS) Directive (2008/105/EC) and its 2012 amendment.

Expected Objectives & Outcomes

Key objectives of this project:

① To test use of various passive sampling technologies and biota monitoring in surface water monitoring of priority substances in Ireland;
② Quantitative and qualitative screening of selected priority substances and proposed priority substances in a number of Irish waters representative of different pressures;
③ Assessment of the status of cypermethrin pollution in Irish surface waters;
④ A screening study of certain pharmaceutical substances in Irish surface waters;
⑤ Development of recommendations and guidelines for use of passive samplers in future monitoring of surface waters in Ireland;
⑥ Development of recommendations and guidelines for biota monitoring, including species/tissue selection, in future monitoring for chemical status in Ireland.

Impacts

Significant progress has been made in recent years (and throughout the lifetime of this project) in respect of the development of mechanistic sampler-water exchange models and improved in situ calibration.

Overall it is generally recognised that passive sampling undoubtedly provides a means by **which low concentrations of hydrophobic pollutants (down to pg L^{-1} levels) can be measured** with at least the same level of accuracy as conventional and "acceptable" spot sampling methods.

There is a key additional benefit that concentration information is subject to **less biological influences** e.g. size, metabolism etc, however it is also clear that passive sampling still faces considerable challenges in order for its applicability to be demonstrated beyond doubt. There is a clear **role for passive sampling in both screening and trend monitoring** and in feeding into **"tiered" risk based approaches (opposite) to operational monitoring** with future derived passive sampling threshold values installed in an assessment hierarchy/framework where exceedance of the threshold value could be used **to flag potential contamination issues**.

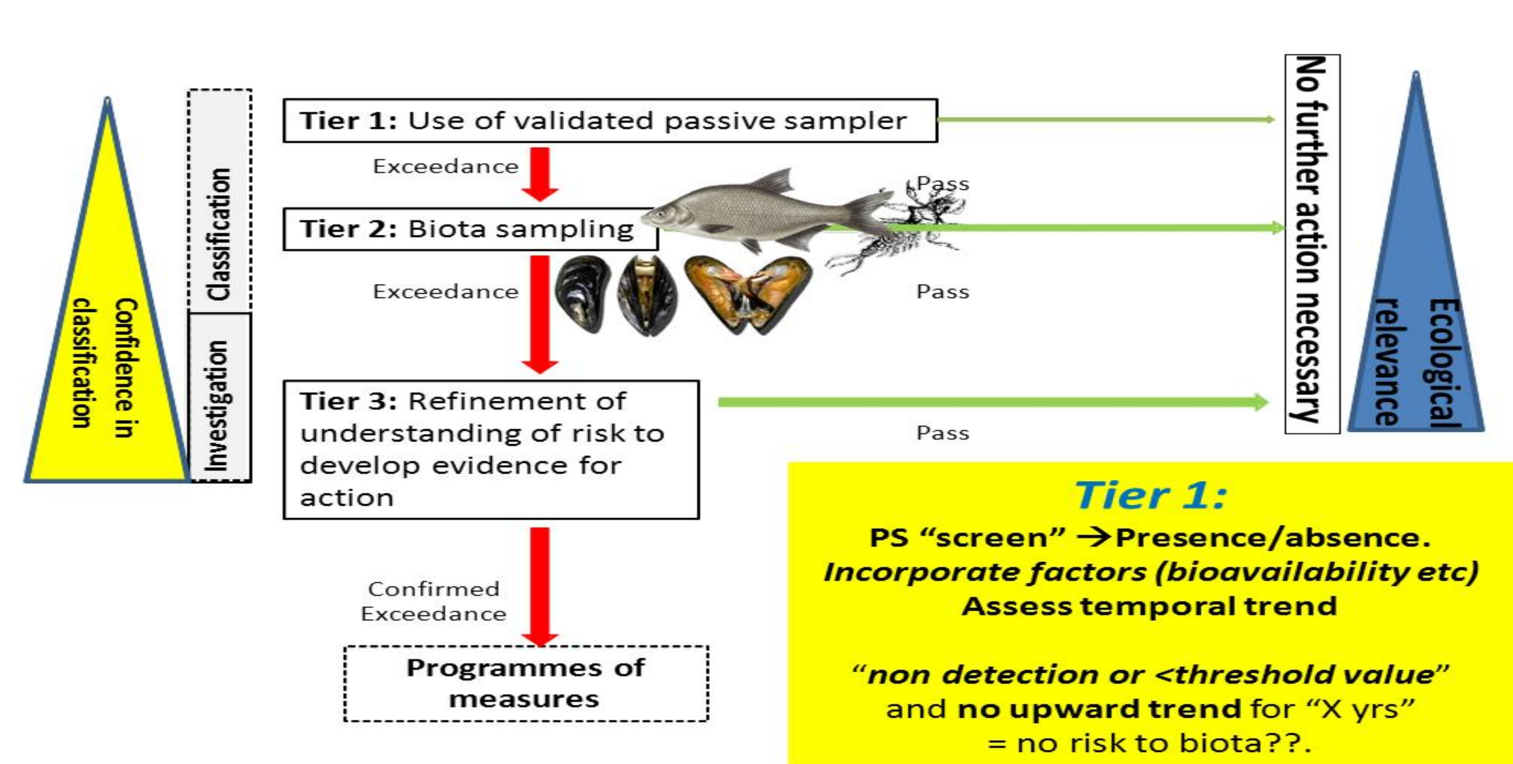
Effectiveness in the field of emerging pollutants

