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"Reconcile land system changes
with planetary health"

Assessing the hydrological impacts of land use/cover change in the Ouémé river basin, West Africa

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Abstract

Population growth, unsustainable land-use practices, and climate change pose significant challenges to agri-food systems. This study examined the relationships between land use/cover change and changes in water balance within the Ouémé River Basin, which are essential for developing sustainable agroecological strategies. LULC was categorised from Landsat imagery for 1986, 2000, 2015 and 2023 using a supervised classification in Google Earth Engine into five main classes: Forests, Savannah, Settlements/bare lands, Water bodies, and Agricultural lands. These historical maps were used to simulate water balance components including surface runoff, lateral flow, baseflow, aquifer recharge and actual evapotranspiration using the Soil and Water Assessment Tool (SWAT). Future LULC projections for 2030, 2063, and 2100 were derived using the cellular automata-Markov model and used to simulate projected hydrological responses. The relationship between the LULC types and average annual water balance components values at the entire basin scale was then analysed using Partial Least Squares regression. Between 1986 and 2023, Forests and Savannahs declined by 4 % and 24 %, respectively, while Agricultural land and Settlements/bare lands expanded by 28 % and 1 %, respectively. These changes were associated with an increase in surface runoff (32 $^{mm}/_{y}$) and reductions in baseflow (5 $^{mm}/_{y}$), lateral flow (6 $^{mm}/_{y}$), aquifer recharge (22 $^{mm}/_{y}$) and actual evapotranspiration (6 $^{mm}/_{y}$). Projections under the business-as-usual scenario showed continued expansion of Agricultural lands and Settlements/bare lands at the expense of Forests and Savannah, with increasing runoff and reducing subsurface flows by 2100. These trends may increase flood risks, limit water availability and threaten agricultural productivity. The findings underscore the urgency of promoting agroecological practices that integrate sustainable land management and climate adaptation to ensure resilient agricultural systems and environmental sustainability.

Keywords: Google Earth Engine, hydrological changes, land use/cover change, Landsat, Ouémé River Basin, partial least squares regression, SWAT, West Africa

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