



## **The orientation of past, current and future catchment and slope erosion research in Sabah (Malaysian Borneo) to the design and implementation of more sustainable land management strategies**

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A series of projects within the long-term multidisciplinary Royal Society SE Asia Rainforest Research Programme based at Danum Valley in Sabah (Malaysian Borneo) since 1985 have been designed to provide the scientific underpinning for land management practices and strategies to reduce the erosional and ecological impacts of selective logging and forest conversion. This paper seeks to demonstrate how the design and results of some of the key projects link directly to sustainable land management issues. Of key importance have been the strong links which the Programme has with the Sabah Foundation (a Government-owned Trust responsible for land management of a considerable section of Sabah), the Sabah Forest Department and other government departments – and more recently plantation companies and the Round Table on Sustainable Palm Oil (ROSPA). These links have been useful in the conception and design of projects, in the dissemination of the results and in some cases the subsequent design and adoption of more sustainable land management practices and policies.

Early projects were designed to assess immediate and longer term slope- and catchment-scale impacts of different types of selective logging and aided in the design (and later the adoption by the Sabah Government) of 'Reduced Impact Logging' protocols. These projects included the long-term monitoring (since mid-1988) of erosion and hydrology of the Baru catchment, which was selectively logged in the first half of 1989 and then left to regenerate. Key findings included a secondary peak in erosion 6-10 years after logging linked to the biogenic decay of stream debris dams and, more seriously, of culverts and bridges along a midslope-aligned logging road, which set off a series of landslides during extreme rainstorms. Repeat-measurement erosion bridge results and sediment fingerprinting data are presented showing that even in 2010, 21 years after logging ceased, a disproportionate fraction of catchment erosion is derived from that part of the catchment affected by the logging road. A key message was that logging roads need to be aligned as much as possible along ridges and to avoid traversing the mid-slopes of even moderately sloping terrain.

Initial results are given of a current project comparing erosion rates and channel capacities in primary forest; naturally regenerating selectively logged forest; rehabilitated (by enrichment planting of canopy species trees) and unrehabilitated overlogged forest; and oil palm plantations. In each case, erosion rates are being assessed (using networks of erosion bridge transects) over a full range of slope angles (5-40°). The aim is to assess and compare the critical angles at which slopewash rates become excessive under each type of forest and plantation land-use. A downstream hydraulic geometry approach based on relationships between channel capacity and catchment area is being used to assess the impacts of the same land-uses on channel size (which will reflect peak runoff rates). Finally a sediment fingerprinting approach is being used to assess changes through time in the relative contributions to erosion of sub-catchments of contrasting current land use. It is envisaged that results will be used to provide the evidence to Government to underpin a land use policy that will retain steep slopes under primary forest, moderate slopes under managed forest and restrict oil palm plantations to floodplain and more gently sloping land.

Finally the aims and design of hydrological and erosional aspects of the new 10-year SAFE (Stability of Altered Forest Ecosystems) Project is described. A major issue concerns the degree of effectiveness of retaining (or restoring) riparian forest zones both as ecological corridors and as buffer zones aimed at reducing hydrological, pollutional and erosional impacts. The project will use a pre-treatment/post-treatment multi-catchment approach to assess the impacts of retaining riparian zones of widths varying from zero to 120 metres during a programme of conversion of logged forest to a mosaic of oil palm plantations and riparian and other forest reserves.