Australasian Groundwater & Environmental Consultants

Report on

GS47
Upper Namoi Alluvium
Stage 5

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GS47 – Upper Namoi Alluvium

Stage 5 – Assessment through multiple lines of evidence

The Upper Namoi Alluvium (GS47) is located within the Namoi catchment in northwestern New South Wales and consists of an unconfined to semi-confined alluvial aquifer system hydraulically connected to the Namoi River (Figure 1; Crosbie et al., 2023). Groundwater entitlements are evenly distributed across GS47 and tend to align with main river reaches and contributing creeks (Figure 1). GS47 spans approximately 3,781 km², with a Sustainable Diversion Limit (SDL) of 123.40 GL/year and a long-term average recharge estimate of 91.00 GL/year (Table 1). Between 2013 and 2023, average annual groundwater extraction was 82.71 GL/year, representing 91% of estimated recharge and 67% of the SDL (Figure 2). Groundwater use supports intensive irrigation and stock and domestic supplies along the main alluvial corridor near Gunnedah and Narrabri, and supplements surface water supply during years of below-average rainfall (Figure 1, Figure 2). 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 generally within 15 m of the ground surface, though some areas exceed 20 m, particularly in jurisdiction management Zones 2, 3, 4, 8, and 12 (Figure 4a). Groundwater flows from southeast to northwest along the main alluvial valley (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 ranges from one or two metres thick, to more than 10 m (Figure 5). In several areas of GS47, the bottom of the groundwater fluctuation zone is aligned with recent (short-term) water levels, indicating that current levels are close to the deepest observed since 1974. Water quality is generally fresh, with salinity below 1,500 mg/L (equivalent to 2239 µS/cm) (Figure 6), with a few isolated brackish to saline pockets towards the fringes of GS47 (MDBA, 2020). Water level trends vary spatially but show widespread declines over the long-term (since the 1970s and 1980s), with multi-decadal variability (Figure 7; Figure 9;Figure 10) linked to extraction intensity, climate, and local hydrogeological conditions. Short-term declining trends are less pronounced, with a marked recovery post-2020 observed in many bores. The understanding of temporal salinity trends is limited due to poor data availability (Figure 8).

MDBA (2020) previously reported recharge at 91.00 GL/year for GS47, an estimate that incorporates diffuse, floodplain and in-stream recharge derived from a calibrated groundwater model. This figure remains representative following a review for the MD-SY2 project (Crosbie et al., 2025). Table 1 shows a storage-to-recharge ratio (S/R) of 352 using this 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-recharge (E/R) and SDL-to-recharge (SDL/R) ratios (Table 1) suggest high pressure on the productive base, particularly in low-transmissivity zones or areas showing delayed recovery from drawdown.

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

The productive base shows significant signs of stress, with long-term water level declines affecting large areas of GS47 (Table 1; Figure 9; Figure 10). Statistically significant ($\alpha=0.05$) declines have occurred since 1974 along the alluvial corridor upstream of Gunnedah and towards Quirindi Creek (Zones 3 and 8), in the lower section of Cox Creek (Zone 2), and downstream of Boggabri (Zone 3). In contrast, short-term trends (Figure 10) show a widespread lack of statistically significant trends, with patchy areas of decline in the upper Mooki River around Quirindi Creek (mainly Zone 8, with a small part of Zone 3), upstream of Narrabri (Zone 5), and in the upper sections of Box Creek (Zone 9) and the Mooki River (Zone 10). Localised short-term increases are also evident in small clusters in Cox Creek (Zone 2) and Mooki River (Zone 3). 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) and pro-active management. Persisting groundwater declines likely affect surface water connectivity, with all reaches with flow data classified as 'mostly losing' during 2000-2019 by Crosbie et al. (2023). Groundwater-dependent ecosystems (GDEs), such as riparian and floodplain vegetation, may also be impacted if water levels drop below ecologically relevant thresholds.

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 58% of the productive base asset area, 63% of the river connectivity asset area, and 57% of the GDE asset area (Table 2). In the short-term, these percentages decreased to 23%, 19% and 21%, respectively (Table 2). Over 50% of each ESLT asset area showed improving water level conditions in the short-term (Table 2), suggesting partial recovery or stabilisation (Figure 11). Levels of uncertainty, as indicated by areas with insufficient data to inform temporal trends, have remained essentially unchanged between the long- and short-term periods (minimal vertical displacement of points in Figure 11). The exception is the water quality (salinity) ESLT value, where recent data gaps have increased, with the short-term asset area fully classified as having 'insufficient data' to determine temporal trends.

