

# Applicability of a model-based assessment of the removal effectiveness of wastewater treatment plants with regard to pharmaceutical substances

## Introduction

More than 3,000 pharmaceutical substances are registered for medical use in the EU, and consumption continues to rise due to population growth, demographic change and increasing per-capita use. After administration, unmetabolised and transformed pharmaceuticals enter wastewater and are frequently detected in surface waters, indicating insufficient removal in wastewater treatment plants (WWTPs) and high environmental persistence.

Understanding pharmaceutical behaviour in WWTPs is therefore essential. Removal depends on physicochemical properties and operational conditions, but monitoring data on influent and effluent concentrations are limited because WWTPs primarily focus on nutrient removal. For this reason, removal efficiencies are often estimated using models such as SimpleTreat, an emission and exposure model under EU REACH.

With the introduction of the Urban Wastewater Treatment Directive (UWWTD, 2025), medium-sized WWTPs must conduct a risk-based assessment of micropollutants. This study evaluates whether SimpleTreat can support such assessments.

## Material and Methods

Modelling in SimpleTreat was carried out for ten substances and four German WWTPs. A sensitivity analysis was conducted to identify sensitive parameters.

To assess the plausibility of the model results, additional modelling was performed for six Finnish and three Latvian WWTPs. For the specified WWTPs, influent and effluent concentration measurements of the respective substances were present. The applicability of SimpleTreat for other WWTP types was examined for an SBR WWTP. To assess the transferability of the model to other WWTPs, additional modelling was executed for an average European WWTP and an average German WWTP.

