# Developing a report card for Alinytjara Wilurara NRM region on the impacts of climate change

DEWNR Technical note 2014/20

Government of South Australia
Department of Environment, Water and Natural Resources

# Developing a report card for Alinytjara Wilurara NRM region on the impacts of climate change

Annelise Wiebkin and Glen Scholz

Department of Environment, Water and Natural Resources

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GPO Box 1047, Adelaide SA 5001

| | |
|---|---|
| Telephone | National (08) 8463 6946 |
| | International +61 8 8463 6946 |
| Fax | National (08) 8463 6999 |
| | International +61 8 8463 6999 |
| Website | www.environment.sa.gov.au |




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# Acknowledgements

This project produced a report card on the impacts of climate change in the Alinytjara Wilurara (AW) NRM region. The content of the report card and the indicators were selected during a workshop, attended by AW regional staff, AW community stakeholders and technical experts in April 2014. The information, data and methods underpinning this report card represent the collective effort of individuals and organisations from Bureau of Meteorology, Department of Environment, Water and Natural Resources and The University of Adelaide. The process used to produce this report card was developed by the Integration and Application Network, University of Maryland Center for Environmental Science. Professor Michelle Waycott (DEWNR) and the staff from the Integrated Application Network team at the University of Maryland provided the Evaluation and Reporting Team (DEWNR) with training on conceptual models and report cards, which enabled the report card to be produced.

# Contacts

Team Leader; Evaluation and Reporting, Glen Scholz, e: glen.scholz@sa.gov.au

Principal Advisor, Evaluation and Reporting, Brad Page, e: Bradley.Page@sa.gov.au

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# Summary

This document outlines the process used to develop a report card on the impacts of climate change in the Alinytjara Wilurara Natural Resources Management (AW NRM) region. The report card was produced to help Natural Resources AW staff measure and track the condition of natural resources as the climate changes. In the AW NRM region, this is expected to include the temperature increasing and changes to rainfall. The report card was developed through an initial literature review, followed by a workshop, which was attended by technical experts, Natural Resources AW staff and community stakeholders. To determine the natural resources that might be impacted by climate change, the workshop incorporated information from the literature and knowledge of workshop participants. The participants identified natural resources that the community valued, and decided how to measure the natural resources with limited funding. The participants also designed a report card, including the messages, the components and the format.

One of the benefits of the workshop was that it increased buy-in and participation of the diverse stakeholder groups. The workshop process also provides justification to the community, scientific community and stakeholders on how indicators for monitoring were chosen.

# 1 How does this report card help Alinytjara Wilurara NRM region manage climate change impacts on natural resources?

Alinytjara Wilurara (AW) Natural Resources Management (NRM) region is building capacity to manage climate change impacts on natural resources. This project aimed to identify and track the potential impacts of climate change on natural resources so that management actions could be planned and evaluated.

A report card was developed to summarise past and predicted changes in the climate and the potential impacts these would have on natural resources. The report card also highlighted indicators that may be measured to track the condition of these resources.

This report card will both educate readers on impacts of climate change, as well as indicate where efforts could be focused to mitigate or adapt to the impacts of climate change.

The AW report card is focused on climate change impacts on country and water, not people.

# 2 Report card development process

## 2.1 Information review

The information reviewed at the beginning of this project included:

- predictions of climate change impacts in the AW NRM region
- impacts of climate change on groundwater resources across the region and in the neighbouring SA Arid Lands NRM region
- other natural resources likely to be impacted by climate change.

A summary of the literature (Appendix 1) provided the basis for selecting natural resources and indicators of their condition for the report card.

Technical experts were also consulted before the workshop, including staff from The University of Adelaide, to ensure that this project was complimentary to their work on community monitoring and vulnerability assessments in the AW NRM region.

## 2.2 Workshop

The workshop was used to decide what AW natural resources might be impacted by climate change. Participants synthesised information from the literature and their own knowledge. The participants identified natural resources that the community valued, and participants decided how we could measure their resource condition. The participants also designed the report card, including the components and the format.

The workshop aimed to increase interest and common understanding about the impacts of climate change in AW NRM region. It also allowed the collection of information from diverse stakeholder groups. The workshop process aimed to provide justification to the community, scientific community and stakeholders on how indicators for monitoring were chosen.

The workshop was attended by community stakeholders, technical experts, and Natural Resources AW staff. The goals of the workshop were to:

1. agree on the predicted changes to the climate
2. select high priority natural resources
3. determine suitable indicators to measure indicators of climate change and the impacts of climate change on the condition of high priority resources
4. design the report card.

**Workshop-process steps:**

## Step 1. What are the predicted changes to temperature and rainfall in the region?

The participants discussed if and how the region should be divided (spatially), to record past and future changes in the climate. The participants decided to split the region into three weather zones, which were based on long-term (100 years) climate modelling work by (Doug Bardsley and Nat Wiseman, The University of Adelaide). The predictions of how climate would change in these zones were presented to the participants.

## Step 2. Selecting natural resources to measure impacts of climate change

A natural resource is something that is spatially explicit and that is valued in some way by people. The AW report card aimed to report on (and track through time) the impacts of climate change on a subset of natural resources. We cannot measure everything in the region's ecosystems because we do not have the resources, so we needed to prioritise the things to measure and the things to manage (in this case, climate change). The natural resources that are most valued are the ones that typically need to be monitored and managed. Values can be derived from a range of sources (e.g. by using social, economic and environmental values).

The participants in the workshop compiled lists of the most valued natural resources, the reasons why they were valued and the spatial extent of each resource (where they were valued most). These were presented and visualised on a map of the AW NRM region.

The list of resources was synthesised to include the natural resources that were likely to be impacted by climate change. Resources were removed from the list if the link between changing temperature or rainfall, and the distribution or abundance of the resource, was unclear. Some resources were also lumped into broader categories, such as all bush foods and medicines.

## Step 3. How are the selected natural resources likely to be impacted by climate change?

The participants looked at how increasing temperature (including heatwaves) and changes to rainfall are likely to impact the natural resources that were shortlisted. Impacts were categorised as direct (i.e. through availability of water) or indirect (i.e. through competition with increasing numbers of feral species that are better suited to the changes in climate). The direct links between climate change and resource condition were generally better understood than the indirect links.

If the likelihood and severity of impacts were known, the resources were assessed as being vulnerable or less-vulnerable.

A driver of change for the natural resources was the availability of water. A conceptual model of how climate change is likely to impact on water resources was drafted for inclusion in the report card. The model provided a way to visualise the impacts on water resources (particularly groundwater) in a spatial setting.

