



CLIMATE CHANGE

Learning about what is happening with the weather in central Australia





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A template of this book is available from Central Land Council so the book can be adapted with local knowledge, weather data and other content relevant to your region.

Citation and Copyright

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Cover photos: Lightning and fire (by Grant Rolph Photography); Shannon Lander (left), Malcolm Furber, Paul Oliver, Ashley Sparrow, Norbert Mulladad and Gibson John discuss weather graphs (by Fiona Walsh); Dingo and mirage (by Mike Gillam).

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Table of contents

1 What this book is about 4-5

Who was involved 4	Introduction 5
------------------------------	--------------------------

2 Arrernte weather observations and calendar 6-9

Uterne (Summer) 6	Uterne (Summer) 8
Alhwerrpe (Winter) 7	What changes have the elders in your community noticed? . . . 9
Alhwerrpe Uyelpuyerre (End of Winter) 8	

3 Recording the weather 10-17

How the weather is recorded 10	Ltyentye Apurte rainfall records 14
Weather timeline 11	Alice Springs rainfall records 15
Alice Springs temperature records 12-13	Ntaria rainfall records 16-17

4 Carbon dioxide and other greenhouse gases 18-25

Some causes of climate change 18	Causes of increases in greenhouse gases 22-23
Carbon dioxide and world temperatures increasing 19	Greenhouse gases in the future 24-25
Jump in temperature and greenhouse gases in the last 150 years 20	What more greenhouse gases in the air will do 25
How greenhouse gases warm the earth 21	

5 Climate change and erosion 26-29

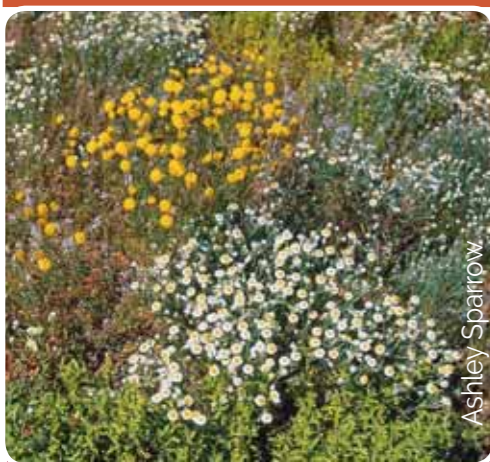
Climate change will increase erosion 26	Bigger storms cause more and larger gullies 28
How erosion gullies form 27	Erosion management 29

6 Adapting to climate change 30-34

What will help communities deal with climate change? . . . 30	Solar power 32
Combining local knowledge and science 31	Further Information 33



Solar Systems



Ashley Sparrow



Michael Barritt

What this book is about

Who was involved in producing this book

This book was produced as part of a CSIRO Climate Adaptation Flagship project in partnership with Ninti One Ltd. The project worked closely with Central Land Council (CLC) Ltyentye Apurte (Santa Teresa) Rangers, and CLC Land Management gave invaluable support. The Indigenous Land Corporation is the major funder of the Ltyentye Apurte Rangers.

The CSIRO project leader was Ro Hill. CSIRO Scientists Ashley Sparrow, Fiona Walsh and Jocelyn Davies, and Meg Mooney from Tangentyere Council, contributed to the project.

Ltyentye Apurte Rangers involved in the project were Richard Furber, Norbert Mulladad, Gibson John, Paul Oliver, Charles Hayes, Malcom Hayes, Charles Lechleitner, Bronwen Cavanagh and Petria Cavanagh, and ranger co-ordinator Shannon Lander.



Some of the Eastern Arrernte elders, Ltyentye Apurte Rangers and scientists involved in the 2013/14 climate change project. From left: MK Turner, Maryanne Ryder, Charles Lechleitner, Meg Mooney, Paul Oliver, Jocelyn Davies, Bessie Oliver, Petria Cavanagh.

Eastern Arrernte elders who contributed to the project were MK Turner, Veronica Dobson, Bessie Oliver, Maryanne Ryder, Elaine Gorey and Stanislaus Mulladad. Longterm Ltyentye Apurte residents Laurie Butcher, Bill Ryan and Miriam Donoghue also contributed.

All drawings are by Blair McFarland, unless otherwise indicated.

Temperature and rainfall graphs and erosion diagrams were produced by Ashley Sparrow. Diagrams about greenhouse gas effects on pages 22-24 were produced by Grant Allan.

The comments in the Indigenous weather calendar come from talks with Eastern Arrernte elders, rangers and others during the project, including an interview in Arrernte by Mary Flynn with one of the elders, MK Turner; notes from MK Turner, Veronica Dobson (another of the Eastern Arrernte elders) and others in an 'Mparntwe Seasonal Change' chart produced by the Alice Springs Desert Park; seasonal notes by Veronica Dobson in IAD Press Jukurrpa Calendars; and 'Listen deeply, let these stories in' by Kathleen Kemarre Wallace with Judy Lovell (IAD Press, 2009).



Scientist Ashley Sparrow talks to Ltyentye Apurte Rangers about erosion along Yam Creek, and how erosion will increase with climate change.

This book has been written for Indigenous communities and others to learn more about climate change. It also aims to encourage people in Indigenous communities to talk about climate change, and what will help their communities deal with these changes in the weather.

The book was produced as part of a CSIRO project with Central Land Council Ltyentye Apurte Rangers and elders. Ltyentye Apurte (Santa Teresa) is an Eastern Arrernte community 80 kilometres southeast of Alice Springs.

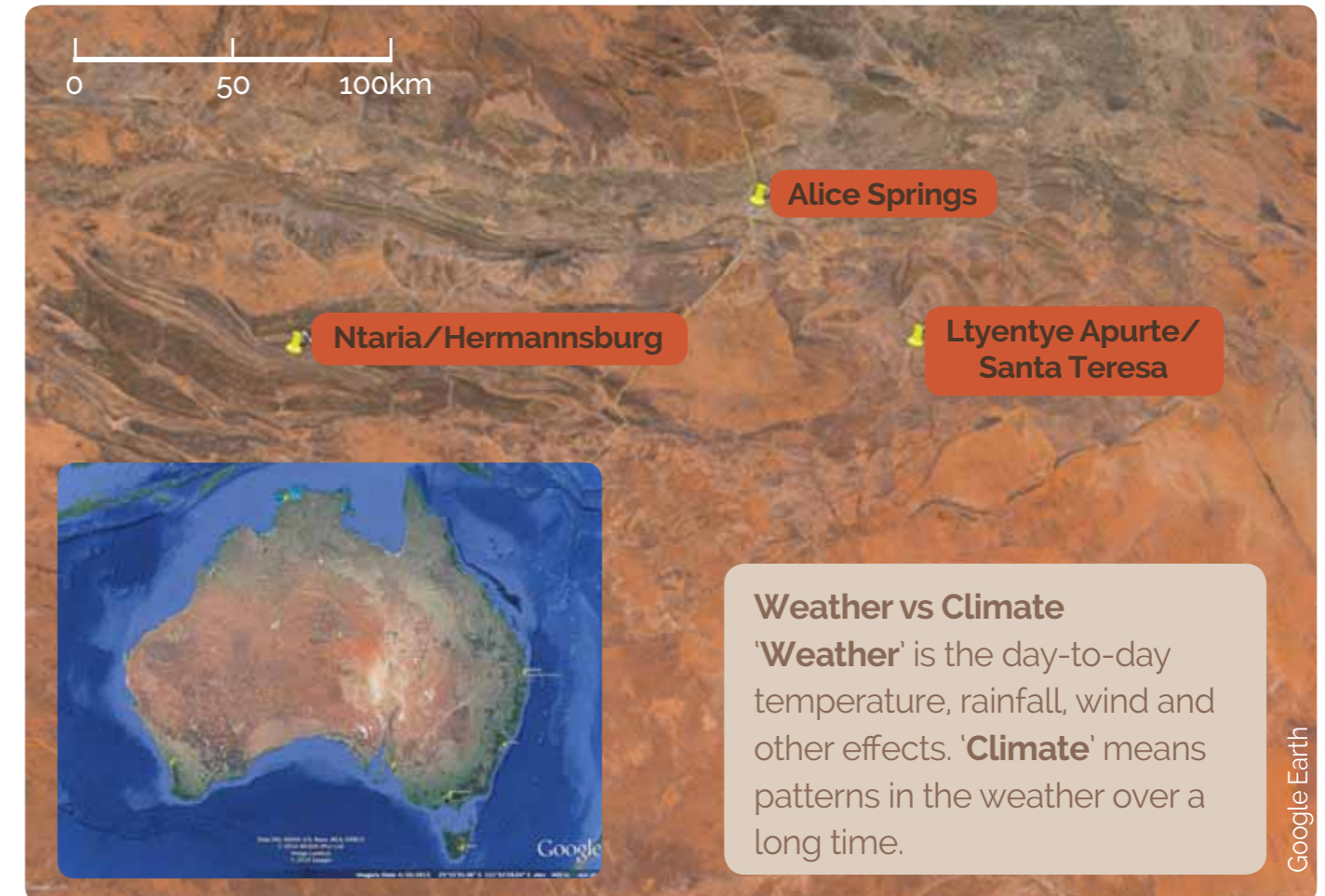
CSIRO scientists talked with rangers and elders about what scientists think is happening with the weather and what they think is causing these changes. Ltyentye Apurte elders, rangers and others told the scientists some of what they know about the weather and some of the changes they have seen. The rangers were supported to make a powerpoint about climate change, and present it to different groups in the Ltyentye Apurte community.

Indigenous ideas of weather don't fit into the European model of four seasons any more than the weather in many parts of Australia does. In central Australia, while

'winter' is colder and 'summer' is hotter, it may rain in either winter or summer, or in neither. Many plants only produce fruit after rains. Some plants fruit after rains at any time of the year, for others the rains have to be at particular times of the year.

Indigenous groups have their own concepts and terms to describe the weather. The division into seasons in the Arrernte weather calendar on the following three pages is just one way Arrernte people see the weather. Other divisions and seasonal names could have been used. The calendar does focus on natural events that are indicators of particular times of the year, although it includes some events that happen after rain when it occurs. This project focused on the indicator events in talks with Indigenous elders, rangers and others because these are the variables by which Indigenous people monitor changes to the climate. Some people think these events are happening at different times now.

Location of places in this book



Arrernte weather observations and calendar

Uterne (Summer)

Uterne mpepe (Middle of summer) December and January



Grant Rolph Photography

The weather is hotter still, the country is very dry. There are rain clouds, thunder and lightning. (MK Turner)

River Red Gums start shedding the thin bark. Sweet liquid, very sticky, drips from under the thin bark. There is also sweet sugar on the leaves. (MK Turner)



Source: NT Parks & Wildlife

The wild orange sometimes flowers early and as late as March now. It is unsure of what the weather is doing. (Veronica Dobson)



John Flynn, National Library of Australia, BibID 923026

Angente (mirages) show hot weather. When you see mirages, it is hot and it means there will be more hot coming. (MK Turner)



When Arrernte people see angente, they know the birds will be quiet in trees, and crows will have croaky voices, but not croaking much. The birds sit in the trees beside the creek, because it's hot. (MK Turner)

Uterne Uyelpuyerreme (End of summer) February to Mid-March



Michael Barritt

Dancing wind: Some women danced after rain. They danced all night and in the morning they whirled around so fast they became that wind.

These whirly winds dance across the landscape, scattering seeds and pulling the growth up from the seeds in the ground. (Kathleen Wallace)



The old people would describe that burning ground as 'ingke-ite-inelpineye', taking the soles off your feet. (MK Turner)



Meg Mooney, Tangentyere Council

Off and on through summer a hot wind blows from the northwest. It may bring rain clouds, thunder and lightning. (Veronica Dobson)



We call that hot northwest wind the bad wind. It makes people tired and irritable. (Veronica Dobson)



Lizards and snakes are moving around, feeding up because they know winter is coming and they will be hibernating soon. (Veronica Dobson)

Alhwerrpe (Winter)

Alhwerrpe urlte (Early winter) Mid-March and April



Mike Gillam

At the beginning of winter, the wind is gusty and has a sharp feeling. Wispy clouds appear from the southeast.

Even though it could be quite a hot day, by the evening there is a taste of cold in the air again. (MK Turner and Veronica Dobson)



The Seven Sisters (Pleiades) are lower and more westerly in the sky. (MK Turner)

The Milky Way is just starting to slope towards the east; it tells us that winter is on the way. (Veronica Dobson)



By mid May the Milky Way slopes 45 degrees to the northeast. Soon after a winter sunset, you can see the entire Milky Way hovering parallel high over the Heavitree Range.



Alhwerrpe mpepe (Middle of winter) May to July



Now it's colder still, the wind is icy cold. (Veronica Dobson)

People used to measure the winter seasons from the processionary caterpillars. A long trail would mean a long, cold winter coming. (MK Turner)

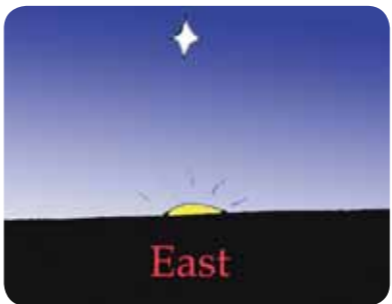


Neil Ross

The frosts come when you see the Two Sister stars. They're any two of the Seven Sisters (Pleiades). When they move the big wind starts to whirl around and they wee, which rains down as frost. (MK Turner)



You can't make a fire because the wind is causing it to throw sparks off everywhere. That's the middle of winter. (MK Turner)

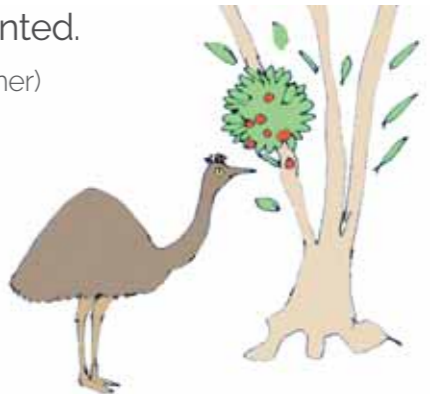


You know winter has properly arrived when the Morning Star appears. (MK Turner)

Alhwerrpe Uyelpuyerre (End of winter) August



Awele-awele (bush tomato) ripen and alatyeye (pencil yam) are big and creamy at the end of winter. But if it doesn't rain at the right time, they might be stunted. (MK Turner)



If there's been rain, the mistletoe berries are ready and the emus are feeding on them. That's the time when the emus and the bush turkeys are getting fat. But the mistletoe often fruits at different times now.



Dingoes give birth (June to August)

Alhwerrpe Uyelpuyerreme

Uterne (Summer)

Alhwerrpe Uyelpuyerreme (End of winter) September



When there's been a lot of rain, the green season comes after winter, when the warm weather starts and the winter finishes. (Veronica Dobson)



Dingo pups start to wean.



