Spatial Modeling of Groundwater across Land use and Climate Change: A case study of Mbagathi Sub-catchment

Asenath A.[a], Gachari M.[b] and Makokha G.[a]

[a]School of Science, Dedan Kimathi University of Technology, Private Bag, Nyeri, 7381, Kenya, E-mail: first@dkut.ac.ke

[b]School of Alternative Sciences, Remote University, Just off Main Street, Mweiga, 8890, Uganda.

Abstract

Groundwater forms the base of all fresh water sources and therefore having its levels declining calls for attention to ensure the resource is sustainable. The interdependence between change in land use and climate is vital in catchment behavioural change, hence the combined use of the two variables in hydrological studies. The study simulated the groundwater within the sub-catchment using the logan's technique deriving a comparative analysis of the Transmissivity, yield and storage co-efficiency. The effects of Land Use Land Cover (LULC) and climate variability on groundwater were modelled using Soil Water Assessment Tool (SWAT). The input variables to the SWAT model were derived from DEM data, Landsat and Sentinel-2 and the climate data for the period 1990- 2020. Maximum likelihood classification method was used on satellite imageries to determine change in LULC. SUFI-2, SWAT-CUP algorithm was used in the calibration and validation of the model. From the results, the coefficient of determination (R2) was 0.63 while the Nash-Sutcliffe efficiency (NSE) was 0.6. The Cellular Automata (CA) Markov chain model was used to predict the LULC while the Autoregressive Integrated Moving Average (ARIMA) model was used to predict the climate scenario to the year 2030. Upon evaluating the change in LULC, increased urbanisation highly impacts groundwater recharge through increased runoff. Likewise, the periodic fluctuations in precipitations greatly affect the future of groundwater.

Keywords: Spatial Modelling, Groundwater, Climate Change, Land use.