Some musings on gardens and climate change

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- I studied agricultural science at university with a PhD in soil science.
- I started teaching at Burnley in 1976 – sciencey stuff.
- I've been gardening in Kyneton since about 1980.
- Initially an old house and garden.
- I realized quickly that cool climate, high rainfall plants weren't for me.
- Teaching horticulture reinforced the importance of matching climate and plants.
- A new house and garden since 2016.
- This talk is based on my thinking about climate change and gardens. I am not a climate scientist and if the topic interests you I recommend you read widley on the topic. Hopefully the information here will provide some plxces to start enquiring.

Climate change and gardens:

What's going to happen?

Should we, as gardeners be proactive about this?

Climate change predictions

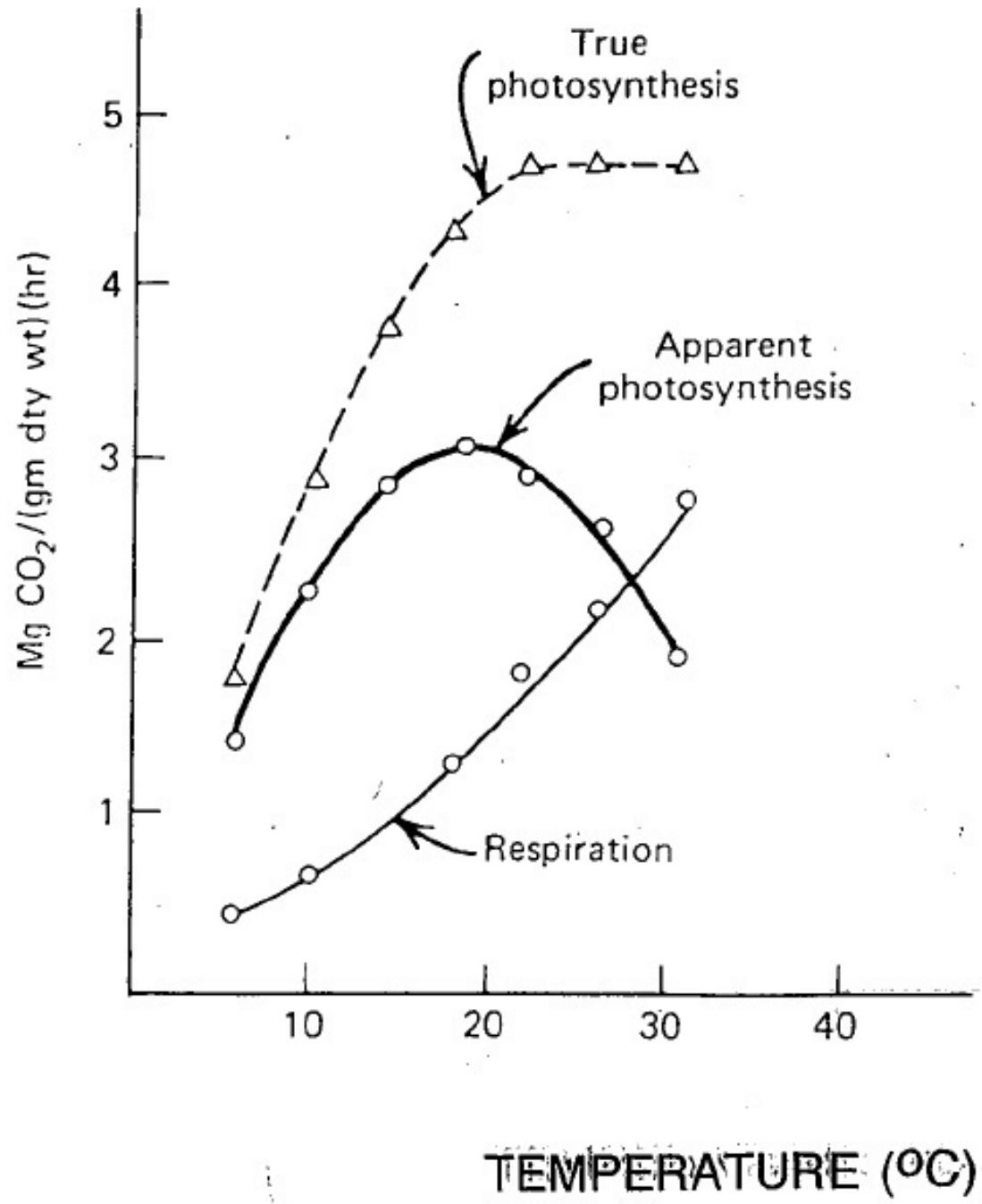
- Increasing temperatures
- Rainfall – changes less certain?
- Extremes

- Do we/can we:
- Modify our gardening practice to deal with the changes?
- Modify our gardening practices to help address the underlying issues of CO2 and other atmospheric pollutants?
- Modify our gardening practices to help insulate us (as individuals) from the changes?
- In this talk I will focus on the first point. My comments relate to gardens specifically.

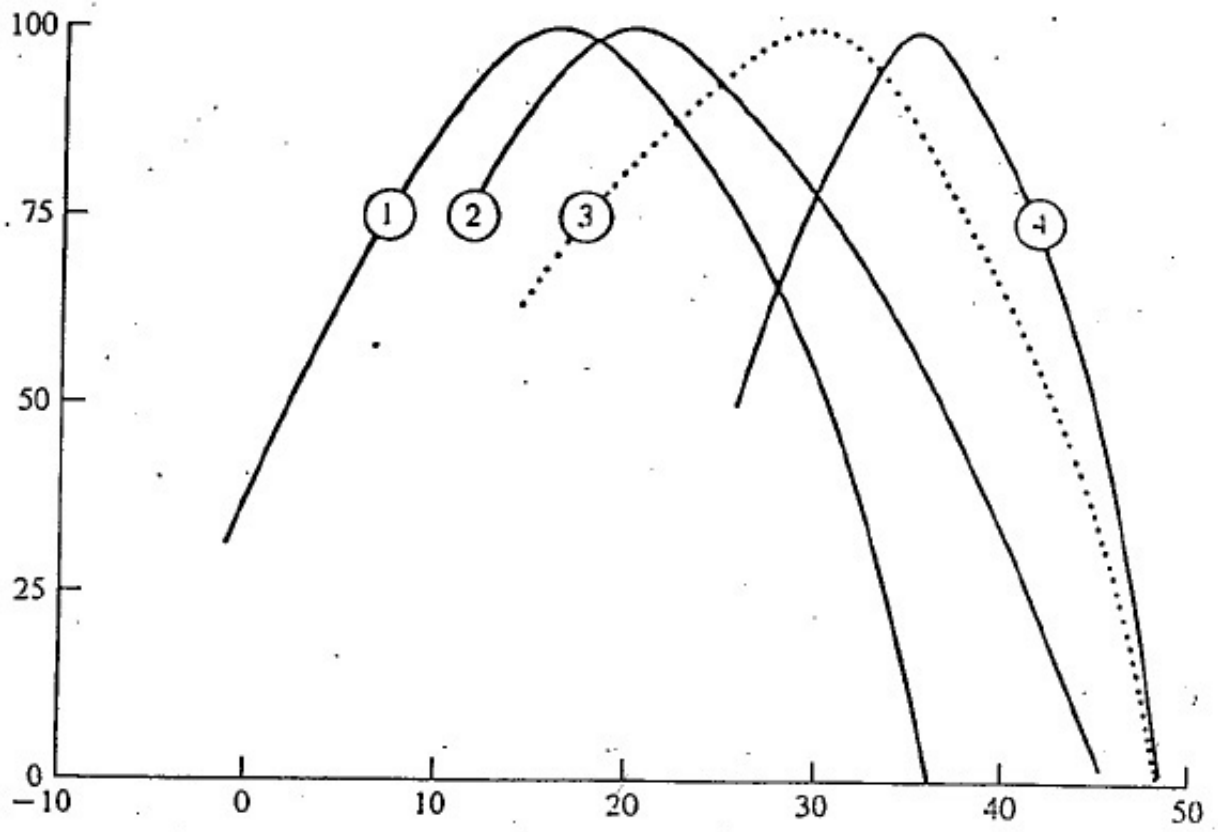
Climate and plants

- Increasing temperatures
- So what?

