Aalto University
Department of Built Environment
Water and Environmental engineering

Emerging micropollutants and antibiotic resistance in wastewater

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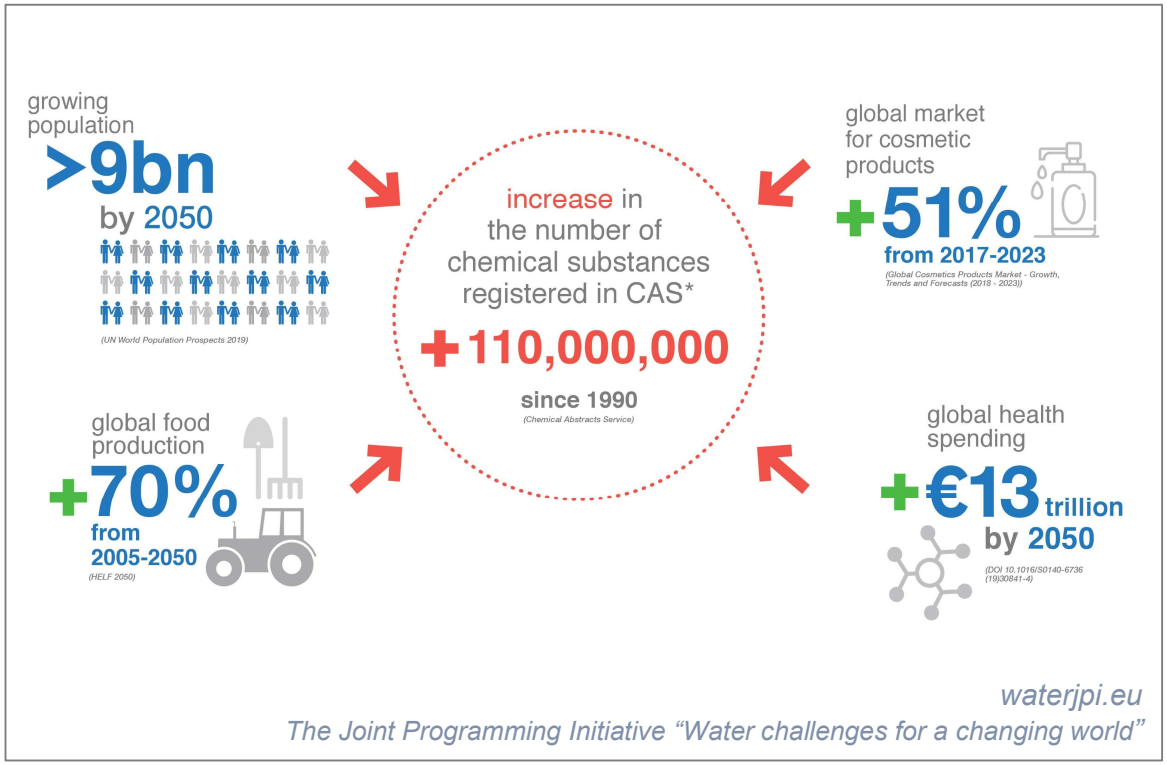
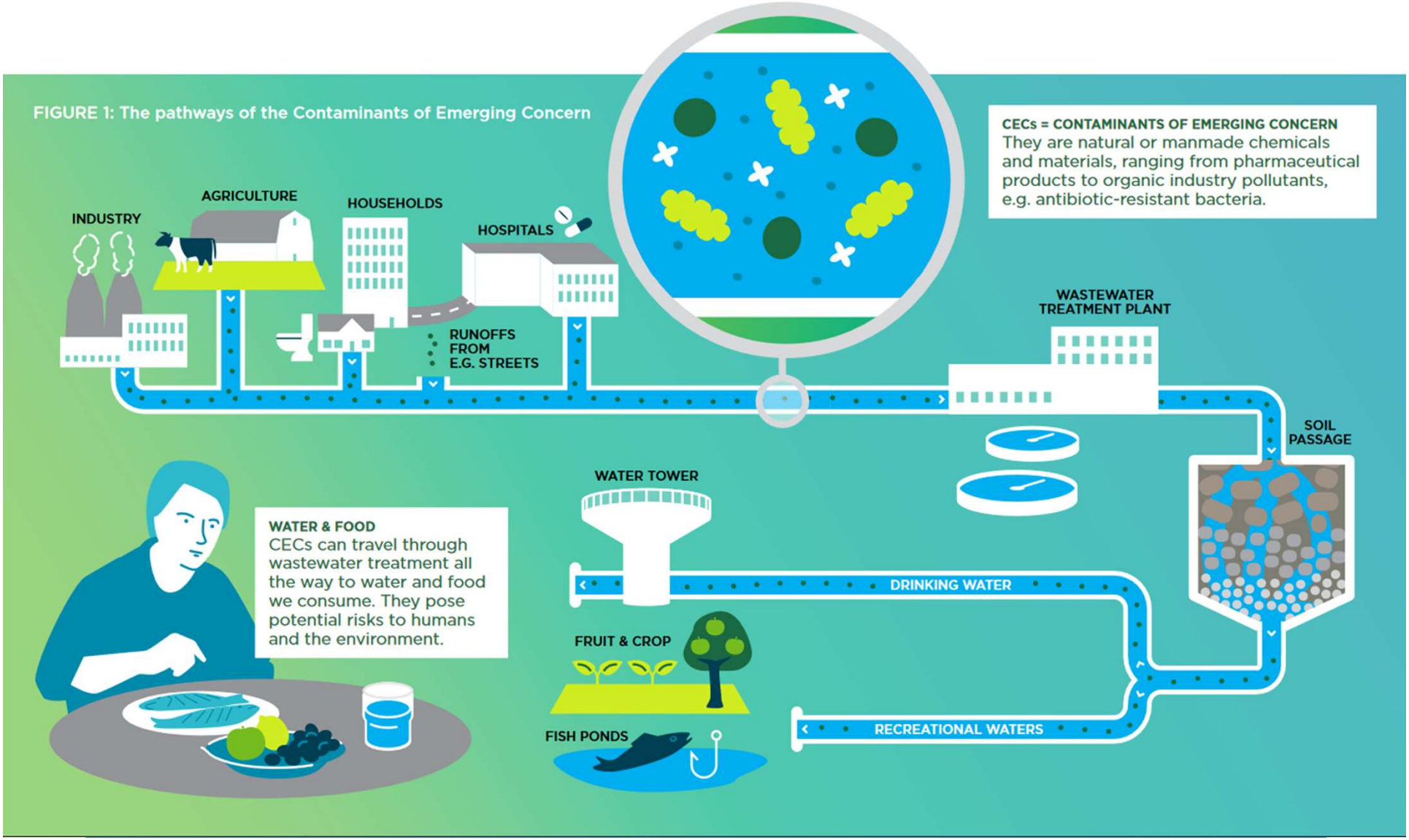
06.04.2021

