RANGELANDS
NRM CLUSTER

CLIMATE CHANGE IN AUSTRALIA
IMPACTS & ADAPTATION INFORMATION FOR AUSTRALIA'S NRM REGIONS

It's hot and getting hotter – executive summary
Australian rangelands and climate change

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http://www.climatechangeinaustralia.gov.au

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The Rangelands Cluster Project was a collaboration between the Rangelands NRM Alliance, CSIRO, University of Canberra and Ninti One. The Rangelands NRM Alliance represents seven NRM regions: Rangelands WA, Territory NRM, Alinytjara Wilurara NRM (SA), SA Arid Lands NRM, Desert Channels Qld, South West NRM (Qld) and Western Local Lands Services.

In 2012, the Australian Government established the regional Natural Resource Management Planning for Climate Change Fund, with the aim of improving the capacity of regional natural resource management (NRM) organisations to plan for climate change. The fund included regional-level planning support (Stream 1) as well as a series of research projects (Stream 2) to provide regional-level climate change information and projections. Stream 2 has been delivered via the National Projections Project and eight regional cluster projects (shown on the map below). The Rangelands Cluster is the largest of the clusters and includes seven NRM regions across five jurisdictions. To agree on priorities for information to support NRM planning across the rangelands, a range of consultation and engagement methods were used, including face-to-face meetings, workshops, surveys and establishment of a reference group and scientific advisory panel. Through these processes, a series of priorities were identified. Relevant information was gathered, collated and interpreted to produce a report on each topic.

This document is the executive summary from the compiled report, which is available at http://www.nintione.com.au/resource/ItsHotAndGettingHotter_Web.pdf. The URLs for the full reports are included under each section.

Climate projections – Rangelands

The projections for the rangelands in the report are based on the outputs of a set of 40 global climate models (GCMs) developed by Australian and international scientists. Climate models are based on established laws of physics and are rigorously tested for their ability to reproduce past climate. These projections draw on the full breadth of available data and peer-reviewed literature to provide a robust assessment of the potential future climate.

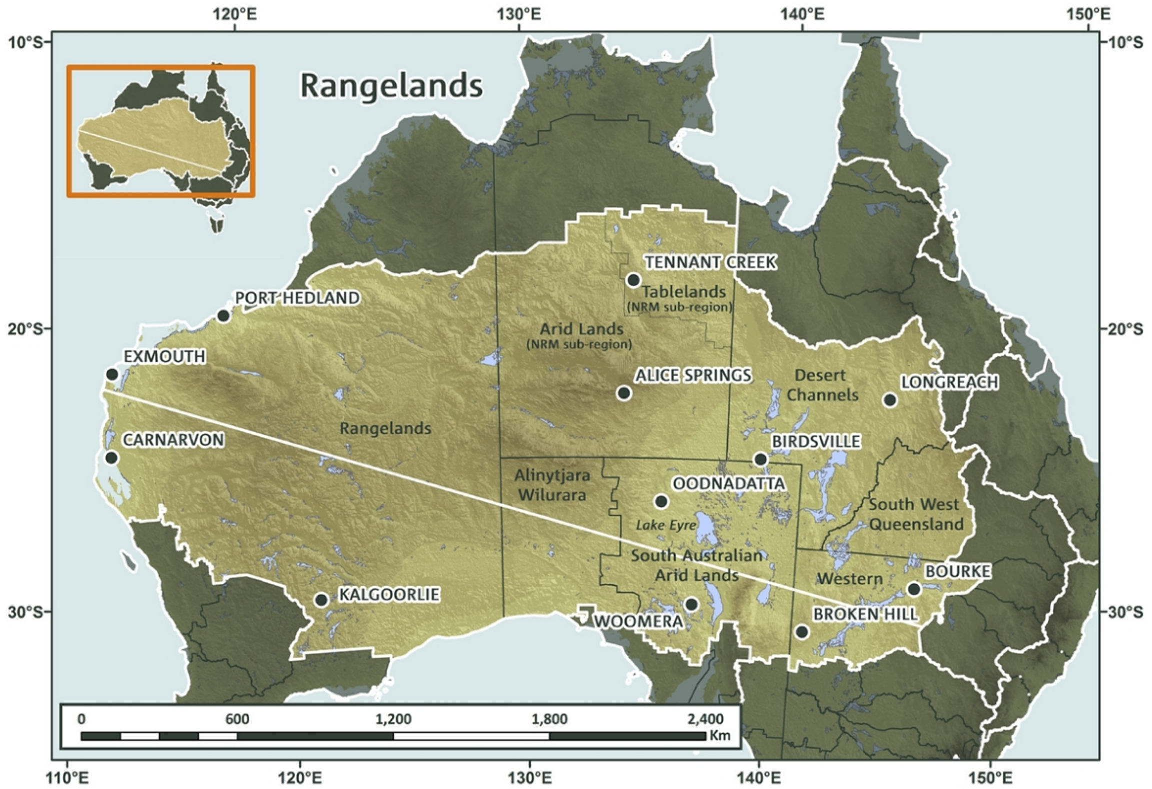
Rainfall systems in the cluster vary from seasonally reliable monsoonal influences in the far north through to very low and variable rainfall patterns in much of the centre and south. Given this, the Rangelands Cluster was divided into Rangelands North and Rangelands South subclusters for the projections work, as shown by the white line bisecting the Rangelands Cluster on the map below.

