Growing Southern Gippsland

FIELD DAY- Securing and managing water for your future. On farm water management in a Changing Climate.

Come and hear about water management in a changing climate and how Southern Gippsland farmers can secure their water future.

- Changing rainfall patterns in Southern Gippsland
- Regenerative methods to rebuild the soil carbon sponge - Declan McDonald (soil scientist)
- Dealing with extreme rainfall events
- Identifying and managing water-based threats on farm e.g. salinity
- Water management planning and water calculators

BASS COAST

RMIT UNIVERSITY

Federation UNIVERSITY·AUSTRALIA

SOUTH GIPPSLAND LANDCARE NETWORK

Bass Coast Landcare Network

The Growing Southern Gippsland project is funded through the Victorian Centre for Climate Change Innovation, Bass Coast Landcare Network, RMIT University and Federation University Australia.

On farm water management in a changing climate.

Key messages from Graeme Anderson – Climate Specialist with Agriculture Victoria

The combination of seasonal variability and climate change can lead to greater variations in regional rainfall patterns, with the increasing challenge for farmers being how to make the most of rainfall when it comes and then be well prepared to manage the times when it's dry. Our traditional variability is likely to increase due to changing climate.

We know more than ever about some of the key drivers of our wetter and drier seasons, and how some of these key drivers are behaving differently due to climate change. Important changes include rising temperature trends, an increasing pressure pattern over parts of southern Australia and increased rainfall intensity. In simple terms weather patterns are shifting southwards in many parts of Victoria.

While Victoria is expected to be drier on average over coming decades, the highest confidence is around the increasing trend in temperatures. Essentially, we need to be planning for a longer summer period. While conditions are expected to be drier on average, there will be times when we will experience extreme rainfall events and wet seasons – so our farms will need to be able to manage for both.

Some examples of on farm actions that are being undertaken to adapt to changing climate includes:

- Improving water and fodder system and storage to better ride out more variable seasons
- Farm planning and design – with attention to managing soil types, vegetation, water, stock management and ensuring ground cover at all times
- A focus on business management to better deal with variable seasons and income volatility. Farms are not only adapting to climate change, but also to changes in markets and technologies.
- Successful agriculture occurs across a wide range of climate zones – however the biggest challenge is when farms experience conditions they have not experienced before. It can be valuable to visit and speak with farmers in warmer/drier climate to understand their farm systems and then look at how some of these innovations could be adapted for your farm.
- Improving soil health and condition to slow surface water movement, increase porosity and conditions suitable for plant root development, moisture conservation and improved soil function.
- Applying new innovations resulting from ongoing research and development – across areas such as breeding/genetics, technology and farm systems.
- Teaming up with local networks to share knowledge, apply innovations and adapt as conditions change over coming years. Staying connected and learning from one another is critical in times of change.

Resources:

Victorian farm businesses have noticed that their seasons and climate is changing. We are also seeing an increasing focus on carbon in agriculture.

Our climate program aims to assist in making sense of these key issues by providing information, tools and resources to support climate change risk management within the Victorian agricultural sector.

A range of climate risk products and updates for Victorian agriculture can be found on the Agriculture Victoria website (www.agriculture.vic.gov.au/climaterisk) including:

- The Fast Break newsletter and Very Fast Break YouTube seasonal updates
- The Soil Moisture Monitoring Cropping and Pasture e-newsletter
- Climate presentation series and recordings

- Farmer case studies
- How to decipher climate models and forecasts
- The famous Climatedog animations on key drivers of wetter and drier seasons
- Annual maximum temperature and rainfall decile maps 1910-2019
- Milking the Weather newsletter
- Understanding carbon and emissions
- Forecast4Profit website (www.forecasts4profit.com.au)
- Local Climate Tool (https://climatetool.forecasts4profit.com.au/)

Ventnor

Figure 1 highlights the historical annual rainfall and where the figure lies above or below the long-term average rainfall of 775 mm.

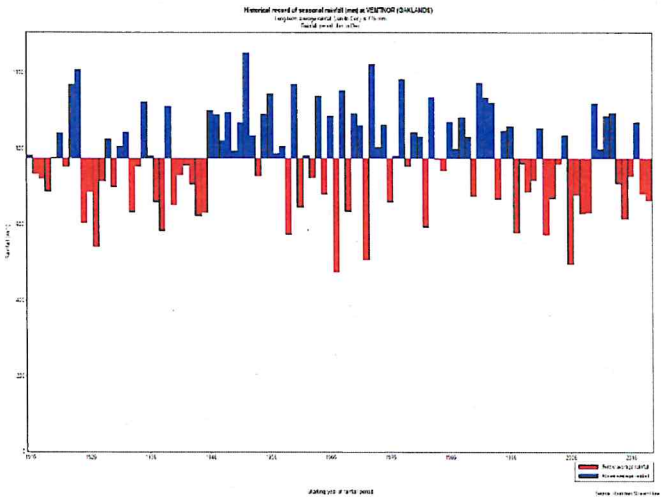

Figure 1. Annual historical rainfall graph for Ventnor.

Figure 2 highlights the historical summer rainfall and where the figure lies above or below the long-term average rainfall of 137 mm.

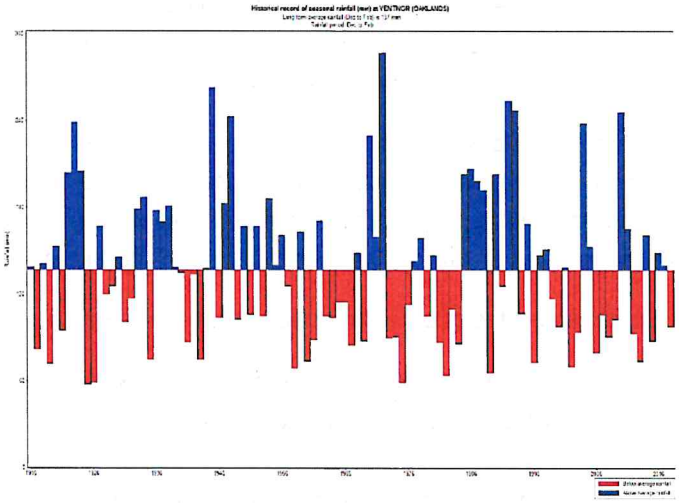

Figure 2. Summer (Dec-Feb) historical rainfall graph for Ventnor.

Figure 3 highlights the historical autumn rainfall and where the figure lies above or below the long-term average rainfall of 194 mm.

Figure 4 highlights the historical winter rainfall and where the figure lies above or below the long-term average rainfall of 240 mm.

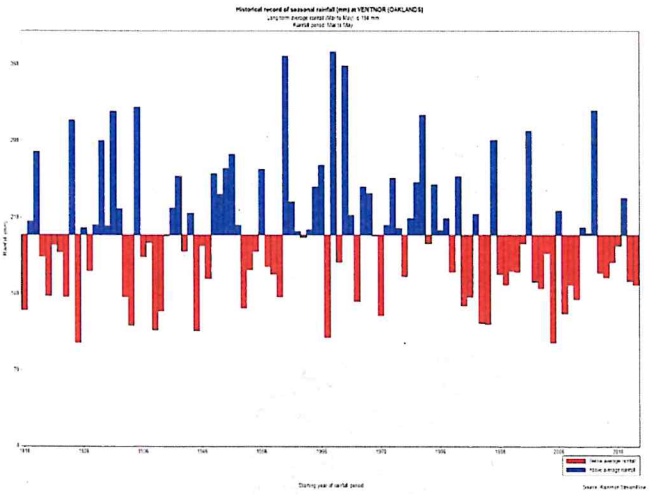

Figure 4. Autumn (Mar-May) historical rainfall graph for Ventnor.

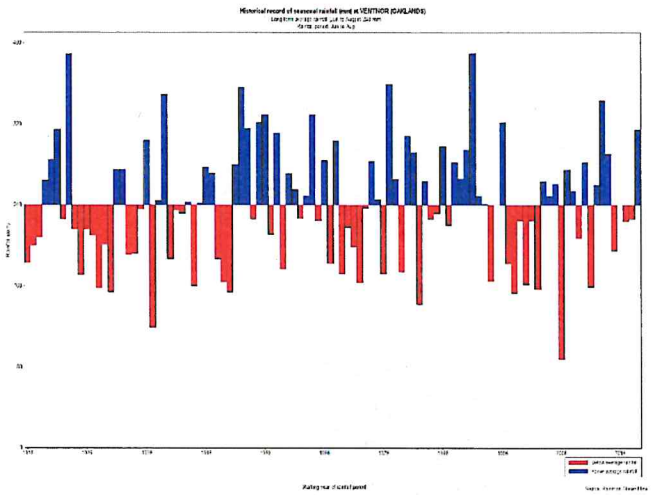

Figure 3. Winter (Jun-Aug) historical rainfall graph for Ventnor.

Figure 5 highlights the historical spring rainfall and where the figure lies above or below the long-term average rainfall of 204 mm.

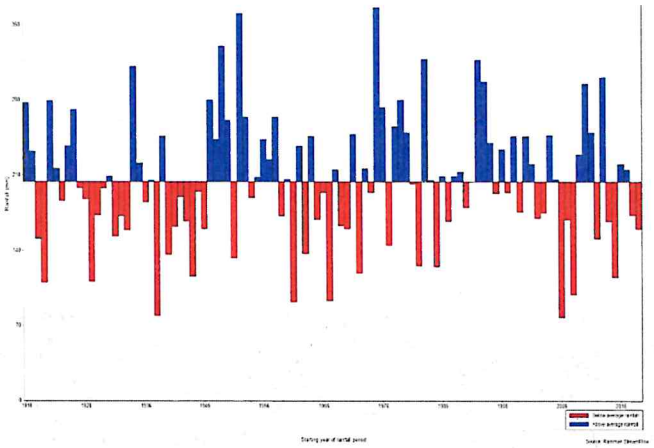

Figure 5. Spring (Sept-Nov) historical rainfall graph for Ventnor.

