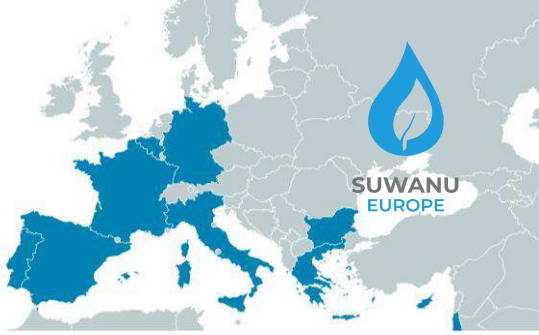
Sustainable **Water treatment** and
Agricultural reuse options in Europe

Info-package 3
Water Reclamation Operators

Fact Sheet 3.3 –**Antibiotic resistance and its health impacts linked to irrigation with reclaimed water**



Reclaimed water quality requirements | Contaminants of emerging concern | **Potential Antibiotic resistance and health impacts linked to irrigation with reclaimed water** | Key for success in Israel (and Cyprus?) | Phosphorus recovery in water reuse

SUWANU EUROPE is a H2020 project aiming to promote the effective exchange of knowledge, experience and skills among practitioners and relevant actors on the use of reclaimed water in agriculture. This factsheet is part of a total of 5 factsheets in Info-package 3 aimed at water reclamation operators and provides information regarding antibiotic resistance determinants in reclaimed water and the potential health impacts linked to irrigation with this type of water.

1. Introduction:

Antibiotic resistance is an antimicrobial resistance (AMR) phenomenon, occurring when an antibiotic compound has lost its ability to effectively control or kill bacterial growth; in other words, the bacteria are resistant and continue to grow and multiply in the presence of therapeutic levels of an antibiotic (U.S. FDA, 2016).

The widespread use and misuse of antibiotic compounds and their uncontrolled emission in the environment was shown to contribute to the proliferation of antibiotic resistance determinants, antibiotic-resistant bacteria (ARB) and their associated genes (antibiotic resistance genes, ARGs) (collectively hereby denoted as ARB&ARGs).

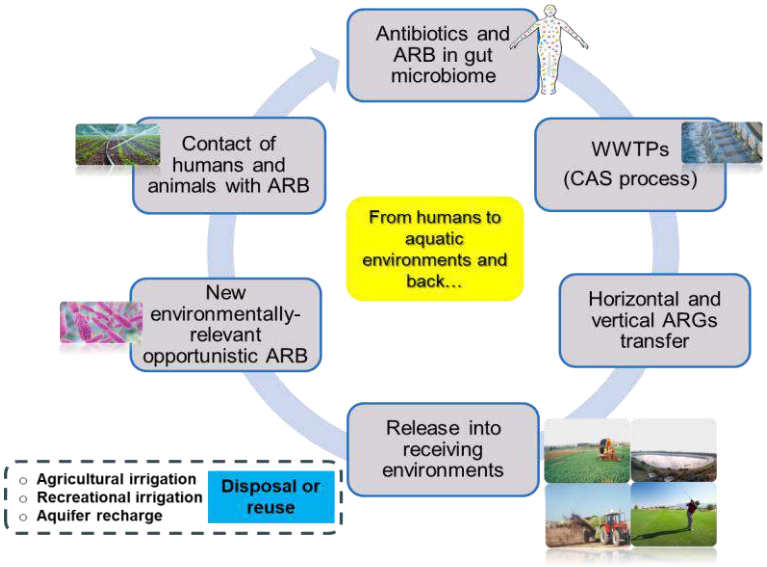
A great concern of the release of reclaimed water nowadays, is associated with the potential development and spread of antibiotic resistance among bacteria in receiving aquatic and terrestrial environments, which potentially leads to a reduction of the therapeutic potential of antibiotic compounds, against human and animal bacterial pathogens.

2. The framework of antibiotic resistance in reclaimed water environments:

Various studies have shown that the concentrations of antibiotic residues in reclaimed water were shown to exceed the bacterial Minimum Inhibitory Concentrations (MICs) for sensitive pathogenic bacteria, thus promoting the prevalence of ARB among total bacterial populations (Bengtsson-Palme and Larsson, 2016), and making antibiotics an important class of contaminants of emerging concern (CECs) for further and closer examination. However, the anthropogenic contribution of antibiotic residues even at very low concentrations (ng to µg L-1) which may be well below the clinically-relevant MICs, has been shown to contribute to the drive of the selection of ARB, thus altering the natural background diversity and size of the environmental ARGs pool, thus contributing to the dissemination and development of antibiotic resistance (Bengtsson-Palme and Larsson, 2016).

As a result, ARB&ARGs in reclaimed water are now gaining scientific attention, and as a result are recently starting to be increasingly included in lists of hazardous agents to be examined, when investigating environmental hazards and risks posed by the practices of reclaimed water disposal and reuse. It was reported that 'resistance anywhere is resistance everywhere' by Prescott (2014), and that antibiotic resistance is a 'highly multifaceted topic at the interface of human, animal and plant health, food hygiene and environmental science' by Butaye et al. (2014).

In addition to the above, the unearthing of 'new' genes to reclaimed water encoding for antibiotic resistance mechanisms, points to the indication that established full-scale WWTPs operating with the CAS process, are significant hubs of ARB development and dissemination. As the CAS process operates with a high, nutrient-rich and a microbially-dense biomass, CAS treatment tanks present ideal environments for the persistence of ARGs in CAS, reclaimed water as well as in biosolids used as soil manure, which once gained and re-purposed by pathogenic bacteria, may have adverse effects on therapeutic courses (Schematic 1).



Schematic 1. Schematic representation of the spread of antibiotic resistance in the environment via reclaimed water (Schematic by Karaolia, 2018)

3. The One Health Approach:

A holistic and multisectoral approach**, -the One Health Action Plan-** is one that aims at addressing AMR on multiple fronts. This approach is a broad, system-based approach aiming at providing solutions to complex problems such as AMR, and considers underlying structural factors affecting this issue, such as socio-political, material, biological and economic factors. In more detail, AMR is addressed in this approach, through the closing of knowledge gaps on the release and spread of antimicrobial-resistant organisms in the environment, and the development of new technologies which have the potential to enable efficient and rapid antimicrobial compound degradation in WWTPs.
Due to the aforementioned complexity of the issue of AMR, the 71st session of the UN General Assembly identified antimicrobial resistance as a dominant global health concern, placing it high on the agenda of national policy makers, international organisations and financial institutions in developed and developing countries, alike. National action plans to tackle this issue in line with the One Health Action Plan have been pledged by states, with interventions targeted at urban wastewater treatment, agriculture, livestock and human health (WHO, 2017).

4. Conclusions:

Still, the understanding of the underlying forces driving the mechanisms of action of such antibiotic resistance determinants, of their exact identity and of their specific genomic context in the environment, remains uncertain. As an outcome, the fate and spread of ARB&ARGs due to the contribution of human and/or clinically-relevant activities and not due to the presence/structure of the background communities is still unclear and may pose a major public health issue and an emerging challenge to combat, globally. Therefore, the lack of inclusion of ARB&ARGs in existing regulations regarding reclaimed water discharge and reuse worldwide, poses a potential risk of ARB&ARGs contamination of ground- and surface-water, wildlife and food chains.

References/further readings:

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