第Ⅱ部門 **Discharge simulation to observe IC-Ratio with various forcing data resolution**

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## INTRODUCTION

Use of a macro scale grid based distributed hydrological model[1)] that simulates water movement, following automated procedures like basin partitioning, sub-basin hydrological modeling and linking sub-basin models together to produce total run-off has made easy to examine effects of forcing data resolution in discharge simulation with the use of OHyMoS, Object –oriented Hydrological Modeling System[2)].

Very high-resolution data may not be necessary to get good result in discharge simulation especially for larger catchment[3)]. As high-resolution data costs more, the use of such data to obtain better result is preferably not welcomed. Suitability of grid resolution depending upon catchment size is matter of discussion in this study, by observing **IC-Ratio** (**Ratio** between **I**nput grid resolution and **C**atchment size) and simulation efficiencies with different forcing data resolution.

Chinese river basins namely Huaihe (132350 km$^2$), Wangjiba (29844 km$^2$) and Suiping (2093 km$^2$) are taken as the case. Grid precipitation and actual evapo-transpiration data, referred from (1) HUBEX IOP EEWB data[4)] (5-minute spatial resolution) (2) GAME Reanalysis 1.25-degree data[5)] (Version 1.1) and (3) GAME Reanalysis 2.5-degree data[4)] (Version 1.1) for the period from May1 to August 31, 1998. Brief descriptions of the findings are presented in this paper.

## DISCHARGE SIMULATION

Discharge simulation is performed with independent runoff process and flow routing process within grid cell, then constructed a total runoff simulation in 10-minute grid resolution.

### (1) HUBEX-IOP EEWB data

HUBEX-IOP EEWB data are converted to 10-minute spatial resolution by averaging the adjacent grid data before feeding into the hydrologic model. This data gives quite satisfactory result while simulating the discharge in Suiping and Wangjiba catchment (Figs. 1 & 2). However, in Bengbu, the simulation remains good for initial 60 days only and then the runoff is predicted below observed values (Fig. 3). This error is believed to appear due to error in source data.

### (2) GAME Re-analysis data

GAME Re-analysis data are re-arranged to 10-minute grid cells, lying within larger (1.25-degree or 2.5 degree) grid coverage by assigning the same value to maintain original resolution effect. The intersecting grid-cells are assigned average values.

### a) GAME 1.25-degree resolution input

The simulation result at Suiping using GAME 1.25-degree data input is not satisfactory, as it often fails to attain the peak values (Fig. 1). The simulation result at Wangjiba is not much bad (Fig. 2).

In Bengbu, the result is better (Fig. 3) with GAME 1.25-degree data. Low flow region has significant error, but the peak flow is simulated quite well than that with HUBEX-IOP EEWB data. The recession limb of hydrograph is not simulated properly. Errors are present in further periods too but the trend is trying to follow the observed hydrograph. Looking over the accumulated discharge values, it has a good matching with observed one, showing satisfactory agreement with the water budget.

### b) GAME 2.5-degree resolution input

This data did not give good simulation results in either basin (Fig. 1, 2, 3). In Suiping the simulation result is similar to GAME 1.25 data, but in Bengbu, the result gives unacceptably significant errors unlike the results with GAME 1.25 or HUBEX-IOP EEWB data.

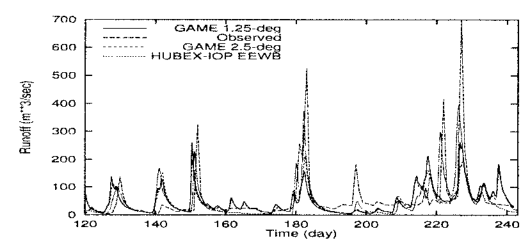

**Fig.1** Simulation results for Suiping basin.

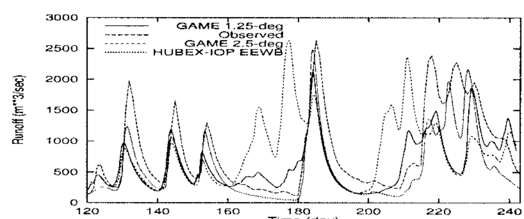

**Fig.2** Simulation results for Wangjiba basin.

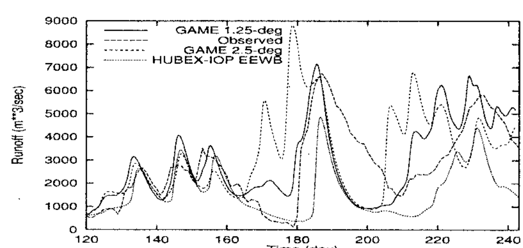

**Fig.3** Simulation results for Bengbu basin.

## WHY SO MUCH VARIATION IN RESULTS?

The river basin's diverse local hydrological and meteorological behaviors are impossible to be reflected in coarse grid information, which may be influencing factor in flow routing process. The mean value of entire grid coverage within a cell in the form of grid-data is believed as the major cause of failure to represent the true basin conditions. On the other hand, the results are gradually improving with finer resolution of input forcing data, which is quite satisfactory in some cases. This provides a base to accept that increased number of grid cell within catchment improves the result.

