# How to create value for society in designing sustainable water solutions?

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University Ambassador Brazil

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Department of Biotechnology

Coordinator EU Horizon2020 Water Mining

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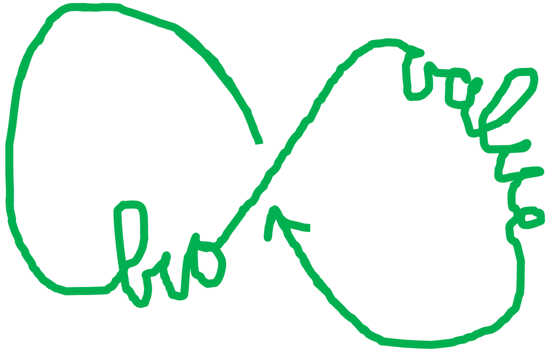

# PROBLEM

- Urban Wastewater from households

- Wastewater from industry

- Wastewater from agriculture

nrc.nl

De boer kan meer doen tegen de uitstoot van ammoniak

## …at the same time we have urgent need for…

- Clean water for consumption, processing and irrigation

- Minerals, fertilisers, materials that could be recovered and are now diluted in our oceans

But there is more!

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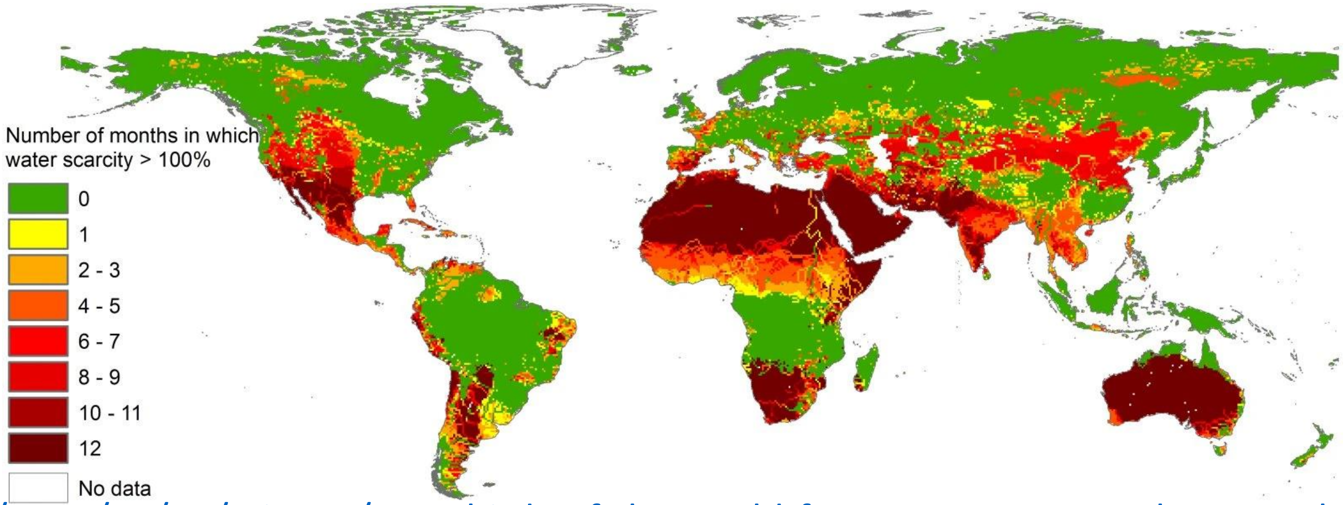
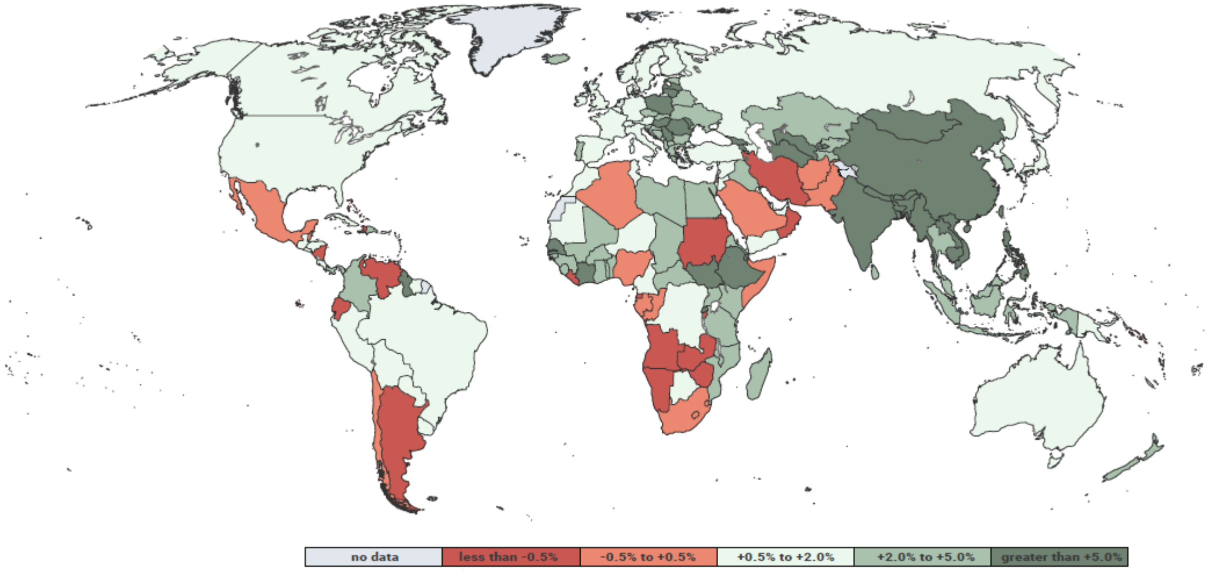



