Australasian Groundwater & Environmental Consultants

Report on

GS54 Queensland Boarder Rivers Alluvium Stage 5

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GS54 – Queensland Border Rivers Alluvium

Stage 5 – Assessment through multiple lines of evidence

The Queensland Border Rivers Alluvium groundwater resource (GS54), located in the Dumaresq River catchment of southeast Queensland, consists of an unconfined to semi-confined alluvial aquifer system with a losing-disconnected relationship to the Dumaresq River (Figure 1; Crosbie *et al.*, 2023). This unit is a contiguous aquifer with the Border Rivers Alluvium unit of NSW (GS32) and the resource is jointly managed by the two jurisdictions, each with a separate SDL volume. The western half of GS54 area is underlain by the Surat Basin, which hosts both Coal Seam Gas (CSG) resources (north of GS54) and Great Artesian Basin aquifers. Groundwater entitlements are distributed across the unit, typically in close proximity to the Dumaresq River, but also along the alignment of its main tributary, Macintyre Brook (Figure 1). Entitlement allocations mainly take from the deeper alluvium and are greater in upgradient areas (near Texas; jurisdiction zones BRA-01 to BRA-05) and are smaller downgradient (near Goondiwindi). GS54 spans approximately 2,214 km², with a Sustainable Diversion Limit (SDL) of 14.00 GL/year and long-term average recharge estimates ranging from 22.78 to 68.50 GL/year (Table 1; Stage 2 used the estimate of 25.69 GL/year). Between 2013 and 2023, average annual groundwater extraction was 11.56 GL/year, representing 44% of estimated recharge and 83% of the SDL volume (Figure 2). Groundwater use supports about 167 licenced production bores, mainly for irrigation, but also reserve town water supply for Texas and Yelarbon, and stock and domestic use, although elevated sodium concentration in the groundwater east of Goondiwindi is affecting the beneficial use (DNRME, 2019a). Historically, water users have relied on both groundwater and surface water, and it appears that groundwater pumping has supplemented surface water supply during years of below-average rainfall (Figure 2). However, after the millennium drought, there is greater reliance on groundwater (DNRME, 2019a), which has also coincided with some changes in land and water use, such as a switch from seasonal crops to perennial crops, or growth in industrial take. Long-term climate observations show a relatively persistent below-average rainfall signal for the 2011–2020 period and a reverse signal post-2020 (Figure 3).

The water table is typically between 5 m and 15 m below the ground surface for most of the SDL resource unit area (Figure 4a), although there is moderate drawdown around take points near Goondiwindi, Texas, and Yelarbon (zone BRA-05). Groundwater flows from southeast and northeast towards the west along the main alluvial valleys of the Dumaresq River and Macintyre Brook (Figure 4b). Long-term (1974-2024) and short-term (2012-2024) median groundwater levels show spatial agreement and are contained within a well-defined multi-decadal fluctuation zone that varies strongly, from one or two metres thick in most areas and up to about 20 m thick in the central part of the unit (Figure 5; near Yelarbon). This strong fluctuation is partly due to the high volumes of take, but also due to the semi-confined nature of the deep alluvium. In several areas of GS54, the recent (short-term) median water level sits below that of the long-term (Figure 5), indicating that current levels remain lower than those of the past. Near Yelarbon (zone BRA-05), a drawdown area is evident in the long-term fluctuation zone (Figure 5). Water quality is generally fresh in all areas (salinity below 1,500 mg/L; equivalent to 2239 µS/cm; Figure 6), but is changing over time in downgradient areas (DNRME, 2019a). Long-term water level trends vary across the unit (Figure 7); they are generally stable or only mildly declining near Goondiwindi and in the Macintyre Brook branch, and are generally declining elsewhere (Figure 9). Short term trends show a lower availability of information and are mostly declining (Figure 10). The understanding of temporal salinity trends is limited due to poor data availability (Figure 8).

MDBA (2020) previously reported recharge at 68.50 GL/year based on WAVES modelling, incorporating diffuse recharge only; however, alternative estimates of recharge are lower (Table 1). The Stage 2 estimate of 25.69 GL/year (derived from chloride mass balance and regional interpolation; Lee *et al.*, 2024) compares favourably to the recent WAVES modelling estimate for diffuse recharge from the MD-SY2 project of 22.78 GL/year (Crosbie et al., 2025), and provides the SDL:recharge ratio (SDL/R) of 0.54. Table 1 shows a storage-to-recharge ratio (S/R) of 641 using the SY2 estimate of recharge and the WERP estimate of storage (Rojas et al., 2022), suggesting high buffering capacity and limited vulnerability to short-term climate variability (above the "low responsiveness" threshold[1] defined in Rojas et al., 2022). However, the high extraction-to-SDL (E/SDL) ratio of 0.83 (Table 1) suggests moderate to high pressure on the productive base, particularly as declining rates of extraction have increased in the central zone recently.

The productive base shows signs of stress, with long-term water level declines affecting about 35% of ESLT asset areas of GS54 (Table 2; Figure 11). Statistically significant (α=0.05) declines have occurred since 1974 across the central and southern parts of the unit, with declines ranging to approximately -1 m/year (Figure 9; Table 1). In contrast, short-term trends (Figure 10) show a greater spatial distribution of bores with declining trends and a greater number of bores with higher rates of decline (Table 1). The short-term period (2012-2024) is characterised by below-average rainfall prior to 2020 (Figure 3) and a substantial reduction in annual take post-2020 driven by a positive annual rainfall anomaly (Figure 2).

Stage 4 of this BPR technical groundwater review provided a quantitative assessment of resource condition indicators within a 5 km buffer around extraction points (asset area). Long-term groundwater level declines were observed in 35% of the productive base asset area, 30% of the river connectivity asset area, and 32% of the GDE asset area (Table 2). In the short-term, these percentages decreased marginally to 30%, 22% and 27%, respectively (Table 2). Between just 9% to 17% of each ESLT asset area showed improving or stable water level conditions in the short-term (Table 2), with more than 50% of the asset areas having insufficient data to assess short-term temporal trends (Figure 11). These zones of uncertainty have remained relatively similar between the long- and short-term periods (Table 2; Figure 11). Although, for the water quality (salinity) ESLT, the zones with 'insufficient data' to determine temporal trends increased from 82% of the asset area in the long-term to 100% in the short-term.

The Queensland state-based risk assessment (DNRME, 2019b) assigns variable risk ratings across ESLT values. For the productive base, the state risk assessment (DNRME, 2019b) highlights a high risk from over-allocation as current entitlements exceed the SDL. In contrast, there was a low assessed risk for groundwater availability both in the deep and shallow alluvial aquifers of GS54 from current or increased licenced take or take under basic rights, citing active management as the basis for an unlikely likelihood and local impacts to users as the potential consequence. Other risks to groundwater availability were also assessed as low, including risks from: take by resource industry, increased surface water take, climate change, and increased drought. The risk of structural damage to the aquifer arising from groundwater take was also assessed as low. The risk of change to surface water-groundwater connectivity for the Dumaresq River and Macintyre Brook is low, and existing management rules protect hydraulic properties and connections (DNRME, 2019b). The river systems have a losing-disconnected relationship with groundwater, meaning persisting declining groundwater level trends (Figure 10) may not be expected to cause baseflow reduction in GS54, although moderate uncertainty remains for this risk. The risk of licenced extraction of groundwater leading to drawdown that results in insufficient water available for GDEs is medium in the Dumaresq Irrigation area (high uncertainty), and low for the Macintyre Brook area (moderate uncertainty; DNRME, 2019b). These GDE risks applied to baseflow GDEs, terrestrial vegetation, and non-riverine wetlands, and they are mitigated through strategies that aim to maintain groundwater levels within the natural range of variability in areas where there are known GDEs. Risks to groundwater quality in GS54 ranged from low to medium risk, with a medium risk being from nutrients and pesticides entering and degrading shallow or deep groundwater quality, and salinity posing a low risk. The extraction of groundwater from the GS54 resource shared with NSW is managed to mitigate these risks, including limiting take to the agreed level of 8.10 GL through announced allocations and preventing trade from the shallow formation to the deep formation.