Of course, the accurate higher resolution data gives better solution with distributed hydrological models, but what criteria defines a necessary resolution to get satisfactory result? If we see over the ratio of input-resolution and catchment size (IC-Ratio), it indicates that there exists some value, which marginates the suitability of largest forcing data resolution to input in the distributed hydrological model with respect to catchment size. Calculating simulation performance and their comparison reveals this fact. A summary of IC-Ratios and model efficiencies are presented in Table 1, 2, 3 and 4 respectively.

While IC-Ratio is 1:11.78 or greater, it gives good result, because Pearson's product moment correlation coefficient (Table-2) and Index of Agreement coefficient (Table-4) has pretty good values. Since Nash-Sutcliffes coefficient ranges from $-\infty$ to 1, its values in table-3 also provides ground to conclude the satisfactory performance of model with this marginal IC-Ratio. Simulation results are not satisfactory with lower IC-Ratios except in Wangjiba with the IC-Ratio 1:2.98. The result with IC-Ratio 1:3.3 in Bengbu does not have satisfactory performance because its performance indexes are quite lower than those considered as good simulation results. It may be too early to draw some specific conclusion, but still this study suggests that the results of distributed hydrologic models are better with IC-Ratio 1:10 (the nearest whole number of present finding) or more.

**Table 1** Input-resolution-Catchment (IC) Ratio.

| Resolution | Bengbu | Wangjiba | Suiping |
|---|---|---|---|
| 2.5-degree (GAME) | 1: 3.3 | 1: 0.75 | 1: 0.05 |
| 1.25-degree (GAME) | 1: 13.24 | 1: 2.98 | 1: 0.21 |
| 10-min (HIOP EEWB) | 1: 744.5 | 1: 167.9 | 1: 11.78 |

**Table 2** Pearson's product moment correlation coefficient.

| Resolution | Bengbu | Wangjiba | Suiping |
|---|---|---|---|
| 2.5-degree (GAME) | 0.2516 | 0.1297 | 0.4405 |
| 1.25-degree (GAME) | 0.7287 | 0.7607 | 0.4557 |
| 10-min (HIOP EEWB) | 0.6771 | 0.9108 | 0.7267 |

**Table 3** Nash Sutcliffes' coefficient of efficiency.

| Resolution | Bengbu | Wangjiba | Suiping |
|---|---|---|---|
| GAME 2.5-degree | -0.7372 | -0.4738 | 0.1801 |
| GAME 1.25-degree | 0.4333 | 0.4654 | 0.1904 |
| H-IOP EEWB 10-min | -0.0307 | 0.6346 | 0.5161 |

**Table 4** Index of Agreement coefficient.

| Resolution | Bengbu | Wangjiba | Suiping |
|---|---|---|---|
| GAME 2.5-degree | 0.5594 | 0.4766 | 0.5452 |
| GAME 1.25-degree | 0.8507 | 0.8022 | 0.5819 |
| H-IOP EEWB 10-min | 0.6916 | 0.8925 | 0.8277 |

In the study basins, large numbers of dams are in operation but current model does not consider its effect. This may be one principal reason to appear significant error. Comparing the results with different data sources and their validities are also a matter of question. However, limitation of available forcing data with different resolution limits more experiments. The IC-Ratio values may stand as a figure to define a necessary resolution. To set a general-acceptable IC-Ratio or to investigate relationship of IC-Ratio with other hydrological factors may be a good research topic in the coming days.

## CONCLUSION

The obtained results clearly indicate that distributed hydrological models are very sensitive with resolution of forcing data. Better simulations are achieved while the IC-Ratio (**I**nput-resolution to **C**atchment **Ratio**) is more than 1:10. IC-Ratio may serve to set as a preliminary criterion to define the necessity of forcing data resolution in distributed hydrological modeling.

**ACKNOWLEDGMENT:** The contribution of providing HUBEX-IOP EEWB data by Dr. K. Tanaka, DPRI, Kyoto University and GAME Re-analysis data by Japan Meteorological Agency are highly acknowledged. The authors are also grateful to the Grants-in-Aid for Scientific Research, Encouragement of Young Scientists (A) 13750491 for their support.

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