For monitoring emerging pollutants, a risk-based approach is recommended with passive sampling as a tier 1 screening mechanism whereby exceedance of the specific threshold value would lead to further monitoring. There is a ongoing need for inter-laboratory comparison study to demonstrate competence with passive sampling techniques.
Use of PDMS samplers for quantitative analysis of a number of non-polar compounds and POCIS sampler ***screening*** for suitable polar compounds is recommended.
The project team propose that passive sampling has more evident applicability in the marine environment and specifically in respect of trend and offshore monitoring (supporting both the tiered approach and MSFD). As the definition of EQS_{biota} embraces other protection goals, i.e. protection of aquatic life, PS can still play a significant role in WFD monitoring.

The project team identified a number of key research gaps namely in the areas of:

① The development of robust data for accuracy, quality control, partition coefficients and in Performance Reference Compounds (PRCs) more robust passive sampling coefficients;
② Ecosystem specific TMF and TL data are required to strengthen future assessment outputs for PS as presently there are great uncertainties in this area;
③ Where PS is employed to support monitoring, consistent approaches (and guidelines) as to how this is completed are required;
④ Cross European collaborative PS studies for groups of chemicals for catchment level monitoring approaches.

Alignment can be achieved for a higher impact



Marine Institute Foras na Mara | epa | IPSR Irish Passive Sampling Research | Environment Agency | Iascach Intíre Éireann Inland Fisheries Ireland | TelLab

