Australian Government

MURRAY–DARLING BASIN AUTHORITY

Aboriginal Weather Watchers Project 2016–19

Final Report compiled by the Murray–Darling Basin Authority

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Acknowledgement of the Traditional Owners of the Murray–Darling Basin
The Murray−Darling Basin Authority pays respect to the Traditional Owners and their Nations of the Murray−Darling Basin. We acknowledge their deep cultural, social, environmental, spiritual and economic connection to their lands and waters.

The guidance and support received from the Murray Lower Darling Rivers Indigenous Nations, the Northern Basin Aboriginal Nations and our many Traditional Owner friends and colleagues is very much valued and appreciated.

Aboriginal people should be aware that this publication may contain images, names or quotations of deceased persons.

Contents

Introduction

The purpose of this report is to present the results of the Aboriginal Weather Watchers Project undertaken by the Murray–Darling Basin Authority (MDBA) between 2016 and 2019.

The project aimed to build knowledge on the impacts of weather on Aboriginal people. Specifically, its purpose was to record the impacts of weather on the everyday lives of Aboriginal people in the Murray–Darling Basin and explore the impact of weather on Aboriginal uses and values of water-dependent natural resources.

The aims of the project were to:

- Conduct participatory research (consistent with MDBA Aboriginal engagement principles and the Australian Institute for Aboriginal and Torres Strait Islander Studies (AIATSIS) *Guidelines for Ethical Research in Australian Indigenous Studies*);
- Produce scientifically rigorous and useful evidence of the impact of weather on Aboriginal life in the Murray–Darling Basin;
- Contribute information to MDBA strategic and research functions;
- Be an ongoing component of MDBA cultural awareness training by providing opportunities for MDBA staff to be on Country with Aboriginal people; and
- Enhance MDBA engagement with the Aboriginal community.

Methodology

The project used automatic weather stations installed on the properties of Aboriginal participants, and regular semi-structured interviews with those participants, to review the weather data being recorded by the station and discuss the impact of this weather on their home and work life. Having weather stations located on the properties of participants allowed conversations regarding specific, local-scale weather phenomena as experienced by the participant. The methodology is defined as a hybrid methodology, derived from different types of methodologies used in social science, especially participatory social impact and citizen science. Participatory social impact studies analyse the social consequences of events (e.g. weather) and citizen science is about having public participation in a project. Citizen science utilises members of the public to gather and analyse data about the natural world. In this project, it allowed a channel for engagement and capacity building as well as an opportunity for Aboriginal participants to tell their story about the impact of weather on their lives.

Ethics

The project was guided by the AIATSIS *Guidelines for Ethical Research in Australian Indigenous Studies*. The AIATSIS Ethical Committee endorsed the project methodology before it commenced, and annual reports have been provided to AIATSIS (as an obligation of the approval).

The project was designed and implemented according to the principles of Free, Prior and Informed Consent (FPIC). The underlying principles of FPIC are laid out in a series of international legal instruments, most notably the United Nations Declaration of the Rights of Indigenous Peoples (UNDRIP).

The four pillars of FPIC are:

1. Free (no manipulation or coercion; a process directed by those affected by the project);
2. Prior consent is gained sufficiently in advance and prior to the commencement of a project);
3. Informed (information about the key points of the project have been provided and understood); and
4. Consent (agreement to participation or consultation).

Potential participants were identified based on the following criteria:

- Identified as Aboriginal/ Traditional Owner;
- Familiarity with Country;
- Interest in the research;
- Referral from another Traditional Owner;
- Cultural Authority to manage cultural knowledge (as confirmed by a nominated person in their Nation);
- Status of property where weather station would be located, for instance property ownership, Land Council owned or public land (a school);
- Water Resource Planning area;
- Gender;
- Age;
- Employment status;
- Educational status, including cultural education;
- Physical ability;
- Familiarity to the MDBA; and
- Any work place health and safety issues.

This information was used to select a cross-section of potential participants that reflected demographic and geographic diversity (ensuring coverage of the potential diversity of impacts on social groups). Potential participants were then approached by the Aboriginal Partnerships team about their participation using the FPIC process.

In relation to this project, each participant (17 in total; see below) went through a detailed process to ensure FPIC had been obtained. This was carried out in several stages:

- Stage 1 (late 2016): Potential participants were contacted via phone; other potential candidates were identified using local networks. Consent for an initial visit to potential participants was obtained;
- Stage 2 (late 2016): MDBA staff visited each potential participant in person to discuss the project and consent process. They were provided with information about the project including its purpose, methodology, their role and Free, Prior and Informed Consent (Appendix A). Project information and consent forms were then left with them to make a decision about their participation; and
- Stage 3 (early 2017): Potential participants were visited again. If they agreed to participate, consent forms were signed and weather stations were installed.

Location

Oregon Scientific WMR300 weather stations (Figure. 1) were installed on the properties of project participants, on the basis of strict meteorological site requirements to reduce the influence of radiant heat or wind deflection. A total of fifteen (15) weather stations were installed, in Charleville (Qld), Mitchell (Qld), Murra Murra (Qld), Dirranbandi (Qld), Goodooga (NSW), Lightning Ridge (NSW), Walgett (NSW), Brewarrina (NSW), Dandaloo (NSW), Geurie (NSW), Narrabinya (NSW), Hay (NSW), Gerard (SA), Swan Reach (SA) and Raukkan (SA) (Figure. 2). Locations included missions and reserves, schools, private homes and properties owned by the Indigenous Land and Sea Corporation. Eight of the weather stations were located in the northern Murray–Darling Basin whilst the remaining seven were in the southern Murray–Darling Basin. Four stations were in Qld, eight in NSW and three in SA. Because property owners changed during the study, there were a total of 17 participants.

Figure 1: One of the project participants inspecting his weather station.

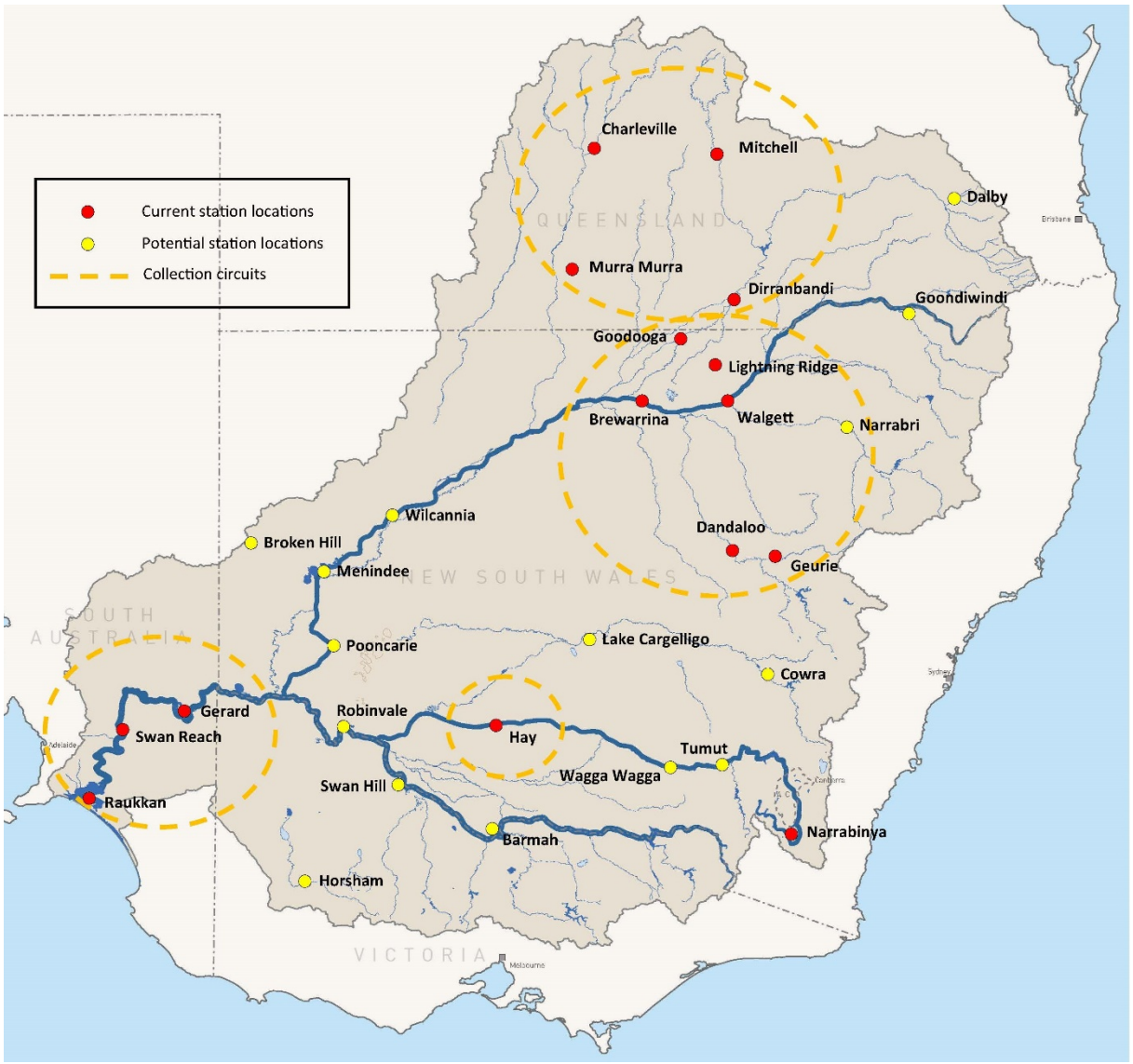

Figure 2: Weather station locations, potential station locations and collection circuits.

Each of the weather stations were grouped into a collection circuit (see dashed lines in Figure. 2). These circuits were assigned to MDBA staff as an ongoing circuit to manage for efficiency and consistency. This allowed multiple sets of data to be collected in one field trip. Furthermore, having the same team member visiting and collecting data from the same participant fostered long-term relationships and built trust. This was particularly important as collection of the data required team members to be invited onto the participant's property and often into their homes.

Data

Weather Data

Stations recorded weather information (e.g. inside and outside temperature, wind speed and direction, humidity and rainfall) every fifteen minutes. Weather stations wirelessly sent data to a display unit usually located inside the house of the participant (Figure. 3), where it was recorded. A laptop was used to download this recorded data and transfer it into a Microsoft Excel file.

