POTENTIAL ALTERNATIVES FOR KEY TECHNOLOGIES TO IMPROVE THE ACCURACY AND THE LEAD-TIME OF FLOOD FORECASTING IN THE MEKONG RIVER

Kazuhiko FUKAMI[1), *M. Levent KAVVAS*[2) *and Riko OKI*[3)

1) Hydrologic Engineering Research Team, International Centre for Water Hazard and Risk Management (ICHARM), Public Works Research Institute (PWRI), Japan
2) Department of Civil and Environmental Engineering, University of California at Davis, USA
3) Earth Observation Research and Application Center (EORC), Japan Aerospace Exploration Agency (JAXA)

1. INTRODUCTION

The Mekong River has the biggest watershed area in Southeast Asia and a typical trans-boundary river located in the territory of six riparian countries, i.e., China, Myanmar, Laos, Thailand, Cambodia and Viet Nam. Since the great flood in 2000 in the Mekong, it has been widely recognized that "living with floods" based on flood management and mitigation is one of the keys for water resources and environment management and sustainable development of the Mekong River Watershed area. In order to maximize the benefit of flood and to minimize the flood disaster for riparian countries and people, it is indispensable for personnel in charge of flood management to disseminate a detailed outlook on the flood tendency based on a flood forecasting with an enough accuracy and lead time both along the main stream but also along the major tributaries of the Mekong. For such an accurate flood forecasting with enough lead time, both a rainfall-runoff model and a rainfall forecasting system is key technical issues. In order to prevail such technology into each tributary, an efficient and easy-to-use hydrologic forecasting system is also very important.

The authors like to introduce an alternative for each key technology from fruitful cooperative research results such as the one between the Univ. of California at Davis (UCD) and the International Centre for Water Hazard and Risk Management (ICHARM) under the auspices of UNESCO of the Public Works Research Institute (PWRI) of Japan, the one between the Japan Aerospace Exploration Agency (JAXA) and ICHARM, and the one between major civil engineering consulting companies in Japan and ICHARM.

2. **RAINFALL FORECASTING** – Potential of Application of Rainfall Reconstruction Technology in the MEKONG

In order to properly make plans and actions for flood management, past historical hydrologic database is indispensable. However, such a hydrologic database is substantially lacked in the Lower Mekong River Watershed owing to the effect of unstable political and administrative conditions for a long time in that region. Therefore, as a member of the research project sponsored by the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) titled "Model Development to Assess the Change of Water Resources due to Human and Natural Changes in the Asian Monsoon Region (so called RR2002-6)"[1) led by Prof. Kuniyoshi TAKEUCHI of the Yamanashi Univ. (also holding the Director of ICHARM), PWRI-ICHARM has been engaged in the reconstruction of past 20-year rainfall distribution in the Lower Mekong River Watershed mainly in cooperation with the University of California at Davis (UCD) and the Toyama Univ.

Here, the cooperative research result between UCD and PWRI-ICHARM is introduced. The approach is to downscale the coarse-grid (2.5 deg.) reanalysis climate data by US National Center for Atmospheric Research (NCAR) into more finer-grid (20km) meteorological data using a UCD-PWRI mesoscale nonhydrostatic atmospheric model: "Regtional Hydroclimate Model (RegHCM)". RegHCM employs MM5 (The Fifth-Generation NCAR / Penn State Mesoscale Model) as the atmospheric model component of RegHCM and the land hydrologic components in the original UCD-PWRI Integrated Regional Scale Hydrologic/Atmospheric Model[2)] (IRSHAM), as its land hydrologic components. A distinctive feature of the RegHCM is 1) to consider detailed soil water holding and moving processes through a spatially-averaged Green-Ampt infiltration model and 2) to realize the full two-way coupling regarding the land-atmosphere interactions. The 20-km grid RegHCM model was applied to the upper watershed area and to the lower watershed area separately. Fig.1 shows an example of the comparison between the preliminary RegHCM's simulated monthly rainfall data and the interpolated ground-based rainfall observational data for the lower Mekong. This shows the good stability of the RegHCM calculations and relatively good coincidences with surface rainfall distribution.

