Australasian Groundwater & Environmental Consultants

Report on

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Lower Gwydir Alluvium
Stage 5

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GS24 – Lower Gwydir Alluvium

Stage 5 – Assessment through multiple lines of evidence

The Lower Gwydir Alluvium (GS24) is located within the Gwydir catchment in northern New South Wales, comprising extensive unconfined to semi-confined alluvial units of the Narrabri and Gunnedah Formations, hydraulically connected to the Gwydir River and its distributary channels (Figure 1). Groundwater entitlements are concentrated in the central area of GS24, between the townships of Moree and Ashley, and in the eastern area, around Pallamallawa; with entitlements loosely aligning with the Gwydir and Mehi Rivers and Carole Creek. GS24 spans approximately 2,517 km², with a Sustainable Diversion Limit (SDL) of 33.00 GL/year and a long-term average recharge of 47.10 GL/year (Table 1). Between 2013 and 2023, the average annual extraction was 30.54 GL/year, representing 65% of the estimated recharge and 93% of the SDL (Figure 2). Groundwater use supports intensive irrigation, stock and domestic uses, particularly in river-adjacent areas where groundwater entitlements are most densely clustered (north of Moree). Five of the eleven assessed years (2012-2023) exceeded the SDL, typically during rainfall deficit periods, highlighting reliance on groundwater during dry conditions (Figure 2). Long-term climate observations show a persistent below-average rainfall signal for the 2012–2020 period, with a minor recovery around 2015 and a reverse signal post-2020 (Figure 3). GS24 shows a semi-arid to arid climate since at least the 1980s based on the precipitation-to-evaporation ratio (Figure 3).

Groundwater is generally shallow in the eastern part of the GS24, where long-term median depths to the water table are mostly within 10 m, while across much of the remainder of the unit, depths typically range from 15 m to 25 m (Figure 4a). Groundwater flows from east to west, consistent with regional topography and the hydraulic gradient away from the Gwydir River and its distributary system (Figure 4b). Long-term (1974–2024) and short-term (2012–2024) median water levels align closely within a multi-decadal fluctuation zone (Figure 5), suggesting broad vertical stability in water levels over the last decade, without widespread declines to historic lows, and in some parts of the central sections of GS24, consistent short-term recovery. Water quality is generally fresh to slightly brackish, with most monitoring indicating that EC values are generally below 2,000 µS/cm (Figure 6), though zones of elevated salinity (>3,000 µS/cm) have been reported in the fringes of GS24 (MDBA, 2020, Rojas et al., 2023). Hydrographs show spatial variability, with some bores indicating gradual long-term declines and others displaying relatively stable behaviour (Figure 7). Short-term trends reveal partial stabilisation or modest recovery since 2020 in select locations (Figure 9; Figure 10). Salinity time series are sparse and irregular, but do not indicate evident deterioration (Figure 8).

Recharge for GS24 is estimated at 47.10 GL/year based on MDBA (2020), incorporating diffuse, floodplain, and in-stream recharge from a regional groundwater model. More recently, the MD-SY2 project (Crosbie et al., 2025) revised the recharge estimate to 38.53 GL/year, but only accounting for the diffuse recharge mechanism. The 47.10 GL/year recharge estimate is adopted in this assessment as it includes all expected recharge mechanisms. Table 1 shows that the storage-to-recharge (S/R) exceeds the "low responsiveness" threshold[1] from Rojas et al. (2022), suggesting strong buffering capacity and limited short-term climate sensitivity. However, the high extraction-to-recharge (E/R) and SDL-to-recharge (SDL/R) ratios (Table 1) imply long-term pressure on the productive base due to overallocation.

[1] S/R ratio: High responsiveness: 29 to 111.
Medium responsiveness: 11 to 333.
Low responsiveness: >333.

The productive base supports moderate to high groundwater use, particularly in eastern and central areas of GS24, where extraction infrastructure and entitlement density are concentrated (Figure 1; Figure 2). In this area, signs of stress have been observed, with a declining trend since the mid-1980s. Statistically significant (α=0.05) long-term declining trends (1974–2024) are concentrated in the central and western areas of GS24, with some bores exhibiting cumulative drawdowns exceeding 10 m (Figure 7; Figure 9). Most trends, however, are relatively slow rates of change (-0.1 to +0.1 m/year).

A single bore in the east, proximal to the Gwydir River, exhibits a statistically significant increasing trend; however, this is spatially isolated. Short-term (2012–2024) trends still show predominantly declining or flat behaviour, with little evidence of recovery and no clear areas of sustained increase. Bores with no statistically significant trends are substantially higher than those observed during the long-term period (Figure 10). This period coincides with variable rainfall and a decline in take after 2020 (Figure 2; Figure 3), but legacy drawdown appears to dominate the aquifer response. The stability of the water level, or further declines in the west, where no significant groundwater take is occurring, suggests a potential disconnection from surface recharge processes. Crosbie et al. (2023) identify the Gwydir River, Mehi River, and Carole Creek as 'always losing' throughout 2000–2019, with only minor reaches in the southern part of the SDL unit classified as 'mostly losing'. Mapped GDEs occur throughout the system and may be vulnerable when water tables drop below ecologically relevant thresholds (Figure 1).

Stage 4 of this BPR technical groundwater review, based on a quantitative assessment of resource condition indicators (RCIs) within a 5 km buffer around extraction points (asset area), shows that 41% of the productive base, 42% of river connectivity, and 43% of GDE asset areas experienced long-term water level declines (Table 2). In the short-term, these values have marginally improved to 36%, 40%, and 38%, respectively, indicating limited recovery (Figure 11). Between 20% and 24% of the asset areas have shown some improving/stable trends in the short term, with uncertainty levels remaining similar or marginally increasing around 40% of the total asset area (Table 2). The exception corresponds to the water quality (salinity) ESLT, where recent data gaps have increased in the short-term asset area, resulting in GS24 being entirely classified as having 'insufficient data' (Figure 11). Overall, there is no clear trend in the resource condition indicators to firmly conclude whether conditions are improving or remaining stable. Uncertainty in data remains high, and trends fall in the variable trends quadrant of Figure 11. This overall result is consistent with the findings of Rojas et al. (2023), who identified no clear evidence of specific resilience, stress, or sustainability issues for GS24.

The NSW state-based risk assessment (NSW DoI, 2018) assigns variable risk ratings across ESLT values. For the productive base, risk factors are rated medium to aquifer structural integrity and high to potential local drawdowns affecting groundwater access. The risks of increased irrigation efficiency/improved water delivery triggering a reduction in recharge are rated as low. River connectivity risks (groundwater extraction impacting instream ecological values) are rated as medium for the Lower Gwydir Northern Subarea Zone and Southern Subarea Zone, and high for the Lower Gwydir Central Subarea Zone. Risks of groundwater extraction on GDEs show the same risk profile as river connectivity, with low risk of climate change reducing recharge/groundwater availability impacting GDEs. Water quality risks, defined as groundwater extraction that induces connections to poor-quality groundwater, are rated as medium. Overall, data availability is extensive for water levels in the central and eastern parts of GS24, but limited for salinity, contributing to residual uncertainty in the risk profile.

