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Rural Livelihood, Biodiversity and Carbon Stock in Vietnam Mountains: Agent-Based Modeling to Anticipate Trade-Offs

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Abstract: Assessment of future multiple ecosystem services driven by alternative land-use policies is useful for supporting decisions about what and where to invest for the best overall environmental and developmental outcomes. The task faces a great challenge due to the inherent complexity of human-landscape systems and trade-offs between rural livelihood improvement, biodiversity conservation and carbon sequestration. Agent-based system models have been recognized to be well suited to simulate the co-evolutions of the community and landscape systems in response to policy interventions. The study applies the Land Use Dynamics Simulator (LUDAS) framework to a mountain watershed in central Vietnam for anticipating trade-offs among rural livelihoods, forest biodiversity and carbon stocks under different land-use policy interventions. Changes in plant species diversity driven by land cover change were calculated using the species-area relationships that were estimated based on vegetation surveys. Total species pool of the study area was calculated with a taking into account of species' turning over different vegetation cover types. Carbon stocks of different forest types were estimated by empirical allometric equations. Our purpose is to assess relative impacts of policy interventions by measuring the long-term landscape and community divergences (compared with a baseline) driven from the widest plausible range of options for a given policy. We design experiments of replicated simulations for relevant policy factors in the study region that include (i) forest protection zoning, (ii) agricultural extension and (iii) agrochemical subsidies. We comparatively assessed trade-offs and synergies between different expectations - i.e. household income and income equity, deforestation and natural vegetation recovering, and forest tree species diversity - driven by different policy interventions. Transparent and objective communication of these informative findings would help increase the effectiveness of multi-stakeholder discussions.

Keywords: Agent-based model, decision support, ecosystem services, household decision making, land-use/cover change, livelihood, species diversity, carbon stock, trade-offs, land use policy