Emerging micropollutants

- **contaminants which are found in the mg L^{-1} or ng L^{-1} concentration range in the aquatic environment**
- **contaminants of emerging concern about their ecological and human health impacts**

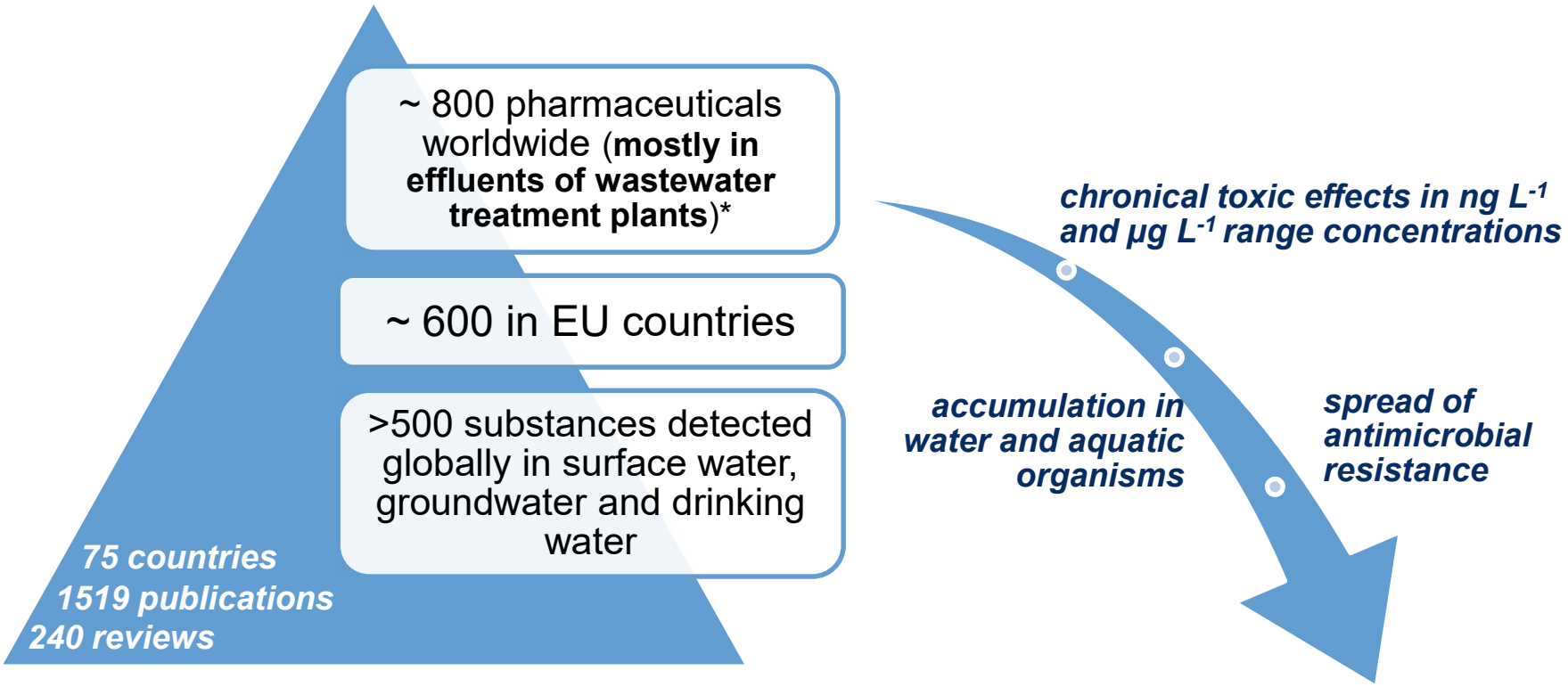


The pollutants that were in wastewaters before are not the ones that are there currently