Figure 6 highlights the frequency of historical El Niño events resulting in a wetter (<394 mm), average, or drier (<338 mm) July to November period.

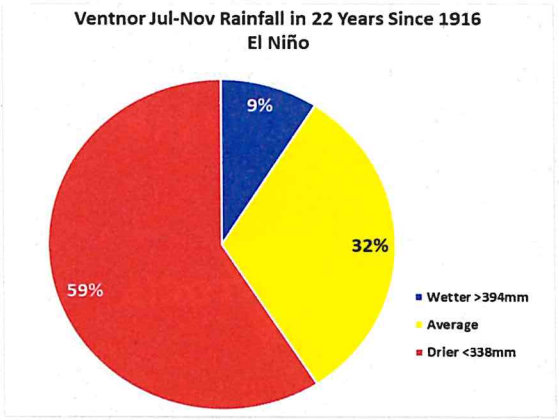

Figure 6. Effect of El Niño events on Ventnor rainfall for July to November.

Figure 7 highlights the frequency of historical La Niña events resulting in a wetter (<394 mm), average, or drier (<338 mm) July to November period.

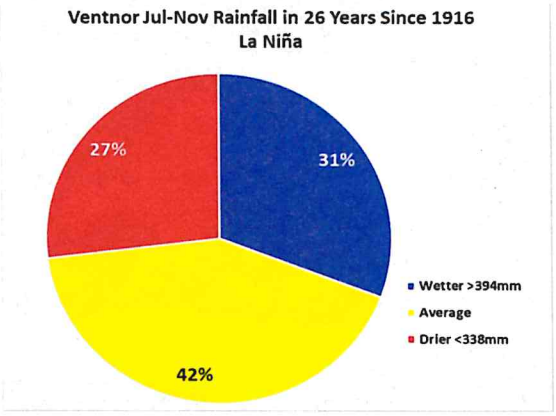

Figure 7. Effect of La Niña events on Ventnor rainfall for July to November.

Figure 8 highlights the frequency of historical positive IOD events resulting in a wetter (<394 mm), average, or drier (<338 mm) July to November period.

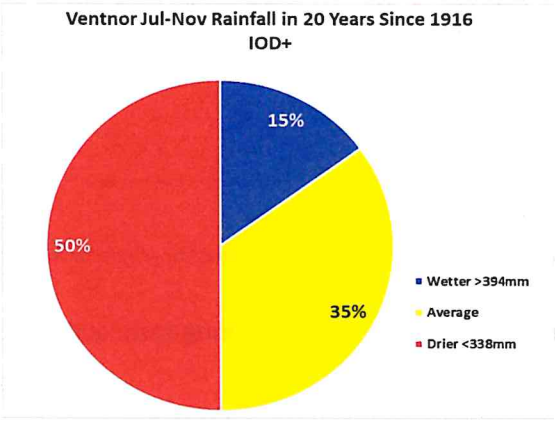

Figure 8. Effect of positive IOD events on Ventnor rainfall for July to November.

Figure 9 highlights the frequency of historical negative IOD events resulting in a wetter (<394 mm), average, or drier (<338 mm) July to November period.

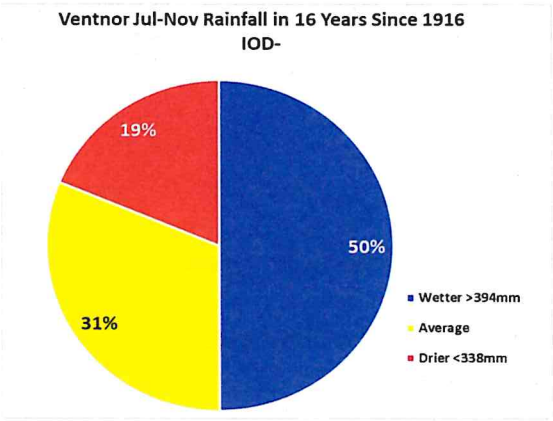

Figure 9. Effect of negative IOD events on Ventnor rainfall for July to November.

Annual maximum temperature deciles 1910 to 2019

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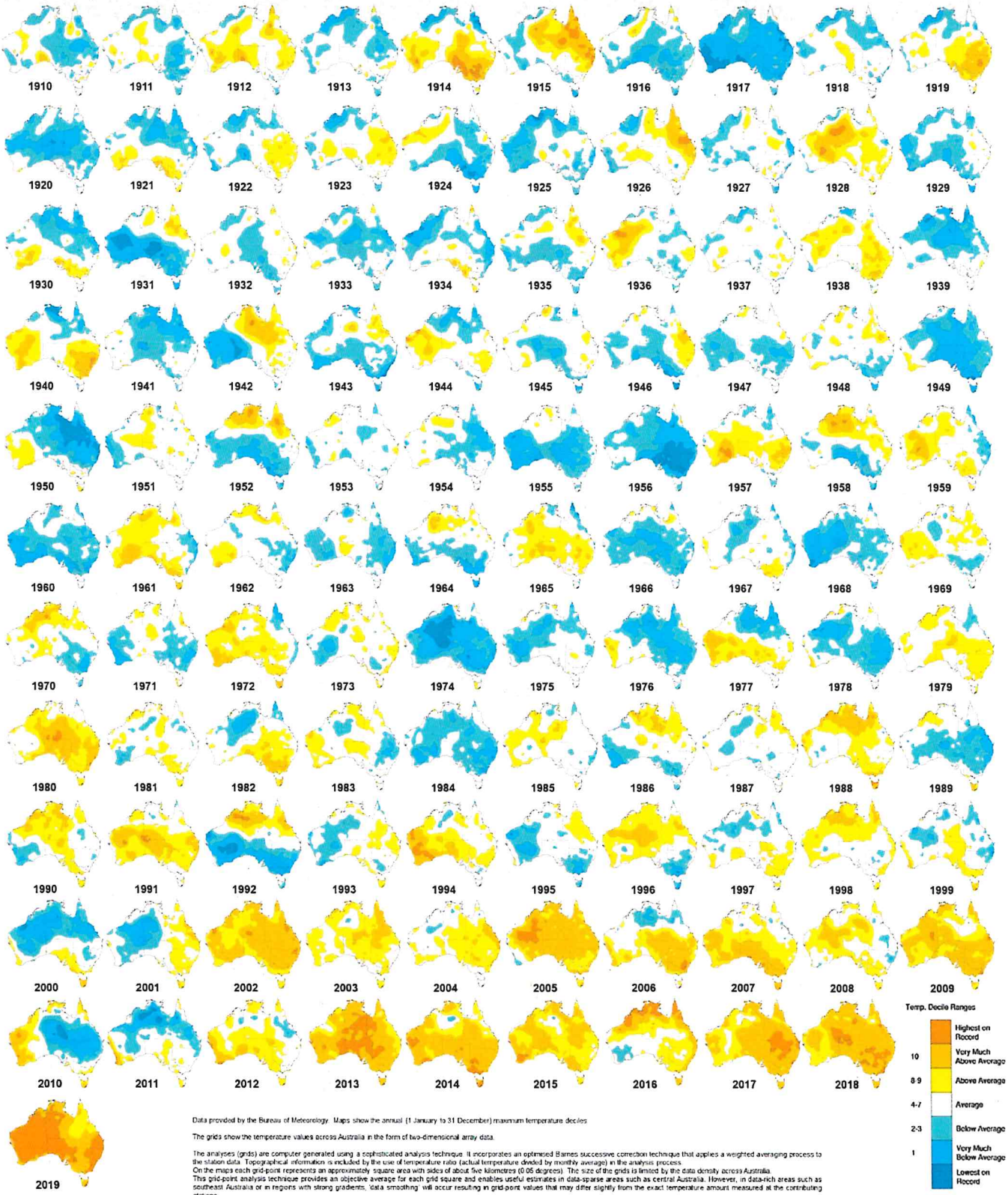


Data provided by the Bureau of Meteorology. Maps show the annual (1 January to 31 December) maximum temperature deciles