CO_2 EVOLUTION OR FIXATION



PHOTOSYNTHESIS



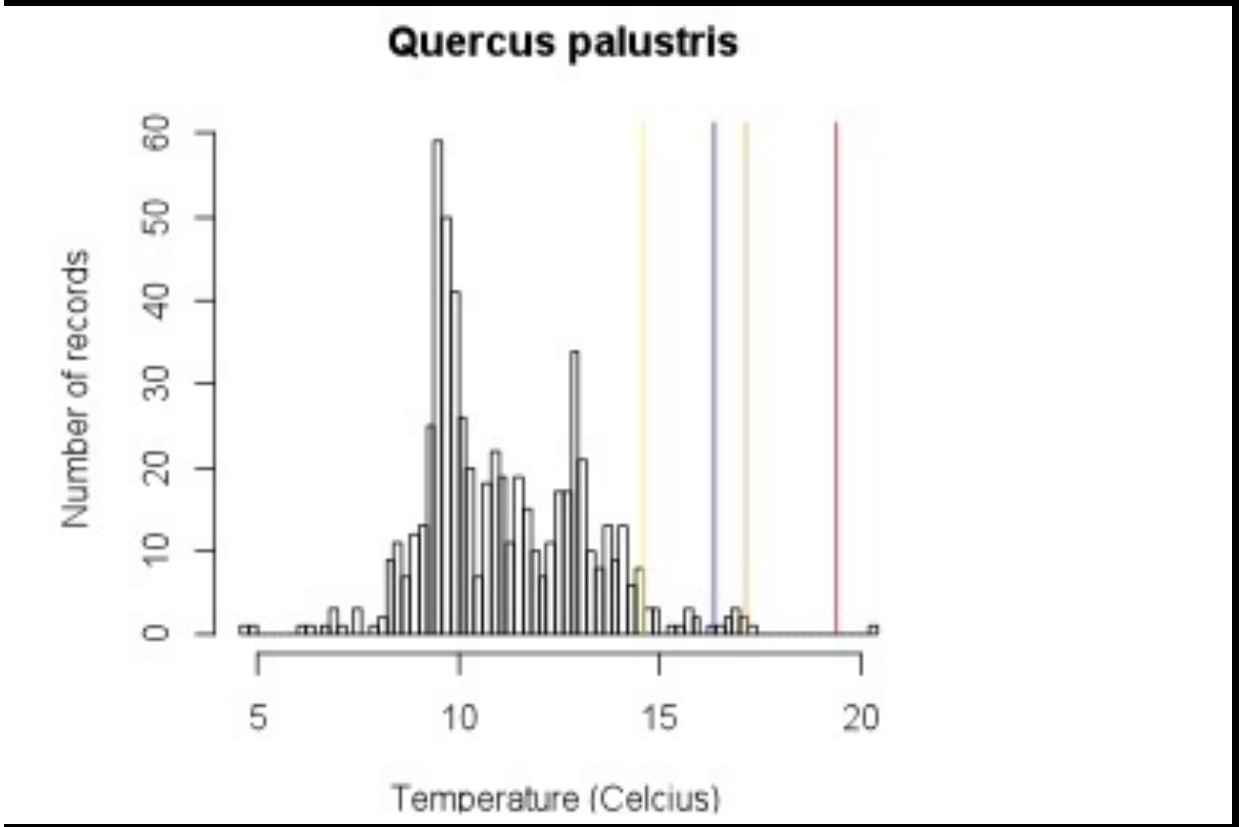
TEMPERATURE (°C)

Temperature (°C)

Figure 5.10 Effect of temperature on photosynthesis of temperate [*Pinus cembra* (1) and *Fagus sylvatica* (2)] and tropical [*Ficus retusa* (3) and *Acacia craspedocarpa* (4)] trees. (After Larcher, 1969; from Kramer and Kozlowski, 1979, by permission of Academic Press.)

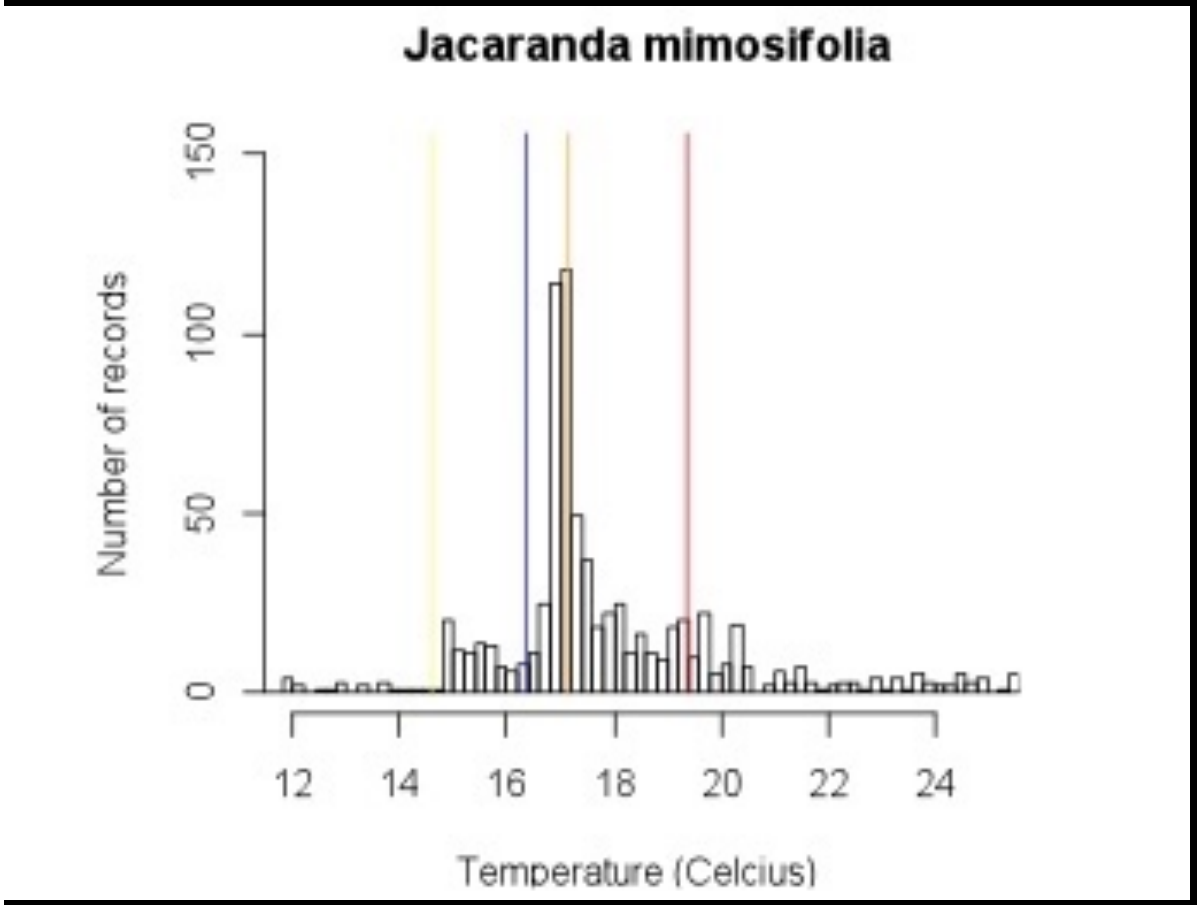
- Dave Kendal's study for City of Melbourne
- *THE CITY OF MELBOURNE'S FUTURE URBAN FOREST: Identifying the vulnerability of trees to the City's future temperature*

- Dave used *annual mean temperature* to model possible tree responses to the warming climate of The City of Melbourne.



Historic mean temp 14
Current mean temp 16
Projected mean temp: moderate change 17.5
Projected mean temp: extreme change 19.5

From Kendall et al 2016



Historic mean
Current mean
Projected mean moderate
Projected mean extreme

From Kendall et al 2016

Melbourne tree temperature threat

Species	Moderate climate change scenario	Extreme climate change scenario
Eucalyptus leucoxylon		
Eucalyptus polyanthemos		
Corymbia maculata		
Corymbia citriodora		
Melia azederach		
Pyrus calleryana		
Quercus palustris		
Ulmus parviflora		
Jacarandah mimosaeifolia		

Using Kendall's analysis, under the extreme change scenario, 62% of the trees in the City of Melbourne will be exposed to temperatures above their tolerance ranges. Data from From Kendall et al 2016

What parts of the CoMelb tree population did the Kendal study find to be most at risk from increasing temperatures?

Species from cooler parts of the northern hemisphere:
birch, beech, linden, some oaks, maples,
and
local native species, which seem to have very narrow temperature ranges in cultivation (is this physiology or limited use in international horticulture?)

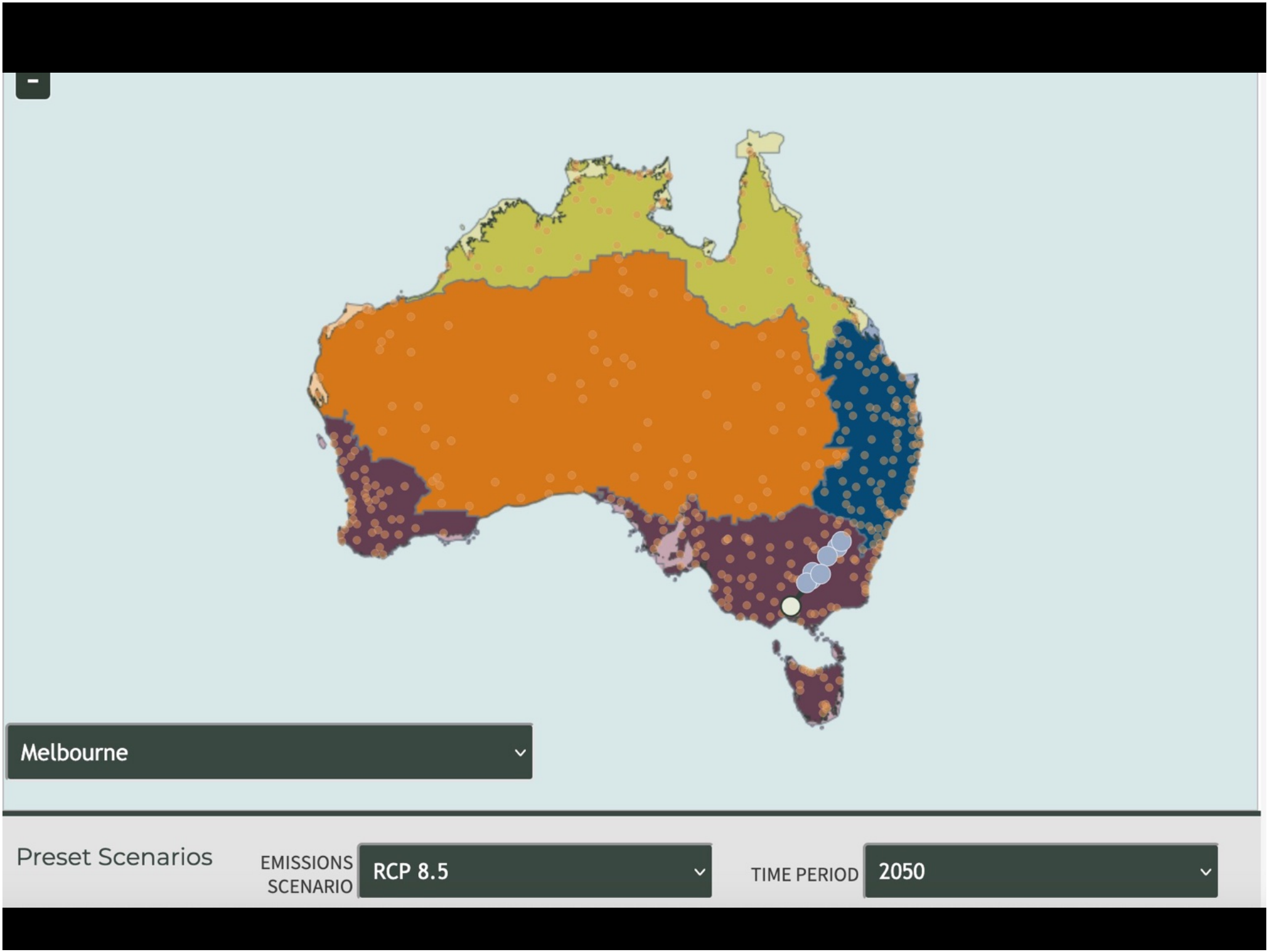
- Kendal did a further investigation of other places in Australia – here's a sample (business as usual scenario – ie uncontrolled emissions).