## Step 4. Selecting indicators

Indicators were selected to measure the change in the climate and the condition of the selected natural resources. The indicators of climate were selected to measure the:

1. amount, frequency and intensity of rain across the year and in growing seasons, and the duration between rainfall events. Rainfall events were selected to reflect the amount required to recharge ground and surface water resources.

2. temperature across the year, as well as the number and duration of heatwaves. Heatwave thresholds were selected to reflect the temperature that may impact survival of plants and animals in the AW NRM region.

The temporal scale of climate indicators was selected to encompass annual variation.

The baseline period was based on available data and for a period that encompassed annual and decadal variation.

The indicators of condition in the selected natural resources were based on the known or assumed links between climate change and resource abundance or distribution. Where the links were not understood, or the resource components were not prioritised, participants agreed that more research was required before indicators could be selected. This was the case for most of the biodiversity, bush foods and medicines.

Participants discussed scoring indicators of resource condition. Indicator scoring can only be undertaken when data are available and when there is a reference or baseline for comparison. There were data available for groundwater resources (water level), but the impact of water extraction (for community use) could not be separated from other impacts (e.g. climate change).

### Step 5. Designing the report card

The participants discussed and agreed on the:

- purpose and role of the report card
- audience for the report card, and who could carry or disseminate the messages
- format of the report card (e.g. brochure, poster, document)
- most important topics to address in the report card and related communications
- main sections of the report card (the selected natural resources, the predicted climate changes, indicators, knowlegde gaps, management considerations)
- specific graphics (e.g. photos, conceptual models, maps) and content of each section in the report card
- layout and subregional context (Figure 2.1); and
- how the broad community in the AW NRM region, AW NRM Board, Natural Resources staff and NRM community may respond to the report card

## 2.3 Following the workshop

### Step 6. Sourcing data

Climate data were sourced from the Bureau of Metereology. Data were processed to report the rainfall, temperature and heatwave indicators selected in the workshop.

Data were not available for resource condition indicators, so trends in resource condition were inferred from the trends in climate data.

### Step 7. Producing the report card

The report card was drafted and sent to workshop participants for comment and input. A final version was produced in Adobe® Illustrator®. Workshop notes were prepared, and additional data that was not included in the report card was documented (Appendixes 2 and 3).

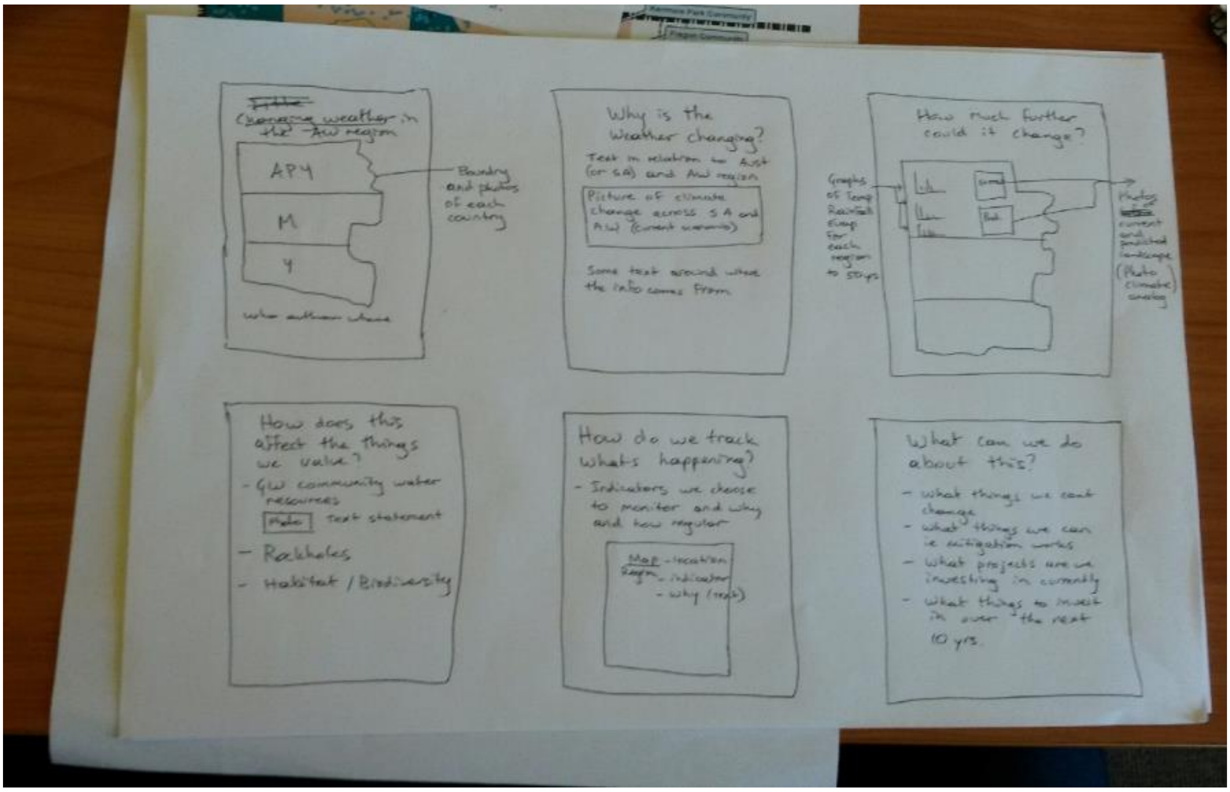


**Figure 2.1 Design ideas for the report card by workshop participants**

# Appendix 1: Background for workshop on climate change impacts in Alinytjara Wilurara

**(provided to workshop participants prior to the workshop)**

**Why are we here?**

To bring together ideas and consensus to communicate the impacts of climate change in a report card. A workshop will combine the information from the literature and knowledge of workshop participants to decide what broad natural resources might change. We will also discuss which resources the community values most, and how we measure them with limited funding.

This is only about country and water, not about people assets

**What will we produce at end of workshop?**

Together, we will produce a draft report card on the impacts of climate change in AW. This may be in poster or brochure format. The report card will use prominent graphics for effective communication with the community.

