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# Tracking post-colonisation geomorphic river sensitivity: A framework for identifying hotspots of river adjustment across a catchment

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Contemporary geomorphic river behaviour can only be understood with a sound knowledge of the historical range of river adjustment. This is particularly the case for rivers that have experienced anthropogenic alterations. Using a case study of Richmond River, New South Wales, Australia, we track the history of geomorphic river adjustment from the time of European colonisation in the late 18$^{th}$ Century. We use this study to develop a novel framework, called the *'Behavioural sensitivity logical tree'* which can be applied to any catchment for assessing and quantifying reach scale behavioural sensitivity, defined as the ease with which geomorphic units and associated water, sediment, vegetation interactions adjust within the expected behavioural regime of a river. We use this framework to develop a behavioural sensitivity index and categorise rivers as *Fragile, Active sensitive, Passive sensitive, Insensitive and Resilient*. When applied across a catchment, such analyses highlights hotspots of river adjustment and sensitivity.

Fragile rivers have a behavioural sensitivity index > 0.85 and have the propensity to undergo wholesale river change such that a new river type and behavioural regime is created. For example, change from discontinuous or absent channels (e.g. swamps) to continuous channelised fills. Active sensitive rivers have a behavioural sensitivity index of 0.50-0.85 and have the ability to re-configure within their contemporary behavioural regime. For example, by reducing sinuosity via abrupt chute cut-off or progressive channel straightening. The behavioural sensitivity index of Passive sensitive rivers is between 0.20-0.50. These rivers have the ability to maintain their behavioural regime and withstand adjustment. Insensitive rivers have a behavioural sensitivity index of 0.05-0.20. They do not readily adjust and may contain significant resistance elements such as fine-grained sediments that limit geomorphic adjustment. Resilient rivers have a behavioural sensitivity index < 0.05 and tend to be confined reaches where the capacity for adjustment is controlled by bedrock or other antecedent controls, such that the river cannot readily adjust.

We further demonstrate the evolutionary nature of behavioural sensitivity itself. The behavioural sensitivity of a river is not set in space and time, rather, rivers can dynamically evolve and shift to a different sensitivity category over time and in response to different forms of direct and indirect disturbance. Analysing a rivers' behaviour sensitivity and identifying hotspots of geomorphic adjustment, can help inform process-based river management practice.