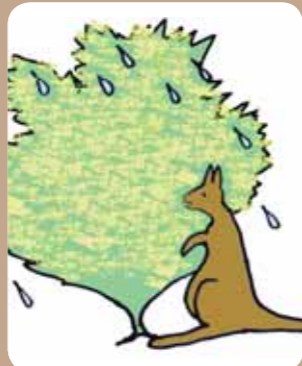
(September to November)

Goannas and perenties come out from hibernation when lightning and thunder strikes the ground. They know it's going to rain. Snakes too. (Gibson John)

Arlepe antethe - Arlepe (*Acacia victoriae*) flowers. Rain falls to help the flowers come.

Kangaroos used to get fat on these flowers, but now the rains don't come at the right time.

(MK Turner)



Arlepe urrpme - Arlepe has green seeds in pods. Parrots come and eat these seeds, they are food for when their eggs are forming.

The parrots tell people the seeds are ready to pick green and cook in their pods in the ashes.

(MK Turner and Veronica Dobson)



Arlepe ntange -

Arlepe has mature seeds and the pods are drying. Light rain used to make the pods fall, so people could collect them from the ground. (MK Turner)



Arlepe sometimes flowers at different times now. It doesn't know how to keep up with the changes in the weather.

(Veronica Dobson)

Uterne urle (Beginning of summer) October



When you see willy-willy winds around the country you know that the hot weather and north winds are coming. (MK Turner)

Trees, shrubs, grasses, bush banana vines, pencil yams and other plants are flowering before it gets too hot. Everything is alive once again. (Veronica Dobson)



Wild orange starts to flower



Ure (Fire time) November



The sun is a scorcher, making the country prone to fire. When I was young, people would light fires in the evening when they knew there would be a dew overnight to help put the fire out. (Veronica Dobson)
Clouds are blowing in with the northwest wind. (Veronica Dobson)



Wild orange starts to fruit



What changes have the elders in your community noticed?

There seem to be more hot days and heat waves.
The weather seems more mixed up.



Jayne BrimBox, NT Parks and Wildlife

I think it is changing, sometimes hotter, sometimes colder. Weather more mixed up. Not hot all the time in summer, cold in winter. People talking about this now, now everything's changing, one day hot, one day cold. (Ltyentye Apurte ranger)

The beginnings of the seasons are confused. The season doesn't come in like it used to. It used to be at the beginning of summer it rained. (Eastern Arrernte elder)

Sometimes plants don't seem to grow back after fire now, or they take a long time to grow back. Even the little grasses don't seem to grow so much after fire now. At the right time of year, the dew used to help them grow. (Eastern Arrernte elder)

Trees are getting burnt by a different kind of wind. After bushfires, the sun burns the little plants down so they don't come up.

(Eastern Arrernte elder)

In the old days, the stars and the weather lined up. (Eastern Arrernte elder)

Blossom flowers come on at different times. Atwakeye (Wild Orange) should be flowering at Christmas time, but they are coming early. Other things come late or early, but are all mixed up.

(Longterm resident of Ltyentye Apurte)

The rains are at different times now. So plants, like mistletoe berries, are coming at different times. (Eastern Arrernte elder)

Arlepe sometimes flowers at different times now. It doesn't know how to keep up with the changes in the weather. (Eastern Arrernte elder)

There are different types of fire now because of the different grasses, like buffel grass. The fires are hotter and fiercer and this affects what's happening up in the sky, it affects the weather. Now it's hard to know when to burn. (Eastern Arrernte elder)

Recording the weather

How the weather is recorded

The weather is recorded daily at weather stations all over Australia and the world. At these weather stations, various instruments measure temperature, rainfall, wind and other aspects of weather. In central Australia, there are weather stations in the towns and at some remote communities and pastoral properties. Many of the smaller weather stations only record rainfall, and sometimes temperature.

CSIRO Scientist Ashley Sparrow downloaded temperature and rainfall records from the Alice Springs weather station off the Bureau of Meteorology website (www.bom.gov.au). He also downloaded the rainfall records from Ltyentye Apurte and Ntaria communities,



This photograph shows the instruments at the weather station near the Alice Springs airport. Temperature, rainfall, wind and sunshine have been measured here since 1943.



A meteorologist shows Ltyentye Apurte students where the temperature is measured at the Alice Springs weather station. The temperature is always measured in the shade.

and from Allambi station, near Ltyentye Apurte. Ashley made these measurements into the graphs on the following pages. You could find out from the Bureau of Meteorology website if there are weather records for your community.

Rainfall was recorded at Ltyentye Apurte (Santa Teresa) from the late 1960s until the mid 2000s. From 2014, the Ltyentye Apurte Rangers have started recording the rainfall again. There are no temperature records for Ltyentye Apurte.

DATE	TIME OF OBSERVATION	AMOUNT OF RAIN		RIVER		ADDITIONAL INFORMATION (e.g. present weather, storm duration etc)
		Gauge (mm)	Rain gauge (mm)	Height (metres)	Flow (litres/litres or arbitrary)	
4/2/14	9 AM	2.5				Large storm gauge overflowing



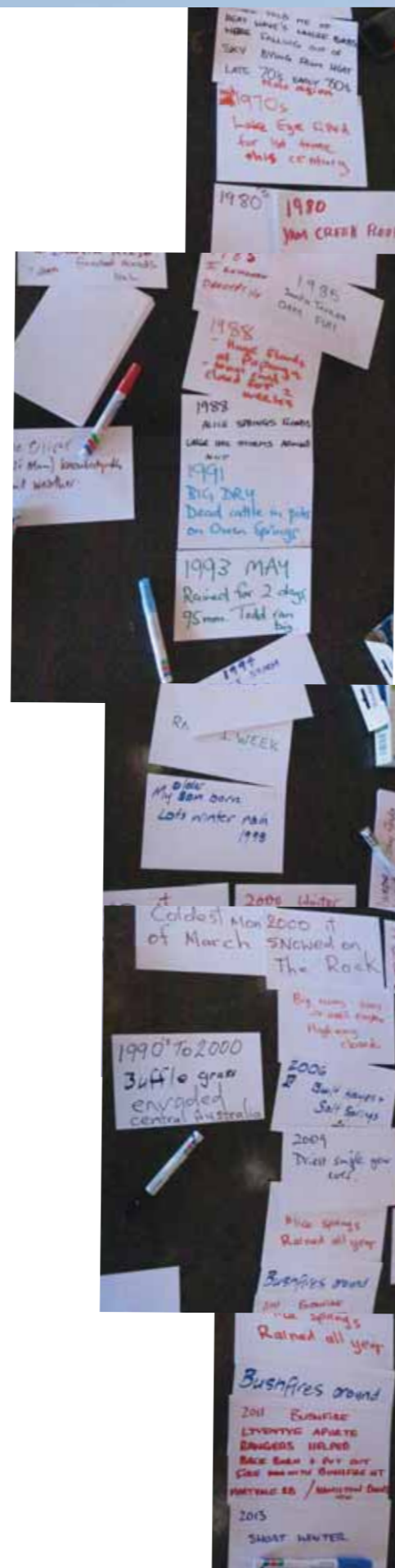
Using a rain gauge to measure rainfall



Weather Timeline

Ltyentye Apurte Rangers and CSIRO scientists wrote down significant historical and weather events they remembered from the 1970s until the present. They talked together and looked at old photos and history books to help them recall the past.

The scientists and rangers used this timeline to talk about what is happening with the weather. Then they related the timeline to temperature, rainfall and other graphs. They also looked at the graphs for trends or changes in the weather over time.



1970 - some of the current rangers were young men



Fiona Walsh, CSIRO

Talking about local temperature and rainfall graphs and comparing them to old photographs and the timeline.



Fo Hill, CSIRO

2013 - these rangers are getting old now!

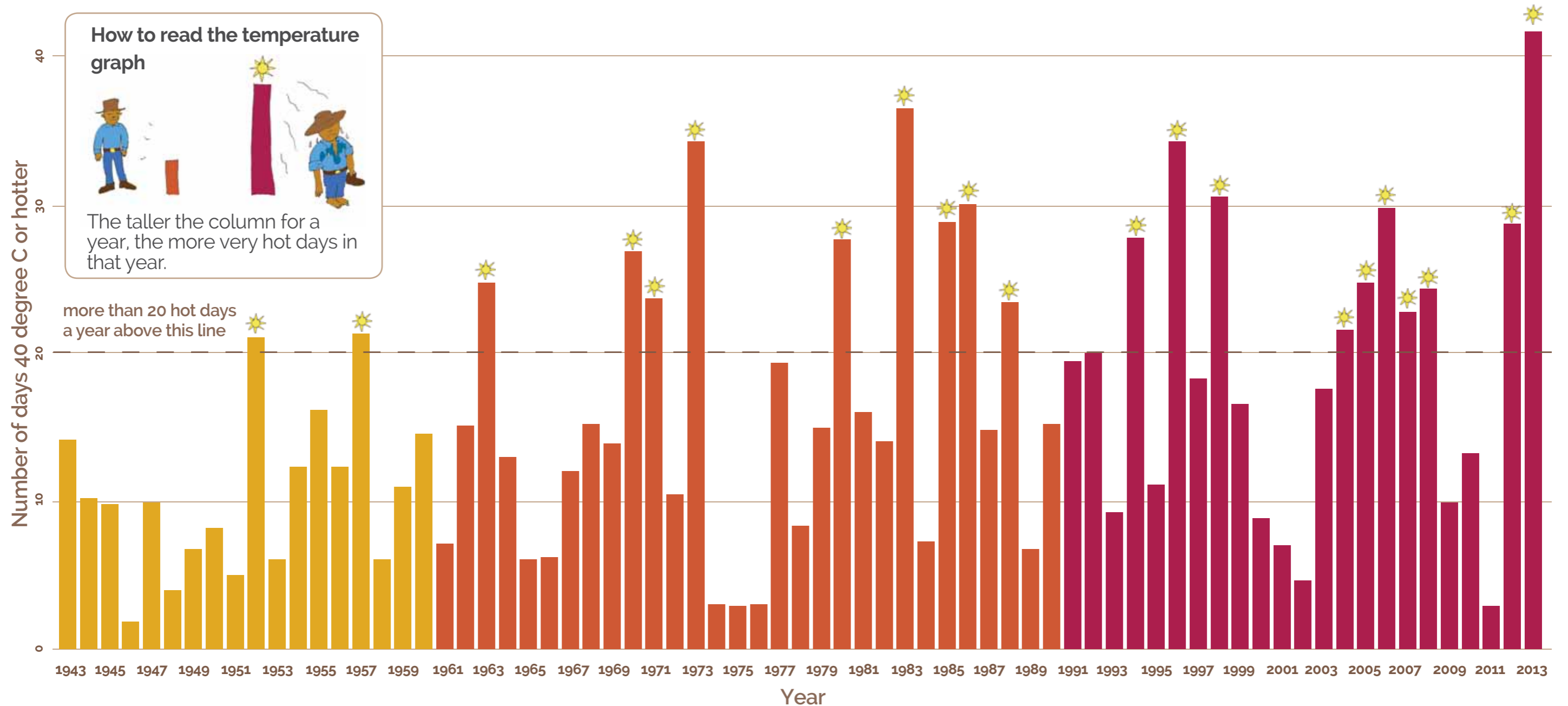


Fiona Walsh, CSIRO

Alice Springs temperature records

Very hot day records show Alice Springs is getting hotter.

This graph shows the number of days that were 40 degrees or hotter in each year.



2 years with more than 20 very hot days

Less very hot days in the 1940s and 1950s

9 years with more than 20 very hot days

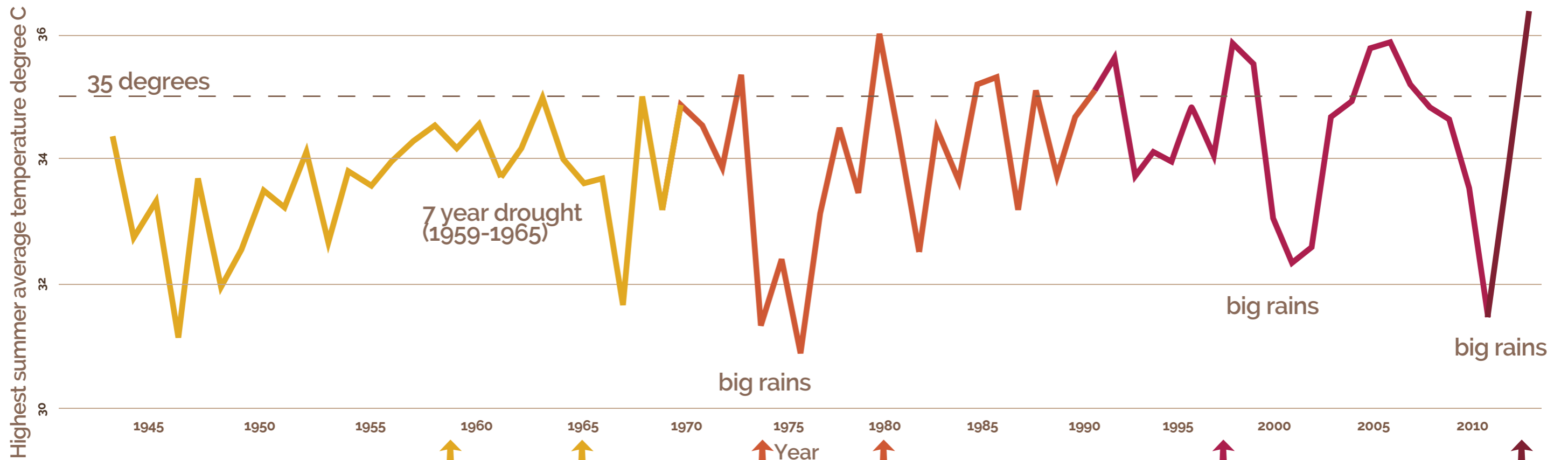
More very hot days in the 1960s to 1980s

10 years with more than 20 very hot days

Still more very hot days in the 1990s and 2000s

Alice Springs temperature records

Alice Springs temperatures are getting hotter. Highest summer (October to March) average temperatures have risen by 1 degree since 1943. Highest winter temperatures have risen overall by 1.5 degrees since 1943. Lowest summer and winter temperatures don't show any obvious trend.



Working out the average highest (maximum) summer temperature

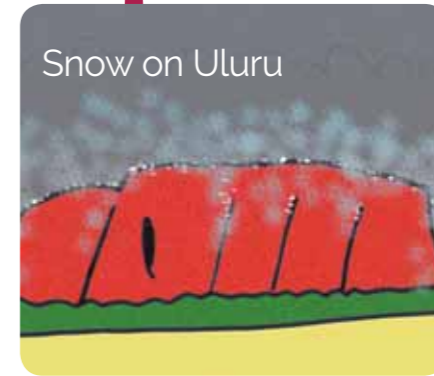
For example, for 2013:

Add up the highest temperatures for every day from the beginning of October until the end of March	6615.6
Add up the number of days from October until March	182
Divide the total of the temperatures by the number of days, 6615.6 / 182	36.3

So the average highest summer temperature for 2013 is **36.3 degrees**



My father told me there were heat waves with birds falling out of the sky in the late 70s and early 80s. (Ltyentye Apurte ranger)



Ltyentye Apurte Rangers backburned to help put out big bushfires after two years with lots of rain.