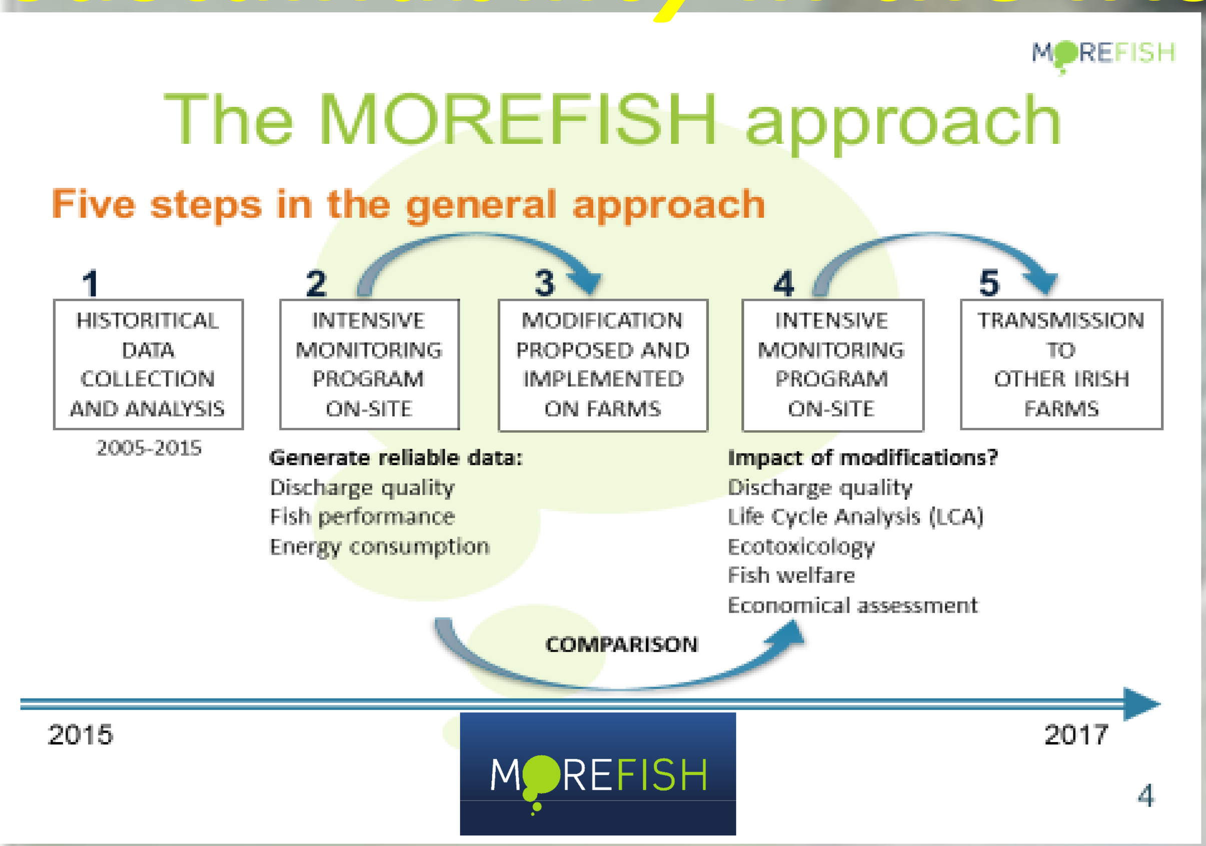
Acknowledgement: This project is funded by the EPA as part of the Science, Technology, Research and Innovation for the Environment (STRIVE) Programme 2007–2013. This programme is financed by the Irish Government under the National Development Plan 2007–2013. It is administered on behalf of the Department of the Environment, Heritage and Local Government by the Environmental Protection Agency, which has the statutory function of co-ordinating and promoting environmental research.

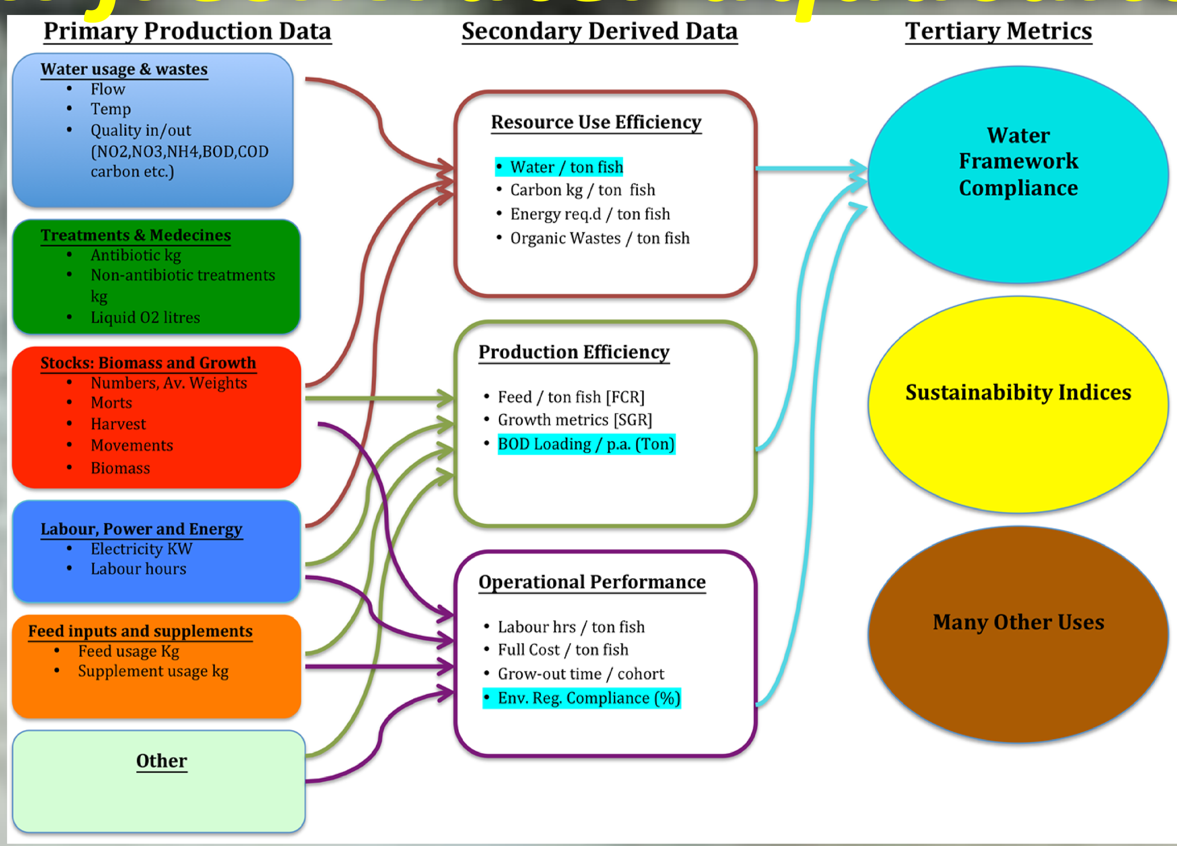
Development of Recirculation Micropollutant Treatment Systems - Moving Away from End-of-Pipe Solutions (Ireland)

