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A Mechanistic Dissolved Oxygen Modeling for Riverine Fish Kill Prevention

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Dissolved oxygen (DO) is a critical factor that controls the health and survival of the aquatic life. In the lower Danshuei River of Taiwan, DO was occasionally lower than 2 mg/L leading to several fish kill events. Since 2018, the Taipei city government started to continuously monitor hourly DO and other water quality factors at sites of Cheng-Mei Bridge and Cheng-De Bridge. However, at most sites, the monitoring has been conducted once a month. To provide sufficient DO predictions for preventing the occurrence of fish kills, a mechanistic DO modeling is required. As a result, in this study, we developed a system dynamic DO modeling considering oxygen exchange between the air-water and up/downstream interfaces with instream interactions of reaeration, photosynthesis, sediment oxygen demand (SOD), biochemical oxygen demand (BOD), respiration, and deoxygenation using the STELLA Architect software. In the model, we used meteorological data, water quality data, and hydrological data (flow rate, cross-section area, and hydraulic depth) simulated by HEC-RAS as input data to simulate daily DO at Cheng-Mei Bridge. Field measurements ranging from 0.21 to 10.34 mg/L were used to calibrate and validate the simulation results during Jan. to Aug. 2018, and Sep. to Dec. 2018, respectively. Our simulation results appeared reasonably good accuracy, in which the root mean square error (RMSE) ranging from 0.5 to 1.5 mg/L, and the percentage root mean square error (PRMSE) ranging from 5 to 15%. Moreover, results showed that DO was most sensitive to hydrological data, deoxygenation coefficient, and reaeration coefficient such that the meteorological conditions, like temperature and wind speed, were also important variables triggering hypoxia or anoxia that caused fish kills. Consequently, to better avoid or mitigate the occurrence of fish kills, we believe this physically-based DO modeling coupled with meteorological variables will offer useful information in predicting the condition of DO along the lower Danshuei River for managers to take preventative actions.