REVIEW OF GROUNDWATER RECHARGE IN THE COORONG DISTRICT

PRODUCED BY THE COORONG TATIARA LOCAL ACTION PLAN

Key Findings

- Local recharge is the primary cause of dryland salinity in the Coorong region.
- The benefits of lucerne in the system are equal to that of Mallee Vegetation when it comes to maintaining the water balance with the capacity to dry the soil profile out over a ten year period.
- Recharge rate is a function of soil texture by land use.

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History of dryland salinity in the Upper South East region

Dryland salinity in the region is caused by a water imbalance where water supply or recharge (primarily by rainfall into the system) – is greater than water consumption (primarily by evapotranspiration through plant water use) resulting in discharge of excess water. Discharge areas exist across the landscape. This is not a new phenomenon with low lying areas of the Cooke Plains embayment being a groundwater discharge area since before European settlement[1] however in the early 1980's these discharge areas were increasing and turning land that was once productive into salt encrusted flats.

Figure 1. Groundwater discharge site at Cooke Plains

The effects of dryland salinity and its impact on land use is widely known. Local recharge is thought to be the primary cause[2] with regional lateral flows of relatively minor importance in the spread of dryland salinity in the Coorong District.

By the 1990's, there was a groundwater rise in the unconfined aquifer of approximately 5-10cm/yr[2]. This triggered research in the area to understand the issue and also try to mitigate the problem by slowing down the water-table rise as increasing discharge zones were appearing. The modelled impacts of maintaining current land use at that time suggested that the area impacted was going to increase significantly if no changes were made.

In the late 1990's – early 2000's in response to these findings, there was a large investment in the region to achieve broad scale landscape change utilising incentives schemes to drive practice change to reduce recharge as it was thought that recharge reduction of a paddock scale had no significant influence of groundwater levels due to overriding effect of higher recharge rates in surrounding areas[3].

This investment saw a slowing of the water table rise (Figure 2 – LVG Netherton annual water table rise) between 1998 and 2008 however in 2010 the water table again rose (although not as rapidly) with levels peaking in 2017 across the region. This co-incided with landholders across the district observing the appearance of discharge areas that were subsequently becoming saline.

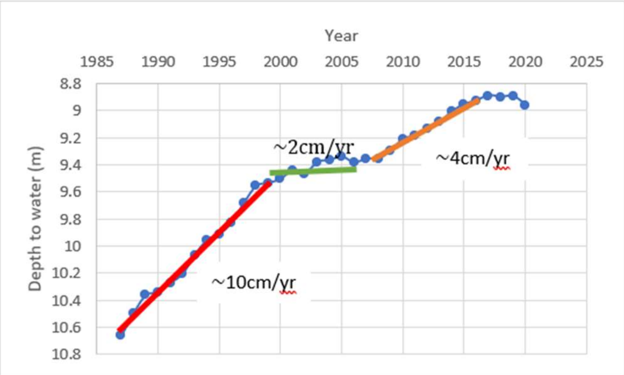

Figure 2. Netherton LVG1 Annual average Obswell data 1998-2020

The seasonal impacts are felt lower in the landscape; areas of low, topographic relief, coupled with shallow saline groundwaters minimise the lag between the effect of increased recharge rates and water table response[2]. This can be seen in Figure 3 – RBY004 Coomandook annual water table rise where it suggests these water table responses are strongly related to the rainfall trends[4] further strengthening the case to reduce overall recharge in the system.

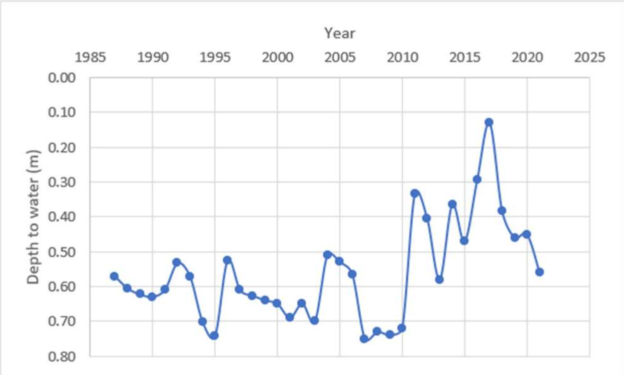

Figure 3. Coomandook RBY004 Annual average obswell data 1988-2021

Influence of soil type on water use, water holding capacity (WHC) and potential recharge

The soils across the region are diverse with varying water holding capacities. When water enters the soil, some is stored within the root zone for plant use, some evaporates and some will drain away through the profile. Sandy soils have a very low water holding capacity (Figure 4) compared to other soils, and the amount that can be held and extracted by plants across the region is also very low, varying from 55mm-100mm plant available water capacity (wheat)[5]. The water that isn't retained in the system flows through the system rapidly and contributes to recharge with 20mm of recharge having the capacity to cause a 100mm rise in the water table due to the porosity of the aquifer[6].