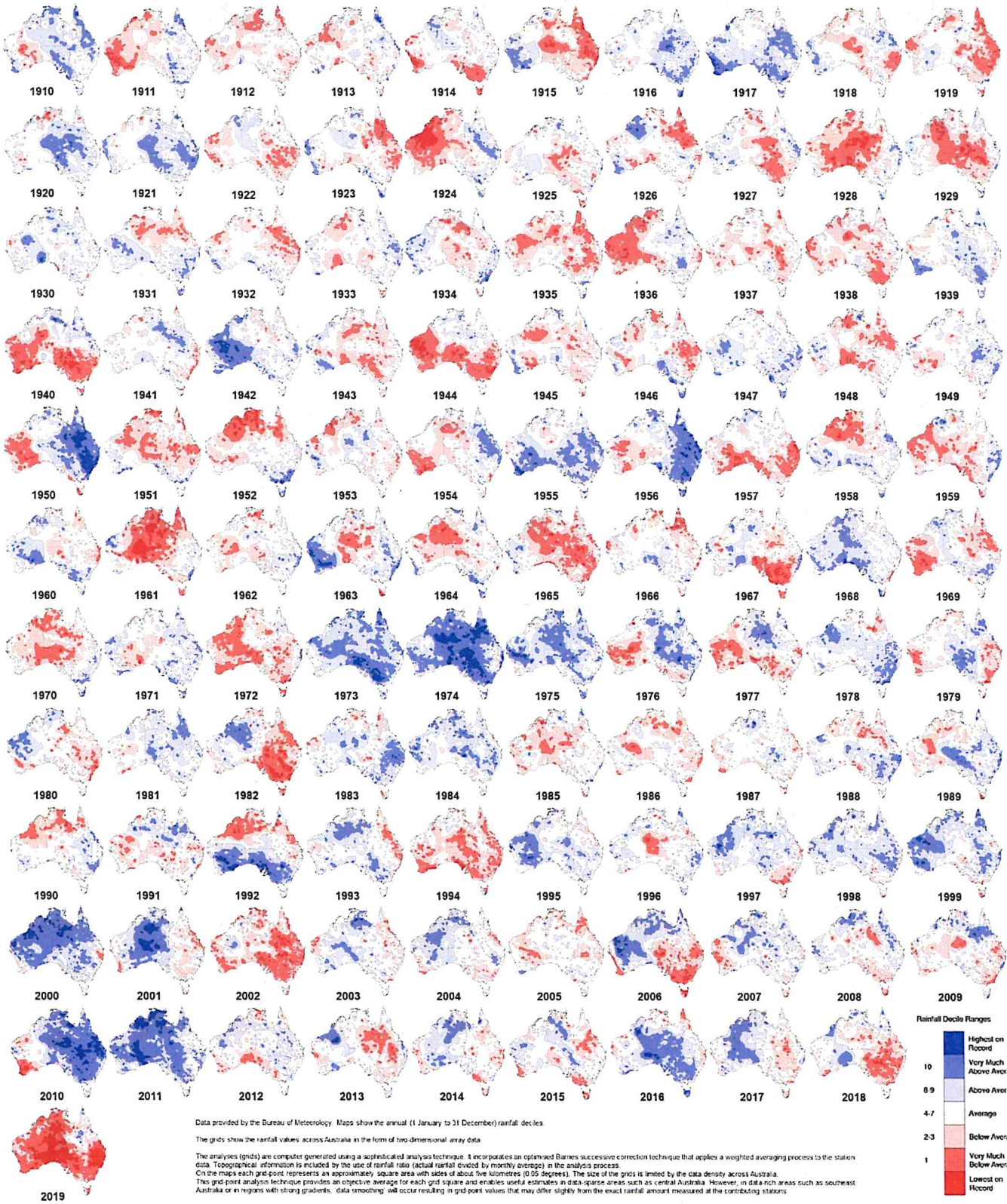
The grids show the temperature values across Australia in the form of two-dimensional array data.

The analyses (grids) are computer generated using a sophisticated analysis technique. It incorporates an optimised Barnes successive correction technique that applies a weighted averaging process to the station data. Topographical information is included by the use of temperature ratio (actual temperature divided by monthly average) in the analysis process.
On the maps each grid-point represents an approximately square area with sides of about five kilometres (0.05 degrees). The size of the grids is limited by the data density across Australia.
This grid-point analysis technique provides an objective average for each grid square and enables useful estimates in data-sparse areas such as central Australia. However, in data-rich areas such as southeast Australia or in regions with strong gradients, 'data smoothing' will occur resulting in grid-point values that may differ slightly from the exact temperature amount measured at the contributing stations.

The observational (station) data on which the analyses were based have an associated accuracy of the order of 0.01 degrees (approximately 1km) or better.

AGRICULTURE VICTORIA

Annual rainfall deciles 1910 to 2019



Data provided by the Bureau of Meteorology. Maps show the annual (1 January to 31 December) rainfall deciles.

The grids show the rainfall values across Australia in the form of two-dimensional array data.

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Rain on the way? Websites to check expected rain next 7 days

Graeme Anderson, Climate Specialist Agriculture Victoria

This one's for all the weather watchers out there, eagerly anticipating the next good rain. Here's some popular sites that show expected rainfall for the week ahead. Sometimes rain-inducing events can have even the experts on the hop, and in those instances some farmers like to surf a few 7 day forecasts to get the overall "vibe". Try out these sites and see which ones work best for you!

Next week's weather

BoM Chartviewer - Next 7 days
http://www.bom.gov.au/australia/charts/viewer/index.shtml

BoM Water & Land - 4 & 8 day rainfall outlook (combines 6 global forecast models in the one product.)
http://www.bom.gov.au/jsp/watl/rainfall/pme.jsp

BoM Met Eye rain,wind, temp forecasts (click on the map near your location)
http://www.bom.gov.au/australia/meteye/

Longer term rainfall outlooks
Agriculture Victoria outlook commentary for Victoria
The Break (subscribe free via The.Break@ecodev.vic.gov.au)
Very Fast Break - monthly updates on youtube
https://www.youtube.com/channel/UCIDCIII7gRZhUs03opGqH1g

Fast Break e-newsletter – plus subscribe button
http://agriculture.vic.gov.au/agriculture/weather-and-climate/newsletters
The Break (subscribe free via The.Break@ecodev.vic.gov.au) provides monthly updates on seasonal forecasts models for Victorian farmers, plus scans of 12 global forecast model outlooks for each of Vic, SA, Tas and southern NSW. (Hint: when more than half the models are indicating drier or wetter outlooks then there is usually something brewing.)

NEW - GRDC-AgVic – Using Seasonal Forecasts guide
See how local rainfall has been affected by past ElNino, LaNina and Indian Ocean Dipole events using the Local Climate Tool https://forecasts4profit.com.au/Local-Climate-Tool
Case studies on farmers using seasonal forecasts and more at https://forecasts4profit.com.au/

CliMATE tool!
Great tool to look at your local rainfall history plus how things are tracking this year
CliMate (Desktop or Phone App) - Can load longer term local rainfall data from your nearest station
https://climateapp.net.au/

Climatedogs – short animations that explain our key climate drivers! Look who rounds up our rainfall in wetter years, and which dog chases the rain away in dry years.....
http://www.climatekelpie.com.au/index.php/climatedogs/

Rainfall & MaxTemp climate posters – since 1910 http://agriculture.vic.gov.au/agriculture/weather-and-climate/climate-posters

BoM Seasonal Climate Outlook - 1 to 3 mths
http://www.bom.gov.au/climate/outlooks/#/overview/summary/

BoM Seasonal Climate Video Updates
http://www.bom.gov.au/climate/outlooks/#/overview/video

BoM ENSO Wrap-ups (El Nino, La Nina, IOD etc)
http://www.bom.gov.au/climate/enso/

BoM Seasonal Streamflow Forecasts (runoff)
http://www.bom.gov.au/water/ssf/

BoM/AWRA Root Zone Soil Moisture (actual & relative to normal maps showing estimated soil moisture reserves). It's modelled, so assumes plants growing throughout year which isn't the case for most cropping paddocks with summer weed control – hence soil probes more accurate for croppers.
http://www.bom.gov.au/water/landscape/

Understanding how to use seasonal forecasts (15 minute presentations) Agriculture Victoria

Graeme Anderson – drivers of variable seasons - https://www.youtube.com/watch?v=sjo3C2zi36Y

Dale Grey – model forecast skill https://www.youtube.com/watch?v=7E1d-QC7T70

Andrew Watkins – BoM forecast products https://www.youtube.com/watch?v=7TnZqMZMZ0k

Plus lots of other sites & sources, apps etc - often useful to compare forecasts to get a feel for the level of skill or uncertainty for a specific rain event. The critical bit is to ensure you know where/who the data is coming from! (ie lots of phone apps don't use the BoM forecast. For extremes weather events always best to follow latest from BoM)

This site compares 3 rain forecasts for your location http://www.ozforecast.com.au/

Aust Weather News uses the US based model. Note (week 1 ok , week 2 map is unreliable)
http://www.australianweathernews.com/sitepages/forecasts/forecast_ww_rain.shtml

Europe based model, but forecasts out for 10 days
http://www.yr.no/place/Australia/Victoria/Melbourne/long.html

Weather.US – useful site has a range of global weather models. Set it up for your location and you can see the outlook for following week and how many models are thinking rain.....

https://weather.us/forecast/2165798-geelong/xltrend/euro/precipitation

Tweet with range of forecast links https://twitter.com/climatedogs/status/1022706043095117824

There's also plenty of new phoneApps on the market (eg Pocket Weather, Willy Weather, Weatherzone, Oz Radar, Windy etc) – test them out, but make sure you know their data source as for extremes weather and big events Australia BoM forecasts are most up to date).

Why the fuss about carbon dioxide? Quick explainer for Australian agriculture with Graeme Anderson sharing the surprising story about how greenhouse gases were first discovered and the laws of physics on why they trap heat https://www.youtube.com/watch?v=7RyApq8COZw

REGENERATIVE AGRICULTURE – WHAT IS IT AND WHY DO WE NEED TO PAY ATTENTION?

If the aliens were to land on Earth and analyse us humans, they would find us perplexing, to say the least. On one hand we are smart enough to put a man on the moon but on the other hand, we are stupid enough to seriously degrade natural resources on which we depend such as soil and water. And we have form here. W. C. Lowdermilk of the US Soil Conservation Service wrote back in 1935 of the decline of civilizations in Asia Minor (e.g. Greece, Albania, Macedonia, Bulgaria, Turkey), North Africa and Peru due to soil erosion.

Sadly our own history of soil degradation is visible in many landscapes today and is recorded in literary accounts including most recently Bruce Pascoe's *Dark Emu*. Pascoe's book explains why Australia was so vulnerable to the farming methods and stock introduced from Europe. In spite of very early reports of major soil erosion and loss of soil productivity, we continued to degrade the land because we only knew one way to farm.