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[1] *S*/R ratio: High responsiveness: 29 to 111.
Medium responsiveness: 111 to 333.
Low responsiveness: >333.

Future projections from the MD-SY2 project suggest that diffuse recharge in GS54 may increase by 2050 due to more intense rainfall events (Crosbie et al., 2025). In contrast, overbank flood recharge and in-stream recharge are projected to decline by 21.5% and 10.4% relative to current conditions, respectively (Crosbie et al., 2025), potentially reducing (localised) episodic recharge and groundwater availability during dry periods. Stage 6 of this BPR technical groundwater review found that the future area of drawdown (Area of Influence, AoI[2]) is projected to expand slightly under climate change scenarios, with the median future AoI (P50) marginally exceeding the present AoI, indicating likely minor increases in deteriorating areas (Figure 12). The SDL/R ratio is also projected to increase very slightly, indicating a general reduction in recharge expected from climate change impacts. The Stage 6 assessment classified the pressure from future climate change on GS54 groundwater resources as very high (based on long-term and short-term water level evidence).

Overall, short-term groundwater level trends (2012–2024) show signs of stress in GS54, with a greater spread of bores with declining trends than in the long-term (1974–2024), and some with higher rates of decline. This is observed over a time of reduction in groundwater take, but a generally drying climatic period. Groundwater allocations are capped, but total entitlements exceed the SDL and this risk of overallocation is high. In response, management of the resource (which is shared with NSW) is active, with limits on take to the agreed level of 8.10 GL through announced allocations and a ban on trade from the shallow formation to the deep formation. Current extraction remains close to the SDL, but take only represents 44% of estimated recharge, and storage estimates indicate a highly buffered system. The river interaction in this unit is assessed as low risk by the state, due to: a) the main take being from the deep aquifer; b) the capping of entitlements; and c) the losing-disconnected stream relationship. Risks to GDEs range from low to medium in the Dumaresq Irrigation area, and known GDEs exist in the area. Water quality changes from pesticides or nutrients are a concern. Climate projections indicate reduced episodic (localised) recharge from floodplain processes in this alluvial unit. Collectively, the analysis suggests moderate to high pressure on the productive base of GS54, with very high pressure from future climatic variability, although high buffering capacity and active management are mitigating factors.

[2] Area of influence is defined as the area impacted by drawdown caused by groundwater extraction. For the quantitative assessment of Stage 4, this is equivalent to the percentage asset area showing a deteriorating resource condition, which is a statistically significant declining trend in groundwater level.

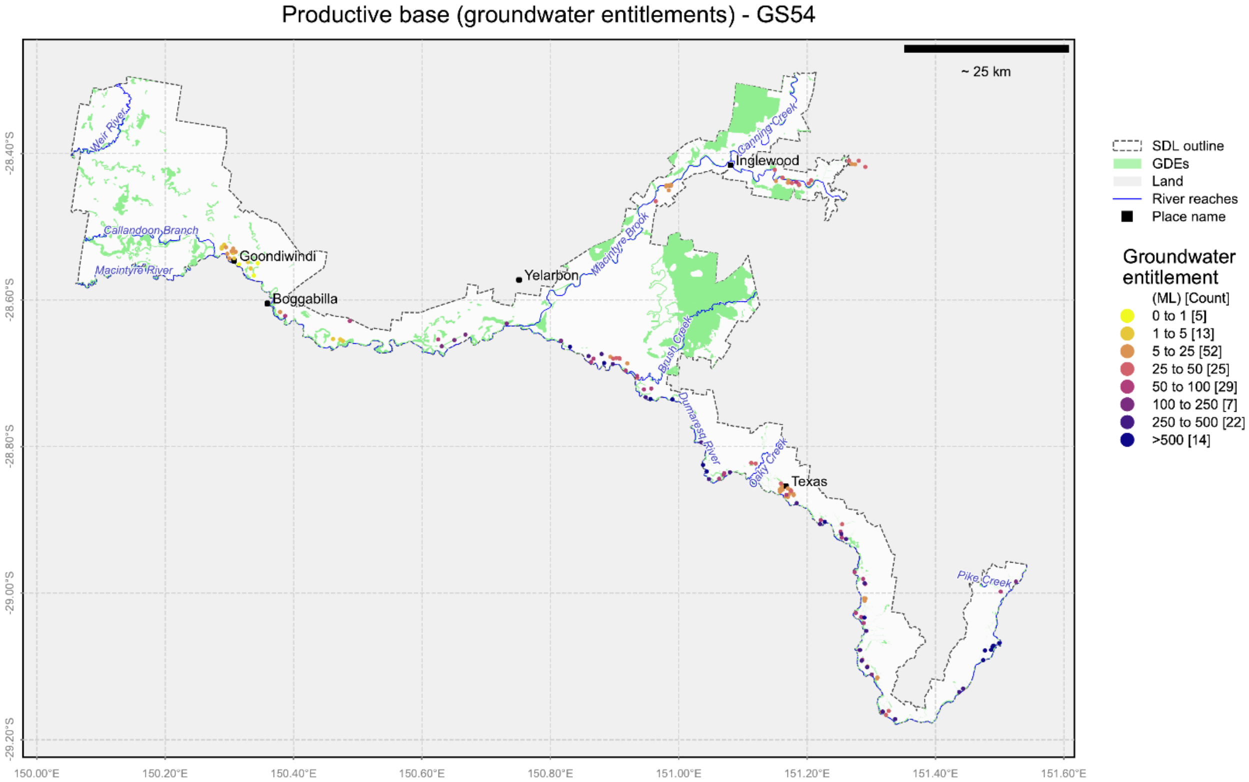


Figure 1 Productive base (groundwater entitlements)

