



Government of South Australia
Alinytjara Wilurara Natural Resources
Management Board



Climate Change Addendum



for the
Alinytjara Wilurara Regional Management Plan

June 2015

ISBN 978-1-921800-83-2



Australian Government

FINAL REPORT JUNE 2015

For the Alinytjara Wilurara Natural Resources Board Management Board

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Acknowledgements

This work has been financially supported through Stream 1 of the NRM Planning for Climate Change Fund of the Australian Government. The authors would like to thank the following contributors for their support: Aude Loisier and Neil Collins for their tireless work on the project and company on field trips; Parry Agius for his support and championing of the project and related work over 4 years; Garry Williams for his help on facilitating the workshops and translating, Laura Mitchell for support on APY workshops, Helen Donald for the editing and arrangement of this report; Leah Kyriacou and Adam Wood for help in spatial data provision; and the many Anangu elders and other community members who shared their valuable insights into their country and the changes they are seeing.

Climate Change Addendum for the Alinytjara Wilurara Regional Natural Resources Management Plan

Stream 1 of the Regional Natural Resources Management Planning for Climate Change Fund

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1. Introduction

This addendum supports the Alinytjara Wilurara (AW) Regional Natural Resource Management (NRM) Plan with the aim of informing climate change adaptation priorities across the region. The goal is to guide the spatial adaptation to climate change impacts on regional ecosystems, as well as to examine opportunities for carbon bio-sequestration (carbon farming) activities in the AW NRM region.

2. What's changed already?

The climate has already changed in Australia over the past century. In the AW NRM region, average temperatures have risen between 0.5°C and 1.5°C since 1910 (BoM and CSIRO 2014) at an average rate of 0.05-0.15°C per decade (Figure 1). The AW NRM region has also experienced a wetting trend in more recent decades, particularly in the north during summer months, possibly as a result of a strengthening of the summer monsoonal system in northern Australia (BoM and CSIRO 2014) (Figure 2).

Figure 1 Annual mean temperature changes across Australia since 1910. (AW NRM region shown in red outline; source: BoM and CSIRO 2014)

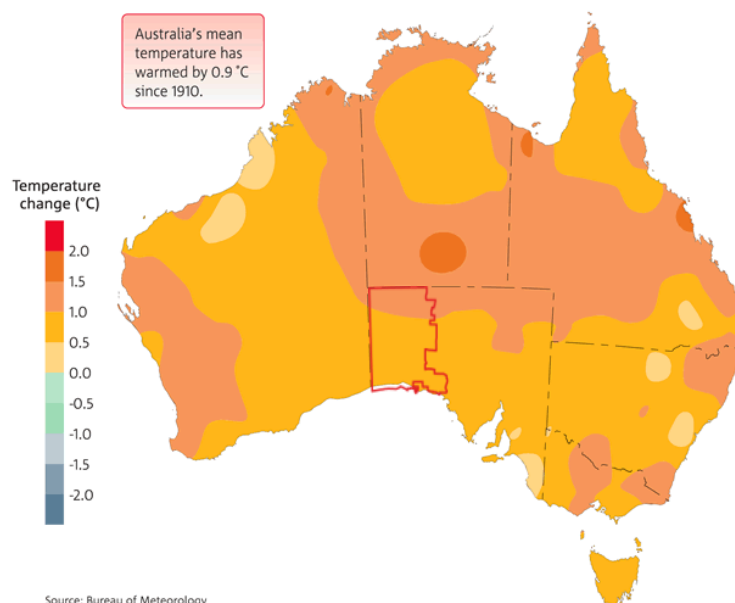
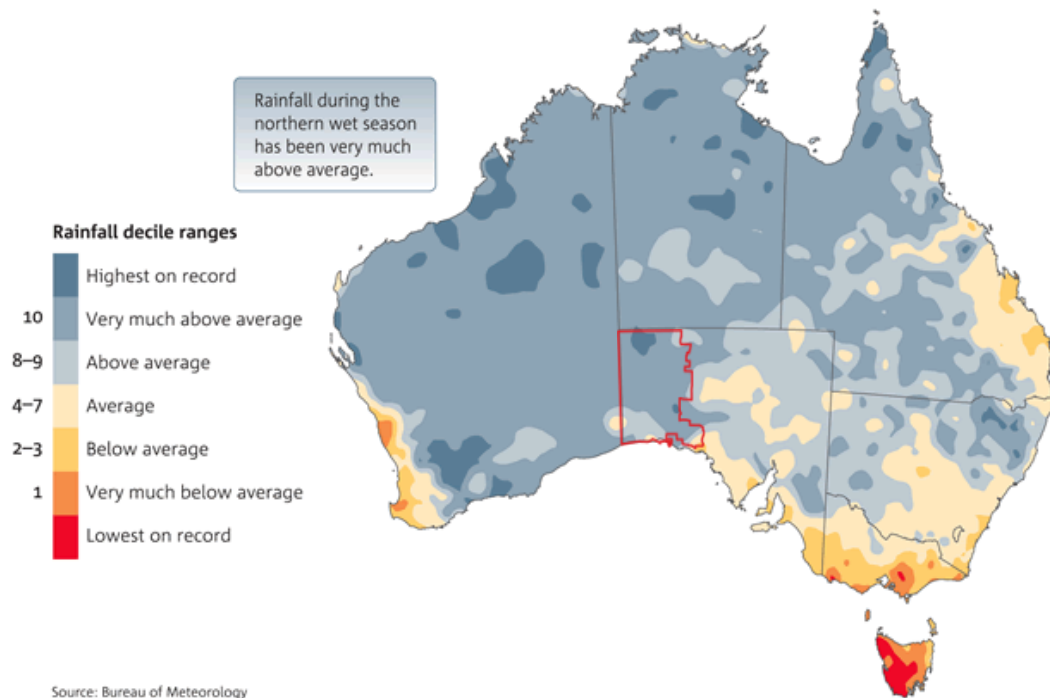


Figure 2 Northern wet season (October–April) rainfall deciles since 1995–96. A decile map shows the extent that rainfall is above average, average or below average for the specified period, in comparison with the entire national rainfall record from 1900. (AW NRM region shown in red outline; source: BoM and CSIRO 2014)



2. What about the future?

As part of Stream 2 of the Australian Government’s Regional NRM Planning for Climate Change Fund, CSIRO and BoM have developed new projections for the Australian Rangelands which are divided into two zones (Rangelands North and Rangelands South) spanning the AW NRM region (Figure 3; CSIRO 2014). The best estimates for future climate in the two zones display overall trends (Table 1). Stream 2 also provides detailed descriptions of climate change emissions scenarios, one representing a stabilised climate by 2100 (RCP4.5) and one representing little change in Greenhouse Gas emissions and no climate stabilisation (RCP8.5) for the two zones.