The NSW state-based risk assessment (NSW DoI, 2019) assigns variable risk ratings across ESLT values. For the productive base, most risk factors are rated low. However, medium to high risks to aquifer structural integrity and potential local drawdowns affecting groundwater access are flagged in four of eight management zones. River connectivity risks are generally low, but some zones, such as Zone 11, are rated medium to high. Risks to GDEs range from low to high depending on location, with most zones classified as medium risk, and Zones 3 and 4 flagged as high risk. These risks align with the spatial variability in recently observed water level trends (Figure 10) and suggest some areas are more vulnerable. Water quality risks are assessed as medium to high in most zones, except for Zones 10 and 11, which are rated low. Data availability is extensive for water levels but more limited for salinity and GDEs, contributing to residual uncertainty in the risk profile.

Future projections from the MD-SY2 project suggest that diffuse recharge in GS47 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 18% and 11% relative to current conditions, respectively (Crosbie et al., 2025), potentially reducing (localised) episodic recharge and groundwater availability during dry periods. These opposing trends introduce uncertainty regarding net future recharge in GS47. Stage 6 of this BPR technical groundwater review found that the future area of drawdown (Area of Influence, AoI[2]) is projected to expand under climate change scenarios, with the median future AoI (P50) exceeding the present AoI, indicating likely increases in deteriorating areas (Figure 12). The SDL/R ratio is also projected to increase, indicating that the rate of replenishment for the resource may change in the future. The Stage 6 assessment classified the pressure from future climate change on GS47 groundwater resources as very high (based on long-term water level evidence) to high (based on short-term water level evidence).

[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.

Overall, short-term groundwater trends (2012–2024) suggest improving or stable conditions across ESLT values in GS47, while uncertainty levels remain largely unchanged from the long-term assessment (1974–2024). Some areas, most notably Zone 8, continue to experience persistent declines in water levels, under a backdrop of a drying climate and reduced groundwater extraction. These trends are the current focus of local management rules. In contrast, uncertainty in salinity trends has substantially increased, with 100% of the short-term asset area now classified as insufficient data to inform temporal trends. Current extraction remains below the SDL and is closely aligned with the recharge estimate. However, the SDL exceeds the recharge estimate, and the impacts of full SDL utilisation have not yet been realised. The state-based risk assessment supports this concern, highlighting medium to high risks in several zones – especially for water quality and local drawdowns. Climate projections indicate reduced episodic (localised) recharge from floodplain processes in this alluvial unit. Collectively, the analysis suggests there is high pressure on the productive base of GS47, with high pressure from future climatic variability.