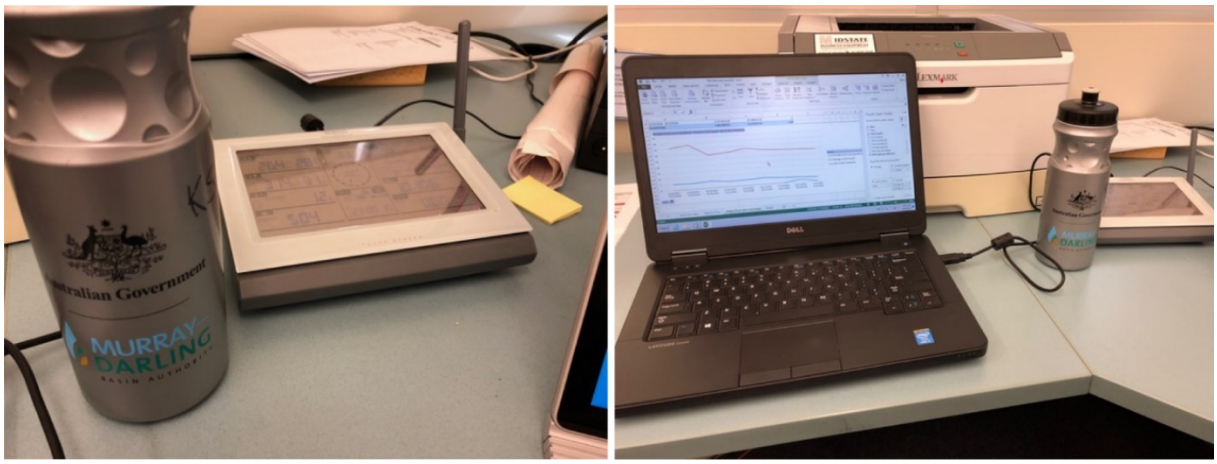

Figure 3: Internal display unit (left photo) that stores the weather station data until downloaded by a laptop computer (right photo).

The participants and the MDBA staff member used this Excel file to examine the weather data that had been captured during the collection period since the last interview. This was used to assist the participants in talking about their observations, and impacts, of the weather. Figure 4 shows an example of the type chart produced in Excel. In the third interview round, Bureau of Meteorology (BOM) observations from a nearby location were used to prompt discussion, when data was unavailable from participants' weather stations (either due to a data recording failure or an inability to download the data during the interview).

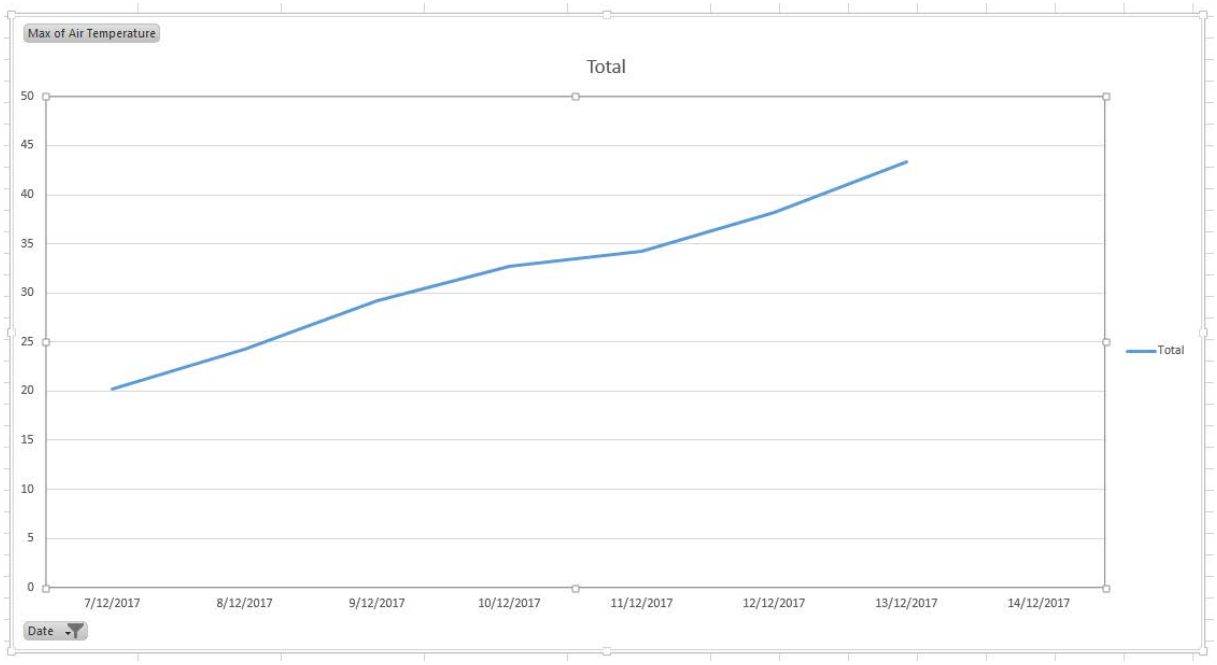

Figure 4: An example of one the charts produced through the weather station download procedure. This graph shows the daily maximum outside temperature (degrees Celsius) over a one-week period, from 7/12/17 to 14/12/17, at Gerard, SA.

Interviews

Semi-structured interviews were conducted with each participant, coinciding with the download of the weather data. The purpose of the interview was to draw out the participants' experience in relation to the weather data that had been recorded by the weather station. This allowed participants to discuss the impact of weather, often forming the core of the interview discussions.

The project involved a total of three interview rounds: January-June 2018 (Round 1), August 2018 (Round 2) and March-April 2019 (Round 3) (Figure. 5). Not all participants were able to be interviewed in a given round. The number of interviews was 12, 4 and 14, for Rounds 1, 2 and 3, respectively (*n* = 30 interview responses for the project).

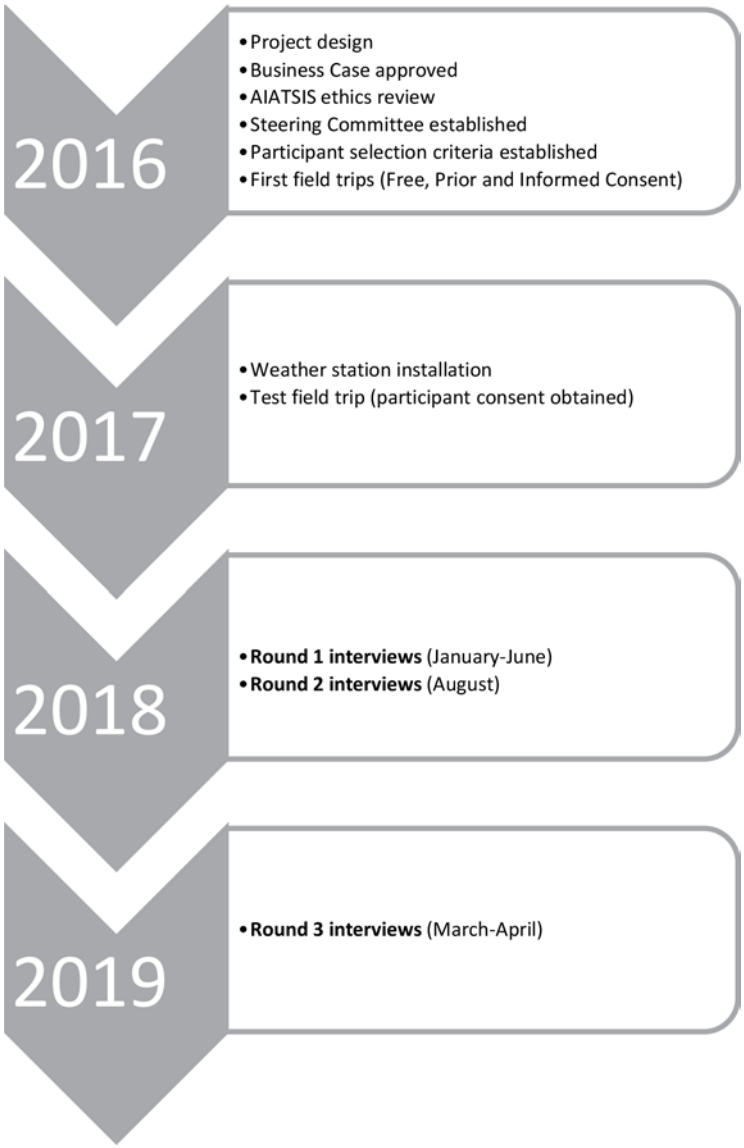

Figure 5: Timeline of interview rounds for the Aboriginal Weather Watchers Project.

The project had an ambitious plan to interview all participants every three months, until 2021. Early in the project, however, it became clear this interview frequency was unable to be achieved with the level of resourcing assigned to the project. As such, the 3 interview rounds, from August 2018 to April 2019, were fewer in number and over a shorter timespan than had been initially planned. The

decision to reduce the number of interviews and shorten the project was also made in the context of a) the increasing failure of the weather stations (weather data was not obtained for about a third of the weather stations visited in round 3), b) similar data (apparent after the first interview round) being available from nearby BOM weather stations and c) the communication of other, related initiatives that could be adopted by Aboriginal Nations (e.g. the development of seasonal calendars through a framework developed by the BOM).

Interview questions (Appendix B) were modified slightly between rounds, however, were consistent with the original intent of the research to examine the impact of weather on the everyday lives of Aboriginal people. Broadly speaking, participants were asked to discuss what the weather meant to them, the impact it had on their lives and environment, and identify a specific weather event that had occurred during the period for which data had been recorded by the weather station. Participants were also encouraged to collect photos or other relevant material. The third interview round asked questions around the drought that was currently occurring and on climate change.

To analyse the interview responses, transcripts were 'coded' with one or more categories (nodes) in the software program Nvivo 11, relating to the different types of weather phenomena (e.g. *heat wave or spike*, *rain*) and the negative (e.g. 'negative impacts on work/education', 'bad for native fauna') and positive (e.g. 'good for native fauna', 'happiness/hope/comfort') impacts of the weather.

Participants were given the option of receiving either a diary or camera, to capture weather observations that may not have been apparent in the weather station data and to serve as a reminder in subsequent interviews. Not all participants chose to refer to these during interviews; participants were generally very accurate with their recollection of weather events, such as the timing, duration and magnitude of events like heat waves, days of record temperatures and significant rainfall events. As a citizen science project, correlating these qualitative interviews with the quantitative science was one of the aims of the project. Their descriptions of these events correlated well to quantitative data shown and discussed during interviews. Participants were comforted by a confirmation that what they experienced and observed matched the 'official' observations of either their own weather stations or a BOM weather station nearby. Participants would also recall additional events or more detailed observations once they began their interview, and so the information offered would increase as the interview progressed (and perhaps because of their increasing level of comfort with the interview process and interviewer).

