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Ecological destabilisation of alluvial wet monsoon rainforest primarily through hydro-geomorphic feedbacks and secondarily through fire in tropical northern Australia

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Isolated patches of wet monsoon forest within a eucalyptus-savanna dominated landscape are present within many springs and alluvial valleys in the Australian Monsoon Tropics (AMT). Using combined field evidence, lidar, and remote sensing data, we observe the ongoing and potentially irreversible destruction of wet monsoon forest downstream of Wangi Waterfalls in Litchfield National Park through hydro-geomorphic feedbacks accompanying the retreat of an alluvial knickpoint. This knickpoint retreat leads to a downstream drop in in-channel water level, which in turn drives a drop in the local groundwater table in a highly transmissive shallow aquifer. This drop in groundwater level causes the shallow anabranches and the formerly water saturated peat floodplain surface to dry out, which results in a reduction in vegetation density. These dry surface conditions then allow the monsoon forest to burn during annual to bi-annual low-intensity bush fires; while wet rainforest remaining upstream of the knickpoint are unlikely to burn. In this paper, we show that hydro-geomorphic feedbacks provide the initial destabilization, with fire able to then take advantage of the resulting environmental conditions. We challenge the prevalent view that fire has first order control in the extension of these ecosystems and show that this is more likely to be second order, since the wet monsoon forest is already diminishing regardless of fire, although fire certainly accelerates its decline. The distribution of remaining wet monsoon forest is therefore strongly dependent on the local hydrological conditions, and less on the frequency of fire.