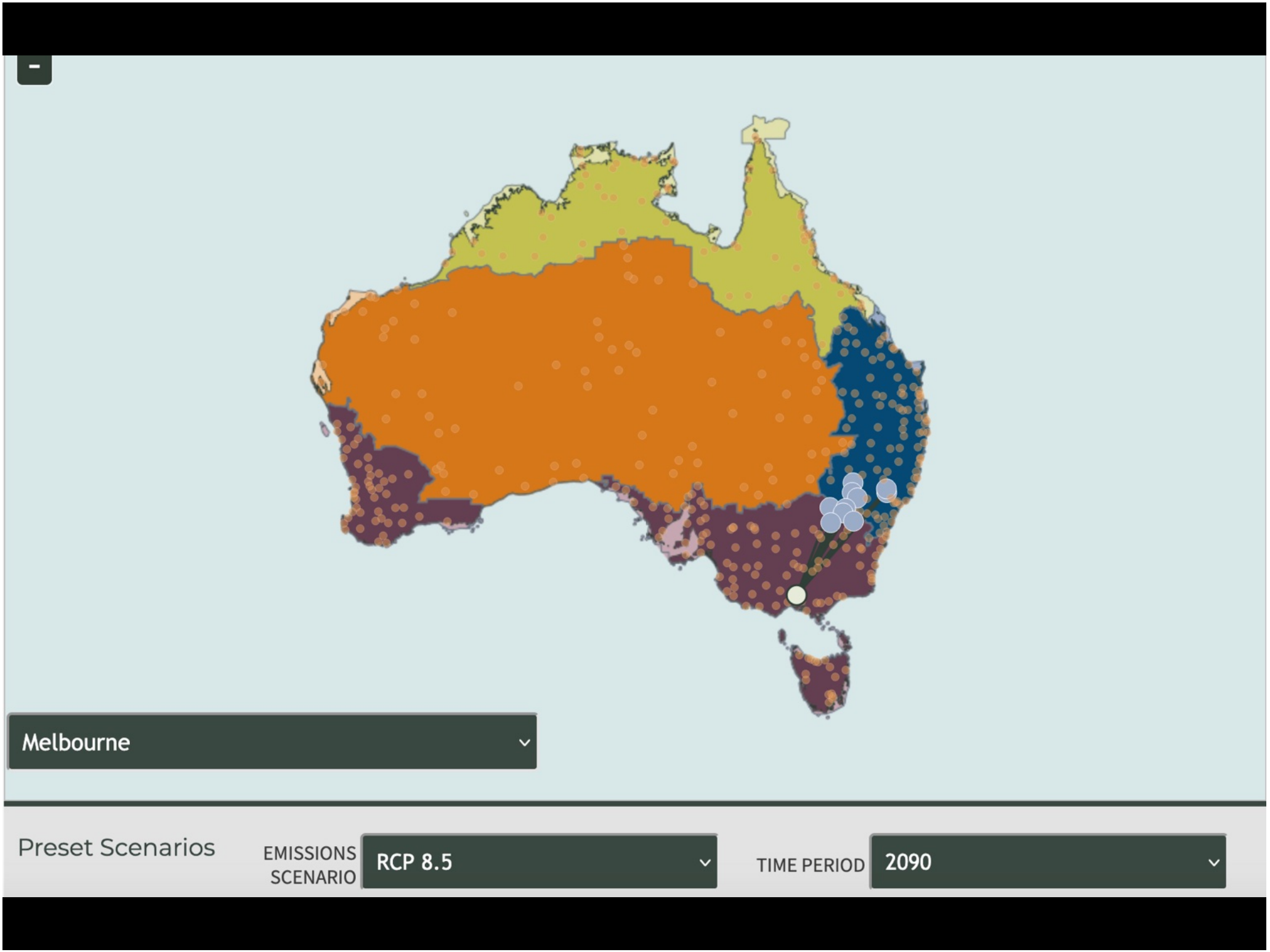
Location	% of species at risk	% of trees at risk
Adelaide	31%	43%
Ballarat	10%	1%
Darwin	100%	85%

https://www.nespurban.edu.au/publications-resources/research-reports/CAULRR07_RisksAustralianUrbanForest_Nov2017.pdf

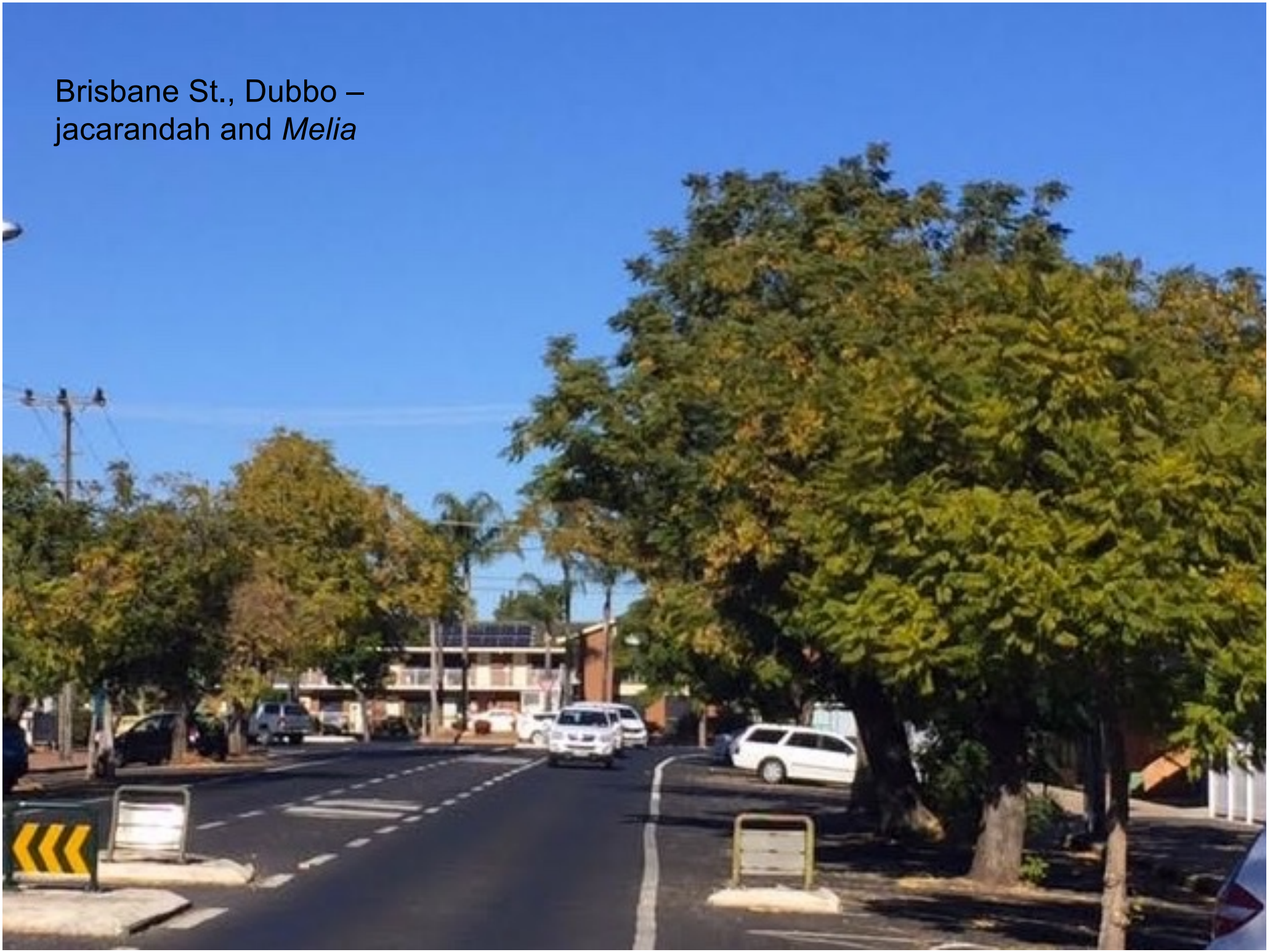
Richmond, VIC March 2009 – following two extreme heatwave events

- So where is the climate going, in terms of temperature? The next two maps show predictions for where Melbourne's temperature is likely to go. Sourced from the Bureau of Meterology website.