**What we know from the literature**

Assets in AW that may respond to climate change include:

- Surface water around communities and livestock, including rock holes and salt lakes
- Ground water around communities, mining sites and livestock
- Biodiversity (especially those in reserves), including iconic species
- Pastoral grasses for livestock
- Coasts including saltmarshes, beaches/dunes and cliffs and associated ecosystems
- Cultural sites (eg. rock holes, creeks)

**Rainfall**

- ***In the past (since 1996):*** rainfall across AW NRM region has been *very much above* the 100yr average during October-April, and generally *above average* during April-November. North west APY has experienced the highest rainfalls on record (CSIRO & BOM)
- ***In the future*:** rainfall is likely to be more variable with longer periods between downpours: Annual rainfall across AW is projected to change between +4 to -15% (best estimate -4%) by 2030 and +9 to -30% by 2070 (best estimate -13%). (Suppiah et al 2006)
  **Southern AW:** annual rainfall is likely to change by -15 to 0% by 2030 (become drier)

  **Northern AW:** annual rainfall is likely to change by -15 to 7% by 2030 (wetter or drier)

**Temperature**

- ***In the past***: temperature in APY has increased by >1ºC in past century (more than national average) and >0.5 ºC in southern AW. (CSIRO & BOM)
- ***In the future:* across whole of AW:** temperature is likely to increase. Average annual temp across AW is projected to increase by 0.6-1.4ºC (best estimate 1ºC) by 2030, and 1.6-3.5 C (best estimate 2.4ºC) by 2070.' (Suppiah et al 2006).
  **Southern AW:** temperature is likely to increase 0.2-1.6 ºC by 2030

  **Northern AW:** temperature is likely to increase 0.6-1.8 ºC by 2030

**Evaporation**

- ***In the future:*** evaporation across AW NRM region is likely to increase: Evaporation is projected to increase by 0% to 3.5% (best estimate 0.5%) by 2030 and by 0.2% to 10% (best estimate 6.5%) by 2070. (Suppiah et al 2006)

**The driver of change in AW NRM region will be rainfall amount and times between downpours**

**Groundwater**

Climate change is likely to affect annual rainfall amounts and reduce the frequency of extreme rainfall events in SA (Suppiah et al. 2006, BOM and CSIRO 2007). Extreme rainfall events are the largest 1% of rainfall events (Crosbie et al. 2012). The link between extreme rainfall events and groundwater resources is strong for some aquifers but not others (Gibbs et al 2013). Recharge of groundwater occurs mostly through heavy downpours seeping through fractured rock in valleys, onto sedimentary plains and into aquifers.

- Across AW, the number of months with rainfall >100mm (recharge events as suggested by Tweed et al. 2011) is projected to decrease by 14% to 39% (depending on C emission level and projection time: 2030, 2050 or 2070). Reductions in recharge events are likely to be more than double (2.2 times) the reductions in rainfall (Alcoe et al 2012).
- The groundwater resources around communities of Yunyarinyi (Kenmore Park), Pukatja (Ernabella) and Kaltjiti (Fregon) are at higher risk from impacts due to climate change. There is also increasing demand for groundwater in 4 of 5 communities (where trend is known) and declining water levels in 5 of 11 communities (Alcoe et al. 2012).
- Yalata groundwater is unlikely to be recharged from local rainfall events (although water levels are declining). (Alcoe et al 2012)
- Mining at Iluka uses 9500ML/yr but the impacts of CC on these resources are not well understood. Mining exploration is active across the area.
- Pastoral stocking rates, status and condition of wells for stock watering and water consumption rates by mammal pests is unknown. Demand for stock water may increase.

**Surface water**

Surface water includes rockholes, plungepools and rivers/streams. Predictions are based on work done in SAAL. Surface water catchments are likely to be recharged from baseflow in permeable ground, not rainfall runoff.

- Any change in annual rainfall will mean twice as much change in surface water runoff (annual average) (Gibbs et al. 2013). Surface runoff is not informative of changes in catchments (rockpools, etc).
- Change in annual rainfall reflects the change in the length of dry periods (in Neales river catchment) (Gibbs et al. 2013). Frequency of events is likely to decrease (especially in northern part of SAAL by between 21%-47% by 2030-2070).
- Time between episodic flow events reflects ecological health of waterholes.

**Biodiversity**

- Eucalypts in the central desert areas of Australia are expected to retract in range because they may lose 20% (or more) of their climate space (Butt et al 2013).
- Bird assemblages may change: generalists and insectivorous birds may dominate increasing periods of dry (study from Simpson Desert) (Tischler et al 2013)
- Wildfire size may increase with larger wet events promoting rapid vegetation growth, and longer periods of growth promoting fire.

**Pests**

Climate change may suit exotic species more than natives. Increased disturbance from fire and floods may provide niches for invasive species. Native species may become more stressed and less competitive with exotic species.

- Camels pose considerable threats to biodiversity through herbivory of plants as well as competition for water and food, and they reduce water quality. In one day, a camel can drink 2000 times more water than a red kangaroo or a euro (Ninti One Ltd 2013).
- Observations of wilddogs, feral cats, foxes, rabbits and starlings are currently concentrated in the southern half of AW (PIRSA).

Weeds decrease biodiversity, threaten iconic native species and damage our important cultural and recreational areas.

- There are records of 4 weeds of national significance in AW: Opuntioid cacti, Silverleaf nightshade, Boxthorn, Athelpine. (PIRSA)
- Bufflegrass, although not a WON, is a priority pest species for AW NATURAL RESOURCE MANAGEMENT region. It is drought tolerant and at risk of spreading across AW, particularly in the APY lands. Bufflegrass promotes hot fires that can destroy fire sensitive species such as wrinkled honey myrtle, figs and spearbush (food of Warru) and *Acacia tenuior*.

**Production**

Rangeland/arid/semi-arid soils are set to lose carbon and nitrogen (nutrients) as the climate changes, affecting food production. The mechanisms for this may be erosion due to reduced ground cover.

**Coastal regions**

Climate change is likely to cause increased sea levels and more storm activity which may inundate and erode low-lying coastal areas.

**Understanding of climate change in the community**

CSIRO surveys show that about 60 per cent of South Australians believe the severity and frequency of record breaking weather events have increased.

Just under half of the people in South Australia believe climate change is caused by humans; a slight decrease since 2010 (Cook et al 2013).

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# Appendix 2: Summary notes from a workshop on reporting the impacts of climate change

**Prepared by Annelise Wiebkin, May 2014**

A workshop on developing indicators and a report card for the impacts of climate change (CC) was held on the 29th April 2014 at the Goodman Building, Adelaide.

Participants were from AW NRM region, Adelaide University, DEWNR, consultants, local community members and an observer from SAMDB NRM region.