Water JPI & Ulla Eronen, Kaskas Media
Academy of Finland Policy Brief, 2019

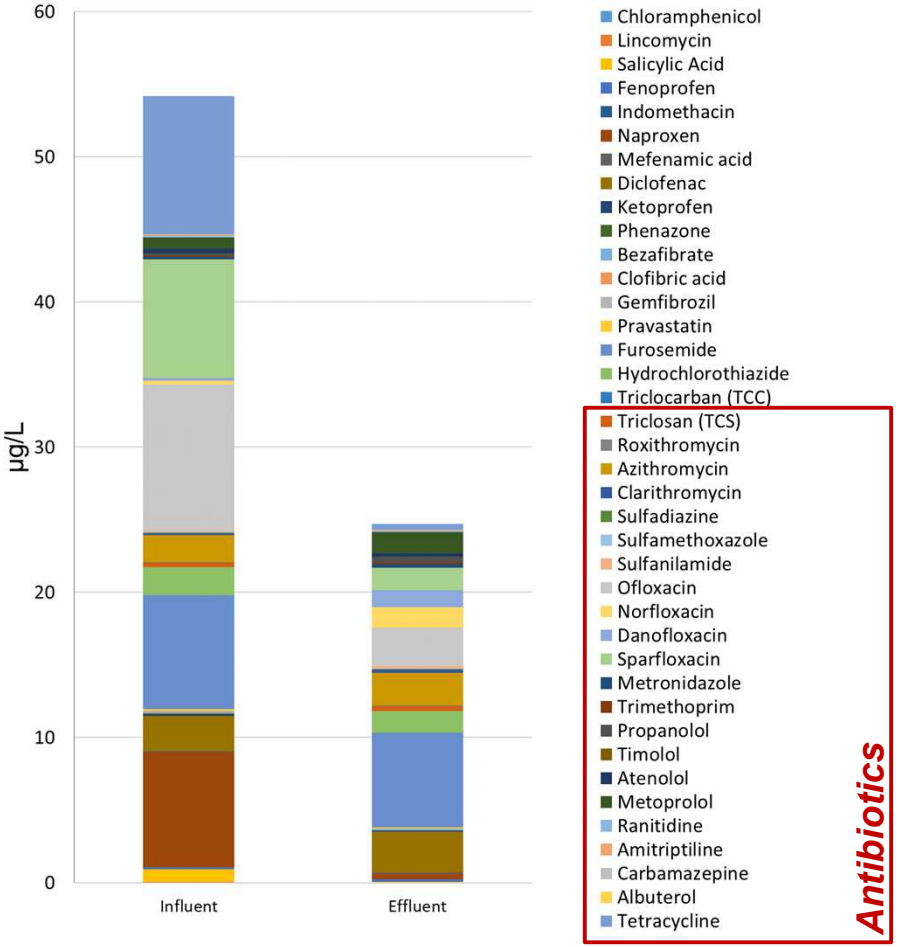
Pharmaceuticals in aquatic environment



**Pharmaceuticals defined as substances that are mainly used for therapeutic purpose*

Dusi et al., 2019

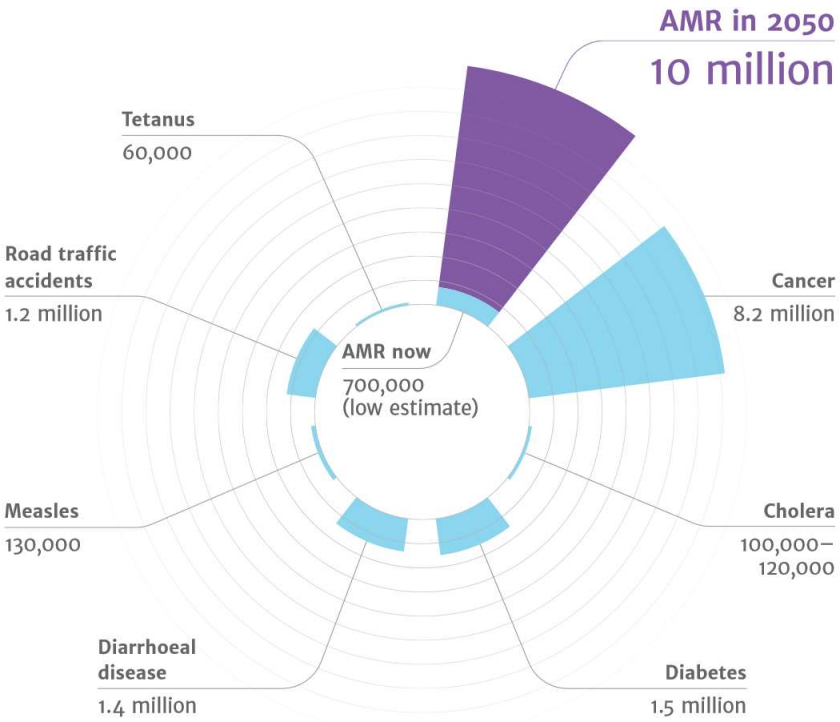
Micropollutants in Finnish wastewaters



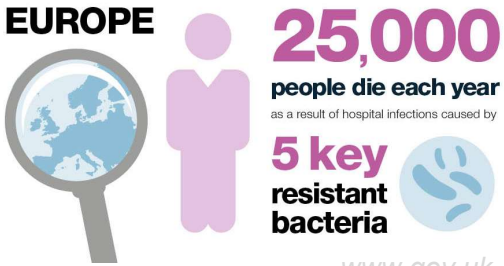
**coffein, ibuprofen and acethaminophen concentrations are not presented in the picture due to much higher numbers*

Kruglova et al., 2019

Antimicrobial resistance (AMR)



~ 700,000 people a year dying from antimicrobial-resistant infections.



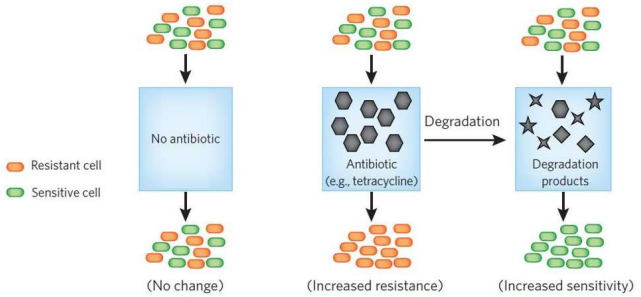
World Health Organization (WHO):

antibiotic resistance as one of the most important public health problems of the 21st century, which needs to be immediately resolved

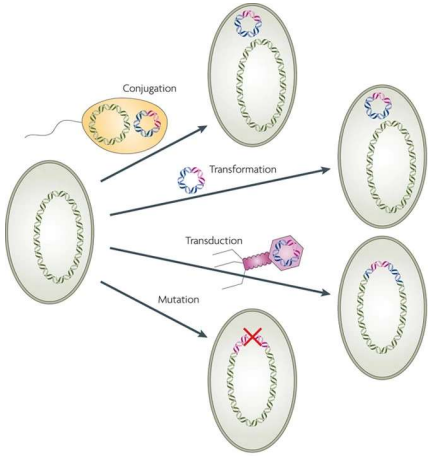
O'Neill, J., 2016

Antibiotic resistance development

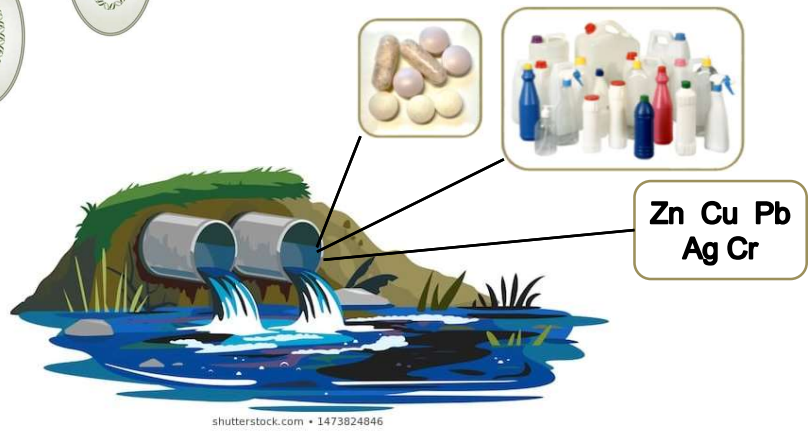
Selective pressure from antibiotics



Resistance may appear as a mutation or bacteria may receive genetic material (horizontal gene transfer)