Melbourne
Preset Scenarios
EMISSIONS SCENARIO
RCP 8.5
TIME PERIOD
2050


Melbourne
Preset Scenarios
EMISSIONS SCENARIO
RCP 8.5
TIME PERIOD
2090

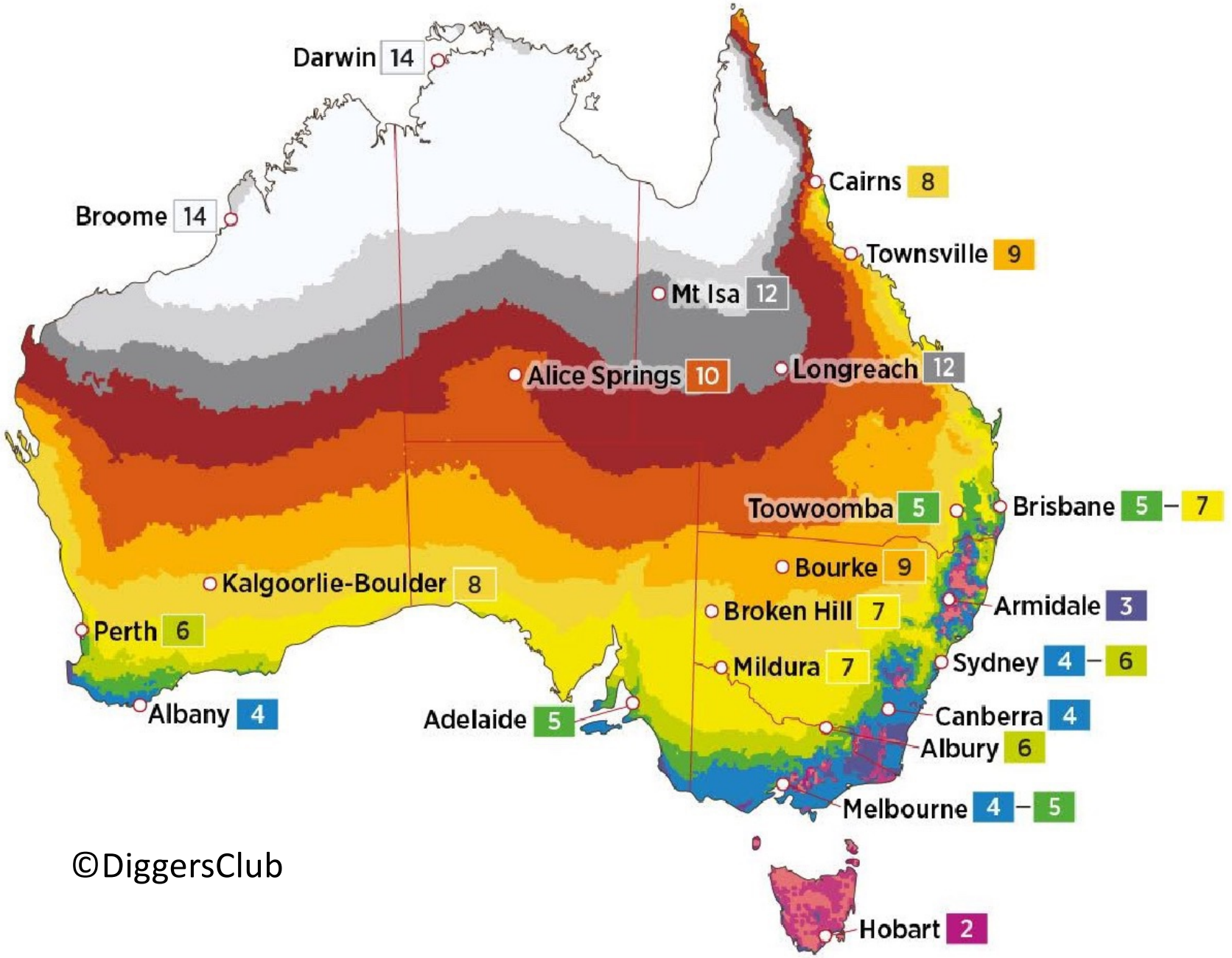
By 2090, Melbourne is predicted to have the temperature climate of Dubbo.


Brisbane St., Dubbo –
jacarandah and *Melia*

Some annual mean temperatures (historical data)

- Kyneton 11.8^{o}C
- Castlemaine 13.7^{o}C
- Bendigo 14.4^{o}C
- Melbourne 14.9^{o}C
- Wagga Wagga 16.5^{o}C
- Dubbo 17.3^{o}C
- Alice Springs 20.7^{o}C

- Another way of looking at this issue is with heat zones
- Originally used by USDA for US mapping and advice
- Zones based on number of days > 30C per year
- Digger’s Club has used this to generate an Australian Heat Zone map, and publish tolerances for the plants they sell.



HZ	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Average days above 30°C per year	< 2	7	14	30	45	60	90	120	150	180	210	240	270	350

eg *Tulipa*: Heat Zones 1-6

eg *Clivia*: Heat Zones 4-10

eg *Gaura/Oenothera*:

Heat zones 3-10

eg *Anemone X hybrida*:

Heat zones 1-7

cat.bcgi.org

Climate Assessment Tool

How To Use

Assessment Results

for taxon **Quercus agrifolia** Née

at garden **Ballarat Botanical Gardens (Australia)**

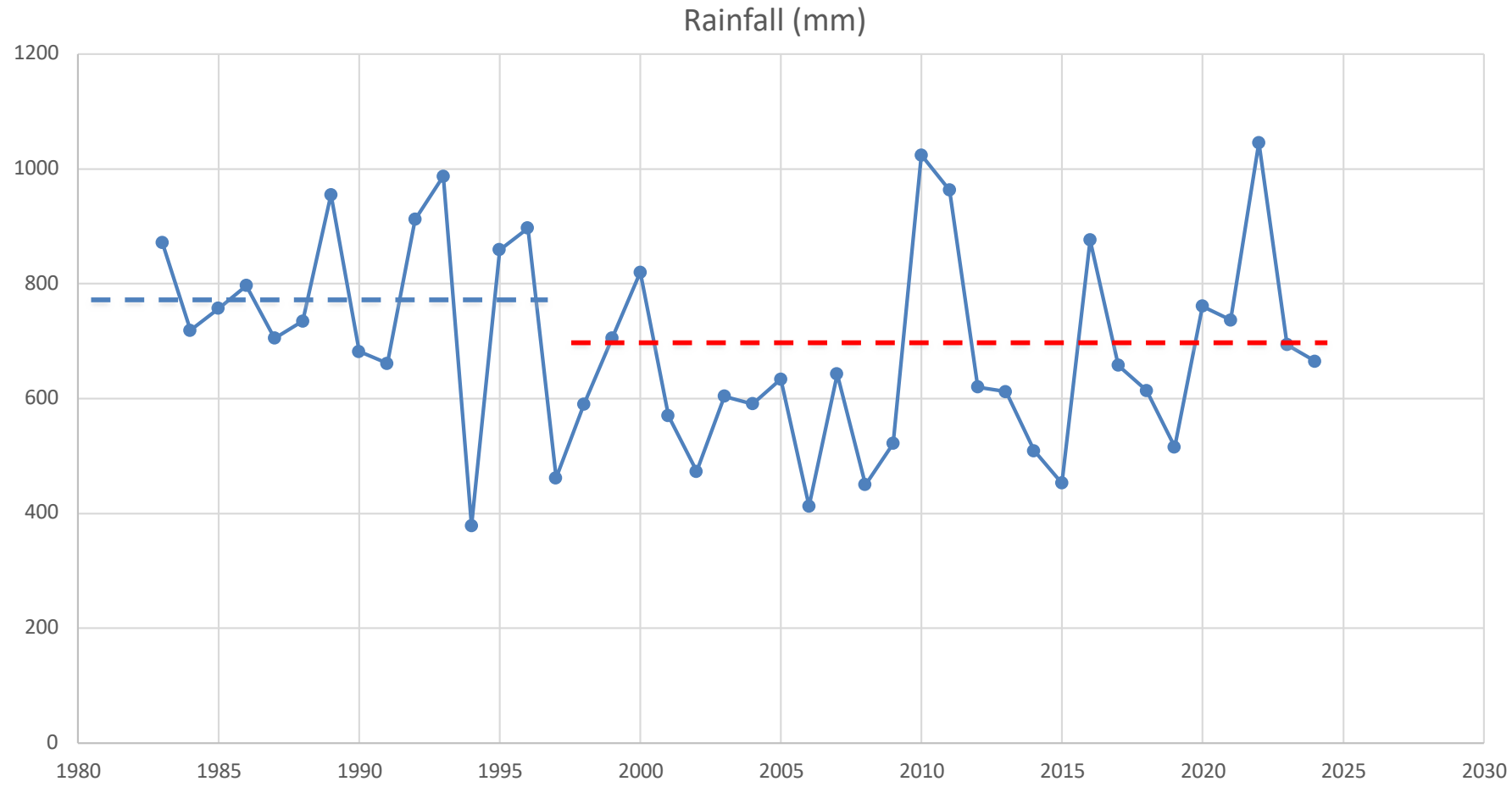
with climate change scenario **Business as Usual in 2090 (SSP3)**

Source	Records	MAT	Temperature in Celsius																Updated At	Hottest Month	Coldest Quarter	Annual Precipitation	Driest Quarter
			8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°					
GBIF BGCI	3982	15.2 °C	0	0	0	0	1	1	3	3	3	3	2	0	0	0	0	0	0	2019-06-13	29.3 °C	10.5 °C	478 mm/year	7 mm/c
GBIF Current	7498	15.3 °C	0	0	0	0	0	1	3	3	3	3	2	0	0	0	0	0	0	2020-10-09	29.2 °C	10.7 °C	480 mm/year	8 mm/c
Model	0	15.2 °C	0	1	1	1	2	2	3	3	3	3	2	1	1	1	0	0	0	2021-06-18			0	0
UrbanPlants	16	15.5 °C	0	0	0	1	1	2	2	3	3	3	2	1	0	0	0	0	0	2020-06-30	27.5 °C	10.7 °C	480 mm/year	8 mm/c
PlantSearch	72	13.6 °C	0	2	3	3	3	3	3	3	3	2	2	1	1	0	0	0	0	2025-06-26	26.1 °C	6.4 °C	785 mm/year	128 mr

- Climate change and water

- Will climate change make our climates wetter or drier (more or less arid)?
- Winter rain predicted to be less
- Totals probably reduced
- Increased temperatures will make it effectively drier