The table to the right is a summary of the predicted changes in a range of climate variables within the Rangelands Cluster region by 2090.

CLIMATE VARIABLE	PROJECTED CHANGE	CONFIDENCE
Temperature	Increase in all seasons	Very high
Extreme temperatures	Increase in hot days and warm spells Decrease in frosts	Very high High
Rainfall variability	Remain high	High
Extreme rainfall events	Increase in intensity	High
Winter and spring rainfall	A decrease in the south likely	High
Summer and autumn rainfall	Trend is unclear	
Drought	Increase over the course of the century	Medium
Potential evapo-transpiration	Increase in all seasons	High
Mean sea level	Continue to rise	Very high
Height of extreme sea-level events	Increase	Very high

Website

http://www.climatechangeinaustralia.gov.au/en/regional-climate-change-explorer/super-clusters/?current=RA



Rainfall variability and pasture growth

From a biological perspective, sequences of rainfall can be treated as events, defined here as one or more closely spaced rainfalls that are large enough to produce a significant vegetation response.

For this analysis, >25 mm of rain over consecutive wet days is considered the minimum requirement for pasture growth to occur across much of the Rangelands Cluster region, and a >50 mm event over the same period should provide ideal growing conditions – particularly where grazed land is maintained in good condition. There are exceptions, of course, to this general guide. Smaller events (e.g. as low as 10 mm) may be effective in cooler weather and for specific locations and vegetation types (e.g. new leaf growth in chenopod shrublands on the Nullarbor Plain). At the other end of the scale, degraded rangeland may respond minimally to >50 mm events.

The frequency of probable past pasture growth events based on daily rainfall gives some indication of what lies ahead for the Rangelands Cluster region under the climate change projection of continuing high natural variability in rainfall.

Findings

- The last 60 years of rainfall data show that periods of rainfall suitable for marginal to ideal growing conditions were infrequent throughout much of the Rangelands Cluster region. The median return period (in days) between >25 mm and >50 mm events lengthens for locations with lower and more variable annual rainfall – that is, to the south (Port Augusta, Cook, Kalgoorlie) and towards the more arid interior (Coober Pedy, Marree, Birdsville, Oodnadatta).
- The median return period for >50 mm events is close to one year for the more arid parts of the cluster region.
- Given the highly episodic nature of rainfall across inland Australia, no trends in return period for specific rainfall amounts were detected.
- As part of this work, a template spreadsheet for users to calculate their own return-period statistics for any rainfall amount and location where historic daily rainfall data are available was developed. This tool summarises periods of continuous daily rainfall; it cannot calculate rainfall intensity. The URL is http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_RainfallVariabilityPastureGrowth_RainfallTemplate.xlsx.
- The reported probabilities are unlikely to improve under forecast continuing rainfall variability. Projected temperature increases will increase soil moisture losses through greater evaporation and evapotranspiration. This will mean that smaller continuous daily rainfalls (>10 and >25 mm events) will be less effective for pasture growth, particularly during hotter weather. At such times, even >50 mm events that are well separated in time may become marginal for effective growth.

Suggested adaptation responses

- A continuing cautious approach to stocking levels should be taken, as well as strict control of total grazing pressure and increased drought preparedness.

Full report

http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_RainfallVariabilityAndPastureGrowth.pdf

Meteorological drought

Drought is a complex phenomenon with mixed environmental, social and economic implications.

