

Appendix 8: Frequency of wet and dry soil conditions in Tasmanian beef and sheep regions under future climate scenarios

Submitted for publication in the 53rd Annual Grasslands Society of Southern Australia (GSSA) Conference Proceedings; July 2012, Launceston, TAS, Australia.

Karen Christie¹, Richard Rawnsley¹ and Peter Ball²

¹ *Tasmanian Institute of Agriculture, University of Tasmania, Burnie, TAS, 7320*

² *Tasmanian Institute of Agriculture, University of Tasmania, New Town, TAS, 7008*

Introduction

Climate is an important driver of pasture production and the intra-annual variability in climate results in different patterns of pasture production which needs to be managed to meet feed demands on extensive livestock farm systems (beef and sheep farms). In recent decades, south eastern Australia has experienced a decline in total annual rainfall (Australian Bureau of Meteorology 2008), with the most substantial reduction occurring in autumn (Gallant *et al.* 2007). General Circulation Models (GCMs) provide the best estimates for assessing potential changes to the climate on a global scale however projections of climate change are not evenly distributed over the globe. This necessitates that local or regional climate projections are required to quantify local or regional climate impacts (Corney *et al.* 2010). The Climate Futures for Tasmania (CFT) project generated climate projections specific to Tasmania through a dynamical downscaling approach (Grose *et al.* 2010). This downscaling approach increased the spatial resolution from 2° to 3° grid cells (~200 to 300km) in the GCMs down to a 0.1° grid (~10km) for Tasmania, thus capturing regional and sub-regional differences allowing the projected climate change impacts to be quantified on a local scale (Corney *et al.* 2010).

Extended periods of both wet and dry soil conditions can strongly influence the managerial operations and productivity of a pasture based farming system. For example, extended periods of wet soil moisture conditions can result in significant pugging damage to pasture, erode the benefits of rotational grazing, reduce pasture growth, increase lameness and the incidence of footrot and foot abscess and other health challenges, add feed costs and incur remedial pasture management costs. Extended dry soil conditions can lower pasture production, live weight gain and wool quality, reduce pasture persistence, ground cover and increase erosion and weed ingress risk and require either reduced herd or flock size or increased reliance on purchased feed to meet animal dietary requirements. This study examined the changes in the frequency of wet and dry days per annum for two extensive agricultural regions of Tasmania out to the year 2090 using climate projection data from the CFT project.

Methods

Daily climate data developed from the CFT project (<https://dl.tpac.org.au/>) was accessed for Cressy (41.7°S, 147.1°E) and Ouse (42.5°S, 146.7°E). For both regions, six down-scaled A2 emissions scenario GCM files (CSIRO-Mk3.5, UKHad, ECHAM5, GFDL 2.0, GFDL 2.1 and MIROC3.2) were used, in combination with the Sustainable Grazing Systems (SGS) biophysical simulation tool (Johnson *et al.* 2003), to simulate a rain-fed perennial ryegrass pasture sward using a generic clay loam soil. The simulated soil moisture content to depth of 400mm was used as the criteria for determining number of wet (soil moisture > 160mm) and dry (soil moisture <120mm) days per annum. The number of wet days represents when the soil is above field capacity and the number of dry days represents the point where water in the soil profile is no longer readily available to the pasture sward, and evapotranspiration falls below its potential rate. The mean number of dry and wet days for each region, averaged across the six GCMs, was computed for the baseline period of years 1971 to 2000 and three future climate periods of years 2001 to 2030, 2031 to 2060 and 2061 to 2090.

Results

Annual rainfall

At Cressy, the mean annual rainfall, as an average of the six GCMs, was predicted to be 726 mm/annum during the baseline period and increase by 3.6, 4.3 and 7.7% during the periods of years 2001 to 2030, 2031 to 2060 and 2061 to 2090, respectively, when compared to the baseline period of years (Figure 1a). At Ouse, the mean annual rainfall, as an average of the six GCMs, was predicted to be 728 mm/annum during the baseline period and increase by 0.5, 2.6 and 4.5% during the periods of years 2001 to 2030, 2031 to 2060 and 2061 to 2090, respectively, when compared to the baseline period (Figure 1b). Most of the increase in annual rainfall occurred during summer and to a lesser extent in autumn, for both regions (data not shown).