Attendees: Aude Loisier, Graham Green, Sam Doudle, Glen Scholz, Lachie McLeay, Adam Wood, Adam Pennington, Nat Wiseman, Lorna Dodd (and daughter and grand-daughter), Saras Kumar, Brett Ibbotson, Annelise Wiebkin. A further 16 could not attend.

Annelise gave a short presentation on the need for the report card and consistently measured indicators and how the workshop would be run. Messages were that we cannot manage what we don't measure, and also that we need to prioritise monitoring efforts given limited budgets and capacity. The report card aims to synthesise published reports and knowledge of workshop participants to communicate the impacts of climate change in a simple and engaging way to NRM staff and community.

Nat Wiseman (University of Adelaide) gave a presentation which summarised past and future trends in climate variables. He detailed how the climate in the north and south may change in different ways and that there is considerable uncertainty around predicted future trends. He also summarised the relative vulnerability of different natural resources to CC.

**SUMMARY OF WHAT WE KNOW**

The climate in AW is likely to change in the following way:

- **Rainfall** is likely to be more variable, but with longer periods between downpours. Events may be more extreme.
  - drier in South
  - may be more summer rain in North
- **Temperature** likely to be hotter
- **Evaporation** likely to increase

Resources that are likely to be impacted include:

- **Groundwater** is recharged in SOME aquifers by local extreme downpours (especially resources around Kenmore Park, Ernabella, Fregon). Yalata groundwater unlikely to be recharged from local rainwater events.
- **Surface water** (rockholes, plungepools, streams) may be most impacted by increased time between flow events
- **Biodiversity** may change with increasing dry periods and with larger fires (fuelled by large wet events).
- **Low coastal regions** may be inundated by rising sea levels and storms.
- **Pests** may be suited to changing environments caused by fire and floods.

What does the community think?

- Two thirds of South Australians believe extreme weather events are more severe and frequent now than in the past
- Less than half of South Australians believe climate change is caused by humans.

Participants did not think this information was relevant to the AW population

**PRIORITISING ASSETS**

The workshop participants split into 3 small groups and brainstormed the places or natural resources (assets) that were of value to the community and ecological function of the region. Participants were asked to only include assets that may be impacted by changes in rainfall amount or frequency or increased temperature.

After the assets were collated, we discarded those that could not be easily managed within the region (eg. Southern Right Whales) and those for which the link with climate change was not well understood (e.g. sandhill dunnart and mulloway).

We agreed that the assets that were not prioritised in this workshop may still be priorities for other reasons outside of the scope of this climate change workshop.

The priority assets were:

- **Rockholes & springs** (water dependent ecosystems)
- **Groundwater sources for community use**
- **Biodiversity & animal food species**
- **Bush medicine, seeds & plants**
- **Landscape scale habitats** (native vegetation communities)

Discussions about these assets:

**Rockholes & springs**

- Include:
  - Permanent springs (groundwater fed)
  - Rockholes & soaks with long water persistence (nyii-nyii)
  - Shallow pans with large water storage but short persistence
  - Paleochannels with shallow water sources and water dependent vegetation communities
  - Those with cultural and ecological significance
- Directly impacted by changes to rainfall (amount of water), increases in evaporation.
- Indirectly impacted by extraction (from people, native animals and pests)
- Short-term impacts may be from months to several years
- Long-term impacts may be decadal

**Groundwater sources for community use**

- Priorities are for domestic use and industry within 10km of towns
- Directly impacted by changes to rainfall amount and frequency of rainfall events of >100mm/month (amount needed to recharge aquifers). Also impacted by water quality.
- Demand for groundwater extraction will increase for domestic, pastoral and mining uses
- To determine the impact of CC on groundwater resources, extraction would also need to be measured near communities.

**Biodiversity (threatened value) & animal food species**

- Specific species that were highlighted included:
  - red and grey kangaroo – CC impacts indirect and direct
  - wombat - CC impacts indirect, less vulnerable
  - bustard CC impacts unknown, indirect
  - goanna – CC impacts of increased temperature is linked to goanna survival
  - mulloway – impacts unknown
  - nganamara (malleefowl),
  - princess parrot – CC impacts mostly indirect, affected by heatwaves, possibly vulnerable
  - sandhill dunnart - CC impacts unknown, indirect
  - waru – CC impacts indirect, vulnerable, info needed on changes to waru habitat
  - echidna - CC impacts unknown, indirect
  - ilkarka (brown & pink bowerbird), CC impacts unknown, indirect
  - honey ants (all over APY) – CC impacts indirect
  - itjari, itjari (mole) CC impacts unknown, indirect
  - desert skink – CC impacts indirect, sand may heat up
  - tinka - CC impacts unknown, indirect
  - emu – CC impacts unknown
  - kipara CC impacts unknown, indirect
  - ngintaka - CC impacts unknown, indirect
- All species are reliant on water availability for drinking and food.
- They are also impacted by degradation of their habitat, surface water features, riparian vegetation, native vegetation etc. Some are also impacted by physical barriers like roads and the dog fence. Other impacts include fire and competition with pests for habitat and water.
- More research is needed on all species to understand links between species abundance or distribution and changes to water availability and increases in temperature. Until these links are better understood, they cannot easily be prioritised and indicators of CC impacts cannot be selected with much certainty.

**Bush medicine, seeds & plants**

- Include:
  - wangunu (seed for making flour) – CC impacts are direct (water availability)
  - ortapa (tree used for spearwood, growing on top of hills)
  - ili (fig) - CC impacts are direct (water availability) & indirect (fires), vulnerable
  - quondong (Mimili) – CC impacts indirect (herbivory by camels)
  - bush tomatoes - CC impacts are direct (water availability) & indirect (bushfires), widespread
- Bush medicine plants grow along the roads, but people need the rains to find them.
- More research is needed on all species to understand links between species abundance or distribution and changes to water availability and increases in temperature. Until these links are better understood, they cannot easily be prioritised and indicators of CC impacts cannot be selected with much certainty.

**Landscape scale habitats**

- Habitat types at various spatial scales have not yet been prioritised in AW. Habitats could be monitored using native vegetation at the landscape scale (9 landscapes in AW regional plan). Yellabinna and Great Victoria Desert were prioritised by one group.
- The native vegetation is directly impacted by changes to rainfall, increases in temperature and evaporation.
- The native vegetation is indirectly impacted by competition from buffel grass, herbivory from pests and degradation from mining.
- Potential indicators: change in habitat condition, landscape stability

Other assets that were discussed but not prioritised, included caves, pastoral (grazing) habitats, other surface and groundwater resources and coastal campgrounds at Yalata.