This report includes the recent history (since 1950) of meteorological drought, which is characterised by severe rainfall deficiency over periods of 12 months or more. Spatially interpolated rainfall data since 1950 were examined to determine the timing and severity of rainfall deficits as an indicator of meteorological drought.

Findings

- For most regions, the longest and most severe rainfall deficit occurred in the late 1950s, extending to the mid-1960s. Other periods of general rainfall deficiency occurred in the early 1980s and the mid-2000s. Deficits also occurred in the 1950s, early 1970s and parts of the 1990s for some regions.
- This analysis of rainfall deficiency for the recent past should provide a guide to the probable severity of future meteorological droughts under continuing, and perhaps enhanced, rainfall variability. Drought will continue to be a recurrent feature in the Rangelands Cluster region.

Suggested adaptation responses

- The key adaptation response for the pastoral industry is simply to be prepared: utilise reliable climate forecasting services and implement drought management strategies promptly as key dates or trigger points for decision-making are reached.

Full report

http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_MeteorologicalDrought.pdf

Heatwaves

Heatwaves are continuous periods beyond a week when the threshold temperature (either 36° or 40°C) was exceeded.

Findings

- Recent decadal patterns in the number of summer days exceeding a threshold daily maximum temperature and the number and length of heatwaves were observed. Temperature data were sourced from the Bureau of Meteorology for 16 towns in (or on the edge of) the Rangelands Cluster.
- Most towns in the region have had more hot days and heatwaves, and longer heatwaves, in the recent past, particularly during the first decade of this century. This pattern is consistent with projected hotter temperatures as part of climate change. More recent contributing factors also included low humidity, cloudless days and increased reflected and transmitted heat from areas with low ground cover associated with protracted and widespread drought conditions during much of the 2000s.
- The trend in heatwave conditions appears to be moderated for northern urban centres (Longreach, Mount Isa and Tennant Creek; not so for Newman). Here, the summer monsoon probably has a moderating effect on extreme maximum daily temperatures (i.e. periods of cloud cover, higher humidity, variable rainfall and increased ground cover).
- It is hot and getting hotter – the regional projections report advises that the Rangelands Cluster region has warmed at a rate of 0.05–0.15°C per decade since 1911.

Suggested adaptation responses

- The recent experience of many rangelands communities in coping with increasing summer temperatures provides some foundation for adjusting to what is projected to come. This acknowledged, there will still be a considerable requirement for further adjustment and adaptation for humans, stock and wildlife. Vulnerability frameworks may assist communities in this process.

Full report

http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_Heatwaves.pdf

Remotely sensed ground cover

Targets specifying the maintenance of minimum levels of ground cover are a common feature of regional NRM plans. Setting realistic targets for broadly different land types within each region is a challenge. Targets should be set and reviewed with climate variability, and change, in mind.

National remote sensing capability now means that fractional cover derived from 500 m MODIS imagery, extending back to late 2000, is available. The bare soil component of fractional cover can potentially assist in setting, monitoring and reviewing regional cover targets. Knowing how amounts of bare soil have varied under recent climate variability, fire regime and grazing management provide some basis for specifying appropriate targets for broadly different land types under continuing rainfall variability and possible long-term change.

Findings

- Fractional cover images for mid-March and mid-September 2001–2013 were analysed to determine how the percentage area of bioregions within NRM regions varied for different threshold levels of bare soil. Threshold values of bare soil within 25 ha MODIS pixels were ≥0.7, ≥0.6, ≥0.5, ≥0.4 and ≥0.3. The mid-March date represents likely maximal yearly bare soil in the southern part of the Rangelands Cluster, and the mid-September date is its equivalent in the central and northern parts of the cluster.
- Using the former NSW Western CMA as an example, the analysis suggests that threshold levels of allowable bare soil should vary with land type (e.g. bioregion). A blanket target for an entire NRM region is not appropriate, particularly where mean annual rainfall, soil and vegetation type vary spatially within the region. Maximum allowable levels of bare soil should be lower in areas receiving higher or more reliable rainfall and where more perennial vegetation should be present. Conversely, more bare soil is permitted in arid parts of the Rangelands Cluster and where predominantly annual vegetation naturally occurs.
- Maximum threshold levels of bare soil have been nominated for major bioregions within all NRM regions of the Rangelands Cluster.

