Land cover dynamics and climate variability influences on hydrological balance of a semi-arid basin

Zakari, O[a, b]., Gyamfi, C[a,c], Ofosu, S. A[d]., Boakye, E[e]., Anornu G.K[a,c]

[a] Regional Water and Environmental Sanitation Centre, Kumasi (RWESCK), Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

[b] Environmental Protection Authority, Savannah Region, Ghana

[c] Department of Civil Engineering, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

[d] Department of Civil Engineering, Koforidua Technical University, Koforidua, Ghana

[e]Department of Civil Engineering, Takoradi Technical University, Takoradi, Ghana

***Corresponding Author: Zakari Osman, email:** ozakari82@gmail.com**; tel: +233243924039**

Abstract

Land use land cover (LULC) changes and variability in climate are critical factors currently impacting on the response and feedback mechanism of river basins. Within this context, this work seeks to examine the effects of LULC changes and climate variability on the hydrological conditions of the Kulpawn River Basin (KRB) in semi-arid Ghana. The study applied the Random Forest (RF) algorithm to classify LULC changes using Landsat images from 1995, 2005, 2015, and 2023. The Soil and Water Assessment Tool (SWAT) was used to analyse the hydro-climatic conditions of the basin. The results revealed substantial conversion of dense savannah vegetation to built-up areas (28.34%), light savannah vegetation (20.83%), and agricultural land (3.22%) from 1995 to 2023. Significant changes were also observed in key hydrological components, with precipitation decreasing by 2.14% and evapotranspiration by 4.91%, while surface runoff increased by 7.78%. In addition, water yield, lateral flow, and percolation declined by 14.5%, 1.8%, and 4.87%, from 1995-2023, indicating reduced water availability within the basin. The study established a strong correlation between LULC changes and hydro-climatic variables of the basin, highlighting the combined effects of LULC changes and climate variability on basin hydrology. The study recommends the implementation of sustainable land and water use planning and the promotion of climate-smart agricultural practices. As well as the integration of climate adaptation strategies into basin-scale water resources management to enhance the hydrological resilience of the basin.

Keywords: Land use-land cover Changes; Climate Variability; Hydrological Processes, Kulpawn River Basin; SWAT Model