## SELECTING INDICATORS

**We selected the following indicators of climate change:**

- Mean max daily temperature at 5 stations: Ernabella & Marla (North), Maralinga & Cook (Central) and Nullarbor (South)
- Annual, summer and winter total rainfall at Ernabella, Maralinga and Nullarbor
- Duration between and number of extreme rainfall events of >25mm/d (enough for surface flows) & >100mm/mth (enough to recharge aquifers) at Ernabella, Maralinga and Nullarbor
- Total number of heatwaves per year (>40 degrees for at least 3 days) at Ernabella & Marla (North), Maralinga & Cook (Central) and Nullarbor (South)
- Mean duration (days) of each heatwave at Ernabella & Marla (North), Maralinga & Cook (Central) and Nullarbor (South)

Baselines for all climate change indicators will be 1961-1990 (where data exists)

Rolling 5-year (short-term) and 10-year (long-term) means will be used to report trends. The duration over which these rolling means will be reported may not yet be sufficient for a trend to be determined. Some indicators may be omitted in the report card to ensure a simple message is communicated.

**The indicators of priority asset condition:**

Data on indicators for the priority assets is lacking in AW NRM region. We will use the climate data to infer changes to the condition of priority assets in the first report card.

Simple indicators to measure their condition in the future will be suggested. Discussions on these indicators are outlined below.

Future indicators to measure rockholes & springs:

- Persistence of water (related to rainfall)
- Water level
- Visitation rates by animals (to infer extraction, or persistence)
- Prioritise rock holes by catchment size (and cultural significance?). Note there is a Stream 2 project aiming to prioritise rockholes

Future indicators to measure groundwater around communities:

- depth to groundwater level and salinity in community aquifers where extraction occurs and outside extraction areas
- We need to monitor extraction wells and observation wells at Ernabella. This extraction data could be coupled with population data (e.g. extraction per head), and then extraction can be inferred using population changes.

Future indicators to measure biodiversity and food animals

- These can be selected when specific species are prioritised and when the link with rainfall and temperature has been strengthened. Given that species are reliant on their habitat, it was considered more important to measure habitat indicators. Then we can infer condition of biodiversity and food species.

Future indicators to measure bush medicine, seeds & plants

- These can be selected when specific medicines are prioritised. Given that medicines, seeds and plants are reliant on their habitat, it was considered more important to measure habitat indicators. Then we can infer condition of medicines, seeds & plants

Future indicators to measure habitats

- Vegetation health assessments done by DEH, but the data is limited to a handful of sites (not randomised). A randomised sampling design across the 9 landscapes would capture the variation in vegetation condition. A monitoring program may need to be designed that is fit for purpose and available budget.
- Remote sampling may provide indicators of greenness as a surrogate of vegetation condition.
- We also discussed that Yalata coastal area is in danger of being inundated by sea level rise, but the area was not considered to be a high priority.

## DESIGNING THE REPORT CARD

The participants decided that the audience of the report card would be Natural Resources AW staff, the NRM Board, people who work with schools and the community, as well as interested stakeholders. We decided that a 4 or 6-page brochure style report card would be engaging for this audience. Some simple messages could be extracted from this brochure for communication to the community by Natural Resources AW staff and educators at a later stage.

The purpose of the report card is:

1) As a communication tool to the Board and staff
2) To help justify why work is being done to monitor/manage assets
3) To guide where and how monitoring should be focused

These people can carry simple messages from the report card to the community.

The participants decided on a few messages. We pooled ideas on the graphics, layout, and content of each section (e.g. on indicators and future changes etc).

The content of the report card included:

1) messages
2) the 5 valued assets (places or natural resources)
3) what are the observed and predicted changes to rainfall and temperature in AW
4) indicators of CC
5) indicators of asset condition: in absence of data, we will infer trends in condition based on predicted climate trends
6) knowledge gaps on links between CC and valued assets: research for the future
7) management considerations, e.g. if we do or don't do something…what might it look like? What can we do?

Participants decided that photos of valued assets in good condition and in poor condition would be an effective way to communicate impacts of CC.

CC may be an abstract concept for many people in the AW region (unlike other regions) and we need to better describe what is happening to our rainfall and temperature patterns.

We need to relate CC to why we do fire management.

We need to give information about why the weather is changing.

A subregional context was deemed necessary because people are most interested in local issues where they work and live. For this reason the report card will have descriptions of 3 climatic zones. These will be presented on a map.

Information (particularly on CC indicators) that does not make it into the report card should also be provided to workshop participants (appendix 3).

# Appendix 3: Data on the selected climate change indicators

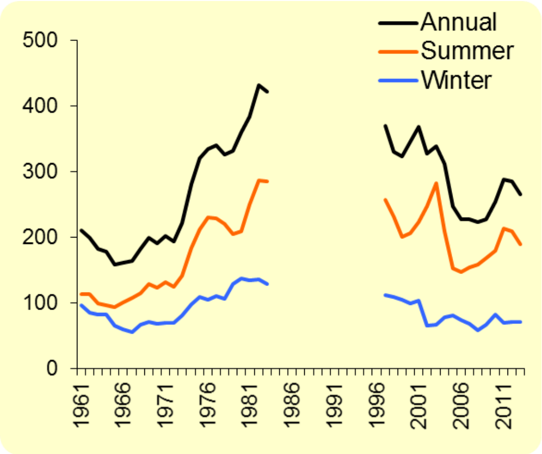
**Prepared by Annelise Wiebkin, June 2014**

The following graphs reflect the indicators of climate change that were suggested in the workshop. Both 5-year and 10-year rolling means were proposed, but trends of 5-year rolling means highlighted considerable variation, making long-term patterns difficult to discern. For this reason, only indicators that used 10-year rolling means were included in the report card, and in this appendix. The data presented below is from 5 weather stations and was accessed from the Bureau of Meteorology.

The graphs below show seasonal and annual rainfall patterns, temperature patterns, the frequency and duration of heatwaves, as well as the frequency of and duration between extreme rainfall events (>100mm per month) and big downpours (>25mm per day) for 3 climate zones (North, Central and South) in Alinytjara Wilurara NRM region. There were some gaps in the available data. T-tests were performed in SPSS to determine differences between climate indicators within the baseline period (1961-1990, where data were available) and the period since (1991-2013, where data were available). Data from 2014 data excluded because the dataset was incomplete at the compilation of this report.

Future rainfall and temperature data will also be available at Oak Valley, Rodinia Airstrip, Murputja, Sandy Bore, Watarru. Data has been collected at these sites since 2013.