Suggested adaptation responses

- Reviewing ground cover targets periodically, as they may need to be adjusted under continuing climate variability and projected change.
- Strategies such as patch burning to reduce extensive wildfire, improved grazing land management and control of feral herbivores should increase vegetation cover in most years.

Full report

http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_RemotelySensedGroundCover.pdf

Fire

Fire is extensive and common in northern Australia, particularly the tropical savanna. In the Rangelands Cluster region, extensive wildfire is more common in the spinifex-dominant deserts and following two or more years of above-average rainfall.

Findings

- Analysis of the recent fire record available from satellite-based fire-scar mapping can provide useful context for predicting what may occur under climate change. Data supplied to the Australian Collaborative Rangelands Information System (ACRIS) by WA Landgate is used to describe the 2011 and 2012 fire regime (extent and frequency) for bioregions within Rangelands Cluster NRM regions.
- It is anticipated that fire regimes in the Rangelands Cluster region will be modified by climate change in three main ways:
  - Although annual rainfall will continue to be highly variable, a greater summer component may increase grass biomass and thereby fire risk, particularly following extended wetter periods.
  - Warmer temperatures will extend the meteorological fire season and greatly increase fire danger following successive wetter years. Within the fire season, increased periods of very high temperature and low humidity will increase periods of potential very high fire danger. This may translate to widespread intense wildfire where fuel loads are sufficient, ignition occurs and there is limited capacity to implement prior strategic controlled burning and other fuel-reduction practices to reduce this risk.
  - The predicted continued spread and thickening of buffel grass will exacerbate this risk.
- Buffel grass can greatly change the fire regime at local scale: it increases fuel loads, responds readily to fire disturbance and has the capacity to make local environments in which it thrives much more fire-prone.

Suggested adaptation responses

- The key adaptation response for fire in the rangelands is to use all available climate information to plan and manage to reduce the risk of wildfire.

Full report

http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_Fire.pdf

Cenchrus ciliaris (buffel grass)

Buffel grass (*Cenchrus ciliaris*) is one of the most widespread exotic grasses in Australia. It is native to tropical Africa and Asia and has been planted widely in central, tropical and subtropical Australia as a pasture species. It has also naturalised throughout this range, invading areas reserved for nature conservation. This contentious species presents special challenges for determining the adaptation response to climate change, because it is both a threat and a beneficial species.

Findings

- Buffel grass has been shown to acclimate to higher temperatures and to maintain competitiveness and response to fire under increased CO_2, conditions expected under climate change.
- Distribution modelling and plant physiological studies indicate that the area where buffel grass is currently present will remain suitable under future climates, thus maintaining or increasing (due to loss of other palatable grasses) its importance for agriculture.
- Modelling the distribution of buffel grass indicates a southward spread in Australia by 2070. This represents a particular threat to the high value nature conservation areas such as the Great Western Woodlands, the Alinytjara Wilurara Natural Resources Management Region and the Great Victoria Desert bioregion.

- There is a risk that many plant species will not survive in a future climate that is hotter and drier. If buffel grass proves to have greater resilience than other plant species, then it might form the basis for a novel ecosystem. Research is needed into ways that buffel grass can be managed to maximise its value to other components of the ecosystem.
- Research is also needed into the genetic diversity in buffel grass with a view to identifying genotypes that are invasive and/or suitable for pasture improvement under climate change.

Suggested adaptation responses

- Containment strategies for buffel grass are required for high value environmental assets, given that eradication will be impossible without considerable resources. Likewise, control is likely to be very difficult, if not impossible, in areas where the plant is already widespread. This makes containment the best strategy for new infestations, given that reinvasion is highly likely.

Full report

http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_CenchrusCiliarisBuffelGrass.pdf

Dust

The level of dust in the air is related to ground cover and provides an indicator of wind erosion rate, although the amount of dust observed is influenced by several factors (e.g. actual weather conditions, soil type, vegetation type and amount of ground cover).
Visibility as affected by atmospheric dust can indicate wind erosion rate, although actual weather conditions, soil type, vegetation type and amount of ground cover are also important.