Future projections from the MD-SY2 project suggest that diffuse recharge in GS24 may increase by 2050 due to more intense rainfall events (Crosbie et al., 2025). Conversely, floodplain recharge during high-flow or overbank events is projected to decline by 13–20% (Crosbie et al., 2025), potentially reducing (localised) episodic recharge during dry periods. These opposing trends create uncertainty about net future recharge in GS24. Under climate change, the groundwater drawdown area (Area of Influence, AoI[2]) is projected to expand, with the median future AoI (P50) larger than the present (Figure 12). An increase in the projected SDL/R ratio also supports the conclusion of Stage 6 of this assessment, which classifies climate change pressure on GS24 as high. This finding, which differs from the state risk assessment, is based on the MD-SY2 modelling, long- and short-term water level evidence, as well as the SDL/R and E/SDL ratios.

[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 condition, statistically significant declining trend in groundwater levels.

Overall, short-term groundwater trends (2012–2024) in GS24 indicate limited recovery across ESLT values, with stabilisation in some areas and ongoing legacy declines around Moree. Uncertainty levels remain high and largely unchanged from the long-term (1974–2024) assessment, especially for water quality (salinity). Notably, 100% of the short-term asset area for the salinity ESLT is classified as 'insufficient data' (Figure 11). Extraction has declined since 2020 and remains below both the SDL and the long-term recharge estimate. The SDL is set at 33.00 GL/year, equivalent to about 70% of the estimated recharge, suggesting conservative management settings that may help buffer the system from overextraction risks. However, legacy drawdown persists, and the full impacts of prolonged SDL utilisation under dry climate conditions remain uncertain. The state-based risk assessment flags high risk of local drawdowns, medium risk to aquifer structural integrity and water quality, and elevated risks to river connectivity and GDEs in central GS24. Future climate projections indicate a likely reduction in episodic recharge via floodplain processes and a possible increase in diffuse recharge (Crosbie et al., 2025), leading to uncertainty about net change in recharge. The projected expansion of the drawdown area under climate change and an increased SDL/R ratio (Figure 12) indicate high climate pressure. Taken together, GS24 presents a system with high-to-moderate pressure on the productive base, with strong buffering capacity, but with persistent uncertainty and legacy declines affecting long-term sustainability.

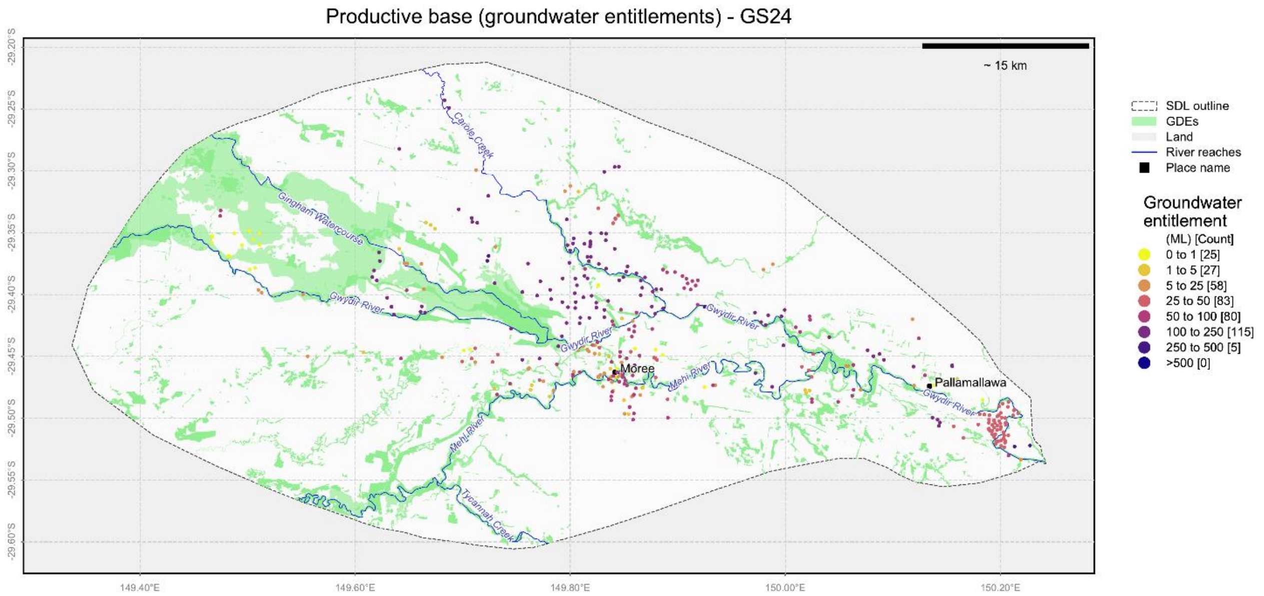


Figure 1 Productive base (groundwater entitlements)