Results & Discussion

Weather conditions

The data collection (interview) period, January 2018 to April 2019, was characterised by very hot and very dry conditions, particularly in the northern part of the Murray–Darling Basin. Based on rainfall deficiency, many areas of the Basin during the study were experiencing the worst drought on record[1] (Figure. 6). This includes the Barwon catchment, which in July 2019, recorded its lowest ever rainfall totals in the preceding 18-, 24- and 30-month period. The effect of this rainfall deficiency is clearly evident in dry creek beds and rivers that ceased to flow during the period. However, groundwater aquifers were also low, and in some areas, lower than during the Millennium Drought.

In addition to being dry, most of the Basin was significantly hotter than average during the study period[2] (Figure. 7). The summer of December 2018 and January 2019 was particularly hot, and in some areas, the hottest on record (for indicators like the number of days above a given temperature, maximum daily temperature, etc.). Above-average temperatures persisted for extended periods and were widespread.

The combination of hot, dry conditions resulted in high evaporative demand and record dry soils, which meant that any rain that did fall typically entered the upper parts of the soil profile without reaching groundwater aquifers or running into streams. The drawdown on storages across the Basin continued during the period, resulting in diminishing and in some cases, record low storage levels. Dry soils and low vegetation cover (as a result of low primary productivity) made much of the Basin susceptible to dust storms during the study period, particularly with windy conditions in the summer months (Figure. 8).

The drought impacting the Basin during the study resulted in creeks and some major rivers such as the Darling River ceasing to flow. Stream channels receded to a series of disconnected waterholes and some of these waterholes dried completely. In December 2018 and January 2019, a series of mass fish death events occurred throughout NSW, most notably on the Lower Darling River near Menindee[3]. These events are expected to be more common with lower and more variable rainfall expected with future climate change scenarios.

The interviews analysed in the following sections offer insight into the lived experiences of these extreme weather conditions.

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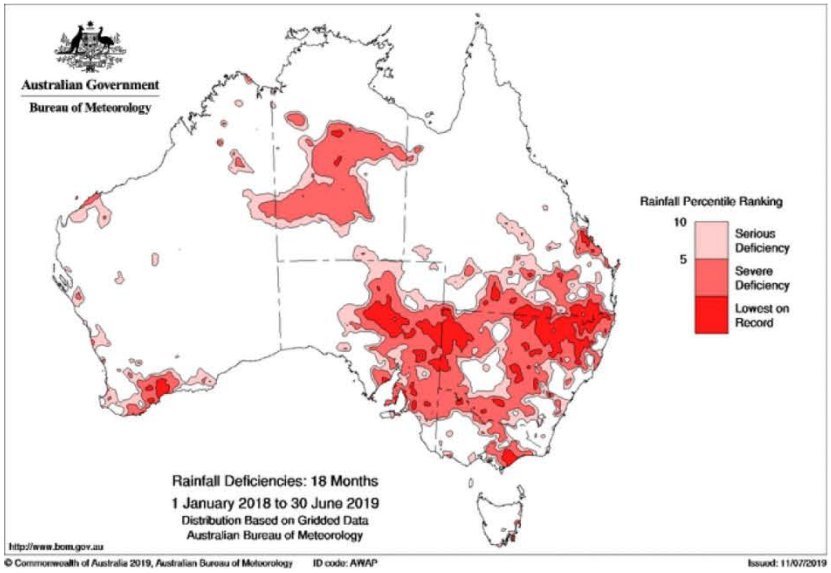
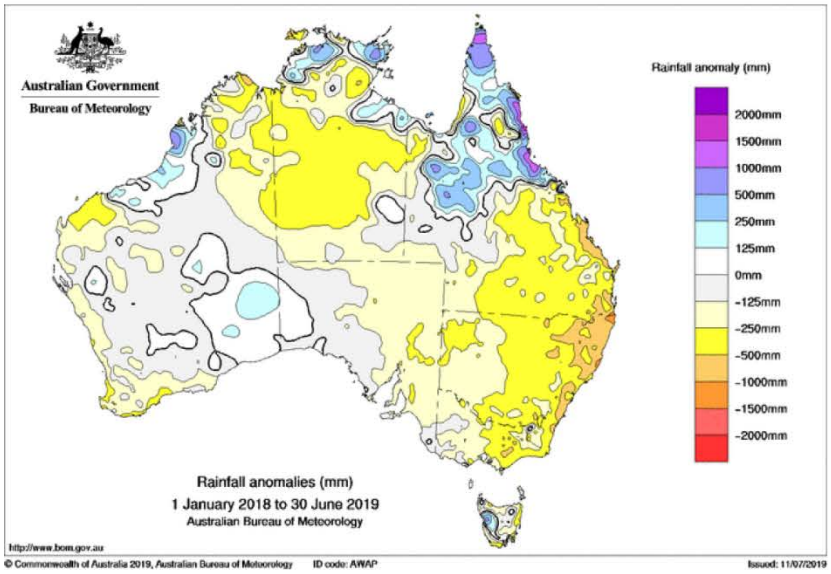
[1] Bureau of Meteorology (2019) *Special Climate Statement 68 – Widespread heatwaves during December 2018 and January 2019.* Bureau of Meteorology, Melbourne.
[2] Bureau of Meteorology (2019) *Special Climate Statement 70 – Drought conditions in eastern Australia and impact on water resources in the Murray–Darling Basin.* Bureau of Meteorology, Melbourne.
[3] Vertessey R, Barma D, Baumgartner L, Mitrovic S, Sheldon F and Bond N (2019) *Final report of the Independent Assessment of the 2018-19 fish deaths in the lower Darling*. Report prepared by an independent panel for the Minister for Agriculture and Water Resources, The Hon David Littleproud.





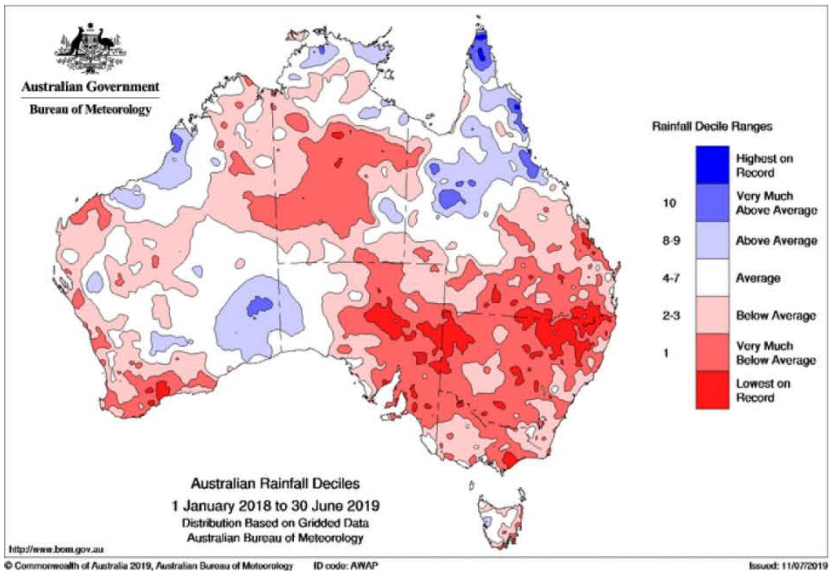
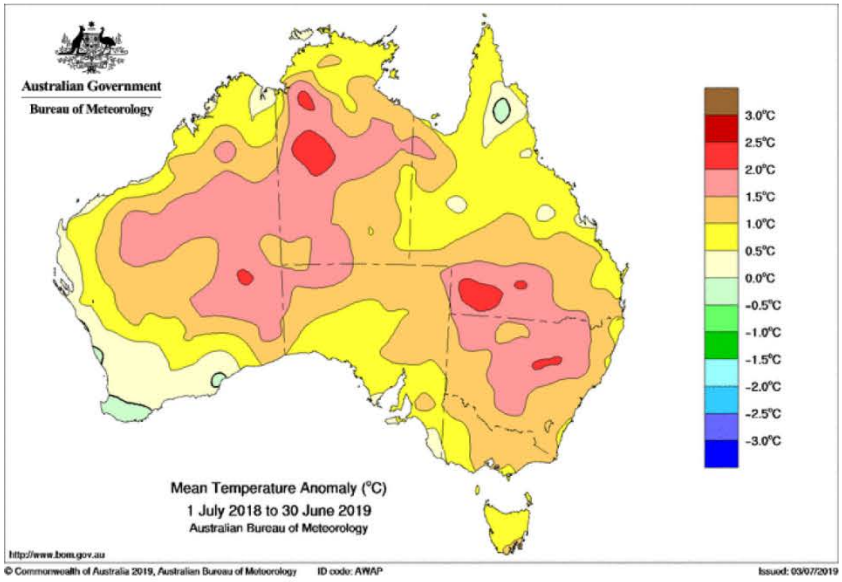
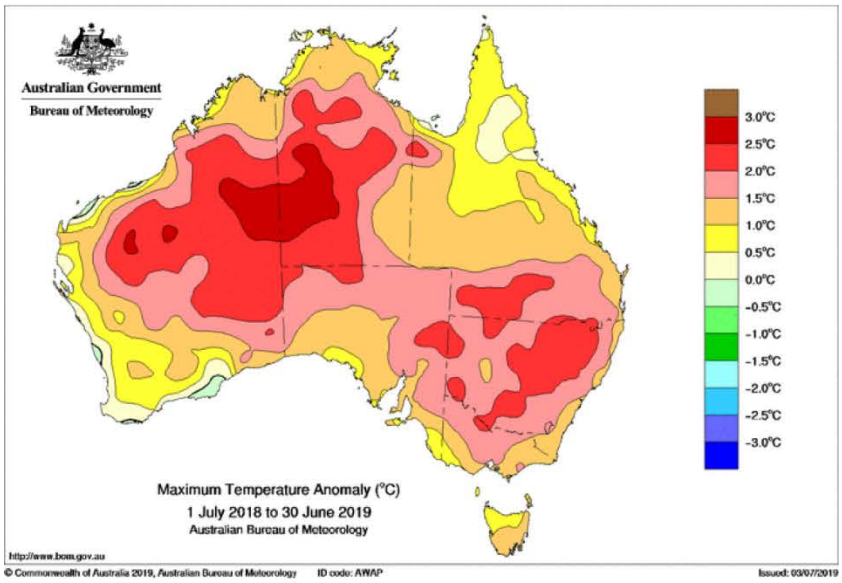


Figure 6: Maps showing rainfall deficiencies, rainfall anomalies and rainfall deciles for the period 1 January 2018 to 30 June 2019.