Professor Neil Rowan (nrowan@ait.ie)
Dr Eoghan Clifford (eoghan.Clifford@nuigalway.ie)

- **Consortia** - Irish (National) linked EPA and Department of Agriculture, Fisheries and Marine (DAFM)-funded projects comprising 2 academic (Athlone Institute of Technology, NUI Galway), 4 SMEs (aquaculture), 1 water utility (16 WWTPs) plus collaborating Marine Institute, National Fisheries Board (BIM)
- **Expertise** - engineering (technology, process), aquaculture, microbiology/parasitology, toxicology, LCA/Biodiversity (key strengths – demonstration works and management of pilot plants, technology development/testing.
- **Expected impacts**– encompass science, technology and policy –
- (a) enhancing sustainability in Irish freshwater aquaculture;
- (b) applying technologies and processes to positively influence discharge license (currently) to include advanced aeration and decontamination;
- (c) use of life cycle assessment (LCA) to improve emissions/resource footprints;
- (d) risk assessment/ GIS mapping to identify priority pressure points for micropollutants in receiving water
- (d) workshops focusing on communication channels to industry stakeholders and public (social and economic connectivity)

DAFM-Funded Morefish platform (www.morefish.ie) - Enhancing sustainability in the Irish freshwater aquaculture





MOREFISH EXPECTED OUTPUTS

Energy/costs savings
Profitability for fish farms and society
Better fish quality
Production increase
Environmental sustainability
Maximized water reuse opportunities
Water quality enhanced
Life Cycle Analysis

Can outcome be increased with some collaboration –
Yes, use of platform for investigating novel water recirculation treatment approaches; real-time sensors; grab vs passive sampling; expanding suite of disinfection technologies (AOPs); social marketing; ICT; climate change (drought, flooding)

Where do you find limits to go further in your project–
Example - limited funding nationally and expansion to include complementary expertise and data sharing from EU partners (this also applies to increasing JPI budget for Ireland); inclusion of diagnostic and additional disinfection technologies

Links to SRIA where it applies–
Cross-cutting links to ecology/biodiversity; environmental risks/mitigation; analytical chemistry ; antimicrobial resistance