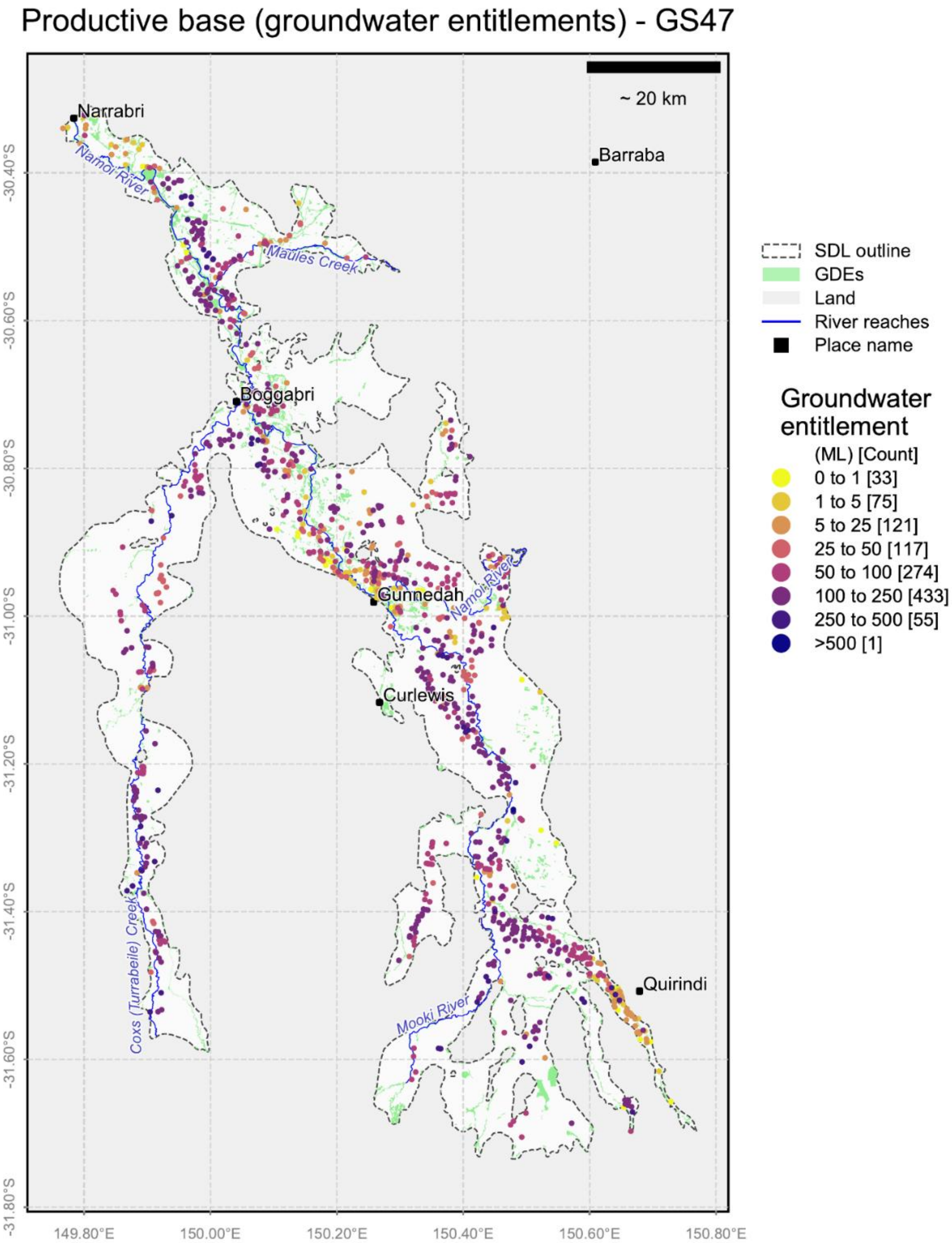


Figure 1 Productive base (groundwater entitlements)