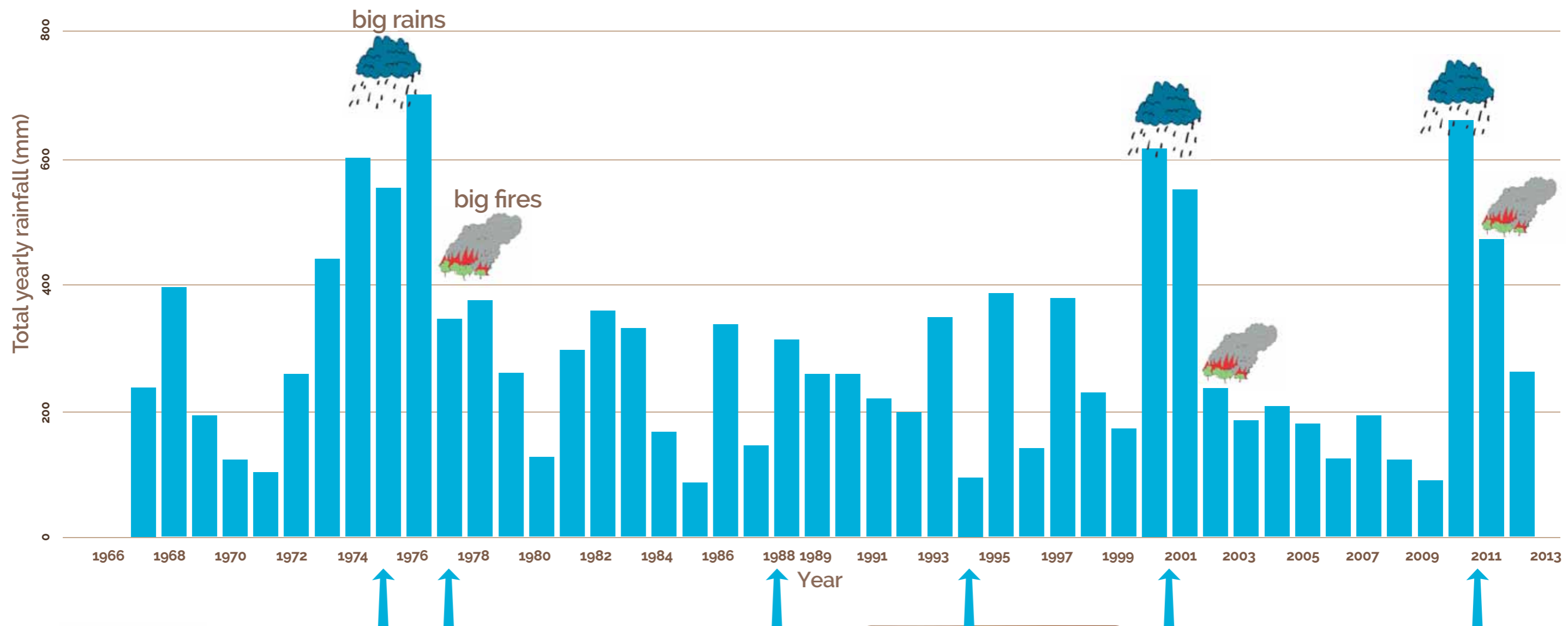
Mid 1940s to 1960s, only 1 year with highest summer average 35 degrees or higher

1970s to 1980s, 5 years with highest summer average 35 degrees or higher

1990s to 2010, 7 years with highest summer average 35 degrees or higher

Ltyentye Apurte rainfall records

Rainfall was recorded at Ltyentye Apurte and nearby Allambi station from the 1960s. This is not enough time to see a pattern in the changes in rainfall. As the Ltyentye Apurte Rangers continue to record the rainfall, patterns in the weather will become clearer.



Big rains in the mid 1970s

Roads were flooded for weeks, so helicopters dropped food to communities.

After the rains in the mid 1970s a big fire burnt right to Alta Creek. (Longterm resident, Santa Teresa)

1988: Big rains at Easter. Road to Alice Springs closed for 2 weeks.



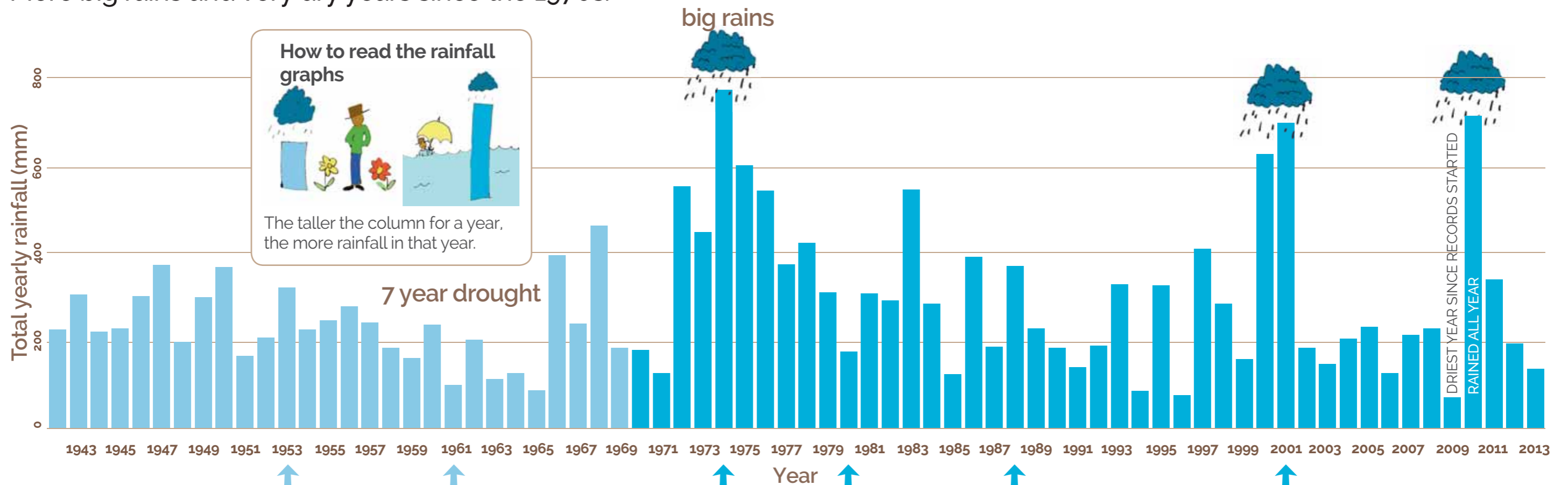
1994: Very dry. Big dust storm in Santa Teresa. (Local ranger)

Big rains in 2000 - 2001, 2010 - 2011

The rainfall records from the last 10 years come from Allambi Station, near Santa Teresa, because rainfall was not being recorded at Santa Teresa during this time.

Alice Springs rainfall records

More big rains and very dry years since the 1970s.



There was lots of rain. It was green, with lots of bush tucker when we first came to Santa Teresa. (Eastern Arrernte elder)



All the kangaroos became too skinny to eat. Lizards and goannas were the same too. We couldn't hunt them, and bush foods weren't growing anymore. (Kathleen Wallace)



Big dry this year. Dead cattle in piles on Owen Springs. (Lyentye Apurte ranger)



Big flood in Alice Springs.



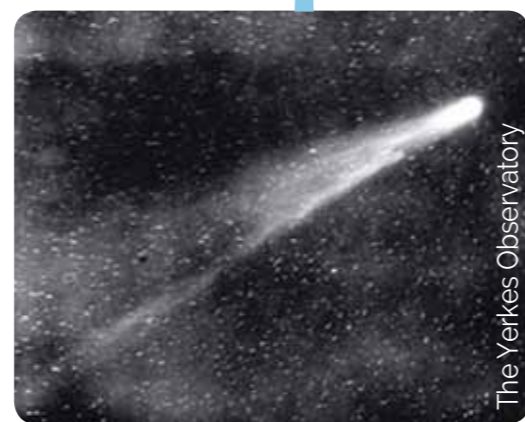
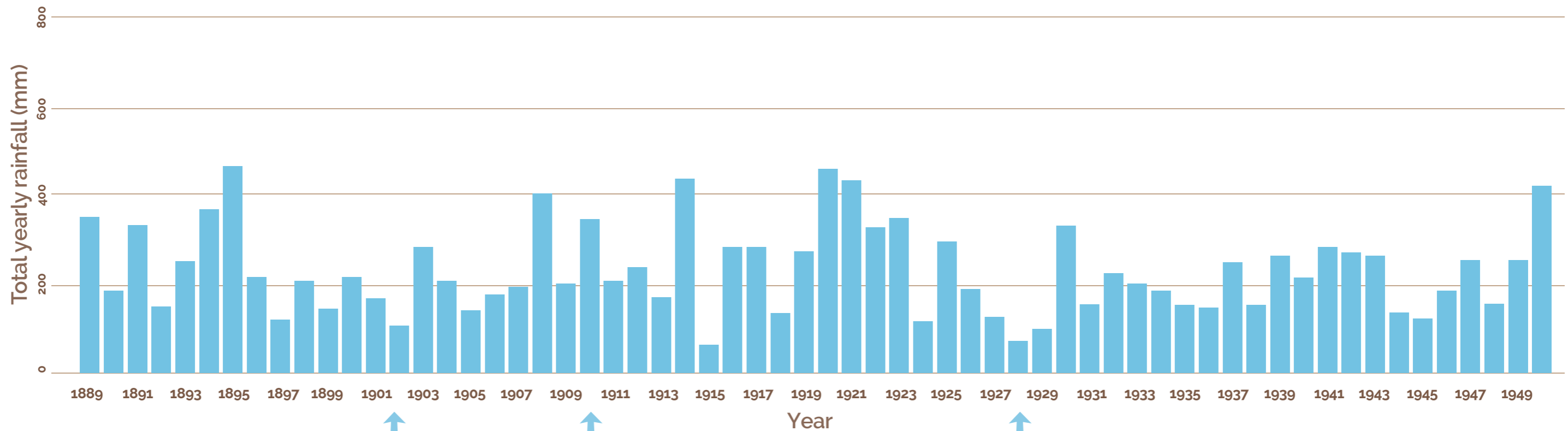
Stuart Highway closed by rain.

Not as much rain from the 1940s to 1960s

More big rains and more ups and downs in rainfall since the mid 1970s

Ntaria rainfall records

Ntaria has long rainfall records.



My parents talked about really big floods around the time of Halley's comet (in 1910). They called that the comet rain. They said the comet lit up the night sky like daylight. (MK Turner)



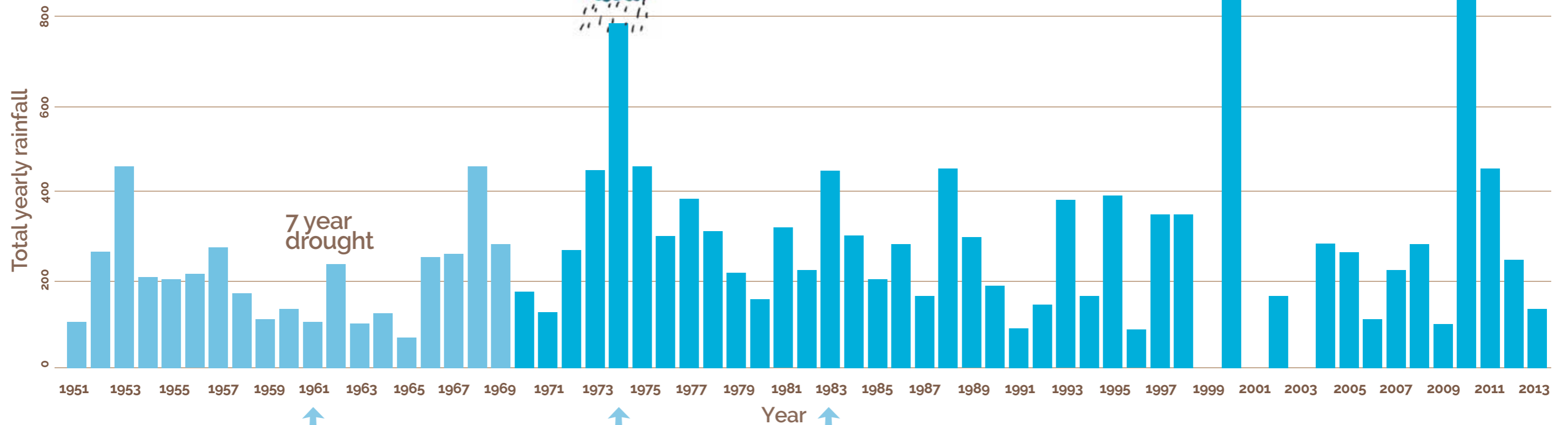
There has been a settlement at Ntaria (Hermannsburg) since the 1880s. So Ntaria has long rainfall records.

There are no longterm temperature records for Ntaria.

No big ups and downs in rain in 1890s to 1940s

Ntaria rainfall records

More big rains and more very dry years since the 1970s.



In 1999, 2001 and 2003, rainfall wasn't measured at Ntaria, so there are no records for these years.



Roads were flooded for weeks, so helicopters dropped food to communities.



Finke River flood near Ntaria.

Why are there more years with big rains since the 1970s?

Scientists say the big rains are happening because temperatures are getting higher. This is causing more evaporation from the oceans and more big cyclones.

