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Buffers, barriers and blankets: The (dis)connectivity of catchment-scale sediment cascades

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Abstract

Catchment configuration and the nature of connectivity within and between landscape compartments affect the operation of sediment cascades and geomorphic responses to disturbance events of differing magnitude and frequency. This paper introduces the concept of landform impediments, termed buffers, barriers and blankets, that impede sediment conveyance by limiting the connectivity between landscape compartments. Buffers restrict sediment delivery to channels, barriers inhibit sediment movement along channels, and blankets drape channel or floodplain surfaces affecting the accessibility of sediment to entrainment. These features operate as a series of switches which turn on/off processes of sediment delivery, determining the effective catchment area at any given time. Using previously documented examples, the role of these features in affecting the operation of sediment cascades in a low relief, passive landscape setting such as the Australian landmass is contrasted to examples from high relief, uplifting settings in New Zealand. The Australian examples are further explored by examining how changes to landscape connectivity brought about by human disturbance since European settlement have impacted upon landscape sensitivity and prospects for river recovery. This approach to analysis of impediments to sediment conveyance is generic and can be applied in any environmental setting.

Keywords: Disconnectivity; Decoupling; Sediment cascades; Sediment budgets; Sensitivity; River recovery; Switches

1. Introduction

Catchment-scale sediment budgets quantify the efficiency of sediment conveyance as expressed by the sediment delivery ratio (Walling, 1983). Source to sink relationships that characterise sediment cascades have been effectively communicated through the use of sediment flow diagrams (e.g. Trimble, 1983; Olive et al., 1994; Fryirs and Brierley, 2001). These diagrams indicate significant basin-to-basin variability in sediment inputs and outputs and patterns of sediment storage within a catchment (Meade, 1982; Trimble, 1993). The position, effectiveness and configuration of sediment storage units in a catchment are represented by the constrictions on these sediment flow diagrams. The distribution of sediment stores and sinks reflects, and in turn influences, the routes and distances of sediment transport, providing a measure of the (dis)connectivity of any given landscape (see Brunsden and Thornes, 1979; Meade, 1982; Phillips, 1992a; Harvey, 2002; Michaelides and Wainwright, 2002; Hooke, 2003).

In an idealised river system, residence times for sediment storage increase in a downstream direction, ranging from transient ephemeral storage features such as bars to more permanent sinks such as floodplains (Meade, 1982). Amongst the many factors that influence sensitivity to reworking of alluvial sediment storage units are the type of store, the volume and calibre of materials stored, vegetation cover and distance from the channel (Brown, 1987; Brunsden, 1993a). Connectivity, defined as the transfer of energy and matter between two landscape compartments or within a system as a whole (Chorley and Kennedy, 1971), must be maintained through the system if inputs from headwater

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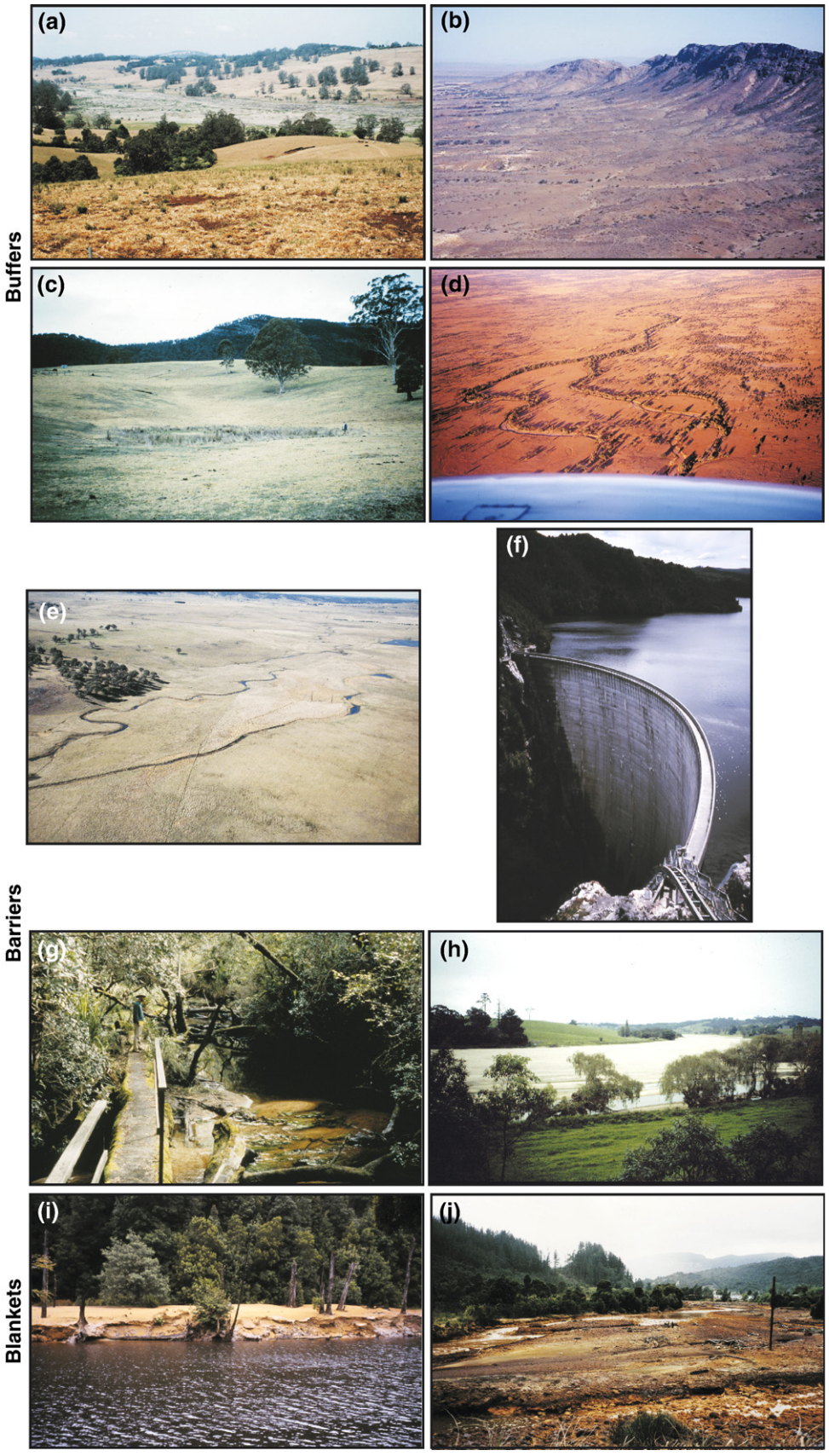
Buffers
(a)
(b)
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Barriers
(g)
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Blankets
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