The new normal? Kyneton rainfall (my own records)



Mean 1983-1996 780 mm

Mean 1997-2024 694 mm

Since 1997, only 7/28 years > mean (drought vs waterlogging)

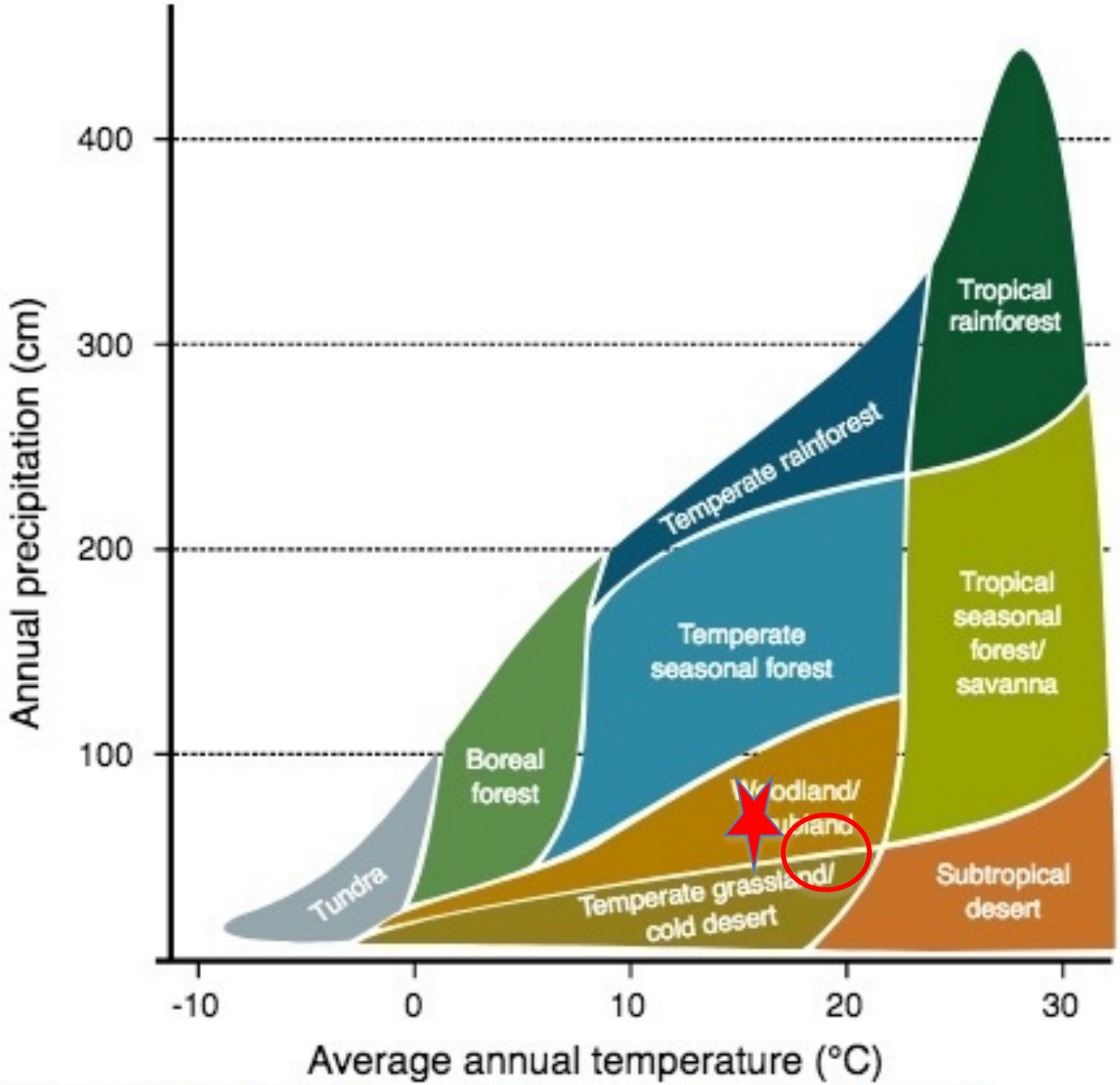
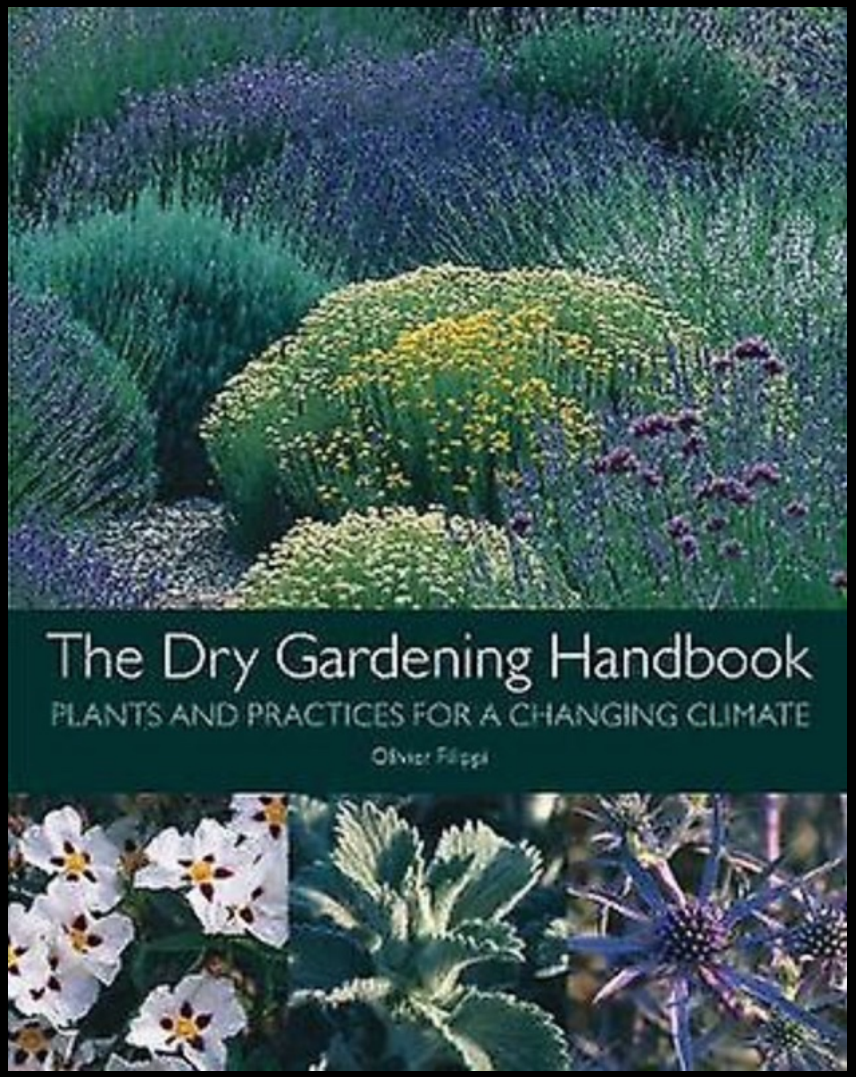
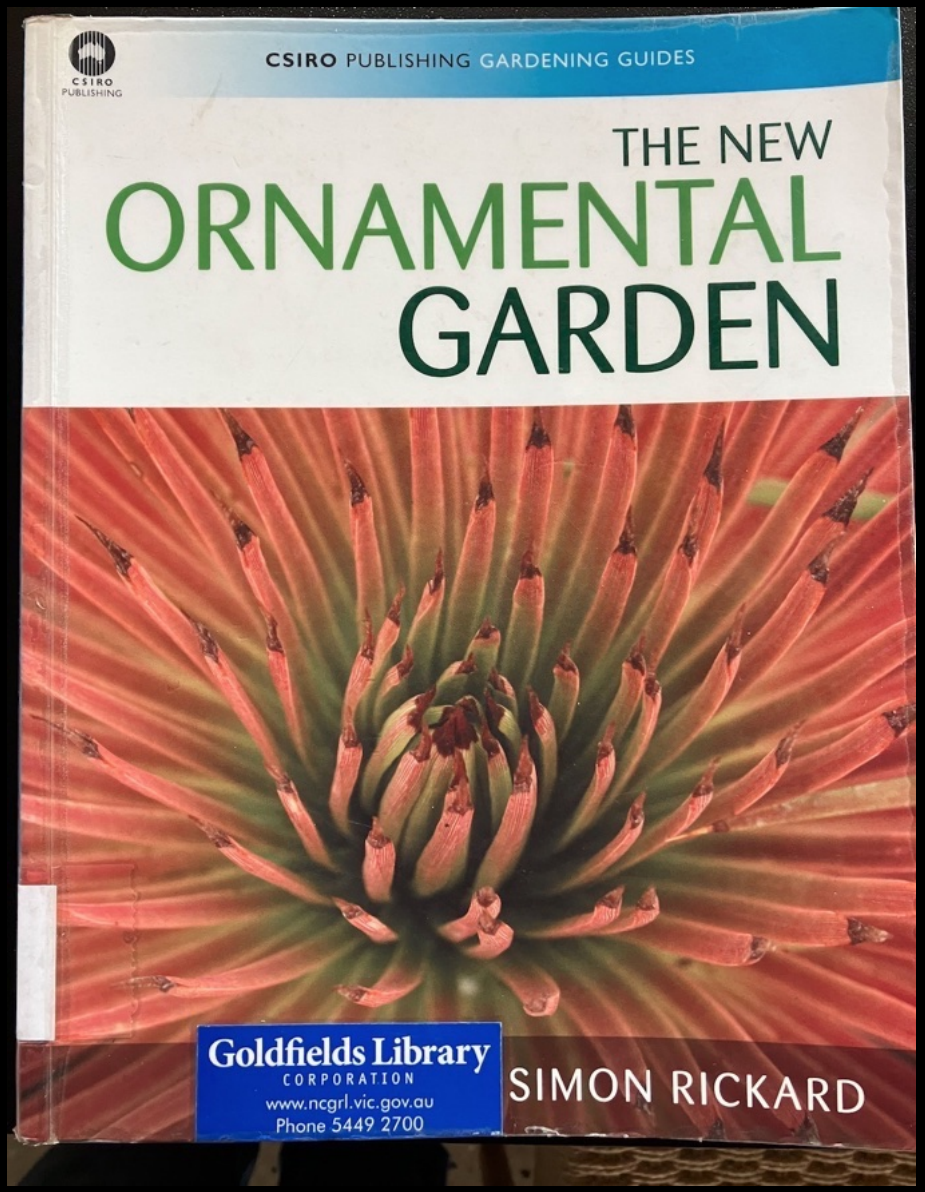