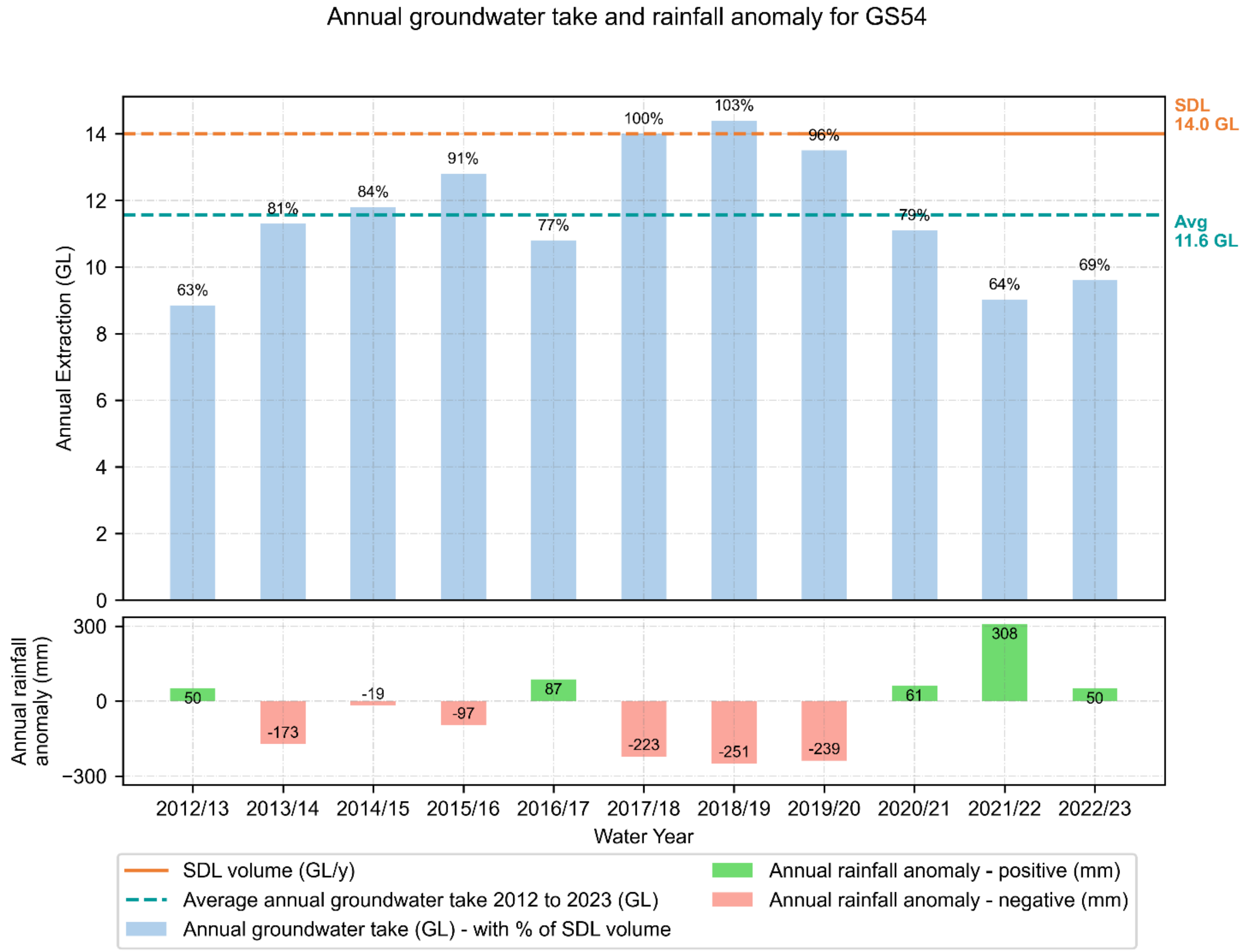


Figure 2 Groundwater take in the SDL since 2012

