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Impact of drought and flood on land condition across Mitchell Grass Downs rangelands

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Abstract

The late January/early February 2019 north-west Queensland flood and associated wind chill event had a devastating impact on the grazing industry and local communities, causing high stock mortality, infrastructure damage, and business disruption. Rangeland condition was also severely impacted by the flood. In some areas, severe erosion stripped away soil, including nutrients and seed bank, while in other areas, soil deposition smothered pasture. Prolonged floodwater inundation (up to two weeks) in low-lying areas also contributed to pasture death. The impacts of the flood were exacerbated by a prolonged drought which impacted the region in the six years prior to the flood, and in the three years following the flood. This project sought to assess land condition recovery on Mitchell Grass Downs rangelands five years on from the flood. In late February and early March 2019 (soon after the floodwaters receded), on-ground land condition assessments were completed at 130 sites across the region. In September 2024, land condition assessments were repeated at 62 of the original sites. In 2024, land condition: improved at least one condition score at 30 sites (48%); remained the same at 29 sites (47%); and declined at least one condition score at 3 sites (5%). Results indicate that land that is maintained in good condition is more resilient to the impacts of extreme weather events (both drought and flood) and recovers more quickly after the event. The observed improvement in land condition at many sites was supported by strategic grazing land management and above average rainfall in recent years. In this region, droughts and floods are likely to increase in frequency and severity. It is critical that we improve understanding of the linkages among drought, floods, grazing land management and land condition to assist producers to build greater resilience in their production systems.

Introduction

High interannual rainfall variability and extreme climate events (e.g., droughts and floods) naturally occur across northern Australia's rangelands (McKeon et al. 2004). In this region, it is common for periods of drought to be immediately followed by periods of intense rain and flooding. During drought, the landscape is most vulnerable to severe impacts associated with flooding, due to reduced surface cover and biomass. The interrelationship between drought and flood impacts on land condition are conceptually understood, but rarely quantified (Barendrecht et al. 2024).

The 2019 north-west Queensland flood, caused by a monsoonal depression, was a particularly significant event. In late January and early February 2019, the Flinders River catchment had 10 consecutive days of widespread heavy rainfall. Julia Creek Airport (Bureau Station 29058), for example, recorded 571 mm over the event, with a maximum daily total of 229 mm. The rainfall event, unprecedented since records started (in the early 1900s), triggered widespread flooding, estimated to cover over 13 million ha (AgForce Queensland 2019). The flood affected area had been in drought for the six years prior to the flood. The flood event, coupled with an extreme wind chill, resulted in the death of over 0.5 million livestock, and caused significant infrastructure damage (Phelps 2019). The flood event also had severe impacts on land condition with widespread soil erosion, soil deposition and pasture death (Hall 2020a,b). Anecdotal evidence from this and other events suggests that land that is maintained in good condition is less susceptible to severe impacts associated with extreme climatic events, and these landscapes recover faster (D. Phelps, pers. Comms). However, this is rarely quantified. In Northern Australia, predicted changes in climate include an increased frequency and severity of extreme climate events (State of Queensland 2019a). Such changes may exacerbate existing pastoral management challenges such as declines in pasture productivity, reduced forage quality, and additional livestock heat stress. An improved understanding of the interrelationships among grazing land management, climatic conditions and pasture responses are needed to help recommend management strategies that build landscape resilience to climate extremes and ensure long-term rangeland productivity.

Methods

The study is focused on Mitchell Grass Downs land types in the Richmond and Julia Creek areas, within the Flinders River catchment of north-west Queensland, Australia (Fig. 1). The study area has a hot semi-arid climate, with high rainfall seasonality. On average, the catchment receives 492 mm of rain per year, 88% of which falls during the wet season (December – March). The topography is relatively flat, intersected by multiple anabranching and ephemeral channels and creeks draining to the Flinders River. In late February and early March 2019, staff from the Queensland Department of Agriculture and Fisheries completed field land condition assessments at 130 sites across the region (Hall 2020a). The land condition assessment utilised the A, B, C, D framework (Karfs et al. 2009). In this framework, A represents the best condition, with good soil condition, high coverage of 3P (perennial, productive, palatable) grasses, and few weeds, while D represents the poorest condition. Sites were limited to land alongside a selection of major highways or secondary roads that could be accessed after the flood. All 3P grasses and seedlings were recorded, as well as annual grasses, legumes and weeds. In August 2020, the land condition assessment was repeated at most of the sites surveyed in 2019 (Hall 2020b). In September 2024, 62 of the original 130 sites were reassessed (Fig. 1).

