# Abstract

Urbanized tropical estuaries in emerging countries are experiencing an imbalance between urbanization and water quality management practices. The lack of monitoring and modeling programs has not allowed understanding the dynamics of nutrients. This thesis aims to study nutrient dynamics in a tropical estuary under the influence of a megacity. Three specific objectives are (i) assessing the biogeochemical functioning of an urbanized tropical estuary (Saigon River Estuary, Vietnam) receiving wastewaters of Ho Chi Minh Megacity (HCMC); (ii) quantifying the role of controlling factors (e.g., nutrient loads, reaction rates, hydrological conditions) in the eutrophication development; (iii) assessing eutrophication risk under the scenarios of rapid urbanization and increased wastewater treatment capacity.

The Carbon-Generic Estuarine Model (C-GEM), a one-dimensional, reaction-transport model, was applied after calibration with the limited datasets existing in developing countries. The biogeochemical functioning was evaluated by analyzing monitoring data (physiochemical, phytoplankton structure and abundance, and greenhouse gases) and completed by the modeling approach. The C-GEM was calibrated and validated for Saigon River Estuary at steady-state in the dry season to evaluate the intensity of biogeochemical reactions. Dynamics of nutrients, phytoplankton, eutrophication were assessed by the transient version of C-GEM for 2017-2018. Statistical methods (e.g., Principal component analysis, Redundancy analysis and Hierarchical Partitioning) were applied to evaluate the contribution of environmental parameters to the responses of phytoplankton, eutrophication, greenhouse gases emissions. Finally, scenarios oriented towards megacity development were evaluated using C-GEM to assess the eutrophication risk.

The results of this thesis are presented in four parts, respectively. The first part identifies the impact of domestic wastewater of the megacity on the temporal-spatial variations of nutrients, phytoplankton, eutrophication and greenhouse gases. There was no statistically significant difference in nutrient pollutant concentrations between the dry season and rainy season. However, the phytoplankton abundance in the dry season is about 100 times higher than that in the rainy season. High concentrations of organic carbon and nutrients (nitrogen and phosphorus) have resulted in oxygen depletion and abundant phytoplankton formation in the urban area of the estuary. The second part explains the biogeochemical functioning of urbanized tropical estuaries with the support of C-GEM model (steady-state version). The key biogeochemical processes (i.e., nitrification, denitrification, primary production) are quantified. This estuary effectively removes nitrogen thanks to the strong nitrification and denitrification processes. The third part studies the seasonal variation of nutrients and phytoplankton under the strong fluctuations of hydrological conditions of tropical estuaries. Residence time is one of the most important controlling factors affecting phytoplankton biomass. Finally, the eutrophication risk assessment results based on megacity development show that an increase in the number of WWTPs still does not guarantee good water quality conditions of the estuary.

Applying the C-GEM model with minimal data source highlights biogeochemical processes and hydrological factors in nutrients and eutrophication dynamics in urbanized tropical estuaries. Thus, this study provides effective support for better management of eutrophication risks for developing countries.