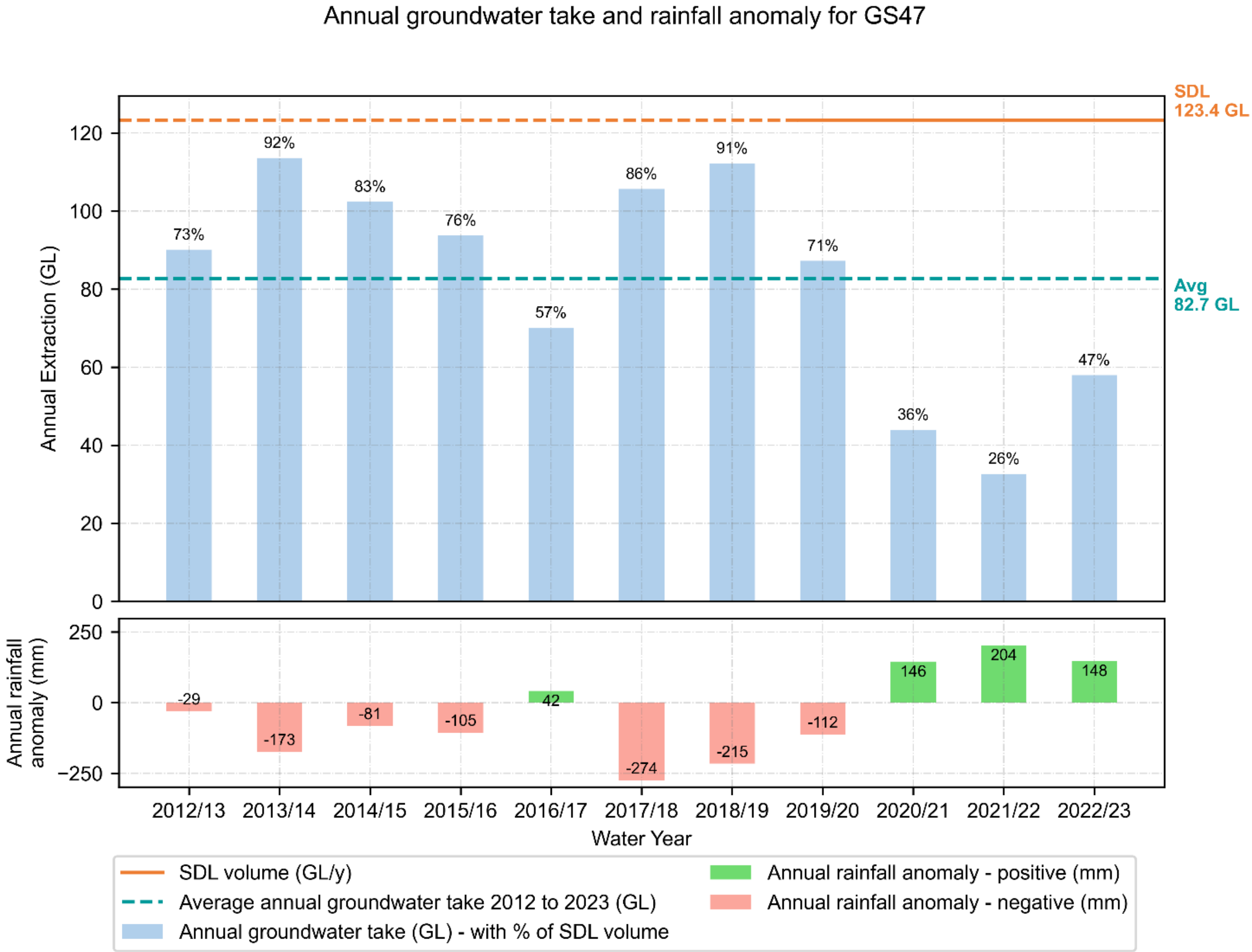


Figure 2 Groundwater take in the SDL since 2012