Findings

- There have been some dramatic year-to-year changes in dust activity in the recent past, particularly between 2009 (when there was substantial dust in the atmosphere) and 2010 (minimal atmospheric dust). These changes were mainly associated with rainfall, that is, improved seasonal quality in 2010.
- In the recent past (1992–2010) within the Rangelands Cluster region, most dust appeared to emanate from within the more arid parts of the Lake Eyre Basin (particularly the Simpson–Strzelecki Dunefields and Channel Country bioregions) extending west into central Australia (the MacDonnell Ranges), north into the Mitchell Grass Downs and Mount Isa Inlier bioregions, east and south-east into the Mulga Lands and Riverina and south into the Gawler bioregion (SA Arid Lands). The WA Rangelands were less active as a dust source.
- Griffith University uses a Dust Storm Index (DSI) to report wind erosion activity across Australia. The index is based on historic visibility data recorded by Bureau of Meteorology observers. DSI maps indicate the likely sources of dust and their levels over time.
- It is probable that the domains and magnitudes of recent dust activity in drought periods will recur with continuing climate variability, particularly rainfall. Increased frequency and intensity of heatwaves and lower humidity may also contribute to increased dust.

Suggested adaptation responses

- Atmospheric dust provides a local- to regional-scale indicator of the effectiveness of grazing management in pastoral country and the recent fire regime in spinifex deserts. Land managers should endeavour to maintain critical levels of ground cover so as to minimise soil and nutrient loss via dust resulting from wind erosion in dry times.

Full report

http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_Dust.pdf

Aquatic refugia

Refugia are defined as habitats that biota retreat to, persist in and potentially expand from under changing environmental conditions. Different types of refugia are important for different species over differing spatial and temporal scales. Two major types of refugial habitats are recognised: evolutionary refugia and ecological refuges.
Findings

- Evolutionary refugia are defined as those waterbodies that contain short-range endemics (species that occur only within a very small area) or vicariant relicts (species with ancestral characteristics that have become geographically isolated over time). Although these species often have very small geographical ranges, their populations are relatively stable and high levels of genetic diversity are present. All aquatic evolutionary refugia in the NRM Rangelands Cluster regions are groundwater-dependent ecosystems. Evolutionary refugia are most likely to persist into the future and should be accorded the highest priority in NRM adaptation planning.
- Ecological refugia are defined according to the water requirements of the species they protect. Obligate aquatic organisms (fishes and some aquatic invertebrates that can only disperse via water) need perennial (permanent) aquatic habitats, or closely located near-perennial habitats, to ensure persistence. In contrast, important ecological refugia for waterbirds are the large temporary or ephemeral freshwater lakes and salt lakes that hold water after infrequent but large episodic rainfall events. The conservation significance of ecological refugia, and the priority assigned to their conservation, depends on the level of knowledge available for the species they support.
- The indirect effects of climate change, particularly an increase in human demands for water (for direct consumption and production of food, fibre and energy), are likely to have greater impacts than direct climatic effects. Excessive groundwater drawdown will destroy spring-based evolutionary refugia, and the construction of surface water impoundments will destroy the aquatic connectivity essential for the persistence of riverine waterholes as ecological refugia. The existing adverse impacts of livestock, feral herbivores, invasive fishes, exotic plants, recreation and tourism must also be managed.
- Tools for NRM adaptation planning provided in this report include a list of priority aquatic refugia (sites likely to act as future refugia) and a decision support tree. The latter will aid the identification of major types of waterbodies and the refugia they provide, vulnerability assessments and development of management responses to address direct and indirect climate impacts and other stressors. A site register of important rangelands aquatic refugia is provided at http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_AquaticRefugia_RegisterAquaticRefugia.zip. This is regarded as a living register that should be updated as more information becomes available.

Suggested adaptation responses

- The NRM Rangelands Cluster region is highly water-limited, and all water (surface and groundwater) in the region is environmentally, culturally and economically important. Given that water scarcity is likely to continue under all climate change scenarios, the identification, management and restoration of aquatic refugia is a critical adaptation strategy for rangelands ecosystems and the biota they support.

Full report

http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_AquaticRefugia.pdf

Native species

Australia supports a unique and globally significant diversity of plants and animals. An important component of this diversity occurs within the Rangelands Cluster region.

Findings

- Macro-ecological modelling indicates that the impacts of climate change will vary across biological groups and, for a number of these groups, will be greater in some regions of the Rangelands Cluster.
- The three groups that will be most impacted by climate change are plants, snails and reptiles; impacts on mammals will be moderate, whereas impacts on birds and frogs will be low.
- Future climate refugia are modelled to occur in the MacDonnell and Central Ranges (NT Arid Lands subregion, WA Rangelands and Alinytjara Wilurara regions), the Channel Country (Desert Channels and SA Arid Lands regions), Mount Isa Inlier (Desert Channels region), the Gibson Desert, the Pilbara (both WA Rangelands), the Nullarbor (WA Rangelands and Alinytjara Wilurara regions) and parts of inland Queensland and NSW (Western Local Land Services and South West Queensland regions).