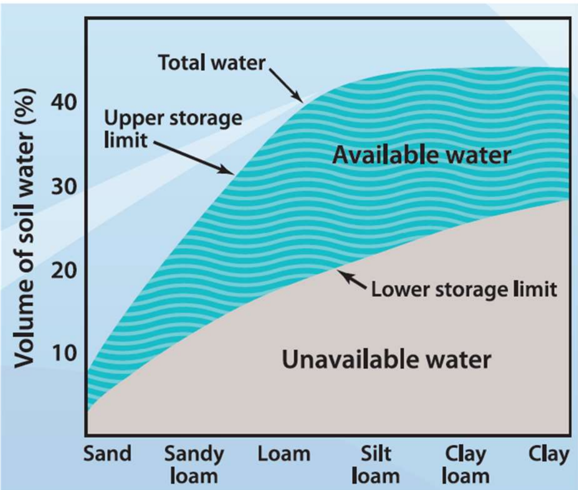

Figure 4. The relative amounts of water available and unavailable for plant growth in soils with varying textures (from Kramer, 1983).

Figure 5 shows the water balance model for a number of stations in the Mallee Region for which daily pan evaporation data existed[7] and includes the field data collected. This shows the mean annual recharge vs maximum soil storage capacity. Soil storage is a function of rooting depth and soil texture and this graph clearly shows the increase in potential recharge on soils with lower storage capacity (e.g. sandy soils). The field data collected suggested that the water balance model can capture the general trends in the drainage flux and contribution to recharge[7].

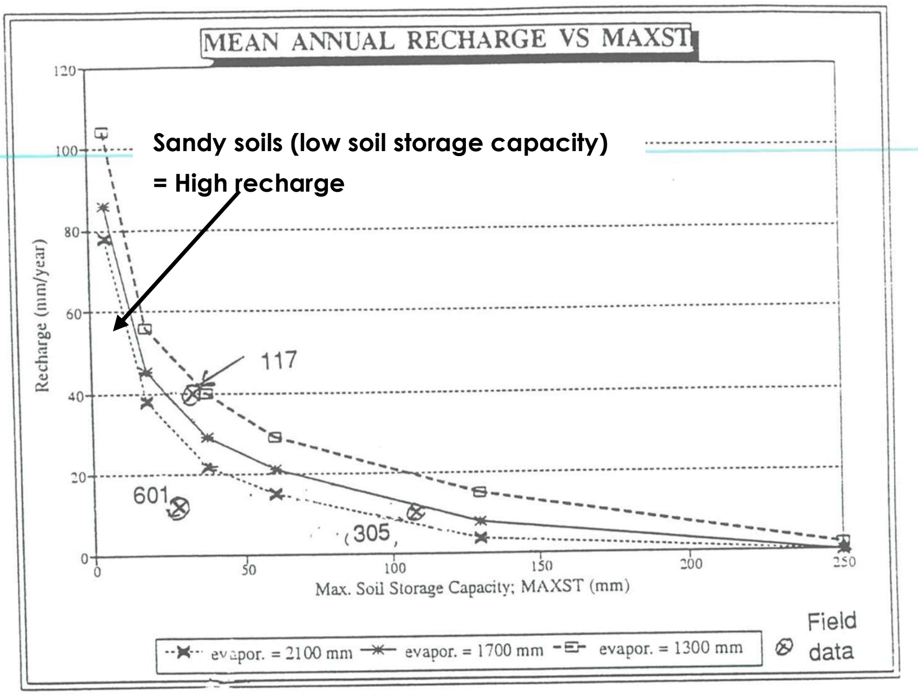

Figure 5. Water balance model – Mean annual recharge vs Maximum soil storage capacity(Source: Walker, et al, 1992[7]).

Soil amelioration work that is being conducted across the region in sandy soils aims to identify and manage soil constraints to increase the maximum soil storage capacity both by increasing rooting depth and/or trying to improve soil structure. Initial results are showing yield improvements and increase in water use by plants suggesting that it will assist in reducing the recharge within the system.

Recharge and Water use under different vegetation

In 1992 recharge studies were undertaken at Cooke Plains[7]. Recharge was found to be greatest in annual crop and pasture systems and lowest in Lucerne pastures and stands of native Mallee vegetation (Figure 6) which had very similar recharge rates.

