Extensive Water Quality Monitoring in the Lake for Hydrodynamic and Water Quality Modeling: Simple vs Complex Modeling

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Abstract : Harmful algal bloom in lakes and water bodies is one of the major environmental problems across the nation. One such highly affected lake in Ohio is Tappan Lake of the Muskingum watershed, which is used as a water supply reservoir. The major objective of this study is to establish several monitoring stations in Tappan Lake to collect monthly and biweekly data for various water quality parameters. Comprehensive water quality data collection has been accomplished from 11 locations across the lake at 1-meter depth intervals, measuring key parameters including temperature, pH, dissolved oxygen (DO), specific conductance (SPC), turbidity, total suspended solids, blue-green algae, chlorophyll a to examine a spatial and temporal variation of key water quality parameters. These data have been used to evaluate the water quality of Tappan Lake through various water quality indexes (WQI), including weighted arithmetic, the Canadian Council of Ministers of the Environment (CCME), and the National Sanitation Foundation (NSF). The WQI employed as a holistic metric yielded values ranging from 0 to 100, suggesting indicative of poor quality and characterizing good quality based on a specific WQI definition. Our preliminary investigation, based on all three indices, suggests that the water quality of the lake is not suitable for water supply. In addition, seasonal trends and stratification of the lake in terms of dissolved oxygen and temperature were also identified, with notable fluctuations of water quality in dry and wet seasons. In the next step, the study was conducted to detect the cause of the algal using various modeling scenarios of algal bloom reduction in the Tappan Lakes to recommend possible remedial measures. For this, complex three-dimensional (3D) hydrodynamic modeling, such as EFDC coupled with the SWAT model, has been developed. Since the application of a simple model might be helpful for the stakeholders working in this lake due to its simplicity, one-dimensional (1D) water quality modeling has also been developed using the soil and water assessment tool (SWAT)-coupled watershed ecosystem tools (WET). Besides reporting the water quality status of the lake, this paper will present the various scenarios of algal bloom reduction using both 1D and 3D models for the improvement of water quality in the lake.