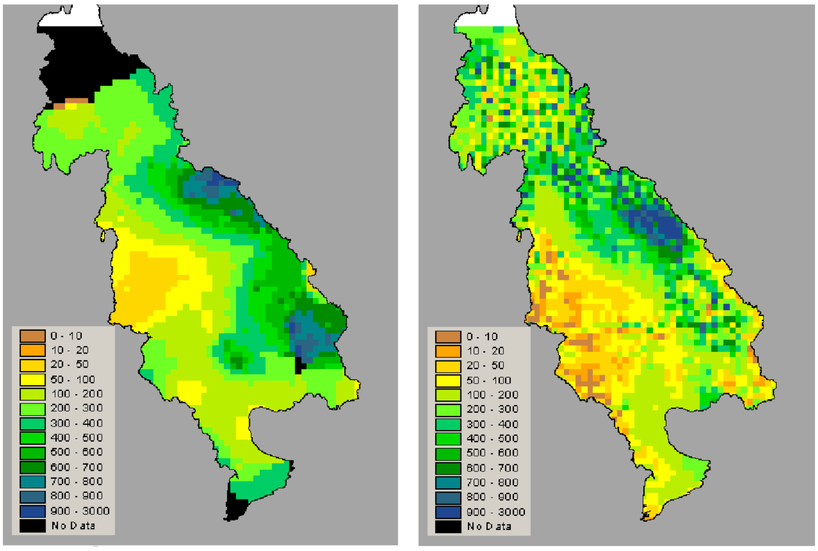

Fig.1 Observed and simulated monthly precipitation (mm) over the Lower Mekong River watershed in July 1994

This technology can be used to improve rainfall forecast in such a large region as well by changing the boundary conditions from the climatic reanalysis data to the real-time grid-point numerical weather forecasting data. In this sense, there is an example to support this idea, i.e. a preliminary study of flood forecasting study in a small mountainous dam reservoir watershed in Japan. The study area was the Shiobara-Dam Watershed (120km^2) in the Kanto District of Japan. The initial and boundary conditions for the then version of RegHCM were given by the 20km-Grid Point Value (GPV) of the Japanese Meteorological Agency (JMA)'s regional spectral model. The JMA's RSM-GPV data was provided to users every 12 hours a day with hourly meteorological forecasts until 48 hours ahead. The nesting had two steps: firstly downscaled into 6km and secondly into 2km, to forecast the rainfall field enough to make flood forecasting in such a small watershed area. The model was applied to the heaviest rainfall event of the region in 1998 (Fig.2).

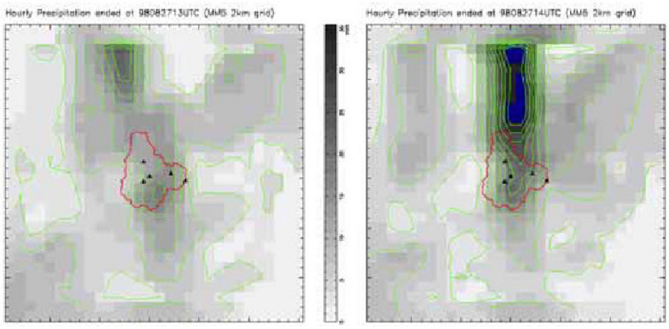

Fig.2 Rainfall forecast result with the then RegHCM at the Shiobara-Dam Watershed and its surrounding area for 21JST and 22 JST on August 27, 1998 (62 x 62 km, 2-km grid)

The result of the rainfall forecast was qualitatively promising in the sense that the 48-hour lead-time forecasted hyetograph was very similar to that of basin-averaged ground-based rainfall data. If the similarity ratio were modified, the result of flood forecasting would be very accurate in spite of the very long lead time (48 hours). This was not perfect but encouraging result for us. Regarding the hydrologic model used in this study will be described in the next section.

