# Uncertainty and sensitivity analysis for reducing greenhouse gas emissions from wastewater treatment plant

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# Uncertainty and sensitivity analysis for reducing greenhouse gas emissions from wastewater treatment plant

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**Abstract:** This paper presents the sensitivity and uncertainty analysis of a plat-wide mathematical model for wastewater treatment plants (WWTPs). The mathematical model assesses direct and indirect (due to the energy consumption) greenhouse gases (GHG) emissions from a WWTP employing a whole-plant approach. The model includes: i. the kinetic/mass-balance based model regarding nitrogen; ii. two-step nitrification process; iii. $N_2O$ formation both during nitrification and denitrification (as dissolved and off-gas concentration). Important model factors have been selected by using the Extended - Fourier Amplitude Sensitivity Testing (FAST) global sensitivity analysis method. A scenario analysis has been performed in order to evaluate the uncertainty related to all selected important model factors (scenario 1), important model factors related to the influent features (scenario 2) and important model factors related to the operational conditions (scenario 3). The main objective of this paper was to analyse the key factors and sources of uncertainty at plant-wide scale influencing the most relevant model outputs: direct and indirect ($DIR,CO_{2eq}$ and $IND,CO_{2eq}$, respectively), effluent quality index (EQI), Chemical Oxygen Demand (COD) and total nitrogen (TN) effluent concentration ($COD_{OUT}$ and $TN_{OUT}$, respectively). Sensitivity analysis shows-up that model factors related to the influent wastewater and primary effluent COD fractionation exhibit a significant impact on direct, indirect and EQI model factors. Uncertainty analysis reveals that outflow $TN_{OUT}$ has the highest uncertainty in terms of relative uncertainty band for scenario 1 and scenario 2. Therefore, uncertainty of influential model factors and influent fractionation factors has a relevant role on total nitrogen prediction. Results of the uncertainty analysis show that the uncertainty of model prediction decreases after fixing stoichimetric/kinetic model factors.

***Keywords****:* Modelling, energy demand, greenhouse gas emission, uncertainty, plant wide assessment.