**Rainfall – for the North area**

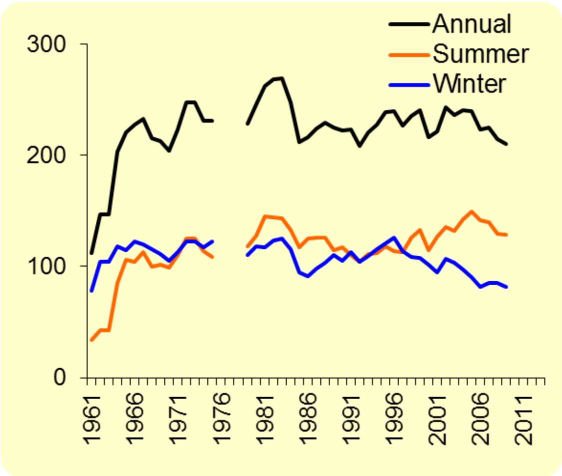



The graph above shows the total rainfall (mm) (10 year rolling mean) since 1961 at Ernabella old station (1961-1983) and new station (1997-2013). Data is presented as yearly, summer (October-March) and winter seasons (April – September). Some monthly data were missing in 8 years, plus all data were missing during the 14 years between the old and new datasets. Missing data prevented the calculation of total rainfall for some seasons and years. In such cases, 10-year rolling means included only the years (within the preceding 10 years) where data were available. Years were calendar years. Comparisons between the baseline and the period since baseline are presented below. Ns= no significant differences between datasets.

| Data period | Mean total rainfall (mm) in baseline period , n (years) | Mean total rainfall (mm) since baseline period, n (years) | Significance for test |
|---|---|---|---|
| Annual | 259.7 (23) | 291.9 (17) | ns |
| Summer | 165.1 (23) | 201 (17) | <0.05 |
| Winter | 93 (23) | 81 (17) | ns |

The comparisons indicate that total summer rainfall has increased since the baseline period. Total annual and winter rainfall amounts have not changed. Most of the rain falls in summer.

**Rainfall – for the Central area**

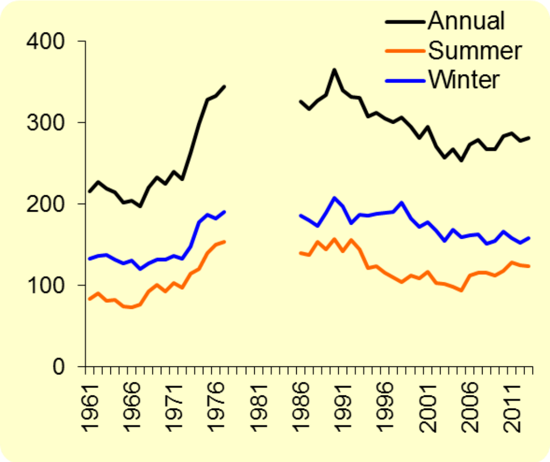



The graph above shows the total rainfall (mm) (10 year rolling mean) since 1961 at Maralinga station (1961-2009). Data is presented as yearly, summer (October-March) and winter seasons (April – September). Some monthly data were missing in 8 years, plus all data were missing during 1976-78. Missing data prevented the calculation of total rainfall for some seasons and years. In such cases, 10-year rolling means included only the years (within the preceding 10 years) where data were available. Years were calendar years. Comparisons between the baseline and the period since baseline are presented below. Ns= no significant differences between datasets.

| Data period | Mean total rainfall (mm) in baseline period , n ( ) | Mean total rainfall (mm) since baseline period, n ( ) | Significance for t-test |
|---|---|---|---|
| Annual | 221(27) | 228 (19) | ns |
| Summer | 109 (27) | 125 (19) | <0.05 |
| Winter | 111 (27) | 102 (19) | <0.05 |

The comparisons indicate that total summer rainfall at Maralinga has increased since the baseline period and winter rainfall has decreased since the baseline period. Total annual rainfall has not changed. Similar amounts of rain fall in winter and summer.

**Rainfall – for the South area**

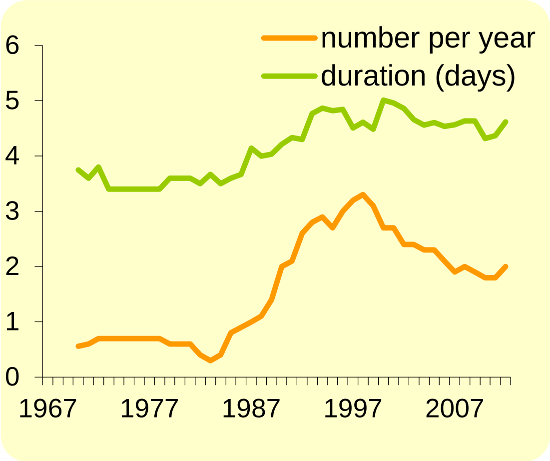



The graph above shows the total rainfall (mm) (10 year rolling mean) since 1961 at Nullarbor station (1961-2013). Data is presented as yearly, summer (October-March) and winter seasons (April – September). Some monthly data were missing in 2 years, plus all data were missing for 8 years between 1978 and 1985. Missing data prevented the calculation of total rainfall for some seasons and years. In such cases, 10-year rolling means included only the years (within the preceding 10 years) where data were available. Years were calendar years. Comparisons between the baseline and the period since baseline are presented below. Ns= no significant differences between datasets.

| Data period | Mean total rainfall (mm) in baseline period , n ( ) | Mean total rainfall (mm) since baseline period, n ( ) | Significance for t-test |
|---|---|---|---|
| Annual | 266 (22) | 290 (23) | ns |
| Summer | 112 (22) | 118 (23) | ns |
| Winter | 155 (22) | 172 (23) | <0.05 |

The comparisons indicate that total winter rainfall has increased by 11% since the baseline period. Most of the rain in this zone falls in winter. Total annual and summer rainfall has not changed.

