

INTEGRATING DISCIPLINES IN STUDIES OF LAND-USE SUSTAINABILITY: METHODOLOGICAL APPROACH OF THE SUSTAINABLE AMAZON NETWORK IN BRAZIL

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Rural development in tropical forest landscapes is often unsustainable, resulting in the conversion of native forests, land degradation and depletion of vital ecosystem services. Driven by the current global demand for food, the land-use change that took centuries to occur in other parts of the world is being played out over the scale of years or decades in many tropical nations. The Brazilian Amazon, encompassing some 40% of the world's remaining tropical forests and a rapidly expanding population of more than 20 million people, is a prominent example. Despite recent improvements in human development in the region, effective conservation of natural resources is likely to be critical to maintaining this pattern in the long term.

Tackling the challenge of sustainable rural development requires integrating different disciplines to acquire a broad understanding of how different land-uses impact the environment, the provisioning of key ecosystem services and the overall benefits delivered for local communities. Here we present the conceptual framework and methodological basis of the Sustainable Amazon Network (Rede Amazônia Sustentável-RAS in Portuguese), a research network of more than 30 institutions led by EMBRAPA, Museu Paraense Emilio Goeldi, University of Cambridge and Lancaster University, with strong links to civil society and local government organizations.

The rationale underpinning RAS is to unravel the complexity that characterises variability in rural development pathways, including both socioeconomic and biophysical components, thereby examining the nature and strength of trade-offs between development activities and environmental conservation in the eastern Brazilian Amazon. The general methodological approach consists in selecting standardized study units (catchment) and performing a matched assessment of its general condition (through metrics related to deforestation, degradation, fragmentation, land use types and distribution), ecological value, economic revenue and social benefits related to the different land uses and management practises. This analytical framework is placed within the regional context, and includes the drivers of socio-ecological change such as local institutions and public policies. This assessment process can then be used to test and validate assumptions about the social-ecological costs and benefits that are associated with different land-use and management options at local, landscape and regional scales.

RAS presents two unique strategic advantages for assessing sustainability. First, work is conducted at spatial scales that are large enough to encompass major gradients of anthropogenic disturbance and multiple scales of management. We collected data from more than 500 farms and 36 catchments (micro-watersheds of approximately 5000 hectares each) in two regions of eastern Amazonia that are distinct in terms of their biophysical and biogeographical context, history of occupation, and recent trajectories of development. Second, we have collected standardised and spatially comparable data from all study farms, including a multi-taxa assessment of biodiversity value (plants, birds, beetles, ants, bees, stream fishes, aquatic insects), a comprehensive ecosystem

service evaluation (carbon storage, soil conservation, water quality and stream habitat conservation), and indicators of socio-economic condition (agricultural productivity, income generation, well-being, overall costs and benefits of different land-use options). Focal production systems include manual and mechanized arable farming, cattle ranching, perennial crop systems, silviculture, and forest management.

Working across multiple scales of management allows insights into the relative importance of different drivers of land management, as well as constraints and potential interventions to deliver improvements in land-use sustainability. Our analytical approach is divided into two overlapping stages: (1) a problem analysis to describe changing patterns of land-value across different management systems, and to quantify environmental-economic trade-offs and synergies, and (2) an evaluation of approaches for sustainable development trajectories. The second stage will draw upon the quantitative problem analyses to identify important areas of heterogeneity in both the ecological and socio-economic system that can provide the motivation and entry-point for future changes, together with an assessment of potential policy levers and market alternatives.

Through the integration of such set of multidisciplinary data, we expect RAS will contribute towards a novel evidence basis for developing improved land management strategies, help guide more effective approaches to complying with environmental legislation, and will help identify opportunities for conservation and revenue generation through emerging certification standards and ecosystem service markets.