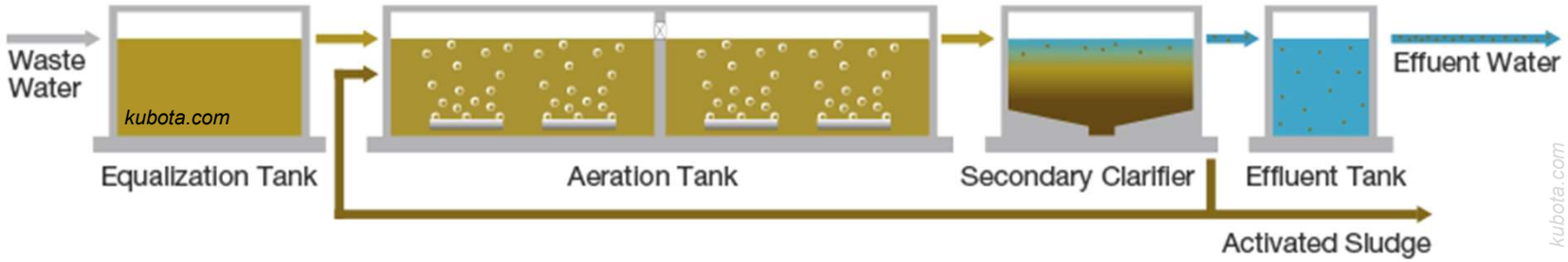


Pharmaceuticals, biocides and heavy metals increase antibiotic resistance (multi-resistance/ co-resistance/ cross-resistance)



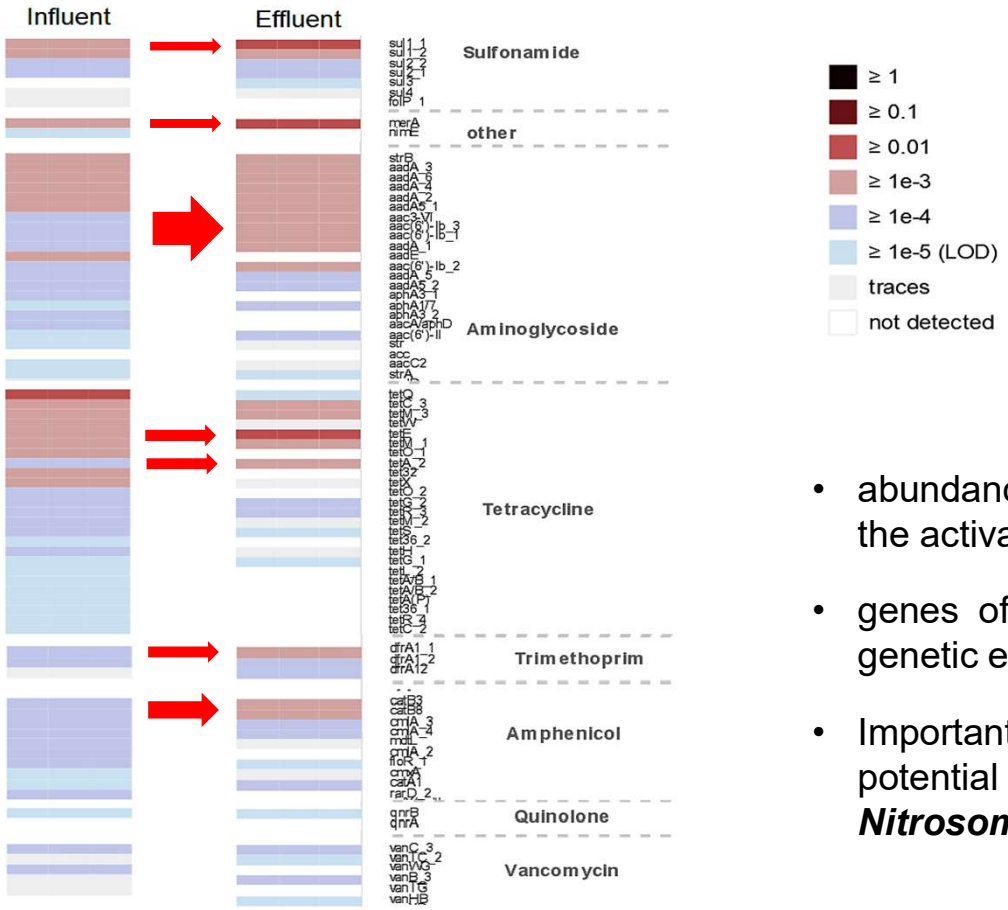
Andersson & Hughes, 2010; Hiltunen et al., 2018; Chait et al., 2012, 2016