## Water Scarcity

https://www.nytimes.com/2016/02/13/science/two-thirds-of-the-world-faces-severe-water-shortages.html

Figure 1

**GDP per capita growth, 2020**




Source: United Nations, *World Economic Situation and Prospects 2020*, Sales No. E.20.II.C.1, chap. I, p. 9. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

## Poverty

## Climate change…

https://www.un.org/development/desa/dpad/publication/world-economic-situation-and-prospects-february-2020-briefing-no-134/

# Trends…

- Growing world population
- Growing consumerism
- Higher demands – lower availability

- 3 billion !  people will live in sever water scarce areas

- Technology to reuse wastewater is ready but main bottlenecks are costs, energy demand, and people's acceptance

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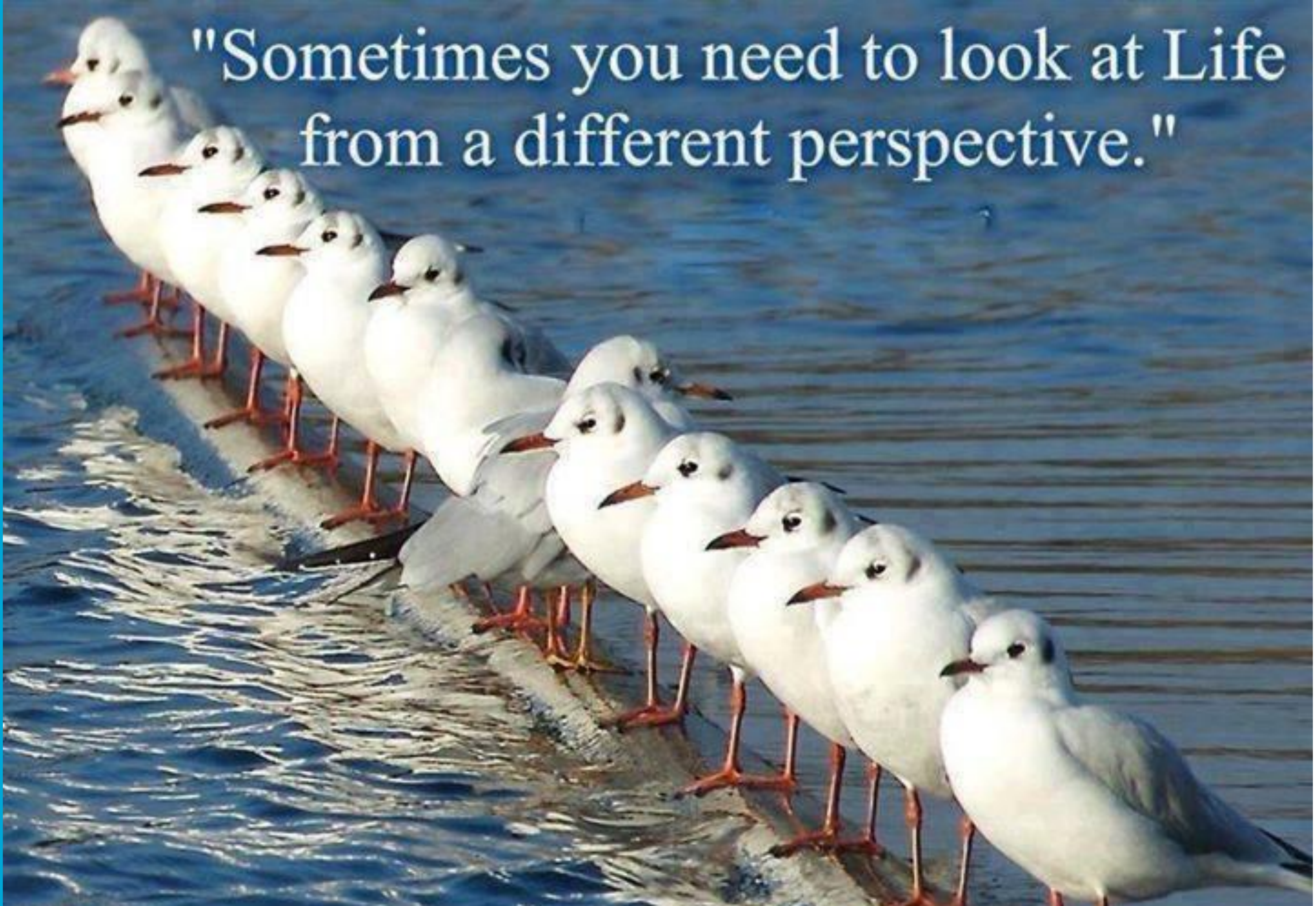
"Sometimes you need to look at Life
from a different perspective."

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# Sustainable development



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# Integral solution for water, energy and food nexus


## Including waste as resource!

As a part of an Academic Consultancy Training (ACT) project
**Project members:** Carolina Muratori, Jaqueline Gama de Souza, Leandro Barbieri, Peter te Marvelde, Rifat Aldina, Robin van der Bles and Silvia Peirolo (Wageningen University & Research)
**Commissioned by:** Federatie Bio-economie Nederland (FBN)

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water mining

value for society

# Next generation water-smart management systems: large scale demonstrations for a circular economy and society

Patricia Osseweijer, Coordinator, TU Delft

P.Osseweijer@tudelft.nl

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement 869474.