Looking back now, it would have been better if the early settlers had recognised that things were going badly and sought a new way to farm within the constraints of the landscapes in which they found themselves. But that is just dreaming …

No, our can-do nature guided us to fix the problems, so state-based Soil Conservation Services were established to undertake land repair. They generally did a great job but the task was too big and the problems were not being addressed at a causal level. And anyway, government funding was gradually withdrawn and services shut down.

Changing awareness

The roots of modern-day environmentalism can be traced to Rachael Carson's *Silent Spring*, published in 1963 which alerted the world to the damage caused by DDT and other organochlorine pesticides. Inevitably that awareness slowly spread to agriculture and horticulture and made us start to question how we are farming.

Whilst the organic farming movement has a long history extending back to the 19th Century, it was never going to win the debate with modern industrial agriculture about cheap and abundant food. However, as the tide of negative press rose on issues of land and water degradation, animal welfare, food quality and

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safety, rural social decline, farmer mental health, climate change and more grew, so too did concern for the long-term sustainability of agricultural production.

In 1987, the World Commission on Environment and Development released a report titled *Our Common Future.* Known as the Brundtland Report it included in its focus both food security and ecosystem protection. It defined Sustainable Development as:

> *"... development that meets the needs of the present without compromising the ability of future generations to meet their own needs."*

From the 1970s interest in alternative agriculture to more sustainably manage resources had taken an upward trajectory. The 1970s to 1990s saw the emergence of Permaculture, agro-ecology, ecological agriculture, biological agriculture, and sustainable agriculture. However, none of these was able to communicate a clear vision for commercial agriculture and the divide between the two (conventional vs. sustainable) deepened.

In spite of generalised interest, the research communities' responses were generally muted with the lion's share of agricultural research funding still going to established areas of soil physics and chemistry. Industry peak bodies' responses to alternative agriculture ranged between curiousity, suspicion and outright hostility. This did little to foster uptake of sustainable land management practices amongst 'serious' farmers. Barriers to uptake of sustainable practices is a long and detailed story and beyond the scope of this article. Suffice to say that changing established practices would require commitment from governments, researchers, peak industry bodies, agronomists, consumer advocates and supermarkets. Alas, much un-weaving of established networks would be required for this to happen.

Regenerating Australian agriculture

However, the good news is that (as so frequently happens) in the absence of leadership from key policy and research institutions, farmers are beginning to revolt! In my twenty years with state governments in NSW, Tasmania and Victoria, I gradually witnessed government extension services being cut and as a result, governments as a long-time ally of farming becoming less relevant to farmer decision-making. Farmers had no choice but to align with agronomy companies for advice but few agronomists were well-enough versed in sustainable practices to be able to assist farmers to farm differently. So where were farmers to turn? On more than one occasion I was bowled over when after an hour of so of conversation, high status conventional farmers walked back into the room with an armful of books on biological / sustainable agriculture and asked 'how do I put this into practice on my farm?'

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What we are now seeing is emergence of a new discipline that is finding general acceptance and is rapidly growing – Regenerative Agriculture.

The popular embrace of the word 'Regenerative' recognises that we have done so much damage to our land but that the situation is reversible. It recognises that the agriculture we have been taught (and that one time I also taught!) is extractive and exploitative and does not return enough to the land. Our conventional model of agricultural production has been shaped by economics and gave rise to the idea that no dollar should be spent on a paddock unless it yields a dollar-plus at the end of the season. That approach treats the soil as part of the machinery that holds up the plant while we make it grow with synthetic fertilisers, herbicides and pesticides. It also champions short-term gain at the expense of long-term pain. If our visiting alien understood that soil is the most complex ecosystem on the planet, how smart would that make us look?

Most farmers would agree that they want to leave the land in as good or better condition than they received it. Few farmers have been able to say that soil quality, soil function and long-term sustainable production is better at hand-over, until now. Regenerative agriculture holds out the potential for this aspiration to become a reality. It aims to sustain production while improving soil condition. Improving soil while growing a profitable crop has not been part of the frame. New strategies suited to Australian soils and climate such as regenerative (holistic) grazing, no till cropping supported by cover cropping, inter- or relay-cropping, and multi-species groundcovers are the keys to soil regeneration. In this lifetime, we only get one soil. Better look after it!

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Securing and managing water for your future

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Senior Soil Scientist
B.Sc (Urban Hort), M.SustAg (Soils)

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WATER
MINING
SPORTS & RECREATION
HORTICULTURE & AGRICULTURE
ENVIRONMENTAL
ENGINEERING & GEOTECH
URBAN HORTICULTURE & LANDSCAPING

1

Plato, 360 BC

" ... in comparison of what then was, there are remaining only the bones of the wasted body, as they may be called, as in the case of small islands, all the richer and softer parts of the soil having fallen away, and the mere skeleton of the land being left"

(http://classics.mit.edu/Plato/critias.html)

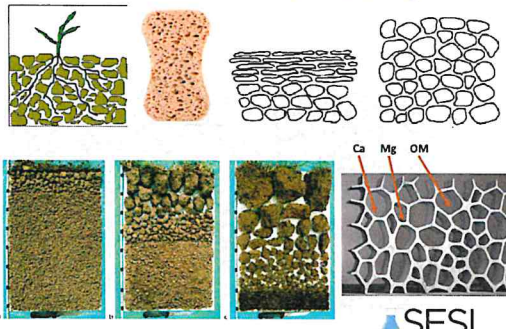
2

How is water stored in the landscape?




3

Soil water use efficiency



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4

Structure vs yield

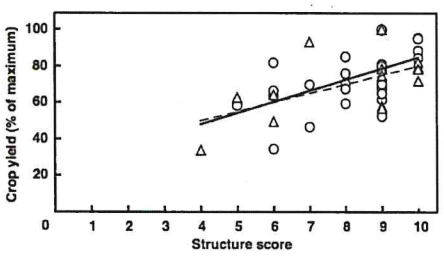

Figure 1. Relationship between crop yield and soil structure score on dermosols and ferrosols. O Ferrosol potatoes; Δ dermosol poppies.

(Cotching et al., 2004)

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5

Role of soil carbon / soil organic matter

From Rab et al, 2019

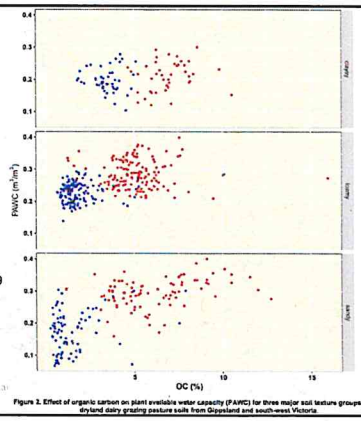
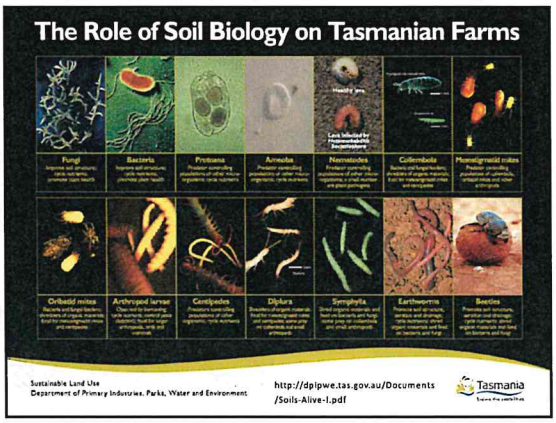


Figure 2. Effect of organic carbon on plant available water capacity (PAWC) for three major soil texture groups of HRZ dryland dairy grazing pasture soils from Gippsland and south-west Victoria.

6


The Role of Soil Biology on Tasmanian Farms
Fungi
Bacteria
Protozoa
Amoeba
Nematodes
Collembola
Mesostigmatid mites
Oribatid mites
Arthropod larvae
Centipedes
Diplura
Symphyla
Earthworms
Beetles
Sustainable Land Use
Department of Primary Industries, Parks, Water and Environment
http://dpipwe.tas.gov.au/Documents/Soils-Alive-I.pdf
Tasmania

7


Nature has been self-organising for millions of years
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8


Self-organising ecosystems (habitat modifiers)
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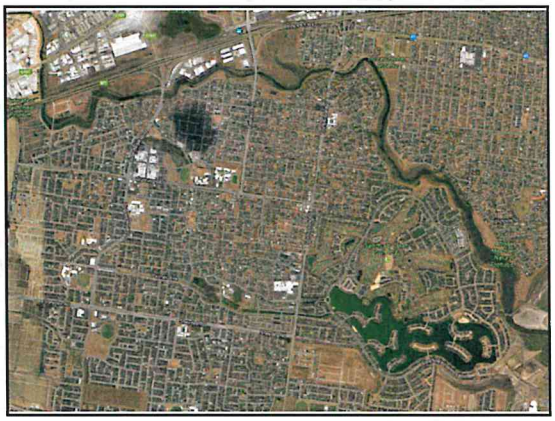
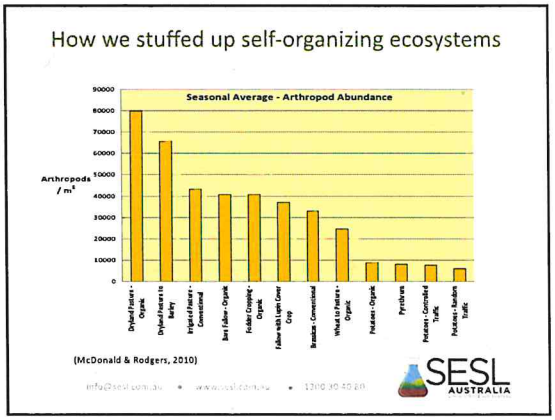
9



10

11


How we stuffed up self-organizing ecosystems
Seasonal Average - Arthropod Abundance
Arthropods / m²
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Dryland Pasture - Organic
Dryland Pasture to Barley
Irrigated Pasture - Conventional
Beef Feedlot - Organic
Feedlot Compost - Organic
Feedlot with Vegetable Cover Crop
Bananas - Conventional
Wheat to Pasture - Organic
Pasture - Organic
Pyrethrum
Pasture - Controlled Traffic
Pasture - Random Traffic
(McDonald & Rodgers, 2010)
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Regenerating agriculture

- We can have our cake and eat it
- We can farm profitably and build soil at the same time
- We humans farmed sustainably for over 4,000 years
- The key is in understanding and managing soil biology

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Regenerating agriculture

- Soil biology is responsible for:
  - Developing and maintaining soil structure and drainage
  - Entering into mutualistic relationships with plants
  - Decomposing OM and cycling nutrients
- Where did we go wrong?
  - Green revolution rode roughshod over soil as an ecosystem and turned farmers in 'technology applicators' (Reeve, 1997)

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What did the Green Revolution do for us?

