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Integrated Data-Archive and Distributed Hydrological Modelling System for Optimized Dam Operation

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In 2012, typhoon Bopha, which passed through the southern part of the Philippines, devastated the nation leaving hundreds of death tolls and significant destruction of the country. Indeed the deadly events related to cyclones occur almost every year in the region. Such extremes are expected to increase both in frequency and magnitude around Southeast Asia, during the course of global climate change.

Our ability to confront such hazardous events is limited by the best available engineering infrastructure and performance of weather prediction. An example of the countermeasure strategy is, for instance, early release of reservoir water (lowering the dam water level) during the flood season to protect the downstream region of impending flood. However, over release of reservoir water affect the regional economy adversely by losing water resources, which still have value for power generation, agricultural and industrial water use. Furthermore, accurate precipitation forecast itself is conundrum task, due to the chaotic nature of the atmosphere yielding uncertainty in model prediction over time.

Under these circumstances we present a novel approach to optimize contradicting objectives of: preventing flood damage via priori dam release; while sustaining sufficient water supply, during the predicted storm events. By evaluating forecast performance of Meso-Scale Model Grid Point Value against observed rainfall, uncertainty in model prediction is probabilistically taken into account, and it is then applied to the next GPV issuance for generating ensemble rainfalls. The ensemble rainfalls drive the coupled land-surface- and distributed-hydrological model to derive the ensemble flood forecast. Together with dam status information taken into account, our integrated system estimates the most desirable priori dam release through the shuffled complex evolution algorithm. The strength of the optimization system is further magnified by the online link to the Data Integration and Analysis System, a Japanese national project for collecting, integrating and analyzing massive amount of global scale observation data, meaning that the present system is applicable worldwide.

We demonstrate the integrated system with observed extreme events in Angat Watershed, the Philippines, and Upper Tone River basin, Japan. The results show promising performance for operational use of the system to support river and dam managers' decision-making.