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Hydrology and Soil Erosion in Tropical Rainforests and Pasture Lands on the Atherton Tablelands, North Queensland, Australia – a rainfall simulator study

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The Barron and Johnstone Rivers rise in the basaltic Atherton Tableland, North Queensland, Australia, and flow into the Coral Sea and Great Barrier Reef World Heritage Area (GBRWHA). Natural rainforest in this region was cleared for settlement in the early 20th century. Rapid decline in soil fertility during the 1940's and 50's forced landholders to turn to pasture based industries from row crop agriculture. Since then, these pasture based industries have intensified. The intensified land use has been linked to increases in sediment and nutrient levels in terrestrial runoff and identified as a major environmental threat to the GBRWHA, which has raised alarm for the tourist industry and resource managers. Studies linking land-use to pollutant discharge are often based on measurements and modelling of end of catchment measurements of water quality. Whilst such measurements can be a reasonable indicator of the effects of land use on pollutant discharge to waterways, they are often a gross assessment. This project used rainfall simulations to investigate the relationship between land use and management with sources and sinks of runoff and soil erosion within the Barron and Johnstone Rivers catchments.

Rainfall simulations were conducted and pollutant loads measured in natural rainforest, as well as dairy and beef farming systems. The dairy farming systems included an effluent fed pasture, a high mineral fertilizer and supplementary irrigation farm, and a rainfed organic pasture that relied on tropical legumes and introduced grasses and returned organic material to the soil. One of the beef farming systems used a 7-10 day rotation with a low fertilizer regime (kikuyu mostly), while the other, used a long period- two paddock-rotation with no fertiliser and paspalum pastures. The rainforests were generally small isolated enclaves with a well developed shrub layer (1-3 m), and a presence of scattered, deciduous trees. Simulations were carried out on sites which were observed to be part of a drainage network and which were typical of the surrounding hillslopes. A 13 m long by 2 m wide portable rainfall simulator was used to produce rainfall associated with high intensity events. The simulator consisted of six A-frame modules with spray nozzles (equipped with pressure gauges) that operated in an oscillating movement. Rainfall from the simulator was measured using seven dynamically calibrated pluviometers ($\sim$0.1mm/tip) and 26 rain gauges (100mm diameter, muslin covered). Runoff volume was recorded using a tipping bucket mechanism. Samples were collected at three minute intervals and used to calculate soil loss using standard methods.

At sites where there was a high rate of infiltration a catena effect on runoff could be discerned. Highest runoff volumes tended to be generated on the midslope, rectilinear segments of the hillslope. However some of the sites exhibited effects from indurated laterite layers, exfiltration areas, and small areas of unweathered basalt veneered by a surface ferrasol. All sites had high levels of vegetative cover but large differences in biomass. While runoff and soil erosion were not significantly correlated with vegetative cover, a useful relationship was found when cover was multiplied by biomass. The rate of soil loss from intensive dairying was less than from the intensive beef grazing sites and cattle tracks. However, because deposition from these point sources occurred it became difficult to verify whether contributions from overland flow to the stream were significant. Observations of farm dam overflows near to the simulation sites confirmed the significant subsurface flows that diluted sediment concentrations in the local waterways.

Overall, the results indicated that to reduce sediment loss farms must be designed and managed according to landscape features. In order to better understand runoff and sediment delivery it would be necessary to measure volumes and rates through a "nested" catchment approach so that stream channel contributions could be quantified.