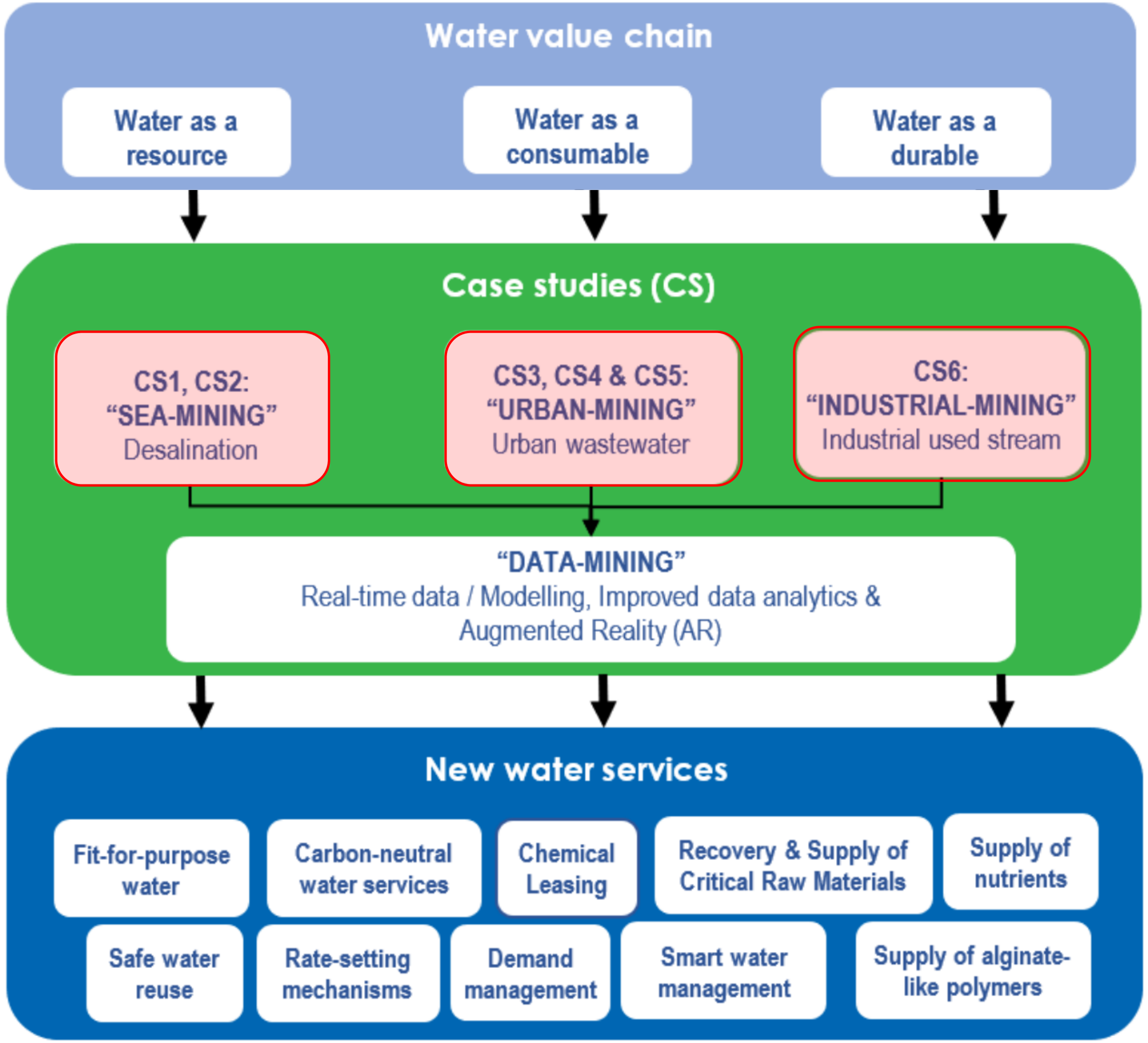
02.02.2021

# WATER-MINING: Overview

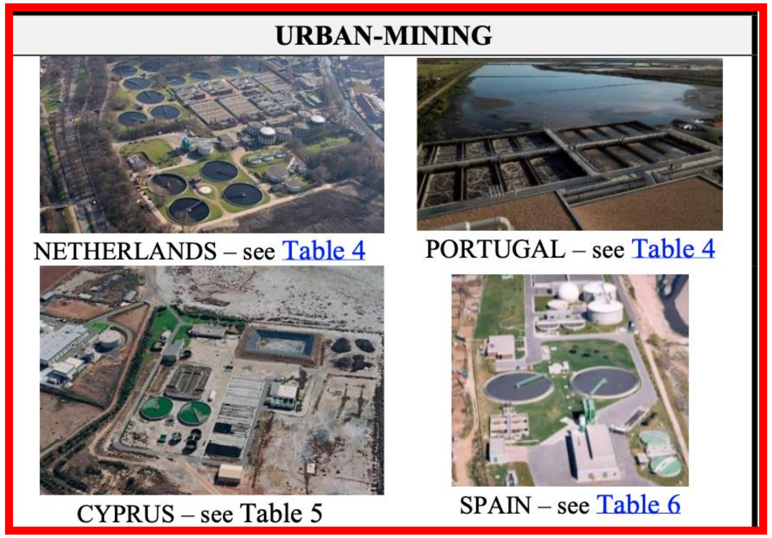
| | |
|---|---|
| **Partners:** | **38** |
| **Coordination:** | **TU DELFT** (Applied Sciences faculty) |
| **Project Budget:** | **19,174,543.75 €** |
| **EC Funding:** | **16,876,959.63** (~88% of total budget) |
| **Duration:** | **48 months** |
| ○ **Start date:** | **01/09/2020** |
| ○ **End date:** | **31/08/2024** |

