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Research Article

Hydrodynamic Modeling of a Tropical Tidal River Using the Dynamic Estuary Model (DYNHYD5): A Case Study in Sibu Laut River, Sarawak, Malaysia

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Application of the Dynamic Estuary Model (DYNHYD5) in a tropical tidal river is limited. The successfully calibrated and validated hydrodynamic model is valuable in subsequent water quality simulation for environmental management. Hence, a hydrodynamic modeling approach using the DYNHYD5 was conducted in a tropical tidal river in Malaysia. Samplings were conducted in the Sibu Laut River to collect the hydrology data for model simulation. The model was calibrated and validated by comparing the simulated flow and mean depth with the field data at different simulation periods of time. The results showed that the model DYNHYD5 was successfully calibrated with channel flows and mean depths and then reproduced with good agreement in validation. The observed and simulated data were linearly correlated ($R^2 > 0.8$) with values of slope γ ranging from 0.891 to 1.204 in both calibration and validation. The Nash–Sutcliffe coefficient of efficiency (NSE) of more than 0.7 in both calibration and validation also indicated satisfactory comparison between the observed and simulated data. The result indicated that the application of the DYNHYD5 is feasible in a tropical tidal river in Malaysia.

1. Introduction

The Dynamic Estuary Model DYNHYD5 [1] is a one-dimensional hydrodynamic model for simulating water velocities, flows, volumes, and heads using a channel junction (link-node) approach. The DYNHYD5 is the most recent version of the modeling software and is distributed and supported by the USEPA's Center through the WASP5 and WASP6 modeling software [2, 3]. The model utilizes a channel-junction (link-node) model network to perform simulations. Streams, rivers, or estuaries are broken down into a series of channels (links) and junctions (nodes). Each junction is a volumetric unit that acts as a receptacle for the water transported through its connecting channels, while each channel is an idealized rectangular conveyor that transports water between two junctions, whose midpoints are at each end. DYNHYD5 can be applied to river systems with moderate bed slopes as well as to tidally influenced estuaries. The model has the capability of simulating complex branching river systems with a maximum of six links either leaving or entering a single junction.

The DYNHYD5 has been successfully used in hydrodynamic simulation, but mostly in a subtropical region. The hydrodynamic model has been calibrated to estimate the daily lake volume of Lake Marion, South Carolina Coastal Plain [4], the daily water level of Vistonis Lagoon, North Greece [5], and water levels and currents of the Venice Lagoon, Italy [6]. Besides, the channel flow and velocity variations in the river Mahadayi (Mandovi) and estuarine zone have been predicted for pre- and post-dam construction project scenarios with DYNHYD5 [7]. The successfully calibrated and validated model can be linked with the Water Quality Analysis Simulation Program (WASP) for water quality modeling.

The use of modeling in simulating river flows and water quality is lacking in tropical countries like Malaysia due to lack of data to calibrate and validate the models. The successful application of the models could aid in the environmental