Water Harmony Innovation Workshop and Project Meeting, Israel

Innovation Camp on Water Harmony
26-30 April 2022

Venue:

Cultural Center (Matnas) at Ben Yair 28
Arad, Israel

organised by

Ben Gurion University of the Negev (BGU)

supported by City of Arad

Rationale:

Arad is a town in Northern Negev located 30 km from the Dead Sea. The city has 31,500 habitants living in 105 square km. It is the second largest municipal area in Israel located in the desert area with 40 mm precipitation that comes in the period December-March. For the remaining 8 months yearly, the city has no precipitation.

The city strives for energy and water independence to be achieved by harmonized actions to release tensions by diverting available sources. In the energy independence vector, the city adopts energy efficient processes for energy saving and non-pollutant energy supply to its residents. The vision is to supply all its municipal electricity needs (about 183 million kWh a year) by the energy produced locally, preferably from renewable sources. In the water/wastewater vector, the city strives for sustainability by diversification of sources and available qualities. Specifically, the city looks on the ways to release scarce tap water used for irrigation, by replacing it with diverse supply of rainwater, treated municipal wastewater, brackish water from local reservoirs, and tap water as an ultimate supplement. Among the strengths, the city has available and cheap land, natural resources such as wind and sun, and centralized planning to fulfil its strategic goals.

Challenges:

The Innovation Camp comprises four parallel challenges. The challenges are presented by challenge owners having a special link to the follow up of that specific challenge. Each challenge is tackled by a dedicated team guided by a professional facilitator. Participants are invited to share their expertise by working together by forming small cross-disciplinary teams, each focusing on one of the camp's challenges. Supported by the facilitators, participants analyze different perspectives and develop detailed suggestions on how to tackle **ש** the challenge in innovative ways. As the camp advances, participants define potential implementation activities and plan for experimenting and piloting of those activities. On the final day, an exhibition or similar showcase event is organized where the participants will present their ideas, solution, or prototypes.

When registering, participants will choose one out of the four challenges:

1. **Irrigation with waste instead of tap water**

   Arad has the second largest municipal area in Israel of 126 square km and low household income population graded at 4^{th} out of 10 on the social-economical grade. Arad discharges 4,400 m^3/day of municipal wastewater to a local wastewater treatment plant located 4 km west from the city. The effluents are treated in waste stabilization ponds to BOD levels of more than 100 mg O_2/l, COD 800 mg O_2/l, TOC 400 mg/l, and used locally for irrigation. The estimated cost of pumping the effluents back to the city is 3.5 million Euro, and it has to be combined with Arad WWTP upgrade project. The project should include connections to nearby Bedouin settlements and intensification of the treatment process. The entire project costs approximately 15 million Euro, and it has not yet been granted by Israeli Ministry of Finances. The

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approximate time for the upgrade is between 5 and 10 years. At current, Arad gardens are irrigated by tap water at the annual cost of 500,000 Euro. Possible solution is the decentralized upstream wastewater treatment that meets an opposition from Israeli Ministry of Health. The conflict is due to the fear of unprofessional treatment of wastes and potential contamination of ground and gardens.

2. **Smart water**

Arad population is growing and consume more water. Still, there is no change in the policy regarding the irrigation that is performed with tap water although Arad has access to tap water, wastewater, brackish water, grey water, secondary effluents from WWTP, and rainwater. All the sources have different qualities that can be used for various purposes, with the implementation of the concept of smart water and digitalization. The challenge is to implement data-driven decisions that help to optimize available resources, minimize climate impacts, and enhance health and safety. Major obstacles are 1) the absence of digital tools that allow the transition; 2) low level of cooperation between the government, the private sector, the academy, and the society; and 3) low trust and support in transition to the smart and digital water in governing bodies.

