NUMERICAL SIMULATION OF FLOW AND SEDIMENT TRANSPORT WITH A COUPLED RIVER-LAKE MODEL

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To perform a computation of water environments in a eutrophied lake, it is necessary to accurately evaluate pollutant loads in influent rivers. It is therefore desirable to appropriately incorporate actual behavior of pollutants in rivers into a lake model for flow and material transport. In the present study, we attempt to present a numerical method with the coupling of river and lake models, named a coupled river-lake model. We here introduce the different horizontal coordinates to river and lake models. Especially, in the horizontal coordinate for the river model, we use a new simplified boundary-fitted coordinate system, referred to here as a horizontal sigma coordinate system, recently developed by the authors (Yamasaki & Nihei, 2005). We apply the present coupled river-lake model to the numerical simulation of flow and sediment transport in Lake Teganuma which is one of well-known eutrophied lakes in Japan. To check the fundamental validity of the present model, the computational results are compared with the observed data obtained by the authors (Nihei et al., 2004).

In the coupled river-lake model, we choose different types of the horizontal coordinates and grid resolutions to river and lake models. In the river model, we here adopt the horizontal sigma coordinate system which has high numerical accuracy and less computational load. As shown in Fig.1, this coordinate system is based on the fundamental concept of a sigma coordinate system in vertical direction originally developed by Phillips (1957). On the other hand, in the lake model, we use the Cartesian coordinate system, mostly taken for lake-flow computations. To consider the interaction of the river and lake models, the computational results of the river and lake models are exchanged at the mouth of influent rivers.

With the coupled river-lake model, we perform the computation of flow and sediment transport in Lake Teganuma and Oohori River, one of influent rivers into Lake Teganuma. The numerical simulation has been done for the period from 0:00 to 6:00 on July 4 in 2003 in which the hydrologic event occurred. We compare the computed results for suspended sediment concentration (SSC) with the observed data for SSC. The computed SSC gives acceptable agreements with the observed SSC in the influent river and lake, demonstrating the fundamental validity of the present coupled river-lake model. The computational results also indicate that the evaluation of the erosion rate of sediments has a key role on an accurate computation of sediment transport in an urban river estuary.

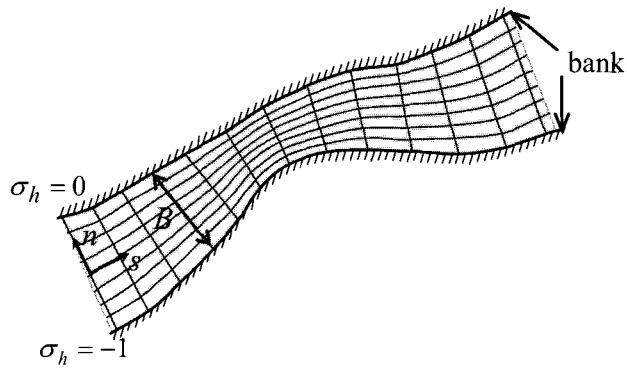

Fig. 1 Definition of the horizontal sigma coordinate system.

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