

Mapping Multifunctional Hotspots: A Spatial Framework to Prioritize Ecosystem Service Conservation in Brazil's Atlantic Forest

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Abstract:

Climate change and biodiversity loss threaten tropical forests and their services, driving urgent demand for integrated solutions. This study optimizes ecosystem service (ES) provision in Brazil's Atlantic Forest by analyzing spatial synergies and trade-offs among carbon storage, water yield, and sediment retention. Using InVEST models with NASADEM elevation and MapBiomas land cover data, we found that 83% of ES hotspots are in Permanent Preservation Areas (PPAs), demonstrating their disproportionate conservation value. These areas highlight PPAs' role in safeguarding biodiversity and hydrological functions despite land-use pressures. Our spatially explicit results reveal that ecosystem service hotspots are spatially concentrated, occupying only 4% of the total study area yet delivering multi-service benefits. These findings pinpoint cost-effective conservation and restoration targets. By connecting global environmental concerns to local strategies, this work offers a science-based framework for policymakers to enhance ecological resilience. The Atlantic Forest's role in water supplies and carbon stocks is underscored, with hotspots concentrated in riparian zones and steep slopes. The study advances nature-based solutions by showing that strategic actions yield outsized benefits for biodiversity and human well-being in threatened ecosystems. Future research should extend this approach to other biomes and evaluate economic incentives for PPA compliance.