3. **Climate solutions**

Climate change is one of the most pressing issues that affect us all. With the clock running out on global CO_2 and other greenhouse gas emissions, humanity struggles to contain global temperature rise at no more than 2°C as compared to preindustrial levels. Present day we experience climate change everywhere and there is a clear need for actions. The real-world climate solutions will not emerge from a single discipline. The design and successful implementation of true solutions requires transformative concepts that run across disciplines with attributes like discovery, application, engineering, implementation, behavioural change and societal acceptance. With these ingredients at the basis of successful development of novel technologies and approaches, they can drive political will and new policies towards mitigating climate change.

One of the pressing issues for Arad is desertification and deforestation due to continuously decreasing social-economic situation that drives the low water consumption and refuse to pay for irrigation of public gardens. The problem is not specific to Arad but embraces many Bedouin settlements that have almost no public gardens. The additional social aspect of the problem is the refuse to plant trees that is viewed as an act of Israeli intervention into Bedouin lands. The solution must be cross-disciplinary and advance the conceptualization, development and/or implementation of climate solutions.

4. **Micro-hydropower (MHP)**

Among various renewable technologies such as photovoltaics, biogas, solar, or wind, micro-hydropower (MHP) is considered a cost-effective, environmentally friendly option. The MHP can run year-round regardless of weather conditions, has extensive life expectancy, low maintenance costs, and no environmental impact. However, MHP technology has been less studied than large scale hydropowers and is still at the developmental stage. Arad WWTP is located at the valley at approximately 50 m height difference from the city and can use MHP to recover a part of the energy that has to be spend if the secondary effluents will be pumped back to the city. The challenge is to understand if the MHP can run on raw wastewater or it requires certain pre-treatment. The additional question is the need for a dam since as of now the wastewater is flowing uninterrupted due to the gravity.

Optimisation of tap water use for city gardening

Extend the existing wireless watering system that is based on annual need with real-time sensors of humidity and temperature

Pros

- Easy to expand existing infrastructure with IoT
- Cheap and easy to implement (CAPEX and OPEX)
- Doable and minimum effort from the municipality
- Avoid overuse of water Feedback based system
- Reveal the real need
- Correct balance in irrigation
- Municipality gains points as innovator

Cons

- Limited and uncertain impact
- Dependency on advanced sensors
- Vandalism of IoTs

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Decentralised WWT

Flexibility in fit-to-purpose both quality and quantity

Pros

- Reduce consumption of tap water for irrigation or domestic non-potable use
- Remote control of the system
- Use of decentralised network to increase resilience
- Smart city concept and innovative image for municipality
- Flexibility of adjusting final effluent quality

Cons

- Too much relay on sensors
- Application limitation due to legislative constraints
- Availability of area for systems inside the city and system footprint
- Public perceptions about setting systems in the city
- Implementation costs will be higher in decentralised systems unless transport costs are inluded

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Source separation

Reuse of resources from wastewater and reduce of transport costs

Pros

- Recover and reuse nutrients in addition to reclaimed water – reduce consumption of synthetic fertilisers
- Reduce use of tap water for non-potable domestic and agriculture
- Smart city initiative
- Low-cost treatment for grey water
- Reduced cost of wastewater transport
- Reuse water without transport
- DBO business or creation of work places

Cons

- Complicated/costly infrastructure for existing buildings
- Legislative barrier related to agricultural reuse
- Public perceptions
- Two separate treatment units
- Footprint in the urban area
- Maintenance cost

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MBR for direct water reuse

More efficient and space-effective solution

Pros

- High-quality effluent suitable for direct reuse
- Adjustable quality of the effluents
- Advanced technology
- Safe on effluent transport for reuse
- Smart city
- Flexible operation
- Possibility of using alternative energy

Cons

- Energy consumption – CO_2 footprint
- Chemical consumption
- More complex operation
- Replacement costs for membranes
- Maintenance costs

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Increased water reuse (decreased water use) without significant extra footprint

Hydroponics for existing farms and urban farming

Pros

- Localised food production
- Increasing self-sufficiency
- New work places
- Increases resilience to extreme climate events
- Reduction of food transports and CO2-budget
- Savings land footprints
- Improved urban spaces

Cons

- Cost
- Low control of the final agricultural product quality
- Negative effects of water salinity
- Unclear benchmarking of hydroponics vs agriculture and within hydroponics as well
- Legislative constraints and public perceptions

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Water Harmony Innovation Camp and Project Meeting, Barcelona

23 – 25 May 2022

Organized by Sorigué with support from the Norwegian University of Life Sciences

Background:

As part of the Water Harmony project two innovation camps were originally planned for 2020. Due to covid this was not possible but, after having held the first camp in the city of Arad in Israel, we are now holding the second camp in Barcelona, Spain.

