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An hypothesis for integrating climate, geomorphology, soils, and land use for interpreting runoff and erosion in catchment management studies, Central Queensland, Australia

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Traditionally, soil movement has been reported in the literature under processes of raindrop impact/splash, overland sheet flow, rills, gullies, and ephemeral and fluent streams and rivers. From the perspective of a land manager this information needs to be structured in a way that integrates these many strands of knowledge thus facilitating decision making about land use operations and conservation of the resource. This paper describes the interconnectedness of hydrologic and sedimentological processes of landscape elements and segments in the headwaters of the semi/arid – subhumid Fitzroy River, Central Queensland, Australia and options for managing severe erosion.

The central notion of the hypothesis is that sediment has been pulsing through this landscape for thousands of years. Stratigraphy of valley alluvial fans indicates that the valleys have been filled and re-excavated many times. The pulsing of sediment through valleys where incision of alluvial fans and subsequent downstream deposition creates a sequence of similar landforms, but of a different scale, is largely driven by the morphology of the landforms themselves. The “noses” of alluvial fans exhibit a convex shape with the surface being characterised by finer sediments. Positive pore water pressures develop throughout the fan due to the highest infiltration occurring at the head of the fan where coarsest sediments are deposited. Strata of coarser materials are thus laid down progressively up-valley as the fans continue to grow. In the base of the “nose” of alluvial fans there are the remnants of the coarse material that were laid down initially and movement of water through fans is subsequently along the layers of coarse gravel and exfiltrated at the “nose” of the fan. A “pothole” in these locations is the first visible evidence of the impending rapid retreat of a new gully whereby sediment is pulsed down-valley and again deposited to form a new fan. Thus alluvial fans are destroyed and gullies are in-filled in a long process of base level lowering and landscape denudation.

These valley processes are linked to hillslope “throughflow” lines and exfiltration points appear in gully walls from which secondary gullies develop, thus creating expanding erosional networks. After incision, channel widening and meandering are followed by gully wall declination and in duplex soils headwall retreat consumes the A horizon of the surrounding hillslope soils. Consequently, sediment from eroding headwalls on the slopes is deposited in the gullies and lower slopes. New vegetation establishes and completely masks the previous gully. This is a different kind of base level effect when compared with the traditional incision by trunk and regional catchment networks and needs to be understood when considering the effects of grazing management.

Recent advances in knowledge about the Southern Oscillation Index and the Inter-decadal Pacific Oscillation are a two-edged sword for land managers because some parts of properties can be best rehabilitated during wet periods while other very productive parts can be damaged the most. Rehabilitation of some key areas on hillslopes, successful introduction of tropical legumes and buffel grass(Cenchus Celaris), choking of gullies where deposition is occurring with growth of Leucaena leucocephala shrubs, and rotational resting (Time Controlled Grazing) from grazing has been highly successful in changing hydrology and erosion.