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Developing a Decision Making Framework for Upgrading and Operation of Wastewater Treatment Plants for Trace Organic Chemical Removal

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Introduction

During the recent past anthropogenic trace organic chemicals (TOrCs) have moved into the focus of regulatory authorities. In contrast to conventional biological wastewater treatment systems, a more complete removal of these contaminants can be achieved by various advanced treatment processes. However, all these treatment approaches usually come with a higher energy footprint. Therefore, this PhD-Project focuses on the heuristic optimization to remove TOrCs while also considering the local discharging situation into a receiving stream.

Concept

The traditional concept of regulating contaminants is rather linear in nature (Fig. 1 A) and usually assumes a rather direct correlation between surrogate parameters and the mostly deterministic contaminant fate model. Especially regarding the prediction of TOrC this is not very promising, because given the wide variety of different TOrCs there is currently not a single strong surrogate. The proposed novel approach (Fig. 1 B) uses the power of statistics and machine learning to define specific surrogate clusters, which are resilient enough to act as more suitable surrogates.

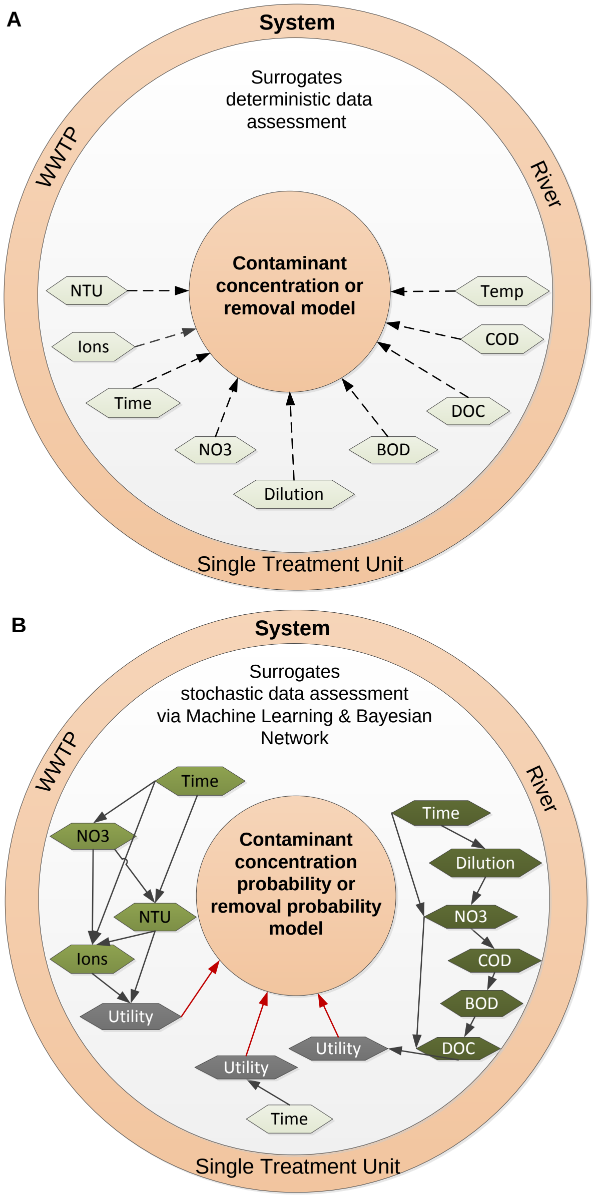

Fig. 1: Traditional surrogate model

Furthermore, the individual surrogates are data sets with a specific probability distribution considering the incoming conditions. This concept even allows real-time monitoring of surrogates and combined with static data sets these can result in a comprehensive dynamic monitoring approach.

This concept offers a large potential to optimize current wastewater treatment system through more flexible operational regimes. Adjusting the treatment system to the individual contaminant load probability will result in significant energy savings.

Activities in 2015

In 2016, the main focus was to complete a review paper which discusses the potential of current regulatory tools and controls for a dynamic water quality risk profile in water quality management. Additionally, a big field sampling campaign at the wastewater treatment plant Munich II was performed, which is one major basis for the data analysis.

For the latter, the computational basis for the different machine-learning modules was developed. A further aspect of this sampling campaign was to investigate advanced statistical machine-learning concepts for the perspective to capture new multi-dimensional sensory data. This type of data is for example obtained by using optical measurement technology like absorption sensors and 3D fluorescence measurement. These sensors generate complex data sets, which can currently only be limitedly used. However, with their embedment in the here proposed machine-learning environment a new knowledge discovery process is envisioned.

Publications for this PhD project are currently in preparation stage