## Results and Discussion

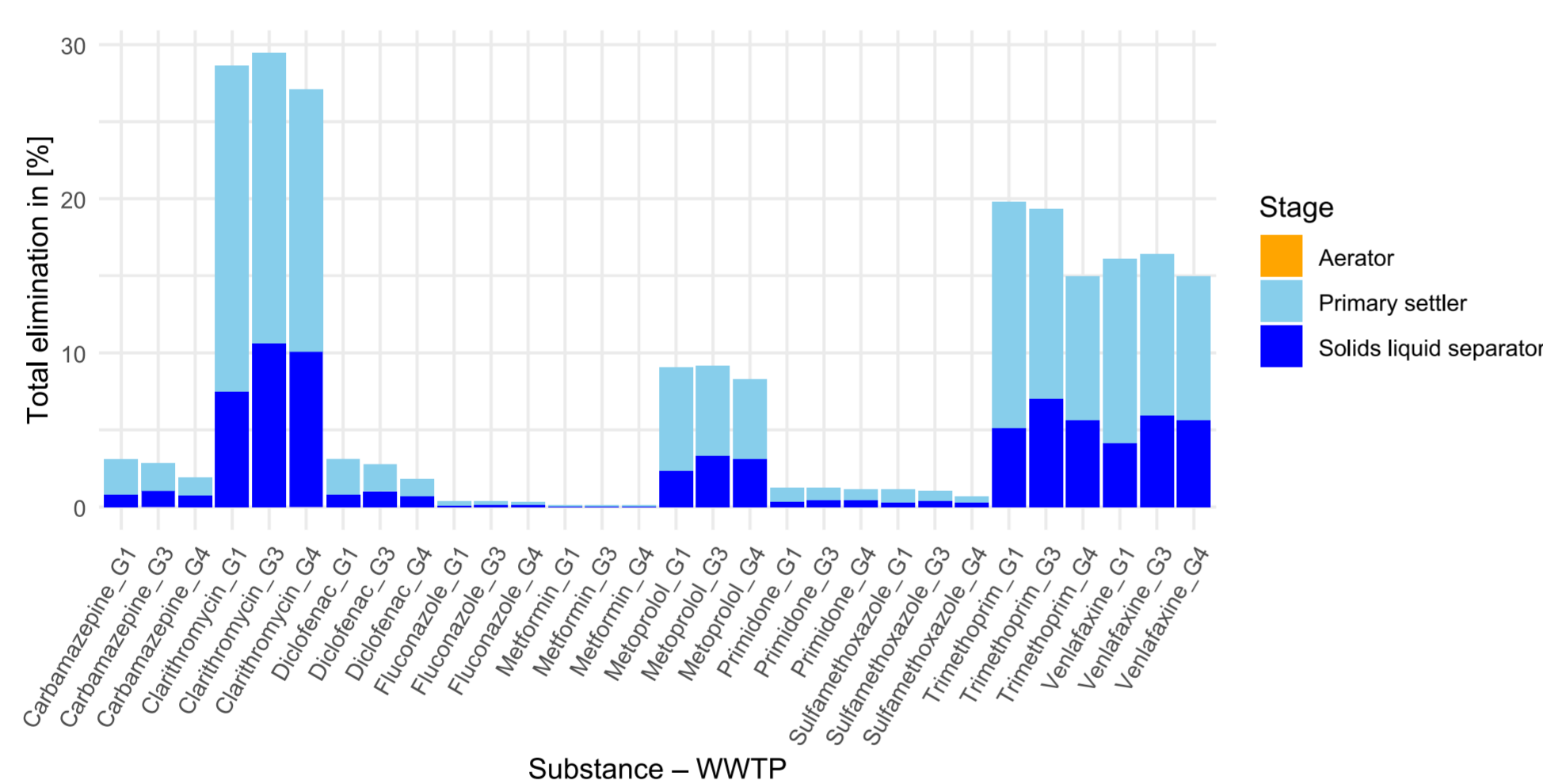


Figure 1 Modelled total elimination rates [%] for three German WWTPs

As illustrated in Figure 1, the model identifies sorption in the primary settler and in the solids liquid separator as the predominant elimination process, thereby precluding the contributions of biodegradation and volatilization.

Figure 2 represents the parameters that are sensitive to the elimination rates and therefore, contribute to the sorption process.

Figure 3 exemplarily shows that SimpleTreat exhibited the tendency to underestimate elimination rates of the respective substances, resulting in overestimated effluent concentrations.

This could be attributed to a substantial underestimation of the biodegradation process in the model, resulting from degradation rate constants that are considered too low.

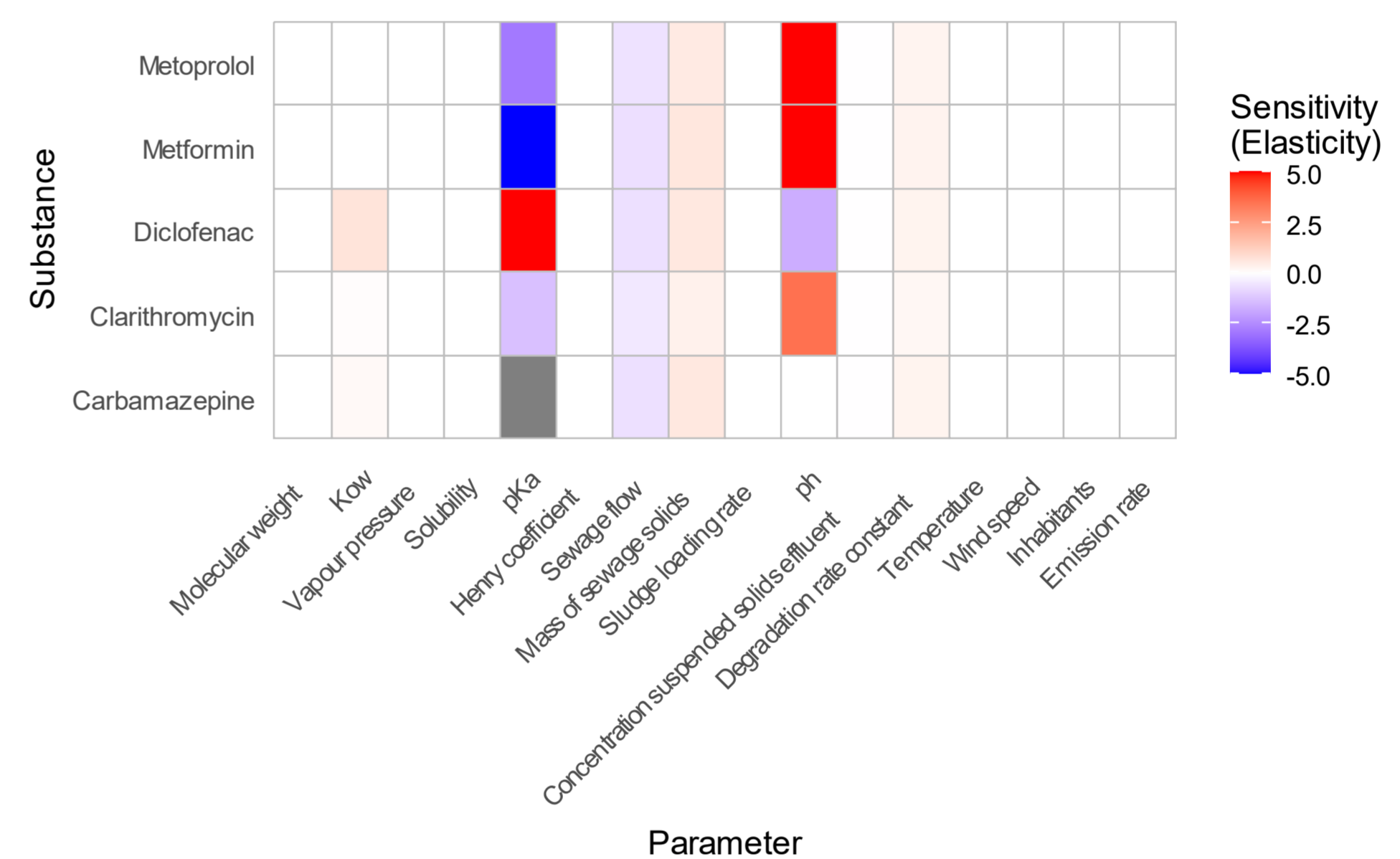


Figure 2 Normalized sensitivity for five substances and G3 WWTP concerning the total elimination of the substance

