Title MSc project: The environmental impacts of advanced urban wastewater technologies

Assignment number: 07.23 **Internal project**

Head graduation committee
Prof. dr. Markus Berger

Daily supervision
Dr. Rosalie Arendt, Dr. Lara Wöhler

Required courses: desired are the Life Cycle Assessment course and the water quality course; interest in working interdisciplinary on environmental topics

Involved organisations: internal **Start of the project:** flexible

Short description project aim and motive:
Emerging contaminants such as micro-/nanoplastics, pharmaceuticals, or biocides resulting from domestic waste water are commonly found in the aquatic environment (Tran et al., 2018, Strokal et al., 2019). Their environmental (as well as human) impact is of general concern due to i.e. their ecotoxicity, bioaccumulation and persistence (Kroeze et al., 2016). The scientific as well as public discourse regarding emission reduction largely focusses on so called end-of-pipe technologies (Rout et al., 2021) (see also this recently published newspaper article about Twente: https://www.tubantia.nl/almelo/saxion-prof-futselaar-twentse-beken-overgevoelig-voor-vervuiling-door-medicijnen-investeer-in-schoner-water~a5d0ab39/). The idea behind this is to equip existing waste water treatment plants with additional treatment steps to eliminate emerging contaminants which are not captured by the conventional (physical, and bio-chemical) treatment. Such advanced treatment steps include technologies such as membranes (nanofiltration, reverse osmosis), disinfection with chlorine and/or UV, or activated carbon (Rout et al., 2021). However, all of these technologies come with certain shortcomings and/or trade-offs. They, for instance, only eliminate certain pollutants (Ahmed et al., 2021), are energy intensive (Obotey Ezugbe and Rathilal, 2020), or produce by-products (Völker et al., 2019). Hence, each technology can have specific positive and negative environmental impacts.

Research objective
The objective of the proposed research is to assess the environmental impacts of different advanced waste water treatment technologies if they would be implemented in (parts of) the Netherlands. It is suggested to compare different environmental parameters (specifically related to water and carbon) of chosen technologies. On the one hand the positive effects from the removal of (selected) contaminants will be evaluated. On the other hand it should be accounted for negative impacts (e.g. carbon emissions) along the whole life cycle.

Method
It is suggested to conduct a life cycle assessment (LCA) of different advanced waste water treatment technologies and compare their environmental performance against each other. The LCA in an environmental management tool to assess the potential environmental impact of products or services. It structured in 4 phases i) goal and scope definition, ii) Life cycle inventory, iii) life cycle impact assessment and iv) life cycle interpretation. Usually the LCA is modelled in an LCA software with an underlying database.
Various studies have applied LCA to waste water treatment technologies in general (Corominas et al., 2020), and also to advanced treatment technologies (Rahman et al., 2018, Li et al., 2019). However, a study that compares the environmental performances of alternative technologies if they would be implemented in (parts of) the Netherlands does not yet exist.

Expected result
The study will shed light on the positive and negative environmental impacts of alternative advanced waste water treatment technologies. Precisely it quantifies the Life cycle impact assessment results of the assessed technologies. Besides the comparison among alternative technologies, results can be compared to other LCA case studies. Additionally they can be compared to a reference of the impact per nation or capita (which is called normalization). This provides an increased understanding about the quantified impacts' relevance. Practically the studies' results can support decision making in Dutch water management where equipping waste water treatment plants with advanced treatment steps is a frequently debated topic.

References

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