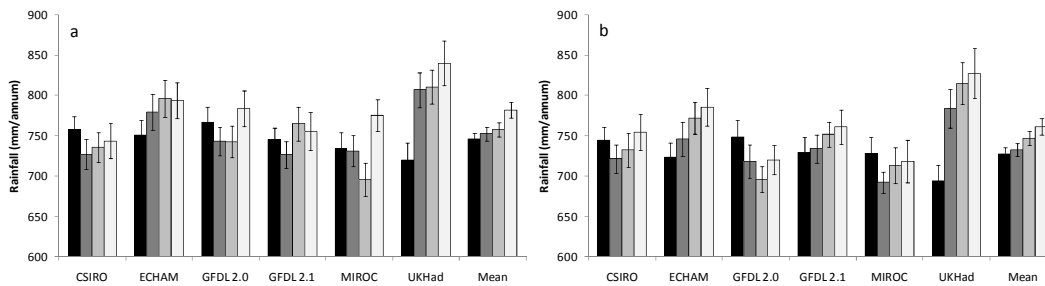


Figure 1. Mean annual rainfall for Cressy (a) and Ouse (b) for the climatic periods of years 1971 to 2000 (■), 2001 to 2030 (□), 2031 to 2060 (■) and 2061 to 2090 (□) according to six general circulation models (vertical bars indicate the standard error of the mean).

Wet days

The mean number of wet days per annum at Cressy, averaged over the six GCMs, was predicted to decline by 3.0, 3.7 and 2.8 days for the period of years 2001 to 2030, 2031 to 2060 and 2061 to 2090, respectively, when compared to the baseline period (Table 1). At Ouse, the mean number of wet days per annum, averaged over the six GCMs, was predicted to decline by 4.4 and 1.5 days for the period of years 2001 to 2030 and 2031 to 2060, respectively, when compared to the baseline period, before increasing by 0.1 days for the period of years 2061 to 2090 (Table 1). Each GCM predicted varying changes in the number of wet days per annum for three future climate periods. During the period of years 2001 to 2030, four of the six GCMs predicted a reduction in the number of wet days per annum compared to the baseline period for both locations (Table 1). The only exceptions were a predicted increase in the number of wet days per annum with the ECHAM5 and UKHad models at Cressy and with the GFDL2.1 and UKHad models at Ouse (Table 1).

Table 1. Mean number of wet days (soil moisture > 160mm) per annum for Cressy and Ouse using six general circulation models for a baseline period (years 1971 to 2000) and change in the mean number of wet days per annum for three future climate periods (years 2001 to 2030, 2031 to 2060 and 2061 to 2090) compared to the baseline period.

Region	General circulation model	1971 to 2000	2001 to 2030	2031 to 2060	2061 to 2090
Cressy	CSIRO-Mk3.5	64.3	-11.3	-11.0	-15.9
	ECHAM5	60.9	+3.3	+3.6	+2.3
	GFDL 2.0	66.1	-5.9	-6.1	-3.4

	GFDL 2.1	63.7	-8.9	+1.9	-9.1
	MIROC3.2	63.1	-5.9	-12.1	+5.0
	UKHad	62.5	+10.5	+1.4	+4.0
	Mean	63.4	-3.0	-3.7	-2.8
Ouse	CSIRO-Mk3.5	53.1	-12.0	-4.1	-8.9
	ECHAM5	49.8	-0.8	+2.1	+5.6
	GFDL 2.0	57.1	-11.4	-13.9	-15.3
	GFDL 2.1	46.1	+2.1	+5.2	+5.8
	MIROC3.2	51.4	-14.8	-11.9	-6.2
	UKHad	45.2	+10.7	+13.7	+19.5
	Mean	50.5	-4.4	-1.5	+0.1

Dry days

At Cressy, the mean number of dry days per annum, averaged over the six GCMs, was predicted to increase by 0.4 and 3.9 days for the period of years 2001 to 2030 and 2031 to 2060, respectively, before declining by 0.2 days for the period of years 2061 to 2090 when compared to the baseline period (Table 2). At Ouse, the mean number of dry days per annum, averaged over the six GCMs, was predicted to increase by 1.2 days during the period of years 2001 to 2030 before declining by 3.4 and 4.5 days during the period of years 2031 to 2060 and 2061 to 2090, respectively, when compared to the baseline period (Table 2). This decline in the mean number of dry days per annum at Ouse was mainly as a consequence of the GFDL2.1 and UKHad models predicting that the number of dry days would decline by between 14 and 27 days during the latter two periods when compared to the baseline period (Table 2).

