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Water resources management using the WRF-Hydro modelling system: Case-study of the Tono dam in West Africa

Edward Naabil (1), Benjamin Lamptey (), Joel Arnualt (), Ayorinde Ayo Olufayo (), and Harald Kunstmann ()
(1) Department of Agricultural Engineering, Bolgatanga Polytechnic, Ghana (bayenbil@yahoo.com), (2) WASCAL, Ghana

Water resources are a major source of economic development for most West African (WA) countries. There is, however inadequate information on these resources for the purposes of planning, decision-making and management. This paper explores the potential for using a state of the art hydrological model (WRF-Hydro) in a fully coupled (i.e. land surface hydrology-atmosphere) mode to assess these water resources, particularly the Tono basin in Ghana. The WRF-Hydro model is an enhanced version of the Weather Research and Forecasting model (WRF) which allows simulating river discharge. A 2-domain configuration is chosen: an outer domain at 25 km horizontal resolution encompassing the West African Region and an inner domain at 5 km horizontal resolution centered on the Tono basin. The infiltration partition parameter and Manning's roughness parameter were calibrated to fit the WRF-Hydro simulated discharge with the observed data. The simulations were done from 1999 to 2003, using 1999 as a spin-up period. The results were compared with TRMM precipitation, CRU temperature and available observed hydrological data. The WRF-Hydro model captured the attributes of the "observed" streamflow estimate; with Nash-Sutcliff efficiency (NSE) of 0.78 and Pearson's correlation of 0.89. Further validation of model results is based on using the output from the WRF-Hydro model as input into a water balance model to simulate the dam levels. WRF-Hydro has shown the potential for use in water resource planning (i.e. with respect to streamflow and dam level estimation). However, the model requires further improvement with respect to calibration of model parameters (e.g. baseflow and saturated hydraulic conductivity) considering the effect of the accumulation of model bias in dam level estimation.