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Microclimatic variability in diversely used landscapes of the northern Ecuadorian Andes: An exploratory investigation of the sites Atahualpa and Mojanda

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Abstract

Mountain regions are among the most dynamic climate spaces on Earth. In the tropical Andes of Ecuador in particular, the complex topography leads to pronounced differences in temperature, moisture, and radiation over very short distances. Microclimatic conditions are closely linked to vegetation structure, influence local biodiversity, and may buffer or amplify species exposure to broader climatic changes. Therefore small-scale microclimatic differences are thus directly relevant to the preservation of regional biodiversity. However, systematic field measurements at the scale of a few hundred metres are largely absent in the Ecuadorian Andes.

This bachelor's thesis aims to record and characterise temperature and soil moisture differences at a small spatial scale in order to comparatively describe microclimatic variability between pastureland, paramo grassland, and mountain cloud forest. The study draws on data from 27 TOMST sensors (model TMS-4) installed in September and October 2025 at the sites Atahualpa (2,100 m a.s.l.) and Mojanda (4,010 m a.s.l.). These sensors continuously measure near-surface temperature at three depths (6 cm below the surface, 2 cm above the surface, and 15 cm above the surface) as well as soil moisture at ten-minute intervals, enabling high-resolution recording of microclimatic conditions directly within the habitat of organisms. In addition, terrain parameters such as elevation, aspect, vegetation cover, and slope form are recorded, alongside remote sensing data from Sentinel-2 imagery and digital elevation models.

The analysis of the TOMST data is carried out using descriptive statistics as well as variance and correlation analyses in R, employing the myClim package in R. The results aim to show how strongly soil and near-surface temperature and soil moisture vary over short distances between the study sites and which terrain properties drive these differences. A better understanding of these small-scale microclimatic patterns provides an empirical basis for assessing habitat quality, modelling biodiversity patterns, and developing land management and climate adaptation strategies in the northern Ecuadorian Andes.

Keywords: Biodiversity, land use, microclimate, mountain cloud forest, northern Ecuadorian Andes, Paramo, soil moisture, soil temperature, Tomst sensors

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