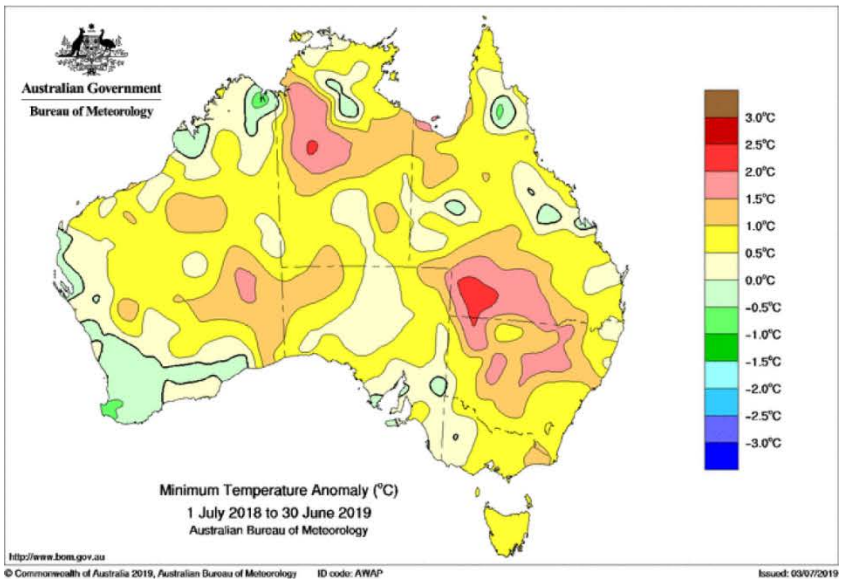


Figure 7: Mean, minimum and maximum temperature anomaly for the period 1 July 2018 to 30 June 2019.

Figure 8: Dust storm near Blanchetown, South Australia, 5 April 2019.

Interview responses

Considering all interview transcripts (*n* = 30 interviews), ‘water’ (211 references) and ‘rain’ (165 references) were the most commonly used words by participants (Figure. 9).

Figure 9: Word cloud using all interview rounds and all participants. The figure presents the most commonly occurring words in those transcripts, with the most common words being larger.

The frequent use of terms like ‘water’ and ‘rain’ indicates a strong focus on these subjects by participants in their interviews, which took place in the midst of the hot, dry conditions affecting much of the Murray–Darling Basin at the time. As mentioned above, the preceding months were generally characterised by warmer than average temperatures and below average rainfall, particularly in NSW and Qld. References to *rain* or *water* were usually in relation to a deficit, that is, below-average rainfall or a lack of water in rivers.

Phenomena

Interviews commenced with participants being asked a question about recent weather – 'how has the weather been in your part of the world since we were last here?' Participants mentioned a number of different weather phenomena. The most commonly spoken about phenomena (as per the nomenclature of the pre-determined nodes or categories) were 'heat wave or spike' (71 references), 'no or very little rain' (48 references), 'rain' (46 references), 'extreme/unusual variability' (41 references), 'drought and dust/dust storm' (32 references each), 'unseasonal weather' (29 references), 'wind' (23 references) and 'cold' (20 references) (Figure. 10).

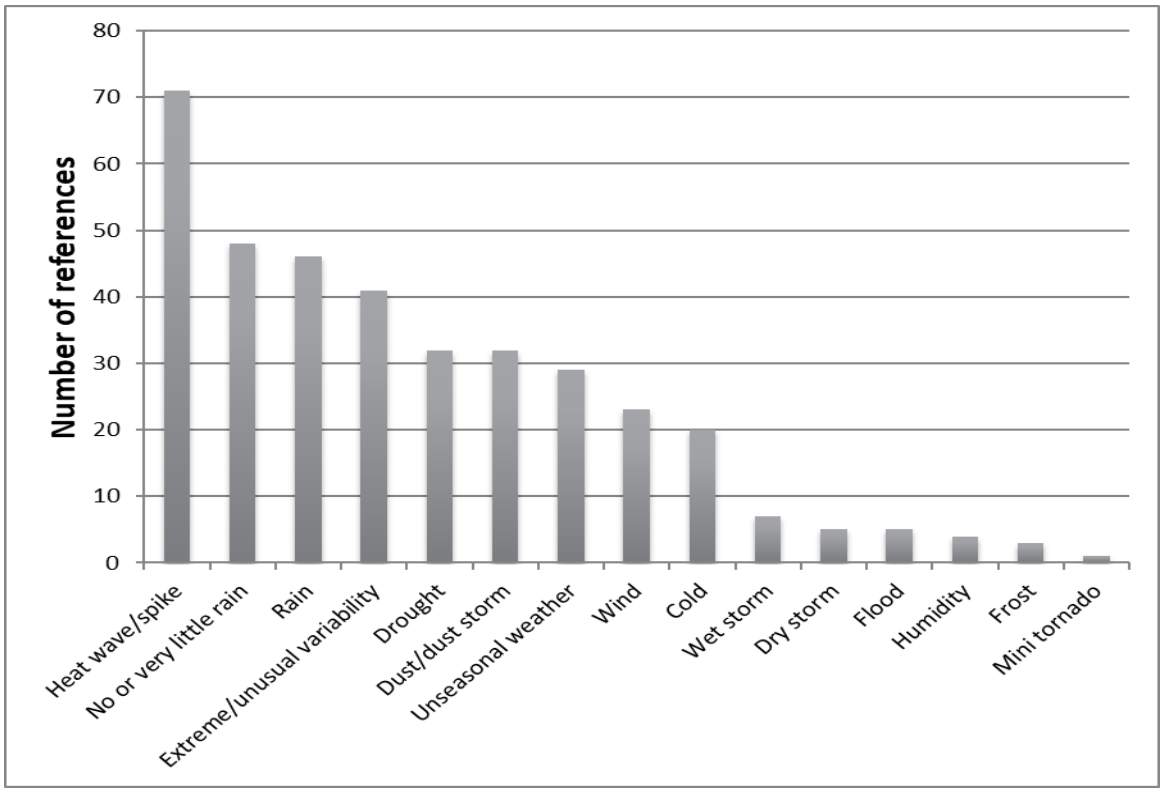


Figure 10: Number of references to weather phenomena, in all interviews (*n* = 30), by all participants.

Like BOM observation data suggests, there was a general consensus by participants that the summer of 2018-2019 was much hotter than average, with record-breaking maximum and minimum temperatures, extended periods of elevated temperatures, and a greater number of heat waves ('*hot all day every day'*). Participants in central NSW in particular recounted that the temperature had been up to 48°C, 50°C or even over 50°C in January 2019, and stated that winter was also warmer than average, in the 30s (°C) and sometimes 42°C. Even the NSW/ACT High Country and the Riverland in SA experienced temperatures into the 40s (°C), which was significantly hotter than the average for those areas. Participants spoke of the lack of relief from the heat, where even overnight minimums were in the high 30s (°C) and even the early morning was still hot. At least in some parts, although there were warm days through winter, there was some relief in the winter mornings with cooler temperatures. One participant stated even the artesian (ground) water was hotter than normal.

One participant spoke about a day where it reached 53°C and said '*you can put a frying pan out there and cook an egg…I did, just for the fun of it...You put the pan outside first, when see it bubbling, then you put the egg on.*'

As mentioned above, references to rain were usually in relation to a deficit ('no or very little rain' or 'drought'), indicative of the conditions at the time of the interviews and in the months prior (hot and dry). Participants would often recall recent conditions, stating that it had not rained in that location for a certain number of weeks or months, or that they had received a certain amount of rainfall at a certain time period (e.g. '*we got 24, 25 mills of rain out of the blue the other day*'). Of course, it had rained during the study period, but often only '*the odd shower*' or '*a few sprinkles'*, which would '*just wet the ground*', '*dry up as soon as it hits the ground*', '*just sink straight in*' or run-off the ground, because of the dry surface and also in some cases, high winds (due to evaporation). One participated added '*you don't call that rain*' – a reference to small, patchy showers. When asked about whether a town in central NSW had received any rain, a participant stated she needed to look up the word 'rain' in the dictionary. The promise of rain, where clouds are seen but do not result in rainfall, was sometimes described in association with high humidity.

Round 3 interviews asked the question: 'are you experiencing drought here at the moment? If yes, describe what the conditions are like, and, how does drought impact your everyday life?' For most participants, the first part of this question was answered quickly and with the affirmative, such as '*oh yeah, big time drought!*' The impacts of the drought were of great concern to participants, and sometimes made them emotional during the interviews as they recalled the direct impacts but also the sense that Country was dying or sick (see Figure. 11, a site mentioned in this respect by a participant).

Figure 11: Weir at Goodooga, NSW, in March 2019.

Participants were very clear that the current drought affecting much of the Murray-Darling Basin is the worst in living memory for them, even worse than the Millennium Drought in the late 2000s. Some participants recalled seeing waterholes with at least some water in them during the

Millennium Drought, but these had now dried up completely. By contrast, South Australian participants were not stating they were in drought, but '*getting there*' (in March 2019).

At least three participants reported local-scale weather patterns (normally with respect to rainfall), such as where places either side of their property receive more rainfall than they do. Participants were of the view that natural features, large water storages and land clearing were responsible for these local weather patterns. One participant noted '*trees make the weather better*' (she had particular interest in revegetation programs for her local area).

Many participants reported dust storms over the summer months (Figure. 12), which were often associated with high winds. One participant commented that he would '*look to west and see it [the dust storm] coming. Looks like rain until you see the orange and red, then you feel the wind*'. High winds often raise the topsoil into the air, especially in drought-affected areas with minimal vegetative cover, creating dusty conditions outside of a dust storm event.

Figure 12: Dust storm approaching the property of one of the participants during the study.

Positive impacts

Participants were asked about the impacts of weather phenomena on their lives and those of other Aboriginal people living in the Basin, in both their work and home life. In total, there were 83 references to positive impacts. The most commonly reported positive impacts (as per the categories / nodes) related to those that were 'good for native fauna' (22 references), 'happiness/hope/comfort' (21 references), those that were 'good for native vegetation' (15 references) and 'recreation' (13 references) (Figure. 13). Given the dry conditions, however, note that participants often discussed these impacts conceptually, rather than report actual observations from the study period.

