第Ⅱ部門

Extending a Distributed Hydrological Model to use Globally Available Topographic Data

DPRI, Kyoto University, Student Member ○ P. B. HUNUKUMBURA
DPRI, Kyoto University, Member Yasuto TACHIKAWA
DPRI, Kyoto University, Fellow Kaoru TAKARA

1. Introduction

Understanding the hydrological response and quantification of available water in a basin is essential for proper management to cope with the possible water related disasters and to limited water resources. With regard to this, distributed hydrological models play an important role as it is capable of incorporating the basin heterogeneity. The *KsEdge2D* model is a distributed hydrological model developed at Kyoto University and it has been well studied and successfully applied for many basins in Japan. As the model was initially developed to utilize the Japanese topographical and river network data, it is not possible to apply for international basins due to the discrepancy of input topographical and river network data formats. This study presents the extension of the *KsEdge2D* model to use globally available topographic data.

2. The *KsEdge2D* model

The model is based on the one dimensional kinematic wave theory and developed by Ichikawa *et al* in 2001. The basin's topography is represented in the model according to the methodology described in Shiba *et al.* 1999. In the model, it is considered that the basin consists of number of slope elements and the slope flow produced due to rainfall is routed one dimensionally. Then it flows to the canal network and routed to the basin outlet.

It is assumed that the each slope segments of the basin covered with a permeable soil layer composed of capillary soil layer and non capillary soil layer. The flow processes of both soil layers and the overland flows are represented with kinematic wave model using a discharge–stage relationship introduced by Tachikawa et al., 2004.

3. Methodology and case study

The *KsEdge2D* model requires basically two files, one with coordinates and the elevation of grid cells *(NodeV0)* and the other having the connection details of grid cells *(EdgeV0),* to represent the topography and the stream network of the basin. Therefore, X, Y and Z Coordinates of the center point of all cells, the flow direction derived according to D8 method (Jenson and Domingue, 1988) and the flow accumulation of the required basin are derived using globally available Digital Elevation Model *(DEM)* with the help of GIS software. A computer model, referred as *DEM-V0-Maker* is developed to generate two files having the same data structure as the *EdgeV0* and the *NodeV0* files, using the above mentioned data derived from the *DEM*. The cells having flow accumulation value grater than a threshold are treated as streams.

The *Mae Chaem* basin in Thailand is selected as a case study basin to apply *KsEdge2D* model using global topographic data. The basin is 3853 km^2 in size and 90% of the area is covered with forest. Average annual rainfall and the discharge of the basin are 1426mm and 1020 MCM

respectively. *DEM (GeoTOPO 30)* and hydro-meteorological data are obtained from the research project, "*PUB-JP Blind Test in Mae Chaem Basin*".

The *EdgeV0* and *NodeV0* data files for the basin are obtained using the *DEM-V0-Maker* programme developed under this study. Figure-1 shows the graphical representation of the *Mae Chaem* basin's EdgeV0 and NodeV0 data. Then the *KsEdge2D* model is successfully applied to the basin using the above data derived from the *DEM-V0-Maker* programme. The model predicted hydrograph and the observed hydrograph are shown in Figure-2. The model parameters are not the optimum parameters for the basin.

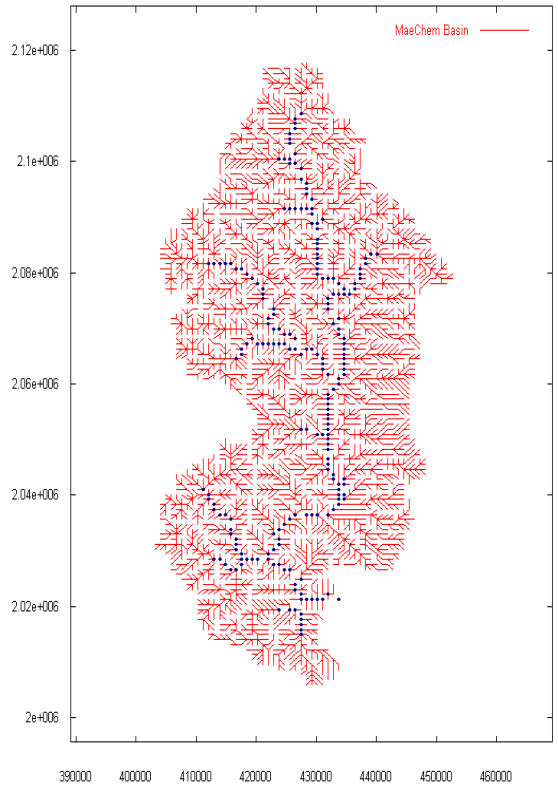

Figure-1. Plot obtained from the EdgeV0 and NodeV0 data of the Mae Chaem Basin

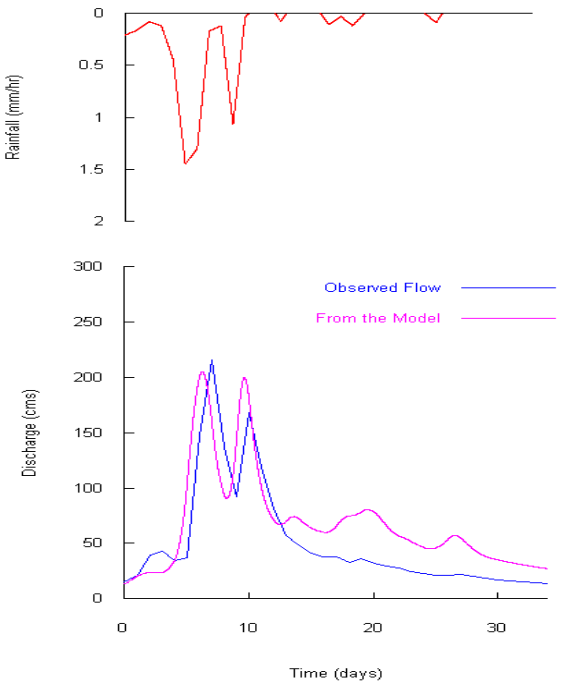

Figure-2. Observed and model predicted hydrographs – 1998/09/01 to 1998/10/05

4. Reference:

1. Ichikawa, Y., Murakami, M., Tachikawa, T., and Shiiba, M. (2001) Development of a basin runoff simulation system based on a new digital topographic model. J. Hydraulic, Coastal and Environ. Engng. JSCE 691 (II-57)43-52.
2. Jenson, S. K., and J. O. Domingue, (1988). Extracting Topographic Structure from Digital Elevation Data for Geographic Information System Analysis. Photogrammetric Engineering and Remote Sensing, Vol. 54, No. 11: pp.1593-600.
3. Shiiba, M., Ichikawa, Y., Sakakibara, T. and Tachikawa, Y. (1999) A new numerical representation form of basin topography. J. Hydraulic, Coastal and Environ. Engng. JSCE 621 (II-47) 1-9.
4. Tachikawa, Y., Nagatani, G. and Takara, K. (2004) Development of stage-discharge relationship equation incorporating saturated–unsaturated flow mechanism. Ann. J. Hydraulic Engng. JSCE 48, 7-12.