- Prevented famine in India and other countries
- Reduced physical drudgery of agriculture
- Greatly increased productivity
- Brought a strong science focus to ag
- Focus on monocultures and increased scale
- Increased reliance on ag chemicals
- Increased exploitation of marginal land
- Increased environmental impacts

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The Green Revolution was a Pyrrhic victory

- A **Pyrrhic victory** is a victory that inflicts such a devastating toll on the victor that it is tantamount to defeat. Someone who wins a Pyrrhic victory has also taken a heavy toll that negates any true sense of achievement or damages long-term progress (Wikipedia)
- We were fed, but were blind to long-term loss of soil biodiversity and soil carbon, the twin pillars of soil fertility and productivity

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Loss of soil biodiversity and carbon

- This is similar to reducing workers and money by about half, and replacing them with automation (robots?!), fast food and vitamin pills
- This works really well in some areas (e.g. protected cropping)
- But poorly in others (e.g. marginal land cropping, extensive grazing)

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Where to from here?

- Our research and extension focus must change from utilitarian / economic to one with soil protection and enhancement at its core
- Our on-farm practices must also be guided by the same commitment
- Farms don't fail due to an overabundance of soil health
- Science is still central to future success especially in the areas of soil function and nutrition

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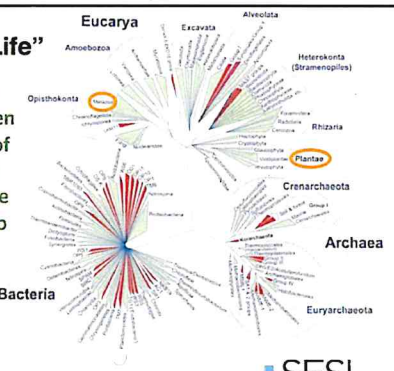
"Tree Of Life"

Soil function happens when the trillions of long-evolved organisms are allowed to do what they have always done



Victoria The Place To Be

Courtesy of Pauline Mele

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Feed the soil

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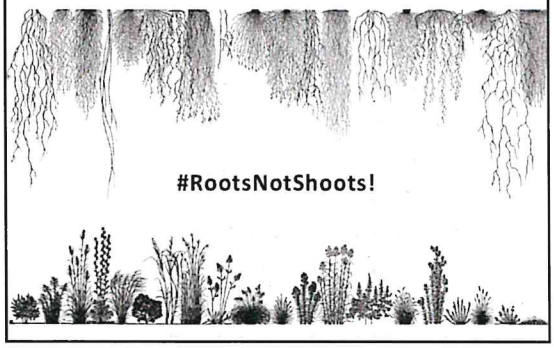
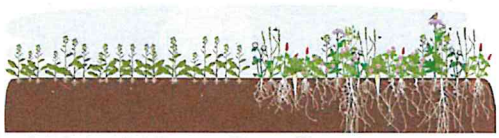
What are you growing?



22

Roots cooperate, not compete



https://www.cotswoldseeds.com/downloads/sort%20out%20your%20soil%202%20website.pdf

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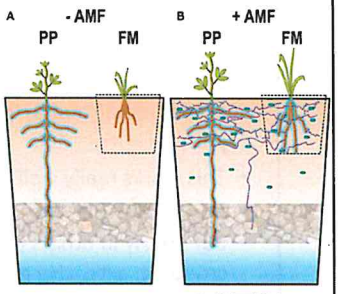
Plants and microbes cooperate

(A) In drought, deep-rooting pigeon pea (PP) accesses water but shallow rooting finger millet (FM) does not

(B) In the presence of AMF, their hyphae re-distribute water lifted by pigeon pea to finger millet and to PGPRs (green dots) in the hyphosphere



Saharan et al, 2018
https://www.frontiersin.org/articles/10.3389/fenvs.2018.00046/full

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Regen ag and water security

- Not about doing one thing
- Focus on what the soil needs
  - Soil needs to breathe
    - Structure, aeration, drainage, infiltration, decompaction
  - Soil needs to be fed
    - First SOM from roots, shoots or other OM; second, address nutrient deficiencies
  - Soil needs to be covered
    - Grazing: adopt minimum groundcovers of 1,500kgDM/ha
    - Cropping: intercrop / cover crop and minimum till

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How to sequester carbon in low rainfall zones?

- Need to respect soil biological processes
- Need to respect SOC sequestration process
- SOC needs to be protected if it is to build up in soils
- Soil pore spaces in the 30-150 micron range most critical
- Larger or smaller pores cannot protect SOC from mineralisation
- Diversity of cover crops essential for this size range of pores

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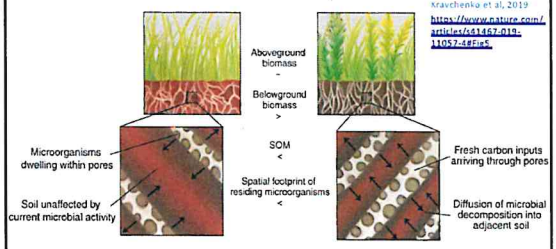
The Goldilocks of soil pore spaces

From: Microbial spatial footprint as a driver of soil carbon stabilization

Kravchenko et al, 2019
https://www.nature.com/articles/s41467-019-11057-4#Fig5



Microbial footprint defines the soil volume available for C protection. Schematic representation of the effect that the abundance of 30–150 μm pores has on the size of the spatial footprint of microorganisms residing in such pores in perennial switchgrass monoculture and biodiverse native vegetation systems

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How to sequester carbon?

- Approach of leading innovators
  - Cover cropping with multi species
  - No MAP or other harsh fertiliser. Consider foliar feeding
  - Compost at 5t/ha+
  - Compost extract (not compost tea) @ 15L/ha
  - Worm leachate @ 5L/ha
  - Pre-treatment of seed with worm leachate @ 5L/t
- Approach not endorsed; But experimentation is!

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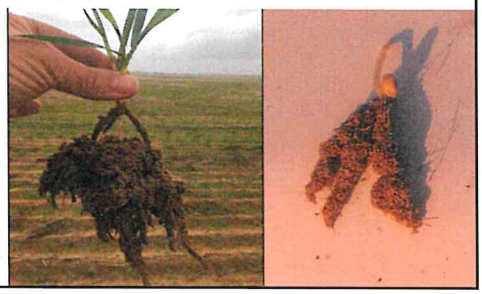
What success looks like

- Heggarty's WA wheatbelt. Note roots and rhizosheaths



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THANK YOU

Declan McDonald
Senior Soil Scientist
B.Sc (Hort), M.SustAg (Soils)

CPSS Certified Professional Soil Scientist

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www.sesl.com.au 1300 30 40 80

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Water planning for a rainfed farm

By Benita Kelsall

Having a secure and reliable water supply is a key foundation for a rainfed farm. Water sustains life and therefore water is needed for stock and human drinking, for cleaning the dairy, in the household, for firefighting purposes, for watering gardens, weed spraying or for washing machinery. The quality of water can also affect animal performance and welfare.

Securing and distributing water for a rainfed farm can be a complex task. This can be particularly challenging when the business changes: for example: as the herd expands; when a new block or farm is purchased, and existing water line locations are unknown; or when water supplies fail due to quality or declining availability.

For long-term farm water planning the impacts of climate change can also be considered. Climate change predictions indicate that the seasons may become more variable (than they already are) with an increased need to plan for a longer drier season associated with temperature increases. This may also be coupled with more extreme rainfall events, increased evaporation and therefore increased risks of bushfire. All these factors can directly affect demand, storage and supply for farm water resources.

When considering changes to farm water management, it's also necessary to ensure all works and uses of water are appropriately licenced (please refer to Further Resources for more information).

The first step to addressing and therefore improving the reliability of a farm water supply is to first understand the current water availability. An Online Farm Water calculator is available at agriculture.vic.gov.au/watercalculator. Figure 1 below provides a summary of the key components to consider when planning water for a farm including the water supply, storage, and usage.