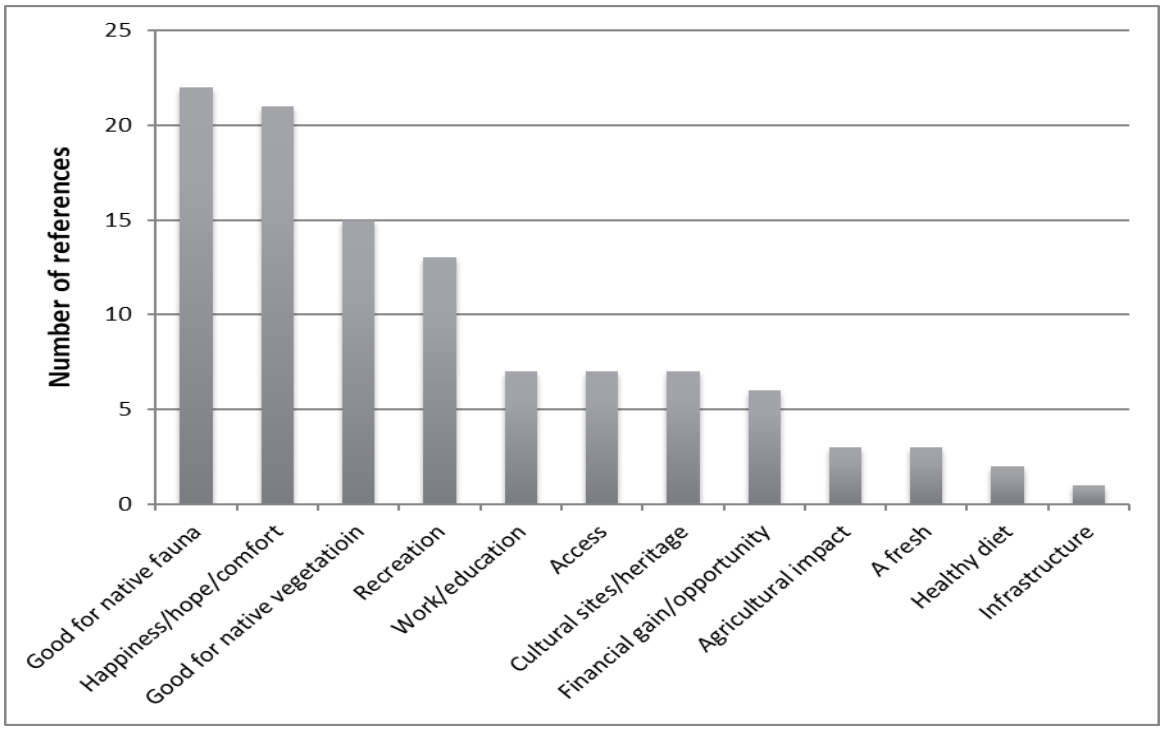


Figure 13: Number of references to positive impacts of the weather, in all interviews (*n* = 30), by all participants.

With respect to impacts that *were 'good for native fauna' and 'good for native vegetation', participants stated that in good seasons, after rainfall, Country* '*bounces back'* and healing occurs in nature. For example, '*rain regenerates things. Rejuvenation. The old girls [large Eucalyptus trees] get their healing, gives them a drink. The land and animals get their healing too'*. Participants reported specific animals being present or abundant as a result of rain, depending on their local area. These included porcupines/echidnas, fish, yabbies (booglies), kangaroos, emus and birds. For the participants, the abundance of certain species was particularly important for totem animals, and it was important for them to be able to see their totem species in abundance. In addition, when native food sources are present, this allows participants to go hunting or fishing ('recreation'). Despite the drought, one participant stated there are permanent waterholes, where you can see fish habitat better, to know where and when to fish when the water levels rise again.

For people too, '*river water cleanses the soul*'. Participants commonly reported an improvement in their mood when it rains. For example, '*when we have lots of water, we are happy'* and also '*[rain] brightens the town up, brightens up the people in the town; everyone is happy*'. *'When it rains and the leaves are all green on the trees it changes your mood and you notice how everyone else is happy with the rain*'.

Rainfall also provided a sense of relief in participants, for example '*you can feel the relief. Makes you feel happy, like going out and dancing in the rain. You can see it in everyone*'. Participants would often talk about recreational activities (which had a positive effect on happiness), such as spending time by the river, following rainfall or when river levels were high.

Particularly apparent during interviews in early 2019 was a sense that the community had been brought closer together as a result of the drought. It was reported that councils and organisations like Rotary have been contributing to the drought-relief effort, such as donating drinking water and hay ('hay runners'). One person reported that there is more help available now because of social media

connections (virtual communities). It was stated that the drought brings out the best in people, as seen with the generosity of those in cities assisting rural communities. In addition, the drought has resulted in new collaborative working arrangements and a greater commitment to working together with existing partners. One participant reflected '*all of us can fix it if we get together. We're all trying to work together. How can we look after the corridor on the river system*' Another participated stated '*we all get together and talk about weed management now. We all work together now*'.

As a result of the drought, people are also more conscious of how they use water and the importance of managing natural resources, which could be seen as positive. For example, '*it [the drought] has made us more aware of how delicate the environment is. It never used to get a mention, now people are more mindful. It's a conversation that was never had much around the weather. Now more mindful people are farming in a more sustainable way than they were before*'.

Other positive impacts of weather phenomena included the financial benefit of not having to buy so much firewood during winter (because of colder weather), having frost in winter kill weeds, and the fun of playing footy during dust storms (reported by the students at Goodooga Central School).

Negative impacts

Participants spoke about the negative impacts of weather far more often than they did positive impacts, reflecting the climatic conditions affecting the region during the study period. In total, there were 309 references to negative impacts. The most commonly spoken about impacts were those related to 'work/education' (62 references), those that were 'bad for native fauna, infrastructure' (49 references each), 'cultural heritage' (42 references), 'sadness/dread/anger' (41 references), 'medical risk' (41 references), 'financial loss or risk' (39 references), those that were 'bad for non-agricultural vegetation' (33 references) and 'recreation' (32 references) (Figure. 14).

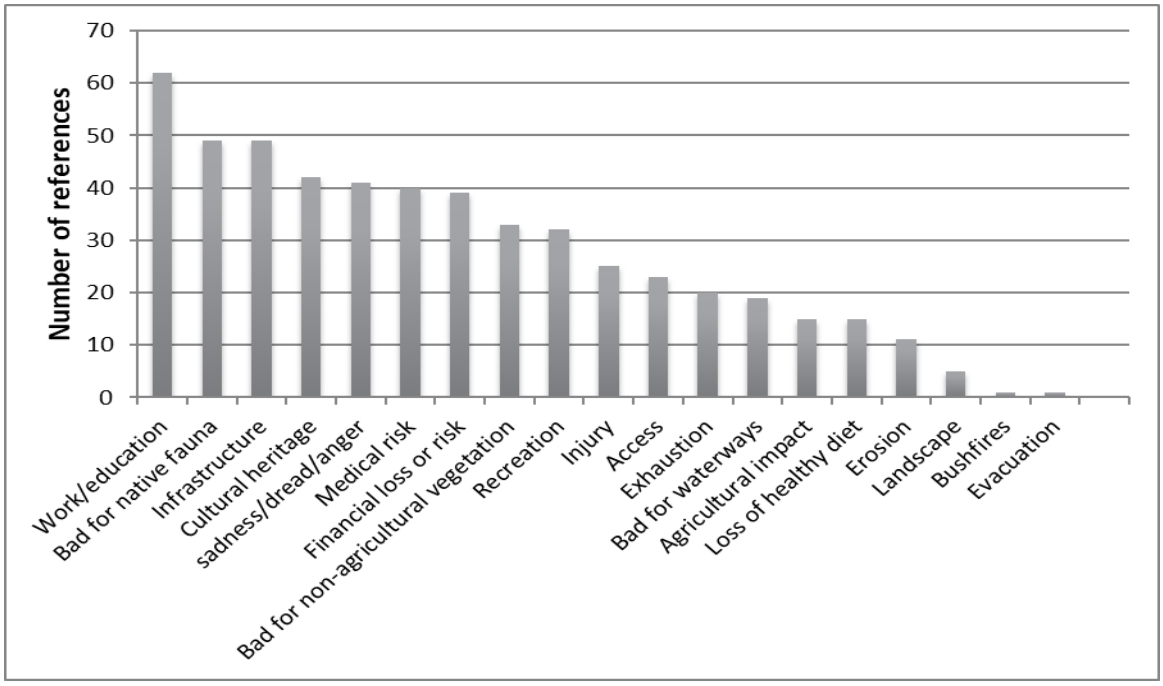


Figure 14: Number of references to various negative impacts of the weather, in all interviews (*n* = 30), by all participants.

Work / education

Many participants were employed during the study period, often in roles where most or all of the work was outdoors (e.g. as a nursery hand and ranger coordinator). These participants spoke of the negative impacts of the weather (usually the heat, cold or rain) on their work. Generally speaking, activities were not undertaken in times of extreme weather, or were undertaken with modifications, either to the nature of the activity or the timing. When participants were not able to do the activities they would normally do, this resulted in work schedules being delayed, less work being done (e.g. shearing less sheep on hot days), work having to start later, work needing to be done seven days per week, different sites being visited, or different activities being undertaken.

In hot weather, people who work outside generally reported starting earlier and finishing earlier, to avoid the late afternoon heat (although this still resulted in uncomfortable conditions). At the Brewarrina Shire Council (where one participant was employed in an outdoors-based role), working hours on such days were typically 6.00am-2.00pm. At least one participant described a daily routine where they would work until about lunchtime, and then '*find a place to keep cool, sometimes by the river and swimming, sometimes in aircon*'. For some, work hours were less on days of extreme heat, for others, they worked the same number of hours. Goodooga Central School students do not have a shorter day but their hours were brought forward (8.40am-2.40pm). These students also had access to the on-site swimming pool. Furthermore, when it is too hot outside, students '*…play sport in the hall…'* instead.

For those participants who had the option of working inside (e.g. in a shed), they took advantage of that, often undertaking routine maintenance activities. However, for some participants, this created a backlog of work in the field, and this was on their mind, that they had to make up for lost time. For some, driving around in air-conditioned vehicles was another viable option. On particularly hot days or during heat waves, sometimes work was not undertaken at all, owing to health and safety risks. Participants who supervised staff were mindful of their staff suffering heat stroke, particularly the people not used to extreme heat.

Participants often reported that they or their staff had difficulty being motivated on days of hot or cold, windy weather, and it may be difficult to attract volunteers on those days. Some rangers would only want to work in air-conditioned vehicles on hot days. Participants mentioned workplace health and safety risks with having staff outdoors on days of severe weather such as heat waves. Heat stroke was mentioned as a concern, especially when field staff were not used to working in hot conditions (and not used to drinking a lot of water). On these days, staff were not as productive, requiring more work to be undertaken when the weather conditions improved. Similarly, at the Goodooga Central School, children reported that they would prefer to stay inside on hot days and their teacher said it was hard to get the students to do their work.