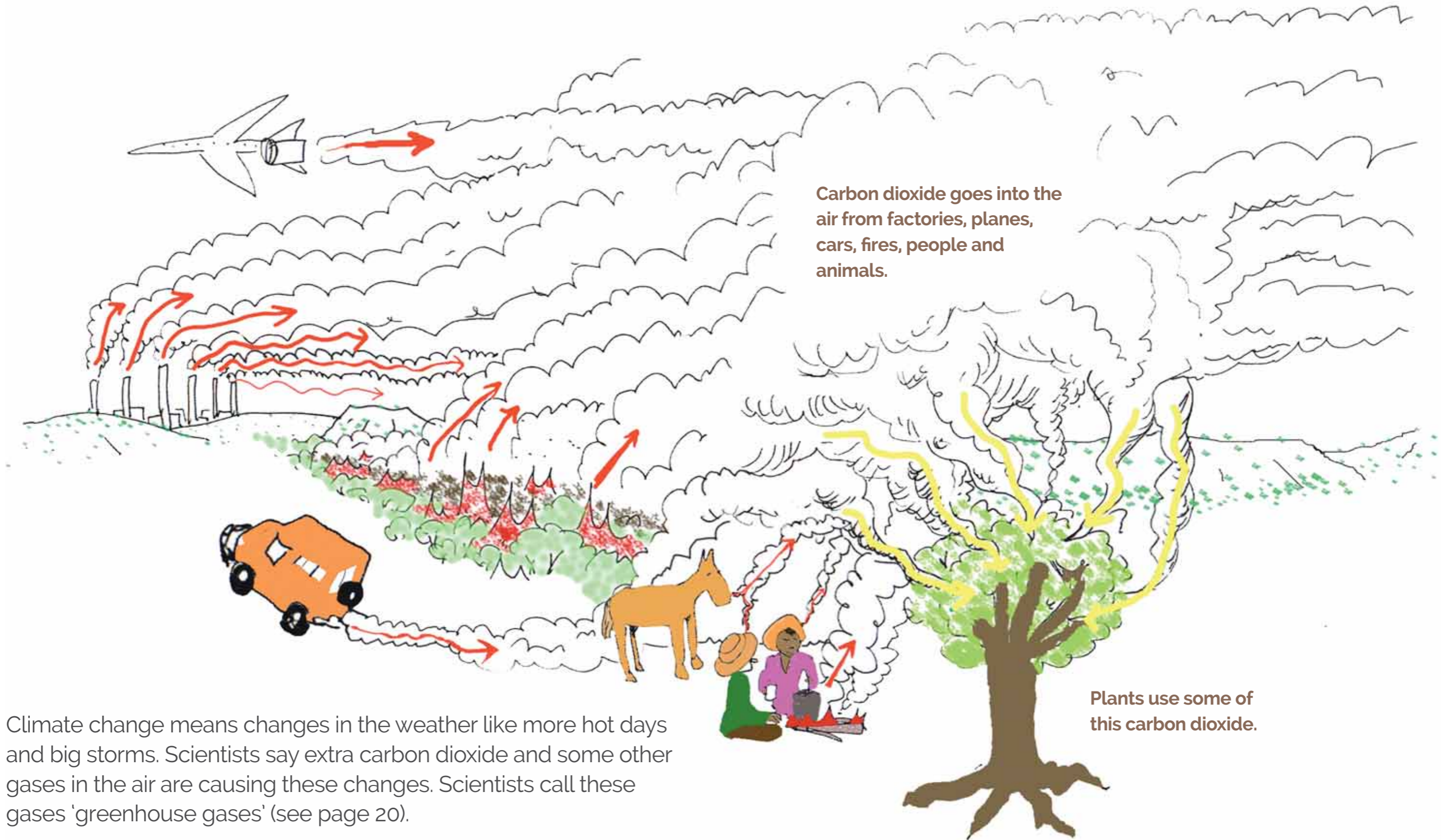
Scientists call these changes in temperature, rainfall and other aspects of weather 'climate change'. The next pages of this book discuss the causes of climate change.

No big ups and downs in 1950s to 1960s

More years with big rains and more ups and downs in rainfall since the mid 1970s

Carbon dioxide and other greenhouse gases

Some causes of climate change



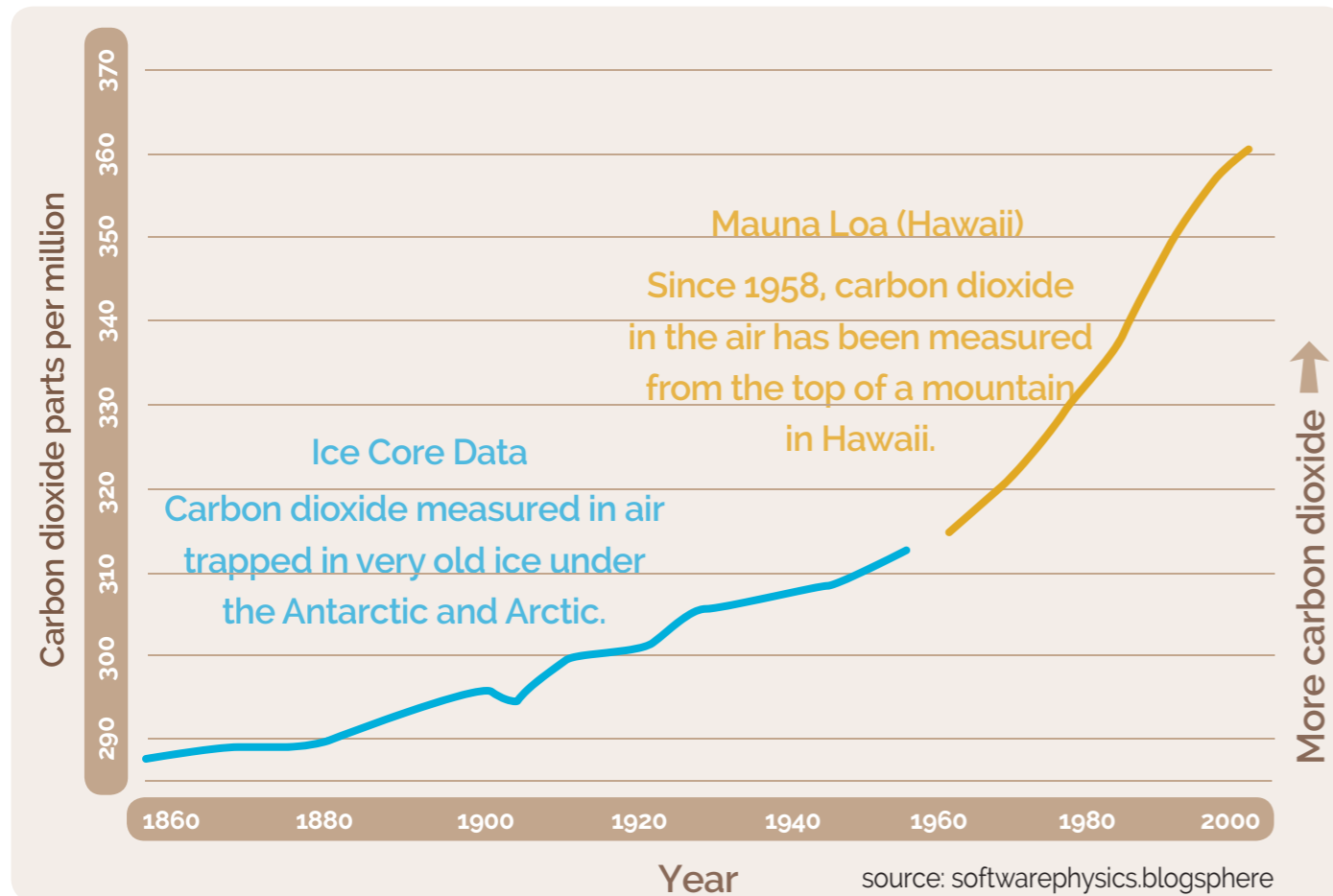
Carbon dioxide goes into the air from factories, planes, cars, fires, people and animals.

Plants use some of this carbon dioxide.

Climate change means changes in the weather like more hot days and big storms. Scientists say extra carbon dioxide and some other gases in the air are causing these changes. Scientists call these gases 'greenhouse gases' (see page 20).

Both carbon dioxide and world temperatures are increasing

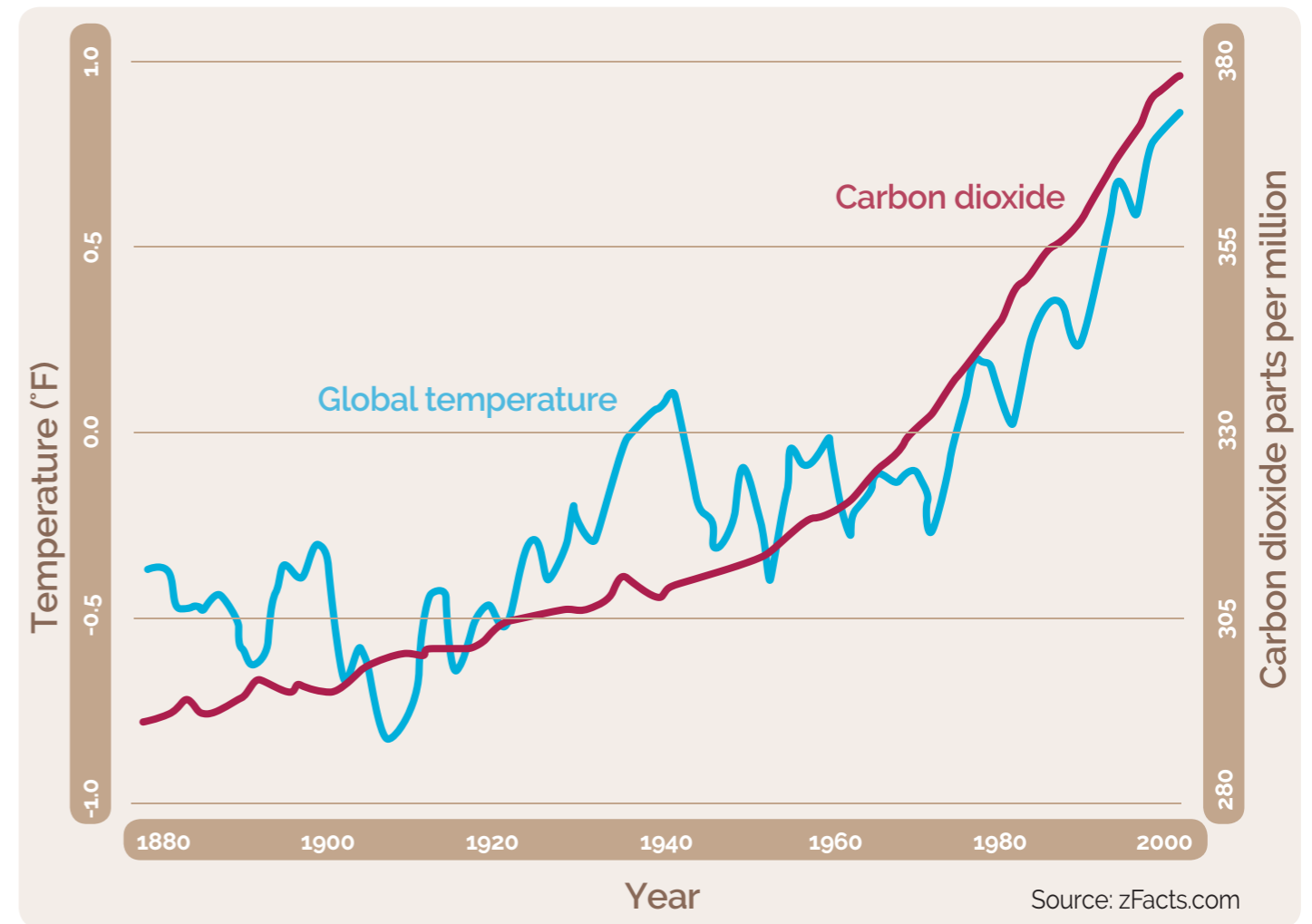
Carbon dioxide in the air since the 1860s



The amount of carbon dioxide in the air has gone up a lot in the last 100 years. Scientists say this is because there are more and more factories, planes and cars giving out carbon dioxide, and because of burning of the world's forests.

There is now about one quarter (25%) more carbon dioxide in the air as there was in 1975.

World temperatures compared to carbon dioxide in the air since the 1880s



World temperatures go up and down, but overall both temperatures and carbon dioxide are going up. Both have gone up more quickly since the 1970s.

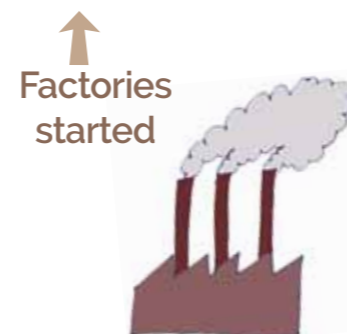
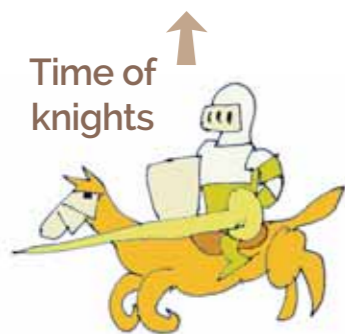
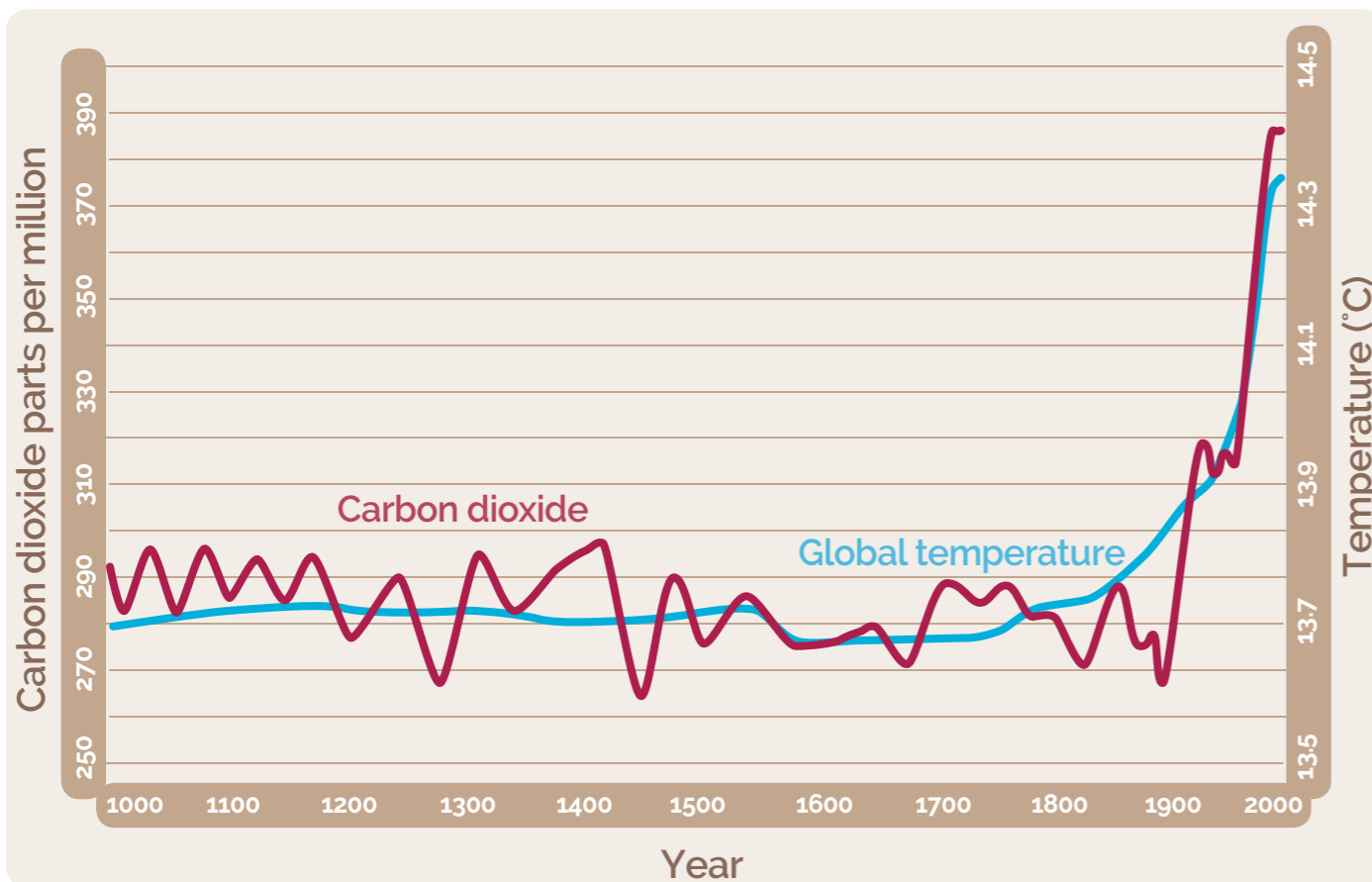
The global temperature for a particular year is the average of temperatures from around the world for that year.