Figure 3 The AW NRM region, Stream 2 Rangelands zones, and seasonal rainfall dominance (red = summer dominant, blue = winter dominant)

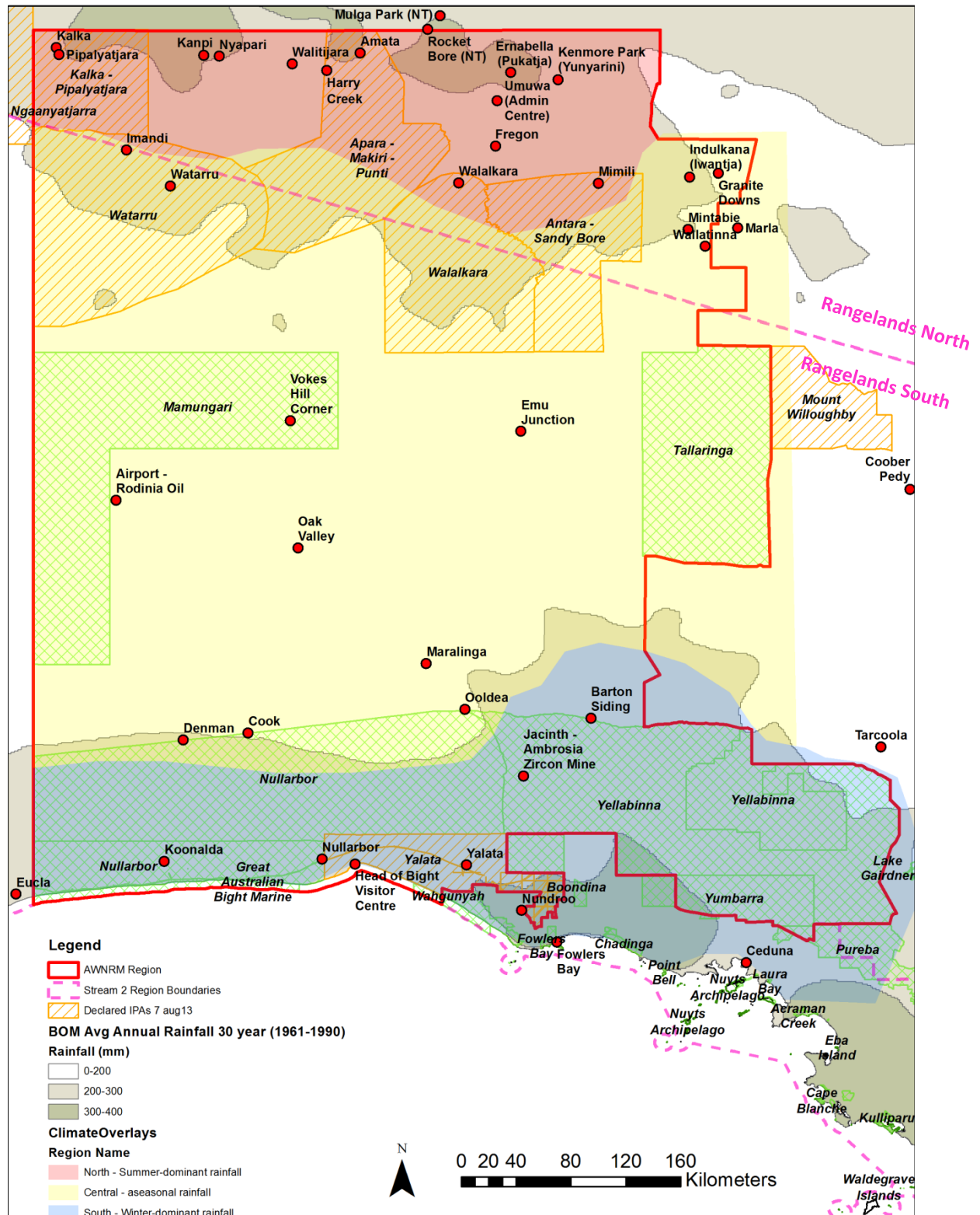


Table 1 Climate projections for North and South Zones developed from Stream 2 work (CSIRO 2014)

	Overall trend	Scenario	Variable	2030	2090
North	Hotter, possibly more regular large downpours in summer, but generally drier	Late century emissions stabilisation (RCP4.5)	Temperature:	Warmer	Hotter
			Rainfall:	Little change to drier	Drier (but with some uncertainty)
		High emissions (RCP8.5)	Temperature:	Warmer	Much hotter
			Rainfall:	Little change to wetter (but with large uncertainty)	Drier (but with large uncertainty)
South	Hotter, drier, rising sea levels along coast	Late century emissions stabilisation (RCP4.5)	Temperature:	Warmer	Hotter
			Rainfall:	Little change to drier	Drier (but with some uncertainty)
		High emissions (RCP8.5)	Temperature:	Warmer	Much hotter
			Rainfall:	Little change	Little change to much drier (but with large uncertainty)

Definitions

Temperature (annual average): Warmer: 0.5-1.5°C; Hotter: 1.5-3°C; Much hotter: > 3°C

Rainfall (annual average): Little change: -5 to 5%; drier: -15 to -5%; wetter: +5 to 15%; much drier < -15%

While there is little doubt that there is likely to be an ongoing warming trend for the AW NRM region, rainfall projections from CSIRO (Table 1) suggest that a drying trend is also likely for the region. Future rainfall trends are however, highly uncertain, particularly as average rainfall has been increasing across the region in recent decades (Figure 2).

3. Local Impacts and Concerns

The changes to climate will have significant impacts on ecosystems and communities within the AW NRM region. Given the large spatial extent of the region and lack of scientific baseline data, community knowledge on local current and future impacts is highly important. To accompany scientific projections therefore, local Aṅangu perceptions of climatic impacts and change were sought during workshops in 2011 and 2014 to inform priorities for future management and adaptation in the region. The community knowledge derived from the workshops is summarised into various themes in Table 2. Future work by AW will incorporate these opinions and concerns into climate change planning in all communities as part of the integrated Healthy Country Planning program.



Nathanael Wiseman consulting with Aṅangu elders at Nyapari

Table 2 Summary of current local community concerns and other observations, and likely future climate change impacts - see Technical Report (Wiseman and Bardsley 2014) for a more in-depth discussion of future impacts.

Themes	Yalata	Ernabella	Kenmore Park	Mimili (Lorna Dodd)	Kanpi-Nyapari	Amata	Kalka-Pipalyatjara	Watarru	Future climate change impacts
Dates of workshops	24/6/2014	21/7/2014 & 22/7/2014	23/7/2014		22/3/2011, & 24/7/2014	21/3/2011	23/3/2011	24/3/2011	
Buffel grass	Buffel grass has been observed in the community recently, and is spreading along road and rail lines	Buffel grass is damaging bushfoods – kangaroos don't eat it, it has harmed emu, malleefowl People are allergic to Buffel grass	Buffel grass is destroying native plants and bushfoods It is most widespread to the north of the community	Buffel in Victory Creek keeps spreading, despite attempts at control	When there is no Buffel they find small herbs and grasses, but Buffel destroys these plants which kangaroos and other animals eat. Buffel is around the community, but not yet established out on country as much	Buffel is widespread in the area	Buffel grass makes the kangaroos sick Buffel grass is pushing into spinifex country, and burning much hotter so nothing else grows	Buffel grass is mainly along the roads, not as much on country, and also around the community. Control measures such as burning and grading are failing to manage it. It has greatly increased the fire risk around the community	Buffel grass is unlikely to be controlled over large areas due to the high likelihood of reinvasion and suitability to a warmer, higher CO ₂ climate. It is likely to spread further south A warming trend with more variable rainfall is likely to make native ecosystems more vulnerable to invasion by Buffel grass
Fire management	A lack of shed tanks and other resources prevents adequate fire management, particularly in the north of the Yalata IPA	Firefighting resources and training are lacking, resulting in recent damage to infrastructure Prescribed burning needs more funding to adequately cover the region	While cattle control grass to some extent to prevent large wildfires, a fire has come very close to the community and was only stopped by a grader	Smoke from nearby recent wildfires has impacted on health in the community	There is not enough burning to reduce fuel loads Fire burns in the hills near Nyapari, but not so much near the community	Timing of burning is not always correct, with too little burning at times, and then too often Firebreaks are not maintained	Buffel grass is causing larger, hotter fires Control burning to prevent large wildfires is not happening as much as it did in the past	People aren't walking country as much anymore, so there is less traditional patch burning	Fire risk is likely to increase in a changing climate due to a combination of: hotter temperatures which extend the fire season and increase the number of extreme fire weather days; possible more summer rain in the north which would increase the amount of biomass and hence fuel loads, and the predicted spread of Buffel grass. The windows for controlled burning are likely to shorten