**Heatwaves – for the North area**

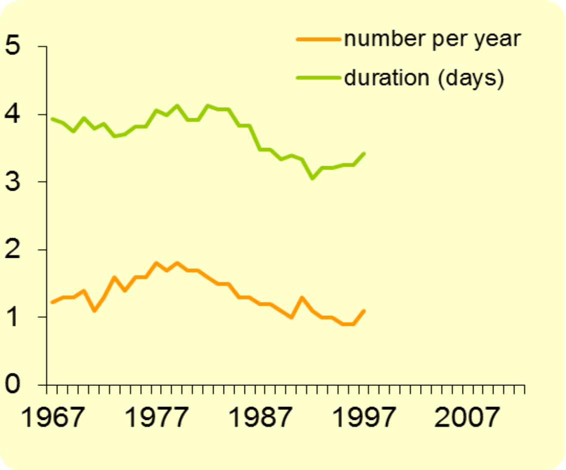



The graph above shows the total number of heatwaves per year and average duration (days) of heatwaves (10 year rolling means) at Ernabella old station (data used 1962-1983), Marla station (data used 1985-2013) and Ernabella new station (data used 1997-2013). Heatwaves were defined as maximum daily temperatures of 40 degrees or more for three or more consecutive days. Years were calendar years. Comparisons between the baseline and the period since baseline are presented below. Ns= no significant differences between datasets.

| Data | Mean in baseline period , n ( ) | Mean since baseline period, n ( ) | Significance for t-test |
|---|---|---|---|
| Number of heatwaves per year | 0.77 (21) | 2.45 (22) | <0.001 |
| Duration of heatwaves (days) | 3.65 (21) | 4.63 (22) | <0.001 |

The comparisons indicate that the number and duration of heatwaves have increased by 218% and 27% respectively since the baseline period.

**Heatwaves – for the Central area**

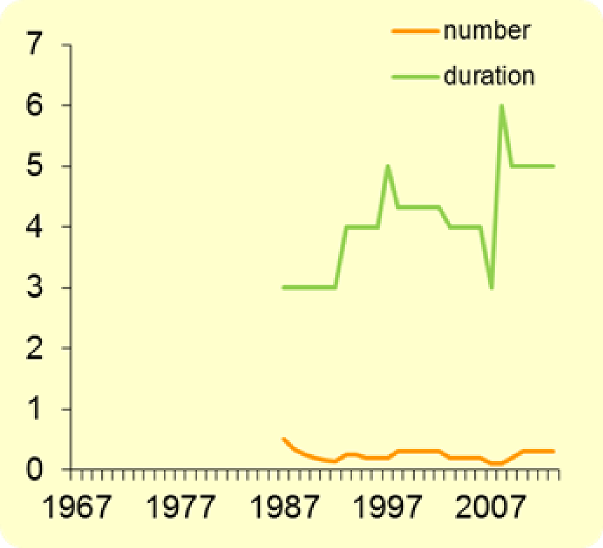



The graph above shows the total number of heatwaves per year and average duration (days) of heatwaves (10 year rolling means) at Maralinga station (data used 1955-1967) and Cook station (data used 1957-1997). Heatwaves were defined as maximum daily temperatures of 40 degrees or more for three or more consecutive days. Years were calendar years. Years were calendar years. Comparisons between the baseline and the period since baseline are presented below. Ns= no significant differences between datasets.

| Data | Mean in baseline period , n ( ) | Mean since baseline period, n ( ) | Significance for t-test |
|---|---|---|---|
| Number of heatwaves | 1.43 (24) | 1.04 (7) | <0.001 |
| Duration of heatwaves (days) | 3.83 (24) | 3.25 (7) | <0.001 |

The comparisons indicate that the number and duration of heatwaves have decreased by 27% and 15% respectively, since the baseline period.

**Heatwaves – for the South area**

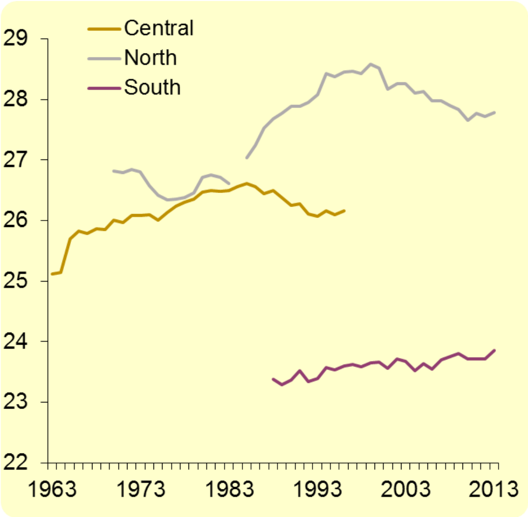



The above graph shows the total number of heatwaves per year and average duration (days) of heatwaves (10 year rolling means) at Nullarbor station (data used 1987-2013). Heatwaves were defined as maximum daily temperatures of 40 degrees or more for three or more consecutive days. Years were calendar years. Comparisons between the baseline and the period since baseline are presented below. Ns= no significant differences between datasets.

| Data | Mean in baseline period , n (years ) | Mean since baseline period, n (years ) | Significance for t-test |
|---|---|---|---|
| Number of heatwaves | 0.36 (3) | 0.23 (24) | ns |
| Duration of heatwaves (days) | 3.0 (3) | 4.24 (24) | >0.001 |

The comparisons indicate that the duration of heatwaves have increased by 40%, since the baseline period. However the baseline data were only for 3 years and more baseline data (from another nearby weather station) would allow a more accurate comparison.

**Maximum daily temperature– for all areas**

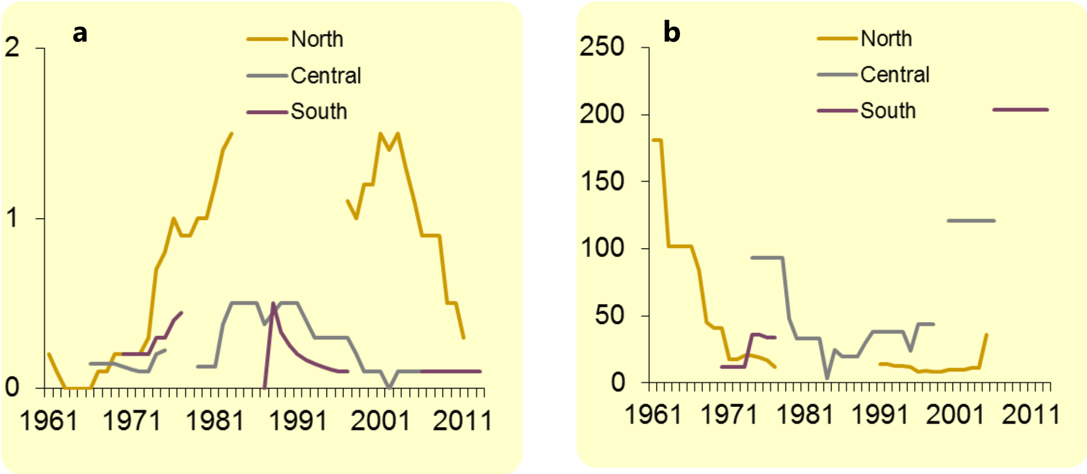



The above graph shows the average daily maximum temperature (degrees C) (10 year rolling means) at Ernabella and Marla (north), Maralinga and Cook (central) and Nullarbor (south) stations (see data durations in heatwave sections above). Years were calendar years. Comparisons between the baseline and the period since baseline are presented below. Ns= no significant differences between datasets.