A big jump in temperatures and greenhouse gases in the last 150 years

Temperature and carbon dioxide over the last 1,000 years

There has been a huge rise in both world temperatures and carbon dioxide in the last 150 years, compared to thousands of years before this time.

World temperatures and carbon dioxide began to go up in the 1800s, when people were starting to build factories and machines that give out carbon dioxide.



What is a greenhouse gas?

Carbon dioxide is one of the main greenhouse gases but there are others, like methane.

A greenhouse is a building with glass or plastic roof and walls. The greenhouse gets hot like a car with its windows shut. The greenhouse traps the sun's heat to warm plants.

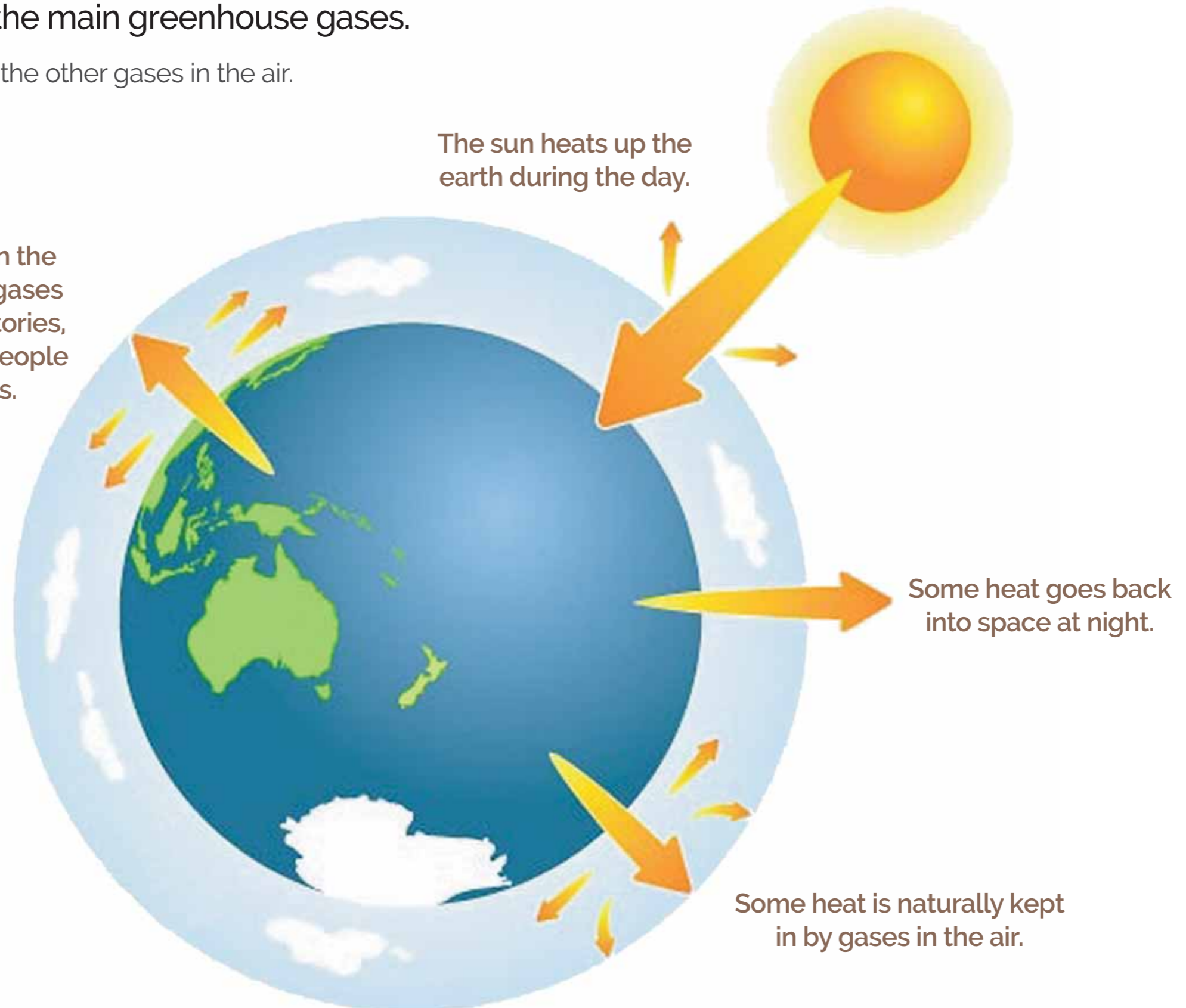
Some, but not all, of the gases in the air trap the sun's heat and make the earth warmer. Scientists call them 'greenhouse gases'.

How the greenhouse gases warm the earth

Carbon dioxide is one of the main greenhouse gases.

You can't see carbon dioxide or the other gases in the air.

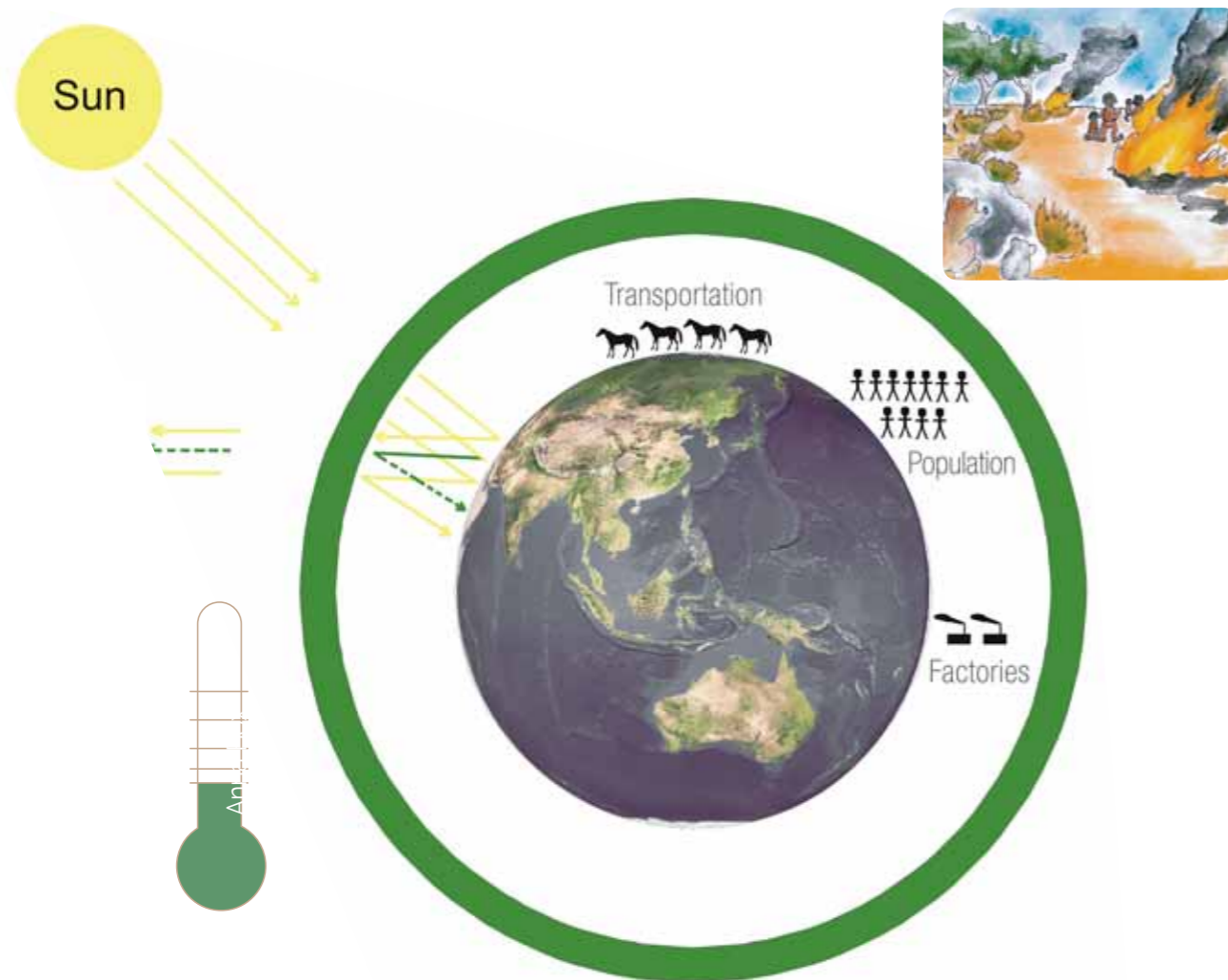
Extra heat is kept in the air by greenhouse gases produced from factories, cars, planes, fires, people and other things.



Causes of increases in greenhouse gases

100 years ago

The green colour is a way of showing people were putting very little extra carbon dioxide in the air, so the earth was not getting hotter.



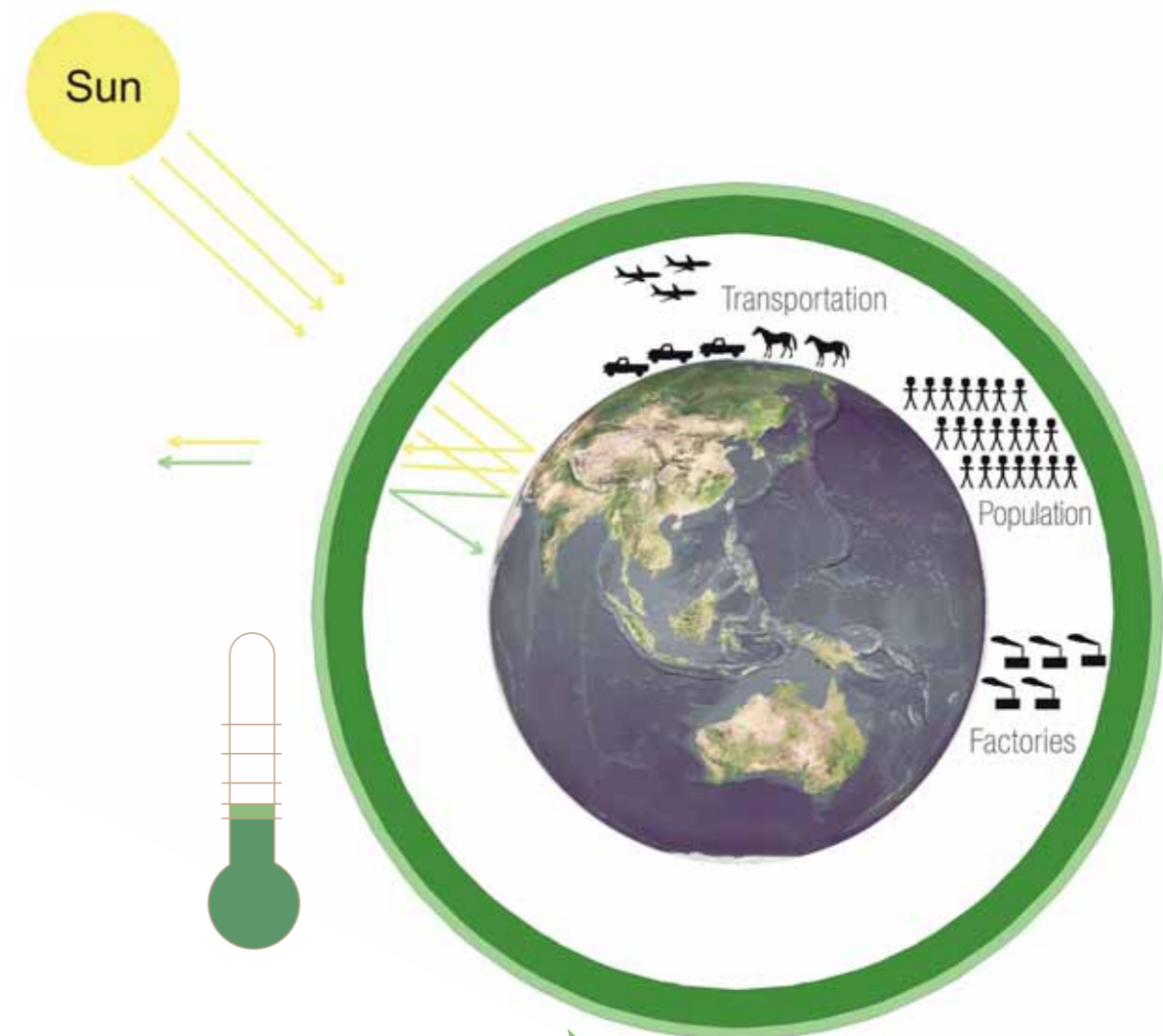
- Not many people
- Not many animals
- Very few factories
- Few cars and no planes
- Mainly small fires

cause

Not much carbon dioxide going into the air

40 years ago

The light green colour is a way of showing more carbon dioxide was going into the air, so the earth was getting a little hotter.