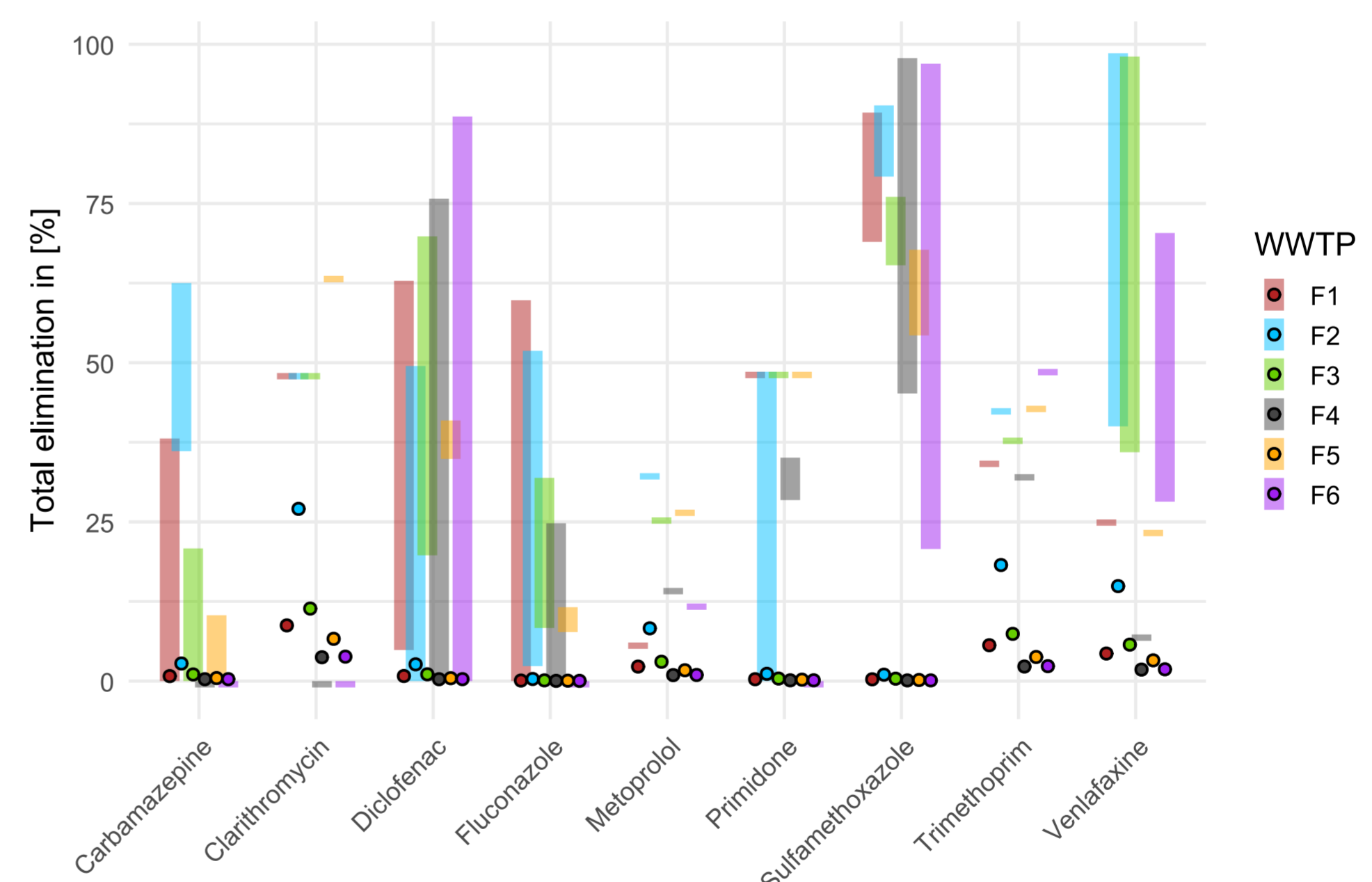


Figure 3 Value ranges of measured elimination rates (represented as bars) and corresponding modelled elimination rates (represented as points) for six Finnish WWTPs

## Conclusion

- Regular underestimation of emission rates by Simpletreat
- When adapting the  $V_{AT}$ , transferability to SBR systems is also possible
- Numerous fixed wastewater treatment plant parameters in SimpleTreat
- Precise mapping of individual wastewater treatment plants therefore hardly possible
- Accuracy of substance modelling can be significantly improved, especially regarding the biodegradability
- Experimental determination of input parameters for indicator substances according to EU-KARL should be taken into consideration