The second camp is organized by Sorigué, a company from Catalonia that, among many other activities, operates Wastewater Treatment Plants (WWTPs). This effort is being extensively supported by the Norwegian University of Life Sciences (NMBU).

Apart from representatives from NMBU and Sorigué, the Camp will be attended by project partners from the University of Technology, Sydney (Australia), Ben-Gurion University of the Negev (Israel), the Swedish Environmental Research Institute (Sweden), the University of Warmia and Mazury in Olsztyn (Poland) and, "Gheorghe Asachi" Technical University of Iasi (Romania).

Stakeholders are drawn from industry, academia, business, and technology centers.

Assisted by facilitators, the participants will analyse the challenges presented, working together from their different perspectives to develop innovative ideas and approaches to tackle them.

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Challenges:

1. Zero Emissions WWTPs.

In November the Spanish Ministry of Ecological Transition and Demographic Challenge (MITECO) published its Long Term Decarbonization Strategy, in accordance with European goals. In this document it is affirmed that by 2050 it will be possible to reduce emissions from the Wastewater and Waste sectors by over 80%. In the specific case of WWTPs, the need to reduce the Nitrogen load has been specifically identified.

Climate change is a critical challenge for the entire global community and natural environment. Reducing the generation of greenhouse gas emissions from wastewater treatment is one of the steps cities and countries can take to lessen their impact on the environment, even explore new technologies that change the standard emission-heavy wastewater treatment processes into more sustainable processes.

In this challenge we want to ask the question:

What can we do now to take steps towards zero emissions from WWTPs?

2. Sludge: from waste to resource

As part of the same section of the strategy document, MITECO mentions the need to move towards the circular economy. The treatment and disposal of sewage sludge is an expensive and environmentally sensitive problem. It is also a growing problem world-wide since sludge production will continue to increase as new sewage treatment works are built and environmental quality standards become more stringent. With some traditional disposal routes coming under pressure, the challenge facing sludge managers is to find cost-effective and innovative solutions whilst responding to environmental, regulatory, and public pressures.

Apart from valid environmental concerns, recent geopolitical events have created economic conditions that favour the examination of previously inviable energy generation options. Energy independence has also become a strategic concern.

In this challenge we want to ask the question:

How can we transform sludge from a waste product to be disposed of into a resource for energy and other raw materials?

Barcelona Innovation Camp

Group 1 discussions

The Challenge: *What can we do now to take steps towards zero emissions from WWTPs?*

1

Background

- In November the Spanish Ministry of Ecological Transition and Demographic Challenge (MITECO) published its Long Term Decarbonization Strategy, in accordance with European goals. In this document it is affirmed that by 2050 it will be possible to reduce emissions from the Wastewater and Waste sectors by over 80%. In the specific case of WWTPs, the need to reduce the Nitrogen load has been specifically identified.
- Climate change is a critical challenge for the entire global community and natural environment. Reducing the generation of greenhouse gas emissions from wastewater treatment is one of the steps cities and countries can take to lessen their impact on the environment, even **explore new technologies that change the standard emission-heavy wastewater treatment processes into more sustainable processes.**
- In this challenge we want to ask the question:
- *What can we do now to take steps towards zero emissions from WWTPs?*

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7-steps template

Day 1

- Step 1. Problem exploration
- Step 2. Outcomes and benefits
- Step 3. Ideate & Design

Day 2

- Step 4. Stakeholders and resources
- Step 5. Risks and assumptions
- Step 6. Build prototype
- Step 7. Roadmap

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What can we do now to take steps towards zero emissions from WWTPs?