LAND USE	SOIL TYPE	SOILS ASSOCIATION	NO. MEASURED SITES	MEAN ANNUAL RECHARGE (mm)
Annual Crop/Pasture	Sands*(often sandy clay or calcrete horizon present)	Coa, Cob	6	5-40
Perennial Pasture	Sands	Coc	1	13
Dryland Lucerne	Sands	Coa	2	3
Mallee vegetation	Sands	Coc	2	1

Figure 6. Recharge rates for varying land use (SOURCE: Walker et al, 1992[7])

Work on lucerne from other parts of Australia indicates that lucerne has the capacity to remove more soil moisture from the profile than an annual crop (Fig 7). This is due to its ability to extract moisture to a greater suction capacity (700kPa compared with 10kPa for an annual pasture). In studies in the Upper South East in 1992, lucerne was found to significantly dry the profile to 4.5m in 10 years[7] further supporting its role in reducing recharge into the system.

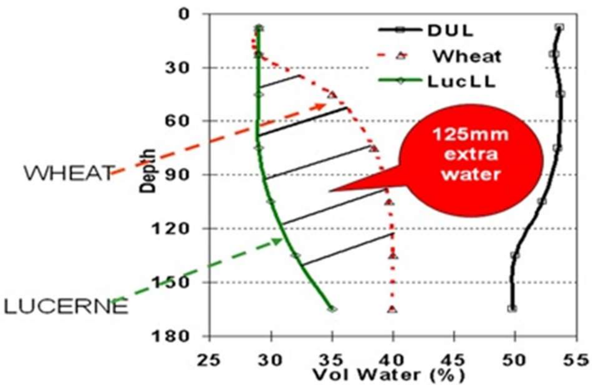

Figure 7. Example of the additional extraction of water from the soil profile by lucerne compared to wheat on the Jimbour plains (Source: GRDC EFS Project, Dalgleish).

Improvements in production and water use efficiency in cropping systems has improved greatly since this literature was published in the 1990's which had wheat yields at 0.3t/ha and barley at 0.6t/ha on sandy soils[8]. By 2020 wheat yields had tripled and barley yields doubled on these soils with increases in production due to advancements in machinery, rotations, crop nutrition, varietal selection, and improvements in weed, pest and disease control.

These improvements all assist in reducing the amount of recharge of winter rainfall into the system however annual crops cannot cope with large, episodic recharge events and out of season rainfall. Perennials and trees are required.[10] This has been observed recently with rainfall in late October 2022 at Coomandook (27mm over 3 days) resulting in an increase in the water table of 8mm[9].

Recommendations for Recharge areas

Historically in the literature the following recommendations were made.

1. Replace annual pasture systems with dryland lucerne (25mm reduction) or veldt/primrose (10mm reduction)[8]
2. Maintenance of native vegetation or establishment of corridors
3. Renovation of perennial pastures and management of perennial pastures to maximise production
4. Land stabilisation and reducing areas of drift where 100% recharge occur

In addition to this, in more recent years large increases in water use efficiency have been made by;

5. Implementing good agronomic practice, crop nutrition, weed, pest and disease management
6. Identifying and managing soil constraints to maximise water use

Recommendations for Recharge areas

The Coorong Tatiara Local Action Plan has delivered projects looking at the management of discharge areas from 2017-2022. Over this time, the key recommendations have been established;

1. Know your soil salinity levels
2. Maximise diversity when sowing into saline land
3. Maintain Groundcover (especially over the summer period)
4. Wait until the winter rainfall has penetrated to 30cms and reduced the salt loading in the surface – the winter "flush" before trying to remediate and sow saline areas

Recommendations for the future

Work to quantify the recharge and plant water use impacts of;

1. Soil amelioration techniques, and
2. Advancements in crop and pasture production due to advancements in machinery, rotations, crop nutrition, varietal selection, and improvements in weed, pest and disease control.

Understanding these advancements in land use and production will provide a more complete picture of recharge in the landscape under current land uses and advances in land management, crop and pasture production.

References:

[1] Von der Borch, C.C. and Altmann, M. (1979) Holocene stratigraphy and evolution of the Cooke Plains Embayment, a former extension of Lake Alexandrina.

[2]Barnett, S.R. (1989) Regional hydrogeology of the Cooke Plains – Coomandook area. SADME Report No 92/14

[3]Pavelic, P. et al (1994) Groundwater Flow Modelling to Assist Land Management in the Cooke Plains area of South Australia

[4]Henschke, C. (2019) Coorong Dryland Salinity Review

[5] CSIRO, APSOIL database

[6]Barnett, S.R. (2019) Coorong Dryland Salinity Review

[7]Walker, G.R. et al (1992) Preliminary Results of Recharge Investigations in the Upper South-East region of South Australia

[8]Butler, P. (1997) Reducing groundwater recharge and the impact of dryland salinity in the Coorong & Districts

[9]Coorong and Tatiara District Council Weather Station Network

[10]Nulsen, R.A. and Baxter, I.N. (1986) Water use by some crops and pastures in the southern agricultural areas of Western Australia