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Contextualising the trajectory of geomorphic river recovery with environmental history to support river management

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ABSTRACT

Geomorphic river recovery is driven and constrained by physical and social conditions and processes, or boundary conditions. Approaches to river rehabilitation that aim to enhance recovery processes require knowledge of these boundary conditions and a river's evolutionary trajectory in order to develop appropriate river management strategies. We draw on a case study from southeast Australia to demonstrate the value of trajectory analysis to understand and support river recovery. Environmental history and geomorphic interpretation are used to contextualise river recovery thus far and to generate possible future trajectories of river adjustment (recovery or degradation). These trajectories are represented on a river recovery diagram, which forms the basis for discussion of opportunities to support recognition, assistance and communication of river recovery in any setting. This approach addresses physical and social constraints on river recovery through analysis of physical boundary conditions and river behaviour, coupled with a dynamic social context and concerns for effective communication between scientists, river management practitioners and community members.

1. Introduction

River rehabilitation can be an expensive exercise. Given the diversity and complexity of river systems, prioritisation and targeting of actions are key to any effective and efficient river management strategy (Beechie, Pess, Pollock, Ruckelshaus, & Roni, 2009; Hobbs & Kristjanson, 2003). In place of hard-engineering solutions to river management problems, in many parts of the world, approaches to river rehabilitation that 'work with nature' and aim to 'enhance recovery' are gaining momentum because of their relatively lower cost and consideration of reach and catchment characteristics (Brierley et al., 2002, 2011; Dufour & Piégay, 2009; Environment Agency, 2017; Fryirs and Brierley, 2000, 2001; Graf, 2001; Gurnell et al., 2016; Piégay et al., 2008; Rutherfurd, Jerie, & Marsh, 1999; Scorpio et al., 2015; Surian, Ziliani, Comiti, Lenzi, & Mao, 2009; Wohl, Lane, & Wilcox, 2015; Yu, Huang, Wang, Brierley, & Zhang, 2012; Ziliani & Surian, 2016). The term 'river recovery' is used here to describe the adjustment processes by which rivers improve their geomorphic condition after disturbance, and 'recovery-enhancement' describes approaches to river management and on-ground rehabilitation that aim to support rivers in recovering from disturbance rather than imposing fixed boundaries to river adjustment (Fryirs & Brierley, 2000).

1.1. What do we need to know?

Supporting and enhancing geomorphic river recovery requires place-specific understandings of the constraints – or boundary conditions – within which rivers adjust over time. Geomorphology is fundamentally important for understanding physical boundary conditions because it provides the adjustable 'physical template' upon which hydrological and ecological processes operate (Brierley & Fryirs, 2008; Fryirs, 2015; Newson, 2002). The potential for rivers to adjust is constrained by both imposed and flux boundary conditions (Fryirs & Brierley, 2013). Whereas imposed boundary conditions such as valley confinement and climate may be generally stable over geomorphic timescales, flux boundary conditions such as sediment type and volume, flow regime and vegetation cover are more temporally and spatially variable, and may be altered by disturbance events, such as floods or human interventions (Brierley & Fryirs, 2005; Phillips & Van Dyke, 2016). If flux boundary conditions are altered, a river's capacity for adjustment may be altered, either constraining or expanding the possible range of behaviours, geomorphic units and associated ecosystems (Brierley & Fryirs, 2016; Fryirs, 2017; Poff, Bledsoe, & Cuhaciyan, 2006; Richards, Brasington, & Hughes, 2002).