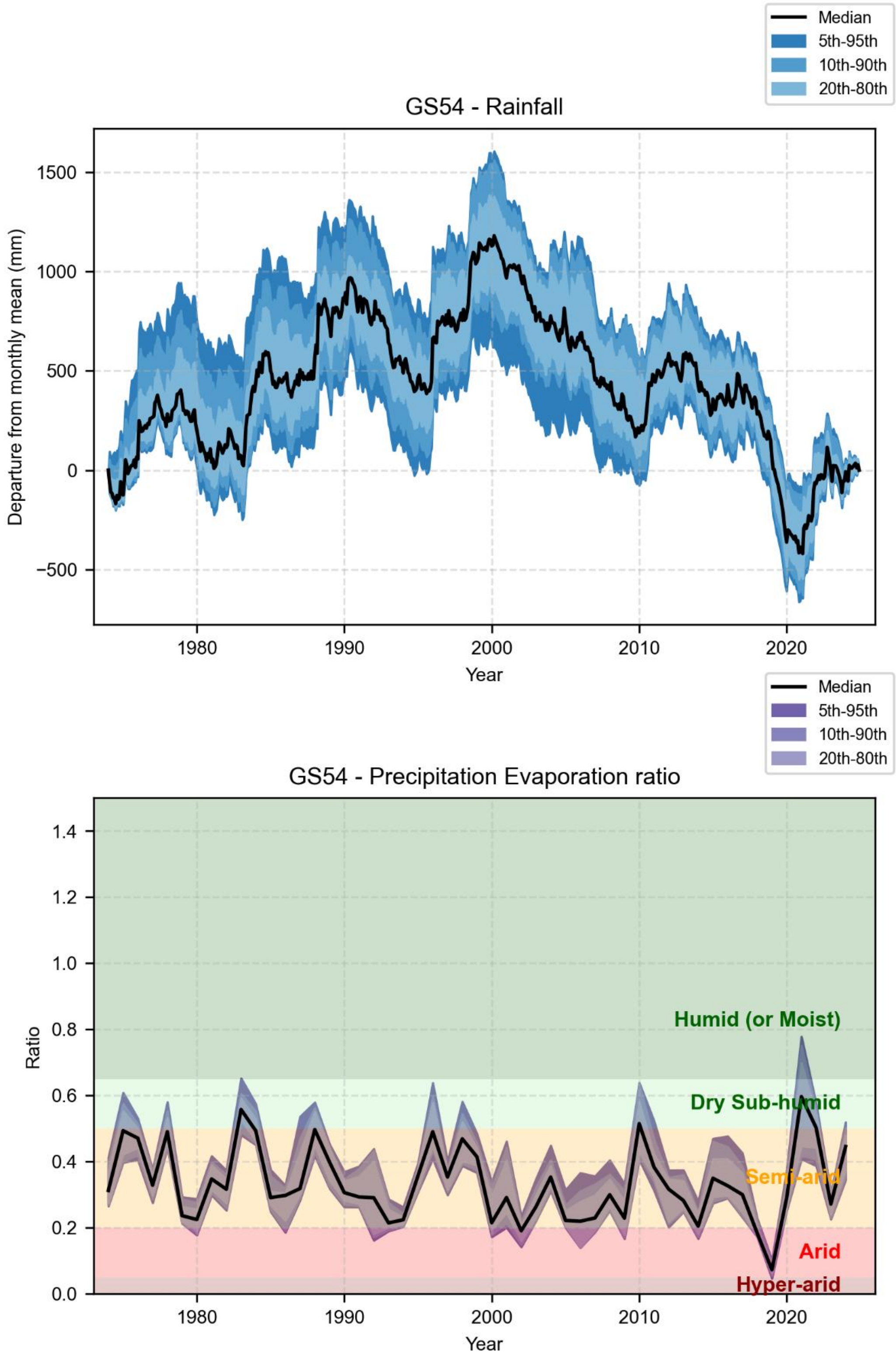
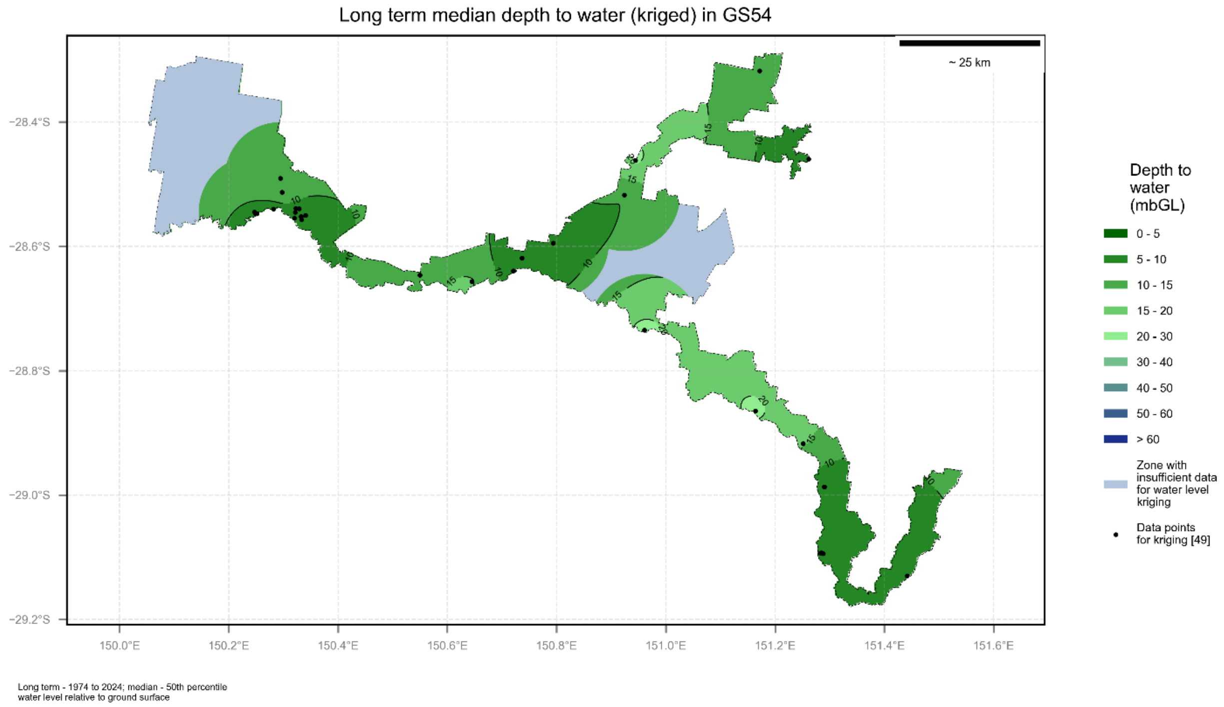
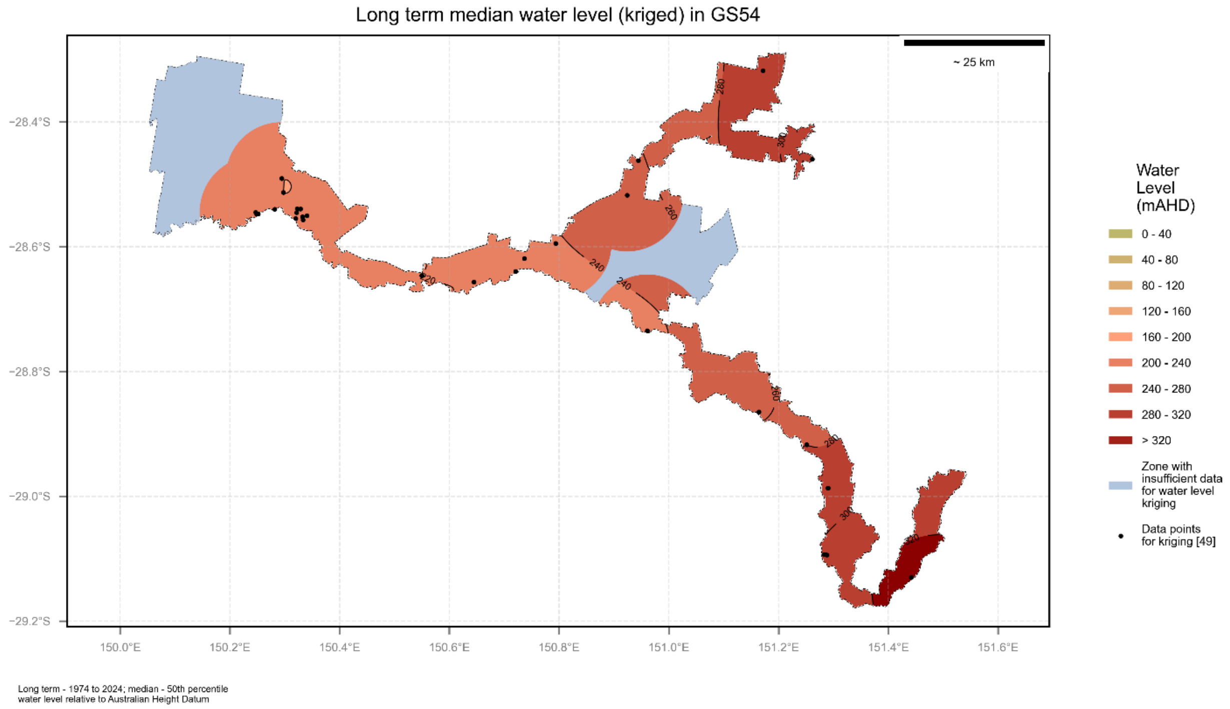


