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Hydrological Appraisal using X-band Phased Array Radar Network for Pluvial Flood Simulations in Chinese Mega Cities

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ABSTRACT

Flooding is one of the most common types of natural hazards leading to wide-spread disturbances and damages to human communities and natural environment across the world. Flood forecasting is an effective means to provide timely hazard information to relevant government decision-makers and practitioners as well as those residents at risk, which plays an important role in flood risk reduction. A complete flood forecasting system normally includes at least two components, that is precipitation predictions and a hydrological or hydraulic model for flooding processes simulation. However, the current flood forecasting especially for urban floods face obvious obstacles. One obstacle is that the conventional methods of precipitation measurement cannot effectively reflect and capture intense rainstorms. Meanwhile, rapid urbanization causes drastic changes in the underlying surface conditions of urban space, which bring higher requirements for hydrological or hydraulic model in being capable of forecasting the spreading flood dynamics and extents for complex urban space.

This two-year trial aims to develop a new forecasting system by coupling a graphics processing unit (GPU) accelerated hydrodynamic model with radar precipitation estimates and predictions to provide high-resolution, urban-scale forecasting of rainfall-runoff and flooding processes induced by intense rainfall. This will be achieved by (1) Improved HiPIMS (High-Performance Integrated hydrodynamic Modelling System) for flood modelling in large cities: HiPIMS will be improved by coupling with drainage models to simulate the flooding inundation process at a city scale. (2) Precipitation forecasts for intense rainfall: Radar rainfalls will be blended with the GRAPES rainfall products to realize the quantitative precipitation forecast for the next 6 hours in every 30 minutes at a spatial resolution of 1 km. The time matching method is adopted to construct the time-varying weight coefficients for nowcasting and numerical model forecasting. (3) Field experiments: urban flood observation and experiments in a site will be undertaken to test the performance of improved HiPIMS and precipitation forecasts. (4) Integrated urban flood forecasting system: With the support of RS, GIS and software engineering, an integrated urban flood forecasting system will be constructed and tested in Guangzhou City, China.

The collaboration built up by this project and the first-hand experiment data will serve well to further catalyse the taking-up of state-of-the-art weather radars for urban flood risk management, and to tackle the innovation in tuning the radar technology to fit the complex urban environment as well as advanced modelling facilities that are designed to link the observations, providing decision making support to the city government. Recommendations for applying high spatial-temporal resolution precipitation data to real-time flood forecasting on an urban catchment are provided and suggestions for further investigation are discussed.

KEYWORDS

Phased-array radar; pluvial flood; radar rainfall nowcasting; spatial and temporal resolution; urban drainage model

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