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Land cover changes, prediction modelling and decline of ecosystem services in lubigi wetland, kampala, uganda

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Abstract

Urbanisation and agricultural expansion often result in degradation of natural wetlands, leading to significant ecological impacts. The study integrated the concepts of ecosystem service theory, positing that land cover changes driven by anthropogenic pressures alter ecological processes. This framework assumes that wetlands function as critical nodes in provision of ecosystem services. By linking land cover dynamics with ecosystem service outcomes, the study adopted a coupled human–environment perspective to understand and predict the consequences of wetland degradation in Lubigi Wetland, Kampala, Uganda. The objectives were to assess the dynamics of land cover changes between 1999 and 2022, predict future land cover scenarios for 2030, and identify the ecosystem services under threat due to wetland degradation. Sentinel⁻² and Landsat imagery were processed using ArcGIS and the Land Change Modeler (LCM) to assess land cover transitions. Multi-Layer Perceptron (MLP) neural network and Markov Chain analysis were employed to model future land cover scenarios. Land cover transitions were quantitatively calculated in terms of gains, losses, and net change. Regression analysis was used to identify key drivers of wetland degradation. The ecosystem services evaluated were categorised into regulating, provisioning, cultural, and supporting services. The findings reveal significant land cover changes in Lubigi Wetland from 1999 to 2022, with built-up areas increasing by 1,140.60% from 10.74 km² in 1999 to 122.5 km² in 2022, while wetland areas decreased by 49.5%, from 453.54 km² to 228.96 km². By 2030, built-up areas are predicted to expand further to 279 km², and wetland areas are projected to shrink to 200 km². The loss of wetland area has had a profound impact on ecosystem services, particularly in flood regulation, water quality, and biodiversity support, all of which have been significantly degraded due to increasing anthropogenic pressures. The results suggest that population growth and urban expansion are major drivers of wetland degradation, and urgent conservation measures are necessary to mitigate further damage. The MLP neural network demonstrated an accuracy rate of 87.64%, supporting its use in land cover change modelling. The study concludes that without intervention, continued expansion of anthropogenic land cover will threaten the ecological stability of Lubigi Wetland.

Keywords: Kampala, land change modeler, land use land cover, Lubigi wetland, markov chain, multi-layer perceptron, remote sensing, Uganda, wetland degradation

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