Figure 3 Historical climate trends



a)



b)

Figure 4 Long-term median (a) depth to water and (b) water level elevation

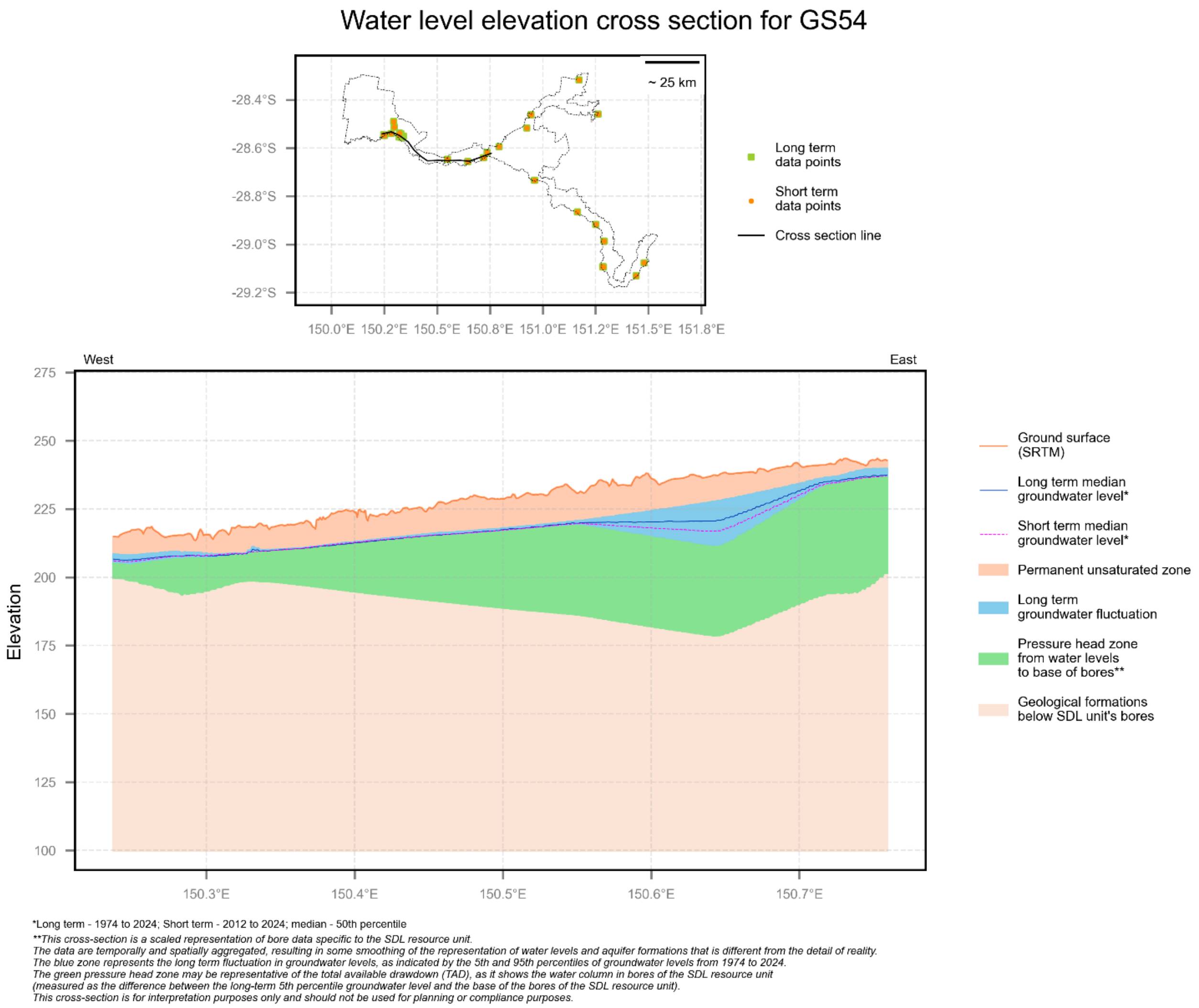


Figure 5 West to east distribution of water levels in the SDL resource unit

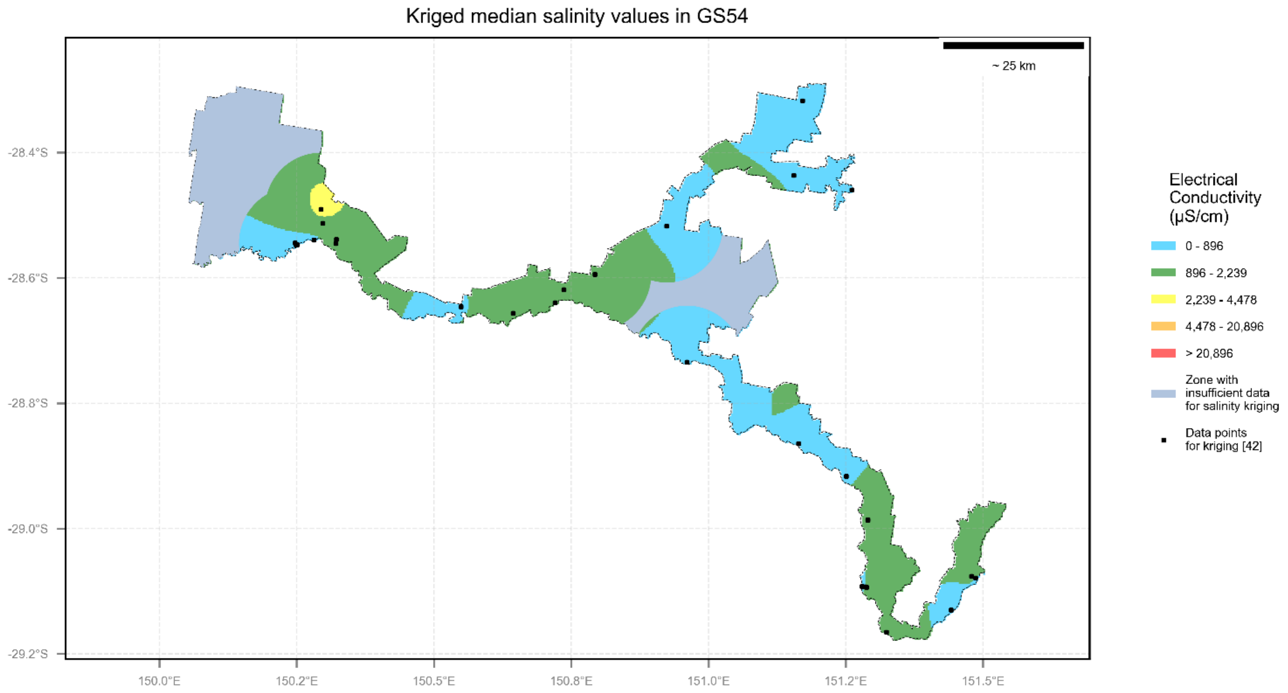


Figure 6 Groundwater salinity distribution

Table 1 Table of groundwater metadata for the SDL resource unit

Parameter	Unit	Long-term (1974 to 2024)	Short-term (2012 to 2024)	SDL resource unit data
SDL volume	GL/y	-	-	14.00
SDL resource unit area	km²	-	-	2,214
Average annual take (2013 to 2023)	GL/y	-	-	11.56
Number of groundwater entitlement bores	-	-	-	167
SDL resource unit storage estimate*	GL	-	-	14,602
Recharge estimate (SY1)	GL/y	-	-	68.50
Recharge estimate (Stage 2)	GL/y	-	-	25.69
Diffuse recharge estimate (SY2 - WAVES)	GL/y	-	-	22.78
Extraction/SDL (E/SDL) (Stage 2 result)	-	-	-	0.83
SDL/Recharge (SDL/R) (Stage 2 result)	-	-	-	0.54
SDL/Recharge (SDL/R) (SY2 or modelled recharge)	-	-	-	0.61
Storage/Stage 2 Recharge (S/R)	-	-	-	568
Storage/SY2 or modelled Recharge (S/R)	-	-	-	641
Number of bores in the SDL unit	-	879	879	-
Number of bores for water level trend analysis	-	74	44	-
Number of bores for water level trend with sufficient data	-	49	36	-
Number of bores with decreasing water level trend	-	31	17	-
Number of bores with increasing water level trend	-	0	1	-
Number of bores with no statistically significant water level trend	-	18	18	-
Mean water level trend magnitude	m/y	-0.12	-0.18	-
Minimum water level trend magnitude	m/y	-1.05	-1.2	-
5%ile water level trend magnitude	m/y	-0.76	-1.03	-
10%ile water level trend magnitude	m/y	-0.56	-0.9	-
50%ile water level trend magnitude	m/y	-0.03	-0.05	-
90%ile water level trend magnitude	m/y	0.12	0.07	-
95%ile water level trend magnitude	m/y	0.2	0.22	-
Maximum water level trend magnitude	m/y	0.36	0.5	-
Number of bores for salinity trend analysis	-	44	22	-
Number of bores for salinity trend with sufficient data	-	6	0	-
Number of bores with decreasing salinity trend	-	0	0	-
Number of bores with increasing salinity trend	-	0	0	-
Number of bores with no statistically significant salinity trend	-	6	0	-
Mean salinity trend magnitude	µS/cm/y	-11	N/A	-
Minimum salinity trend magnitude	µS/cm/y	-50	N/A	-
5%ile salinity trend magnitude	µS/cm/y	-43	N/A	-
10%ile salinity trend magnitude	µS/cm/y	-35	N/A	-
50%ile salinity trend magnitude	µS/cm/y	-19	N/A	-
90%ile salinity trend magnitude	µS/cm/y	20	N/A	-
95%ile salinity trend magnitude	µS/cm/y	29	N/A	-
Maximum salinity trend magnitude	µS/cm/y	37	N/A	-

Note: *Groundwater resource storage estimate source: WERP (RQ8b).

Table 2 Table of results from spatial analysis of RCI trends in ESLT asset areas

ESLT Value	Asset area (m2)	Long-term				Short term			
		Proportion of asset area with improving/ stable RCI trends	Proportion of asset area with deteriorating RCI trends	Proportion of asset area with uncertain RCI trends	Trend grouping	Proportion of asset area with improving/ stable RCI trends	Proportion of asset area with deteriorating RCI trends	Proportion of asset area with uncertain RCI trends	Trend grouping
Productive base	2,032,316,792	5%	35%	59%	Insufficient data	9%	30%	61%	Insufficient data
GDEs	1,972,398,302	5%	32%	63%	Insufficient data	9%	27%	64%	Insufficient data
River connectivity	2,717,439,966	10%	30%	60%	Insufficient data	17%	22%	61%	Insufficient data
Water quality	2,032,315,895	18%	0%	82%	Insufficient data	0%	0%	100%	Insufficient data