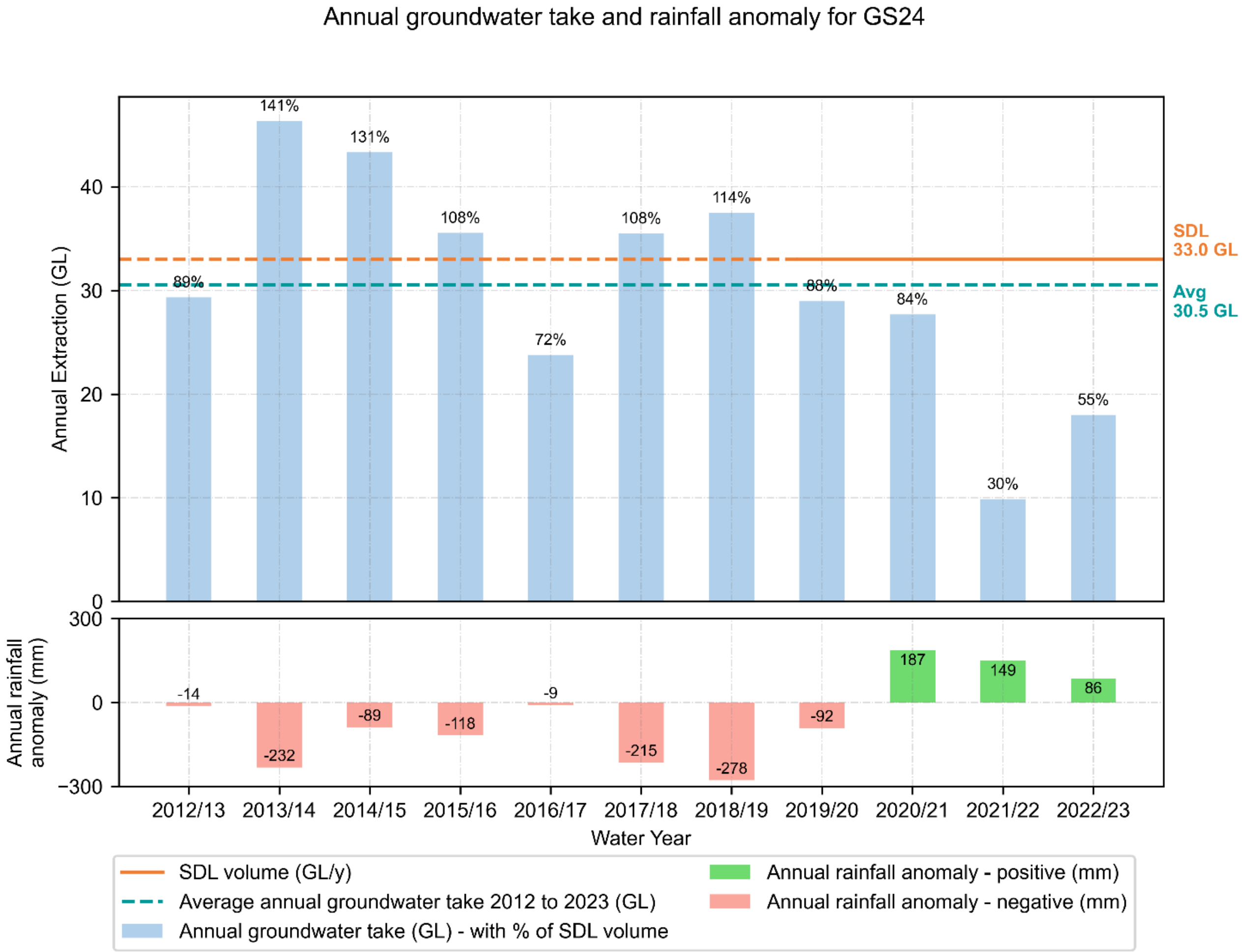


Figure 2 Groundwater take in the SDL since 2012

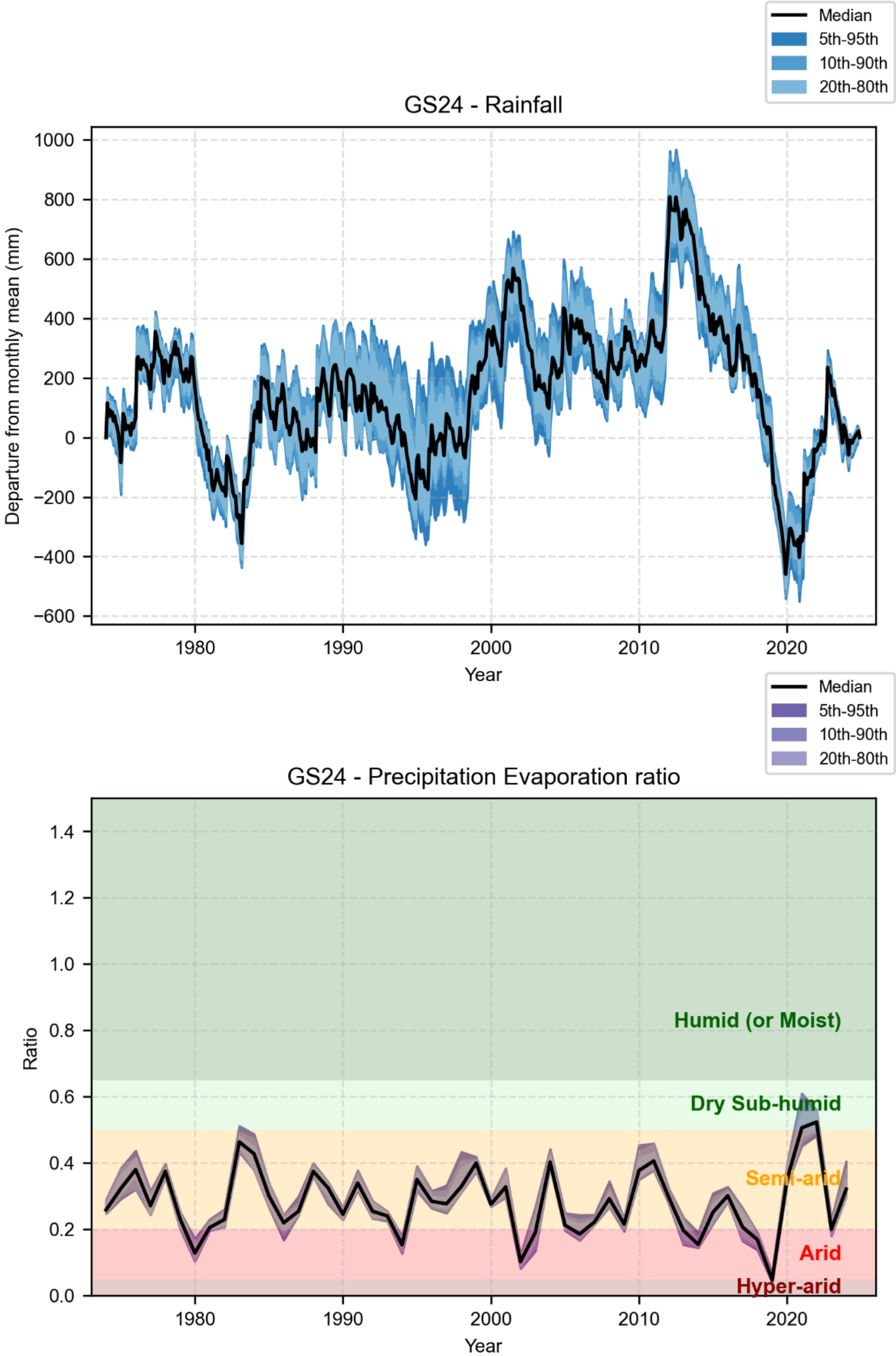


Figure 3 Historical climate trends

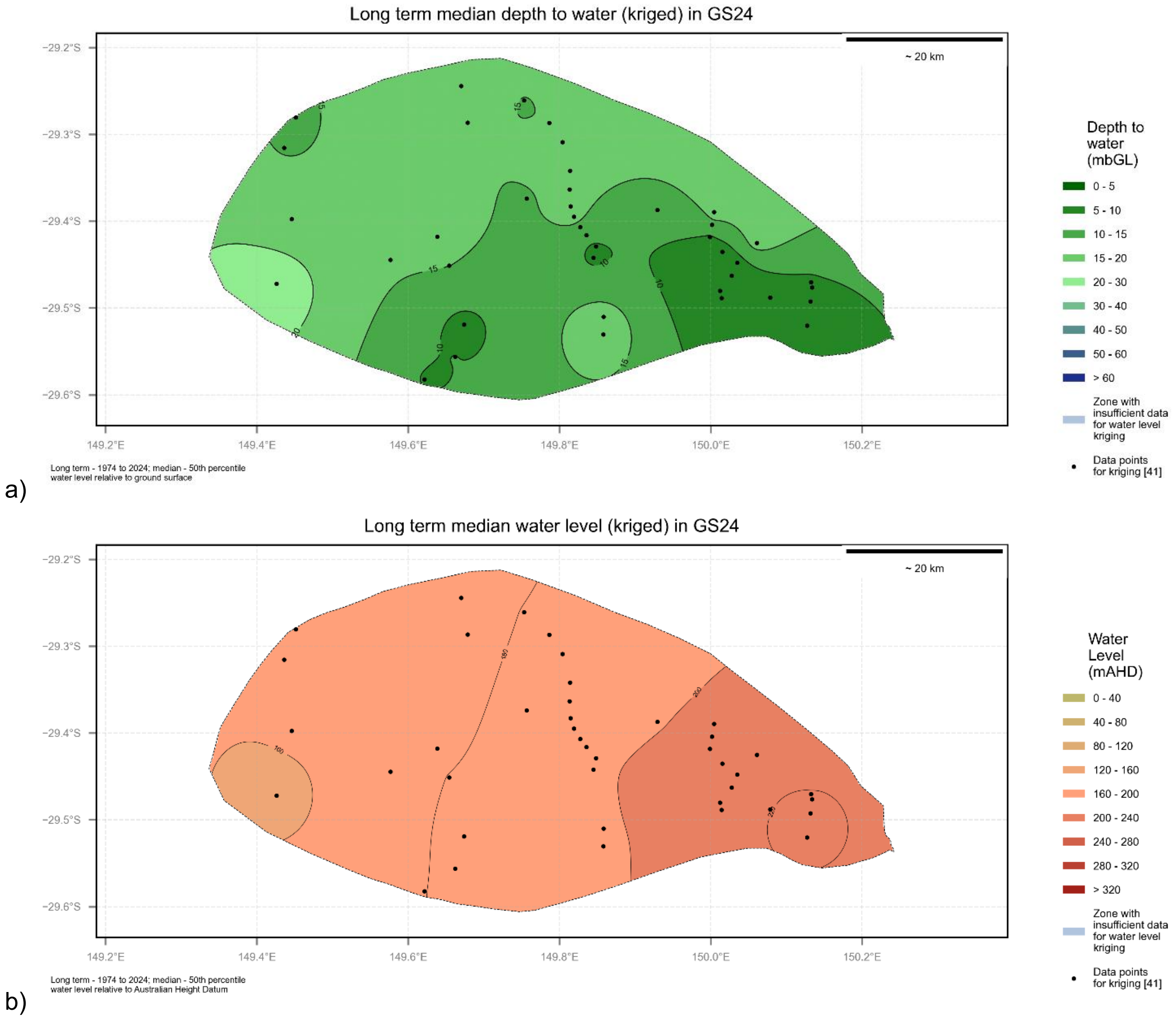
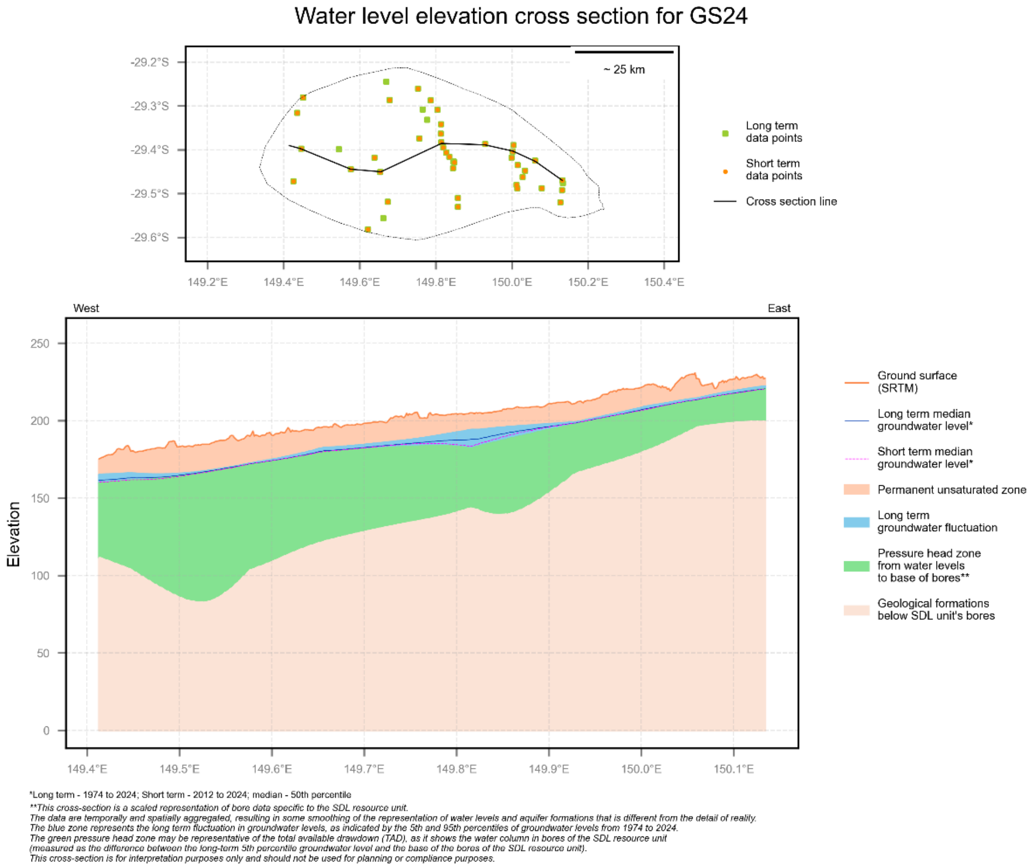