Figure 2. Precipitation and temperature are the two most important climatic variables that determine the type of biome in a particular location. Credit: "Climate influence on terrestrial biome" by Navarras is in the Public Domain, CC0

Kurt Wilkinson’s garden in the Adelaide Hills (image used with permission).
Instagram @kurt.wilkinson

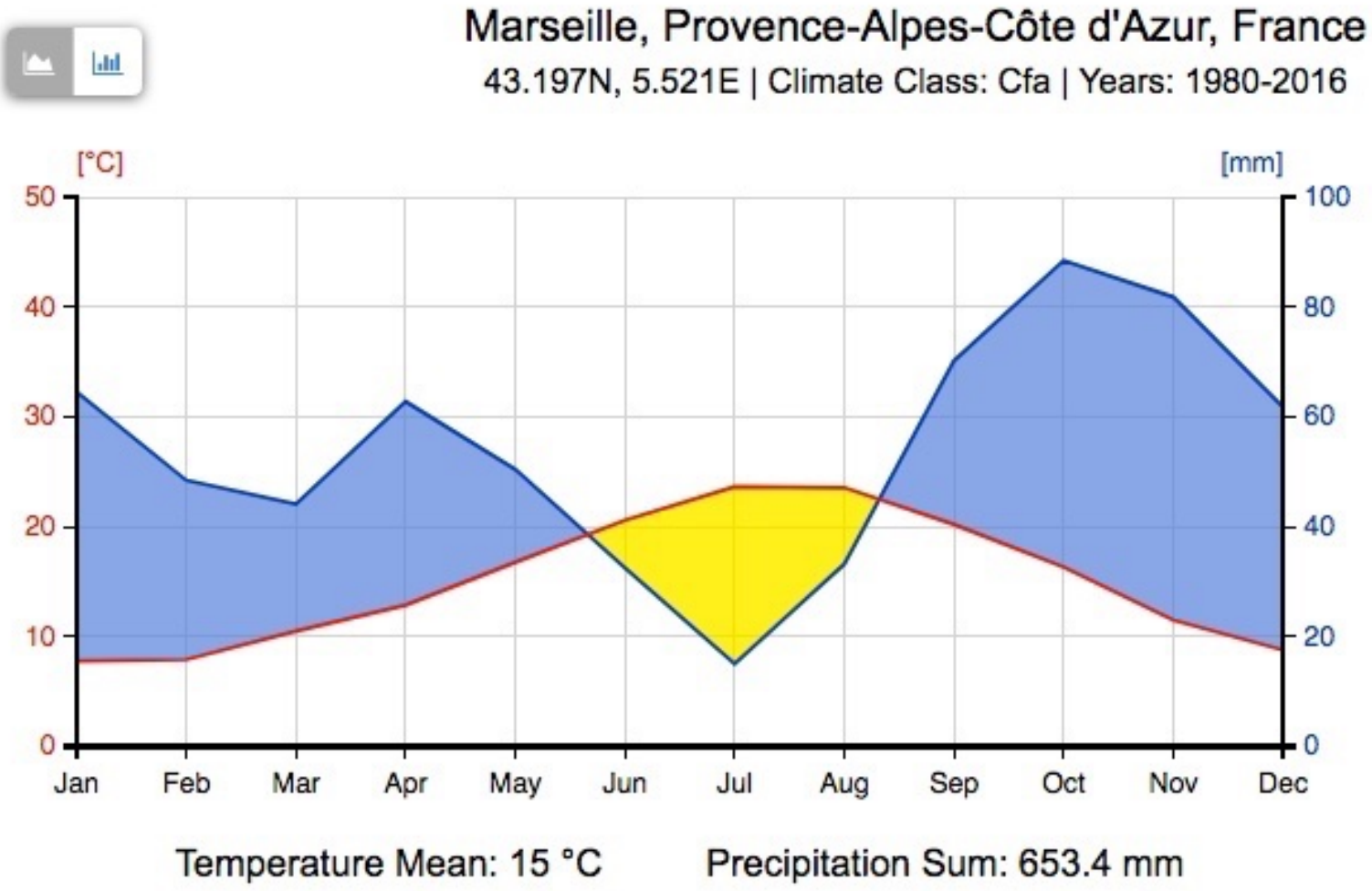
Temperature effects on aridity





- One method for describing aridity is that of Gaussen and Bagnouls (“botanistes célèbres”) to determine number of “dry” months in a year.
- Note: not months with no rain.
- Monthly mean rainfall and temperature determine whether a month is “dry” or not.
- This may not be the best measure of climatic aridity and is used here to illustrate, rather than absolutely predict, possible changes to aridity.

The ombrothermic chart



Month	Temp	Precip
Jan	7.8	64.5
Feb	7.9	48.4
Mar	10.5	44.1
Apr	12.9	62.8
May	16.8	50.4
Jun	20.6	32.5
Jul	23.6	15.0
Aug	23.6	33.2
Sep	20.2	70.2
Oct	16.3	88.5
Nov	11.5	81.8
Dec	8.8	61.7

