



## **Impact of flooding on rangeland condition in low-gradient multi-channel river systems of the Flinders River Catchment**

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### **Abstract**

Across northern Australia's rangelands, riverine flooding has long-lasting impacts on landscape health, function, and productivity. This PhD project aims to improve understanding of the factors influencing the impact of flooding on rangeland condition in low-gradient, multi-channel river systems. The project focuses on the Flinders River catchment, north-west Queensland, Australia. Using on-ground and remote sensing data, the project will: (i) develop a hydrologically conditioned high-resolution digital elevation model (DEM) for enhanced flood modelling; (ii) simulate flood events using hydrodynamic modelling; (iii) determine the impact of flooding on rangeland condition; and (iv) identify the key factors influencing post-flood rangeland condition recovery. The research will provide valuable new insights into flood impact and recovery to inform land management, flood mitigation, and conservation practices, supporting long-term rangeland health and resilience.

### **Introduction**

Australia's northern rangelands cover over 1.2 million square kilometres, including parts of Western Australia, Northern Territory, and Queensland (Russell-Smith and Sangha 2018). These rangelands provide multiple critical ecosystem services, including food production, cultural and recreational values, habitat for wildlife, water and nutrient cycling, and carbon sequestration and storage (Brown and MacLeod 2017). In northern Australia, as is the case globally, the health and function of rangelands are under increasing pressure from the combined effects of climate change and extreme climate events, invasive species, altered fire regimes, land use conversion and poor grazing land management (McKeon et al. 2004; Boone et al. 2018).

The frequency and intensity of floods has increased globally due to climate change, deforestation, poor land management, population growth, and overgrazing (Power and Callaghan 2016; Huda et al. 2022). This trend is projected to worsen, resulting in escalating flood losses and economic impacts (Taguchi et al. 2022). In northern Australia, climate change is expected to intensify floods and prolong droughts (Ghofrani et al. 2016; State of Queensland 2019a; IPCC 2023). The impacts of floods on rangeland condition in northern Australia, however, are not well quantified, and the interplay between flooding and other factors influencing rangeland recovery remains poorly understood.

Flooding in northern Australia's rangelands is a recurring hazard with significant social, economic and environmental implications (Nafari et al. 2016; McLean 2022). The 2019 Flinders River flood, for example, inundated approximately 13 million hectares (Figure 1). The flood event, coupled with an extreme wind chill event, resulted in the death of over 450,000 head of cattle, caused widespread infrastructure damage, and had long-lasting impacts on community well-being (Phelps 2019).

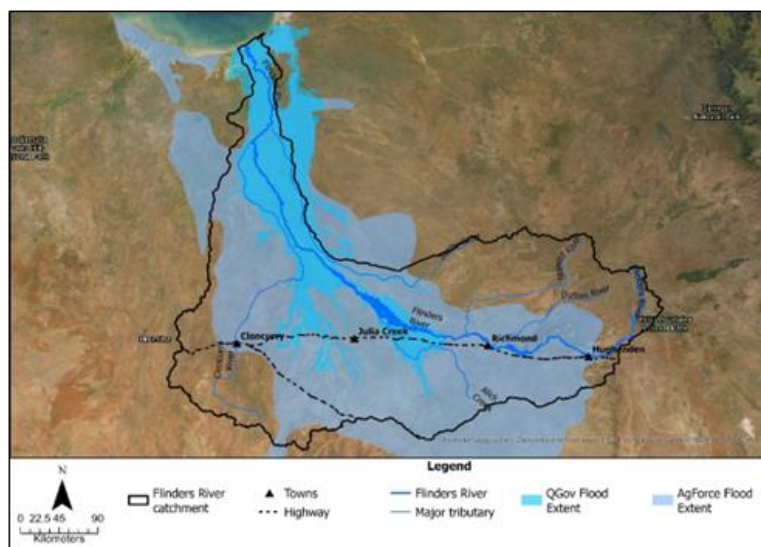


Figure 1. Inundation extent of the flood zone as mapped by the State of Queensland (2019b) and AgForce Queensland (2019).

The flood event also had severe impacts on the health and functioning of the region's sensitive natural assets (Figure 2), including widespread soil erosion, native vegetation and pasture die-back, as well as reduced water quality and availability (Hall, 2019).



Figure 2. (A) Dead Mitchell grass tussocks in a heavily washed area; (B) pedestalling of Mitchell Grass tussocks; and (C) silt deposition.

