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A GIS and Remote Sensing Based Analysis on Spatio-Temporal Changes of Water Retention Capacity of the Udawalawe Reservoir

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Abstract

The Udawalawe Reservoir in Sri Lanka supports irrigation, cultivation, and power generation while experiencing water level fluctuations due to seasonal climatic variations. This study analyzes the reservoir's spatio-temporal changes in water retention capacity from 1993 to 2023 using Geographic Information System (GIS) and remote sensing techniques. This study aims to fill the knowledge gap by analyzing the influencing factors such as climate change and land use/land cover (LULC) alterations. The study utilized temporal Landsat data including Landsat 4-5TM images from 1993 and 2003, Landsat 8/9 OLI/TIRS images in 2013 and 2023 to extract the surface water area of the reservoir during both dry (July) and wet (November) seasons using Normalized Difference Water Index (NDWI). Additionally, same temporal satellite data were employed to derive LULC maps for the respective years through supervised image classification technique, specifically using the maximum likelihood algorithm. Climatic data were derived from the Center for Hydrometeorology and Remote Sensing (CHRS) data portal to analyze the temporal precipitation and temperature trends. The findings reveal a declining trend in water capacity from 1993 to 2023. During the wet season, water capacity decreased from 349,472.09 ac.ft to 200,158.02 ac.ft respectively. The dry season depicts an even sharper decline, from 224,695.15 ac.ft to 2,509.53 ac.ft. LULC changes indicated a reduction in forest cover from 49,479.28 acres to 37,695.81 acres, while built-up areas expanded from 177.46 acres to 2,852.81 acres, reflecting substantial transformations in LULC. Notably, the lowest recorded temperature of 25°C in November 1993 corresponded with the highest water capacity of 349,472.09 acre-feet, whereas the highest temperature of 36°C in 2023 aligned with the lowest capacity of 2,509.53 acre-feet. Overall, the findings demonstrate a consistent decrease in water capacity during both seasons over the 30-year period, alongside a steady rise in temperatures. This observed oscillation in water capacity, influenced by deforestation, urbanization, and climate change, underscores the impact of both climatic and anthropogenic factors on the retention capacity of the reservoir.

Keywords: *Water retention capacity, Spatio-temporal analysis, GIS and Remote sensing, Climate change, Land Use/Land Cover Change*