# 38 Partners from 12 countries (140 people)

# WATER-MINING: Case study concept





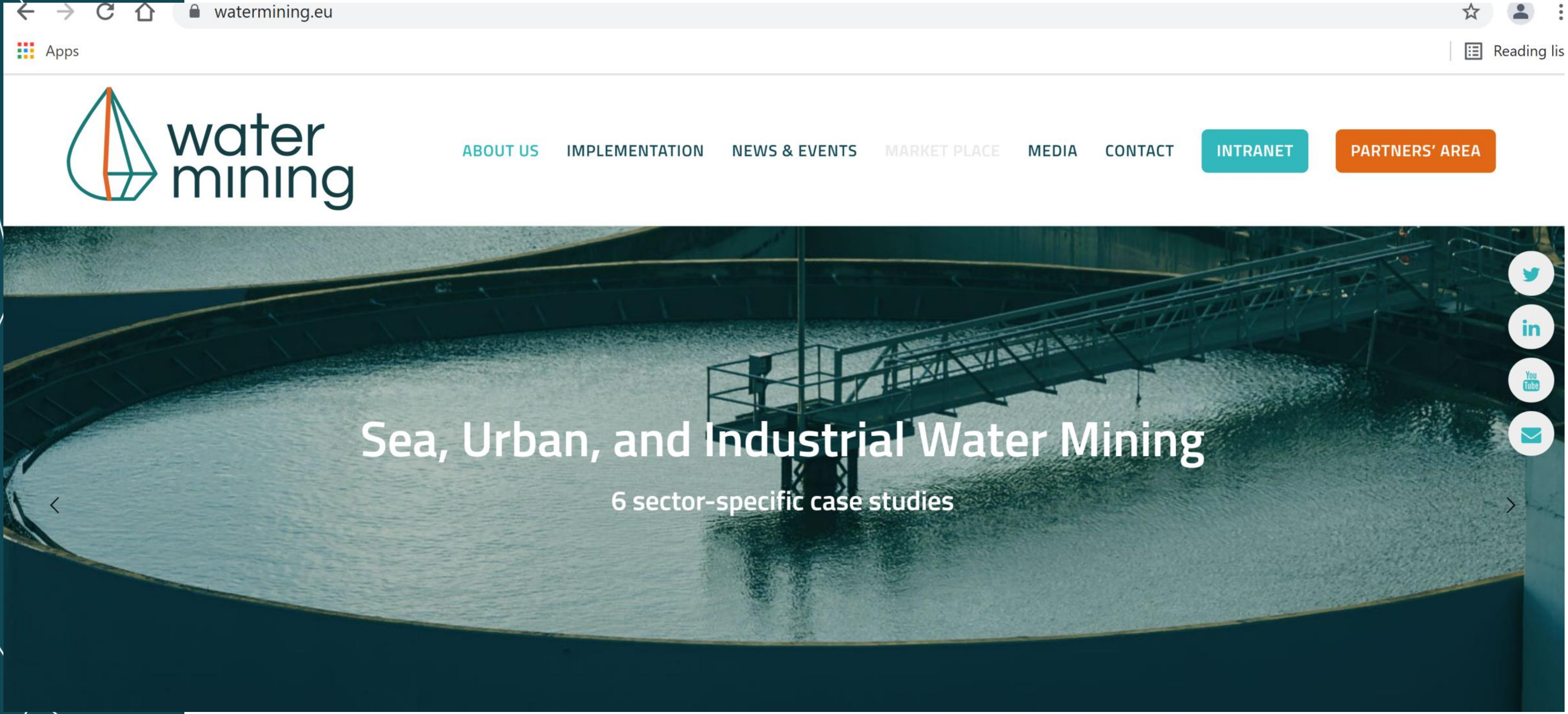



# Summary of case studies

| | Case study | Capacity | CE intervention / Demo | Impacts |
|---|---|---|---|---|
| SEA-MINING | CS1: SELIS / ITALY | 5,000 l/h | Zero Liquid Discharge Seawater Desalination combined with recovery of of waste heat | ✓ Increase in water recovery by 50%<br>✓ Share of renewables & waste heat: > 50%<br>✓ Mg, NaCl and other salts (<10% waste resources) |
| | CS2: CIEMAT / SPAIN | 2,500 l/h | Zero Liquid Discharge Seawater Desalination combined with renewable energy (solar) | |
| URBAN-MINING | CS3: TUDELFT / NL & PORTUGAL | 500 l/h ($5m^3$/day) | Recovery of high added value raw materials: Kaumera Nereda® Gum & Phosphate from urban wastewater | ✓ >90% of water from NEREDA installation suitable for reuse (capacity: 5 m3/day)<br>✓ Production of CH4 gas (50kg of CODeq per day), which can be converted to energy<br>✓ 50 kg ODM/day of Kaumera & 75 g of phosphate/ m3 of treated water |
| | CS4: LARNACA / CYPRUS | 1,000 l/h | Recovery of water fit-for-purpose, Recovery of phosphorus, Zero Liquid Discharge, Recovery of salt / internal recycling and transformation to chlorine for onsite use | ✓ >90% water reuse (capacity: 1 m3/h)<br>✓ Use of renewables<br>✓ Calcium phosphate and salts |
| | CS5: ACSA / SPAIN | 400 l/h | Energy production, reduced energy consumption and production of added value by-products for industrial or agricultural purposes. The main goals of this process are CE, energy efficiency, water reuse and phosphorus and energy recovery | ✓ >90% water reuse (capacity: 10 m3/day)<br>✓ Production of biogas: ~0.45 m3 biogas/kg of volatile matter inlet<br>✓ ~75 g Vivianite & 5g Ca3(PO4)2 per m3 of treated water |
| INDUSTRIAL-MINING | CS6: HEXION/ THE NETHERLANDS | 10 l/h | Zero Liquid Discharge, Transition from ownership to leasing (for the end-user) and Extended Producer Responsibility (for supplier) application of Chemical Leasing concept | ✓ Water consumption decrease by>70% & water recovery increase by 40% (0.95 m3 of water re-used per m3 of treated industrial waste water)<br>✓ Waste heat recovery from oxidization reaction (>40% of total energy needs)<br>✓ >90% recycling of chlorine/sodium streams<br>✓ 110 kg NaCl per m3 of treated industrial wastewater |
| | CS6: VSI/ INDIA | | Recycling of brines including organic compounds in the sugar production sector. | (replication case study) |

