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# SYNERGISTIC EFFECTS OF ATMOSPHERIC LEAD DEPOSITION AND CLIMATE CHANGE FACTORS ON UPPER MONTANE FOREST DIEBACK IN SRI LANKA

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Reported since 1978, Upper Montane Rain Forests (UMRFs) in Sri Lanka have been threatened due to a high degree of forest dieback. This study examined the effects of atmospheric lead (Pb) deposition and rainfall variability, representing climate change factors on UMRF dieback. Nine study sites were selected across Horton Plains National Park, Pidurutalagala Conservation Forest, and Knuckles Conservation Forest, representing dieback-affected and relatively healthy areas. Vegetation health trends were assessed using Enhanced Vegetation Index (EVI) imagery processed with a Python-based image segmentation programme to quantify the unhealthy vegetation percentage. To minimise Pb interference from soil, 27 epiphytic *Thuidiaceae* moss samples were collected methodically from the nine study sites, digested, and analysed via inductively coupled plasma-mass spectrometry as bioindicators of atmospheric Pb deposition. Lead concentrations in moss samples were compared between healthy and unhealthy sites. Monthly rainfall data (2017 – 2024) were incorporated into correlation analyses with vegetation health data. An overall positive trend in forest regeneration from 2017 to 2024 was observed in 88.9% of sites. Concentrations of Pb in moss samples did not show a clear relationship with vegetation health within sites. However, a significant difference ($p < 0.001$) in Pb concentrations was found between the eastern and western slopes of the central highlands, suggesting a possibility for atmospheric deposition and transboundary pollution. Importantly, 77.8% of sites exhibited a moderately strong to strong negative correlation between rainfall and unhealthy vegetation, with stronger effects at higher elevations (*e.g.*, Great Western Mountain, Pearson correlation coefficient = $-0.84$). Across dieback-affected sites, the mean unhealthy vegetation percentage (EVI < 0.2) was 51.19±8.98%, with the highest at the Great Western Mountain summit (64.29±9.73%). In 2020, unhealthy vegetation peaked with a mean of 57.06±12.31%. It is concluded that rainfall variability, representing climate stress, has a more significant relationship with UMRF dieback than atmospheric Pb deposition.

**Keywords:** Forest dieback, Climate change, Lead deposition, Moss bioindicator, Heavy metal pollution