Table 2. Mean annual number of dry days (soil moisture < 120mm) per annum for Cressy and Ouse using six general circulation models for a baseline period (years 1971 to 2000) and change in the number of dry days per annum for three future climate periods (years 2001 to 2030, 2031 to 2060 and 2061 to 2090) compared to the baseline period.

Region	General circulation model	1971 to 2000	2001 to 2030	2031 to 2060	2061 to 2090
Cressy	CSIRO-Mk3.5	204.3	+5.0	+18.9	+21.8
	ECHAM5	207.1	-10.5	-1.3	-9.7
	GFDL 2.0	204.5	+5.8	+6.3	+6.8
	GFDL 2.1	210.6	+9.2	-6.9	-3.4
	MIROC3.2	208.3	+6.3	+11.3	-9.2
	UKHad	214.6	-13.1	-4.6	-7.9
	Mean	208.2	+0.4	+3.9	-0.2
Ouse	CSIRO-Mk3.5	198.5	+8.6	+9.3	+10.8
	ECHAM5	201.0	+2.9	+0.2	-5.1

GFDL 2.0	204.7	+2.3	+3.5	+4.8
GFDL 2.1	208.6	-0.9	-13.5	-14.8
MIROC3.2	204.2	+15.5	+7.2	+2.8
UKHad	219.2	-21.3	-27.4	-25.3
Mean	206.0	+1.2	-3.4	-4.5

Discussion and conclusions

This study concluded that while there was substantial variation between GCMs, there is an indication that the mean number of wet days per annum at Cressy for all three future climate periods will decline. In contrast, the mean number of wet days was predicted to remain relatively similar at Ouse for the two latter periods of years (years 2031 to 2060 and 2061 to 2090) when compared to the baseline period. Managing extended wet periods could increase the need for improvements to on-farm drainage, the provision of feed pads, for sacrifice areas, for more consideration of topography and livestock class in the grazing/feed plan, flexible approaches to managing stock density aligned to triggers for action, and possibly consideration of pasture species more tolerant to water logging.

There was also substantial variation between GCMs in terms of the number of dry days per annum for both regions under the future climate scenarios. The mean number of dry days was predicted to increase at Cressy during the period of years 2031 to 2060. Interestingly the increase in rainfall during summer and autumn did not necessarily result in a reduction in the mean number of dry days per annum at Cressy, highlighting the importance of undertaking a biological assessment of future climate impacts through biophysical modelling and not relying exclusively on meteorological data. In contrast, the mean number of dry days was predicted to decline at Ouse, predominantly as a consequence of two of the six GCMs predicting a substantial decline in the number of dry days per annum and thus diluting the influence of the four other GCMs that predicted an increase in the mean number of dry days per annum. Managing extended dry periods could include the adoption of better adapted and deeper rooted pasture species into the feedbase, making provision for confinement feeding or the implementation of irrigation, especially given the relatively low mean annual rainfall for both regions.

References

- Australian Bureau of Meteorology (2008). Australian Climate Change and Variability. http://reg.bom.gov.au/climate/change/aus_cvac.shtml
- Corney SP, Katzeffey JJ, McGregor JL, Grose MR, Bennet JB, White CJ, Holz GK, Gaynor SM and Bindoff NL (2010). Climate Futures for Tasmania: climate modelling technical report. Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania.
- Gallant AJE, Hennessy KH and Risbey J (2007). Trends in rainfall indices for six Australian regions: 1910-2005. *Australian Meteorological Magazine* **56**, 223-239.
- Grose MR, Barnes-Keoghan I, Corney SP, White CJ, Holz GK, Bennett JB, Gaynor SM and Bindoff NL (2010). Climate Futures for Tasmania general climate impacts technical report. Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Tasmania.
- Johnson IR, Lodge GM, White RE (2003). The Sustainable Grazing Systems Pasture Model: Description, philosophy and application to the SGS national experiment. *Australian Journal of Experimental Agriculture* **43**, 711-728.

This study was supported by funding from Dairy Australia, Meat and Livestock Australia, Tasmanian Institute of Agriculture and the Australian Government Department of Agriculture, Fisheries and Forestry under its Australia's Farming Future Climate Change Research Program.