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Simulation of 2D Depth Averaged Saint Venant Model of Shatt Al Arab River South of Iraq

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ABSTRACT

Shatt Al Arab River in Basrah province southern Iraq is a tidal stream and it represents the main feeder of water to Basrah province. The river is characterized by having many branches during its course from upstream to downstream. The main aim of this study is to model a 2D hydrodynamic model for Shatt Al-Arab River with seven branches inside Basrah city which are Jubyla, Muftya, Robat, Khandek, Ashar, Al-Khora, and Saraji in addition to Karmat Ali river by the Hydrologic Engineering Centre's River Analysis System (HEC-RAS) software, where most of the previous studies relied on the consideration of the river as one-dimensional, i.e., neglecting the transverse or vertical directions. Accurate input data like Digital Elevation Models (DEMs) were provided and enhanced with the help of Geographic Information Systems (GIS) as well as a data for the year 2014 was used as boundary conditions to develop the hydrodynamic model. The discharge values at the Qurnah station were extracted from the results of a previous one-dimensional HEC-RAS mathematical model. To prove the efficiency of the model, mean absolute error (MAE), root mean squared error (RMSE), and Nash-Sutcliffe efficiency (NSE) were implemented to check the convergence between observed and simulated data through calibration and validation processes. The result of NSE was 0.836, and this indicates an acceptable convergence between the simulated and observed values. Also, the methods of RMSE and MAE support that convergence to zero. It is worth noting here that the NSE method was more sensitive to the change in the resulting values and therefore it can be recommended to use this method in hydrodynamic models. The hydrodynamic model can provide important information for models of sediment transport or water quality. Therefore, it is essential to have a good understanding of the hydrodynamic processes in a water system, before embarking on studies of sediment transport, or water quality.

1. INTRODUCTION

Surface water system is any water that accrues on the surface of the earth and certainly open to the atmosphere such as oceans, seas, rivers, lakes, reservoirs and estuaries. These types of surface water, although their characteristics differ, but they share the same uses. Surface water is extremely necessary as it makes up about 80% of the water used on a daily basis, and it also makes up most of the water used for aquatic life support, water supply, transportation, industry, and irrigation. Surface water, is an interactive system, that continually changes because human and natural forces. Modeling surface waters such as rivers is complex for several reasons, including the change of geometric shape during the flow and the change of hydrological properties with time and space. Previously, most studies relied on simplified methods such as a one-dimensional model in representing the Shatt al-Arab river in southern Iraq and neglecting these studies for the impact of the many branches of the River within the borders of Basra province. 1D unsteady flow was adopted to study hydrodynamic simulation of the Shatt Al-Arab River by using HEC-RAS was made [1]. Al-Mahmoud et al. [2], were used Mike 11 hydrodynamic (HD) model to simulate the hydrodynamic demeanor of 64 kilometers of Shatt Al Arab River, from the Qurnah confluence (upstream of the river) to Maqal port in Basrah province (downstream of the river). The Danish Hydrologic Institute (DHI) created Mike 11, for the river modeling system. It used the Saint Venant equations to produce an implicit finite difference computation of unsteady flow in rivers. The simulation process was executed at Basrah University's Marine Science Center. Abdullah [3] studied a systematic monitoring and modeling on water availability, quality and seawater intrusion into the Shatt al-Arab River. Hamdan [4] find hydrodynamic simulations of river water for whole length of 200 km by controller gates in the Shatt Al Arab River. Hamdan et al. [5] focused on tracking the sea water penetration into the river from the Arabian Gulf. One-dimensional HEC-RAS model has been used to understanding the dynamics of total dissolved solid in the river. The study for the purpose of studying the Hydrochemical of the River's water was conducted by AL-Amiri and Disher [6]. Al-Asadi et al. [7] investigated dimensional variability of the temporal, spatial, and vertical salinity in the transitional zone between the water of Shatt Al-Arab River and the gulf (estuary region) that helps to display the saltwater propagation into the river during 2019-2020. Al Murib [8] used CE-QUAL-W2 to develop a two dimensional hydrodynamic and water quality model (width averaged) of the main stem Tigris River from Dam of Mosul to Kut Barrage (880 km). Alzahrani [9] focused on the implementation and making a comparison of two