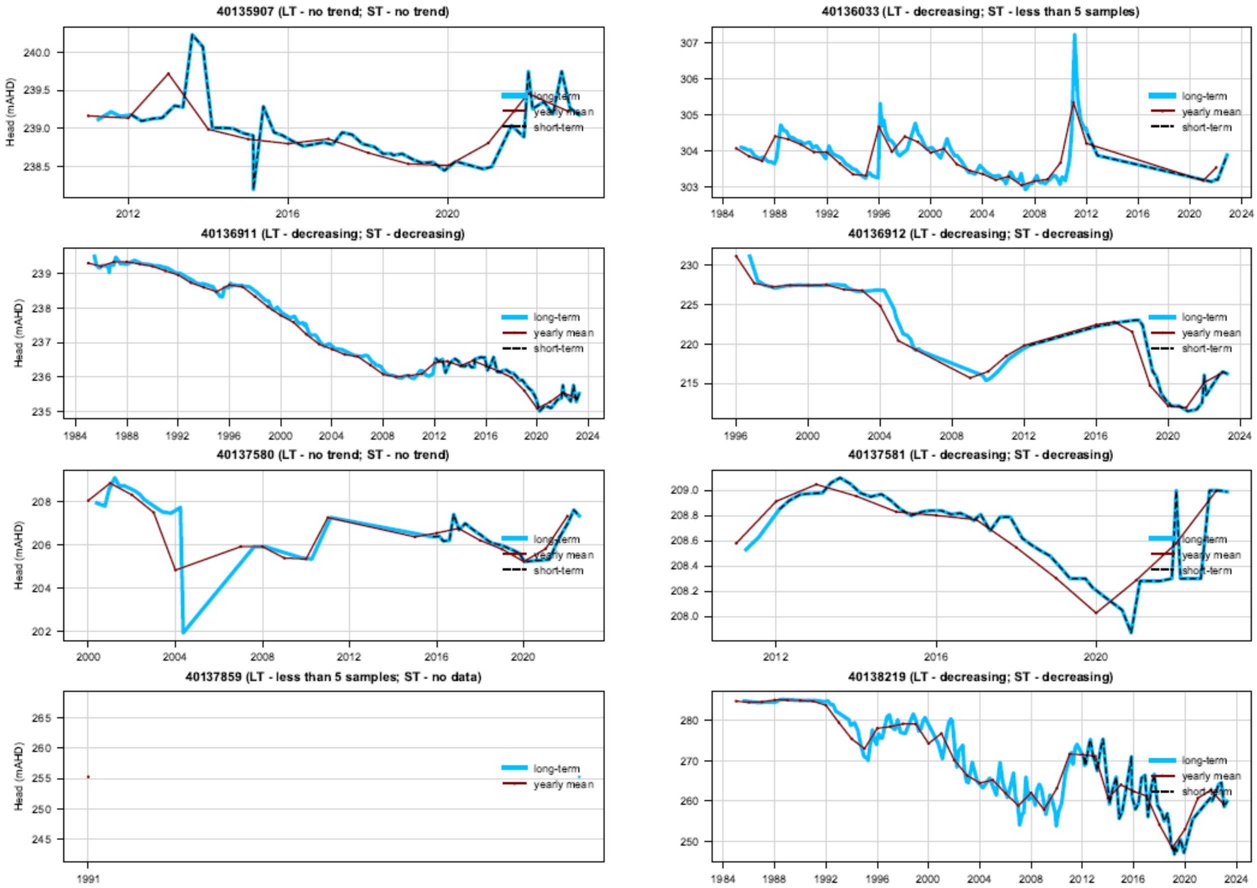


Figure 7 Representative groundwater hydrographs for the SDL resource unit

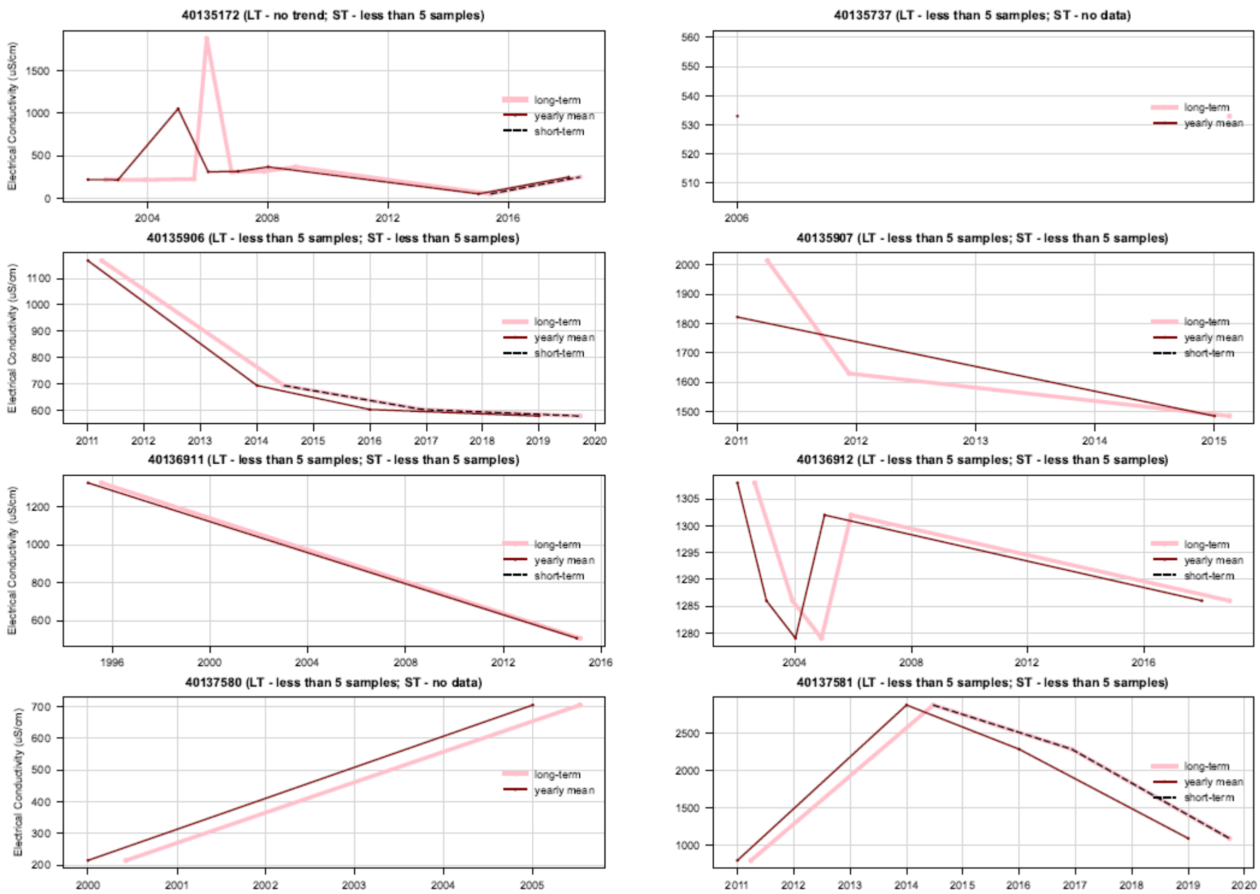
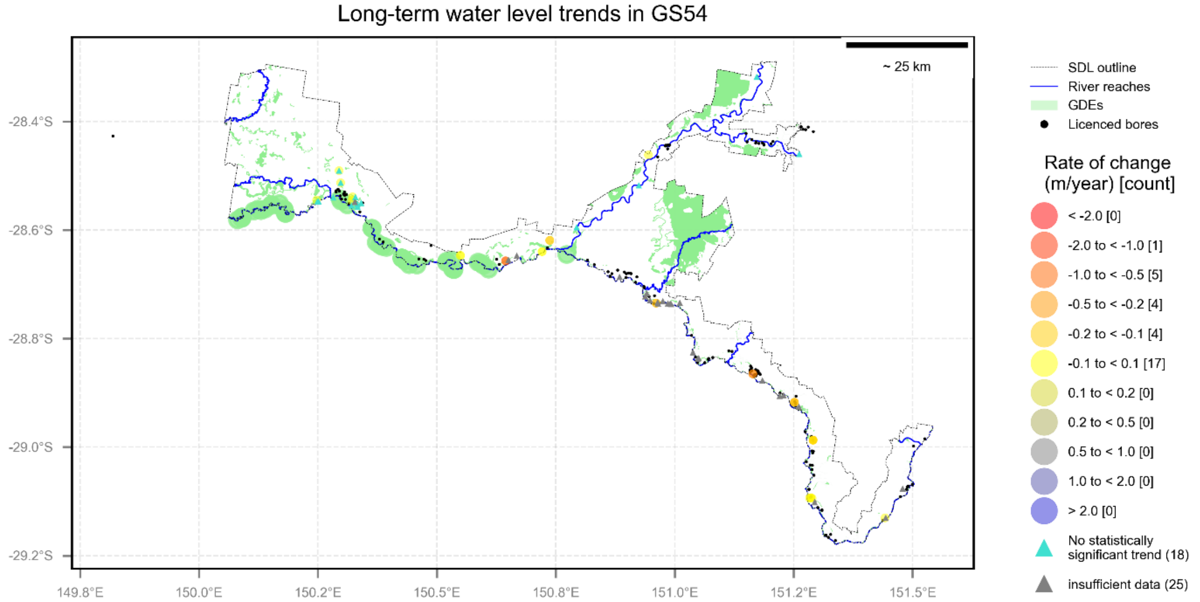
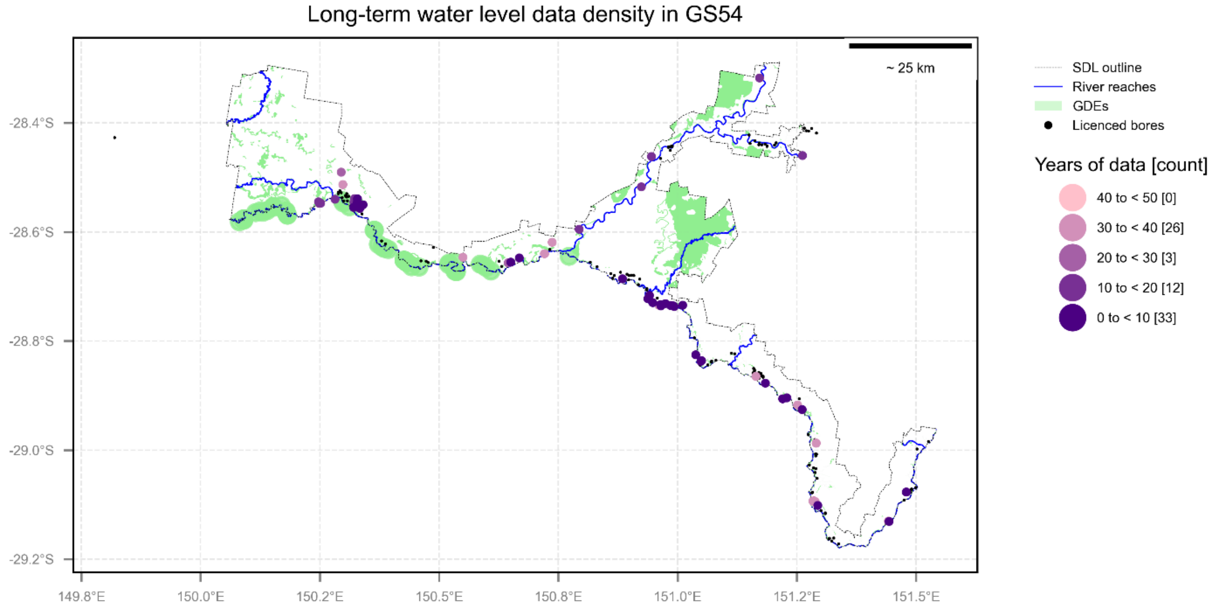