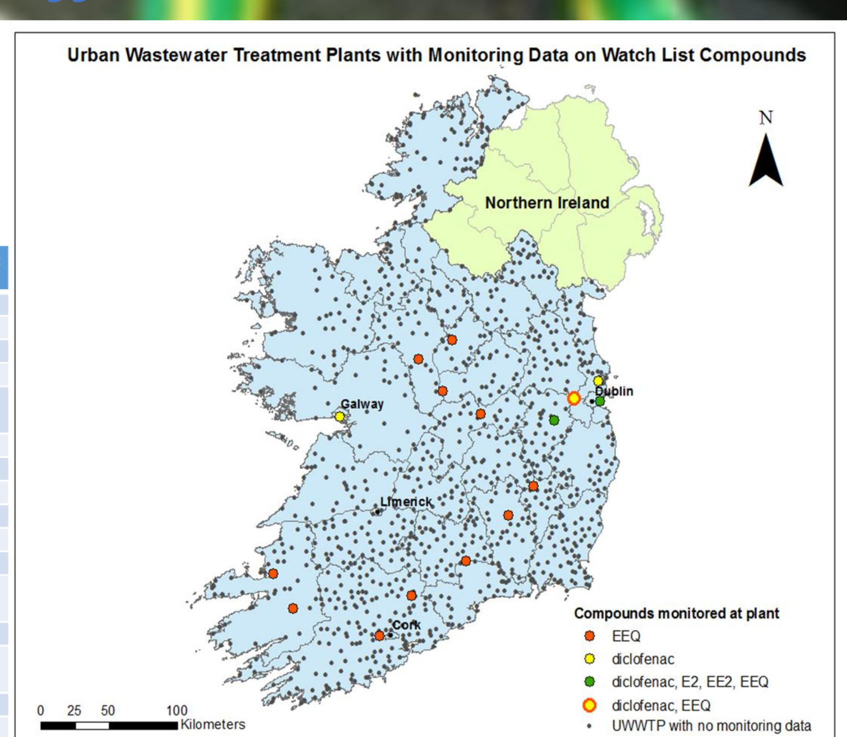
How can RDI community be more effective in this field–
Development of cross-jurisdiction (RA) EU model for tracking and monitoring micropolluants (big-data)

How to make use of the RDI results in emerging pollutants–
We found that frequency and variety of workshops for knowledge sharing with end-users effective

Linked EPA-Funded GIS mapping and risk assessment project for micropollutants in receiving waters

Monitoring and mitigation strategies for pressure points in receiving water (Irish WWTPs)

WWTP name	County	Catchment	WFD river basin district	Size (PE)	Type of secondary treatment (final)
Carlow	Carlow	Barrow	South-eastern	39043	Extended Aeration
Ballincollig	Cork	Lee	South-western	27697	Extended Aeration
Fermoy	Cork	Blackwater	South-western	18608	CAS
Ringsend	Dublin	Coastal	Eastern	2124000	Sequence Batch Reactor
Swords	Fingal	Broad Meadow Water	Eastern	77014	Extended Aeration
Galway	Galway	Coastal	Western	213424	CAS
Killarney	Kerry	Laune	South-western	41836	CAS
Tralee	Kerry	Coastal	Shannon	35149	CAS
Leixlip	Kildare	Liffey	Eastern	100309	CAS
Osberstown	Kildare	Liffey	Eastern	104723	Sequence Batch Reactor
Kilkenny	Kilkenny	Nore	South-eastern	51988	CAS
Longford	Longford	Shannon Upper	Shannon	11672	CAS
Tullamore	Offaly	Shannon Lower	Shannon	24055	CAS
Roscommon	Roscommon	Shannon Upper	Shannon	6989	CAS
Clonmel	Tipperary	Suir	South-eastern	34909	Extended Aeration
Athlone	Westmeath	Shannon Uppe			



- **Aims met – established GIS mapping of water quality to determine source, receptors and pressure points for emerging micropolluants (EU watch list chemicals) in river basins/ catchments**
- **Development of semi-quantitative risk assessment and model for decision making for these micropollutants**

Barrett, M., Fitzhenry, K., O'Flaherty, V., Dore, W., Keaveney, S., Cormican, M., Rowan, N, Clifford, E. 2016. Detection, fate and inactivation of pathogenic norovirus employing settlement and UV treatment in waste water treatment facilities. Science of the Total Environment (568), 1028-1036.
Tiedeken, E. J., Tahar, A., McHugh, B., Rowan, N. 2016. Monitoring, sources, receptors and control measures for three European Union watch list substances of emerging concern in receiving waters – a 20 year systematic review. Science of the Total Environment (574), 1140-1163).
McGillicuddy, E., Murray, I., Kavanagh, S., Morrison, L., Fogarty, A., Cormican, M., Dockery, P., Prendergast, M., Rowan, N., Morris, D. 2016. Silver nanoparticles in the environment: sources, detection and ecotoxicology. Science of the Total Environment. (575), 231-246.

AIT Connect & Discover
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Department of Agriculture, Food and the Marine An Roinn Talmhaíochta, Bia agus Mara
Water JPI