# Quantification of impacts per case study

| Impact | SEA-MINING | URBAN-MINING | | | INDUSTRIAL-MINING |
|---|---|---|---|---|---|
| | CS1 & CS2 | CS3 | CS4 | CS5 | CS6 |
| **Water** | Increase in water recovery by 50% (Currently recovery factor ~45%) | >90% of water from NEREDA installation suitable for reuse (capacity: 5 $m^3$/day) | >90% water reuse (capacity: 1 $m^3$/h) | >90% water reuse (capacity: 10 $m^3$/day) | Water consumption decrease by>70% & water recovery increase by 40% (0.95 $m^3$ of water re-used per $m^3$ of treated industrial waste water) |
| **Energy** | Share of renewables & waste heat: > 50% | Production of $CH_4$ gas (50kg of CODeq per day), which can be converted to energy | Use of renewables | Production of biogas: ~0.45 m3 biogas/kg of volatile matter inlet | Waste heat recovery from oxidization reaction (>40% of total energy needs) |
| **Resources** | Mg, NaCl and other salts (<10% waste resources) | 50 kg ODM*/day of Kaumera & 75 g of phosphate/ $m^3$ of treated water | Calcium phosphate and salts | ~75 g Vivianite & 5g $Ca_3(PO_4)_2$ per m3 of treated water | >90% recycling of chlorine/sodium streams 110 kg NaCl per $m^3$ of treated industrial wastewater |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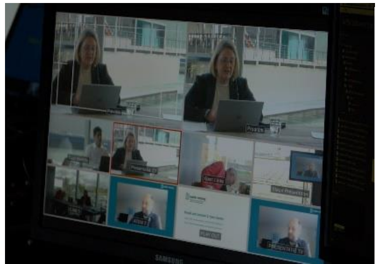
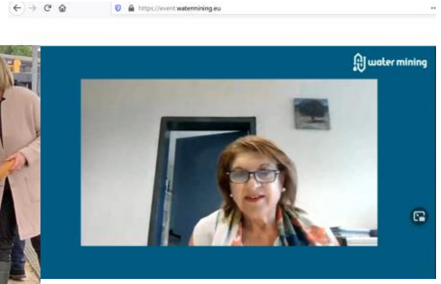
PARTNERS' AREA
Sea, Urban, and Industrial Water Mining
6 sector-specific case studies

# Innovation in **value sensitive design & social engagement**

- Using novel ICT tools such as augmented reality
- Integrating sustainable impact info & novel marketing solutions
- Developing policy packages taking context dependencies into account
- Engaging citizens, policy makers, industries, experts, regulators, NGOs, civil communities in Case Studies and Living Labs
- Additional input through European Science Musea








water mining
...INPUT FROM STAKEHOLDERS WILL BE USED TO IMPROVE THE INNOVATIONS AND THEIR IMPLEMENTATION IN SOCIETY. I AM REALLY LOOKING FORWARD TO THIS PROCESS.
PATRICIA OSSEWEIJER
PROFESSOR OF BIOTECHNOLOGY AND SOCIETY, TU DELFT
Sardinia 2014

