Water Balance Analysis of Laguna de Bay, Philippines with focus on lake-water use and salinity intrusion

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A 2-dimensional hydrodynamic model was set-up for Laguna Lake using Delft-3d to properly understand the physical and environmental processes that govern and influence the lake dynamics. Laguna Lake, with a surface area of 900 km2, is the largest, most important lake in the Philippines. With increasing demand from its various and sometimes conflicting users, and the pressure of environmental degradation, the allocation of water quality and quantity becomes the most important and critical issue in the lake management. The model was set-up to take into account the physical effects of natural climatic and hydrologic factors such as the stream flows from tributary creeks and rivers from the lake watershed, where a separate hydrological analysis was carried-out, direct rainfall on the lake, lake evaporation, watershed groundwater contribution, wind induced circulation, and the tidal conditions at the boundary (Manila Bay). Fishpen and fishcage structures used for aquaculture which affects water circulation and lake water withdrawal for domestic and industrial water supply, irrigation and other farming purposes, and power plant cooling were also incorporated. The configuration of the lake model was defined by its geometry, bathymetry and other physical parameters such as bed roughness, lake water viscosity and diffusivity etc., which served as parameters for calibration. Field surveys conducted on the lake hydrodynamic and water quality parameters, as part of the ongoing IMSWES project, were made use for the calibration and validation of the model. A scenario simulation was made to study the impact of increasing lake water-usage to the entry of saline water to Laguna Lake through the Pasig River. Simulation results indicated an increase saline water entry to the lake for an increase lake water abstraction, especially during the dry season. Different abstraction rates corresponded to different movement patterns and concentration rates of the saline water plume with its entry thru the Pasig River to the lake. With the lowering in lake water level by about 2.5-3.0 centimeters for every 400 million liters lake abstraction, Pasig River backflow (Manila Bay to Laguna Lake) is further induced by the hydrodynamic imbalance between Laguna Lake and Manila Bay. Consequently, incidence of salinity intrusion into the lake is enhanced. With the drop in annual average Pasig River outflow (Laguna Lake to Manila Bay), the eventual exit of saline water from the lake with the start of the rainy season and correspondingly, the residence time of the lake, will take a longer time as compared to the standard hydrodynamic simulation without abstraction.