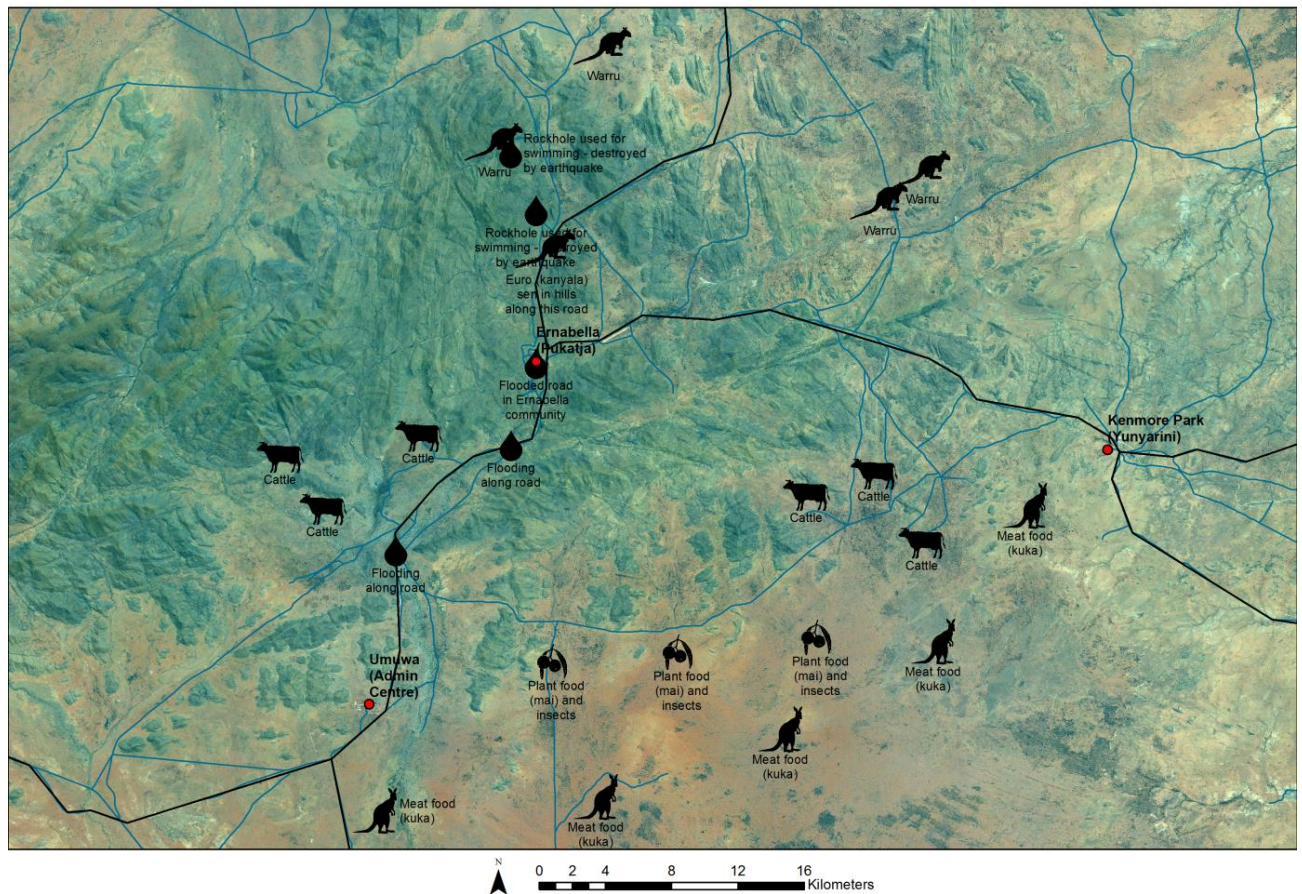
Themes	Yalata	Ernabella	Kenmore Park	Mimili (Lorna Dodd)	Kanpi-Nyapari	Amata	Kalka- Pipalyatjara	Watarru	Future climate change impacts
Grazing of livestock	There's been discussion about re-starting grazing on the old sheep stations but nothing has eventuated yet	Cattle are damaging ecosystems through overgrazing and spreading Buffel grass, and preventing fires being burnt to control Buffel	Land to the north, east and south of Kenmore Park is overgrazed by cattle – they are damaging country		-	Cattle with hard hooves are increasing wind erosion	-	-	Increasing temperatures and heatwaves and more variable rainfall will put increased pressure on stock and supporting resources (water, grazing land)
Bushfoods / biodiversity conservation	Kangaroos have been hunted out of the local area – people have to travel a long way to hunt them Wombats are still plentiful in the region	Kangaroos have gone far away. Wildfires, camels, cattle and Buffel have reduced bushfood availability in the region. Conservation priorities should be to the northeast where there are more trees and bushfood	The community wanted an IPA to the north but the country has been damaged too much by cattle. There are Quandong around but they need to be monitored for camel impacts People have to go a long way to hunt kangaroo –not many around now		There are only a few kangaroos around, compared with the old days. There are no emus left Quandong have been eaten by camels, a few plants in the ranges are still left	Kangaroo have disappeared from around the community Warru (black-footed rock wallaby), possums and other animals have been killed by cats, foxes and dingos	People have to travel 70-80km to find kangaroos to hunt There are only two warru in the hills behind the town, but lots of Euro	No kangaroos within 30km of town. Programs to provide artificial watering points for kangaroos, emu and other bushfood were supported, but there was no ongoing funding for them	The existing drivers of bushfood & biodiversity decline are likely to intensify with future climate change, as well as increases in heatwaves and more variable rainfall Climate change will change the timing of important seasonal events such as hibernation and flowering/fruiting
Heatwaves	Heatwaves have led to power failures in Yalata community, and the whole community has been evacuated to stay in a hotel due to blackouts in the past	The rockholes north of Ernabella are no longer able to be used for cooling down People migrate to Pt Augusta or Adelaide to escape the heat Recent heatwaves have killed kangaroos (51°C)	Air-conditioning failed during the last heat wave. Healthy people leave the community to somewhere cooler, but the sick people have to stay even when it's hot.	Mimili has a swimming pool which allows the community to cool down during heatwaves	Two years ago when it was very hot and not much water was left a lot of the animals died, birds, other animals and even camels The community can't swim during summer school holidays because teacher goes away	There have been more extreme heatwaves in recent years			Heatwaves are likely to get hotter, longer and more frequent

