

Analyzing the Relationships between Disturbance, Landscape-level Change, Land-formation Mechanisms and Biota in Complex Socioecological Systems

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Socioecological systems are often described as 'complex' and 'dynamic' systems, but prevalent analytical frameworks have so far mainly explored biological and human parameters of the environment. The classical definition of ecosystem ecology by Odum (1953) mentions abiotic components of the environment as key to ecological dynamics, and more recent socioecological research focusing on periodic release and conservation of energy in ecosystems (Gunderson and Holling 2012) implies that landscape formation and change play vital roles in socioecological systems. However change in land-formation and landscaping processes over time and their interaction with the biotic components remain under-researched and generally poorly understood. This paper shows how such lack of understanding may be detrimental to the resilience of the landscape through a case study of the Shirakami Mountains World Heritage Property in Japan. The mountains provide one of the last natural forests of the Siebold's Beech (*Fagus crenata*) in Asia, and are protected for their biological diversity. These forests have also provided vital ecosystem services to local communities through ages. The landscape dynamics though, have not been adequately addressed in the existing protection and management frameworks. As global climate change and anthropogenic impact on land-formation processes escalate to a new level, governance of such biologically diverse and change-prone systems require understanding based on questions such as: 'what causes change in complex socioecological systems on what scales, and how it is related to the resilience of these systems?' Key findings are: Disturbance is a fundamental component in landscapes and over time generates landscape heterogeneity, but at the same time, scale is critical. If disturbance ceases to be 'local' and transcends boundaries, fragmentation of socioecological systems occurs. Landscaping mechanisms are directly linked with land-formations processes that evolved over geologic time scale and these mechanisms ought to be taken into account for socioecological system governance.

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