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High-Resolution Ensemble Precipitation for Pluvial Flood Forecasting in the Urban Data Scarce city of Alexandria, Egypt

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High-resolution Quantitative Precipitation Forecasts (QPF) are essential to accurately forecast the magnitude, timing and location of precipitation and as input for pluvial flood forecasting using urban drainage models. However, there are challenges of producing high-resolution forecast capable of capturing the spatial and temporal variability of rainfall needed for urban flood modelling and the uncertainty associated with meteorological forecast and urban flood models. Therefore there is a challenge to balance data availability, model uncertainty, resolution, forecast lead-time and computational demands, especially in data-scarce regions.

Ensemble precipitation forecasts are used to capture uncertainties of meteorological forecasting in flood models. This research aims to evaluate the skill of a downscaled ensemble precipitation forecast over the coastal city of Alexandria, Egypt which experiences extreme rainfall and flooding from winter storms. A Weather Research Forecast (WRF) convection-permitting model was initialised using the Global Ensemble Forecast System (GEFS) which provides 21 ensemble members (1 degree archived). The model was run using three domains with horizontal grid resolutions of 30km, 10 km and 3.3 km at a 24h leadtime). For the 3.3 km horizontal grid, ensemble members were coupled with a 1D Mike urban model to evaluate the meteorological uncertainty representation and propagation.

In the absence of sufficient rainfall and flow gauge data, results were verified against Multi-Source Weighted-Ensemble Precipitation (MSWEP) satellite-derived product and further compared with the ECMWF ensemble prediction system precipitation forecast. 1D flood simulations were evaluated against 1D- 2D hydrodynamic simulations run with MSWEP data.

Ensembles showed varying probability of detection for different severity events. In general, the majority of ensemble rainfall values resulted in flooding greater than the flooding simulated from the satellite observed rainfall. Although deterministic forecast also indicated flooding and threshold exceedance, the number of ensemble members exceeding critical thresholds has the benefit of providing decision-makers with the probability of threshold exceedance and likelihood of flooding to trigger protective actions. A study such as this provides knowledge for understanding, future applications and limitations of using high-resolution ensemble Quantitative Precipitation Forecasts (QPFs) and the importance of capturing the spatial and temporal variability

of rainfall in urban drainage models. Additionally, the potential use of MSWEP for the verification of ensemble forecasts in ungauged and data-scarce regions is investigated.