Themes	Yalata	Ernabella	Kenmore Park	Mimili (Lorna Dodd)	Kanpi-Nyapari	Amata	Kalka- Pipalyatjara	Watarru	Future climate change impacts
Water management	Yalata groundwater supplies are declining due to over-extraction	Recent floods washed the road away behind the store and damaged the clinic. Food had to be flown in. People in homelands were stuck and couldn't come back for weeks. Donkeys and camels drink and foul rockholes	Some roads were cut off during recent floods as the community is in a low-lying area Groundwater levels are dropping due over-extraction and use by cattle	Local rockholes appear to be stable even in drought years, however camels drink and foul the water	Flooding cut Nyapari off from the store at Kanpi – they had to drop food by helicopter	Flooding has had some impacts, with some roads being cut and eroded	Floods cut off the town, but didn't cause much damage. There wasn't a food truck delivery for 4 weeks and a plane couldn't land because the airstrip was underwater	Flooding cut off road access to the store, and supplies became very low Rockholes near the roads are maintained to hold water, but camels keep dying in the water and messing things up Many of the rockholes further away from the roads that elders knew about and used to manage aren't being maintained now	Larger downpours may increase aquifer recharge in the central ranges, but increasing temperatures will put increasing pressure on groundwater extraction to supply communities and stock, and for emergency fire-fighting Heavier rains will likely increase flood impacts
Feral animals	Foxes and cats are an issue, however dingos control them to some extent	200 camels entered the community a few years back. Horses and donkeys are a problem too. Cats and foxes eat small marsupials	Cats and foxes are destroying native animals	Significant number of camels and horses around the community	Camel mustering should happen to provide the community with an income The camels have been damaging water holes for a long time Foxes have been a problem, eating waru and birds	Camels and cats are the big problem, donkeys, rabbits, horses...Camels have been a big problem in the drought before 2011, damaging community infrastructure looking for water	Camels have caused significant damage to community infrastructure, as well as bushfoods such as quandong Camels need to be mustered or culled	Camels have damaged claypan vegetation by churning up the mud. They have killed all the quandongs in the local area	Large feral herbivores (camels, donkeys, and horses) as well as the red fox present the biggest threats as a result of climate change, with these species projected to either remain stable (feral herbivores) or increase in abundance (red fox) In contrast, rabbits, cats and goats are projected to decrease either in abundance or distribution

Themes	Yalata	Ernabella	Kenmore Park	Mimili (Lorna Dodd)	Kanpi-Nyapari	Amata	Kalka- Pipalyatjara	Watarru	Future climate change impacts
Coasts	<p>Storm surges have inundated low-lying campsites in the past</p> <p>Changing ocean currents and temperatures have led to unusual fish and other marine species appearing</p>								<p>Rising sea levels and associated storm surges will further threaten coastal camps</p> <p>Changing coastal patterns (e.g. wave direction, sea temperature, wind erosion) may change habitat suitability for species</p>

More detailed mapping activities were conducted with some communities to determine where problem areas existed. An example is shown in Figure 4, which depicts local concerns and places to protect for Ernabella community. These maps were used, in conjunction with other spatial data sets (e.g water assets, vegetation cover and fire scars), and research products from Stream 2, to establish short- and long-term adaptation priorities across the AW NRM region.

Figure 4 Ernabella community concerns and other observations



5. Adaptation options

Potential adaptation activities for the AW NRM region were developed to respond to local community concerns, as well as likely future threats from climate change, and are summarised in Table 3 and Figure 5 for the north and Table 4 and Figure 6 for the south. While adaptation responses have been grouped into themes, it is important to recognise the need for integrative, holistic approaches to adaptation rather than piecemeal efforts. Projects that combine several adaptation benefits, for example, integrated management of bushfoods or the protection of long-lived carbon assets, or those with far-reaching consequences, such as managing Buffel grass or increasing community resilience to extreme events, should be given priority over more spatially constrained or short-term activities.

Priority adaptation projects in the region include:

In the north:

- **Protection of long-lived carbon assets** in major drainage channels in APY (primarily Officer Creek catchment, but also around Mimili and Kanpi-Nyapari)
- **Designation of bushfood zones** in areas of high hunting, invasive species, fire or community pressures to reduce non-climatic pressures on native species within vital ecosystems
- **Integrated management of fire and Buffel grass along roads** as these represent the key areas of ignition and also the major sources of Buffel grass invasion
- **Adaptation to heatwaves**, for communities, stock and native species, particularly to ensure vulnerable community members are cared for
- **Managing flooding** by reducing risks to key infrastructure, and providing community reserves of fuel, food, and medicine
- **Developing seasonal calendars** as monitoring tools to track changes in flowering, breeding and other phenomena over time

In the south:

- **Protection of long-lived carbon assets** in the southern third of Mamungari CP and north of the Nullarbor Plain
- **Managing southward migration of Buffel grass** by concentrating control along major road and rail lines and in Yalata community
- **Reducing the risks of sea level rise** by relocating camp sites higher and further away from the shoreline
- **Adaptation to heatwaves**, for communities and native species, particularly to ensure vulnerable community members are cared for
- **Developing seasonal calendars** as monitoring tools to track changes in flowering, breeding and other phenomena over time

Adaptation activities in the following tables make a distinction between short-term actions to reduce specific vulnerabilities, and long-term actions to increase resilience (Measham 2014). Where relevant, adaptation responses are followed by bracketed notes, e.g. '(W1)' to indicate that they are supported by existing actions in current NRM Plan, using the numbering convention outlined in the Technical Report. Where no bracketed note exists, it indicates a new action not currently supported in the existing NRM Plan. The maps that follow the tables indicate large-scale adaptation responses at a sub-regional to regional scale – for finer-scaled responses, please refer to the Technical Report (Wiseman and Bardsley 2015).

