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Agroforestry management practices as nature-based solutions for climate change adaptation in the Galapagos Islands

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Small tropical islands in the Pacific Ocean are highly vulnerable to climate change. Nature-based solutions can help local communities adapt their local agricultural systems. Through a comparative analysis, we evaluated the effects of agroforestry management practices on soil temperature, soil water availability and storage, and carbon stocks in Santa Cruz Island (Galapagos Archipelago). We installed six monitoring sites that consist of two replicates per agroforestry management practices: (i) conservation of native forest, (ii) traditional agroforestry, and (iii) abandoned farmland in passive restoration. After pedological characterization of the sites, the soil physicochemical and hydrological properties were determined in the laboratory. Over 30 months (July 2019 to December 2021), the environmental sensors captured the hydrometeorological and soil physical and hydrological properties of the sites. This was done by a dense network of rain gauges, air temperature and relative humidity sensors, and time-domain reflectance probes that registered volumetric water content and soil temperature.

We measured differences in soil temperature, moisture availability and soil organic carbon content between soils under forest, traditional agroforestry and passive restoration. Forest soils are protected from direct solar radiation, and trees keep the soil 12% cooler than soils converted to agricultural land. Soil moisture is 20% higher under forest than under traditional agroforestry or abandoned farmland, and forest soils have a lower dry bulk density, lower saturated hydraulic conductivity and higher water retention capacity. The forests and sites under passive restoration store more than 377 Mg C. ha⁻¹ (1 m depth), about 50% more than under traditional agroforestry. The study shows that conserving forest patches in an agricultural landscape might be a promising strategy to mitigate increasing soil temperatures, agricultural drought, and decline in soil organic carbon content. However, more studies on landscape scale are needed to corroborate those results.