Source: www.climatecharts.net

Some plant tolerances to aridity - Fillipi

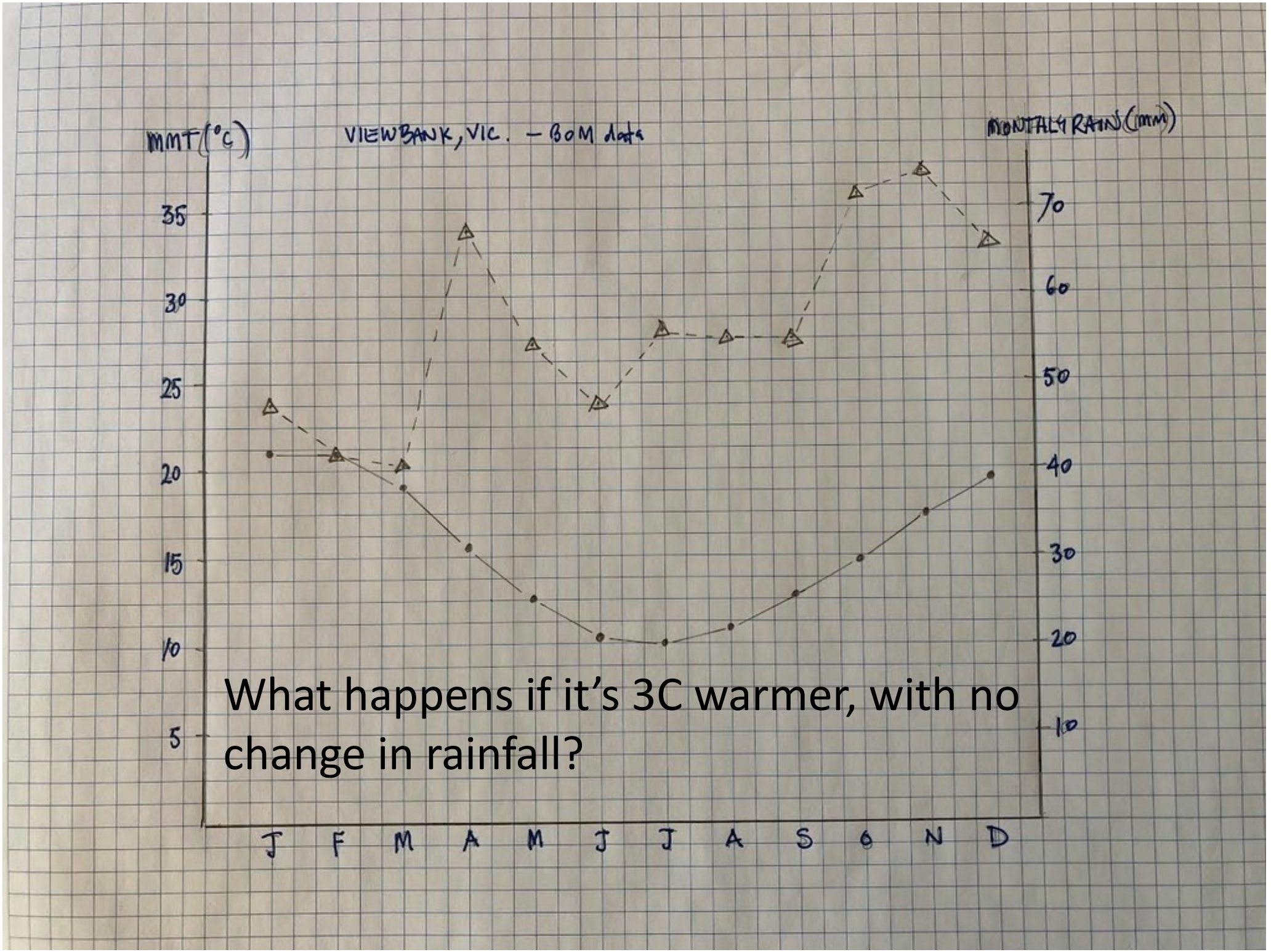
2 months
- *Festuca glauca*

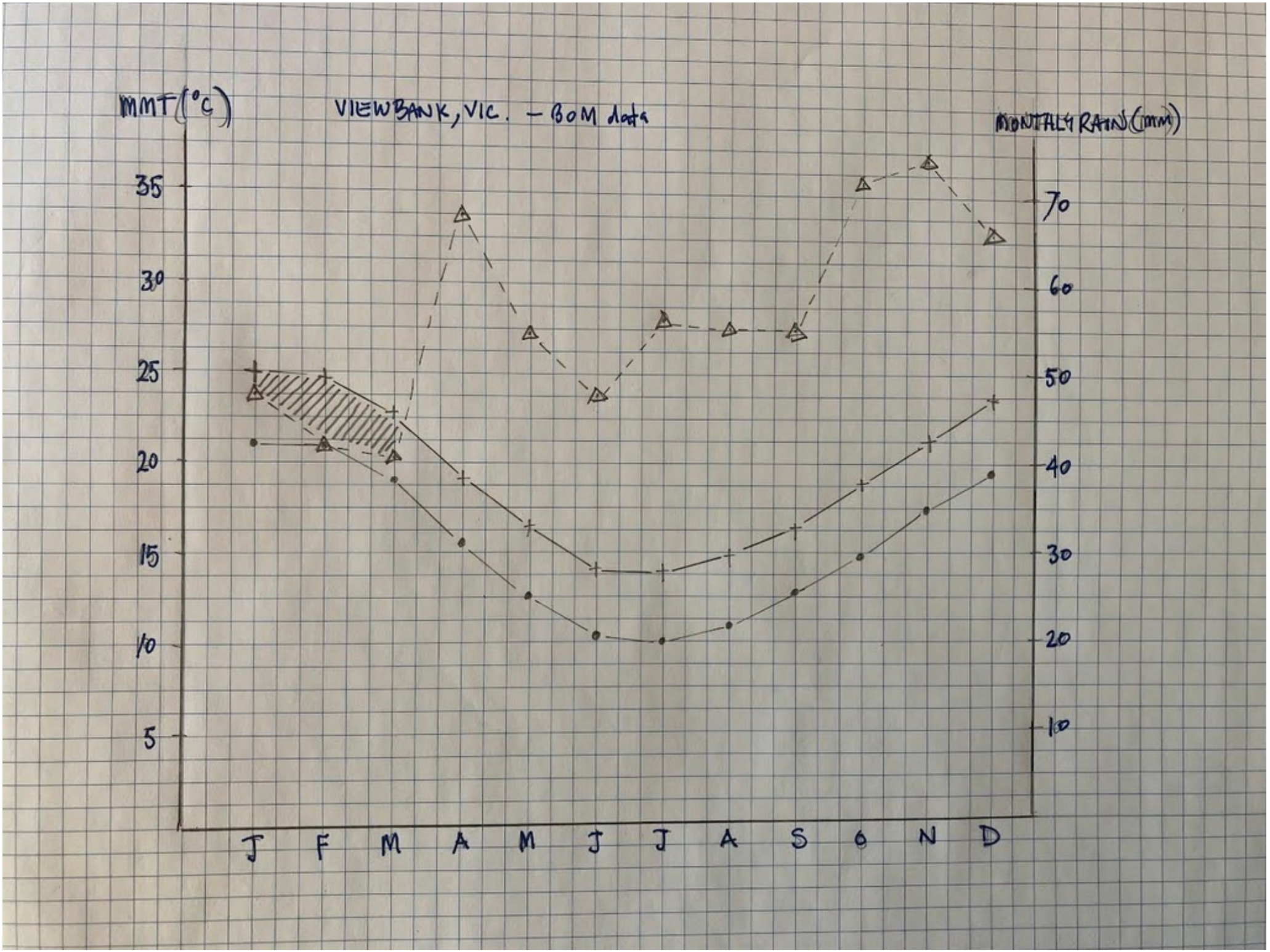
3 months
- *Kniphofia sarmentosa*
- *Phlomis russeliana*

4 months
- *Epilobium* Catalina
- *Gaura lindeheimeri*
- *Lavandula X* Grosso
- *Perovskia atriplicifolia*

5 months
- *Euphorbia rigida* and *E. chariacas*
- *Iris unguicularis*
- *Olea europaea* (but not for fruit production in my experience)
- *Salvia chamaedryoides*
- *Stipa gigantea*

6 months
- *Hesperaloe parviflora*


MMT (°C)
VIEWBANK, VIC. – BoM data
MONTHLY RAIN (mm)
35
30
25
20
15
10
5
70
60
50
40
30
20
10
J F M A M J J A S O N D
What happens if it's 3C warmer, with no change in rainfall?


MMT (°C)
VIEWBANK, VIC. – BoM data
MONTHLY RAIN (mm)
35
30
25
20
15
10
5
70
60
50
40
30
20
10
J F M A M J J A S O N D

- Climate change looks to be making it warmer and more arid.
- A logical first response to these potential changes is to accept the climate reality of where we are now.
- Which frankly, many gardeners don’t do and nurseries don’t encourage.
- Simple example, silver birch.
- A lot of future-useful plants are already in gardens around us.

Many contemporary Australian gardens will only survive *"as long as the life-support system that keeps the reality of our climate at bay continues to operate.*
Collectively, we need to take a deep breath and step back from our rigidly held assumptions about what makes a garden beautiful or worthwhile."

- Simon Rickard (2011) *The New Ornamental Garden*, CSIRO Press

- A list of cities most likely to face critical water shortages:
- Cape Town
- Cairo,
- Los Angeles,
- Jakarta,
- Beijing,
- Mexico City,
- Sao Paulo,
- Melbourne.

Source: *History for the Future*, Roman Krznaric, WHAllen, 2024.

Responding to climate change in your own garden

For short-lived plants it doesn't matter.

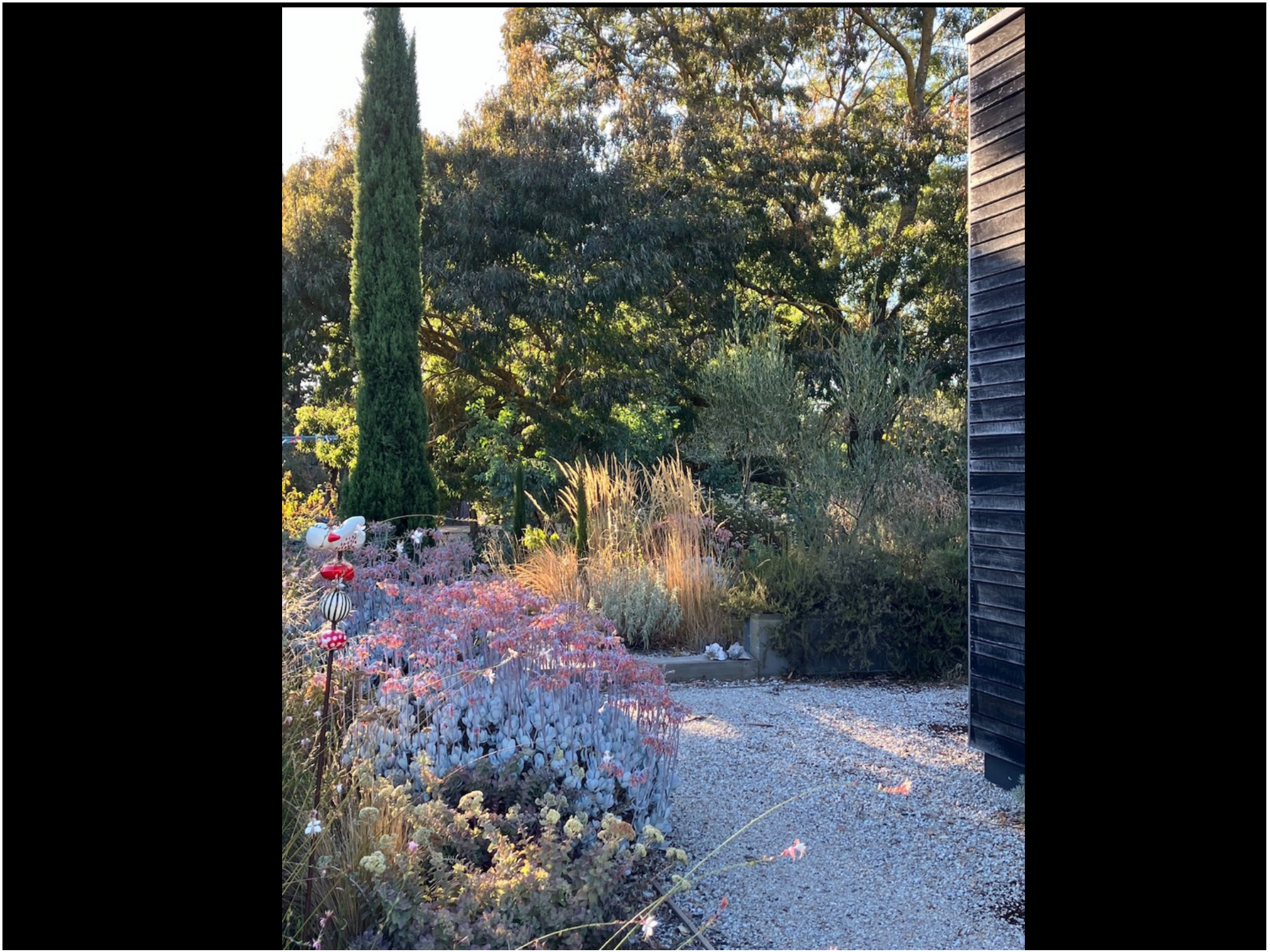
If you are about to plant long-lived plants you might think about where the climate is going (hotter, not necessarily less frosty, effectively drier) – local government is already acting on this in many places.