In low-gradient, multichannel systems such as the Flinders River catchment, intricate drainage networks, channel morphology and floodplain topography influence water and sediment distribution during flood events (Sockness and Gran 2021; Jacobson et al. 2022; Dawson and Lewin 2023; Shukla et al. 2024). To fully understand the flood impacts in these rangeland ecosystems, reliable flood mapping and modelling is essential. Although recent advances in satellite technology offer opportunities for developing high-resolution elevation models to improve flood modelling, gaps in coverage due to dense vegetation and clouds, and lack of sufficient details in elevation remain the main challenges for accurate flood extent mapping, especially in data-scarce low-gradient multichannel systems (Jarihani et al. 2015; Peramuna et al. 2023; Cohen et al. 2024).

This PhD project seeks to address the identified knowledge and information gaps and provide stakeholders and policymakers with the necessary information to inform decisions on effective flood management strategies, supporting land recovery and resilience in the Flinders River catchment and rangeland systems more broadly.

### Methods

This study will collect data from primary sources, including on-ground elevation measurements and land condition assessments, as well as secondary sources such as Digital Elevation Models (DEMs), satellite images, and climate and hydrology information. To enhance flood mapping and modelling in the Flinders River catchment (Figure 3), the conventional 30-m DEM will be optimised by integrating higher resolution DEMs with on-ground Real-Time Kinematic GPS measurements. The optimised DEM will be utilised alongside satellite imagery to analyse flood characteristics and simulate flood events using advanced hydrological software (e.g., SWAT, HEC-RAS) integrated with Geographic Information Systems. These flood models will serve as inputs for assessing the impact of flooding on rangeland condition through ground cover change analysis before and after flood events. This assessment leverages on-ground land condition evaluations and satellite imagery and employs spatial regression models to reveal the dynamics of ecosystem resilience and recovery following flooding events.

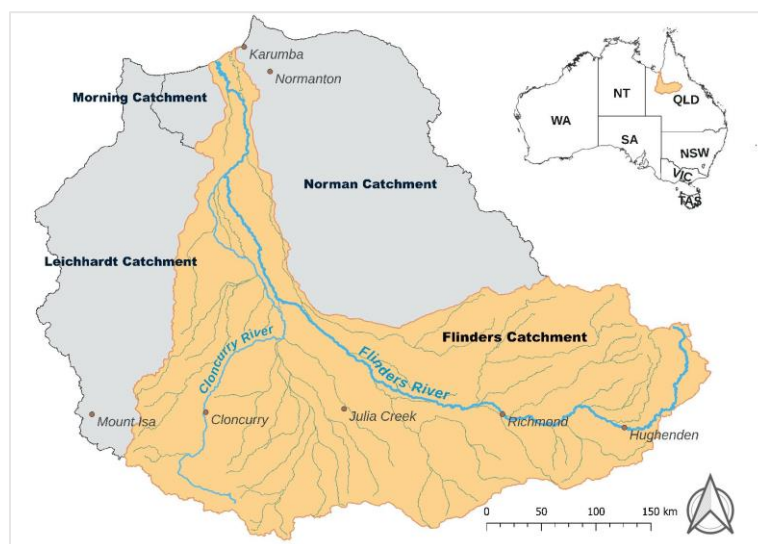


Figure 3: The Flinders River Catchment

### Result and Discussion

The project is in early stages of development and as yet, no results have been obtained.

The proposed research will enhance fundamental scientific understanding of the impact of flooding on rangeland systems in low-gradient multichannel catchments. The detailed assessment of flood impacts on land condition in the Flinders River catchment will provide valuable insights into landscape resilience and the factors that affect recovery of rangeland condition after extreme floods. Detailed information on floods and how they affect rangeland condition will enable better prediction and help mitigate the destructive outcomes of future flood events. The project will also enhance the accuracy of flood modelling and prediction tools by capturing the complexities of flooding in low-gradient multi-channel systems. In general, the outcomes of this research will provide stakeholders and decision-makers with the necessary information and data to make well-informed decisions about land management strategies in a way that will promote both flood mitigation and rangeland conservation across the Flinders catchment and beyond.

### Expected outputs

The expected outputs of the research are:

- A hydrologically conditioned high-resolution DEM for enhanced flood modelling in low-gradient multichannel systems.
- Comprehensive flood maps and models for the Flinders River catchment.
- Detailed assessment reports on the impact of flooding on rangeland condition.
- Insights into the key factors influencing post-flood recovery of rangelands in the Flinders River catchment.

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