Figure 4 Long-term median (a) depth to water and (b) water level elevation



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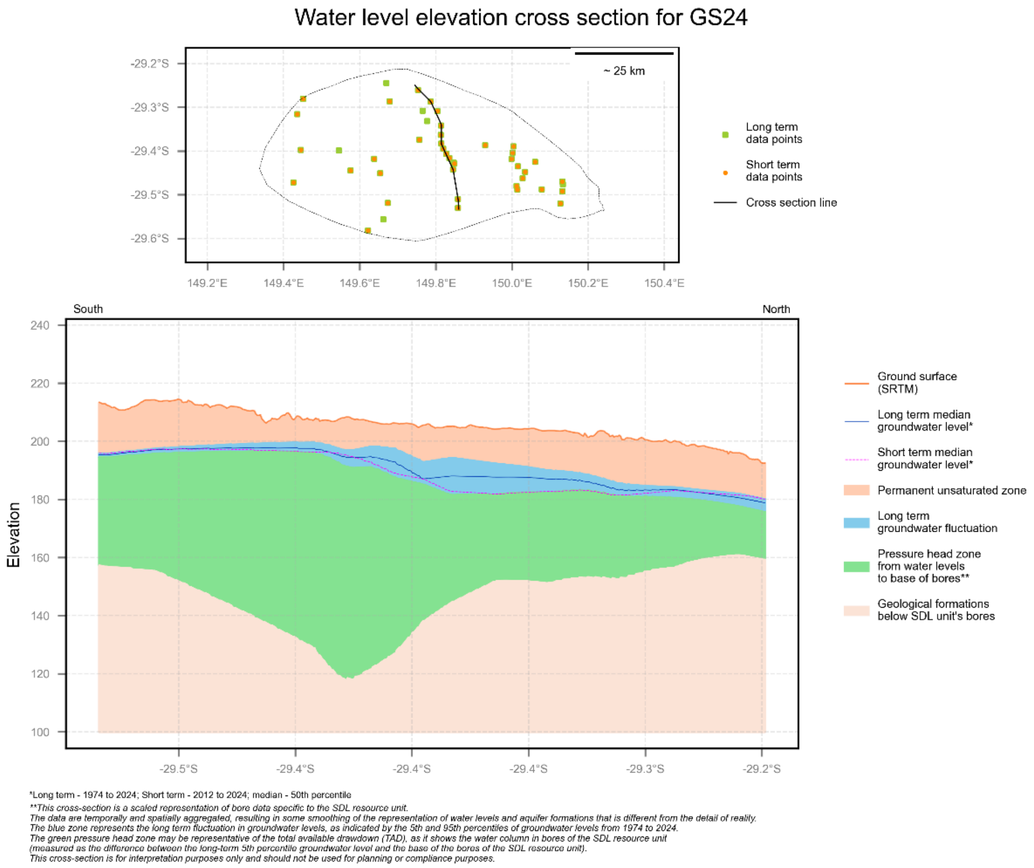


b)

Figure 5 (a) West to east and (b) south to north distribution of water levels in the SDL resource unit