Step 1. Problem exploration

Challenge	Context	Opportunities
• N-removal is specifically mentioned in MITECO • Not only to remove but also to recover (OrgC, P, N) • Focus on CEC and MPlastics • Reduce Green house gases (GHG) • Reuse wastewater • Lack of sewer transport utilities for water reuse	• No N-removal step in the current WWTP? • At present no CEC and MP removals • Heavy metals in sludge makes it impossible to use in agriculture • Technologies are available, but still not affordable • CEC/MP are probably not in the emissions regulation • Tertiary treatment will be required • Not allowed as drinking water	• Reduce HM in ww- from industries? (source reductions) • N recovery technologies are in R&D stage • Struvite as P-recovery in some WWTP, but possible to increase • R&D on CEC/MP removal- local R&D org are involved • GHG reduction – increase biogas production (50% non-nuclear) • Increased Biogas = reduce use of conventional energy sources • Introduce innovations in WWT (micro filtration)

Insights

- Stringent regulations on sludge use in agriculture
- Sceptical public opinion on WW sludge in agriculture
- No natural gas in Spain, imported from North Africa… (co production of biogas with natural gas is a good source for low energy process).

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Step 2. Outcomes and benefits

Desired outcomes

- Improve mixing in the Activated Sludge tanks (concept is ready, through piloting)
- Efficient removal of particles
- Improved removal of CEC, MPs with minimum investments
- Introduce solar power in utilities
- Increased use of advanced process monitoring leading to better process control

Desired benefits

- Reduce GHG, reduced penalties
- reduce plant footprint - space for advanced biological treatment will be available
- Use reduced space for new treatment processes
- Reduce conventional energy (↓ GHG)
- Improved treatment efficiencies

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Step 3. Ideate & Design

Improve Activated Sludge process: to reduce energy consumption

Deep understanding

- *What if?*
  - Technological challenges (mass transfer limitations, modification of equipment, automation, sensors – calibrated/maintained, data management etc)
  - Footprint challenges (reduced footprint with micro screens)
  - Financing challenges
  - Suitability of treatment processes for local conditions
- *What could work?*
  - Existing concessions model (private/public operators) for BOO mat allow new investments/operational costs
  - Mostly few companies have BOO contracts thus they ca share resource persons efficiently when required
  - Competent staff and technologies centres (Leitat++) to implement and manage new technologies
  - Existing financial fines for non-conformity of treatment
  - Awareness raising – general people, high school students
  - Low threshold in the use of solar power / bottle necks with legislations
  - Easily available technology, suppliers increasing- so it must work
- *Who benefits?*
  - Planet earth/environment, general public (reduce cost)
  - Health impacts
- *Why*
  - A solution mitigate CC, GHG
  - Compliance new treatment

Key message

- Improved treatment efficiency using innovations in the waste treatment

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What can we do now to take steps towards zero emissions from WWTPs?

Key message

- WWTP in Barcelona discharge effluents partially to rivers which are utilised by other users. Xx tons of Org-Carbon, xx t N and xx t P are annually discharged to water bodies, together with an unknown amount of CECs and microplastics. To achieve the zero emissions status, the WWTPs must drastically reduce COD, P, N, CEC, MP as well as GHG.
- Improved treatment levels often means increased WWTP infrastructure, which is not feasible in BCN. Thus, innovations for compact treatment processes must be sought.
  - The latest innovations in pre-treatment with micro-screens (even down to 20μ, www.renasys.com) may remove 95% of particles, drastically reducing the load to downstream processes (which consumes energy), releasing >50% area.
  - Being the main treatment process, Activated sludge plants is a big consumer of energy, and innovations to reduce this, optimised aerators, should be evaluated.
  - Less energy and space consuming technologies as Anammox should be evaluated for N-removal. Struvite production should be further promoted.
  - The result of all these will also reduce the consumption of energy, which is a contributor to the GHG emissions. By introducing solar power at WWTPs, the conventional energy need will be further reduced.
  - New technologies for CEC and MP removals should also be considered.
  - Real-time monitoring of water quality and their use in active process control (e.g. DO in aeration control) may reduce energy consumption, better and more even removal of pollutants. This will also enable early warning and rapid recovery after physical & cyber security events, making the WWTPs **smarter**.
  - When most pollutants are removed, the treated effluent will have many uses, reducing burden on the high-quality water produced by the DWTPs in BCN.
- Pilot scale demo tests should be considered for technical and scale-up feasibilities.

