Modelling nutrient and organic waste behaviour in a tropical wetland in Singapore under projected anthropogenic scenarios

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Nee Soon swamp forest is one of the last vestiges of tropical wetland in Singapore, and is important both as a site for ecological preservation, as well as a source of water for potable treatment. Understanding the hydrological regime of the swamp forest and implications for water quality is critical to guide stakeholders in implementing effective measures to preserve the wetland against anthropogenic impacts. In particular, although current field measurement data do not indicate a concern with organic or nutrient pollution, reviewing the ways in which the wetland responds to elevated waste discharges can help identify potential hotspots, and the impact on the outflow from the catchment which drains into downstream controlled watercourses. An integrated water quality model is therefore developed in this study to investigate spatial and temporal concentrations of DO levels, organic pollution (as quantified by biochemical oxygen demand, BOD), and nutrient pollution (NH3-N and NO3-N) within the catchment’s river network under projected scenarios of upstream wastewater inflow. The model was developed using MIKE HYDRO for modelling the study domain, as well as the MIKE ECO Lab numerical laboratory for characterising water quality processes. Model parameters are calibrated against time series of observed discharges and dissolved oxygen levels at measurement stations along the river network. The calibrated model was then applied to study downstream impact due to elevated BOD and ammonia from upstream wastewater discharge. Over a simulation period of April 2014 to December 2015, the model predicted that a spiked inflow of 400 mg/l BOD and 30 mg/l NH3-N upstream will elevate downstream concentrations at the catchment outlet to an average of 13 mg/l BOD, and 0.7 mg/l nitrogen (NH3-N, NO3-N), from a baseline of 0.4 mg/l BOD, 0.03 mg/l NH3-N, and 0.07 mg/l NO3-N. Levels of DO were decreased from an initial 5.4 mg/l to 3.6 mg/l. Though a scenario of spiked pollutant influx at the swamp forest’s undeveloped upstream sub-catchments is currently unlikely to occur, the outcomes nevertheless will be beneficial for future planning studies in understanding how the water quality of the catchment will be impacted should urban redevelopment works be considered around the swamp forest.

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