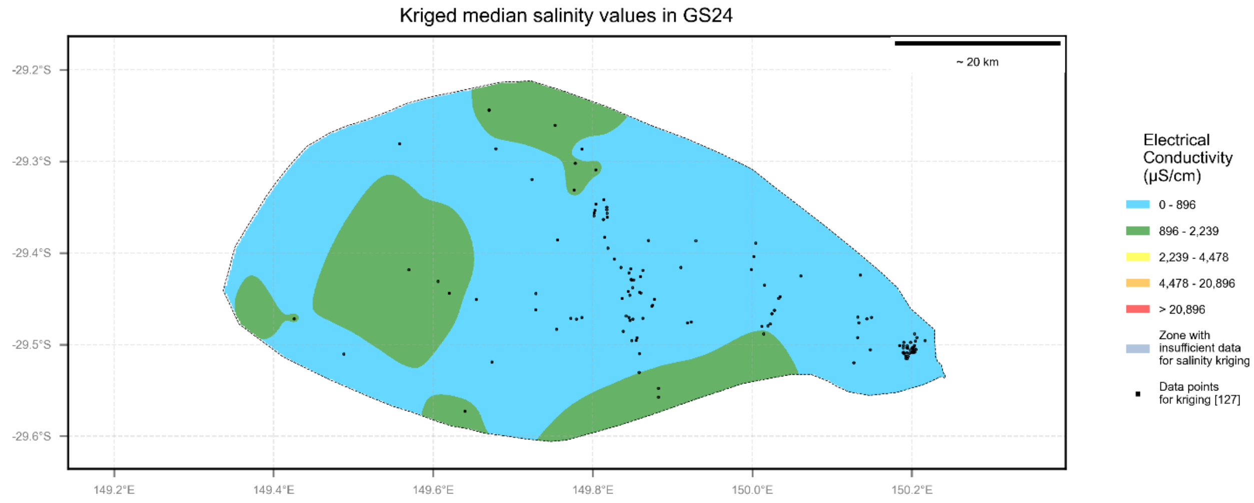


Figure 6 Groundwater salinity distribution

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	-	-	33.00
SDL resource unit area	km²	-	-	2,517
Average annual take (2013 to 2023)	GL/y	-	-	30.54
Number of groundwater entitlement bores	-	-	-	393
SDL resource unit storage estimate*	GL	-	-	23,312
Recharge estimate (SY1)	GL/y	-	-	47.10
Recharge estimate (Stage 2)	GL/y	-	-	47.10
Diffuse recharge estimate (SY2 - WAVES)	GL/y	-	-	38.53
Extraction/SDL (E/SDL) (Stage 2 result)	-	-	-	0.93
SDL/Recharge (SDL/R) (Stage 2 result)	-	-	-	0.70
SDL/Recharge (SDL/R) (SY2 or modelled recharge)	-	-	-	0.70
Storage/Stage 2 Recharge (S/R)	-	-	-	495
Storage/SY2 or modelled Recharge (S/R)	-	-	-	495
Number of bores in the SDL unit	-	2,100	2,100	-
Number of bores for water level trend analysis	-	47	40	-
Number of bores for water level trend with sufficient data	-	42	37	-
Number of bores with decreasing water level trend	-	27	22	-
Number of bores with increasing water level trend	-	8	0	-
Number of bores with no statistically significant water level trend	-	7	15	-
Mean water level trend magnitude	m/y	0.53	-9.74	-
Minimum water level trend magnitude	m/y	-0.29	-356.4	-
5%ile water level trend magnitude	m/y	-0.24	-0.44	-
10%ile water level trend magnitude	m/y	-0.22	-0.29	-
50%ile water level trend magnitude	m/y	-0.03	-0.09	-
90%ile water level trend magnitude	m/y	0.03	0.01	-
95%ile water level trend magnitude	m/y	0.06	0.03	-
Maximum water level trend magnitude	m/y	24.94	0.05	-
Number of bores for salinity trend analysis	-	133	N/A	-
Number of bores for salinity trend with sufficient data	-	26	N/A	-
Number of bores with decreasing salinity trend	-	0	N/A	-
Number of bores with increasing salinity trend	-	1	N/A	-
Number of bores with no statistically significant salinity trend	-	25	N/A	-
Mean salinity trend magnitude	µS/cm/y	8	N/A	-
Minimum salinity trend magnitude	µS/cm/y	-22	N/A	-
5%ile salinity trend magnitude	µS/cm/y	-3	N/A	-
10%ile salinity trend magnitude	µS/cm/y	-3	N/A	-
50%ile salinity trend magnitude	µS/cm/y	3	N/A	-
90%ile salinity trend magnitude	µS/cm/y	20	N/A	-
95%ile salinity trend magnitude	µS/cm/y	48	N/A	-
Maximum salinity trend magnitude	µS/cm/y	87	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	1,809,303,488	22%	41%	37%	Variable trends	24%	36%	40%	Variable trends
GDEs	1,606,759,839	16%	43%	42%	Variable trends	20%	38%	42%	Variable trends
River connectivity	1,732,352,378	20%	42%	38%	Variable trends	20%	40%	41%	Variable trends
Water quality	1,707,016,522	38%	3%	59%	Insufficient data	0%	0%	100%	Insufficient data

