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Seasonal variation in standardized litter decomposition and effects of elevation and land use at Mount Kilimanjaro

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Decomposition is one of most important ecological steps in organic matter and nutrient cycles, but studies and reliable data from tropical regions in Africa are still scarce. At the global scale, litter decomposition and recycling is controlled by climatic factors and land-use intensity. These factors can be linked to specific ecosystem characteristics along the unique elevation gradient of Mt. Kilimanjaro. Our objectives were to assess the effects of climatic conditions (i.e. elevation) and land-use intensity on C turnover and stabilization and investigated the seasonal variations.

Tea-bag Index (see www.teatime4science.org) was used to measure decomposition of a standardized litter substrate by microorganisms and mesofauna <0.25 mm. Nine pairs of litterbags were exposed in eleven ecosystems for ∼90 days during the short-rainy (October-December), warm-dry (December-March), long-rainy (March-July) and cold-dry season (July-September) respectively.

Decomposition rates increased from k=0.007 in savanna, up to a maximum of k=0.022 in cloud forest (i.e. mid elevation). The increase was followed by a decrease of ∼50% in (sub-) alpine ecosystems. Stabilization factors decreased from savanna (S=0.33) to coffee plantations or cloud forest (S=0.11) respectively and strongly increased again to a maximum of S=0.41 in the alpine helichrysum ecosystem. During all seasons, we found the highest decomposition rates at mid elevation. However, during both warm seasons the peak is shifted upslope. Savanna experienced the strongest seasonal variation, with 23 times higher S-values in dry- compared to rainy season. Mean annual k-values increased for about 30% with increasing land-use intensity.

C stabilization in Mt. Kilimanjaro ecosystems is strongly dependent on seasonal moisture limitation (lower slope) and perennial temperature limitation (alpine zone). Ecosystems at mid elevation (around 1920 & 2120m) represent the interception zone of optimal moisture and temperature conditions. High input and fast turnover drive the C sequestration in these ecosystems, while restrains on decomposition control the C turnover in lower and higher elevation zones. Land-use intensification decreases stabilization from new C inputs in transition zones from savanna to maize monocultures and from traditional homegardens to large-scale coffee plantations.