Cold weather had a similar effect on the work lives of participants. When it is cold, participants often chose to work indoors where a heater is available (e.g. '*work indoors and turn gas heater on in big shed*'). One participant spoke about starting later or sitting in the car with heater on. For a participant who undertook guided tours on Country, she described how when it is cold and rainy, they cannot take people on guided walks and have to undertake boat tours instead. Similarly, when it is raining, cultural heritage staff do not undertake surveys. Rather, time is spent fixing roads. When it rains, weed spraying is avoided and weeds like Noogoora burr, Bathurst burr and Bindi eye flourish.

Cattle businesses are particularly affected by drought. Participants with cattle had to agist or sell them, reduce stocking rates, bring in feed and for some, truck in water. Stock need to be rotated around paddocks more often and water use is made more efficient where possible, including using polypipe.

For a participant who worked at a nursery, watering went from every second day to daily or even twice per day, and from 10-15 min to 30 min each time. This undoubtedly increased the cost of the nursery operation. This participant also spoke of a new wetting agent that they are trialing in the field, to enable the soil to hold more water and prevent plants from drying out between watering events.

Native fauna

Participants described how the '*animals are all dying*', and often stated which animals were seen in reduced numbers (or not at all) because of the drought, including the Goodoo (Murray Cod) and other fish, birds, kangaroos, crayfish/yabbies (booglies), rabbits and pigs. Participants described how even when present, these animals were often in poor condition (e.g. kangaroos and emus) because of the lack of feed (and green pick). This is significant from a cultural perspective, where these animals are totemic (e.g. kangaroos), for some Nations or individuals, or have importance for bush tucker. The sight of totem animals in poor condition (or disappearing) causes significant distress to these individuals, as they cannot carry out their cultural obligations. It was also apparent that the weather had resulted in changes to the distribution of animals, where participants described both kangaroos and birds coming into town to access artificial water sources and irrigated green lawns.

Round 3 interviews included the question: 'Has the climate changed here? If yes, explain how, and, how does the new climate impact your everyday life?' Without exception, all participants stated that it was hotter and drier (with longer periods of extreme heat), compared to when they were younger. This is consistent with BOM observation data that indicates a 20-year trend of increasing temperatures and a decline in cool season rainfall across most of the Murray–Darling Basin. Some participants stated there were significantly more dust storms and that it had become more humid.

Participants described local observations regarding changes to the abundance, distribution and migration of native animal species. For example, participants described how the mating period for echidnas has become earlier, Cape Barren geese were arriving in and leaving the Coorong several months later than normal, and lower numbers of birds, eastern longneck turtles, fish (including yellowbelly), snakes, frogs, koalas, insects, dunnarts and geckos. For example, '*birds are not here anymore like they used to be. Koala: we haven't seen many of them anymore. Snakes: we used to get about 5 a season. I only seen one this year and it was a python. It ate the cat*'. In terms of native vegetation, one participant described how there was a lack of spring germination (native or introduced species), including bush medicine species, even after a little rainfall.

'*I haven't seen a frog for years. I remember when there used to be frogs out here in my garden. Not anymore, and I would know, I hate them, I have a phobia about frogs. When I first came to [name of locality redacted] it was a lot more lush than it is, looking out this gully here my mother sat out here and said "I never knew there was so many shades of green" and she was right. It's all covered in dust now, I would have to say it's changed over the last 20 years'*.

Part of these changes to the abundance, distribution and migration of native animals could be attributed to the lack of surface water resources at this time. Participants spoke of how, in the past,

there would always be permanent water holes keeping fish and native animals alive, but now even they have dried up. '*Rivers [are the] driest I've ever seen. [The] weir [has] never been dry like that before. All the big water holes are dry*'.

Some participants described changes to the timing and direction of rainfall events, and also offered an explanation to the cause of these local-scale changes in weather patterns. The most commonly stated cause of shifting rainfall patterns (either a reduction or change in distribution) was land clearing for agriculture (particularly cotton). Many participants also described situations where their neighbours would receive rainfall, but not their properties.

Infrastructure

Participants reported power blackouts or brownouts during times of extreme heat (due to excessive loads) or as a result of electrical storms. From a welfare perspective, participants indicated that this could compromise access to emergency services when phone lines were not working. Furthermore, a lack of telecommunications also made some participants feel stranded and socially isolated.

It was also stated that extreme heat and drought placed a load on water infrastructure and water supplies. For example, one participant stated that water supplies were placed under strain when kids would play with the hose on hot days.

The most significant damage to infrastructure related to roads, which would melt or crack in extreme heat, especially when large trucks were using the road. It was also reported that tees or limbs would fall during windy conditions, potentially landing on houses and sheds, and also that mini tornadoes blow roofs off houses.

In cold weather, a participant stated that it takes longer to warm up mechanical equipment. Hydraulics need to warm up, otherwise parts (and tools) could break, leading to more down time and costly repairs.

Culture

Whilst participants reported impacts of the weather on culture, participants were often unwilling or unable to express the exact nature of these impacts, particularly for cultural or spiritual elements that are intangible (e.g. '*when it's dry, Country is sick'*). This difficulty is also related to the concept that 'culture is everything' and exists within all other things. When talking about the weather, one participant said, '*it just impacts your whole wellbeing and it impacts your cultural side of things*' and another, *'rivers were everything'.*

Two participants stated that flooding and severe rain events would uncover burial sites, which led to repatriation and restoration works being required. For example, *'the rain in December pelted down and uncovered some burial sites. We had to do recovery works with the truck and bobcat as they were exposed'.* Another participant, however, was not concerned about the uncovering of burial sites.

One of the most significant cultural impacts of the weather is the impact on bush tucker availability (including porcupines, kangaroos and emus); Aboriginal people in the study still relied on native plants and animals that they, or others, obtain. One participant even described **needing** bush tucker in their diet. Impacts relating to diet were almost always in relation to dry conditions or low flows

more generally, and the impact this had on bush tucker availability. For native plants, dry conditions have affected the flowering and fruiting of some species, some have dried out, making them bitter to the taste, and for some bush medicines, affects their potency. One participated stated he has not been able to collect bark (for coolamons) and spinifex resin because of the drought (moisture from frost and sap in the bark would make the bark easier to lift off). Furthermore, with fire bans, one participant described how she could not have a fire for a smoking ceremony. Participants expressed significant worry on the condition of native animals that were suffering in the drought. One participant bought 'nuts' for kangaroos to eat, and would place small bowls of water and water the lawn for birds and kangaroos.

Whereas people would often be at the river fishing for yellow belly and crayfish, 'yarning' and sharing bush tucker, participants described how this does not currently occur because of the drought and the lack of water in the rivers. Even where animals or fish may be present, participants recognised the need to avoid taking them at that time. Not only has the drought made such activities impossible (e.g. fishing in a dry river bed), it was described that Elders don't **want** to go on Country. It was also stated that cultural activities (centered on the river) at the Goodooga Central School had stopped because of the drought.

In response to the drought, participants spoke of cultural activities to make it rain. One participant stated, in jest, that she would '*strip off and go dance Dithiegooki*'. Another participant would '*go to river and talk to the Mundagudda [Rainbow Serpent]. [They] talk to land and listen for the language…we can tell Country it is still loved and respected and ask for help, for the dryness, for all things living*'. Because bush tucker and traditional medicines are hard to find, participants' family members often brought bush tucker and medicinal plants to them, when passing through.

Emotions (including sadness, dread and anger)

Participants described how they experienced feelings of sadness and despair, usually in relation to the drought (e.g. '*it's been depressing in how little rain we have'*). These feelings were either generic or connected to specific observations (e.g. as a result of the drying up of particular waterholes or the fact that animals were dying). Emotions included frustration (e.g. when seeing rain clouds in the distance that move away), worry (e.g. a participant was '*worried about when the next rains are going to come*', another would worry about securing a reliable water supply for their cattle) and deprivation (e.g. not being able to water gardens, which was a favorite pastime of one of the participants). One participant noted that '*Country looks sick*'. '*Sometimes when you see it that way you don't feel good in yourself. Another had "mild anxiety and despair, worrying about what is coming*'.

Emotions are exacerbated in extreme heat, especially when there is no electricity to power fans and air conditioners. Participants often described how the heat '*makes you cranky*' and irritable, and how it '*sucks the life out of you*'.

Health (medical risk)

Participants spoke of a range of health and wellbeing impacts as a consequence of the weather, including both physical and mental aspects. From a physical perspective, participants described how hot, dry winds would pick up sand, 'stinging' or 'sandblasting' people who work outside. Some participants described how they would not be burnt by the sun, but by hot winds. The children at

Goodooga Central School described how they were performing a cultural dance for a funeral in January (2019), with bare feet on the hot, sandy soil. They burnt their feet, though wanted to do the dance regardless. Many of the children required first aid treatment for blisters.

Raised sand and dust was described as a hazard for asthmatics, and it was also mentioned that it '*gets in your nose and eyes*' and through the air conditioner vents in cars (finer dust). Dust storms also present a risk for driving, and some participants described having to pull over to the side of the road at the height of a dust storm. Dry, unsealed roads become powdery, which was described as a driving hazard. Sealed roads are also a hazard in hot weather, where they become hot and soft. Other hazards include trees that may have fallen on the road e.g. due to low moisture content or wind storms. Participants reported concern should their vehicle break down in extreme conditions, especially when transporting children.

Many participants described how extreme heat made them tired, and the same at night resulted in poor sleep, making them tired for work the next day. The '*body works harder*' and '*stresses the body*' in these conditions, participants reported. Extreme heat resulted in exhaustion for school students and other participants, which lead to a lack of enthusiasm for performing normal activities, connecting with social groups and/or being out on Country (e.g. '*stuck at home'*). There was particular concern for children, because they '*don't want to go out and do anything*'. Being confined to the home could be due to both physical limitations but more often, participants not *wanting* to go outside (e.g. '*if I know Country is dry you don't want to visit sites'*). Participants often expressed sadness over not being on Country, and expressed how being at home resulted in social isolation. Participants also disliked extreme cold, because of the health-related impacts (for one participant, the cold weather gave her a backache).

One participant relies on tank water at their house, however, when these ran dry they filled them up from the nearby river. The participant reported that the quality of the water was not as good as rainwater and noted that stations upstream were returning water (possibly polluted) back to the river. Kids in particular, known to the participants, were known to swim in unusual locations in times of hot weather, such as rainwater tanks. This is a hazard to their safety and potentially those who drink the water. Bees were also reported to swarm, stinging family members of one participant (including one who had an allergic reaction).