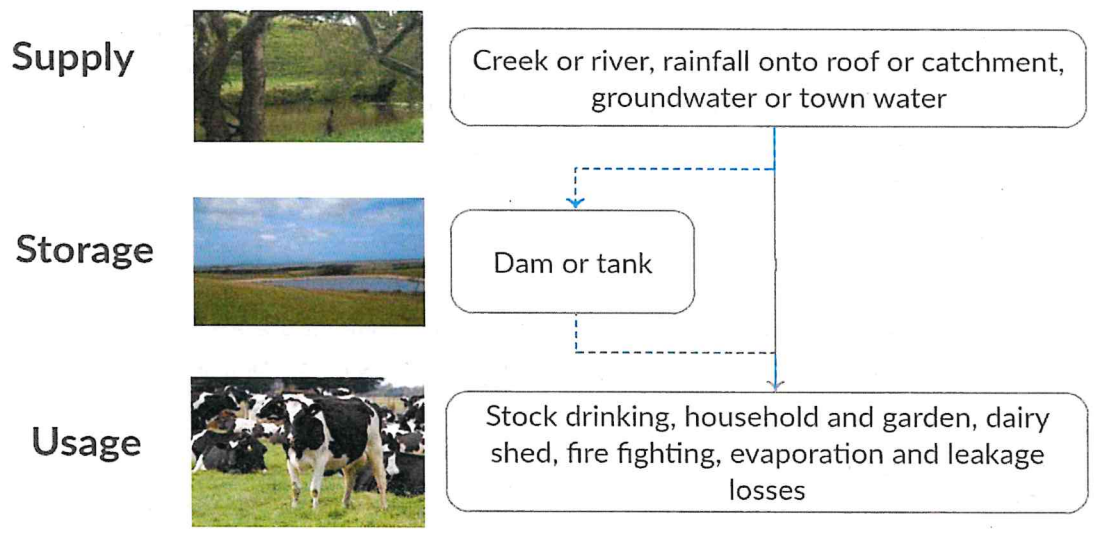

Figure 1. Key components to consider around farm-water planning

What is the farm water requirement?

Water may be required for stock drinking, dairy shed wash and other uses too such as garden watering, household and firefighting. Knowing how much water stock require is needed to determine flow rates required at troughs and back up storage dam and header tank volumes to ensure a reliable supply.

The best way to understand how much water your stock require is to directly measure it if you can through estimating the proportion of a tank of water stock drink per day (and at different times of the year). For many though, estimating stock water requirements directly is not possible. Consequently, average estimations of stock water requirements can be used, as per Table 1.

Table 1. Daily stock water requirements, annual average stock water requirements and peak flow rate (Department of Primary Industries 2012, pp.54).

Livestock unit	Daily Average (L/head/day)	Winter Daily Average (L/head/day)	Summer Daily Average (L/head/day)	Peak Flow Rate (Summer) (L/min/head)	Annual Average (L/head/year)
Beef cattle	70	42	98	0.408	25,550
Weaners (250-300kg)	50	30	70	0.292	18,250
Dairy cow, milking	150	90	210	0.875	54,750
Dairy cow, dry	80	48	112	0.467	29,200
Horse (working)	55	33	77	0.321	20,075
Nursing ewe on dry feed	10	6.0	14	0.058	3,650
Prime lamb on dry feed	4	2.4	5.6	0.023	1,460
Mature sheep on dry feed	7	4.2	9.8	0.041	2,555
Mature Pig	20	12	28	0.117	7,300
Laying hen	0.33	0.2	0.46	0.002	120
Alpaca (dry)	6	3.6	8.4	0.035	2,190
Milking goat	6	3.6	8.4	0.035	2,190
Goat (dry)	4.5	2.7	6.3	0.026	1,645

The water requirement for stock changes depending upon feed, temperature, the class of animal (if they're lactating or not) and other factors such as shade and shelter and walking distances to water. Consequently, reducing the farm water requirement through provision of shade for stock and recycling water where possible can help to improve the reliability of water supplies by virtue of requiring less water.

OTHER REQUIREMENTS

Household

For rural properties, an indicative range for household and domestic usage is 120 to 180 litres per person per day. This range covers the basic household uses such as cooking, washing, bathing, laundry and toilet.

Firefighting reserve

The CFA advises, and some municipal councils require, that rural properties maintain a reserved store of water for firefighting purposes. Landholders should check what the minimum recommended volume is, which can range from 10,000 litres to 45,000 litres. Even in the absence of a council requirement, it is in a landholder's interest to maintain a dedicated reserve of water to use for

firefighting in an emergency and to have an up to date fire plan. Go to <www.cfa.vic.gov.au> for further advice.

Garden requirements

The amount of water required for watering and maintaining a garden is dependent upon the type of garden, the annual rainfall and rainfall patterns, and area of the garden.

The watering allowance listed in Table 2 is the amount required to supplement rainfall, assuming average summer rainfall. It assumes an irrigation period of 105 days (15 weeks) centred over summer (with no supplementary water use for the rest of the year). These assumptions should be considered when thinking about current and future water use within a variable climate.

Table 2. Average annual garden water requirements to supplement rainfall (litres per square metre of garden)

Garden Type	Average Annual Garden Water Requirement (litres/m² of garden)		
	Average Annual Rainfall		
	Above 800mm	Between 500 and 800mm	Less than 500mm
Native garden (no lawn)	50	100	150
Lawn with shrubs	150	300	450
Vegetable garden	300	600	900

CALCULATING YOUR OWN ANNUAL WATER REQUIREMENT

Annual water requirements can be calculated by tallying up the individual uses for water per day and multiplying by the number of days used per year.

For example, a beef property with 50 head of cattle and a native garden in Gippsland that's 300m² has the following water requirements;

- Stock daily average = 50 head x 70 litres/day = 3,500 litres/day
- Stock annual average = 3,500 litres/day x 365 days/year = 1,277,500 litres/year
- Garden water requirement = (300m² x 50L/m²) = 15,000L/year
- Total Annual Requirement = 1,227,500 L/year + 15,000 L/year = 1,242,500L/year

Ensuring supply through on-farm storages

Reliability of groundwater, river and creek supplies

Improving the reliability of water supplies on farm for sources such as groundwater, rivers and creeks generally involves having some on farm storage such as a dam or tank to provide a backup in the event that the supply goes dry, is temporarily unavailable due to pump breakdown, a flooding event or contamination. For information relating to groundwater resources please refer to SRW Groundwater Hub (Resources section below).

Reliability of catchment runoff into dams

When the farm is supplied with catchment runoff into a dam, the storage may need to be larger as the variability or consistency of the supply can be greater. For example, having six to twelve months' worth of stock water plus allowances for evaporation and seepage can be used as a guide for back up storage volumes on Gippsland farms. Dam reliability can be improved by through ongoing maintenance of the dam spillway and removal of trees from the dam wall. Excluding stock from the dam will also help to prevent erosion of the dam as stock can wallow and erode banks.

Locating a new dam so it has a large catchment area feeding into the dam or capturing runoff from an impervious surface such as diverting shed overflows can help to improve the reliability.

Annual average stock water requirement information (Table 1) can be compared to water storages on farm such as dams to see how much back up water supply there is on farm, in the event of a low rainfall period. Table 3 provides approximate dam volumes for square and rectangular dams.

Table 3. Volume of a square/rectangle dam with a batter slope of (1:2.5 batter) and depth in brackets (Department of Primary Industries 2011, pp15).

Width (m)	Length (m)				
	15m	20m	30m	40m	60m
15m (3m)	0.23ML	0.34ML	0.56ML	0.79ML	1.24ML
20m (3m)	0.34ML	0.53ML	0.9ML	1.28ML	2.02ML
30m (4m)		0.93ML	1.73ML	2.53ML	4.13ML
40m (4m)		1.3ML	2.53ML	3.73ML	6.13ML
60m (4m)		2.13ML	4.13ML	6.13ML	10.13ML

*ML = Megalitre = 1,000,000 litres

Evaporative Loss

The amount of water lost from a farm dam through evaporation, can be a significant proportion of the total amount of water stored, particularly for smaller, shallower dams. Reducing the total surface area of the water by having fewer larger, deeper dams rather than many smaller shallower dams reduces evaporative losses. The following formula is used to estimate evaporative losses on-farm which uses the Pan Evaporation rate for Gippsland at 1200mm/year sourced from the Bureau of Meteorology, the dam surface area, and a factor to account for the dam depth of 0.67.

Evaporative Loss (litres) = 0.67 x PAN evaporation (1.2m) x dam surface area (m^2) x 1000

For example: A dam that is 30m x 40m with a capacity of 2.53ML has a surface area of $1200m^2$. The evaporative loss is therefore $1200m^2$ x 0.67 x 1.2m x 1000 = 964,800 litres/year.

How does your farm compare?

A full water audit can be undertaken to understand the reliability of farm water supplies (see Resources below). Table 4 provides a very quick ballpark for assessing the difference between on farm storage and water requirements. Please note; this process doesn't account for seepage losses, rainfall onto the dam surface, catchment runoff or consider the reliability of supply.

Table 4. Activity for determining how long the dam will last without rain

Total Annual Water requirement + evaporative loss (litres/year) (A)	Volume of Dam/s in litres (B)	Length of time dam will last without rain (B divided by A) (year)
1,242,500L + 964,800L = 2,207,300 Litres/year	2,530,000 litres	1.14 years

Things to consider for a reticulated water supply

Reticulation of water supply to troughs can enable smaller paddock sizes which may align with rotational grazing ambitions. Studies have also shown that stock perform better on troughs when compared to dam water due to improved water quality (DEPI 2012). Providing water supply to stock through direct access to a dam for some may be the best option if owners are absent from the property for periods of time or as a bushfire strategy.

Matching water requirements with supply – know your flow

Summer Peak Flow Rate (Table 1) provides the ideal flow rate required at a trough to meet the highest demand in summer (assuming you are running stock in summer) within a four-hour period. This flow rate assumes that the animals are drinking from one trough or one line if in multiple paddocks. A four-hour period is used as animals tend to drink as a mob and at certain times of the day which creates a higher demand for water and consequently a higher flow rate.