Table 3 Summary of themes and adaptation responses in the North

	Buffel grass	Fire management	Heatwaves	Bushfoods	Water management	Livestock grazing	Feral animals	Biodiversity and Carbon
Current State	Buffel grass is widespread, and negatively impacting on important bushfoods and biodiversity	Fire regimes have changed dramatically since European colonisation, due to less traditional burning and introduction of Buffel grass Fire presents a significant risk to communities and infrastructure in the APY lands given the current lack of response capacity	Heatwaves are impacting on communities, particularly the elderly or sick who cannot easily leave the lands during the hotter months Blackouts are common under peak loads from air conditioning Recent heatwaves have negatively impacted on biodiversity	Bushfoods are declining due to a combination of Buffel grass invasion, over-hunting, feral animal competition and predation, and cattle grazing	Groundwater levels are already declining in some communities and pastoral stations due to over-extraction Rockholes are being over-exploited and damaged by feral camels Flooding has impacted on communities, damaging infrastructure and cutting off roads and access to food. People staying in homelands get cut off for weeks	Grazing is destroying bushfoods in some areas, as well as biodiversity Stock waters are drying up due to over-extraction	Feral animals, including camels, donkeys, horses, red foxes, rabbits and cats are causing significant environmental damage, including damage to bushfoods and sacred sites such as rockholes	Long-term decline in woody biomass (e.g. mulga woodlands) has been observed in parts of the AW NRM region due to changing fire regimes and introduction of feral herbivores Carbon planting is marginal in most of the region due to low rainfall, and frequent fire regimes which prevent long-term carbon accumulation
Future Issues with Climate Change	Buffel is unlikely to be controlled over large areas due to the high likelihood of reinvasion and suitability to a warmer, higher CO ₂ climate	Fire risk is likely to increase in a changing climate, due to a combination of hotter temperatures which extend the fire season and increase the number of extreme fire weather days, larger summer rains which will increase the amount of biomass and hence fuel loads, and the predicted spread of Buffel grass. The windows for controlled burning are likely to shorten	Heatwaves are likely to get hotter, longer and more frequent	The existing drivers of bushfood decline are likely to intensify with future climate change, as well as increases in heatwaves and more variable rainfall Climate change will change the timing of important seasonal events such as hibernation and flowering/fruitletting	Larger downpours may increase aquifer recharge in the central ranges, but increasing temperatures will put increase pressure on groundwater extraction to supply communities and stock, and for emergency fire management Heavier rains will likely increase flood impacts	Increasing temperatures and heatwaves and more variable rainfall will put increased pressure on stock and supporting resources (feed, water, grazing land)	Large feral herbivores (camels, donkeys, and horses) as well as the red fox present the biggest threats as a result of climate change, with these species projected to either remain stable (feral herbivores) or increase in abundance (red fox). In contrast, rabbits, cats and goats are projected to decrease either in abundance or distribution	The drivers of woodland decline are likely to intensify with climate change CFI activities present significant risks due to increased fire intensity and decreases in natural carbon sequestration rates due to hotter temperatures and increased fire frequencies

	Buffel grass	Fire management	Heatwaves	Bushfoods	Water management	Livestock grazing	Feral animals	Biodiversity and Carbon
Short-term adaptation priorities (bracketed notes, e.g. 'W1' indicate support of existing actions in current NRM Plan)	Roadside control of Buffel grass (C4) Prioritise control within major drainage lines and creeklines, working from upstream down (see Carbon and Biodiversity) Asset protection (built and natural assets) by prescribed burning, herbicide application, grading, or controlled grazing Monitor Buffel grass in the southern parts of Walalkara, Antara-Sandy Bore and Watarru IPAs	Concentrate fire management along major roads, as these are the highest sources of ignition. (C10) Increase prescribed burning around woodland vegetation (e.g. Desert Oaks between Amata and Kanpi, mulga woodlands in Watarru IPA, and along major drainage lines) (C10)	Have a record to check on vulnerable people in community Ensure access to air-conditioning and swimming pools during summer months Manage peak loads with spare generators or solar PV to prevent blackouts Ensure stock and mustered animals have access to adequate shade and water Provide alternative water points for native animals	Conduct patch burning to reinstate traditional fire serral mosaics, and monitor post-fire recovery of plants and animals (C10, C12) Manage feral animals to reduce competition and predation (C3)	Implement groundwater resource monitoring and develop alternative supplies for high risk communities, which include Amata, Ernabella, Kenmore Park and Fregon (W11, W15) Ensure rockholes are cleaned regularly to store maximum water Ensure timely maintenance of stock waters to prevent stock dehydration and stress Conduct audit of significant rockholes and other aquatic refuges using Davis' (2014) methodology, combined with cultural significance weighting, to determine a management priority list of surface water resources and groundwater dependant ecosystems, such as the major creeklines (C9, W3, W7, W21)	Conduct regular community-based monitoring of existing grazing photopoints (C2) Set and enforce stocking rates based on existing pasture coverage and quality Ensure shaded areas are available for stock to rest during heat waves to reduce stress Shade stock waters to reduce evaporation rates Limit stock access to creeklines to reduce damage to long-lived carbon assets	Construct mustering yards for feral herbivores in line with Feral Animal Management infrastructure plan (AW NRM 2014) (C3) Ensure adequate shade and water is available to prevent heat-related stress on mustered stock Minimise stock holding times before they are removed to reduce heat-related stress Provide payments for feral animal culling and monitoring	Prioritise management of major drainage lines (e.g. Officer Creek) – and control livestock/feral herbivore pressure and Buffel grass within and adjacent to these areas

	Buffel grass	Fire management	Heatwaves	Bushfoods	Water management	Livestock grazing	Feral animals	Biodiversity and Carbon
Longer-term resilience actions	<p>Develop biocontrol measures</p> <p>Develop a use for harvested Buffel grass – e.g. as fuel, fodder, biochar feedstock, etc.</p> <p>Support community monitoring and management of outbreaks</p>	<p>Develop community CFS programs which involve interested community members in fire management and training for both traditional cultural reasons and also asset protection activities</p> <p>This could be developed through the TAFE as an accredited training program (P11)</p> <p>Develop fire fund which is tied to seasonal rainfall to provide adequate funding for prescribed burning following wet years when the need is greater. Deposits can be made every year, with withdrawals made only after exceptionally wet periods</p> <p>Consolidate fire management activities as the fire season extends – perhaps using casual staff or other flexible arrangements to focus activity in the brief window of opportunity before the fire season begins</p>	<p>Improve building thermal performance, increase shade trees, improve community health</p> <p>Consider temporary migration for vulnerable people within communities during the summer months</p> <p>Schedule the majority of NRM work during the cooler months of the year</p> <p>Consider assisted migration of sensitive species (e.g. Warru) to higher, cooler refuge areas</p>	<p>Designate refuge areas where bushfoods are more intensively managed through conservation works and controls on hunting, to provide surrounding areas with greater hunting opportunities These conservation zones could also be managed for carbon assets where appropriate to achieve multiple benefits to communities</p> <p>Implement community-based monitoring of hunting and harvesting to better understand bushfoods that are under threat from over-harvesting</p> <p>Implement community-based monitoring of seasonal events to track changes in bushfoods over time (C26, C27, P7, P10, P13, P19)</p>	<p>Implement groundwater resource monitoring for all major communities in the region (W15)</p> <p>Implement water conservation measures in communities, including transparent information on household water use, and investigate pricing mechanisms to regulate overuse. (W16)</p> <p>Utilise rainwater harvesting techniques to passively irrigate community trees and reduce peak stormwater flows and flood risk</p> <p>Development supplemental supply, with larger rainwater tanks sized for projected increases in peak rainfall intensity</p> <p>Investigate ways of augmenting inflows into rockholes through swales, and reducing outflows by fencing feral animals out and shading rockholes with vegetation or shade cloth</p> <p>Ensure essential community infrastructure is located away from flood-prone areas</p>	<p>Monitor long-term seasonal forecasts</p> <p>Stock for the worst years, not the best to conserve perennial vegetation, or ensure rapid changes to stocking rates with seasonal changes</p> <p>Create ponding banks where there is erosion potential to capture larger rainfall events, reduce erosion and grow productive perennial grasses</p> <p>Use smaller paddocks, more water points and higher rotations with long rest periods</p> <p>Breed cattle as part of operations and select for resilient stock</p>	<p>Encourage dingo populations in order to increase predation of and competition with the red fox, which is the only species projected to increase in abundance with future climate change. Aerial culling of camels may support larger dingo populations by allowing them to feed on the carcasses</p> <p>Develop local abattoir processing capability and infrastructure for mustered feral herbivores to reduce heat stress on animals, provide local employment, and provide a buffer against heatwaves (e.g. cold storage) or floods preventing truck access and decline in animal condition</p>	<p>Manage threatening process (particularly inappropriate fire regimes and feral herbivores – C3, C10) to promote natural carbon regeneration, rather than planting trees</p> <p>Ensure riparian vegetation (predominantly <i>Eucalyptus camaldulensis</i>) is regenerating naturally through ongoing monitoring</p>