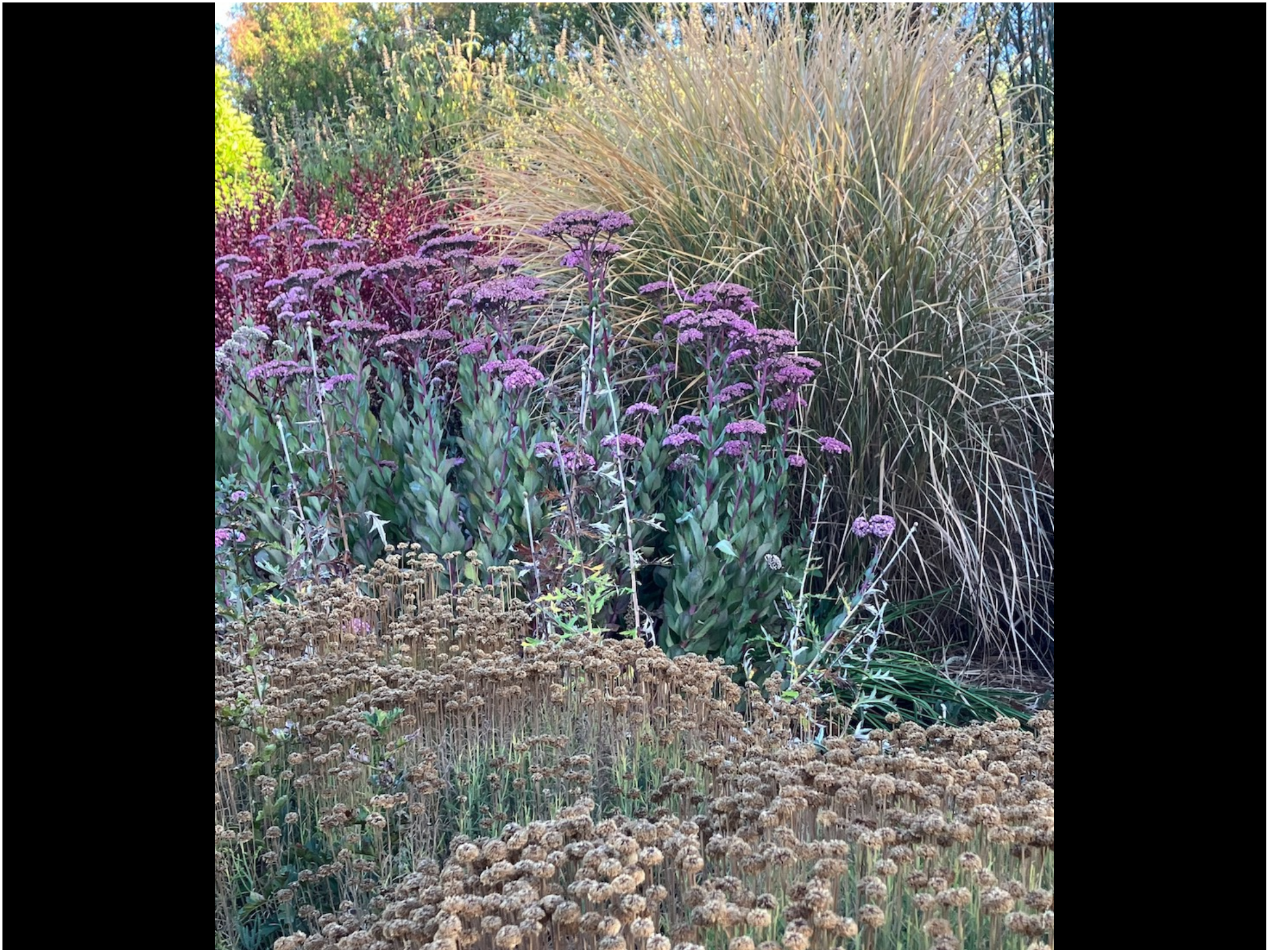
Extremes will probably become more common (heat, drought, wind).

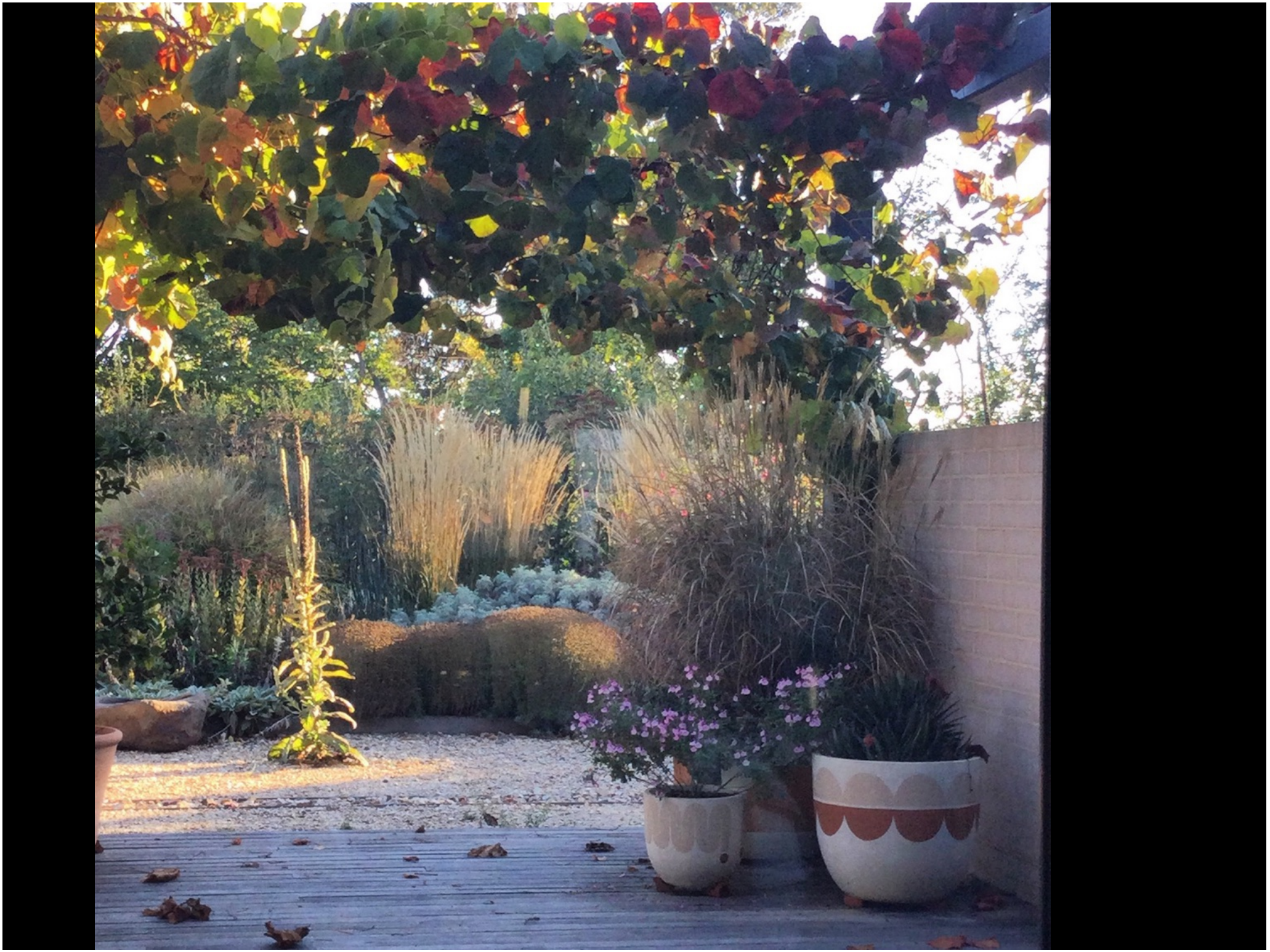
My own garden: an attempt to operate within the constraints of the site.
No irrigation, no soil amendment, no fertilizers, no pest and disease control.


December 2014

A year







Some musings on gardens and climate change, by Dr Peter May

Dr Peter May, former head of the Burnley College of Horticulture, addressed the topic of the impact of climate change on gardens. He began by noting that gardening heads the list of favourite recreational pursuits and provides many physical and mental health benefits to humans, not to mention habitat benefits to non-humans. Therefore it is extremely important that considerations are given to how we can best continue to garden in the context of a changing climate.

The basic rule of horticulture was stressed – we need to match plants to the climate, rather than attempt to create a climate and conditions suitable to the plant. Climate science predictions tell us that while temperatures will rise, the impact on rainfall is less clear. What we can say is that, although the average rainfall may not change a great deal, the occurrence of rain will almost certainly be more variable, with longer periods of drought interspersed with severe flooding events. This presents a challenge to gardeners. Peter observed that he lost more plants in his garden at Kyneton in the 'wet' years compared to the millenium drought years.

Higher temperatures will have a greater impact on some species than others. Plants vary in their temperature range tolerances. Some northern hemisphere species such as pin oak and red maple are already at the upper end of their temperature range in Melbourne, while others such as the jacaranda are in the middle of their range and can tolerate higher average temperatures. Interestingly and disturbingly, some indigenous species such as Eucalyptus leucoxylon and Eucalyptus polyanthemus, our local iconic red box, are also threatened by higher temperatures. This has implications for bush regeneration as well as gardening – we may need to look for more heat tolerant species to revegetate our bushland.

Even with the same average rainfall, higher temperatures will mean increased dryness. Peter introduced us to the term 'ombrothermic chart', which plots precipitation and temperature on different axes, and gives a measure of aridity at different times of the year. When evaporation due to high temperatures exceeds rainfall, this is a 'dry' month, and places drought stress on plants. With a 3 degree temperature increase, Melbourne will be experiencing longer 'dry' periods in the future; five 'dry' months of the year, instead of the current two. We will need to choose plants that can cope with arid conditions. By 2090, on the current climatic trajectory, Melbourne's climate will be similar to that of Dubbo. We will move out of the current woodland vegetation class to one more resembling a savanna grassland.

He finished with some images from his own garden – one that focusses on drought tolerant species and requires almost no additional watering.

Some useful references:
The City of Melbourne's Future Urban Forest – Dave Kendal
Sustainable Gardens by Rob Cross, Roger Spencer (Ebook) - Read free for 30 days