- More people
- More factories
- More cars and some planes
- Some bigger fires

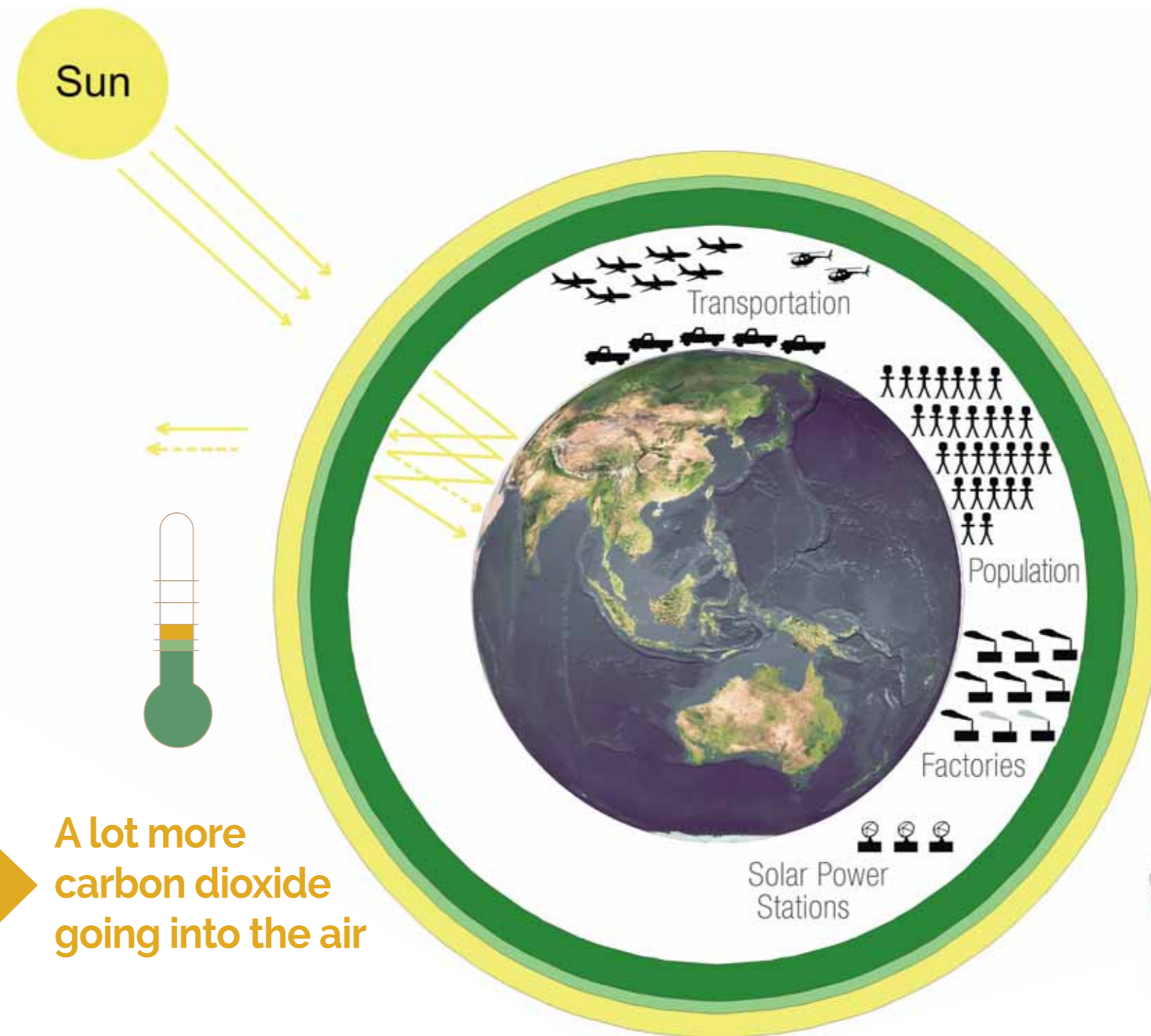
cause

More carbon dioxide going into the air

Greenhouse gases in the early 2000s

The temperature has gone up 1 degree in the last 100 years.

The yellow colour is a way of showing extra carbon dioxide in the air has made the earth hotter.



- A lot more people
- Lots of factories
- Lots of cars and planes
- Lots of big fires

cause

A lot more carbon dioxide going into the air



People mostly driving around. Mainly big fires because people are not walking around burning country regularly.

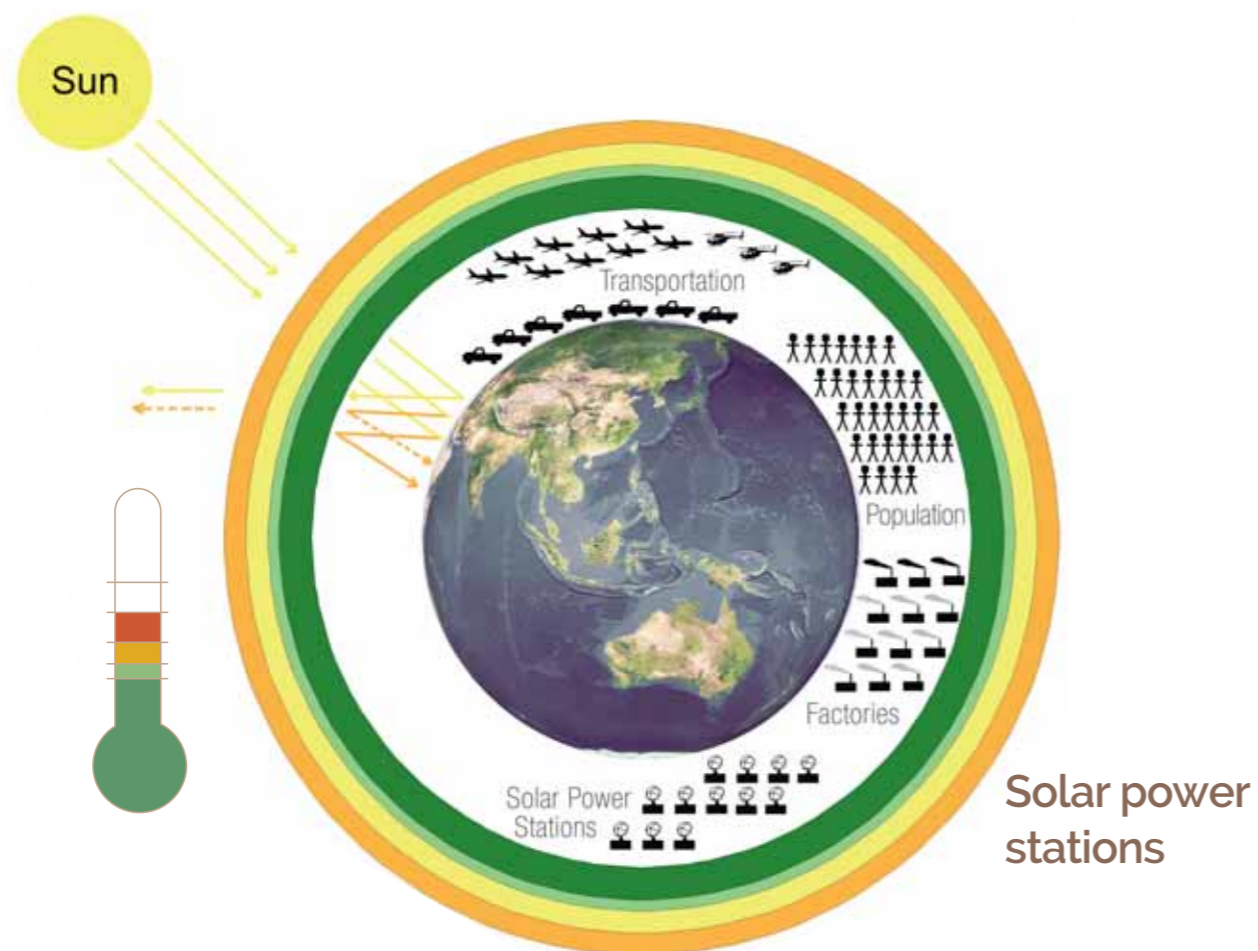


Greenhouse gases in the future

Choice 1 - Lots of change to reduce carbon dioxide

The temperature will go up 1 or more degrees in the next 50 years with positive changes like solar and wind power, and smaller wildfires.

The orange colour is a way of showing more carbon dioxide in the air will make the earth hotter than it is now.

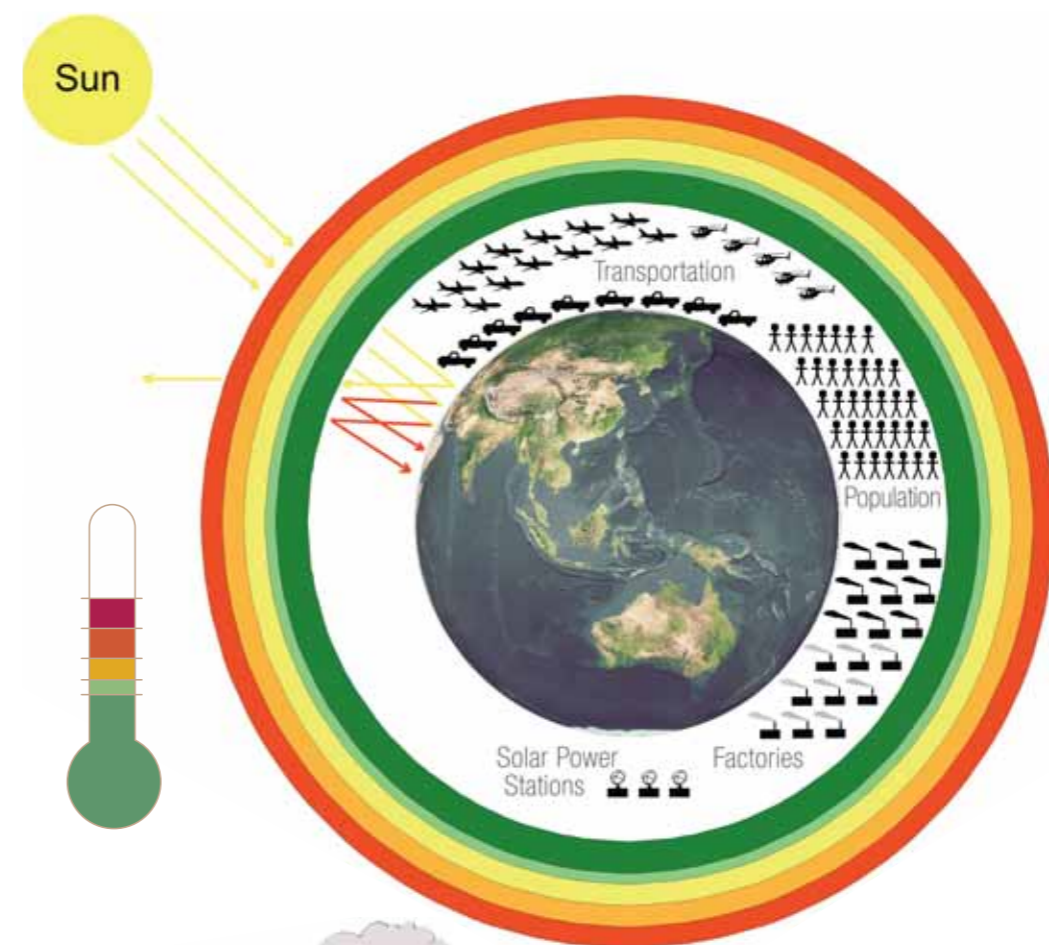


People travelling around in cars and helicopters lighting lots of small fires, so there are not so many big fires.

Choice 2 - Not enough changes to reduce carbon dioxide

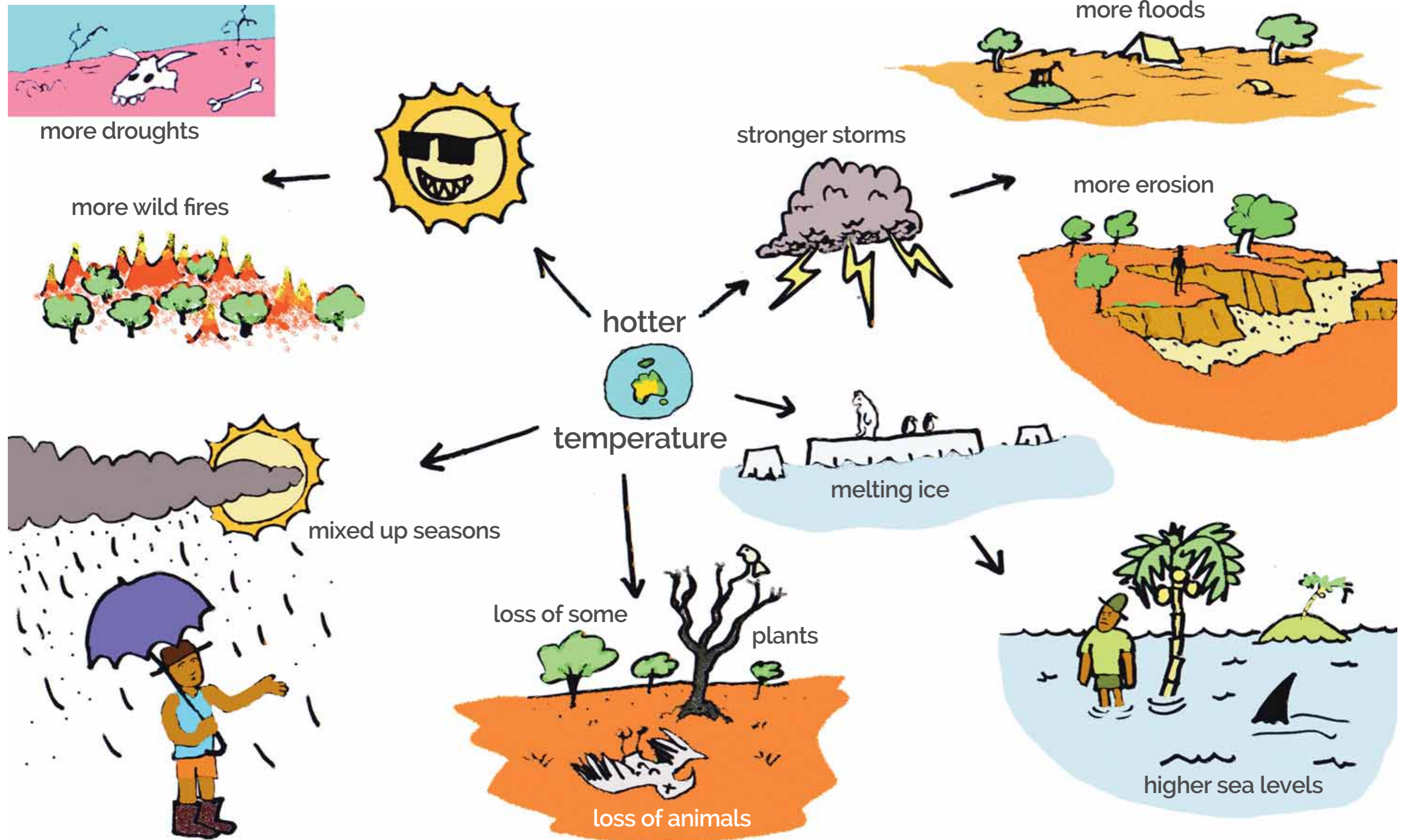
The temperature will go up 3 or more degrees in the next 50 years without positive changes. By the end of the century the temperature could go up by 6 degrees!

The red colour is a way of showing much more carbon dioxide in the air will make the earth a lot hotter than it is now.



People not travelling around burning much. There are really big fires.