Suggested adaptation responses

- Adaption options require careful assessment of the relevant species, but may take the form of one of the following management options: in-situ management, facilitate responses of wild populations, ex-situ management, and monitoring and research to improve understanding and predict what may happen.

Full report

http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_NativeSpecies.pdf

Invasive animals

The invasive animals having the most impact and considered the greatest management concern in the Australia rangelands include large herbivores, mammalian carnivores and the cane toad.
The ten species of significant vertebrate pest in the Rangelands Cluster region are considered in this report: feral goat, one-humped camel, feral horse/brumby, feral donkey, feral pig, red fox, feral domestic cat, dingo, European rabbit and cane toad.

Findings

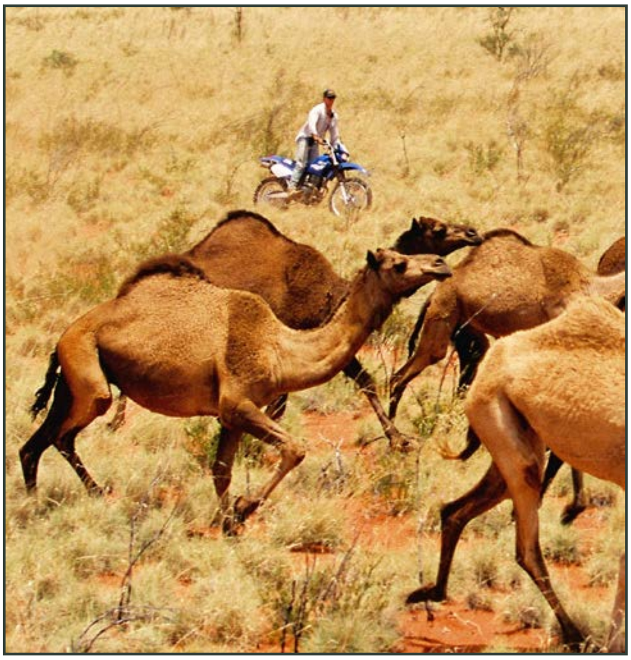
- Predicted changes in abundance and distribution with climate change indicate a decrease in the abundance and/or distribution of five species within the region (cat, goat, pig, rabbit and cane toad), with a further three species predicted to have stable abundance and distribution (camel, horse and donkey).
- Only two species, red fox and dingo, may show increased abundance and/or distribution in response to climate change.

Suggested adaptation responses

- Management recommendations in response to climate change are essentially to do more of the same. That is, to continue actively managing the species and their impacts.

Full report

http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_InvasiveAnimals.pdf



Guidance to support adaptation

Rangelands have distinct ecologies and social systems, such that conventional approaches to climate adaptation may not always work in these remote areas.

Findings

- Rangelands researchers have developed a unique framework tailored to remote areas.
- The approach brings together two different sides to adaptation, vulnerability reduction and enhancing resilience in a single coordinated framework. Rangelands populations tend to think long term – and this is exactly the approach put forward in the remote area framework – using some types of management strategies to 'buy time' while other types of strategies are coming into effect.
- This framework is illustrated with case studies drawing on past research, including research about human responses to heatwaves, to show how different strategies for reducing vulnerability and building resilience can be combined over time (Maru et al. 2014). The framework is also considered in relation to buffel grass management.
- The approach balances resilience and vulnerability reduction and draws on the existing capacity of rangelands residents.

Full report

http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_GuidanceToSupportAdaptation.pdf

Pastoral production and adaptation

Grazing of livestock is the most extensive land use in the Rangelands Cluster region. Projected changes in climate will impact the future ways in which pastoralism occurs and adaptations will be required, both at enterprise scale and regionally.

