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Use of the North American Regional Reanalysis Data for Hydrological Modeling in Reconstructed Watersheds

Nader Keshta (1) and Amin Elshorbagy (2)

(1) University of Saskatchewan, Civil & Geological Engineering, Saskatoon, Canada, (2) University of Saskatchewan, Civil & Geological Engineering, Saskatoon, Canada (amin.elshorbagy@usask.ca, 1-306-966-5414)

Modeling hydrological processes for reclaimed landscapes (artificial or reconstructed watersheds) is essential for assessing the performance of different reclamation strategies and their evolution over time. Simulations require a reliable continuous source of input data; however, data availability is the exception not the rule. This study evaluated the utility of using precipitation and temperature data from the North American Regional Reanalysis (NARR) for the hydrological modeling of two reconstructed sites (D3 and SWSS watersheds) located north of Fort McMurray, Alberta, Canada. The analysis showed that mean RMSE and R values between the NARR and onsite observed data were found to be 2.25 mm and 0.64, respectively; and the corresponding values for temperature were 4.21°C and 0.96. A generic system dynamics watershed (GSDW) model was initially calibrated using the onsite meteorological data, resulting in simulated soil moisture values that slightly overestimated observed values. The model was recalibrated using the NARR temperature and precipitation data as inputs while the remaining data were obtained from the weather station. The recalibrated model was a good alternative to onsite weather station data for simulating soil moisture patterns. For the D3 cover, R values ranged from 0.47 to 0.65 in the upper peat layer; in the lower till layer, R values were 0.53 in 2004 and 0.89 in 2005, but negative (-0.60) in 2006. The model provided average MARE values of 9% and 4% in the peat and till layers, respectively. For the SWSS site, the average correlation coefficients were 0.62 and 0.25 for the upper and the lower layers, respectively; and the corresponding MARE values were 7% and 11%. The recalibrated model was used along with the NARR long term dataset (1979-2006) to evaluate the long term hydrological performance of existing reconstructed watersheds, with respect to soil moisture deficit, using a probabilistic framework. Frequency curves of the maximum annual moisture deficit indicate a high probability that the reconstructed watersheds will meet the threshold of soil moisture demand during the growing season. The current study demonstrates and validates the application of NARR data to hydrological modeling, particularly in remote regions. Furthermore, adopting NARR data for the assessment of the long term hydrological performance of reconstructed watersheds can provide insightful information with respect to the design of future reconstructed soil covers.