| Area | Mean degrees C in baseline period , n (years) | Mean degrees C since baseline period, n (years) | Significance for t-test |
|---|---|---|---|
| North max daily temp | 26.9 (20) | 28.1 (23) | <0.001 |
| Central max daily temp | 26.1 (28) | 26.1 (6) | ns |
| South Max daily temp | 23.3 (3) | 23.6 (19) | <0.001 |

The comparisons indicate that the temperature has increased in the North and South by 4.5% and 1% respectively, since the baseline period. Note, the baseline data for the South was only for 3 years and more baseline data (from another nearby weather station) would allow a more accurate comparison. Temperature in the Central area remained stable until 1997, after which data were not available.

**Number and duration of extreme rainfall events (>100mm rain in a month) – for all areas**

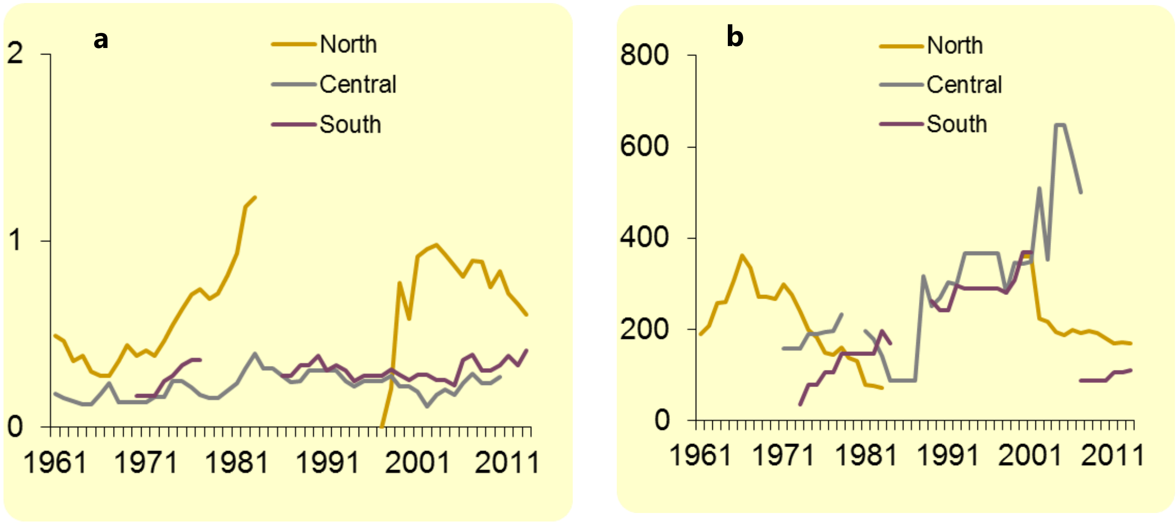



The above graphs show the average number of extreme rainfall events (more than 100mm in a month) per year (a), and duration between events (months) (b). The data is presented as 10 year rolling means at Ernabella (north), Maralinga (central) and Nullarbor (south) stations (see data durations in rainfall sections above). Years were calendar years. Gaps exist in the datasets because missing months of data prevented the duration between events to be calculated. Comparisons between the baseline and the period since baseline are presented below. Ns= no significant differences between datasets.

| Area | Mean in baseline period , n (years) | Mean since baseline period, n (years) | Significance for t-test |
|---|---|---|---|
| North-number of big rainfall events per year | 0.52 (23) | 1.0 (15) | <0.005 |
| Central-number of big rainfall events per year | 0.27 (22) | 0.19 (19) | ns |
| South-number of big rainfall events per year | 0.28 (12) | 0.12 (15) | <0.001 |
| North-duration between big rainfall events (months) | 65 (17) | 12.3 (15) | <0.001 |
| Central-duration between big rainfall events (months) | 47 (17) | 77 (15) | <0.05 |
| South-duration between big rainfall events (months) | 23 (8) | 204 (8) | * |

In the North, the number of events has doubled since the baseline period, and the average number of months between events has dropped from 5.4 years to 1 year. In the Central area, the time between events has almost doubled from 3.6 years to 6.4 years. In the South, the number of events has decreased by more than half. * More data is needed to compare the duration between events.

**Number and duration of big downpour events (>25mm rain in a day) – for all areas**




The above graphs show the average percent of days with big downpours (more than 25mm in a day) per year (a), and duration between downpours (days) (b). The data is presented as 10 year rolling means at Ernabella (north), Maralinga (central) and Nullarbor (south) stations (see data durations in rainfall sections above). Years were calendar years. Comparisons between the baseline and the period since baseline are presented below. Ns= no significant differences between datasets.

| Area | Mean in baseline period , n (years) | Mean since baseline period, n (years) | Significance for T-test |
|---|---|---|---|
| North- % of days with big downpours | 0.57 (23) | 0.73 (17) | ns |
| Central- % of days with big downpours | 0.21 (30) | 0.23 (20) | ns |
| South- % of days with big downpours | 0.28 (13) | 0.30 (23) | ns |
| North-duration between big downpours (days) | 212 (23) | 215 (14) | ns |
| Central-duration between big downpours (days) | 177 (18) | 411 (17) | <0.001 |
| South-duration between big downpours (days) | 75 (4) | 224 (20) | * |

In all areas, the percentage of days with big downpours has remained stable since the baseline period. In the Central area, the average number of days between downpours has increased 1.3 times. * More data is needed to compare the duration between downpours in the South area.

**Indicators of selected natural resources**

More data on the condition of the selected natural assets (below) is required to link impacts of climate change to these assets.

- Rockholes & springs (water dependent ecosystems)
- Groundwater sources for community use
- Biodiversity & animal food species, bush medicine, seeds & plants
- Landscape scale habitats (native vegetation communities)

There was data available for groundwater resources (water level), but the impact of water extraction (for community use) could not be separated from other impacts (i.e. climate change). Until anthropogenic impacts on groundwater can be quantified, the impacts of climate change cannot be measured.

Government of South Australia
Department of Environment,
Water and Natural Resources