Effect-Directed Analysis of Advanced Treated Wastewater to Assess Reuse Potential

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1) Objective

To assess treatment efficiency and reuse potential of treated wastewater (TWW) using effect-based methods.

2) Background

One option to fight water scarcity is reusing TWW. However, it has to be ensured that confounding risks posed by micropollutants (MPs) that are present in TWW, are properly understood and addressed. Therefore, a pilot plant was installed in Wervershoof, The Netherlands (see Fig. 1), that aims to achieve reuse of TWW from a wastewater treatment plant (WWTP) after advanced treatment.

3) Sampling & Workflow

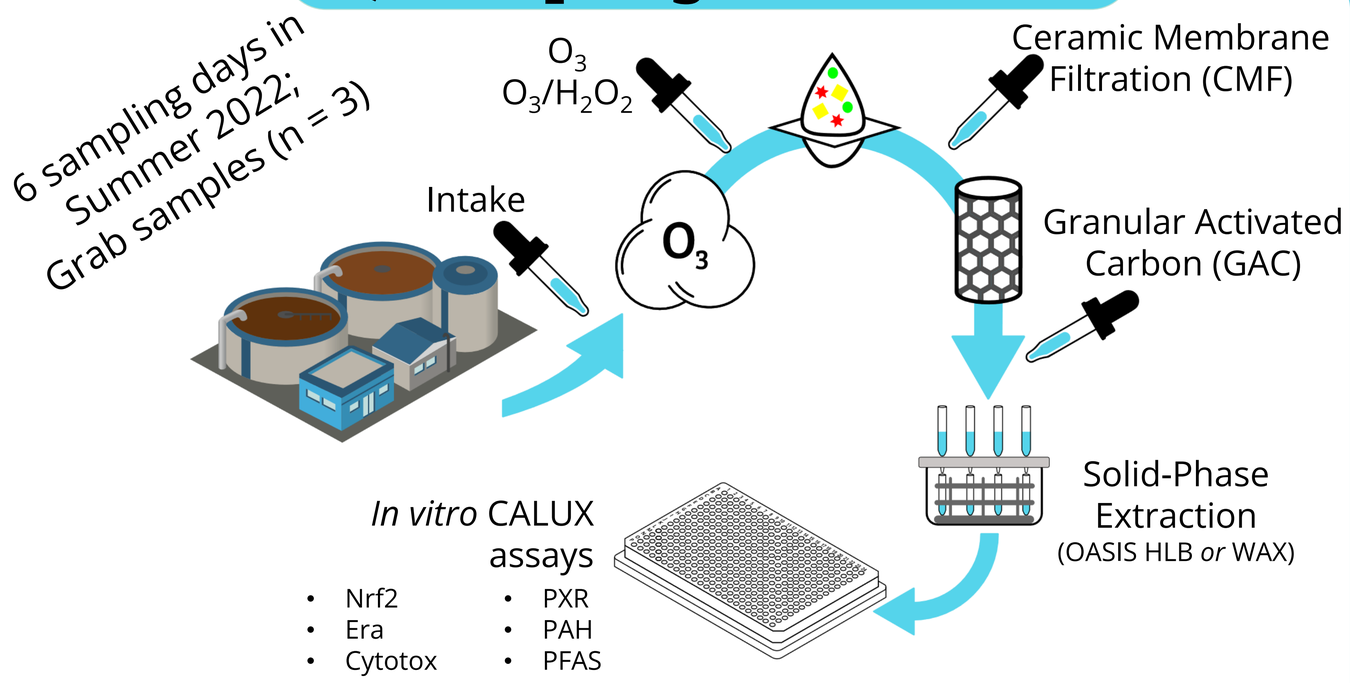

Fig. 1: Sampling scheme and sample analysis workflow.
Samples were taken at the intake (WWTP effluent) of the pilot plant and after the treatment steps. After solid-phase extraction (OASIS HLB *or* WAX), sample extracts were analysed with CALUX *in vitro* bioassays.

