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with planetary health”

Harnessing earth observation data to verify deforestation-free risk compliance under the EUDR: The case of smallholder coffee agroforestry systems in Mexico

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Abstract

The new EU Regulation on Deforestation-free Products (EUDR) represents a significant step towards reducing global deforestation. The EUDR requires companies to demonstrate that cacao, cattle, coffee, oil palm, rubber, soy, and timber commodities and derivatives placed on the EU market are not linked to recent forest loss or forest degradation. For smallholder-dominated landscapes, such as the coffee agroforestry systems of Oaxaca and Chiapas in southern Mexico, this presents both challenges and opportunities. These bio-diverse, multifunctional systems are often embedded in complex mosaic landscapes, where the distinction between forest, agroforestry, and deforested land is nuanced and context-dependent. This study explores the application of Earth Observation (EO) data and geospatial analysis to support EUDR compliance in such settings.

Using high-resolution, earth observation time-series data from 1990 to 2024, we assess land-cover change and verify deforestation-free claims at the plot level through ground truthing (field visits, GPS, drone), and key informant interviews based on a stratified sample of $n=40$ smallholder coffee production areas. We evaluate the sensitivity of deforestation detection thresholds, comparing different forest definitions and forest reference map products, to assess the robustness of compliance verification under different regulatory interpretations.

Our findings demonstrate the viability of EO data to support traceability and risk assessment for EUDR compliance, particularly when combined with local knowledge and contextualized forest definitions. However, the analysis also highlights technical and governance challenges, including data accessibility, classification uncertainty in heterogeneous landscapes, and the risk of excluding smallholders due to technical or bureaucratic barriers. We argue that compliance mechanisms need to be adapted to the realities of smallholder agroforestry systems, by integrating transparent, inclusive, and spatially-explicit tools.

This case study contributes to broader debates on the operationalizing of sustainability regulations such as the EUDR in complex land systems and underscores the need for harmonised EO-based approaches that are both scientifically rigorous and socially equitable.

Keywords: Coffee agroforestry, earth observation, EUDR, forest reference maps, Mexico, remote sensing, smallholder production