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Step 4. Stakeholders and resources

Stakeholders

- Who is needed to realise the proposal?
  - Utility owners (ACA+)
  - National/Regional/City authorities (discharge permits),
  - Politicians/decision makers
  - Financial institutes/Funding agencies (Eu, national, regional..), R&D funds of utilities
  - R&D community (including international collaborations), consultants
  - Equipment/process suppliers
- Who must buy-in?
  - ACA, End-users, Env policy makers (MITECO)
- What do they need?
  - Legislations (EU, national), ambitions (MITECO), funding, Driving forces (individuals), motivated NGOs?, Dedicated R&D focus on the topics, join forces among R&D actors
- How do they interact?
  - Communication forum for stakeholders (CWP as a facilitator, for eg), webforums etc

Resources

- Funding
- Competent Resource persons
- International collaboration (experts, demo cases, influence on legislations) since the topic has benefits beyond BCN/National region
- Facilities for testing/piloting (space, infrastructure, willingness, …)
- Access to / motivators for Innovative technologies and solutions

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Step 5. Risks and assumptions

Risks

- What might go wrong?
  - Scale-up issues
  - Technological gaps/feasibility for local conditions
  - Financing
  - Legislations
  - Social/public acceptance for reuse/increased costs
  - Administrative bottlenecks
  - Global/regional crisis
- Why?

Assumptions

- What assumptions is this proposal based on?
  - Willingness of stakeholders to engage/prioritise
  - Funding for reducing R&D risks
  - Legislative/political ambitions inline with priorities
  - Competency and availability of resource persons
  - Sustainability of the holistic concept

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Step 6. Build prototype

The prototype

- Basic concepts?
  - R&D community and industries to propose implementation concepts leading to funding proposals
- Big picture?
- Look and feel?

Constraints

- Conditions that influence realisation and delivery

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Step 7. Roadmap

6 weeks	6 months	6 years
• Concept slides – 1 week • Consultant – **16 June** • Concept note • Funding landscape overview • Go/No-Go – online meeting	• Conceptual proposal	• …

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Barcelona Innovation Camp

Challenge 2

How can we transform sludge from a waste product to be disposed into a resource for energy and other raw materials?

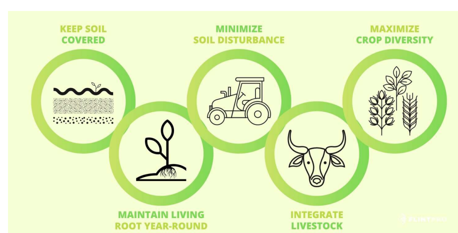
1

Key messages

How can we transform sludge from a waste product to be disposed into a resource for energy and other raw materials?

- Both P and N are beyond zone of uncertainty (high risk) on planetary boundaries. There is no space to increase energy production and at the same time we need to defossilise the industry
- Valorise sludge into energy (anaerobic digestion) and as fertiliser **in regenerative agriculture** (NBS) to **maximise the gain** and **avoid the losses**
- This requires new approach: **smart design** and **smart monitoring**, production of **biofertilizers**
- Implementation needs guidance (because of customized solutions), decision support tool, benchmarking (LCA and integrated economic analysis) on demo cases, accounting climate conditions, health/environment safety issues
- Wide awareness and exploitation to policy makers

Overarching research question: efficiency / feasibility / robustness of the concept