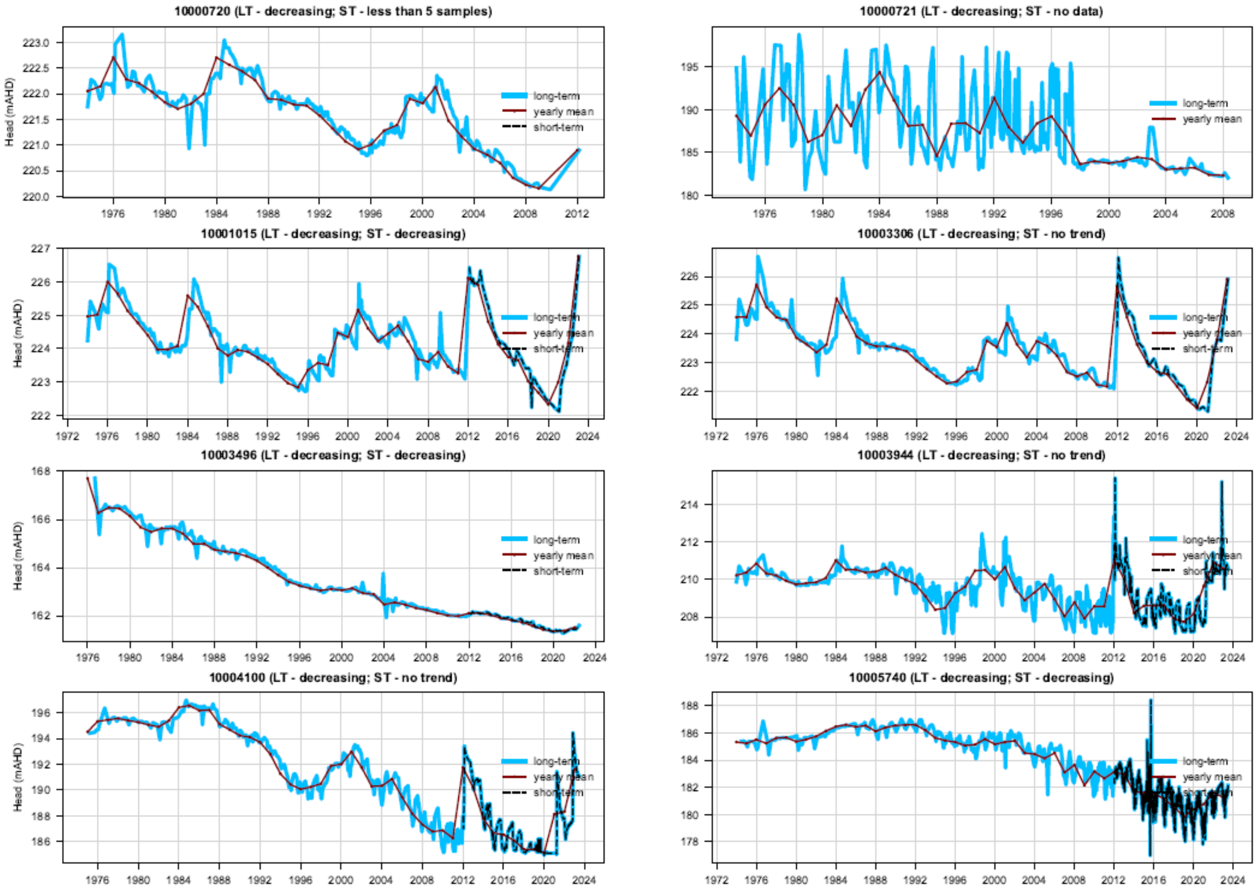


Figure 7 Representative groundwater hydrographs for the SDL resource unit

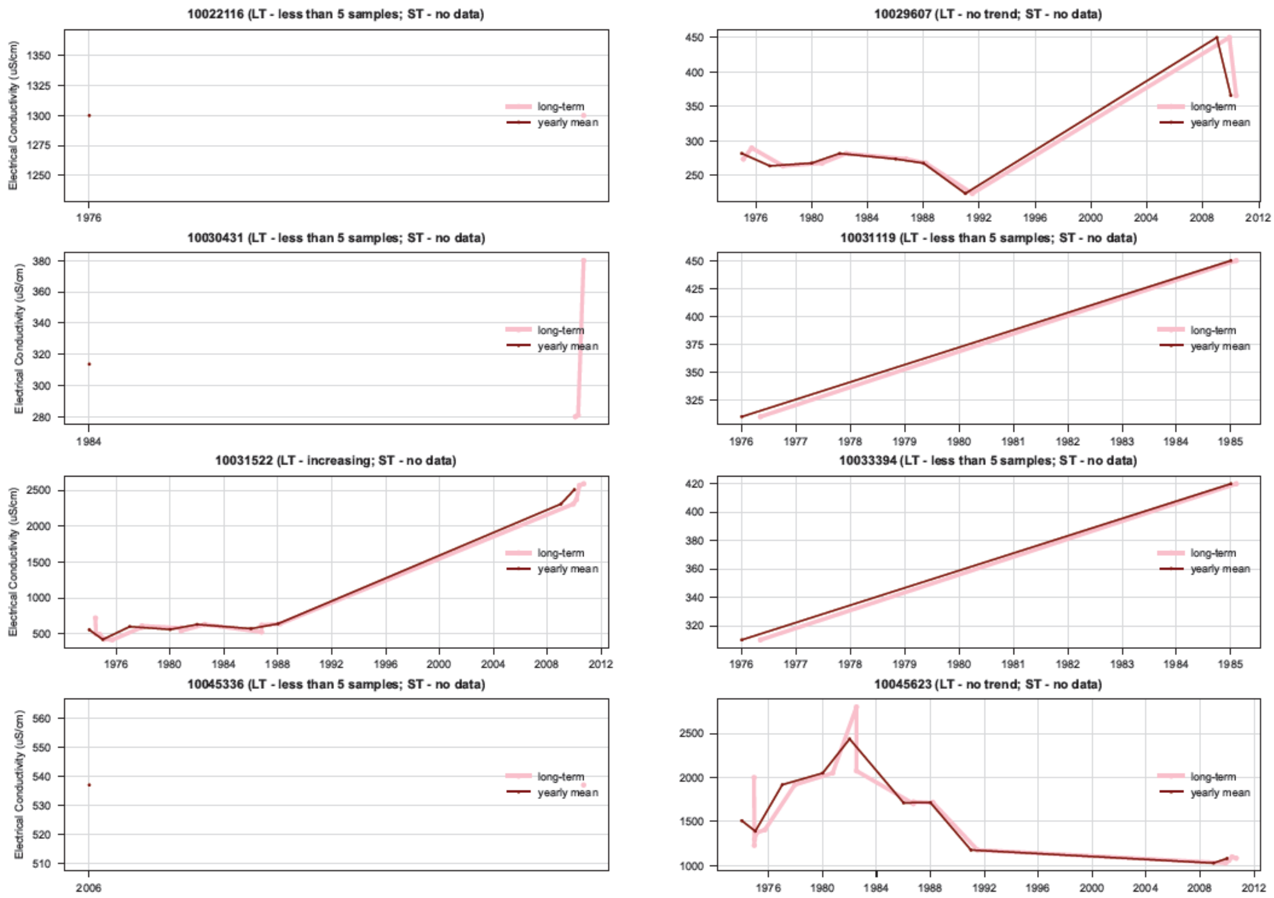
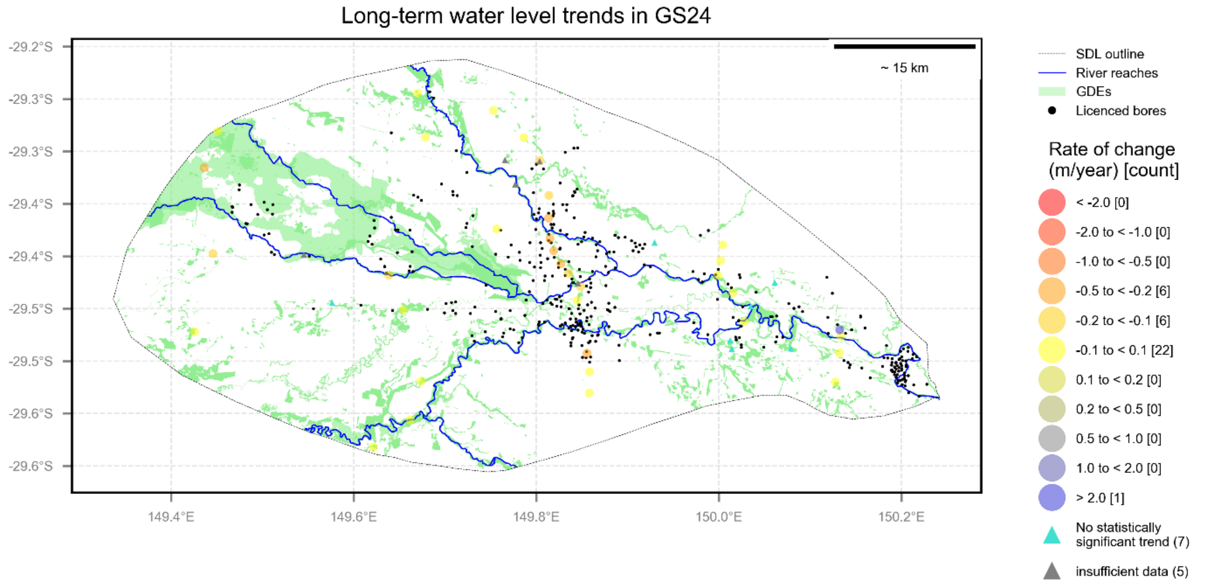


