Enhancing streamflow prediction skill of WRF-Hydro-CROCUS with DDS calibration over the mountainous basin.

Muhammad Shafqat Mehboob*, Jaehyeong Lee**, Yeonjoo Kim***

Abstract

In this study we aimed to enhance streamflow prediction skill of a land-surface hydrological model, WRF-Hydro, over one of the snow dominated catchments lies in Himalayan mountainous range, Astore. To assess the response of the Himalayan river flows to climate change is complex due to multiple contributors: precipitation, snow, and glacier melt. WRF-Hydro model with default glacier module lacks generating streamflow in summer period but recently developed WRF-Hydro-CROCUS model overcomes this issue by melting snow/ice from the glaciers. We showed that by implementing WRF-Hydro-CROCUS model over Astore the results were significantly improved in comparison to WRF-Hydro with default glacier module. To constraint the model with the observed streamflow we chose 17 sensitive parameters of WRF-Hydro, which include groundwater parameters, surface runoff parameters, channel parameters, soil parameters, vegetation parameters and snowmelt parameters. We used Dynamically Dimensioned Search (DDS) method to calibrate the daily streamflow with the Nash-Sutcliffe efficiency (NSE) being greater than 0.7 both in calibration (2009-2010) and validation (2011-2013) period. Based on the number of iterations per parameter, we found that the parameters related to channel and runoff process are most sensitive to streamflow. The attempts to address the responses of the streamflows to climate change are still very weak and vague especially northwest Himalayan Part of Pakistan and this study is one of a few successful applications of process-based land-surface hydrologic model over this mountainous region of UIB that can be utilized to have an in-depth understanding of hydrological responses of climate change.

Keywords: WRF-Hydro, CROCUS, Upper Indus Basin, Dynamically Dimensioned Search (DDS), Climate change

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*PhD Student, Department of Civil & Environmental Engineering Yonsei University. Email: shafqat@yonsei.ac.kr
**PhD Student, Department of Civil & Environmental Engineering Yonsei University. Email: jhlee647@yonsei.ac.kr
***Associate Professor, Department of Civil & Environmental Engineering Yonsei University. Email: yeonjoo.kim@yonsei.ac.kr