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Insights into effects of land cover change on hydrogeomorphic processes in Southeast Asia

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Land use activities in the tropics of Southeast Asia can have a substantial impact on the occurrence and severity of floods, landslides, debris flows, and severe soil erosion. In addition to generating widespread sedimentation and damage to streams and riparian habitat, these hazards pose significant risks to humans, infrastructures, and property in the runout zone. The probability and severity of these natural hazards can increase related to timber harvesting, road building, vegetation conversion, urbanization, and recreation. Such land use activities in this region have placed natural resources at high risk, especially in mountainous forested areas.

The widespread conversion of native forests to permanent agriculture and plantations (e.g., oil palm, coffee, rubber, fruit trees) throughout Southeast Asia has created problems related to hydrogeomorphic processes and related hazards. The relative extent of anthropogenic impacts may be strongly associated with the spatial and temporal attributes of land uses. Due to high rates of decomposition, many of these sites have only thin litter layers protecting the mineral soil. Therefore, disturbances associated with vegetation conversion can have profound impacts on infiltration capacity, stormflow runoff and pathways, and erosion. Long-term impacts on slope stability can occur related to decreases in vegetation rooting strength. Without understanding the controls on materials transported through and stored in headwaters, it is difficult to develop prudent long-term management plans for larger catchments. The interactions of land use with water pathways and storm runoff, as well as with natural hazards, have not been extensively studied in tropical ecosystems of Southeast Asia. Thus, land management agencies and water users are left to decide on acceptable activities based on poor scientific information and the biased perspectives of both environmental groups and the industrial sector. Nowhere in the world are natural resources more at risk than in developing rural regions of Southeast Asia.

Research currently underway in Peninsular Malaysia, Thailand, Myanmar, and Sumatra is focusing on *sources* and *pathways* of sediment, water, and nutrients within managed catchments. Such an approach facilitates not only the assessment of the hazard or hydrogeomorphic process *on-site*, but also evaluates the linkage of the process to the catchment scale and downstream resources. For example, in the Bukit Tarek catchment in Malaysia, erosion (largely surface erosion with small-scale mass wasting) from logging roads and skid trails was about 275 t $ha^{-1}yr^{-1}$ during the first 1½ years after selective logging. An important finding is that many of the discharge nodes from poorly designed logging roads are directly connected to the stream channel, thus enhancing sedimentation and potentially peak flows. Roads cut into hillsides may intercept subsurface water and reroute it into drainage systems or along the road surface, thereby enhancing peak flows. Road-related runoff facilitates stormflow routing to channels and causes channels to headcut, generating additional sediment. Mass wasting from roads occurs episodically, with little soil loss in many years and much erosion during years with large storms. In contrast, skid trails, which had few or no deep cut slopes and were more remote from channels, were generally poorly connected to streams; much of the sediment mobilized from skid trails was stored either on adjacent hillslopes or the trails themselves.

An overview of other research on land cover change will be presented for studies in northern Thailand and Sumatra. The Thailand study involves a small catchment partially converted to agricultural crops with access roads and footpaths. All of these land uses affect the routing of water, sediments, and nutrients to streams. In Sumberjaya, Sumatra, a nested catchment approach is being used to assess the effects of forest conversion to coffee plantations on erosion and peak flows.