Anticipating the onsets of collapse/insecure phases in community livelihoods in a tropical forest margin

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Abstract

The critical degradation or transition to resilience of a coupled human-environmental system theoretically involves controlling variables crossing certain critical thresholds, under the influences of external drivers. However, so far these controlling variables, their thresholds and respective drivers have been unknown regarding transitions in real coupled systems, such as community-forest landscapes in the tropics. This study investigates this issue in the ecologically diverse Vietnam central mountains, using a multi-agent system model representing the underlying coupled human-environmental system. The human population and the forest landscape both are represented by self-organized interactive agents. The forest-dependent community is represented by household agents that integrate household and policy information as well as heterogeneous environmental information into logging decisions. The forest landscape was modelled as landscape agents representing regular forest stands naturally grown. Moreover the forest agents respond to diverse site conditions and logging activities, exerting influence on each unit of land and its immediate neighbourhood. Our simulation results revealed the combined effects of logging rate (connected to market demand and logging mechanization), degree of forest fragmentation and land-form heterogeneity. These factors determine whether the community-forest landscape changes into severe degradation or recovery. The model helps anticipate different onsets of the collapse or insecure phases in the community livelihoods and forest resources under different scenarios of timber market demands and forest zoning policy. Measurable indicators allow for recognition of thresholds which is useful for sustainable forest landscape management. We also discussed the adaptive, dynamic supply-demand equilibrium and its relation to the regime shifts of community-forest landscapes.

Keywords: Human, environment system, critical transition, regime shift, tipping point, threshold, slow variable, dynamic supply, demand equilibrium, heterogeneity, forest fragmentation, livelihood

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