Fate of antibiotic resistance in Wastewater Treatment Plants



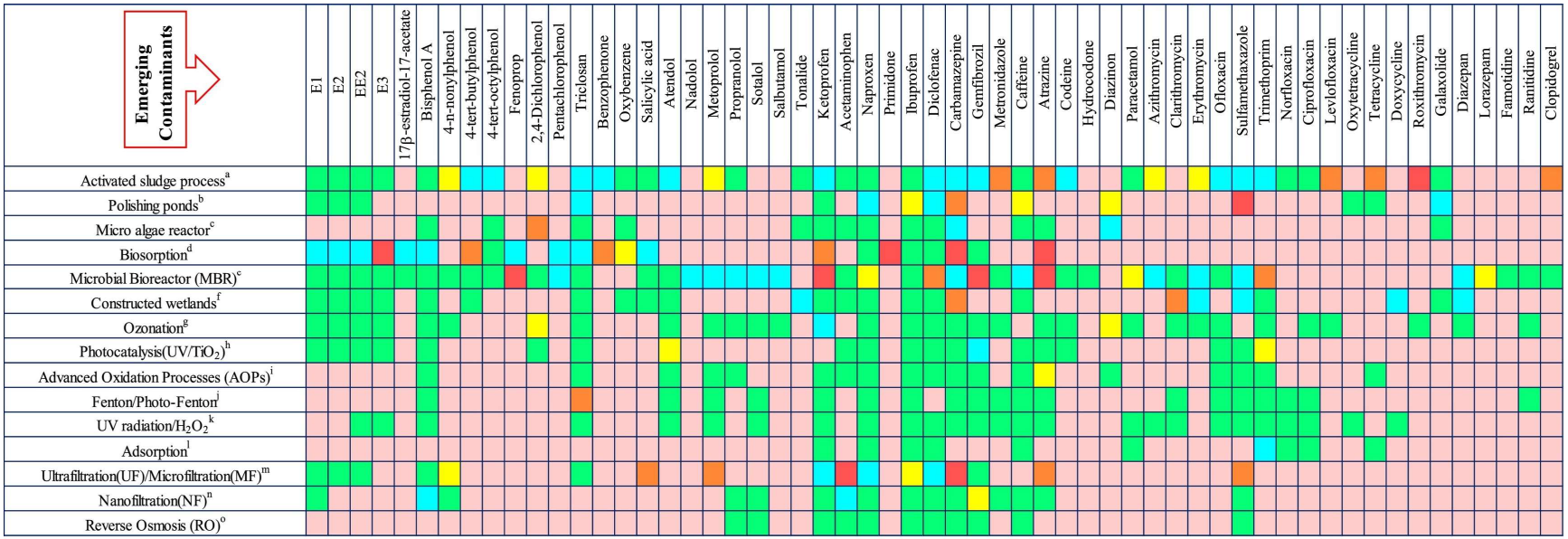
- High concentration of bacteria from different sources
- Different antibiotics excreted by humans (sub-lethal concentrations)
- Other micropollutants (additional selective pressure)
- **Bacteria excreted by humans meet water and soil bacteria**

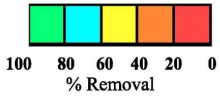
Antibiotic resistant genes in Finnish wastewater treatment plants



- abundance of multiple genes increase among the activated sludge bacteria
- genes of multi drug resistance and mobile genetic elements are abundant in effluents
- Important process bacteria are among the potential hosts of multiple ARGs (ex. ***Nitrosomonas***)

