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Geomorphological impact on agroforestry systems in the interior highlands of Nicaragua, Central America

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Cerro el Castillo is located in the NW of Nicaragua, Central America, close to the border of Honduras (Provincia Central de las Cordilleras) at 1000-1200m above sea level. In this region, small and medium-sized farms are agroforestry systems with mangos, avocados, coffee, papayas, bananas, strawberries, maize, pumpkins, beans and other vegetables. The production systems are strongly linked to facilities for raising small domestic animals and cows. Main regional agricultural production problems are steep slopes, soil erosion, varying precipitation and distribution, water management and the unstable family income.

An investigation of topsoil properties with comparable management systems showed on small scales significant differences in key values of soil chemistry and mineralogy. The outline of the analytical parameters included determination of pH, electrical conductivity (EC), cation exchange capacity (CEC), organic carbon (TOC), dissolved organic carbon (DOC), total nitrogen (TN) and dissolved nitrogen (DN) in soil solution, and plant available nutrients (P and K). The soil's mineralogical composition was determined by X-ray diffraction analysis.

The area is a highly weathered karst landscape within a tropical limestone region displaying different amounts of volcanic pyroclastic parent material. The dominant Nitisoils and Andosols show degraded argic and andic horizons along the upper half of the mountainside. The pH values in the topsoil are moderate from pH 5.0 to 5.6. The upland topsoil is decalcified and the amount of plant available phosphorous is very low with significant low Ca concentration at the sorption complex. The mineralogical composition points to the high weathering intensity of this area (high content of kaolinite and a lower concentration of potassium and plagioclase feldspars and andesite). Along the upper half of the mountain, the soil profiles show wider C:N ratios and lower amounts of organic matter.

Topsoil at lower altitude and with a lower slope is influenced by accumulation of pyroclastic material. Theses soils can be characterized through a closer C:N ratio, higher pH (5.7-6.2) values, and plant available phosphorus reach values of 23 mg/kg. The mineralogical analyses illustrated less weathered volcanic material here and in the investigated samples zeolithe, smectite and a higher amount of plagioclase could be found. Cristobalite und pyroxene could be detected in all samples and indicate the influence of volcanic activity. Smectite und zeolithe are reason for the higher CEC values of these soils.

Erosion and intensive tropical weathering processes including solutional weathering of limestones decline production potential at higher altitudes. Agroforestry systems are the most adapted systems for sustainable plant production systems in this area. Phosphorus release of soil is strongly influenced by the geomorphology of this landscape. Limiting parameters of this production system is the amount and the distribution of precipitation. The impact of global change to this specific area of Nicaragua will lead to extreme values of local precipitation events and an increase in temperature. If these events continue important production areas for optimum coffee production in agroforestry systems in Central America will be lost.

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