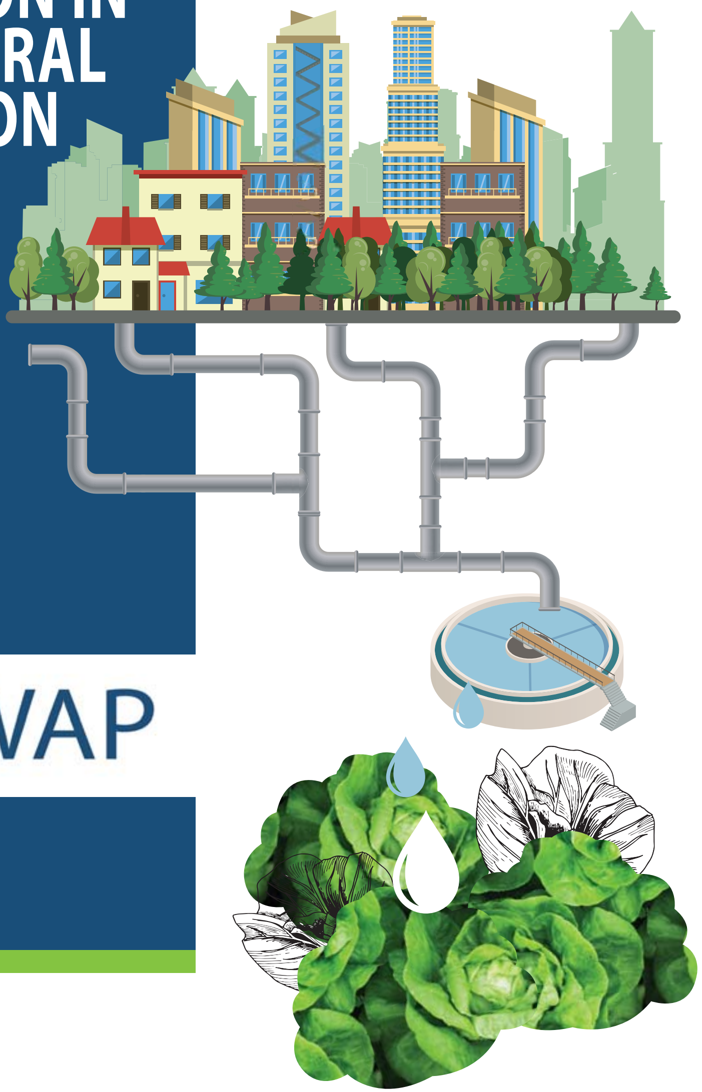
DECISION SUPPORT-BASED APPROACH FOR SUSTAINABLE WATER REUSE APPLICATION IN AGRICULTURAL PRODUCTION (DSWAP)



DSWAP

THE PROBLEM

Wastewater treatment requirements for effluents used for agricultural irrigation are considerably different from those of effluents discharged to aquatic environments. For example, nitrogen and phosphorus are essential elements for plant cultivation and therefore exhaustive processes for reducing nutrients (i.e. denitrification and phosphate removal) are not imperative in wastewater reuse for irrigation. Conversely, the capacity of human pathogens and associated antibiotic resistance genes to persist in irrigated soils and to potentially colonize plant tissues, as well as evidence of the uptake of various contaminants of emerging concern (CECs) by crops makes treated wastewater irrigation a potential public health hazard because these elements can be transferred to humans and animals through the food chain. In addition, the detrimental long-term effects of effluent-derived salinity and CECs on soil structure and crop yield in treated wastewater irrigated fields (especially in clay-rich soils) suggest that salt removal may be crucial when irrigating with wastewater effluents.

ORIGINALITY AND INNOVATIVE ASPECTS OF DSWAP

DSWAP adopts a circular economy approach, aiming for safe and sustainable valorization of wastewater for irrigation, with minimized ecological and agronomic impacts. The overall concept is to develop cost-effective, modular, de-centralized wastewater treatment/irrigation systems coupled to a decision support tool that enables the removal of contaminants such as pathogens, CECs, and salinity, while retaining beneficial parameters such as nutrients, whose levels can be adjusted as a function of local needs. This will be achieved by the coupling/decoupling of treatment modules as a function of the wastewater source and measured quality parameters, and will ensure optimal water quality for irrigation and long-term sustainability of irrigated soils. Individual modules within these networks will be coupled to alternative energy sources to reduce costs and greenhouse gas emissions.

The above concept focuses on seven wastewater treatment modules. **Two novel decentralized secondary treatment modules, three energy-efficient advanced treatment modules** specifically designed to remove microbial and chemical contaminants and **two units designed to remove salinity**. A key component of the DSWAP project is the **decision support tool** for the application of post-treatment desalination and pathogen intervention, which requires efficient data transfer, processing and harmonization from online and offline monitoring sources. The monitoring will rely on a comprehensive diagnostic toolbox, which will not only evaluate the quality of the effluents from individual and integrated technological systems (modules), but also their impact on soil quality, ecosystem functioning and agronomic performance.

EXPECTED IMPACT OF THIS PROJECT

DSWAP will have a major impact on the enhancement of sustainable wastewater reuse. In essence, it is expected to facilitate a paradigm shift from conventional wastewater treatment approaches that are specifically designed for effluent discharge to aquatic environments, to systems designed for wastewater reuse, with a special emphasis on agricultural irrigation. These systems will become increasingly imperative in the coming years due to dwindling freshwater resources associated with increasing world population and global climate change.