Results

Out the 62 sites initially surveyed in 2019 and re-assessed in 2024, land condition: improved at least one condition score at 30 sites (48%); remained at the same condition score at 29 sites (47%); and declined at least one condition score at 3 sites (5%) (Table 1, Figure 1). Overall, where the pastures had been well managed during the six-year drought prior to the flood and the Mitchell grass tussocks retained at least 15 cm of basal stem, there was a higher proportion of plants surviving and regrowing within a month of the floodwaters receding. These plants are still surviving. Several sites that were assessed to be in C or D condition in 2019, have improved to a B condition in 2024 (Fig. 2A, B). Despite considerable soil loss during the flood event, enough seed bank remained at these sites to stimulate pasture re-establishment. Anecdotal evidence suggests such re-establishment has been supported by strategic grazing land management and above average rainfall in recent years. Conversely, despite receiving good wet season rainfall over the past two years, some sites have remained in C- or D condition (Fig. 2C), while nearby other properties have A and B condition Mitchell grass pastures. After the flood, tussock rhizomes were exposed at many sites due to severe wash, resulting in tussock death. In 2024, evidence of exposed tussocks still remains at most sites, but the surviving tussocks seem to be in relatively good health (Fig. 2D). The impact of the flood appeared to be more severe in lower parts of the undulating landscape where flow depths, velocities and periods of inundation are likely to have been higher than on the more elevated parts. The flood impact also appeared to be more severe closer to the main drainage channels, creeks and the Flinders River.

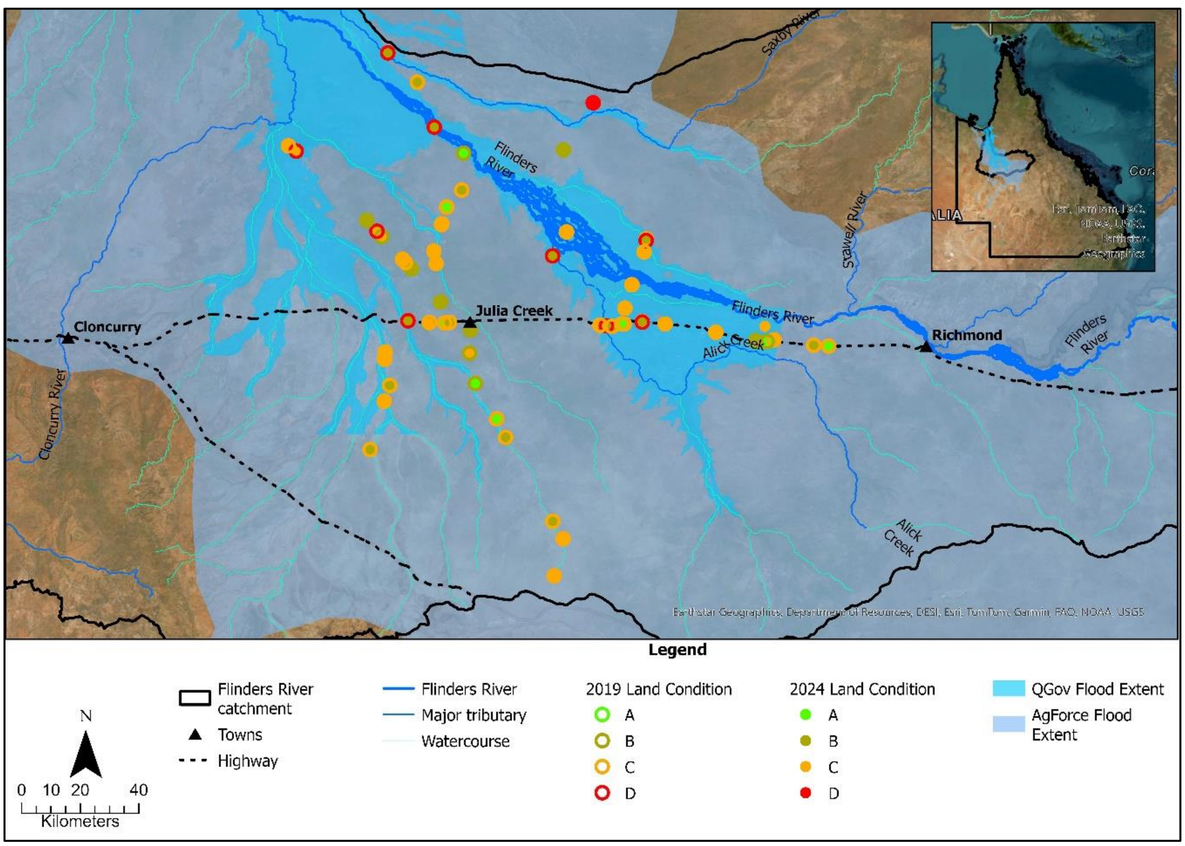

Figure 1. Map showing the change in land condition rating of sites surveyed in both 2019 and 2024, as well as extent of the flood zone as mapped by the State of Queensland (2019b) and AgForce Queensland (2019).

Rainfall across the study areas was average to below average in the six years prior to the late January/February 2019 flood and in the three years following the flood (Fig. 3). Well-above average rainfall occurred in 2022/23 and average rainfall occurred in 2023/24.

Table 1. Matrix showing the change in land condition rating of 62 sites assessed in 2019 and 2024.

