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“Reconcile land system changes  
with planetary health”

## Co-producing social-ecological scenarios and iterative modelling alternative land-use futures in southwestern amazonia

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### Abstract

We present the results of an inter- and transdisciplinary research framework that focuses on the border triangle of Brazil, Peru, and Bolivia in Southwestern Amazonia. This framework consists of (i) iterative participatory scenario development, involving diverse regional stakeholders and (ii) simulation-based analyses using the spatially explicit LandSHIFT model to investigate land-use change trajectories under the specific scenario assumptions. To better align with regional stakeholder expectations and to capture the complexity of human–environment interactions within the region, the land-use model was adapted and further developed e.g. by integrating agroforestry and non-timber forest production systems.

The regional social-environmental system (SES) is characterised by diverse cultural and societal settings embedded within a relatively homogeneous tropical forest ecosystem. These interactions, influenced by local and global demands for food, feed and fiber, lead to varying land-use practices and intensities of deforestation across the border triangle. Deforestation, in turn, contributes to regional climate change and may increase the risk of crossing critical tipping points within the regional SES.

Project scientists and regional stakeholders collaboratively co-produced four exploratory scenarios, which served as inputs for land-use and land-cover change (LUCC) simulations. The results indicate that in two of the scenarios, LUCC stabilises because of either bottom-up or top-down transformative changes that effectively control the future expansion of agricultural areas, especially pastures. In contrast, the remaining two scenarios depict extensive agricultural expansion into forest ecosystems, driven by uncontrolled market liberalisation or the failure of governmental institutions to enforce environmental regulations. These pathways result in significant impacts from LUCC that may accelerate regional climate change and enhance risks of tipping point crossing in Southwestern Amazonia.

We also discuss the limitations of our research framework and highlight the need for stronger integration of bottom-up approaches, particularly in relation to sustainable land-use practices. Finally, we offer a brief outlook on ongoing participatory research efforts in the region, which aim to identify key processes and leverage points for transformative change toward positive future land-use visions.

**Keywords:** Acre, Amazon, explorative scenarios, land use change modelling, MAP region Madre de Dios, Pando, participative scenario development, sustainability