Removal of emerging micropollutants in wastewater treatment processes

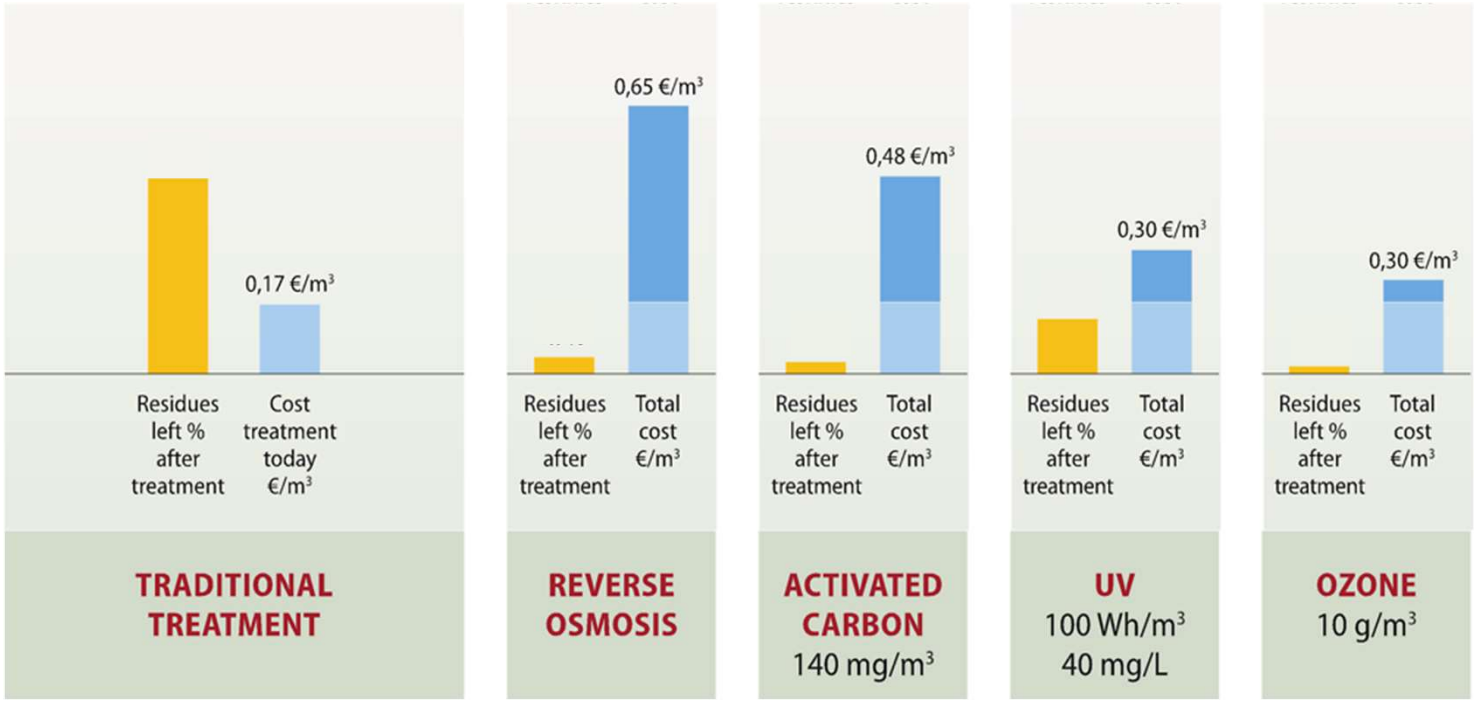




Not Available

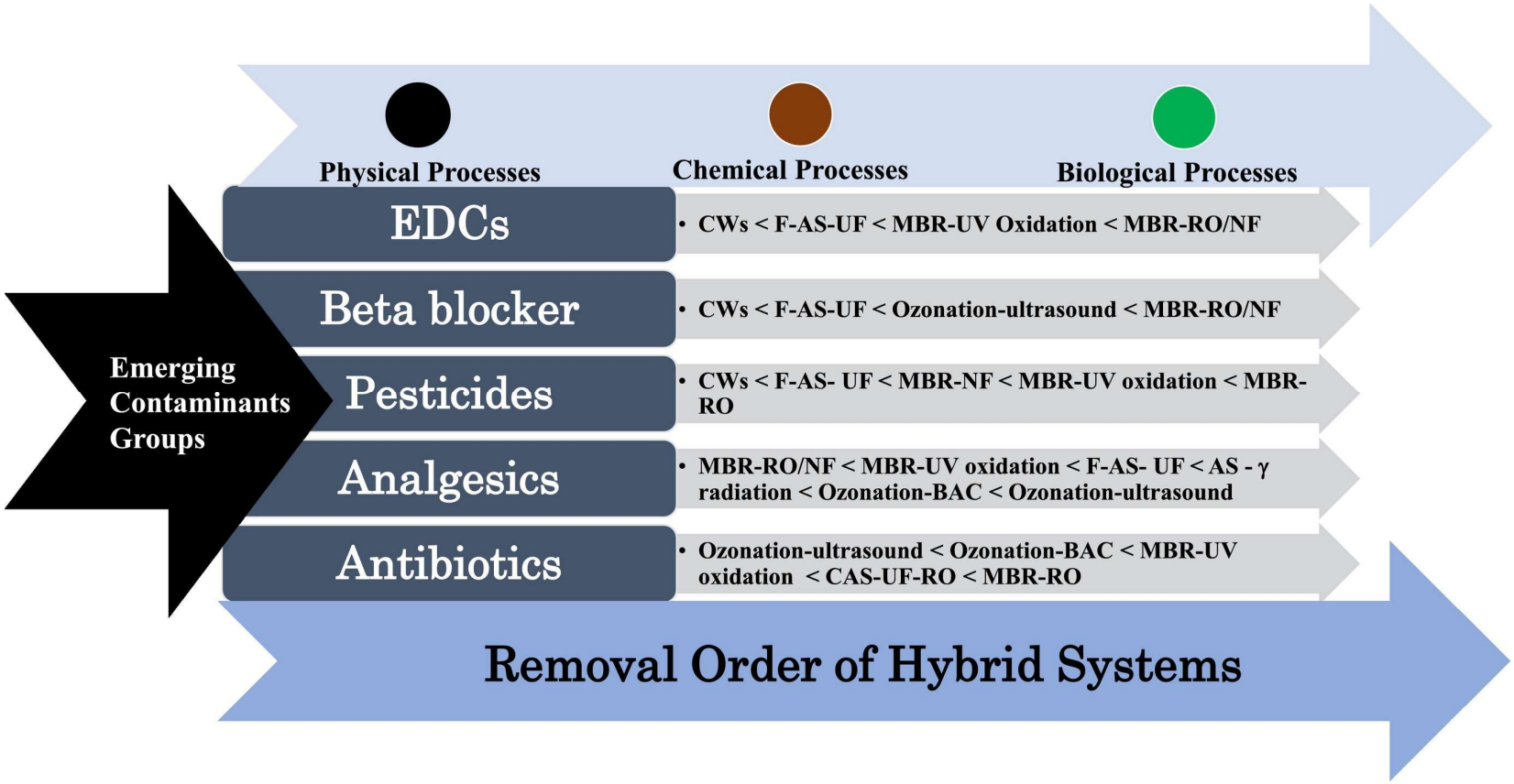
Dhangar K. & Kumar M., 2020

Treatment cost estimation



Bui et al., 2016

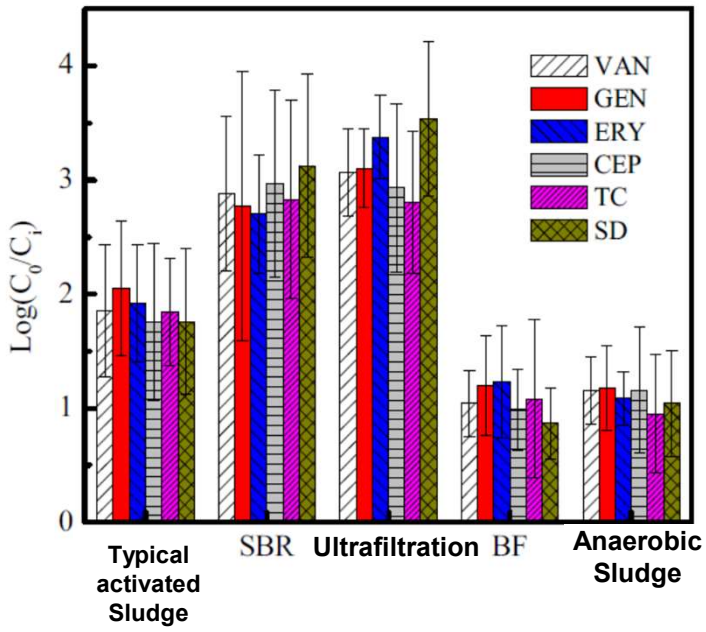
Hybrid treatment systems



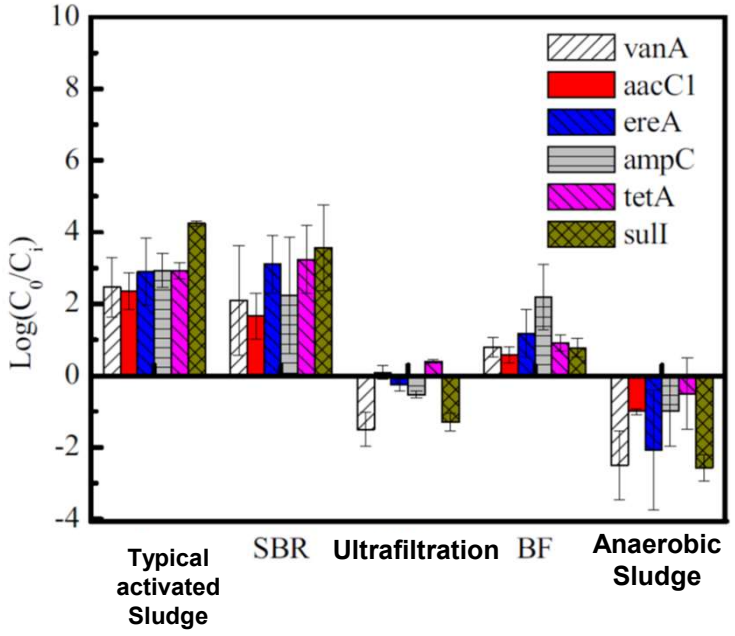
Dhangar K. & Kumar M., 2020

Removal of antibiotic-resistant bacteria and antibiotic resistance genes by ultrafiltration