What more greenhouse gases in the air will do



Climate change and erosion

Climate change will increase erosion

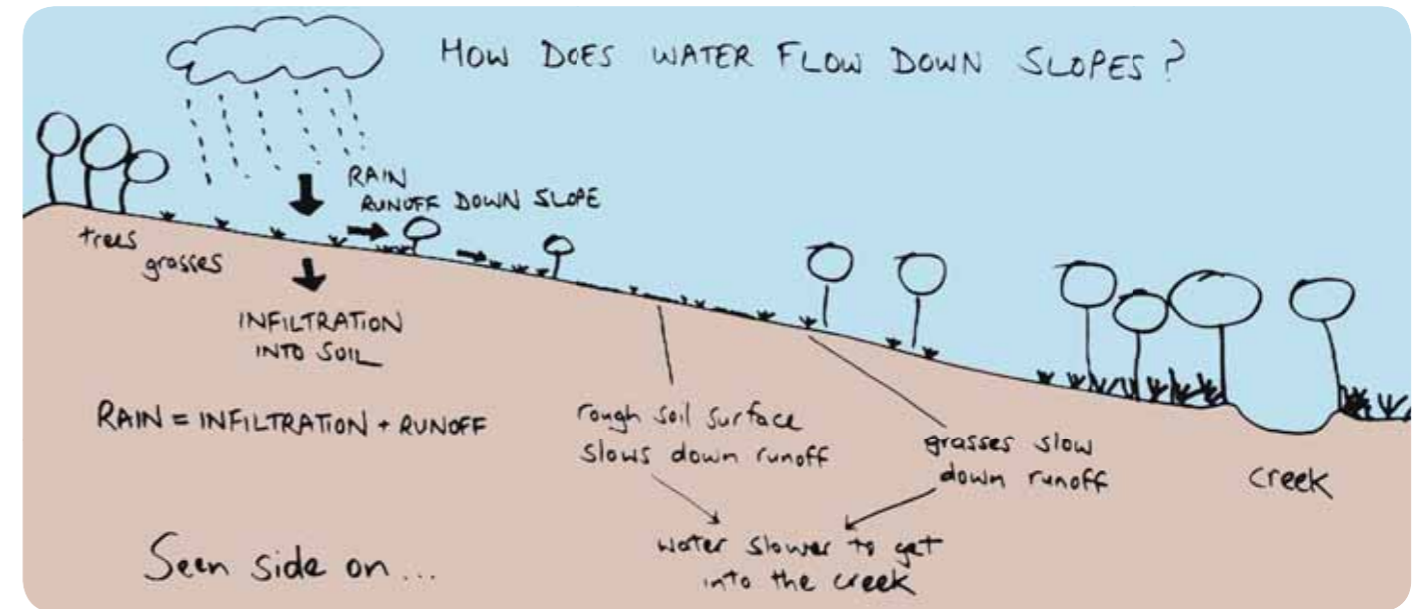
Stronger storms will wash away more soil, especially on country where the soil crust is broken up by horses and cattle.



Clear water flows down slope with crust and grass



Ashley Sparrow poured water onto the ground on soil with a crust and grass. The water ran down the slope slowly and wasn't very muddy. Not much soil gets washed away on ground undisturbed by horses or cattle.



Muddy water flows down slope with crust broken and grasses destroyed by horses.



Ashley also poured water on a horse track. More water soaked into the ground in the horse track but the rest of the water ran down the slope faster and muddier. More soil gets washed away on ground disturbed by horses or other hooved animals.

CSIRO scientists talked to the Ltyentye Apurte Rangers about how climate change will probably bring more big storms to central Australia. The rangers are concerned there will be more erosion.



The soil crust is alive. It is made of fungi and algae. The crust is often black when dry and greenish when wet. It holds the soil under it in place, like the scab on a wound.

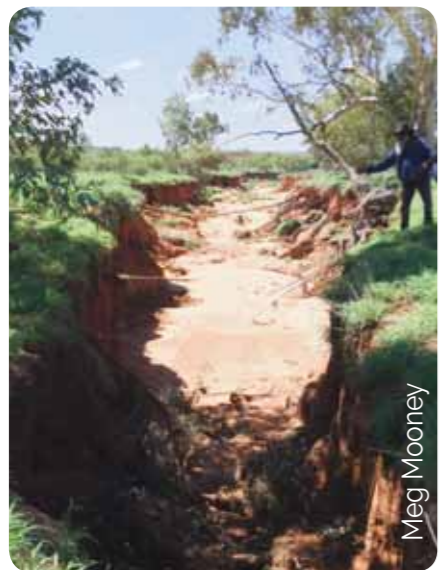
How erosion gullies form

Near Lytentye Apurte (Santa Teresa) there is a large gully in Yam Creek. This gully is quickly getting longer and deeper. CSIRO scientist Ashley Sparrow talked to the Lytentye Apurte Rangers about what caused the gully. Stronger storms from climate change will cause more big gullies to form.



Meg Mooney

Yam Creek, just upstream from the gullyhead. The rangers are pointing towards the main Alice Springs to Santa Teresa road, around a kilometre upstream.

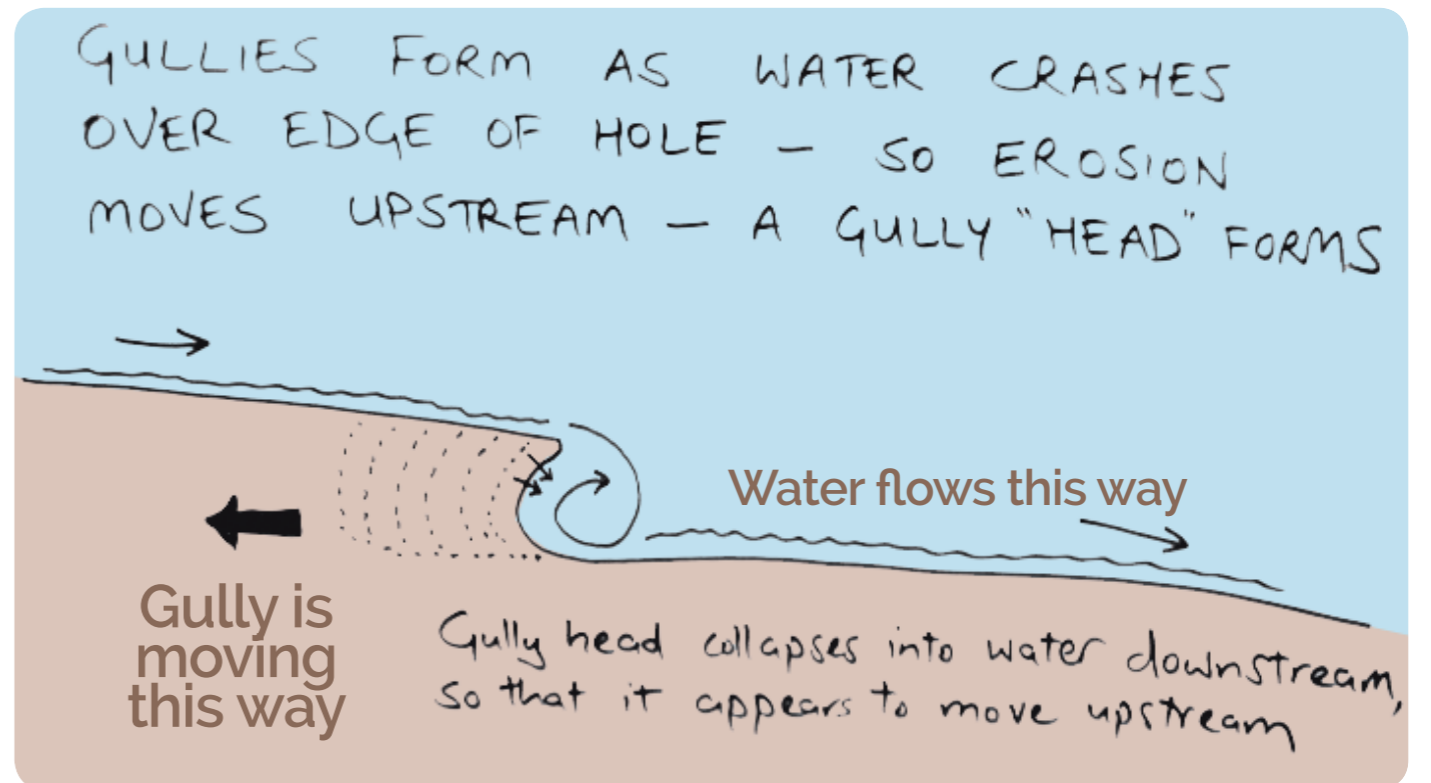
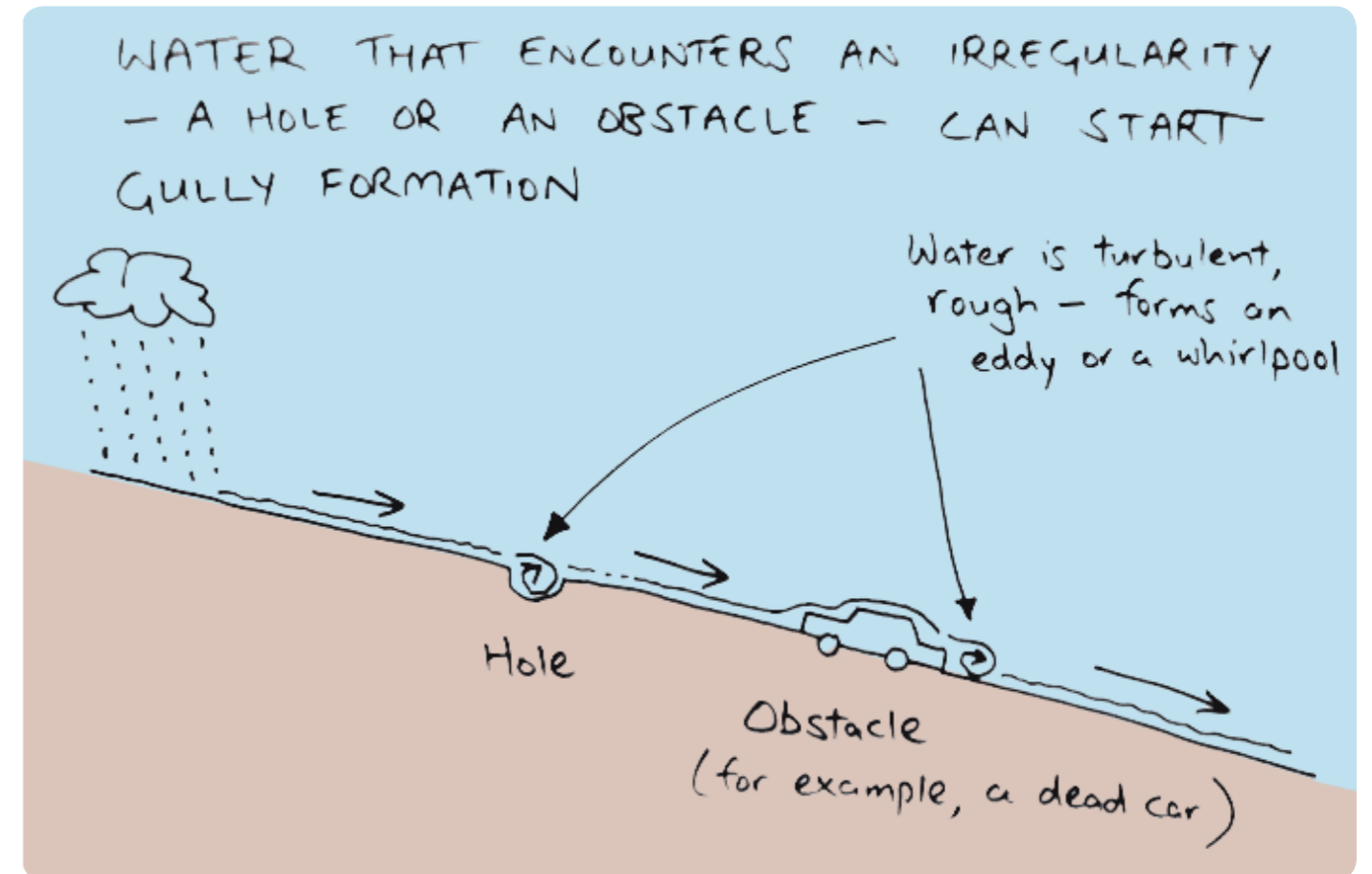


Meg Mooney



Fiona Walsh, CSIRO

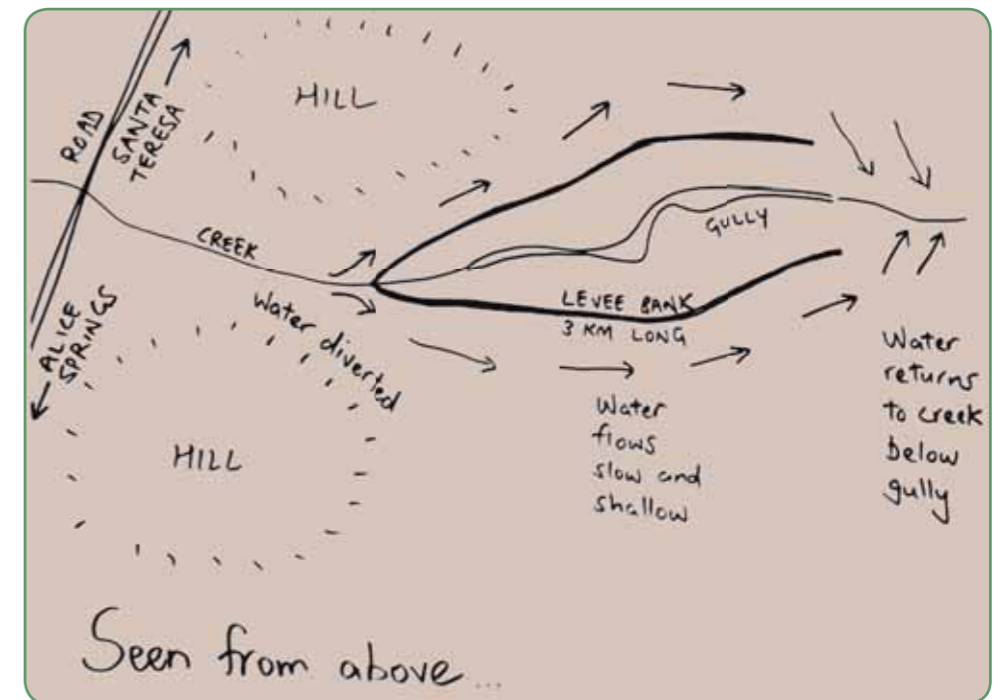
The gully just downstream The gully a kilometre downstream from the gullyhead.



Bigger storms cause more and larger gullies



Stronger storms mean faster and deeper water. This leads to bigger erosion gullies that move quickly. Yam Creek gully is already moving fast.



Ashley explained how levee banks can direct creek water away from a gullyhead, and then back down into the creek further downstream.

This starves the gullyhead of water and stops it from moving further upstream.

Erosion management prepares the country for climate change

In the last few years, the Ltyentye Apurte Rangers have been doing a lot of erosion control work, as a result of Ecosystem Management Understanding (EMU) planning with Traditional Owners of the Santa Teresa Aboriginal Land Trust. The rangers have built 20 kilometres of new fences and repaired another 20 kilometres of fences. They made a large paddock, next to important springs, to keep out feral horses, cattle and camels. They also made a large paddock for local people to keep their horses in.

The rangers have also constructed whoa boys to slow the flow of water and channel it across roads and slopes around Santa Teresa. This work to repair the country will help prepare it for climate change.

