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Contextualising impacts of logging on tropical rainforest catchment sediment dynamics using the stratigraphic record of in-channel bench deposits

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It is widely recognised that commercial logging and conversion of tropical rainforest to oil palm plantation leads to enhanced fluvial sediment flux to the coastal zone but the dynamics of delivery and mechanisms that act to retain sediment and nutrients within rainforest ecosystems, e.g. riparian zone and floodplain storage, are poorly understood and underexploited as a management tool. While accretion of lateral in-channel bench deposits in response to forest clearance has been demonstrated in temperate landscapes, their development and value as sedimentary archives of catchment response to human disturbance remains largely unexplored in tropical rainforest river systems.

Working within the Segama River basin, Sabah, Malaysian Borneo, this study aimed to test the hypothesis that (1) lateral bench development in tropical rainforest rivers systems is enhanced by upstream catchment disturbance and that (2) the sedimentary record of these deposits can be used to infer changes in sediment provenance and intensification of sediment flux associated with logging activities. Sediment cores were taken from in-channel bench deposits with upstream catchment contributing areas of 721 km^2 and 2800 km^2 respectively. Accretion rates were determined using fallout ^{210}Pb and ^{137}Cs and the timing of peak accumulation was shown to correspond exactly with the known temporal pattern of logging and associated fluvial sediment response over the period 1980 to present following low pre-logging rates. Major and minor element geochemistry of deposits was used to assess the degree of weathering that deposited sediment had experienced. This was linked to surface (heavily weathered) and subsurface (less weathered) sediment sources relating to initial disturbance by logging and post-logging landsliding responses respectively. A shift in the dominant source of deposited material from surface (i.e. topsoil) to subsurface (i.e. relatively unweathered subsoil close to bedrock) origin was observed to coincide with the increase in accretion rates following logging of steep headwater slopes.

Coherence of sedimentary, monitoring and observational evidence demonstrates that in-channel bench deposits offer a previously unexplored sedimentary archive of catchment response to logging in tropical rainforest systems and a tool for evaluating the erosional responses of ungauged basins. In-channel bench development due to catchment disturbance may augment ecosystem services provided by the riparian corridors of larger rivers and process knowledge gained from sedimentary archives can be used to underpin future riparian and catchment forest management strategies.