3. PRECIPITATION-RUNOFF MODELING IN A POORLY-GAUGED BASIN – POTENTIAL OF APPLICATION OF A PHYSICALLY-BASED DISTRIBUTED HYDROLOGIC MODEL

On the platform of RegHCM's atmospheric and hydrologic data that are provided at ~10km spatial resolution, one can then implement a physicall-based distributed hydrologic model, such as the Watershed Environmental Hydrology (WEHY) Model[3], which presents a new approach to the modeling of hydrologic and environmental processes in watersheds in order to account for the effect of heterogeneity within watersheds. Toward this purpose, the point location-scale conservation equations for various hydrologic processes were upscaled in order to obtain their ensemble averaged forms at the scale of the computational grid areas. These upscaled equations possess the dynamic interaction feature of the standard point location-scale two dimensional hydrologic conservation equations. A significant computational economy is achieved by the capability of the upscaled equations. The emerging parameters in the upscaled hydrologic conservation equations are areal averages and areal variances/covariances of the original point-scale parameters[4]. The parameters of the WEHY model are related to the physical properties of the watershed, and they can be estimated directly from readily available information on topography, soils, and vegetation/ land cover conditions, and not from fitting to historical rainfall-runoff data. As a result, WEHY model can be applied to large-scale ungauged watersheds where there are no historical rainfall-runoff data. An overall structure of WEHY model is given in Fig. 3. The WEHY model was validated, for example, at the same Shiobara Dam watershed in Japan[5].

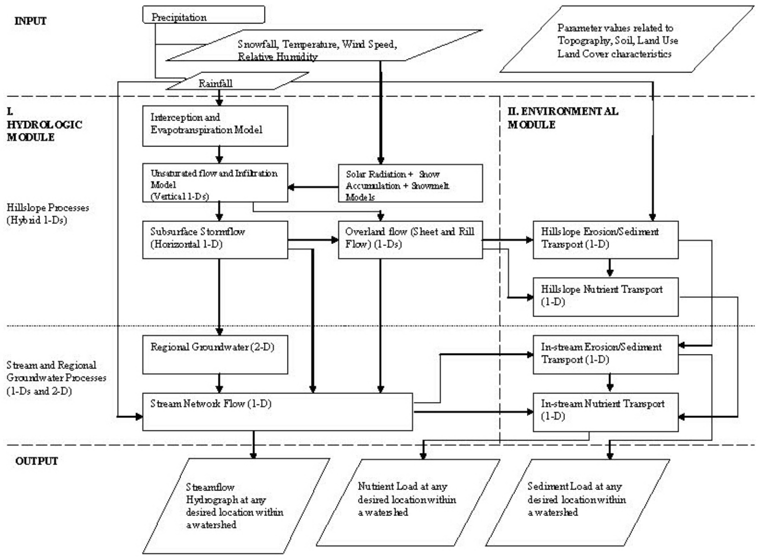

Fig.3 Structure of WEHY model

4. JAXA-ICHARM joint study on global rainfall estimation from satellites' data

A reliable and useful flood forecasting requires on-line real-time rainfall data. Although the actual definition of "real time" should be dependent upon its requirements and the availability of on-line data at the target area, the availability of ground-based real-time rainfall data does not seem enough for flood forecasting in the Mekong River. JAXA and PWRI-ICHARM has just started a joint study to develop an original satellite-based real-time global rainfall data, under the cooperation of a JST-CREST research group titled "Production of High Precision and High Resolution Global Precipitation Map by Using Satellite Data" led by Prof. Okamoto of the Osaka Prefecture Univ. Our goal is to improve the accuracy of real-time satellite-based rainfall data in time and space based on microwave information. The update information of the study will be presented at the Forum.

5. AN OPEN PLATFORM FOR FLOOD RUNOFF ANALYSES: IFAS

PWRI-ICHARM has also started a joint research with major civil engineering consultant companies to make an Integrated Flood Analysis System (IFAS) to provide hydrologists in charge of flood analyses and forecasting, especially in developing countries with many ungauged basins, with an open and easy-to-use platform for operational flood runoff analyses at minimal cost. If completed, IFAS would be useful in particular for flood forecasting and analyses in tributaries of the Mekong River. The concept and details of the IFAS development will be presented at the Forum.

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