Rivers are inherently dynamic systems, usefully understood in terms of a dynamic range of variability rather than stasis (Fryirs, Brierley, &

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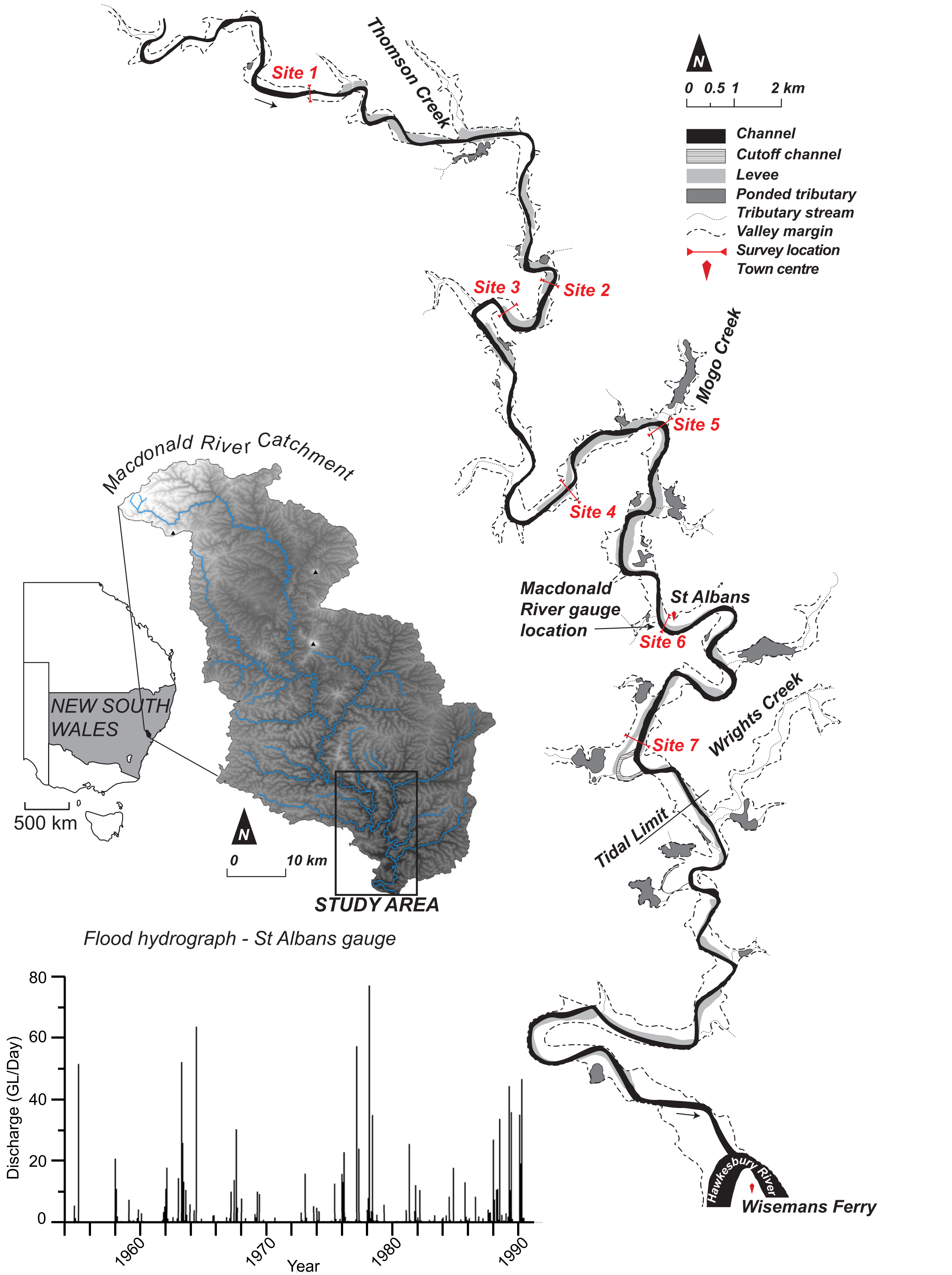

Fig. 1. The study reach of the Macdonald River. Note locations of transect sites used for topographic surveys and stream power modelling. The St Albans river gauge (Number 061353 – Bureau of Meteorology) was installed after the 1949-55 floods (data acquired from NSW Office of Water PINNENA database).