Impact of trees and soil interactions on ecosystem services in the highlands under changing climate in Tanzania: a case of ecological gradient of Mount Kilimanjaro

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Soil and tree resources provide important ecosystem services (ES) that sustain human livelihoods and help in mitigation and adaptation to climate change (CC). This study assessed the interaction of soil properties and tree stocks on the slopes of Mount Kilimanjaro, an area reportedly under CC regime. The study site contains three altitudinal zones including Upland, Midland and Lowland, that span at elevation of 1696 to 680 m a.s.l. Results indicated that soil acidity, Al, total C and N increased with elevation, while exchangeable bases (Ca, K, Mg and Na), and available P and S decreased with elevation. Distinct tree species communities were noted associated with the three main land use zones ($p<0.05$). Soil Organic Carbon (SOC) stocks indicated poor correlation with Above Ground Tree Carbon (Pearson's: $r = 0.327$, $df = 47$, $p = 0.023$) and poor interaction (Wald = 0.0008, $df = 1$, $p = 0.977$). Soil properties influenced tree species distribution; where SOC and moisture content indicated a high correlation with tree species ($r > 0.8$, $p < 0.01$), while Mg, soil pH, P, Ca, K, Na and bulk density indicated a poor correlation ($r < 0.2$, $p < 0.001$). The variation and interactions of the tree stocks and soil properties were influenced by temperature and precipitation differences along the land use zones. Potentials to withstand impacts of CC and retrieval of ES decreased with decreasing altitude (Upland>Midland>Lowland). It is therefore, recommended that intervention strategies should consider ecosystem-based management to address the challenges in the entire study site as a whole. Improving tree cover and addressing salinity in the Lowland remain a priority. Maintaining tree cover and addressing some soil nutrient deficiencies in the Upland and Midland may ensure sustainable benefits of ES under CC regime.