WHAT IS MY CURRENT FLOW RATE?

It's possible to measure your current flow rate at the trough by first measuring the volume of your trough, then emptying it and then timing how long it will take to refill. The flow rate is then calculated by dividing the volume of the trough (litres) by the amount of time it took to fill (seconds) to give you the flow rate in litres/second.

HEADER TANK

Header tanks are used in a water supply system to act as a backup and can allow pumps to run on a timer rather than switching on continuously if working under a pressurized system with no storage tank. Tank water level devices can be fitted to tanks to assist with monitoring water levels.

Summer daily average water requirement information (Table 1) is useful for planning header tank volumes. Header tanks for example as a general principle should have about three days' worth of stock water in the event that the pump breaks down or there is a power failure.

Strategies for a reliable water supply in a variable climate

Strategies that improve water use efficiency will reduce the risk of running out of water, such as;

- Providing shade for stock.
- Recycling water for cleaning, such as dairy yard washing with effluent.
- Reducing evaporative losses through storing water in deeper dams.
- Capturing water off shed rooves which have high catchment runoff rates.
- Reduce losses associated with reticulation such as protecting float valves from stock, fixing leaks and putting taps into the design.

Other strategies to increase the reliability of farm supplies include;

- Protecting water quality, through stock exclusion and nutrient management of supplies.
- Ensure flow rates are matched to stock requirements.
- Consider alternative power supplies or gravity fed systems in case of electrical outage.
- It may be necessary to pump from creeks during winter to store in dams if catchment runoff is limited.
- Linking dams to be able to transfer water around the farm can assist with risk management.

References

Department of Primary Industries, 2012, *Farm Water Planning Presenters' Resource Kit*, State Government of Victoria, Melbourne.

Department of Environment and Primary Industries, 2012, *Stock Perform better when drinking from troughs*, viewed 6 April 2014, http://www.depi.vic.gov.au/agriculture-and-food/farm-management/soil-and-water/water/farm-water-solutions/how-can-i-more-efficiently-use-my-farm-water/stock-perform-better-when-drinking-from-troughs

Department of Primary Industries, 2011, *Managing Farm Water Supplies*, State Government of Victoria, Melbourne

Farm Water Planning Resources

On-farm Water Audit Calculator Tool and farm water planning resources
Agriculture Victoria, Department of Jobs, Precincts and Regions,
http://agriculture.vic.gov.au/agriculture/farm-management/soil-and-water/water/farm-water-solutions/
Benita Kelsall Phone: 56242218

Rural Water Corporations
Rural Water Corporations manage rural water and licence the construction of farm dams and groundwater bores across the region. A list of all Victorian Water Corporations is available at;
https://vicwater.org.au/victorian-water-sector/regional%20victoria

Catchment Management Authorities
Catchment Management Authorities (CMAs) are responsible for catchment and waterway management. Contact your regional CMA to obtain a Works on Waterways permit prior to undertaking any earthmoving or construction in and around a waterway. For a list of CMA's go to https://viccatchments.com.au/about-us/our-cma-regions/

Groundwater Hub of Southern Victoria
Information and interactive maps relating to existing bores, aquifers and licensing. http://gwhub.srw.com.au

Emergency Water Supply Points
Victoria has a network of about 300 emergency water supply points which provide water for emergency stock and domestic purposes during severe dry seasonal conditions.
https://www.water.vic.gov.au/groundwater/emergency-water-supply-points

Farm Water Quality Information Note
Farm Water Quality and Treatment – DPI NSW, 2014,
http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0013/164101/Farm-water-quality-and-treatment.pdf

On-farm Water Reticulation Planning Guide
GWM Water,
https://www.gwmwater.org.au/connecting-services/rural-pipeline/designing-your-on-farm-piped-system

Crown Land Water Frontages Fact Sheet
Department of Environment, Land, Water and Planning
https://vicwater.org.au/wp-content/uploads/2013/08/Publication-Crown-Land-Water-Frontages-Factsheet-2013.pdf

Southern Rural Water
Managing Water. Serving Communities.

Fact sheet

Constructing a bore

You need a Works Licence to construct a bore

You must understand and comply with the licence conditions

If you want water for anything but domestic and stock use, you will also need to apply for a Groundwater Licence.

If you are planning to construct a bore, you need a Works Licence. You can find a Works Licence application form on theSouthern Rural Water website, or obtain one by calling us on 1300 139 510.

For domestic and stock use only, you can apply online at www.waterregister.vic.gov.au

Approving applications

Southern Rural Water prefers that our customers have no surprises during the application process. We strongly urge anyone thinking of constructing a bore to talk to one of our assessment officers before you apply.

In most cases, applications to construct a bore for domestic and stock purposes only are approved.

However, if you are applying for a bore that will be used for new irrigation, commercial or industrial purposes, you should remember that many areas in Victoria are "capped", which means no new Groundwater Licences can be granted. If you want to apply to use groundwater in a capped area, your Works Licence application should be sent to us together with an application to transfer groundwater from someone else with an existing licence. Information about groundwater trading can be found on our website.

Commercial use includes irrigation, dairy shed water, mining, aquaculture, feedlots, piggeries, poultry farms, golf/sporting areas, guest accommodation, water bottling and snow making.

In many cases, applications for Groundwater Licences must be advertised locally, including notifying neighbours, and submitted to relevant authorities for comment.

Works Licence conditions

Once approved, your Works Licence is only valid for 12 months. If your bore is not completed in this time, you can apply to renew the licence prior to the expiry date. After this date, you will need to apply for a new licence.

You cannot start drilling until you have received your licence.

Your Works Licence will have a number of conditions on it - please read and understand the conditions before any workstarts. If you have any questions about your conditions, please call us.

Southern Rural Water inspects most bores during or after construction.

Proposed position / setback distances

While legislation sets strict guidelines on where bores can be positioned, we recommend that you talk to your neighbours and local council prior to drilling a bore.

You will also need to consider accessibility to the proposed site and whether it is prone to flooding, what type of pump will need to be installed and if it will need power.

As a general guide, these are the suggested minimum setback distances from a bore:

Building foundations, 3 metres [1]
Lakes or waterways, 200 metres
Power lines, 6 metres [1]
A bore not in your ownership, 300 metres
Drainage pipes, 20 metres [1]
Storage sheds or feed lots, 20 metres
Onsite effluent disposal systems up to 50 metres [1] [2]
Irrigation channels, 50 metres
Drain field systems, 40 metres

[1] Contact EPA Victoria, your local council or agency for more information.

[2] Refer to the Code of Practice - Onsite Wastewater Management. Available from www.epa.vic.gov.au

Specific setback distances may be listed on a Works Licence.

Water quality/quantity

Southern Rural Water does not guarantee the quality or quantity of any groundwater. Groundwater should not be considered safe for human consumption unless properly treated.

To get an idea of what water quality you might expect from a new bore, check with:

- A qualified hydrogeologist
- Drillers who work in the area
- The Department of Sustainability and Environment Groundwater Database (www.dse.vic.gov.au)

If you are unsure about how much water you need, we recommend you seek advice from the Department of Primary Industries on 136 185 or www.dpi.vic.gov.au.

Once your bore has been drilled, you or your driller must submit a water sample to Southern Rural Water's laboratoryofchoice for testing. We will advise laboratory details when your licence is issued.

You or your driller must also provide us with a Bore Completion Report within 28 days of the bore being drilled.

Metering

If your bore is for a commercial use, it has to be metered.

Southern Rural Water will provide a water meter at cost. It must be installed to our specifications, either by yourself or a contractor. We will inspect the installed meter to ensure it meets our standards.

All meters remain the property of Southern Rural Water.

Domestic and stock bores do not need to be metered.

More information
Contact us on **1300 139 510** for more information or to make an appointment to chat to one of our assessment staff.
Moreinformation can also be found at www.srw.com.au

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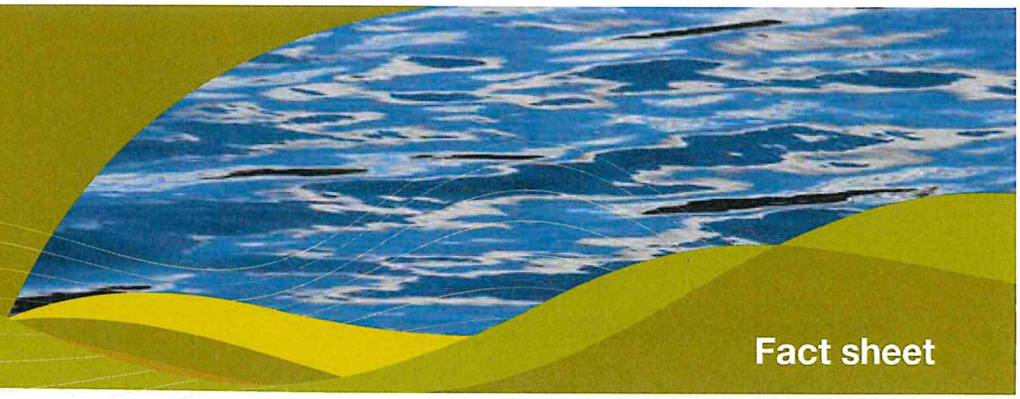


Fact sheet

Water for my rural property - do I need a licence?

You may need a licence to obtain water from your rural property, depending on how and why you want to use the water, and where it comes from.

Licences are issued by your Southern Rural Water as your local rural water corporation.

