

Evaluation of WRF and WRF-Hydro Models in Simulating Heavy Rainfall and Streamflow in the Talomo Watershed: A Baseline Study for the Development of a Hydro –Meteorological Flood Forecasting System for Davao City

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1. Introduction

The increasing occurrence of river flooding in Davao City, Philippines brings up the need for a hydro-meteorological forecasting system that integrates the relationship of atmospheric phenomena and the streamflow within the Davao City's watershed area. This study aims to evaluate the performance of the Weather and Research Forecasting (WRF) and the WRF-Hydro models in simulating heavy rainfall and streamflow events in Davao City, respectively. The models were configured to simulate the observed intense precipitation and streamflow event in the Talomo River in 01 August 2015.

2. Experimental Design

Using Final (FNL) Operational Global Analysis as global forcing, numerical experiments were performed following the best WRF model setups of past studies for heavy rainfall events (Skamarock, 2008; Cruz and Narisma, 2016; Kaewmesri et al., 2017; Olaguera, 2015). Sensitivity to initial time of simulation, initial and lateral boundary conditions, and horizontal resolutions (9-, 3-, 1-km resolution) were conducted on the model configurations used in the numerical experiments. The WRF output from the experiment with the least bias was then utilized as input to the WRF-Hydro simulation. The results from the previous experiments determined the model setup used in the rainfall and streamflow forecasting. The initial and boundary conditions for the forecasting were provided by Global Forecast System (GFS) and Global Data Assimilation System (GDAS)

3. Results and Discussion

A set of numerical experiments and sensitivity tests with model validation were performed to determine the optimal model setup for Davao City rainfall. The numerical run with the highest horizontal resolution and both WRF 1 (with WSM6 as microphysics scheme; New Tiedtke as cumulus scheme; RRTMG as long and short wave radiations schemes; Yonsei University as PBL scheme; Noah LSM as land surface scheme) and WRF 4 (with Goddard as microphysics scheme; Grell 3D Ensemble as cumulus scheme; RRTM as long wave radiation scheme; Dudhia as short wave radiation schemes; Yonsei University as PBL scheme; Noah LSM as land surface scheme) of WRF outperforms other test simulations (Figure 1). Output from WRF 1 and WRF 4 were then utilized as forcing to the hydrological model to simulate streamflow and forecast possible flood events within the city. As shown in Figure 2, results from WRF-Hydro simulations show the capability of the

model to recreate the observed hourly pattern of strong streamflow in the Talomo River during the first 12 hours of the simulations but had difficulty in modeling the forecasts (after 12 hours).

4. Conclusion

Among the numerical experiments, WRF 1 and WRF 4 (refer to Figure 1) has showed promising results in simulating rainfall patterns. However, based on the hydrograph (Figure 2), the model captured higher discharge values during the initial simulation but was unable to simulate peaks at the forecast. Further tuning of the meteorological and hydrological models is needed to improve the accuracy of the output. Nevertheless, this study introduces numerical tools and baseline results to be used in developing a hydro-meteorological flood forecasting system among the major rivers of Davao City.

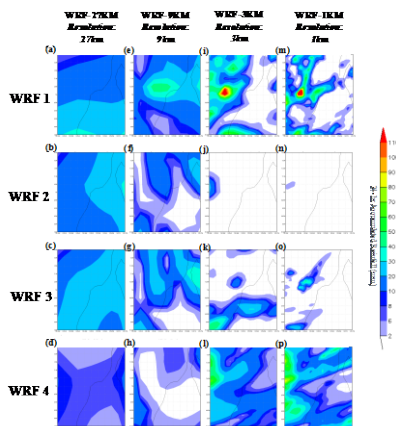


Figure 1. Accumulated rainfall (mm) on 01 AUGUST 2015 over Davao City for each simulation experiment at 27-km resolution (a-d), 9-km resolution (e-h), 3-km resolution (i-l), and 1-km resolution (m-p)

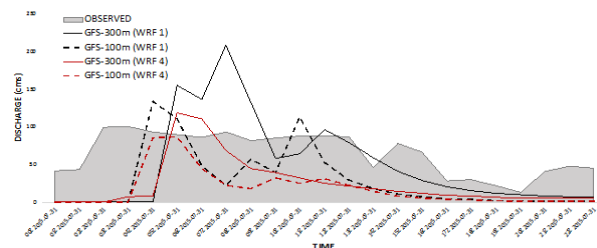


Figure 2. Observed and simulated (GFS) hydrograph for the period of 31 JULY 2015 00Z to 01 AUGUST 2015 09Z

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