Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

MAG022-15 Room:国際会議室 Time: May 28 14:15-14:30

Optimal Reservoir Operation for Downstream Flood Reduction Using NWP in Central Vietnam

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Many reservoirs are operational with single objective, for instance, hydropower reservoirs. This type of reservoirs is targeted to maximize water availability for power generation. On the other hand, other objectives are not prioritized or at very limited capability, flood reduction for example. In many cases, improper reservoir operation has produced extra flood threat for downstream because of dam safety issues. This paper proposes an optimal reservoir operation for downstream flood reduction using inflow forecast based on combination of numerical weather prediction (NWP) and distributed rainfall runoff models. Short range quantitative precipitation forecast, up to 84 hours lead time, obtained from the relatively high resolution (0.5 degree) global NWP (operated at Japan Meteorological Agency) was used as input to the runoff model. The case study was conducted for a medium-sized reservoir in Central Vietnam, the A Vuong hydropower reservoir with catchment area of 650 km2 and reservoir volume of 340 million m3, during the effect of the typhoon Ketsana on late September 2009. The flood forecasts were issued at 00UTC on 28th September for two scenarios. First scenario, the flood forecast was based on rainfall prediction that was obtained directly from NWP model output (DMO). Predicted total inflow volume was 16% less than the observed total inflow volume (320 million m3). Second scenario, model output statistic (MOS) method was used for better runoff forecast by means of rainfall prediction improvement. The model slightly overestimated the total inflow volume (8% higher). With respect to the actual reservoir operation, given no prediction of incoming flow, the reservoir started discharging as water level reached the maximum elevation of 380m at 06UTC on 29th September. It means a water volume of 160 million m3 was released to downstream. However, by using the forecasted inflow, the reservoir can be pre-emptied to increase free volume though the forecasted inflow was lagging behind the observed inflow. In this case, the actual volume discharged to downstream can be reduced by 44% and 72% for flood forecast based on quantitative rainfall prediction derived from DMO and MOS respectively; at the time of issuing the inflow forecast the reservoir free volume was about a half of the incoming volume.

Keywords: Numerical weather prediction, Flood forecast, Reservoir operation