Most participants described how they disliked the heat and humidity (that it was uncomfortable), with one stating it impacted her asthma. Many participants spoke of the effect of the weather on their asthma, with the most common intervention being the use of their asthma medication (puffers). One participant spoke about how she would carry an EpiPen (Epinephrine auto-injector) for potential allergic reactions to bee stings. Wind, dust and pollen resulted in one participant being hospitalized for a week due to pneumonia (not for the first time). Because of the risk of getting pneumonia again, this participant does not go out on Country fishing anymore. He was concerned that these weather conditions and resulting hay fever symptoms might also stop him from working one day.

Financial loss

Participants stated that it was more expensive living in a drought, through both increased electricity use and also other increases in living costs (such as the cost of goods and water rates). Many participants described how having air conditioners on constantly over summer resulted in very high electricity bills (in

some cases, over double the normal bill amount). This places additional pressure on their family, to make sure they are eating well. One participant stated *'My Mum is too frightened to turn the power on, because of the bills. She won't cook for herself as it's too expensive. We take meals up'.* One participant had to purchase two air conditioners (fans '*just blow hot air*'), and as has been mentioned, the increased use of electricity (for fans and air conditioners) is a financial burden. This resulted in participants having to rearrange their budget, and participants were less likely to have holidays. Whether this was because of the financial impact, or due to participants simply not wanting to have holidays during drought, is unknown. Some families purchased generators because of the frequent brown outs in summer, and some purchased solar panels to help with the cost of electricity.

Participants have in some cases reduced their water use, but others reported that this was not possible, given the requirement for water to wash dishes, clothes etc. Participants were adapting to using less water and using water more efficiently, including by cutting down on showers and clothes washing, using polypipe (to reduce evaporation), using grey water to water lawns, and having pot plants instead of lawns and gardens.

Hot weather in particular resulted in damage to infrastructure and farm machinery, which needed replacing or repairing. This includes damage to fuel pumps on all-terrain vehicles (ATVs) that could not handle the heat, damage to tyres, blown motors, pumps/bores that fail, and air conditioners that 'gave out', possibly as a result of being on almost constantly. Stock losses were also reported in extreme heat. One participant reported the theft of diesel and water, and also the breaking of fences by the person(s) who committed the offence.

Small agricultural communities were seeing the downturn of their local economy, and participants described how '*cafes [had] shut up and gone'*. Participants also noticed less tourists visiting, particularly those towns that attracted visitors because of rivers and lakes. It was noted that money and skills (through skilled workers) was being redirected out of these communities. Participants were concerned that if they didn't receive rain soon, people would leave the land to find other work. One participant described how the younger generation has transport (i.e. cars), so were moving to the coast, either permanently or semi-permanently (for the summer months) or major inland towns like Orange or Bathurst. It was stated that this was because they '*can't handle the heat*'.

Native (non-agricultural) vegetation

Participants described a number of impacts on native vegetation as a result of the extreme weather that was experienced during and in the lead up to the study. For example, participants described how trees were dying ('*even the big old box [Corymbia spp.] are dying'*), and they feared that big gum trees would be dying soon without rain. Heat apparently killed seedlings, and wind storms also damaged trees, in one case pushing old gum trees into the river. Dust storms were also reported to knock down trees and limbs.

Participants spoke of impacts on the soil seed bank. For example, the hot, dry conditions apparently created a hard, compacted surface. It was also described that the topsoil would be washed away with rain and in windy conditions. In some parts of the Basin, heavily-grazed areas had resulted in a lack of surface vegetation cover (Figure. 15).

Figure 15: Grazed paddock near Lightning Ridge, NSW, at the time of round 3 interviews in March 2019.

It was noted that rain can stimulate the growth of weeds, if no follow-up rainfall is received, and also that following rain weeds can outcompete with native seedlings. For participants involved in weed management, they stated that plants do not soak up herbicide when dormant during dry conditions, and thus required pulling out by hand. It was noted that the weed Noogoora burr was abundant in dry creeks and river channels at this time.

Recreation

In relation to hot weather, participants described how they do not socialise as much ('*don't get out much now'*), either at home or through visits to town (where '*you don't see people walking around*'). Participants described how this made people feel isolated, particularly for those who are unable to travel outside during hot weather. The confinement also impacts participants' moods, describing how they were '*sick of sitting inside'*. As stated above, participants were less likely to go on holidays in extreme heat.

Because of the drought, the most significant impacts on recreation were seen with water-related activities such as swimming (either as a cultural or recreational activity). Put simply, one participant stated how they '*can't go swimming*', because as another stated, they '*will be swimming in dirt!*' Even if there was some water in creeks or rivers, there were apparently subsurface hazards (e.g. sticks) that made people apprehensive about being in the water or gave them concerns regarding water quality (e.g. blue-green algae) that could result in health impacts. Concerns over water quality also prevented some participants from eating fish caught in these waterways.

The daily schedule for participants and their families revolved around trying to keep as cool as possible. This included drinking plenty of water, having cold showers, staying indoors with fans and

air conditioners (where there is access to Wi-Fi and television), swimming in pools, going to the beach, and going to the river to swim, have BBQs and fishing (providing there was enough water). One participant described how in former times, her '*old man would dig a hole under a bough to sit in'*. Participants were concerned about the effects of the sun in the middle of the day (e.g. skin cancer), especially in the fairer-skinned kids. As such, social activities, if they do occur, were usually confined to the evenings or night.

Participants often reminisced about the recreational activities that they used to undertake when water was available. For example, one participant described how they '*would be out fishing all the time*' or '*used to go camping all the time*'. '*On hot days you would go fishing, swimming, play around water, [to] keep the kids cool. Good place for [a] BBQ, but don't do that because [it's] too hot*'. Evidently rivers are a gathering place, often involving food, e.g. '*used to have families down there, having lunch'*. At the time of the study, kids would '*go into town and get in trouble*' (anecdotally there is a relationship between crime rates and water availability) and '*run amok'* when playing inside on hot days.

Conclusion

Revisiting its principal aims, the project was successful in conducting participatory research that provided evidence of the impact of the weather on the lives of Aboriginal people in the Murray–Darling Basin. Participants recounted with a high degree of accuracy recent weather events, with a strong focus on negative impacts relating to the hot, dry conditions, often told with heightened emotions (e.g. sadness and angst). To some extent, the observations and impacts reported by participants were not unexpected, as many would be consistent with those of the broader community in the Murray–Darling Basin, including irrigators whose livelihoods depend on natural resources and water availability. However, the point of difference with this study (and its real value) is the impact of weather on Aboriginal culture.

The information provided by participants during the study, across the entire range of phenomena and impacts, indicated a strong relationship between water availability and wellbeing (Figure. 16), through the impact of water availability on ecosystem condition (from an Aboriginal perspective, the health of Country) and how that condition affects opportunities and a person's willingness to spend time on Country. As one participant said: '*For us, it is about using water for cultural purposes. Water is our lifeline for Aboriginal people. That's our life source, the river. That's part of us that river. When anything happens, it affects it. When we see [kangaroos] dying out, that's part of us saying we're going too. It's a belonging. We belong to the earth. Our totems are things we need to look after. Other people have taken them away…It's not water in the tap that's important. Water in the river is what's close to our heart. It is a belonging.*'

Figure 16: Relationship between rainfall and wellbeing evident in the project, relevant for both dry and wet conditions.

When river levels are low or completely dry (e.g. Figure. 11), the condition of water-dependent ecosystems deteriorates. There are many ways of measuring this, however, participants in this study

described it in terms of reduced (or absent) native animal and plant populations (including those with cultural significance), animals like kangaroos suffering due to a lack of available feed, an increase in weeds and a change in the distribution or migration of native animals. Because cultural activities are typically centered on the river and their associated ecosystems (e.g. fishing, hunting bush tucker or collecting plant products from the surrounding landscape), this deterioration had a profound impact on the participants' ability to undertake them. Furthermore, the hot weather and the appearance of the environment (dry) also reduced participants' willingness to be out on Country, even if a cultural activity could still be undertaken. The net result was that when river levels were low (in hot, dry conditions), participants were more likely to spend time at home (resulting in actual or perceived social isolation) and were less likely to undertake cultural or recreational activities on Country. Because of the importance of Country to Aboriginal people, including being on Country or knowing that it is being looked after, participants reported impacts on their psychological wellbeing in this situation, including worry and angst, either for themselves, family, community or Country. There was also a sense that physical health was affected too, as one participated stated, he *needed* bush tucker in his diet.

The complete opposite of the relationship in Figure. 16 is true for wet conditions, when river levels are high. That is, in times of above-average rainfall, ecosystem condition is good, native plants and animals are healthy and abundant, Aboriginal people spend time on Country undertaking cultural and recreational activities (including fishing and hunting), Country is being looked after, and people are happier, healthier, more content from a cultural/spiritual perspective and are more socially connected.

The results of this study reinforce how critical water (in rivers and wetlands) is to Aboriginal people. It demonstrates the importance of current initiatives that involve Aboriginal people in environmental water planning and delivery, and implement the findings of the National Cultural Flows Research Project.

Future research

The research undertaken in this study will contribute to the MDBA's Climate Change Research Program (CCRP), which aims to ensure that the impacts of climate change across the Basin are well-understood before the review of the Murray-Darling Basin Plan in 2026. The CCRP commenced in late 2019 with a high-level scan phase, where the vulnerabilities of the environment and Basin communities to climate change are documented. This includes understanding specific vulnerabilities of First Nations people to climate change. This project report is one of the lines of evidence which will inform these vulnerabilities. Climate change projections indicating hotter, drier conditions reinforce the need for climate change preparedness work to be undertaken in Aboriginal Nations, mitigating future risk.

Further research could consider the ecological and cultural significance of the change in the abundance, migration and distribution of animals, or the abundance and distribution of plants (especially those with totemic or other cultural importance). Research on the patterns of abundance/migration/distribution of animals and plants is typically undertaken by research institutions without consideration of species that are of cultural importance. However, it would be possible for researchers to consider research questions for species that have both environmental *and* cultural significance.

