II-247 Comparison of One-dimensional Hydraulic models & methods in flood Routing

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1.Introduction : In this paper three models namely (a) dynamic wave model in four point implicit scheme (b) diffusion wave model in four point implicit scheme and (c) dynamic wave model in characteristic scheme are compared. The characteristic scheme used in this paper is same as described earlier by Iwasa & Inoue (Ref.2). The models are applied for the unsteady flow simulation in Seta river and for flood simulation in the river network of Yodo river.

2.Description of Rivers : The two rivers are regulated natural rivers and located in the central part of Japan. The seta river is irregular in cross-section & is controlled by a weir gate at the downstream end. The river also provides a constant discharge to a power plant at the downstream. The details are shown in Fig.1. The yodo river comprises of Uji river, Kizu river and Katsura rivers. Hydraulic conditions at the junction (Fig.2) are considered as :

(a) $Q_3 = Q_1 + Q_2$

(b) $h_1 + \frac{Q_1^2}{2gA_1^2} = h_2 + \frac{Q_2^2}{2gA_2^2} = h_3 + \frac{Q_3^2}{2gA_3^2}$

For this river only first two models are used. The details of river are shown in Fig.(3). The other details of numerical simulation can be find in Garg (Ref.1).

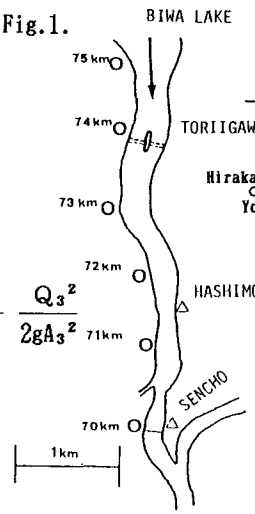
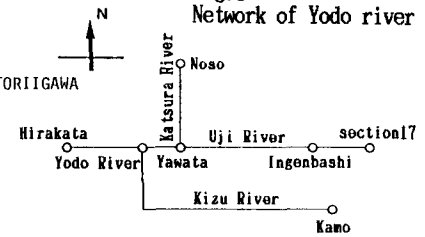


Fig.1 Details of Seta river

Fig.3 Network of Yodo river



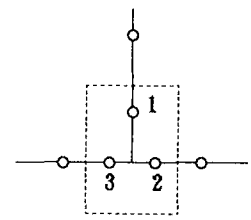


Fig.2 Confluence

3.Results & Discussions : A general numerical dynamic wave model based on four point implicit scheme are formulated. Fig.(4) & (5) shows the given stage hydrograph (boundary conditions) & calculated discharge hydrographs at the upstream & downstream respectively of Seta river. Fig.(6) shows the hydrographs at Hashimoto (a point 2,420m downstream from upperend Toriigawa) of Seta river & compared them with the observed one. The two different marks are with two different measuring instruments. In comparing the three models, the dynamic wave model in characteristic scheme & in four point implicit scheme gave almost the identical results. The diffusion wave model is convenient among the three but its accuracy suffer for larger time increment. The CPU time is almost similar in both the diffusion wave model and the dynamic wave model in implicit scheme. From this study, it is concluded that though all the three models are workable, and that all could be calibrated to give computed values quite close to those observed in the field ; the dynamic wave model in four point implicit scheme is most preferable for one-dimensional unsteady flow simulation in natural channels.

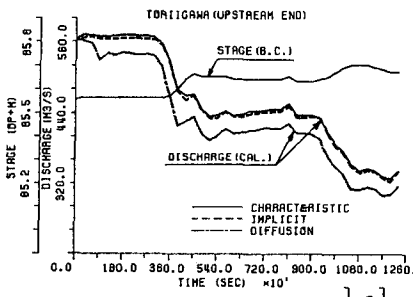


Fig.4 Hydrographs at upstream

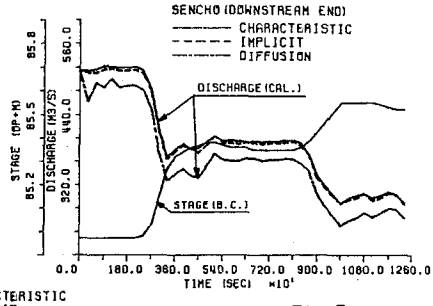


Fig.5 Hydrographs at downstream

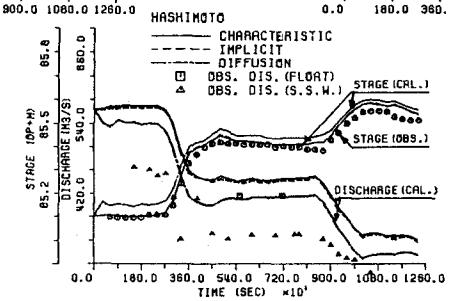


Fig.6 Hydrographs at Hashimoto

The simulation of flood in the Yodo river network also shows the dynamic wave model in four point implicit scheme require a much smaller quantity of computer memory, very less computational costs & accuracy & stability under a wide range of time increments. The model is found to have the same convergence & stability characteristic as when applied to a single channel (Seta river). For accuracy, the results are checked with the results of charateristic scheme due to lacking of actual field data. Fig.(7,8&9) shows the calculated stage & discharge hydrograph at Ingenbashi & Yawata, the two important downstream point in Uji river and at Hirakata (downstream end). The CPU time for simulation of flood in yodo river is 2.5 times in the characteristic scheme of the four point implicit scheme.

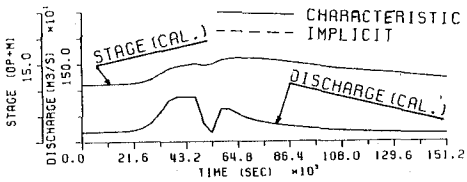


Fig.7 Stage & discharge hydrographs at Ingenbashi

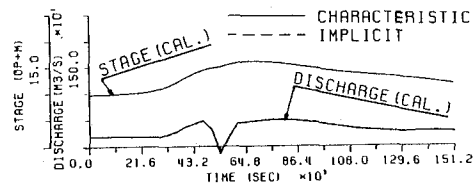


Fig.8 Stage & discharge hydrographs at Yawata (Uji)

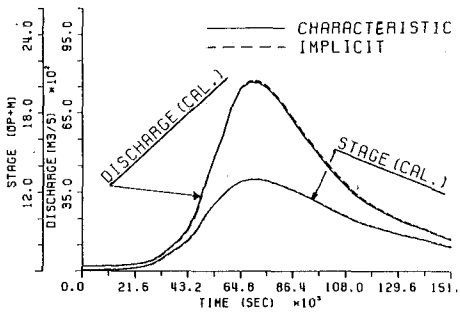


Fig.9 Stage & discharge hydrographs at Hirakata (downstream point)

These studies concluded that dynamic wave model in four point implicit scheme is probably the best model to use for flood routing in natural channels from economic as well as computational point of views.

4. References :

1) Garg, A.K. (1988) Ph.D. Thesis, Kyoto university.

2) Iwasa Y. & Inoue K. (1982) ; J. of natural disaster science, vol.4, No.1.