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Insights

3

Stakeholders and resources

Stakeholders

- Who is needed to realise the proposal?
  - Microbiome research + nutrient recovery
  - Agri robotics (low volume – high value)
  - Soil researchers
  - Agri / env / waste / energy ministry/agency
  - WWTP operators (private / municipal)
  - CAT bio-energy cluster
  - Vehicle operators, gas companies, biofuel distributors
- Who must buy-in?
  - Farmer cluster / association
- What do they need?
  - Right business model
  - Demo cases
- How do they interact?
  - Some relationship between WWTPs and agri – safety concerns

Resources

- Engaged champions/stewardship, local groups, motivated individuals
- Environmental education, awareness, behavioural change – social sci, NGOs
- Regulatory/incentive influence/support/harmonisation
- Coordination by an agri organisation with high reputation – address conservative farmers
- Representative demo-sites
- Funding for demo project
- Funding for fundamental research

4

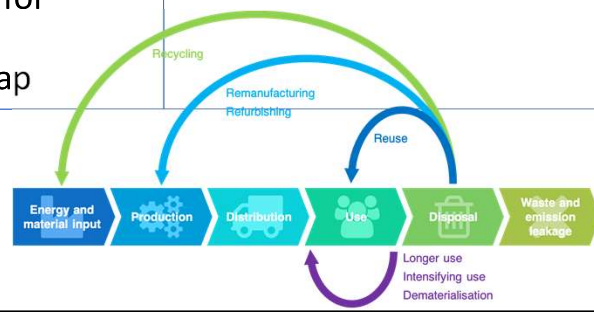
Problem exploration

Challenge
- Sludge is coming from the biological process
- Pollution in the sludge (?)
- Transport and water content – GHG emission, economical issue
- Use of chemicals in sludge processing, sludge management costs
- Energy potential of WW is underestimated in the region – feeding of An-digester

Context
- Competition between industrial and environmental stakeholders: land
- Nutrients are in demand
- Regional needs for circularity and stakeholders map

Opportunities
- Source of
  - **Energy**
  - Nutrient
  - Organic soil conditioners
  - Metals
- Free land

Insights
- How and where to close the circle (?)
- Centrally or decentralised (?)



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Outcomes and benefits

Desired outcomes
- Local production of energy under conditions of increasing prices for fuels
- Energy analysis of WWTPs
- Avoid sludge transportation
- Circular economy on a regional level engaging stakeholders
- Metals recovery
- Co-processing of waste
- Reuse of nutrients as fertilisers

Desired benefits
- District heating
- Energy supply to industry
- Energy self-sufficiency of WWTPs
- Reduce GHGs emissions
- Alignment of stakeholders, resolving conflicts
- Reuse of metals
- Agricultural development
- Reduce discharge of nutrients and prevent contamination of water resources

6

Ideate & Design

Deep understanding

- *What if?*
  - **Mapping** / system analysis of the region
  - **Scenario planning** (effects on water treatment, energy shortage, extreme events, climate change)
  - Local government put **restrictions, incentives** (grants, subsidies) and **fines/penalties** on sludge landfilling – stakeholder engagement
  - Prepare and harmonise regulatory framework for developing market for the circular product
  - New business models
  - PPPs fast-track project on waste management in the region
- *What could work?*
  - An-digestion: sludge for agriculture, P recovery (struvite production) from digestate, N recovery
  - Incineration: energy intense, CAPEX

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Ideate & Design

Anaerobic digestion

- Separation of heavy metals
- Smart biofertilisers after anaerobic digestions – improve bioavailability

Incineration

- You waste resources by burning, recovering only energy

Smart design "regenerative agriculture" – "sludge circular product", smart monitoring, smart biofertilisers

Guide, decision support tool, benchmarking and demo cases, accounting climate conditions, health/environment safety issues

Regenerative agriculture systems to achieve synergy (NBS)

Energy needs and emissions must be taken into account

LCA and integrated economic analysis

Awareness and exploitation to policy makers

8

Step 7. Roadmap

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4. DESCRIPTION OF THE PARTICIPATING RESEARCHERS

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

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

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

5. CAPACITY OF THE CONSORTIUM ORGANISATIONS

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

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

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