	2024					
	Rating	D	C	B	A	Total
2019	D	1	3	7	0	11
	C	1	21	10	6	38
	B	0	2	7	4	13
	A	0	0	0	0	0
Total		2	26	24	10	62

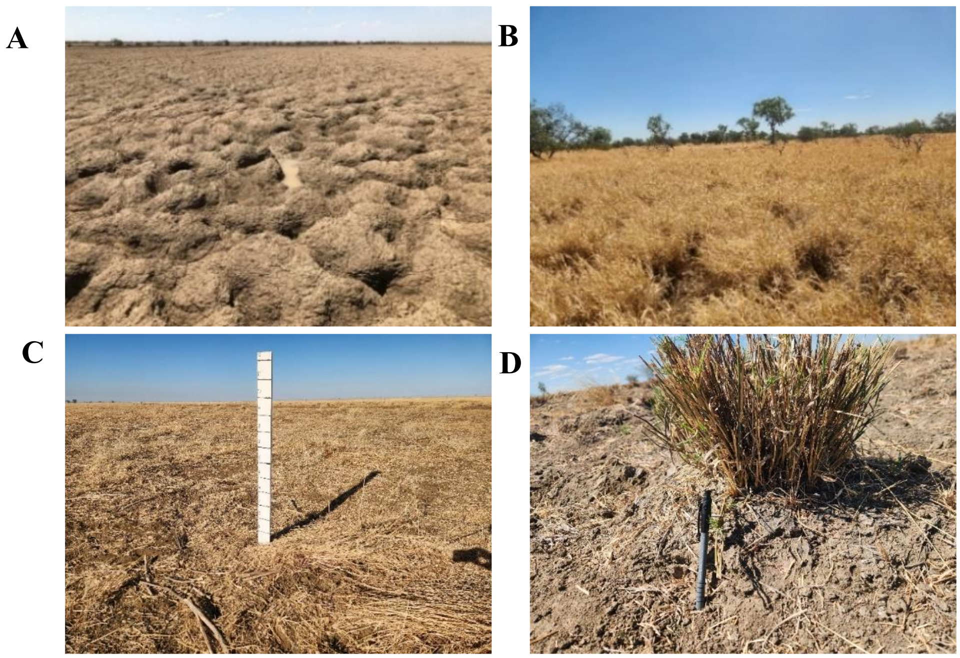

Figure 2. (A) Photo of a site that was in D condition in early March 2019 with complete loss of pasture cover and serious scouring. (B) Photo of the same site in September 2024. The site has recovered to B condition with high coverage of Mitchell grass. Note, the 2024 was taken closer to the treeline, visible in the 2019 photo. (C) Photo of a different site in 2024 that has remained in C- condition. (D) Photo of an exposed Mitchell Grass tussock in 2024.

Discussion

Across the Mitchell Grass Downs, a wide range of flood impact and recovery responses on land condition are evident. The variation in response can be linked to interactions among: (i) historical grazing management; (ii) the impact of the preceding long-term drought, combined with the grazing management imposed during this drought; (iii) the hydrodynamics (depth, velocity and duration of inundation) during the flood; (iv) grazing management following the flood; and (v) climate conditions following the flood. Overall, it is clear that land managed to remain in good condition (A or B), is much more resilient to severe impacts associated with extreme climate events (both drought and floods) and recovers more quickly. Continued monitoring at the assessed sites will enable long-term quantification of pasture recovery while accounting for seasonal climatic fluctuations. Further work is needed to better understand the role that soil type has in influencing flood impact and recovery. Further work is also needed to better model the hydrodynamics of floodwater in this low-gradient, multi-channel landscape.

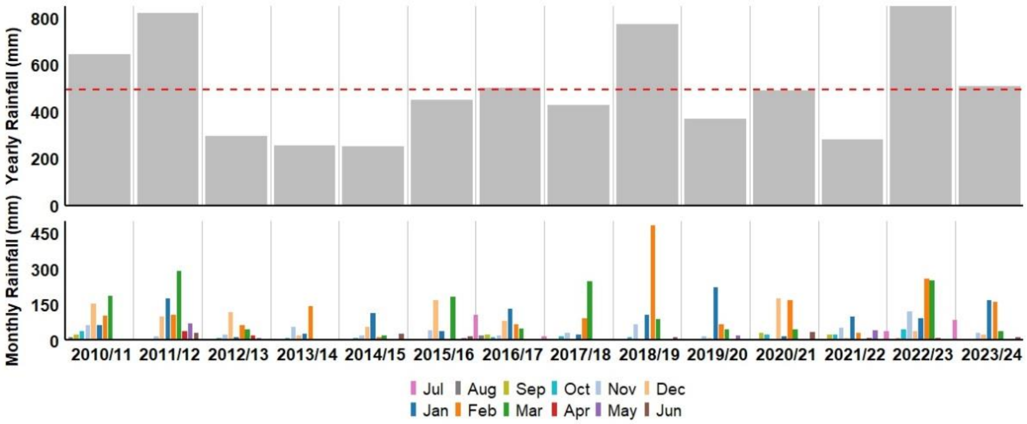

Figure 3. Monthly and yearly rainfall at Julia Creek. Annual rainfall is calculated as commencing on 1 July and ending on 30 June the following year to encapsulate a full wet season. The red dotted line shows the long-term (1888/89 – 2023/24) mean annual rainfall. Data source: State of Queensland (2024).

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