DSWAP OBJECTIVES

The main goal of DSWAP is to develop modular cost- and energy-efficient wastewater treatment systems specifically designed for wastewater reuse in the context of crop irrigation that safeguard human and environmental health and long-term agronomic sustainability. This goal encompasses five specific objectives:

- Optimization and evaluation of energy-efficient secondary treatment modules specifically designed for integration to decentralized wastewater reuse systems.
- Development and evaluation of novel advanced treatment (tertiary) modules for integration into decentralized wastewater reuse systems for reduction of microbial pathogens, antibiotic resistance elements and contaminants of emerging concern (CECs).
- Development and evaluation of modules for reduction of effluent salinity to prevent soil salinization, which over time can detrimentally impact soil quality and crop productivity.
- Evaluation of integrated modular configurations (using the modules described above) that meet the needs and criteria of specific stakeholders based on local infrastructure, geography, influent load, installation and energy costs and maintenance availability.
- Development and application of decision support tool that integrate and evaluate data generated by a myriad of state-of-the-art diagnostic tools for holistic evaluation of microbial, chemical, phyto-toxicological and ecosystem functioning-associated parameters in effluents and in corresponding irrigated soils.

Some specific impacts of the project include:

- Novel, energy efficient wastewater treatment technologies able to be integrated into decentralized wastewater reuse networks that can be customized according to specific regions and end-user needs to enable worldwide application.
- Safe and agronomic beneficial wastewater reuse that consider environmental, socio-economic and legal constraints regulating the adoption of these technologies.
- Reduction of soil salinization (leading to alteration of soil properties/reduction of agricultural yield) and promotion of sustainable and safe agricultural production.
- Ecosystem and public health protection through the transfer of knowledge and best practice to key stakeholders.
- Recommendation for the preparation of guidelines, standards and regulations for harmonized testing of the quality of wastewater to be reused through the development of a unique decision support tool.
- Technological solutions/tools that may be commercialised by the Small and Medium-sized Enterprises (SMEs) of the consortium, contributing thus to the enhancement of their company profile, their profit margin, the expanding of their clientele and increased competitiveness for European companies.

PARTICIPATING COUNTRIES AND ORGANIZATIONS

The DSWAP consortium brings together researchers from seven universities/research centres with outstanding expertise in environmental engineering, environmental chemistry, microbiology, molecular biology, plant physiology and risk assessment, and three dynamic SMEs that develop and apply cutting-edge wastewater treatment technologies.

Agricultural Research Organization (ARO), Volcani Centre, ISRAEL (**Coordinator**)
Dr. Eddie Cytryn

Fluence Corp. (FLC), ISRAEL
Ronen Shechter

Technical University of Dresden (TUD), GERMANY
Prof. Thomas Berendonk

University of Cyprus, Nireas-International Water Research Centre (Nireas-IWRC, UCY), CYPRUS
Prof. Despo Fatta-Kassinos

S.K. Euromarket LTD (SKE), CYPRUS
Stathis Kyriakou

Spanish National Research Council (CSIC), SPAIN
Prof. Joseph Maria Bayona

Apria Systems (APRIA), SPAIN
Javier Pinedo

University of Loraine, CNRS (LCPME), FRANCE
Dr. Christophe Merlin

University of Salerno (UNISA), ITALY
Prof. Luigi Rizzo

Catholic University of Portugal (UCP), PORTUGAL
Dr. Celia Manaia

WORK PLAN AND ORGANIZATION

The DSWAP work plan consists of five main Work Packages (WP).

WP1 MODULE OPTIMIZATION AND IMPLEMENTATION

MAIN OBJECTIVES: (i) develop, evaluate and optimize state-of-the-art secondary treatment, disinfection and desalination modules specifically designed for treated wastewater irrigation schemes; and (ii) integrate and evaluate selected modules.

WP2 DIAGNOSTIC TOOLBOX

MAIN OBJECTIVES: (i) define the impact of crop irrigation by treated wastewater on soil and plant quality with respect to agricultural production and public health; and (ii) evaluate the performance of treatments modules.

WP3 DECISION SUPPORT TOOL

MAIN OBJECTIVES: (i) develop an online inter-consortium data transfer network that will harmonize, integrate and analyze all of the data collected in WP2; and (ii) define and monitor online indicators that will be coupled to selected disinfection and desalination modules, to monitor and if necessary regulate module operation to ensure water quality of treated wastewater for irrigation while concomitantly reducing costs.

WP4 COMMUNICATION/DISSEMINATION AND TRAINING

MAIN OBJECTIVES: (i) transfer information to local and international stakeholders (public health, environmental and agricultural officials and wastewater treatment plant managers); (ii) organize educational workshops and training events (stakeholders Engagement workshops, people-2-people (P2P) activities, field trips to showcase, exchange, and transfer the proposed solutions); (iii) publish and present scientific breakthroughs; and (iv) organize an international symposium on wastewater irrigation.

WP5 PROJECT MANAGEMENT

MAIN OBJECTIVES: manage and coordinate scientific, financial and administrative aspects of the project.

CONTACT US:

PROJECT COORDINATOR
Dr. Eddie Cytryn
Agricultural Research Organization (ARO), Volcani Centre, Israel
eddie@volcani.agri.gov.il

COMMUNICATION AND DISSEMINATION MANAGER
Dr. Kyriakos Manoli
Nireas-International Water Research Centre, University of Cyprus, Cyprus
manoli.kyriakos@ucy.ac.cy

MORE INFO:

Project Website: http://dswap-prima.eu/

Twitter: https://twitter.com/DSWAP1

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