Figure 8 Representative groundwater salinity time series for the SDL resource unit



a)



b)

Figure 9 Long-term (1974 to 2024) (a) groundwater level trends and (b) data availability

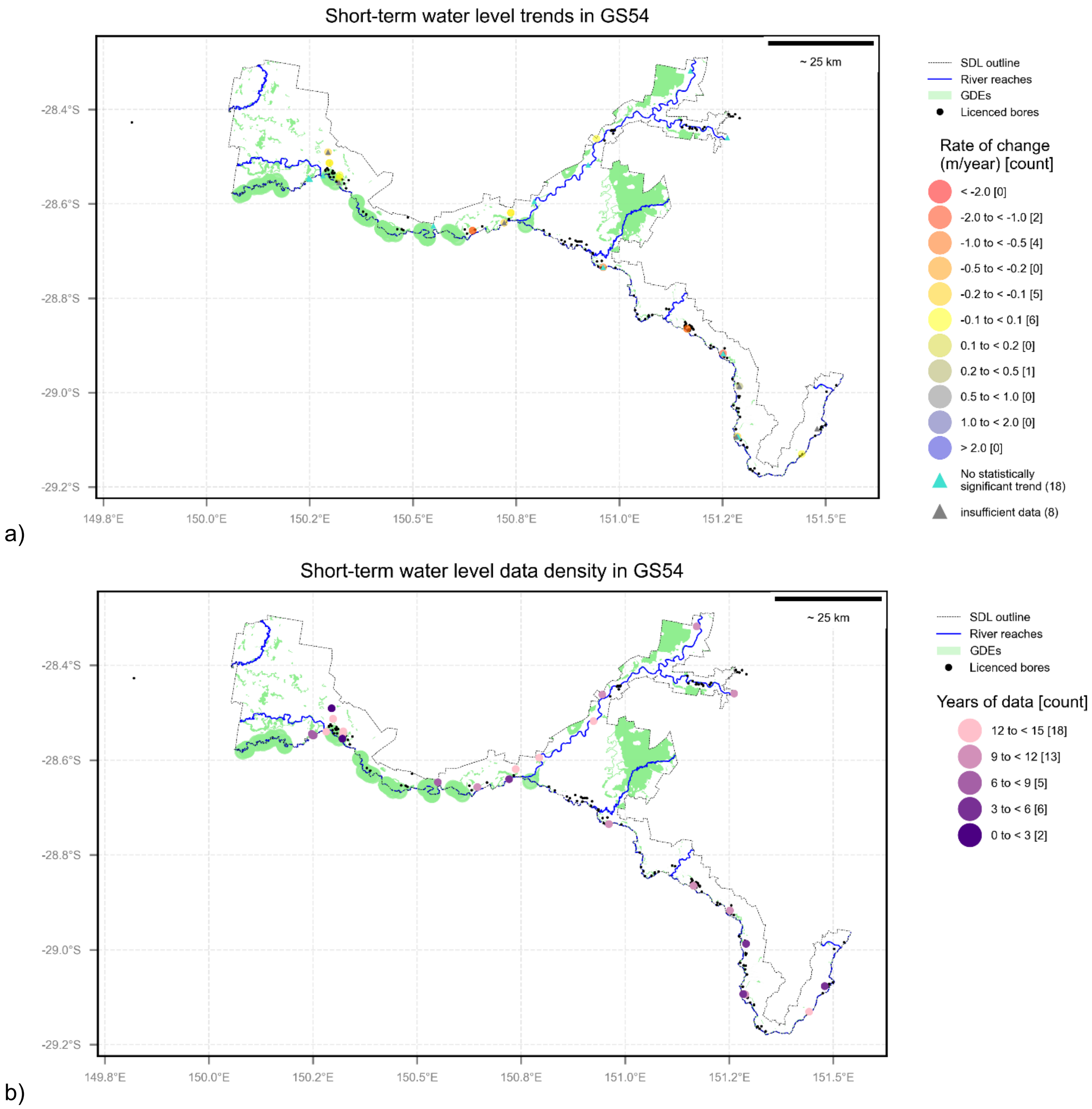


Figure 10 Short-term (2012 to 2024) (a) groundwater level trends and (b) data availability