Findings

- A linked vulnerability and resilience framework was used to illustrate how the range of available pastoral adaptations might best be implemented across the different NRM regions in the Rangelands Cluster.
- Among the climate change projections, hotter maximum temperatures and associated heatwaves, continuing highly variable rainfall and the probable occurrence of both more frequent drought and intense rainfall are considered the most adverse factors affecting future pastoralism.
- Good practical examples and appropriate technical advice are available to guide required short- to medium-timeframe adaptation responses to continuing rainfall variability and recurrent drought (e.g. out to about 2030). Longer term adaptation may require a fundamentally more conservative approach to stocking rates, adjusting stocking rates as local pasture productivity changes and increasing the robustness of pastures by encouraging regeneration of palatable perennial forage (where possible). Repairing formerly productive, but now degraded, country may also have increased prominence as maximising rain use efficiency becomes more important through increased evaporation and reduced soil water availability.

- Hotter maximum temperatures and increased frequency and duration of heatwaves will place greater emphasis on human safety and wellbeing and animal welfare (particularly when stock is being handled). Both aspects may need to be more formally recognised and planned as part of routine station management.
- Longer periods of hotter weather will also require increased robustness in stock water supply. There will be a reduced safety margin around existing supplies as livestock consume more water in such periods. Repairs following failure will become more time critical, and human occupational health and safety will also be paramount when attempting repairs to failed water infrastructure during heatwaves.
- Increased rainfall intensity has the potential to damage station infrastructure and increase erosion. The latter can be partly mitigated by maintaining minimum critical levels of ground cover on the most vulnerable soil types. Reducing the actual and financial risk of infrastructure damage may require its relocation to less vulnerable areas, a degree of over-engineering (by present-day standards) and increased use of insurance.
- Higher temperatures negatively affect pasture growth by reducing the efficiency with which plants use water, but this will be partly offset by the beneficial effects of rising atmospheric CO_2 on pasture. Tropical and subtropical grasses with the C_4 photosynthetic pathway are likely to expand ranges southward at the expense of existing C_3 grasses. The digestibility and nutritive value of pastures are likely to decline from the combined effects of rising temperatures, increasing CO_2 and increases in C_4 grasses, so overall animal production may decrease. This can be alleviated for cattle by introducing/increasing *Bos indicus* genetics and increased use of nutritional supplements. C_4 grasses are more flammable, and more extensive and frequent fires that burn hotter may result.

Suggested adaptation responses

- It is anticipated that both gradual and transformational adaptation responses are required to suitably respond to likely climate change impacts on pastoral land.
- Appropriate transformational change will probably require a fundamental shift in the current thinking (paradigm) about how rangelands are managed towards a more conservative risk-based approach to the use of natural resources. This will be a gradual process that requires facilitation, structural change and perhaps supporting legislation to achieve the best long-term outcomes for the pastoral industry and the natural resources on which grazing is based.
- It is unlikely that current best-management practices will remain so under projected climate change.

Full report

http://www.nintione.com.au/resource/AustralianRangelandsAndClimateChange_PastoralProduction.pdf

Adaptation User Guide–incorporating climate information into NRM planning

- Through the Rangelands Cluster Project, a considerable amount of rangelands specific climate information has been developed and made available to support NRM planning for climate change. One of the challenges is how to incorporate that information in planning and planning processes.
- It is recognised that for planning for climate change adaptation, we need relevant information, climate projections, potential adaptations and a process for incorporating information into planning, including identifying priority actions.
- A simple framework (shown below) has been developed to assist regional NRM organisations to work through the available information and the climate projections, identify likely impacts/risks and then identify priority actions.
- The framework is part of a simple process for use at NRM Board, NRM organisation/staff or community level to incorporate project information, and other information that may be accessible, into regional NRM planning process by supporting the development of priority actions.
- Users take information relevant to their region about the projected/likely climate impacts (as developed under the Rangelands Cluster Project) and populate the table with respect to each of the specific issues. This process helps identify priority actions for each issue.

To enable people planning for NRM in the rangelands to easily access relevant and current climate information, these reports have been collated into one document. Further information, including that prepared for other parts of Australia and tools to help communicate and understand climate change, is available at www.climatechangeinaustralia.gov.au.

Projected/likely climate impacts	Rainfall and pasture growth	Meteorological Drought	Heatwaves	Ground cover	Fire	Buffel grass	Dust	Aquatic refugia	Native species	Invasive animals	Pastoral production
Increased temperatures											
Increased extreme temperatures											
Increased rainfall variability											
Decreased winter rainfall											
Increased evapotranspiration											
Priority ACTIONS											

http://www.climatechangeinaustralia.gov.au
http://www.nintione.com.au