Figure 8 Representative groundwater salinity time series for the SDL resource unit



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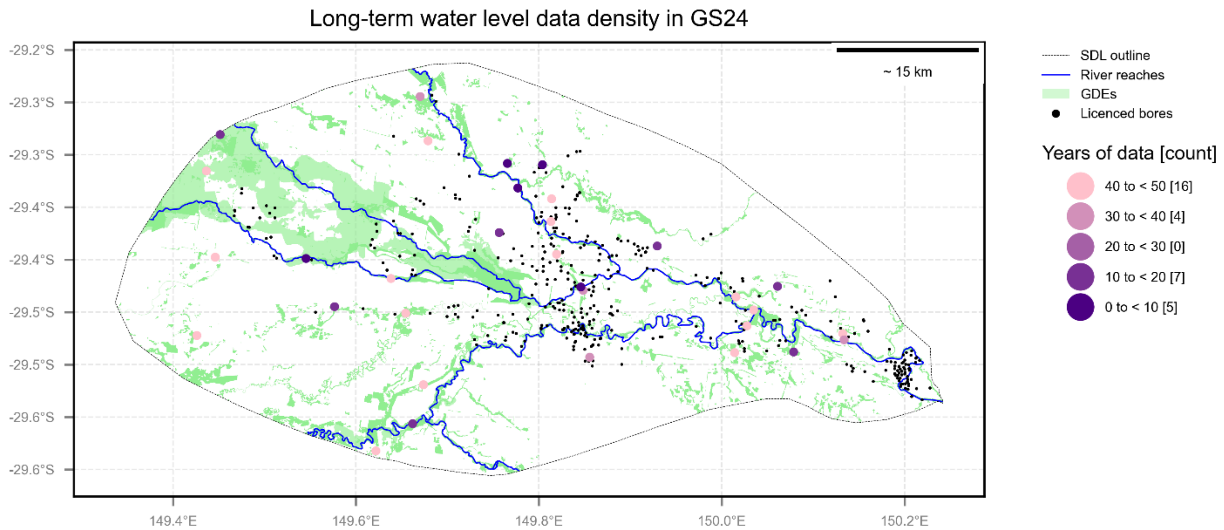

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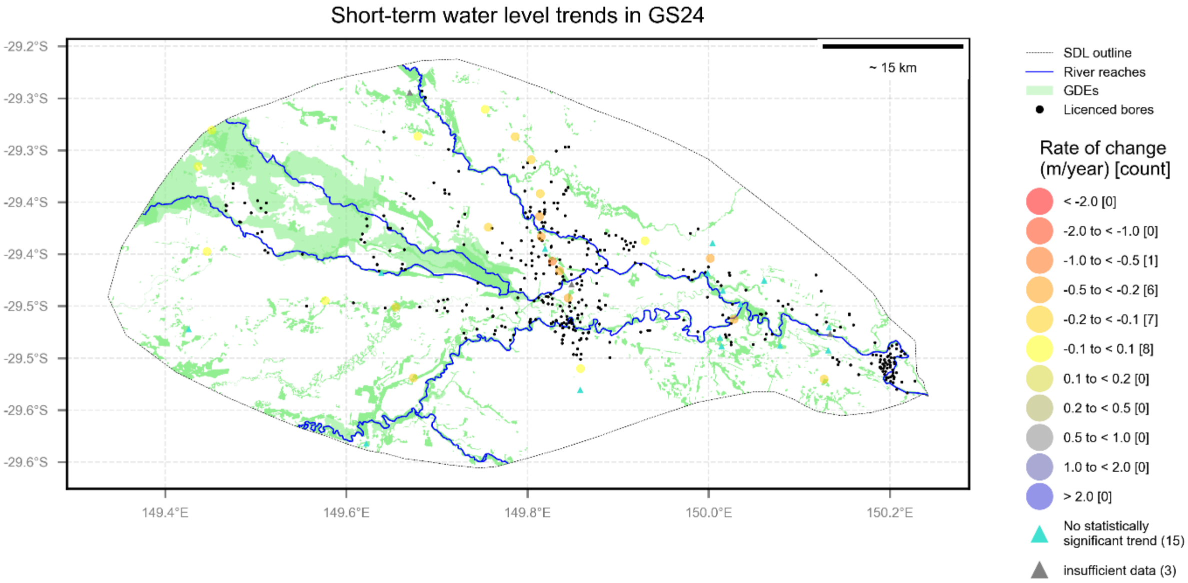
Figure 9 Long-term (1974 to 2024) (a) groundwater level trends and (b) data availability



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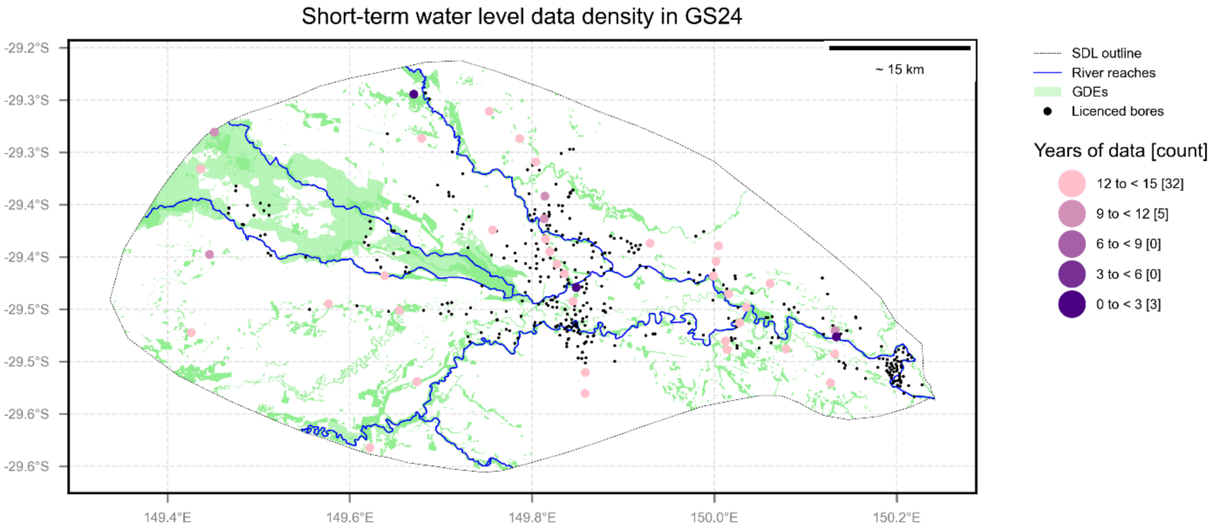

b)