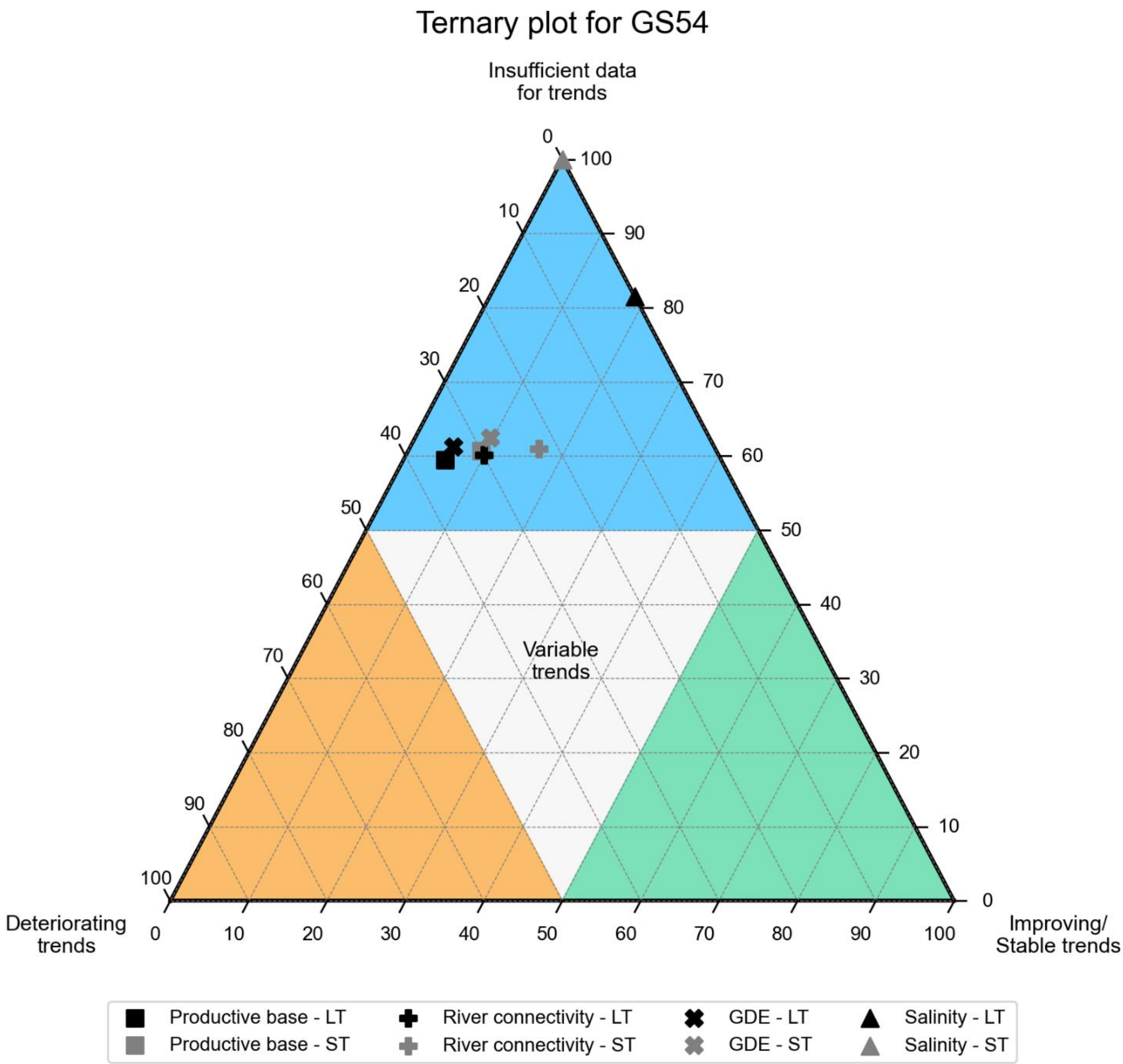


Figure 11 Stage 4 assessment outcome: trends in resource condition indicators for ESLT values

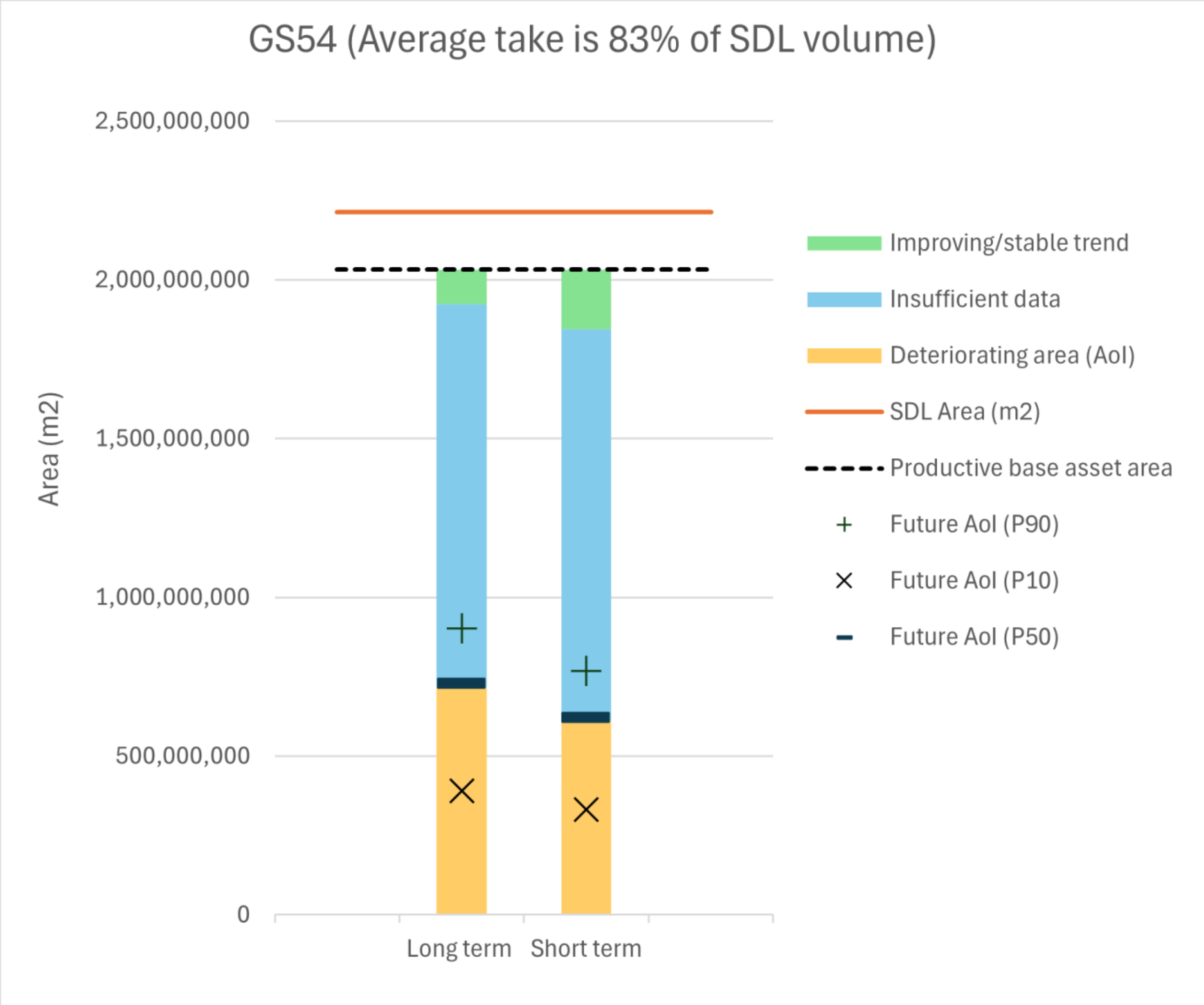


Figure 12 Estimates for change in area of influence (AoI) due to climate change

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