Controlling erosion on roads



The 'Two paddocks' project

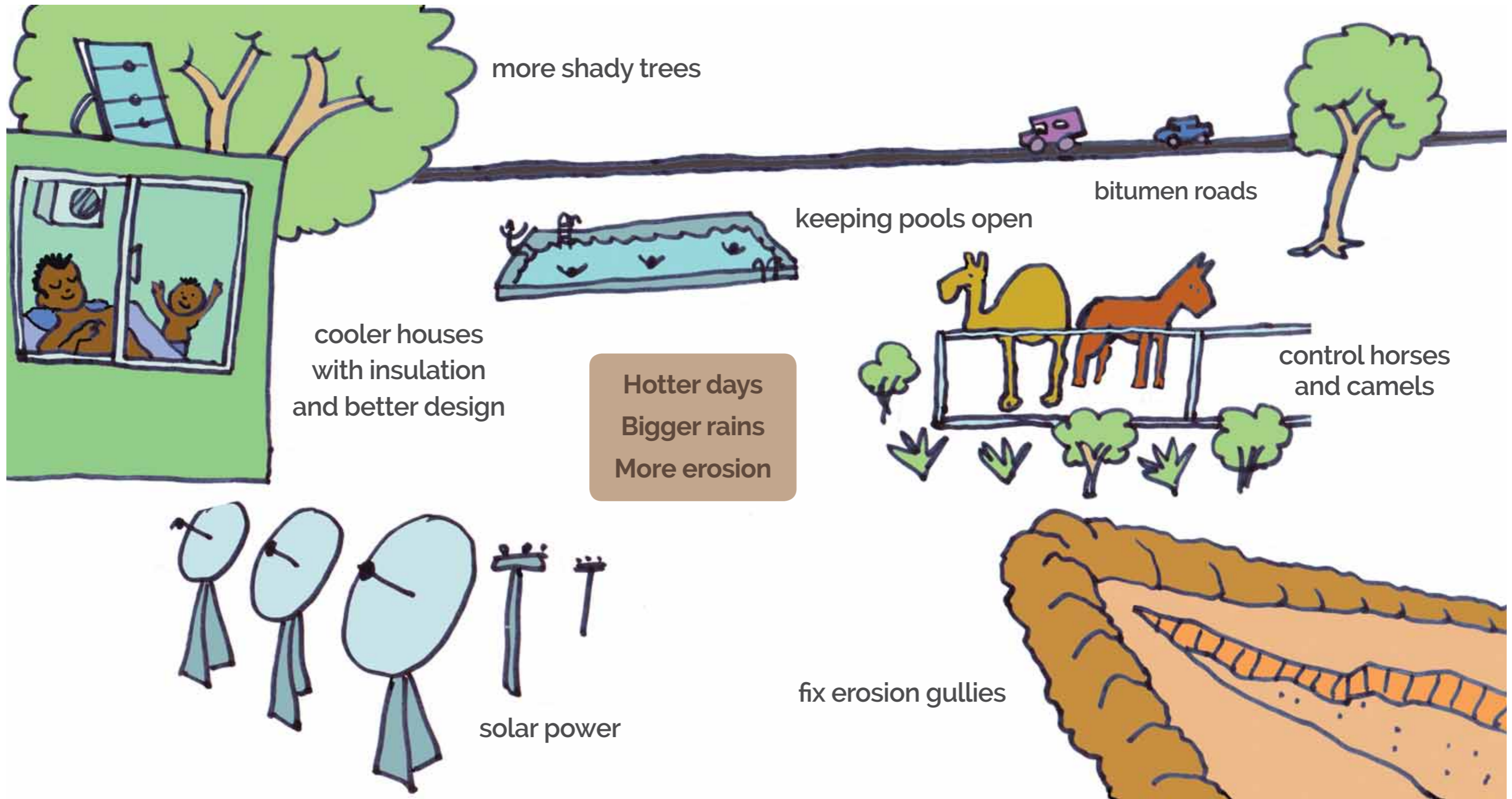


Photos on this page: Ltyentye Apurte Rangers, Central Land Council

Adapting to climate change

What will help communities deal with climate change?

Many different activities will help people and communities respond to climate change. These are some examples that people from Ltyentye Apurte identified.



Combining local knowledge and science will help communities adapt

Accurate, clear and easily understandable information will help local people understand climate change. This information will also empower people to work with their land management, health, school and other services to get the responses to climate change that a community needs.

We found that workshops with elders, community rangers and scientists exchanging information helped everyone to learn more about climate change. The Ltyentye Apurte Rangers developed a good understanding of climate change from this process and from producing a powerpoint presentation. Their talks, using this powerpoint, to local community groups were clear and informative.



Ltyentye Apurte Ranger Richard Furber uses the rangers' powerpoint presentation to talk about climate change to the Year 8/9 class at Ltyentye Apurte Community Education Centre.



A ranger hands out cards showing some ways of dealing with climate change to women at the Ltyentye Apurte aged and disability care centre. CSIRO scientist Ro Hill then discussed these adaptations with the women.



After the climate change presentation to their class, Year 8/9 students arrange, according to what they think is important to their community, the cards about dealing with climate change.

Solar power - one way to reduce carbon dioxide in the air

Using alternative energy, like solar and wind power, instead of burning coal, oil and gas means a lot less carbon dioxide goes into the air.

Hermannsburg/Ntaria



Yuendumu



Hermannsburg, Yuendumu and Lajamanu have solar power stations that provide around a third of the communities' power.

The Bushlight Program of the Centre for Appropriate Technology (CAT) designs and builds solar energy systems for people who live in small remote communities.

Some businesses, and private houses in Alice Springs have solar panels to provide all their power.



Many houses in Alice Springs, including some Territory Housing houses, have solar panels on their roofs for hot water. So far, few remote community houses have solar hot water.



Further information about

Climate science, climate change and climate adaptation for central Australian people

Videos



'Climate Change: Everyone's business' by Live and Learn Environmental Education (2012)
<http://www.youtube.com/watch?v=roKlfqvJPQo>
Published on May 1, 2012, Viewed 15 July 2014
A video about climate change, global warming, the greenhouse effect; impacts and the need for adaptation and mitigation actions, explained through a fun and educational animation. Ideal for schools, classroom or community education programs. Stars cartoon bats by Live & Learn Environmental Education.



'Understanding why the Earth system is warming'
<http://www.youtube.com/watch?v=Gw420atqLXI>
Published 27 September 2013, Viewed 23 July 2014
Video explains how and why the earth is warming
Shows patterns of warming and cooling



'Livelihood futures in PNG'
<http://tv.csiro.au/?v=xbz1895qhfpd>
A CSIRO researcher and PNG researchers explain their start to work with local groups and communities to help understand climate change and look at adaptation options.

Websites



The Bureau of Meteorology produces writes many regular climate products and reports.
Reports about rainfall, temperature and solar exposure maps, are produced each day for every State. Detailed climate statements and weather reviews are produced each month. Annual statements are released each year.
Many reports can be found on the Bureau's website at www.bom.gov.au/climate



North Australian Indigenous Land and Sea Management Alliance (NAILSMA) includes reports on 'A carbon guide for indigenous Australians' 2009, 'Climate change experiences in Northern Australia' 2008, 'Emissions trading, carbon financing and indigenous peoples' 2009, 'Indigenous knowledge for climate change workshop' (2012), 'Savanna burning educational resources' 2013
<http://www.nailsma.org.au>



<http://www.icat.org.au>
The Centre for Appropriate Technology produces the magazine 'Our Place'.
This has articles about people and technology in the bush. It includes practical guides to adapting to extreme conditions in remote Australia.
The CAT website and Our Place have information related to water, energy, housing, communications, infrastructure, livelihoods and training fro indigenous settlements.

CAT ran a special edition on Climate Change, 'Our Place Number 38'
<http://www.icat.org.au/wp-content/uploads/2012/08/ourplace38/index.html>



Climate change in Australia
www.climatechangeinaustralia.gov.au
This major website provides information on:
Observed climate change over Australia
Likely causes of climate change
Likely future changes to Australia's climate
New information and climate projections will be uploaded to this site in October 2014



NRM InfoNet
<http://www.ntinfonet.org.au/infonet2/#>
A website to map and report on aspects of natural resource management
The website includes a Google Earth option with different map layers like tenure and rivers.

Reports can be made for an area of interest (e.g. Santa Teresa Land Trust).
These reports can include fire history, weather data, weeds and native species. This could be useful for planning and monitoring land management activities.



Interactive map: '100 years of drought in Australia' by B. Spraggon, S. Elvery and M. Liddy (2014) interactive map showing 100 years of rainfall patterns across Australia
<http://www.abc.net.au/news/2014-02-26/100-years-of-drought/5282030>
Interactive map: '100 years of temperatures in Australia' Interactive map to explore 100 years of annual average temperatures across Australia
C. Tilley, Spraggon, S. Elvery and C. Gourlay (2014)
<http://www.abc.net.au/news/2014-07-09/100-years-of-temperatures/5582146>

Reports



'Jadagen, Warnkan and Barnden: Climate change in Gija country' by Frances Kofod, Sonia Leonard and Warmun Art Centre with Rusty Peters, Mabel Juli, Shirley Purdie, Nancy Nodea, Mary Thomas, Gordon Barney, Churchill Cann, Richard Thomas, Patrick Mung Mung, Betty Carrington (2013) from NNCARF and The University of Melbourne
A report about adaptation and climate change language and the land with words, paintings and narratives about different seasonal periods, the plants and animals associated with them includes artists biographies.



'State of the Climate 2014' by CSIRO and Bureau of Meteorology (2014) Australian Government
Website: www.bom.gov.au/state-of-the-climate



'Climate change and community-based REDD + education manual' by Robbie Henderson, Anjali Nelson and Sasha Kiessling 2012 from Live and Learn Environmental Education., Suva, Fiji.
<http://www.livelearn.org/resources/climate-change-and-community-based-redd-education-manual>
This report identifies ways to present 'intangible' scientific and economic concepts of climate change and REDD+ to an audience that includes people with limited formal education (if any) and low literacy. (REDD+ is United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries)



'Aboriginal responses to climate change in arid zone Australia: regional understandings and capacity building for adaptation'. Final report. P. Memmott, J. Reser, B. Head, J. Davidson, D. Nash, T. O'Rourke, H. Gamage, S. Sullivan, A. Lowry and K. Marshall, National Climate Change Adaptation Research Facility, Gold Coast, pp. 287
<http://espace.library.uq.edu.au/view/UQ:304557/Memmott-Aboriginal-responses-climate-change-arid-Australia.pdf>

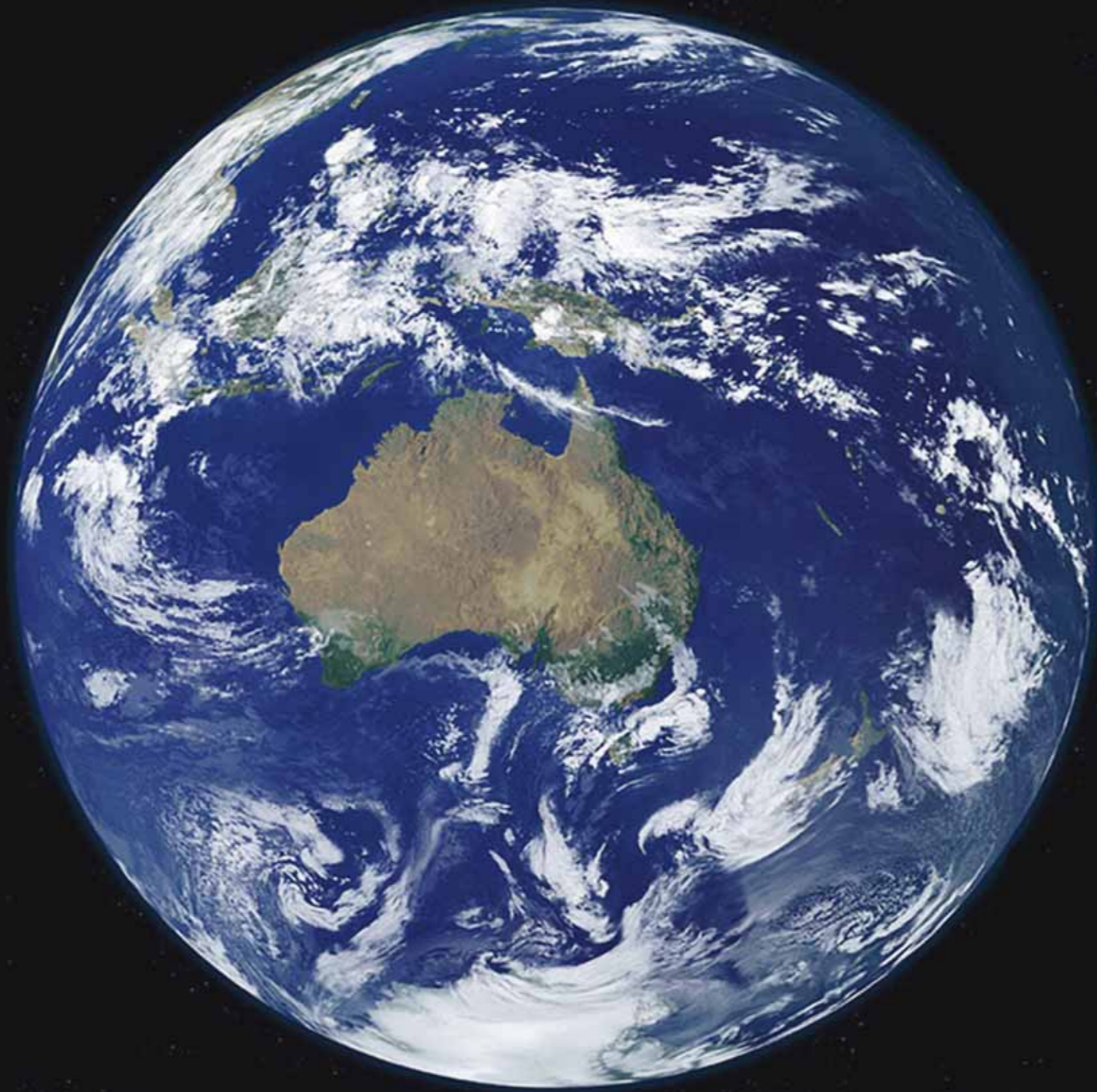
Books



'Listen deeply, let these stories in' by Kathleen Kemarre Wallace with Judy Lovell (2009), IAD Press
A book about the origins and beliefs of Eastern Arnernte people. Chapters on cultural ways, family, country, ancestor spirits, water, drought, healers, Santa Teresa mission, growing up, what is happening now and knowing culture.
Referred to in this report



'Climate change: Science and solutions for Australia' by Helen Cleugh, Mark Stafford Smith, Michael Battaglia and Paul Graham (2011), CSIRO Publishing
A book that presents summaries of recent research on climate change, adaptation and mitigation.
Go to www.csiro.au/Climate-Change-Book for a free copy of the eBook
Further information is on the website:
<http://www.climatechangeinaustralia.gov.au/index.php>



Climate change is happening all over the world.

Climate change affects everyone.

We all need to adapt to climate change.