Log removal of antibiotic-resistant bacteria

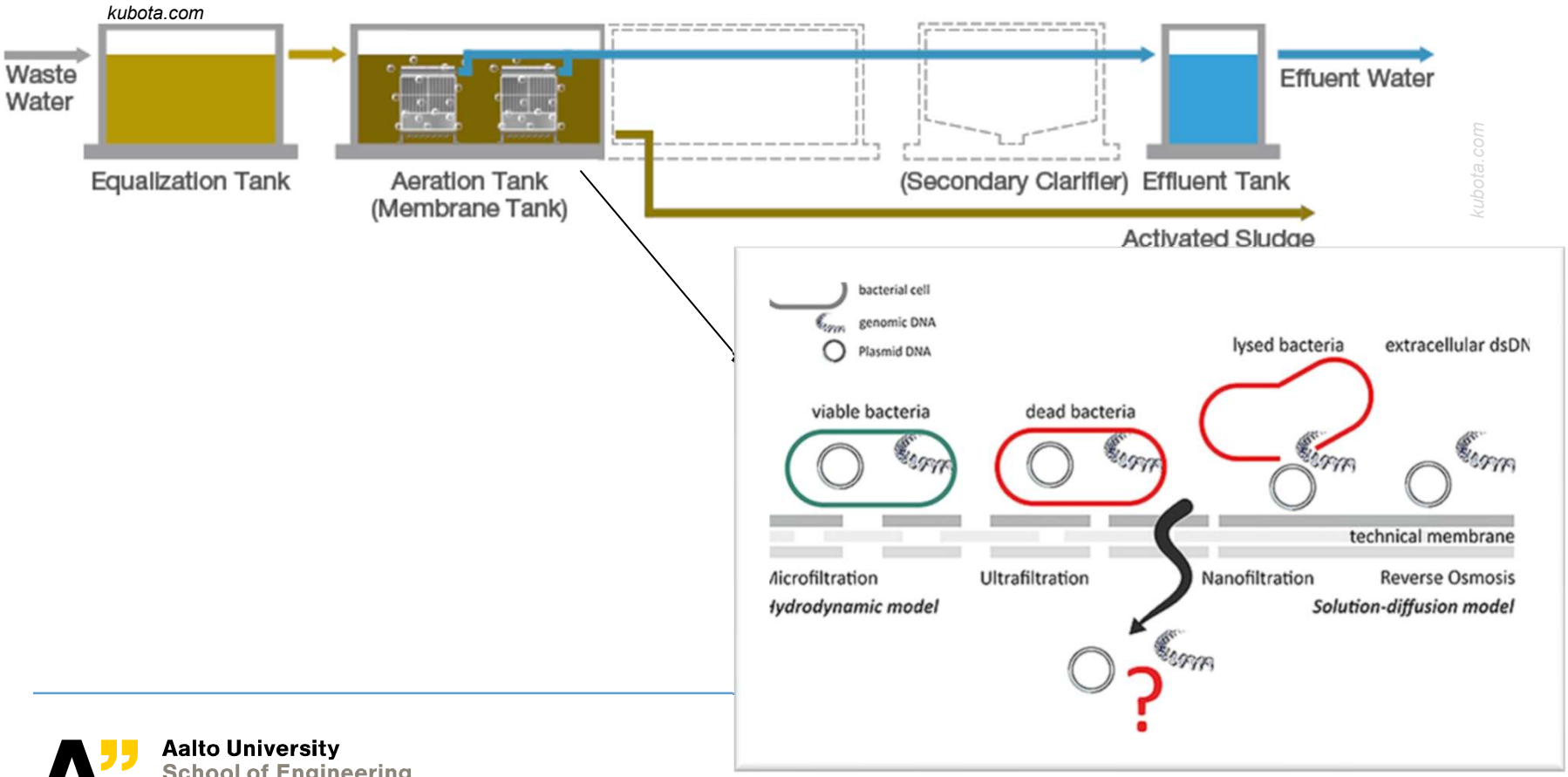


Log removal of antibiotic resistance genes

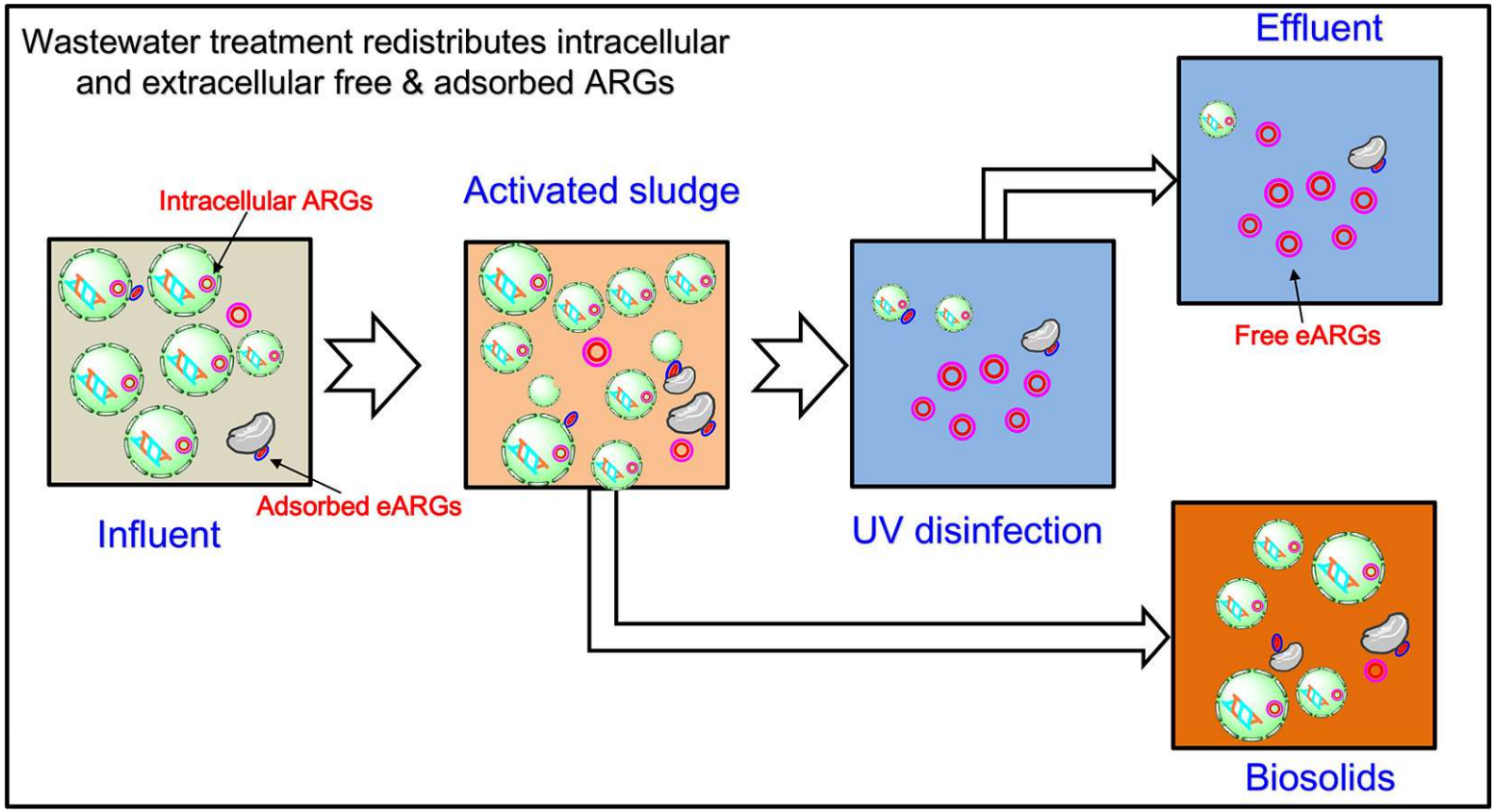


Yuan et al., 2016

Membrane technology



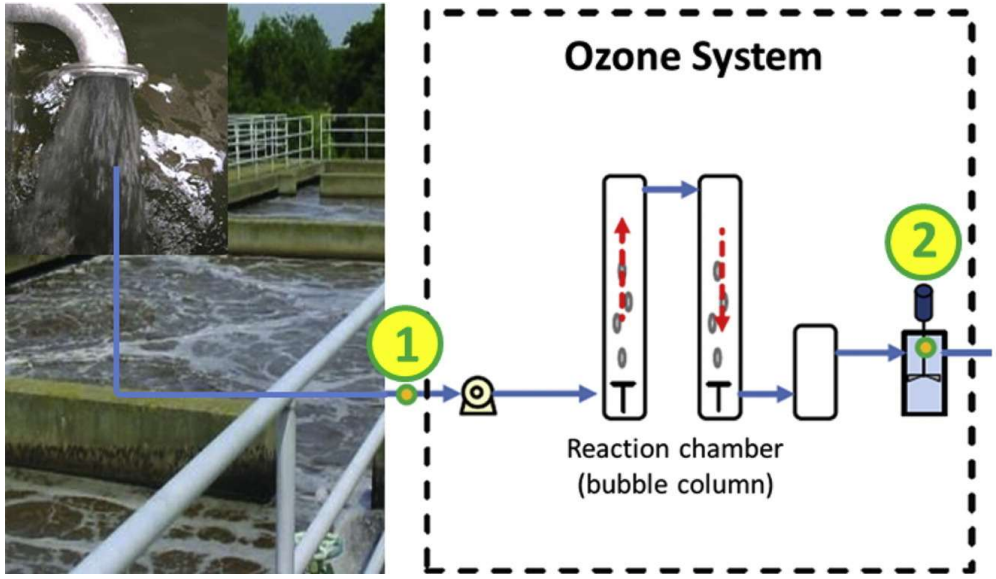
Disinfection methods

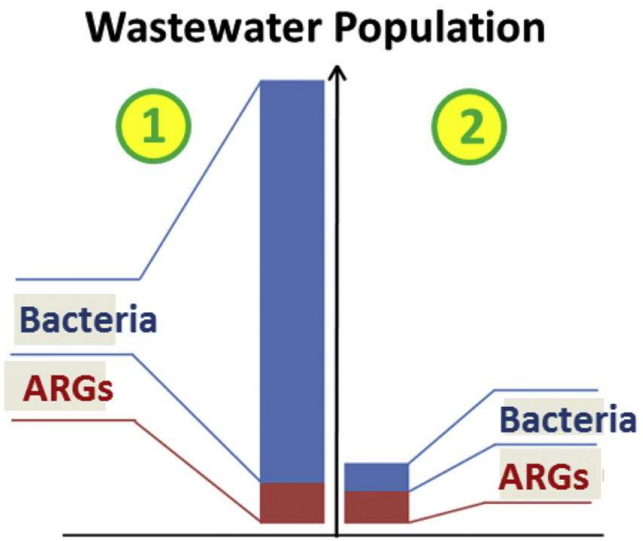


Qing-Bin Yuan et al., 2019

Ozonation

- Ozone treatment selects vancomycin- and imipenem- resistant bacteria
- Ozone impact depends on bacterial species
- Possible effluent toxicity (ozonation by-products)





Alexander et al., 2016

Modern wastewater treatment challenges

- There are major risks associated with the occurrence of emerging contaminants, pathogens and antimicrobial resistant bacteria in our water bodies and oceans
- Advanced technologies, hybrid processes and process optimization are essential for better treatment of modern wastewaters
- Implementation of green and sustainable technologies for cost effective solutions
- Development of the new monitoring methods to detect and manage emerging micropollutants