# EU funding requires more than technology piloting

## *Q: What makes a project successful?*

Market **replication**

Pilots or **demonstrations**

**Innovation** to improve products, processes or services

**Producing** plans and arrangements or designs

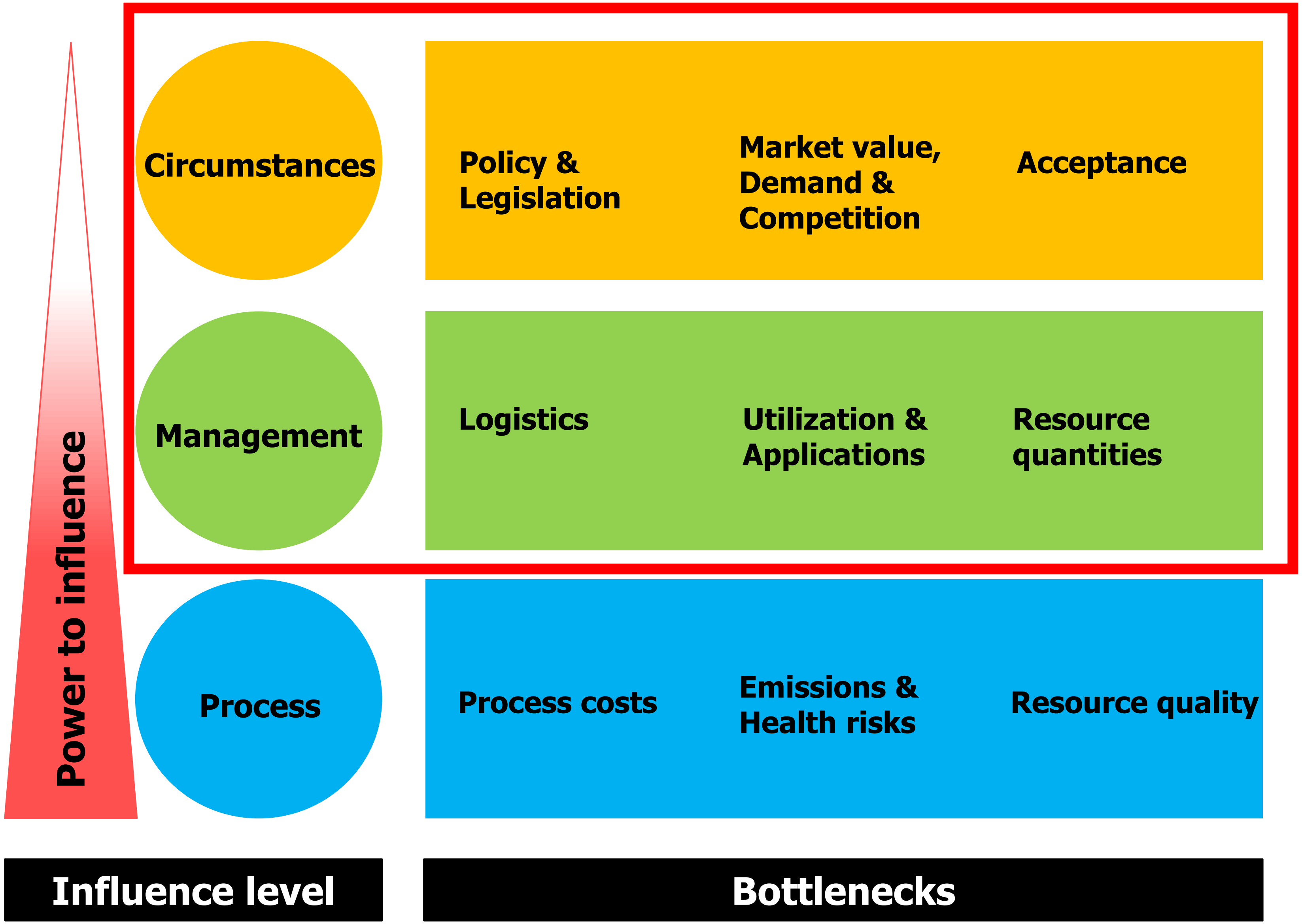

***A: To produce financially and environmentally <u>sustainable business models</u> driven via <u>collaborative scientific innovation</u>***

Ref.: Violeta Kuzmickaite (EASME)

# Value chain and marketability criteria for recovered resources

| | |
|---|---|
| **Applications** | Exploring applications and utilization routes for recovered resources |
| **Monetary value** | Estimating the market prize of recoverable resources and applications |
| **Demand** | Quantifying and localising demands for recoverable resources |
| **Supply potential** | Estimating quantities of resources recoverable in a WWTP and relate the to the demand |
| **Logistics** | Analysing distance, topography, and transport possibilities of recoverable resources to reach customers |
| **Legal situation** | Analysing regulations and policies that support or hinder the recovery of a resource |
| **Political support** | Analysing available subsidies, or political bias for investing in a recovery route |
| **Acceptance** | Estimating the consumer perspective and acceptance for resources recovered from municipal wastewater |

# Role of water utilities in market development

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# Stop labelling waste as waste!

- Regulation and acceptance
- Review of end of waste criteria

# Sustainable development


# And we need translation in context!

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# Thank you all

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# Multi- & Interdisciplinary Research

- WP1 - Project management
- WP2 - Co-creation through social engagement for societal embedding (stakeholders)
- WP3 - Demonstration of renewable desalination and sustainable brine management
- WP4 - Demonstration of extraction/valorisation of Kaumera Nereda Gum
- WP5 - Demonstration for P, water, salt and energy recovery from urban wastewater
- WP6 - Demonstration for closed-loop water recovery in the industrial sector
- WP7 - Development of ICT tools supporting process monitoring, control & optimization, immersive stakeholder engagement (AR-applications) & market creation
- WP8 - Circularity and Sustainability evaluation of demo activities
- WP9 - Market exploitation and Circular Economy Business Modelling
- WP10 - Advanced Policy Formulation, policy packaging & roadmap
- WP11 - Dissemination and communication activities