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Impacts of projected climate change on pasture growth and safe carrying capacities for 3 extensive grazing land regions in northern Australia

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Introduction

The northern beef industry is a major component of the regional economies of Queensland, Northern Territory and northern Western Australia, and has contributed an estimated $5 billion to Australia's economy in 2009-10. Projected climate change will have an adverse impact on Australia's agricultural production (McKeon et al. 2008), with an expected 3.5% decline in beef production in northern Australia by 2030 (Heyhoe et al. 2008). The GRASP pasture production model (McKeon et al. 2000) has been used to evaluate impacts of climate change in Australia's rangelands (Crimp et al. 2002; McKeon et al. 2008), with the positive effects of higher carbon dioxide (CO_2) on pasture growth likely to be offset by reductions in pasture productivity and digestibility due to lower rainfall and higher temperatures (Crimp et al. 2002). The impacts of 3 projected future climates on livestock carrying capacity of grazing lands in the Fitzroy, Maranoa-Balonne and Victoria River District regions were assessed using GRASP.

Methods

The impacts of future climates on moderately productive pastures in each of the Fitzroy, Maranoa-Balonne and Victoria River District (VRD) regions were simulated using GRASP over a 30-year period (1981−2010). Results are presented as percent changes in pasture growth and safe stocking rate relative to the current climate. Current climate files for 3 locations (Duaringa in Fitzroy, Mitchell in Maranoa-Balonne, Wave Hill in VRD) were obtained from Specialised Information for Land Owners (SILO) climate database. For each location, the Queensland Climate Change Centre of Excellence (QCCCE) provided climate data from 19 Global Circulation Models with 3 global sensitivities to rising greenhouse gases, that included a seasonal change factor for climate attributes, under 8 climate emission scenarios. Climate projections that represented the 90th percentile (High), 50th percentile (Median) and 10th percentile (Low) rainfall for an approximate 3 ^{o}C increase in maximum temperature were extracted from the QCCCE climate data. Selected climate projections were under A1F1 and A2 emission scenarios in 2050. The effects of CO_2 on plant growth (C4 warm season grasses) are represented in GRASP by varying parameters that increase the efficiency, with which plants use light, water and nitrogen resources at a specified CO_2 level (Stokes et al. 2012).

Results and Discussion

Variation in projected rainfall was the major driver of regional differences in projected impacts on pasture growth and carrying capacity. Declines in pasture production and carrying capacity of moderate productivity grazing lands were projected for all regions under the Low and Median rainfall future climates (Figure 1). Maranoa-Balonne was the most severely impacted region with pasture growth (6–79%) and safe stocking rates (14–60%) lower than current climate for all projected climates (Figure 1a). In the Fitzroy region (Figure 1b), even under the High future climate, projected pasture growth and safe stocking rates were at best on par with current climate. Only in the VRD, when annual rainfall was projected to be 20% higher than current climate (High), were projected pasture growth (9%) and stocking rates (11%) higher than those for the current climate (Figure 1c).

Projected seasonal rainfall for spring (50% lower than current climate) and autumn (40% higher than current climate) indicate a delayed start and finish to the wet

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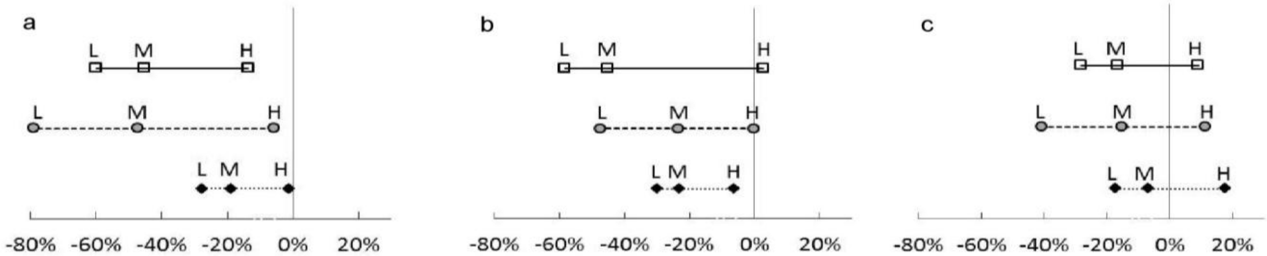

Figure 1. Percent change in projected rainfall (····◆····), pasture growth (– –●– –) and safe stocking rates (—□—) from current climate (0 in X axis) for High (H), Median (M) and Low (L) rainfall climate outcomes for: (a) Maranoa-Balonne; (b) Fitzroy; and (c) Victoria River District moderate productivity land types.

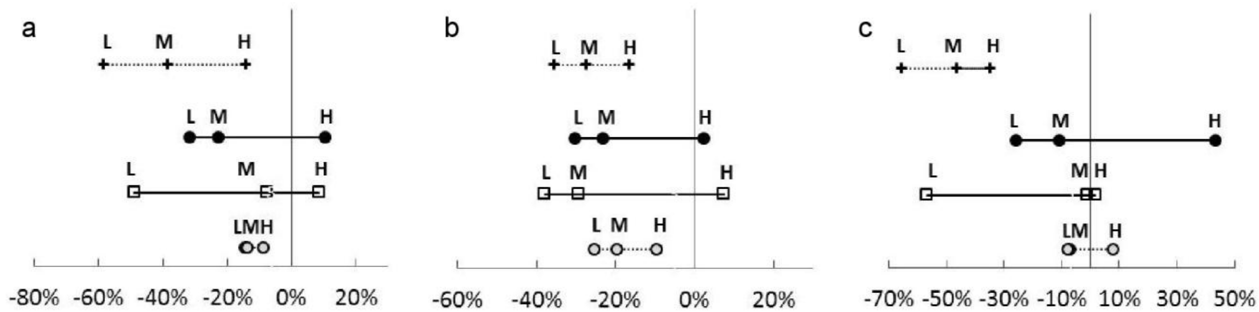

Figure 2. Percent change in projected mean monthly rainfall for Summer (···○···), Winter (—□—), Autumn (—●—) and Spring (···+···) from current climate (0 in X axis) for High (H), Median (M) and Low (L) rainfall climate outcomes for: (a) Maranoa-Balonne; (b) Fitzroy; and (c) Victoria River District moderate productivity land types.

season in VRD under the High future scenario (Figure 2c). Conversely, for both Maranoa-Balonne and Fitzroy regions, rainfall during summer was lower than current climate for all future climates (Figures 2a and 2b). In these regions, High projected rainfall was 10% less than current climate during the optimal pasture growing months. For this High rainfall outcome, the projected increases in rainfall (10%) occur within the cooler autumn/winter months, when light, temperature and moisture conditions are less conducive for C4 pasture growth.

Conclusion

Declines in pasture production and carrying capacity were projected for 3 extensive grazing regions in northern Australia under climate change scenarios. The positive effects of CO_2 fertilization on pasture growth, including improved water-use and nitrogen-use efficiencies, were offset by lower annual and seasonal rainfall. Grazing management practices, that include matching stocking rates to forage availability, maintaining land in good condition and resting pastures, will assist producers adapt to changing climate. Adjusting the timing and frequency of management practices (mustering, calving) and maintaining high tropical breed content of herds will assist producers adapt to extended late dry seasons. Managing pasture composition to match rainfall distribution of future climates will help ensure potential carrying capacities are achieved. Incorporating winter growing grasses (C3) into pastures in regions, where 25−50% of annual rainfall falls during cooler months, may achieve better pasture growth under higher rainfall future climates. In regions where nitrogen is limiting, the addition of legumes may facilitate better pasture growth under higher rainfall scenarios.

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