Work could be undertaken to develop a framework that allows Traditional Knowledge to feed into BOM weather products, to improve overall forecasting capability and the cultural appropriateness of existing products. Project participants described numerous signs or markers of seasons and future weather events from their cultural perspective, including the presence of animals or appearance of flowers of certain species (e.g. '*When we need rain, it comes. You see Willy Wagtails – a sign rain is coming*'). The Traditional Knowledge of Weather and Climate in the Pacific project[4], undertaken in Pacific Island nations, is a potential model that could guide this future work. This project is working to 'document existing traditional knowledge used for forecasting and attempt to produce an integrated forecast which uses both traditional knowledge and western data. The traditional knowledge collected will also be used as a tool for communicating climate messages to local communities'[5]. There is strong interest within Aboriginal Nations in the Basin to develop Aboriginal seasonal calendars, either through their own frameworks or through the BOM framework.

Benefits to Aboriginal people

After the last interview round, telephone discussions were held with participants to understand how the research could benefit themselves and their Nation. Participants suggested it could provide useful evidence in support of various new or existing initiatives. For example, one participant suggested there should be a bus to transport older people into town (e.g. air-conditioned shopping centres) during summer, particularly during heat waves. That is, this report, documenting the various impacts of extreme heat, could be used to boost support for such an initiative when approaching relevant organisations for in-kind support or financial contributions. Another participant suggested that the report could be useful to support grant applications, such as those for shade structures or the planting of trees. One participant spoke of how their local health clinic was at risk of closure and suggested that the report could be used to provide evidence for the need to keep it open (given the physical and mental health-related impacts of the hot conditions being experienced).

Participants also suggested the report could be used for educational purposes within their Nation. For example, one participant wanted to use the report to inform her Nation of the effects of climate change and use it for educational purposes at the health clinic, where they could outline the effect of the dry weather on Aboriginal peoples' health. This participant also indicated that it could be used to support the prevention of land clearing, which they stated was contributing to dust storms and associated health problems. It was also suggested that the findings of this research will also help to empower local Aboriginal communities to make informed decisions regarding service provision (including mental health) in extreme weather events and identify relevant social and economic opportunities.

[4] Funded by the Department of Foreign Affairs and Trade through the Climate and Oceans Support Program in the Pacific, implemented by the Secretariat of the Pacific Regional Environment Programme in collaboration with the BOM.
[5] From http://cosppac.bom.gov.au/traditional-knowledge/. Accessed 11 October 2019.

Appendices

APPENDIX A:
Free, Prior & Informed Consent information

Aboriginal Weather Watchers Project
Weather and Aboriginal life in the Murray–Darling Basin

PARTICIPANT INFORMATION SHEET

Team members: [redacted]

What is the project about?

The aim of this project is to raise public awareness about how Aboriginal peoples' lives in the basin are effected by the weather, and to use this information to improve their lives.

Who is involved in the project?

This project is being conducted by the Aboriginal Partnerships team at the Murray–Darling Basin Authority (MDBA). The project is made up of 30 Aboriginal participants located the length of the basin. It is supported by an Advisory Group with representatives from the MDBA, the Bureau of Meteorology, the Australian National University, the project's participant community, the Northern Basin Aboriginal Nations (NBAN) and the Murray Lower Darling River Indigenous Nations (MLDRIN).

When and how long is the project? Can I withdraw?

This project is a 5 year project starting in December 2016 and finishing in June 2021[6]. We hope to begin installing weather stations in March 2017, when consent to participate will be formalised with each person. You can withdraw from the project at any time. If you do withdraw, we will need to talk with you about how to manage the research material your created – your stories and photos, and the removal of the weather station.

Why have I been invited to participate?

You have been invited to participate because you live in the basin, identify as an Aboriginal person and/or a Traditional Owner, have told us you are interested in weather, that you are supported by your family and community to participate in the project, and have agreed to have a weather station on your property for 5 years. Your participation also complies with the selection criteria as we have discussed.

Will I be paid?

You will be offered a gift certificate for a local grocery store or fuel card to the value of $50 to thank you for each visit. Cash is not an option.

Confidentiality and Intellectual Property

Any information that is collected in connection with this project and that can be identified with you will remain confidential unless otherwise permitted by you, or as required by law. You may wish to be identified with some or all of your stories – if you are directly quoted - in which case you will be named. Next to your quote / the story we will insert the following:

(Your Name, your Nation if you so choose)

You will retain any moral rights associated with your own personal interview recordings. Copyright will be with the Commonwealth of Australia for published materials using your information.

[6] The length of the project was subsequently shortened.

PARTICIPANT INFORMED CONSENT FORM

1. I understand what the project is about. I know that I can ask more questions whenever I like.
2. I agree to participate in the project. I understand the project will grow over time and I will make up my own mind to participate if the terms of the project change. Nobody is making me do it.
3. I know that I can agree/disagree to any use of my information before it is used by the project.
4. I know that I can withdraw from the project at any time. And if I do withdraw the team member(s) will negotiate with me how and if my information will be used. If I can I will help them find a replacement site and participant.
5. I agree that weather data will be downloaded from the weather station at my site every 3 months. I agree that the team member(s) can interview me for about 2-3 hours every 3 months. I agree to help to review the project reports, to make sense of the information, and suggest ways of using the results to benefit my people.
6. I agree to photographs being taken of my participation in the project and for the photos to be used in media and other products only by the MDBA.
7. I agree to a mourning notice being included in published materials that identify participants and their families.
8. I will be given a voucher for a local grocery store or fuel card to the value of $50 at the end of each visit. I will not be paid additional amount or in cash.
9. The information I give will be as accurate and true as I can make it without causing harm to me or others
10. I know that the risks of participating are that the information won't be useful to me, that I and my site may be exposed to public view, that I might be upset if some of the effects on the weather are sad, and that frequent visits from MDBA staff makes my life visible to the government.
11. I know that I can stop the interview at any time if I feel sad or angry and that I can talk to……..
12. I understand that the project should be enjoyable, recognise my way of understanding weather and its impacts, and benefit my people as decided by them.
13. I understand that the project team member(s) want(s) to write about the project in reports, academic papers, conferences, media and social media. They will be the primary author(s) of the publication but my participation will always be acknowledged if I want it to be. My name and my Nation will only be mentioned in reference to the material used or in the acknowledgements if I wish to be named. I understand that the information will be archived by the MDBA.
14. I have moral intellectual property rights over my material, and final cultural authority to determine how cultural knowledge is treated by the project, but will only act on my cultural authority if my decision is endorsed by my local cultural group.
15. I know that if I am worried about the project I can contact [redacted].

Participant's name

Signature and Date

Team member's name, signature and date

APPENDIX B:
Interview Questions

Round 1

Aboriginal Weather Watchers Interviews

1. Respondent information

    - Name:
    - Location (nearest township):
    - Date of interview:

2. When you think about the thing we call “the weather” what comes to your mind?

3. How does the weather effect your everyday life where you currently live? Consider throughout the year.

4. Are there people, plants, animals, important buildings, infrastructure and landscapes (including waterways) that are particularly effected by the weather where you live?
    - ☐ People
    - ☐ Plants
    - ☐ Animals
    - ☐ Cultural sites
    - ☐ Buildings
    - ☐ Infrastructure
    - ☐ Landscape
    - ☐ Other (please specify)

5. Is there any weather data from the last collection period that we can look at to understand these impacts?
    - Weather chart reference:
    - Weather phenomenon:
    - Effect:
    - Meaning:

6. Do you have any other data (photos, media, and collections) that you want to bring to this interview for the project’s records?

7. Research questions

Round 2

A. Interview management	
Collector's name	
Location of weather station	
Date of interview (day, month, year)	
Name of participant	
Same participant as agreement made with?	Yes No
If a new participant: name, age, gender information	Name: Age: Gender:
Date of last download	
B. General discussion about weather and impacts	
How has the weather been in your part of the world since we were last here?	
What aspects of your everyday life have been effected by the weather? First hand (not reported) accounts please Where possible please name species and waterways Prompts: • People (family, local community – e.g.: work, education, recreation, health, income, living conditions) • Plants (native, agriculture) • Animals (native, agriculture) • Important buildings • Land assets • Culture (sites, artefacts, ceremony, obligations) • Landscapes (waterways, catchments, cultural) • Infrastructure (roadways, communications, power) • Anything else	
Actions taken to adapt to negative impacts	
How long has the participant been doing this?	
Action taken to adapt to positive impacts	
How long has the participant been doing this?	
c. Specific Event – weather chart and specific impacts/outcomes	
1. Weather chart reference	
Weather event	
Effect of event of person's life (impact)	

Meaning of effect (outcome)	
d. Other matters	
Participant research questions	
Other matters related to research questions (not project management)	

Round 3

a. Interview management	
Collector's name	
Location of weather station	
Date of interview (day, month, year)	
Name of participant	
Same participant as agreement made with?	
If a new participant: name, age, gender information	Name: Age: Gender:
Date of last download	
b. General discussion about weather and impacts	
How has the weather been in your part of the world since we were last here?	
What aspects of your everyday life have been effected by the weather? First hand (not reported) accounts please Where possible please name species and waterways *Prompts:* • *People (family, local community – e.g.: work, education, recreation, health, income, living conditions)* • *Plants (native, agriculture)* • *Animals (native, agriculture)* • *Important buildings* • *Land assets* • *Culture (sites, artefacts, ceremony, obligations)* • *Landscapes (waterways, catchments, cultural)* • *Infrastructure (roadways, communications, power)* • *Anything else*	
Actions taken to adapt to negative impacts	See above.

How long has the participant been doing this?	
Action taken to adapt to positive impacts	
How long has the participant been doing this?	
c. Specific Event – weather chart and specific impacts/outcomes	
1. Weather chart reference	
Weather event	
Effect of event of person's life (impact)	
Meaning of effect (outcome)	
d. Other matters	
Participant research questions	
Other matters related to research questions (not project management)	

Round 3 Additional Interview Questions

e. Climate change *(Note: possible repetition if phenomena and impacts already reported)*	
Has the climate[7] changed here? If yes, explain how. *[Prompt for types of weather phenomena and timing. Note reference points for change e.g. in last 10 years].* *[If answering 'yes' above, ask the below questions]*	
How does the new climate impact your everyday life? Consider both good and bad impacts.	
What are the things you and your family do to adapt to the new climate?	
f. Drought *(Note: possible repetition if phenomena and impacts already reported)*	
Are you experiencing drought here at the moment? If yes, describe what the conditions are like. *[If answering 'yes' above, ask the below questions]*	
How does drought impact your everyday life? Consider both good and bad impacts.	
What are the things you and your family do to adapt to drought?	
g. Research outcomes	
Once we have done the interviews with all the other participants, what would you like to see done with the information? How could it be used by your mob?	

[7] What the weather is normally like.

Office locations
Adelaide
Albury-Wodonga
Canberra
Goondiwindi
Griffith
Mildura
Murray Bridge
Toowoomba

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