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

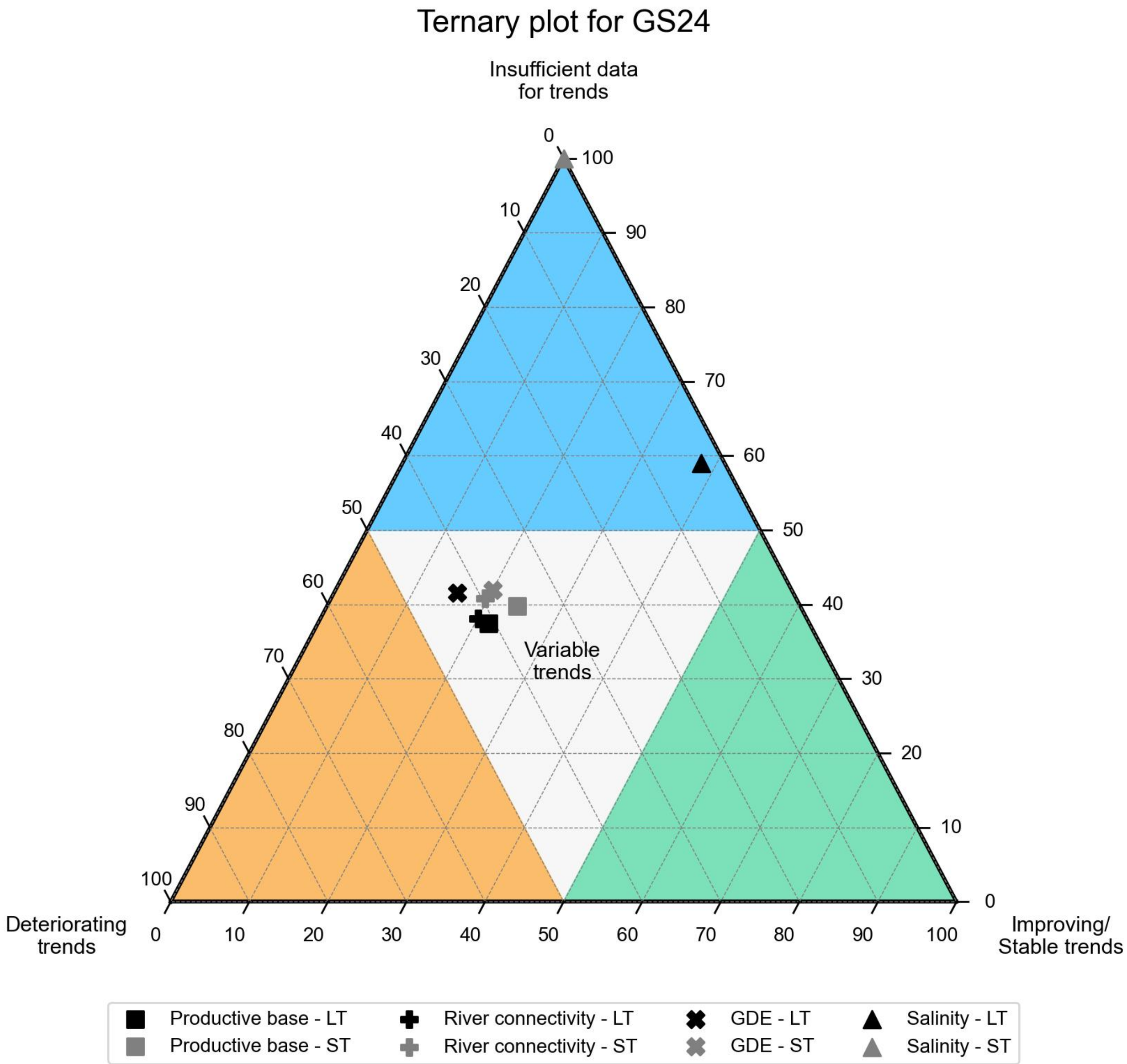

Figure 11 Stage 4 assessment outcome: trends in resource condition indicators for ESLT values

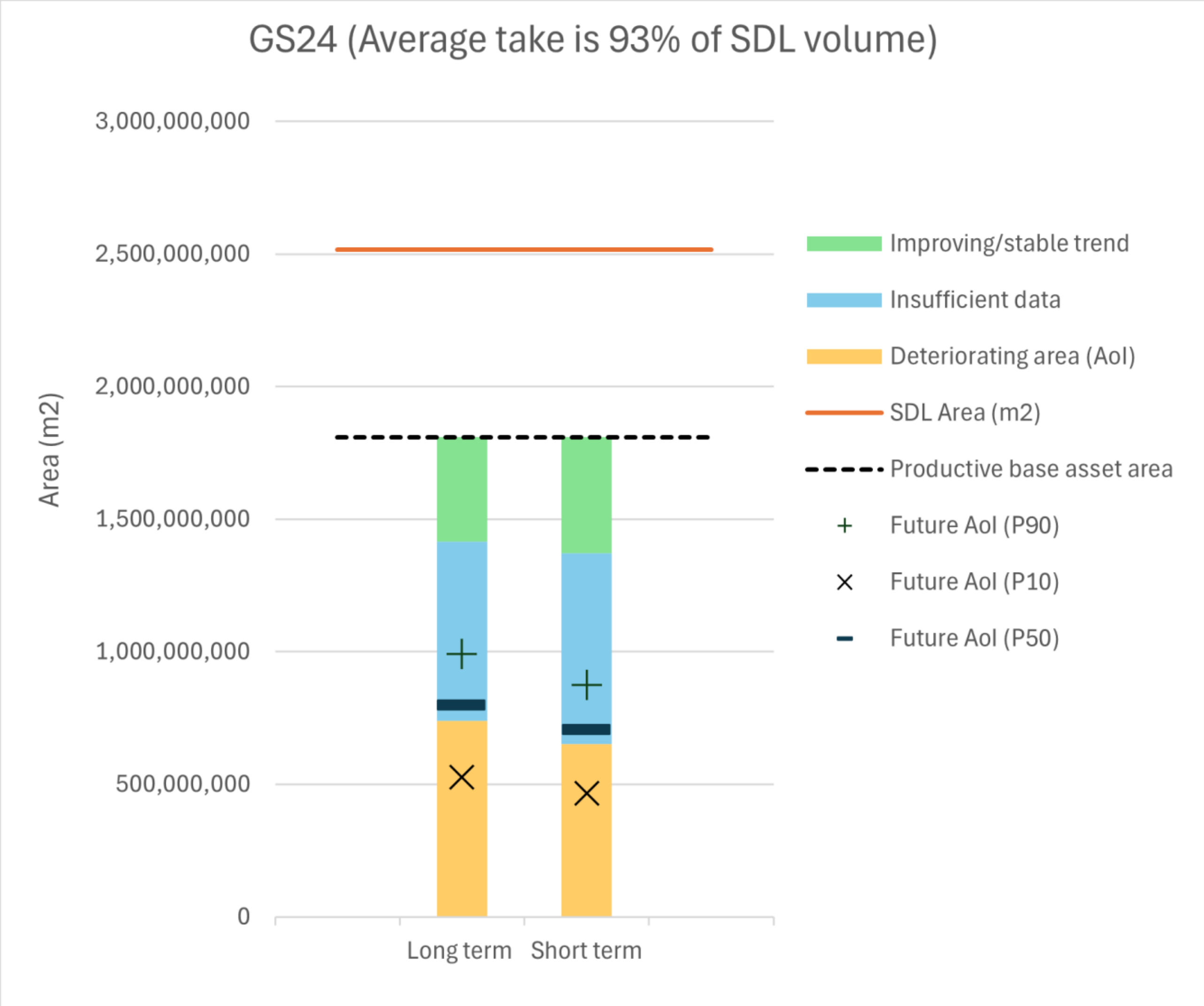

Figure 12 Estimates for change in area of influence (AoI) due to climate change

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