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Climate change and tropical crops: Disruption in the geography of coffee and cocoa

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Abstract

Assessing the impact of climate change on high-value tropical crops such as coffee and cocoa is essential for long-term pro-active adaptation planning. A coherent approach which integrates analysis of change, hazards, risks and potential impacts enables the development of adaptation strategies for the coming decades, while acknowledging that climate-driven impacts will vary significantly across different geographical regions and require differentiated adaptation measures. In this study, we identified the most and least suitable areas for coffee and cocoa production over a 30-year horizon, employing an agroclimatic zones approach and the latest CMIP6 climate projections.

This analysis was supported by the integration of Random Forest models with occurrence data, bioclimatic variables for precipitation, temperature and evapotranspiration; and key agro-climatic indices- such as the Number of Dry Days (NDD), Number of Days with Temperature above 30°C (NTx30), and Number of Water Logging Days (NDWL0). These variables were focused on their behaviour relative to presence points through a categorical data reclassification process. These variables act as vital indicators for crop distribution, providing the scientific evidence needed to prioritise climate resilience interventions and steer the transition of perennial production systems over the coming decades.

NDD showed more dry days in Southeast Asia and Oceania, but fewer in Andean and Central American mountains. NTx30 projections revealed widespread warming, especially in the Andes and North-Central Africa. Meanwhile, NDWL0 indicated increased waterlogging in Central and South America, while West Africa's cocoa regions faced a slight reduction in these events.

Our main findings showed that coffee will lose suitability in countries like Indonesia, Tanzania, Southern Mexico and regions in Brazil and Bolivia. In contrast, Colombia, Perú, Honduras and Uganda are expected to remain suitable for production. As for cocoa, we see a widespread shift in agro-climatic zones where comprehensive adaptation is the dominant impact category. While the regions would stay suitable, changes in climatic hazards will require a substantial overhaul of local farming practices to adapt to climate change - a phenomenon particularly evident in Colombia, Venezuela, Perú and Central Africa. Meanwhile, Ecuador, Côte d'Ivoire, and Ghana stood out for maintaining higher future suitability compared to other regions.

Keywords: Agroclimatic indices, climate change, cocoa, coffee, random forest

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