THE UNIVERSITY OF CONNECTICUT

CIVIL & ENVIRONMENTAL ENGINEERING

MD ABUL EHSAN BHUIYAN

PHD DISSERTATION
DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING
UNIVERSITY OF CONNECTICUT

2:00 PM – MONDAY, AUGUST 27TH, 2018
CAST 306

Advisory Committee:
Prof. Emmanouil N. Anagnostou (Major Advisor), CEE, UConn
Dr. Efthymios I. Nikolopoulos, CEE, UConn
Prof. Guiling Wang, CEE, UConn
Prof. Marina Astitha, CEE, UConn

Uncertainty of Global Precipitation Datasets and its Propagation in Hydrological Simulations

ABSTRACT

Accurate estimates of precipitation at the global scale are vital for a variety of hydrometeorological applications. Quantification of the error sources along with characterization of the error propagation in hydrological simulations are required for promoting use of satellite and reanalysis precipitation estimates in hydrological applications. In this study we address the remotely-sensed precipitation products uncertainty characterization based on a machine learning tree-based model, Quantile Regression Forests (QRF). We first apply the model to satellite passive microwave estimates from the TRMM satellite. Reference precipitation was based on high-resolution (5 min/1 km) rainfall fields derived from the NOAA/National Severe Storms Laboratory multi-radar multi-sensor system. The model was evaluated using a K-fold validation experiment using systematic and random error statistics of the model-adjusted TRMM passive microwave rainfall point estimates, and ensemble verification statistics of the corresponding prediction intervals. Then, this framework was utilized to combine dynamic and static land surface variables together with multiple global precipitation sources to stochastically generate improved precipitation ensembles (combined product) over complex terrain. Input to the model included multiple global satellite precipitation products, CMORPH, PERSIANN, GSMaP (V6); and 3B42 (V7); an atmospheric reanalysis precipitation product (EI_GPCC); and other auxiliary variables including a daily soil moisture dataset, specific humidity and a terrain elevation dataset. The model performance was demonstrated over three mountainous study areas (Peruvian and Colombian Andes and the Blue Nile in East Africa) based on 13 years (2000–2012) of reference rainfall data derived from in situ rain gauge networks. Results showed that the proposed blending framework could significantly reduce the error and adequately characterize the uncertainty of the combined product. In the last section of this study we investigate the impact of the combined product in hydrological simulations. The Iberian Peninsula was chosen as the study area, which has precipitation and climate variability due to complex orography influenced by both Atlantic and Mediterranean climates. Comparisons of the precipitation product-driven hydrological simulations by a distributed hydrological model against reference-driven streamflow simulations by the same model showed that the magnitude of systematic and random errors for the combined product was significantly lower than those for the individual precipitation products. Moreover, this blending framework rendered a detailed investigation of the precipitation error propagation into multi-hydrologic model simulations, which was accomplished using four global-scale land surface models (JULES, ORCHIDEE, HTESSEL and SURFEX) and one global hydrologic model (WaterGAP3). Through this analysis we investigated the error characteristics of different precipitation forcing datasets (satellite, reanalysis, and combined product) and their error propagation in different hydrologic variables (surface/subsurface runoff, evapotranspiration).