For domestic and stock use of water

(which includes water for household purposes,watering of animals kept as pets, watering of cattle or other stock, watering around the house for fire prevention and watering a kitchen garden).

If your land fronts a waterway:

Check with your local water corporation to see if you have a private right to access water

If you do:

Domestic and stock rights apply.

You do not need any consent from your rural water corporation to take water.

If you don't:

You will need a Surface Water Licence (or "take and use" licence) from your rural water corporation.

If your land does not front a waterway:

and you want to build a small dam

Check with your rural water corporation.

You may need a licence, depending on the dam's location and size.

and you want to take water from a nearby river

You must obtain a Surface Water Licence from your rural water corporation.

If you want to sink a bore or well:

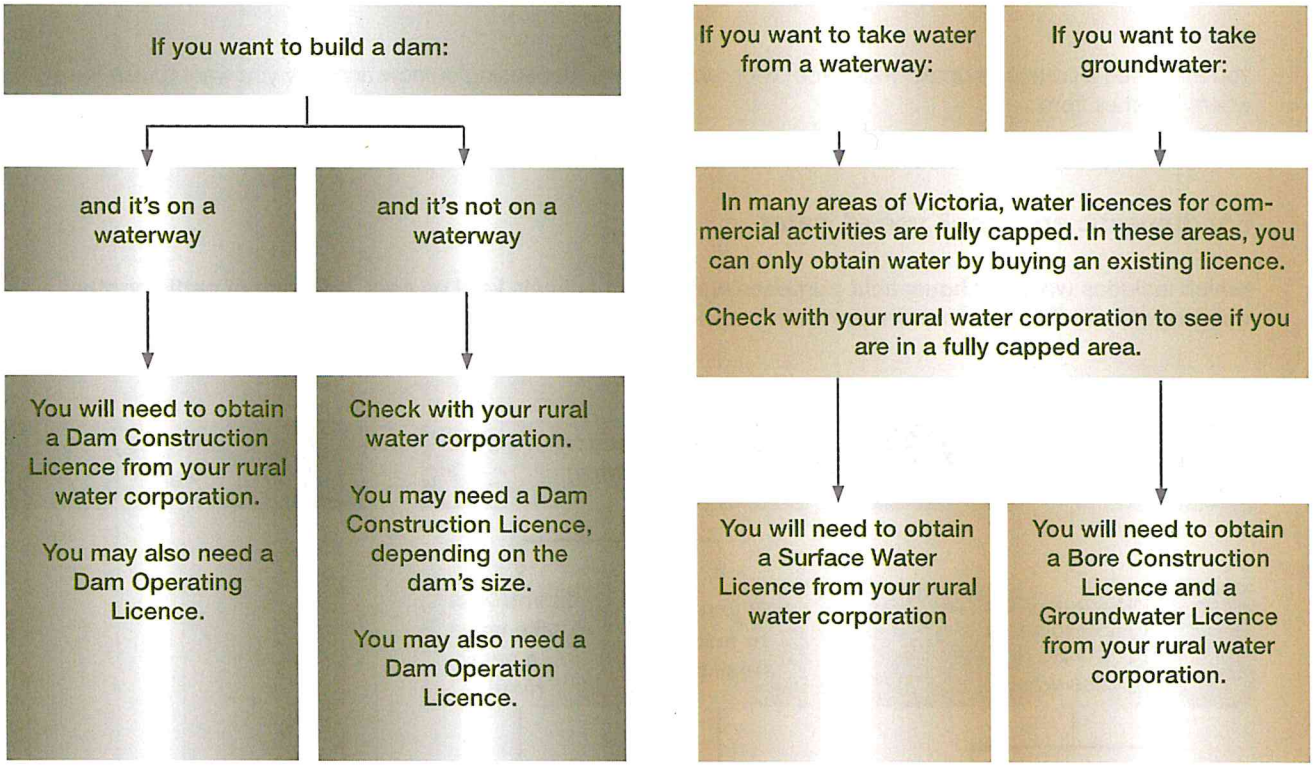
Domestic and stock rights apply.

You must obtain a licence to construct your bore or well from Southern Rural Water, either by applying online or contacting us. You do not need an annual licence to take groundwater for domestic or stock use.

Rainwater harvested from rooftops and buildings is exempt from any rural water corporation licensing requirements.

For commercial activities

(eg irrigation, mining, aquaculture, feedlots, piggeries, poultry farms, golf/sporting areas, guest accommodation, water bottling, snow making)

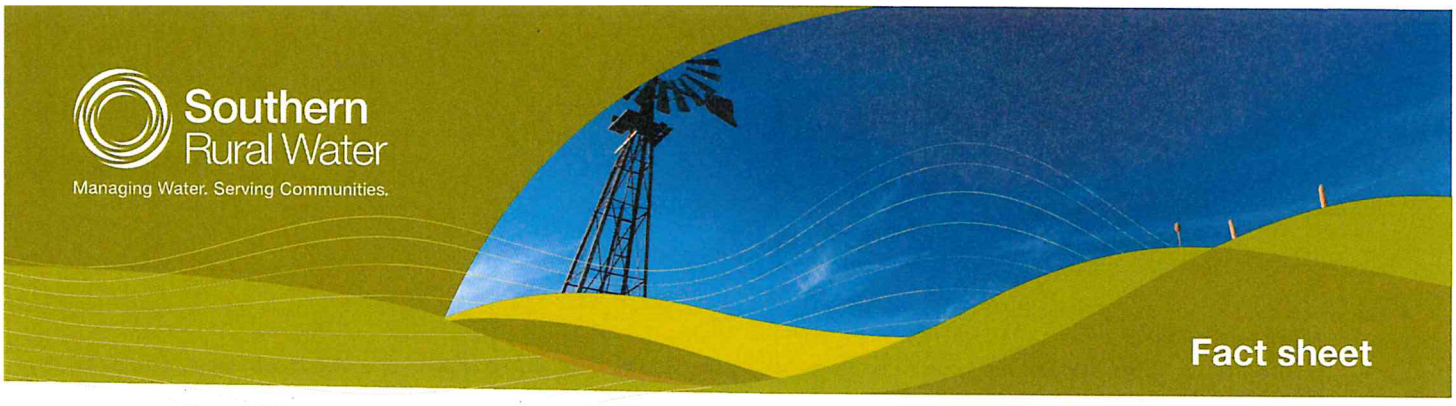


More information

For more information, contact your nearest rural water corporation:

Southern Rural Water
1300 139 510

Melbourne Water (surface water, Yarra and Maribyrnong waterways)
131 722



Your right to domestic and stock water

Your basic rights under the Water Act

What can you use domestic and stock water for?

Using bore or river water

The *Water Act 1989* says that anyone in the state can take domestic and stock water from a river or bore that they can access.

The exact wording from the Act is on the back of this fact sheet.

What is "domestic and stock" use?

You can use domestic and stock water for:

- The house
- A kitchen garden
- Watering pets or stock
- Fire prevention (only if taken from a spring or soak)

You cannot use domestic and stock water for dairies, piggeries, feedlots, poultry or any other intensive or commercial use.

River or bore water is not treated and is not always suitable for humans. You should test your water source before you drink it.

River or creek water

You can take river or creek water for domestic and stock use if:

- Your property title includes the river
- Your property title directly abuts the river
- You lease Crown Land abutting the river

Bore water

You can take bore water for domestic and stock use if the bore is located on your property.

If you don't have a bore, you can have one built. You will need to obtain a Bore Construction Licence from Southern Rural Water before work starts on the bore. Check our website for current licence fees.

More information
Contact us on **1300 139 510** for more information or to make an appointment to chat to one of our assessment staff. More information can also be found at www.srw.com.au

Extracts from the Water Act 1989

WATER ACT 1989 - SECTION 8

Continuation of private rights to water

(1) A person has the right to take water, free of charge, for that person's domestic and stock use from a waterway or bore to which that person has access —

(a) by a public road or public reserve; or

(b) because that person occupies the land on which the water flows or occurs; or

(c) in the case of a waterway, because that person occupies land adjacent to it and the bed and banks of the waterway have remained the property of the Crown by virtue of section 385 of the Land Act 1958 [3] or any corresponding previous enactment; or

(d) subject to section 33C, in the case of a bore, because that person occupies it.

While legislation sets strict guidelines on where bores can be positioned, we recommend that you talk to your neighbours.

(3) A person has the right to use water taken by that person from a waterway under subsection (1)(a), if the water is being used at the place at which it is taken.

DEFINITIONS (SECTION 3)

Domestic and stock use, in relation to water, means use for-

(a) household purposes; or

(b) watering of animals kept as pets; or

(c) watering of cattle or other stock; or

(ca) in the case of the curtilage of a house and any outbuilding, watering an area not exceeding 1·2 hectares for fire prevention purposes with water obtained from a spring or soak or water from a dam; or

(d) irrigation of a kitchen garden-

but does not include use for dairies, piggeries, feed lots, poultry or any other intensive or commercial use.

Kitchen garden means a garden

(a) that is used solely in connection with a dwelling; and

(b) no produce from which is sold; and

(c) in the case of a garden irrigated solely with surface water that is not part of an allotment that was alienated from the Crown before 15 December 1886, that is not bigger than 0.1 hectares; and

(d) in the case of a garden irrigated with both surface water and groundwater that is not part of an allotment that was alienated from the Crown before 15 December 1886, that is not bigger than 0.4 hectares; and

(e) in the case of a garden irrigated solely with groundwater, that is not bigger than 0.4 hectares; and

(f) in the case of a garden that is part of an allotment that was alienated from the Crown before 15 December 1886, that is not bigger than 1.2 hectares.