4) Results

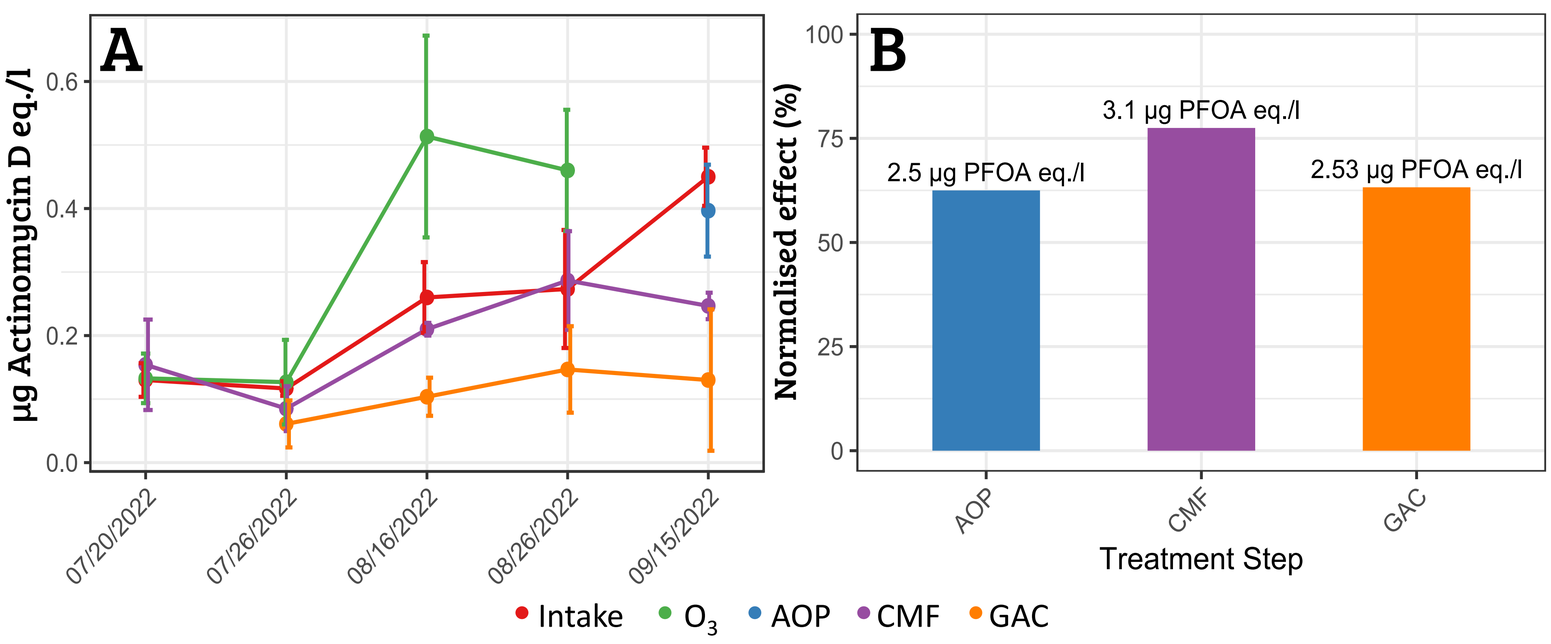

Fig. 2: Responses of the Nrf2 (A) and PFAS (B) CALUX assay.
The Y-Axis shows the observed response translated as biological equivalent (BEQ) concentrations of the reference compound as mean with standard deviation (A). For the PFAS assay (B), effect levels were normalised to the intake of the pilot. The X-Axis shows either the sampling day (A) or the treatment (B). Values above the bars represent the BEQ concentration.

- O_3 & O_3/H_2O_2 (AOP) can substantially increase oxidative stress (see Fig. 2A)
- PFAS related effect removal is overall poor (see Fig. 2B)

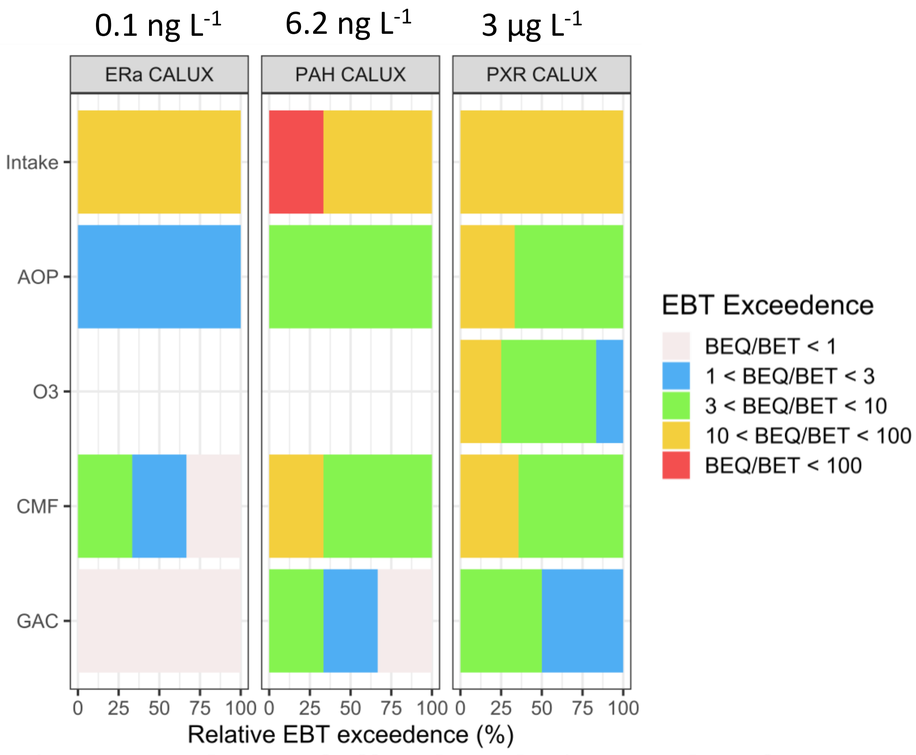

Fig. 3: Exceedance of effect-based trigger values for surface water.
The chart shows the frequency and severity of exceedance for the respective CALUX assay according to the NORMAN network. Applied EBTs are shown above the figure.

- Effect-based triggers (EBTs) are frequently exceeded but decrease during treatment (see Fig. 3)

5) Conclusion

- Reuse without additional treatment is **not** advised.
- Special attention for **persistent** compounds such as PFASs

6) Further work

- Target to non-target screening
  - Which MPs could explain observed effects?
  - Which transformation products are formed during treatment?

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