Figure 5 Subregional-scale summary of suggested adaptation responses in North (finer-scaled adaptation responses omitted from this figure)

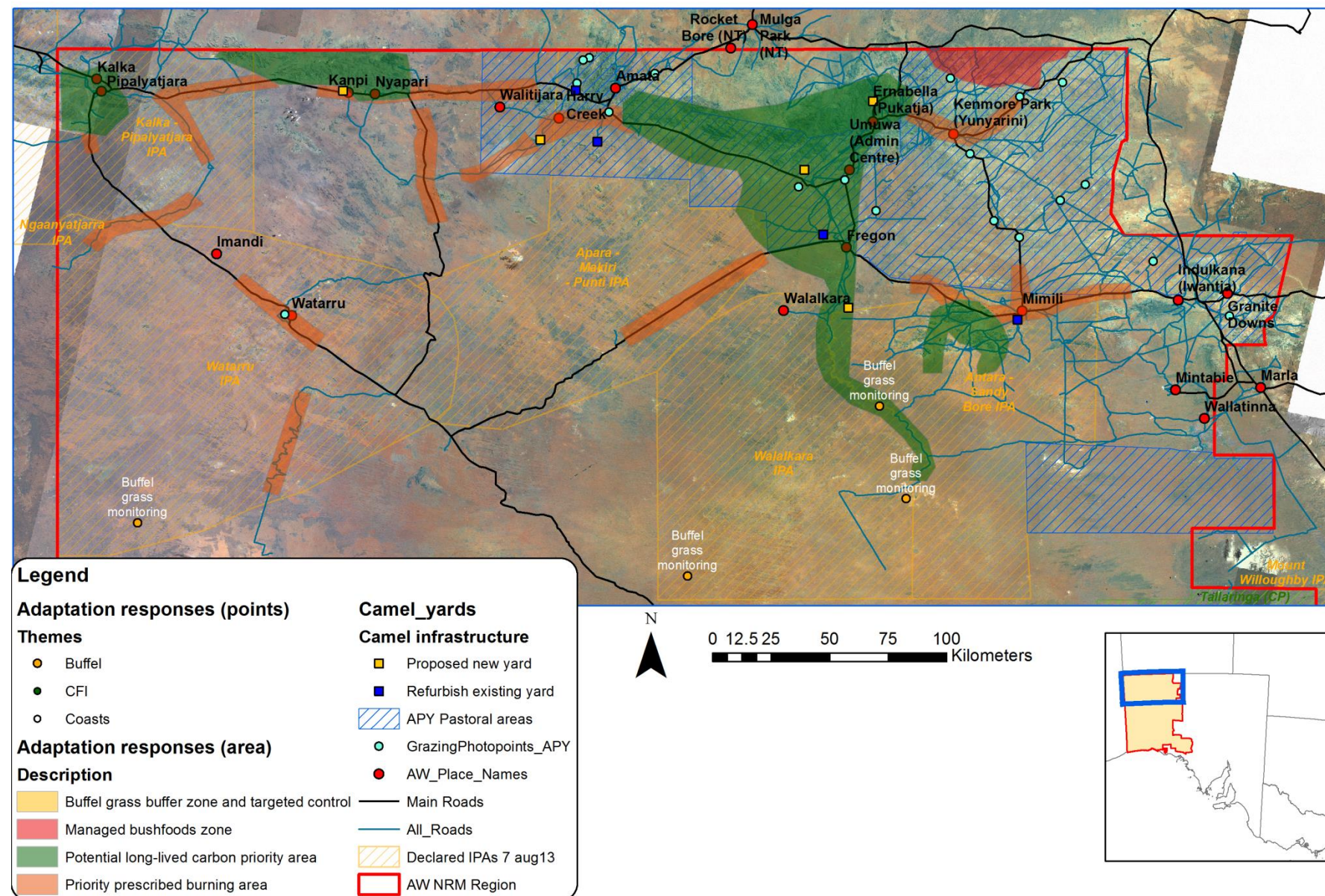


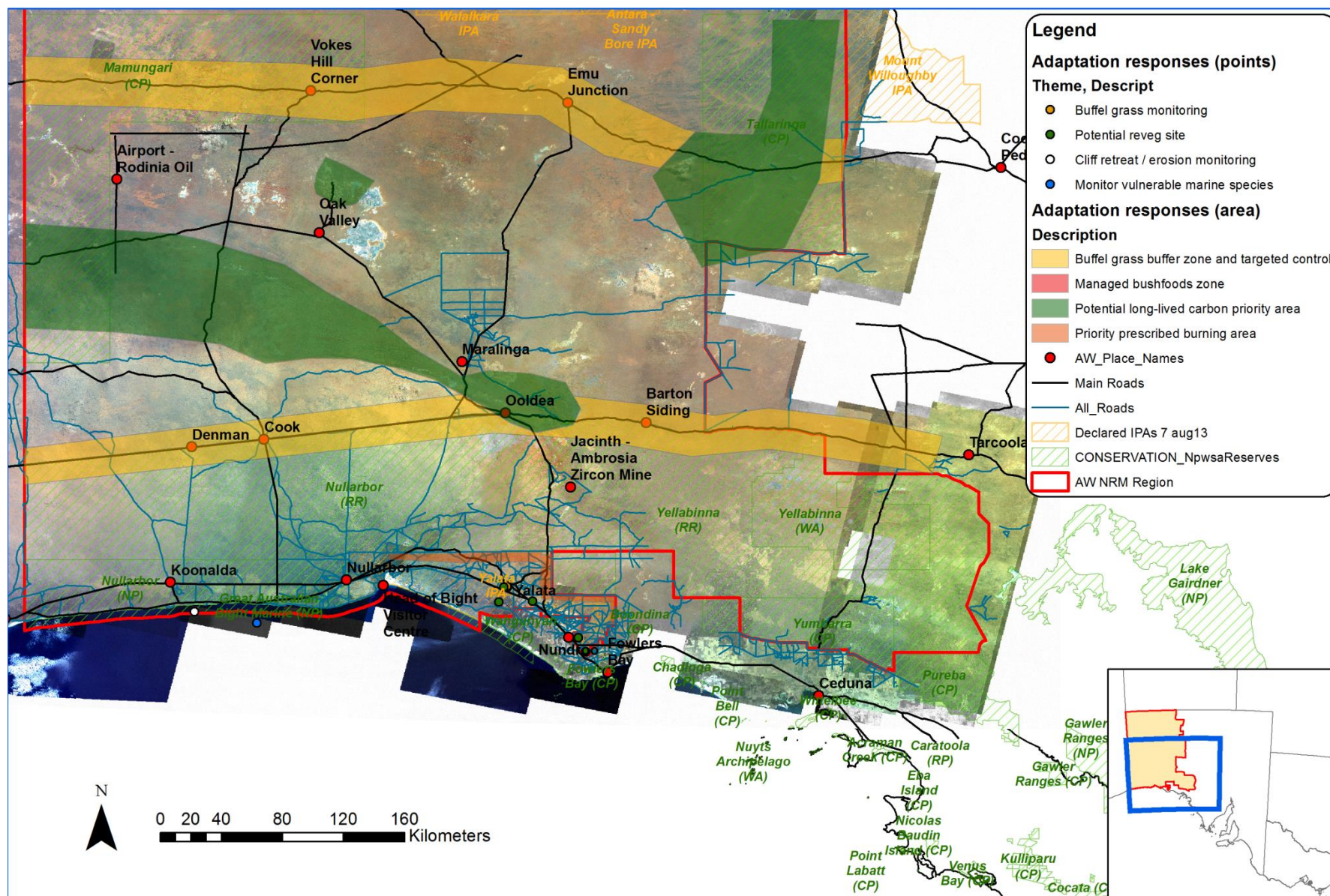
Table 4 Summary of themes and adaptation responses in the South

	Buffel grass	Fire management	Heatwaves	Bushfoods	Water management	Feral animals	Coastal zone	Biodiversity and Carbon
Current State	Buffel grass has been observed in Yalata Community, as well as along roads and the rail line	Fire regimes have changed since European colonisation. Fire presents a significant risk to IPA management given the lack of response capacity	Heatwaves are impacting on communities, with blackouts common under peak loads in summer from air conditioning Recent heatwaves have negatively impacted on biodiversity	Some bushfoods such as red kangaroo are declining due to a combination of over-hunting and feral animal competition (particularly rabbits and camels). Dingo populations have controlled foxes and cats to some extent Changes were noticed in some fish species, linked to changes in currents and ocean temperature	Groundwater levels in Yalata are declining due to over-use Groundwater in Oak Valley is depleted – water is sometimes brought up from Yalata Insufficient emergency water for tourists and fire-fighting	Camels are less of an issue for Yalata IPA compared with further north Still, rabbits, cats and foxes all impact on native biodiversity	Storm surges have washed out low-lying campsites in the past Changing ocean currents and temperatures have led to unusual fish and other marine species being identified along the AW coastline	Long-term decline in woody biomass has been observed in parts of the AW NRM region due to changing fire regimes and introduction of feral herbivores Carbon plantings may be viable in the southern edge of Yalata IPA
Future Issues with Climate Change	Buffel grass is likely to spread further south in a warming climate Containment is essential to prevent further spread which will be impossible to remove if it becomes established	Fire risk is likely to increase in a changing climate, due to a combination of hotter temperatures which extend the fire season and increase the number of extreme fire weather days, and the predicted spread of Buffel grass. The window for prescribed burning is likely to shorten	Heatwaves are likely to get hotter, longer and more frequent	The existing drivers of bushfood decline are likely to intensify with future climate change, as well as increases in heatwaves and more variable rainfall Climate change will change the timing of important seasonal events such as hibernation and flowering/fruitletting, and may further change fish patterns due to change in currents and temperature	Oak Valley and Yalata are at low risk of climate change impacting on groundwater levels, but both communities are at risk from over-extraction Hotter temperatures and increased fire risk will increase the need for emergency water supplies, as well as increase the demand for water within communities	Large feral herbivores (camels, donkeys, and horses) as well as the red fox present the biggest threats as a result of climate change, with these species projected to either remain stable (feral herbivores) or increase in abundance (red fox). In contrast, rabbits, cats and goats are projected to decrease either in abundance or distribution	Rising sea levels and associated storm surges will further threaten coastal camps Changing coastal patterns (e.g. wave direction, sea temperature, wind erosion) may change habitat suitability for species	The drivers of woodland decline are likely to intensify with climate change CFI activities present significant risks due to increased fire intensity and decreases in natural carbon sequestration

	Buffel grass	Fire management	Heatwaves	Bushfoods	Water management	Feral animals	Coastal zone	Biodiversity and Carbon
Adaptation priorities (bracketed notes, e.g. 'W1' indicate support of existing actions in current NRM Plan)	<p>Containment and eradication of Buffel around Yalata is a high priority</p> <p>Quarantine measures which prevent cars from spreading seed from further north should be investigated (C2)</p> <p>Support community control along the rail line and major roads to prevent Buffel spreading further south is also a priority (C2)</p>	<p>Increase prescribed burning on northern Yalata IPA boundary to reduce grass fires spreading from further north (C10)</p> <p>Increase the number of shed tanks in the more remote sections of Yalata IPA to improve fire-fighting capacity</p>	<p>Ensure access to air-conditioning and swimming pools during summer months</p> <p>Manage peak loads with spare generators or solar PV</p>	<p>Conduct patch burning to reinstate traditional fire seral mosaics, and monitor post-fire recovery of plants and animals (C10, C12)</p> <p>Manage feral animals to reduce competition and predation (C3)</p>	<p>Establish shed tanks in strategic locations for emergency water supplies for tourists and fire-fighting</p> <p>Implement water conservation measures in communities, including transparent information on household water use, and investigate pricing mechanisms to regulate overuse (W13, W16)</p>	<p>Continue aerial culling programs for feral camels (C3)</p> <p>Continue baiting programs for foxes, and control for rabbits (C3)</p> <p>Provide payments for feral animal culling and monitoring</p>	<p>Relocate low-lying campsites further away from the shoreline, and provide supplementary water points for emergency use</p> <p>Record species caught by recreational fishers, perhaps by promoting the Redmap software: http://www.redmap.org.au/ (C27, C28)</p> <p>Establish monitoring points to record dune movement over time</p> <p>Track trends in groundwater levels at Yalata Swamp</p>	<p>Investigate carbon potential of groundwater-dependant vegetation to the north of the Nullarbor Plain, and in the southern third of Mamungari Conservation Park</p>

	Buffel grass	Fire management	Heatwaves	Bushfoods	Water management	Feral animals	Coastal zone	Biodiversity and Carbon
Longer-term resilience actions	Develop bio-control measures – this may be particularly applicable in the South where Buffel is not such an important pasture species compared with northern Australia	<p>Greater funding for training and coordinated responses to fire through local CFS teams</p> <p>Concentrate fire management activities and funding to the coolest part of the year to achieve prescribed burning objectives before the fire season</p>	<p>Improve building thermal performance, increase shade trees, improve community health</p> <p>Consider temporary migration for at-risk people within communities during the summer months</p> <p>Schedule the majority of NRM work during the cooler months of the year</p>	<p>Designate refuge areas where bushfoods are more intensively managed through conservation works and controls on hunting, to provide surrounding areas with greater hunting opportunities</p> <p>These conservation zones could also be managed for carbon assets where appropriate to achieve multiple benefits to communities (e.g. to the north of the Nullarbor Plain)</p> <p>Implement community-based monitoring of hunting and harvesting to better understand bushfoods that are under threat from over-harvesting</p> <p>Implement community-based monitoring of seasonal events to track changes in bushfoods, whales and fish over time (C26, C27, P7, P10, P13, P19)</p> <p>Encourage dingo populations to increase predation on foxes and cats</p>	Development supplemental supply, with larger rainwater tanks sized for projected increases in peak rainfall intensity and longer dry periods	<p>Encourage dingo populations in order to increase predation of and competition with the red fox, which is the only species projected to increase in abundance with future climate change</p> <p>Aerial culling of camels may support larger dingo populations by allowing them to feed on the carcasses</p>	<p>Provide space for swamp ecosystems to retreat in-land and allow for natural colonisation by salt-marsh species in response to rising water levels</p> <p>Determine and monitor cliff retreat rates and plan access roads and other infrastructure to minimise impacts of cliff retreat</p>	Manage existing long-lived carbon assets by controlling threatening process (particularly inappropriate fire regimes and feral herbivores) to promote natural carbon regeneration, rather than planting trees which carries greater risks

Figure 6 Subregional-scale summary of suggested adaptation responses in South (finer-scaled adaptation responses omitted from this figure)



6. Priorities for future work

1. Utilise future SA State Government Climate Change Adaptation Framework funding (DEWNR 2014) to embed and integrate this addendum's recommendations into other related sectors (e.g. health, emergency management, education, mining).

This addendum and related technical report represents the culmination of four years of work between the University of Adelaide, the Alinytjara Wilurara NRM Board and the region's communities. The authors have produced an integrated assessment of climate change risks to natural resources (Bardsley and Wiseman 2012), looked at community-based monitoring opportunities in the region (Wiseman and Bardsley 2013), and finally, extended this work into detailed spatial adaptation plans and priorities for the region. Rather than re-inventing the wheel as part of the State Adaptation Framework (which requires regions to conduct an integrated vulnerability assessment, engage communities, and develop adaptation action plans – DEWNR 2012), funding through the Framework could be used to promote this report's findings and develop cross-sectoral agreement on the ways forward for NRM in the AW region. Given the high levels of community engagement fatigue observed in communities, perhaps communities that have already been consulted on environmental change issues should not be asked to run through the same issues again and rather consultation could focus on communities that were not consulted such as Maralinga Tjarutja and Oak Valley (see Point 3) and on developing opportunities for integration and shared activity with other SA Government sectors.

2. Use Healthy Country Planning as the framework to operationalise the recommendations in this report. Healthy Country Plans (also called Conservation Action Plans) aim to translate cultural and ecological objectives and goals into detailed work plans (The Nature Conservancy 2014). The level of detail proposed for these Plans is just what is required in order to take the sub-regional scale recommendations in this report (e.g. develop a bushfood management zone to the NW of Ernabella) and turn them into detailed actionable guides on how to make this happen (i.e. who will do the work, where will the funding come from, in what timeframe, with what benefits, and using what indicators for success).

The spatial maps developed in the course of this work could be used for future Healthy Country Planning to take back to communities and refine the information, rather than re-starting conversations about Buffel, camels, fire etc. from scratch. The spatial data layering approach, using the themes discussed in this report, could be also be utilised more broadly for community consultation in the region, so that workshops are able to provide relevant information to other projects and workshops, as well as utilising past information, without needing to go through the same steps each time community views are needed. The spatial data could also be integrated with project mapping in the AW NRM region, which is currently underway in response to earlier recommendations provided to the Board, to identify areas that are relatively well understood and others that are less known across the region.

3. Communicate workshop results to communities, and consult any remaining communities that were not covered in this project (particularly Maralinga Tjarutja and Oak Valley in the central sub-region) utilising a similar framework for engagement and to integrate into Healthy Country Planning.

A short film discussing the project's findings could be a good way of presenting results back to communities and providing a forum for group discussion about next steps, changes to any information, etc. The community handbooks developed as part of this project will be another tool for communicating results and gathering feedback from communities.

7. Conclusions

The AW NRM region has already experienced climate change, with the region becoming hotter over the past century, and wetter over the past few decades. Future climate change is likely to make the AW NRM region even hotter, with longer hotter heatwaves, as well as increasing rainfall variability. In the north, there may be an increase in extreme rainfall intensity at times, especially due to an increased summer monsoon in the north of Australia. In the south, a stronger drying trend is likely over all seasons.

While changes to climate will have impacts on people and country, there are many things that communities in the region can do to help prepare for future change. Protecting long-lived carbon assets (trees and shrubs), managing fire, controlling Buffel and other invasive species, protecting bushfoods, managing flooding and heatwaves, and recording and monitoring seasonal changes are some of the activities that will help people and country adapt to a changing climate. Many of these activities are already happening across the AW NRM region, but could be strengthened and supported for their value in adapting to climate change and also for providing opportunities for training and employment. Importantly, most activities to prepare for climate change are also good ways of caring for country anyway – they represent 'win-win' actions that will make a difference now and in the future.

There is one other broader conclusion that emerges from this work within remote indigenous communities over the last four years, which is relevant to a strategic response to environmental change across the AW NRM region. People want to live in country, understand country and make country healthy again. At the moment, insufficient support is provided to remote indigenous communities to make full use of the incredible local human resources for sustainable environmental management in the remote north-west of SA. That could be rectified without significant additional costs to Australia, but would provide enormous benefits in regards to managing changing environmental conditions; providing opportunities for training and employment; as well as renewing and strengthening the traditional socio-ecological relationships which remain a vital component of the heritage of South Australia.

*Traditional Owners
visiting cultural sites
in Mamungari
Conservation Park*



References

- Bardsley D.K. and Wiseman N.D., 2012. *It Depends Which Way the Wind Blows: An integrated assessment of projected climate change impacts and adaptation options for the Alinytjara Wilurara Natural Resources Management region*. Government of South Australia/Alinytjara Wilurara NRM Regional Board, Adelaide. Available at <http://www.naturalresources.sa.gov.au/alinytjara-wilurara/about-us/our-region>
- Department for Environment, Water and Natural Resources (DEWNR), 2012. *Prospering in a Changing Climate: A Climate Change Adaptation Framework for South Australia August 2012*, SA Government, Adelaide.
- Measham, T.G., 2014. *Australian rangelands and climate change – guidance to support adaptation: Addressing climate adaptive capacity, resilience and vulnerability of people in remote and marginalised regions*. Ninti One Limited and CSIRO, Alice Springs.
- The Nature Conservancy, 2014. Conservation Action Planning webpage <http://www.conservationgateway.org/ConservationPlanning/ActionPlanning/Pages/conservation-action-plann.aspx>, accessed 10/12/2014
- Wiseman, N.D., and Bardsley, D.K., 2013a. *“Feeling the changes”: Indigenous community monitoring of environmental change in the Alinytjara Wilurara Natural Resources Management region*. Government of South Australia/Alinytjara Wilurara NRM Board, Adelaide.
- Wiseman, N., and Bardsley, D.K., 2015. *Climate Change Addendum – Technical Report*. Alinytjara Wilurara NRM Board, Government of South Australia.

Salt Pan in the APY Lands