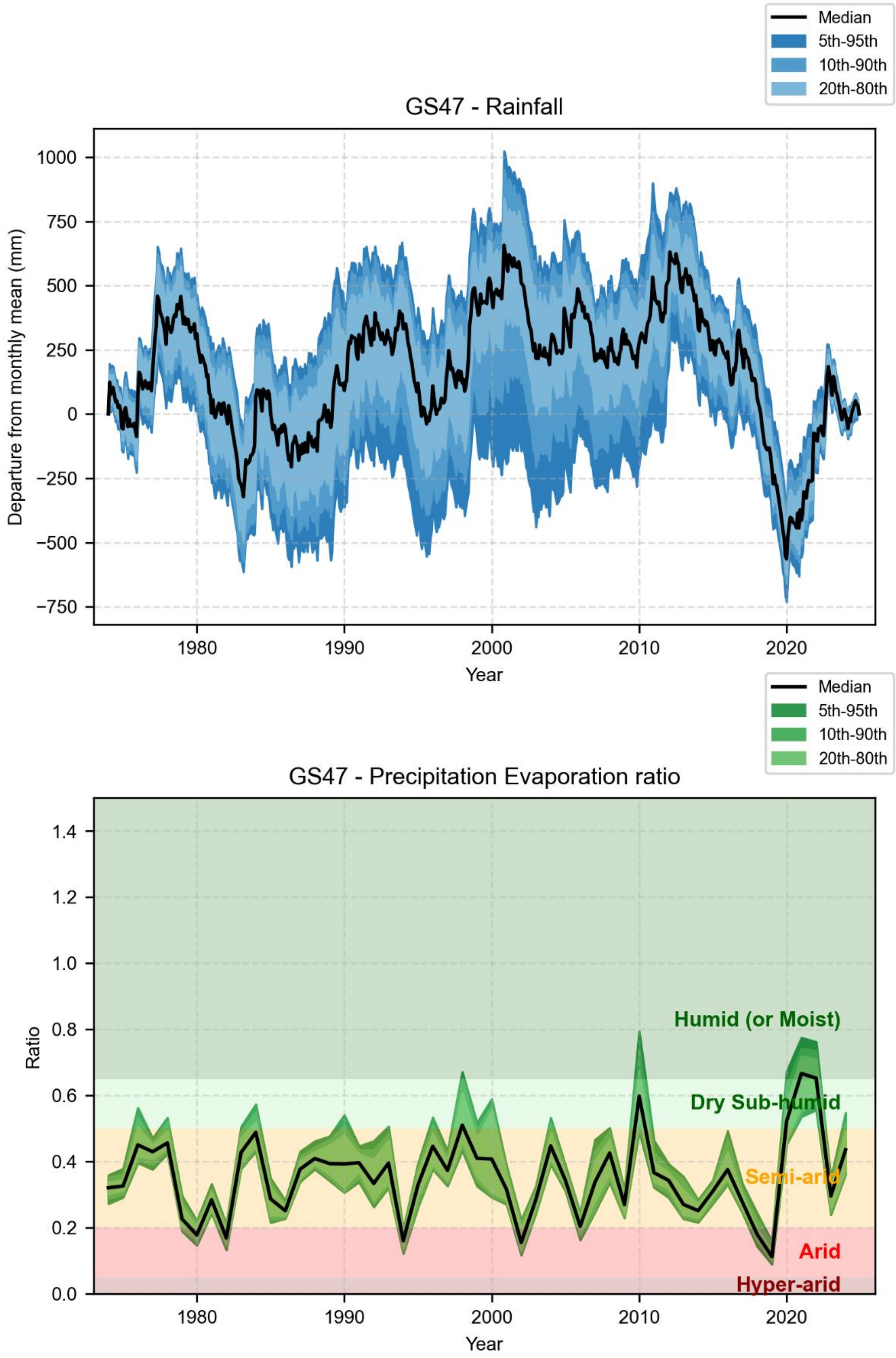
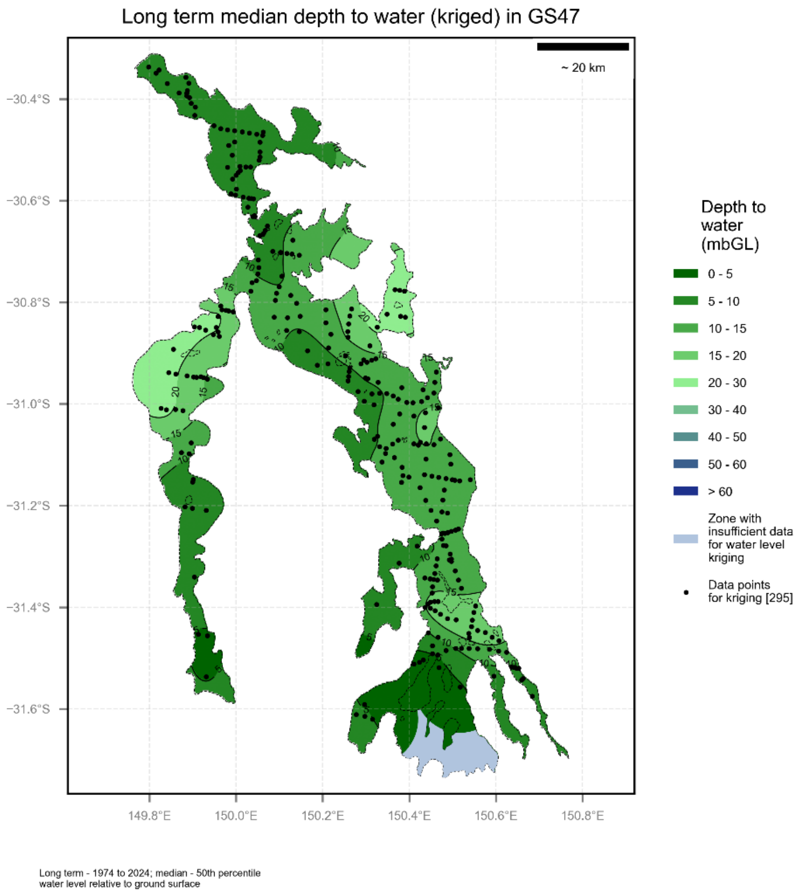
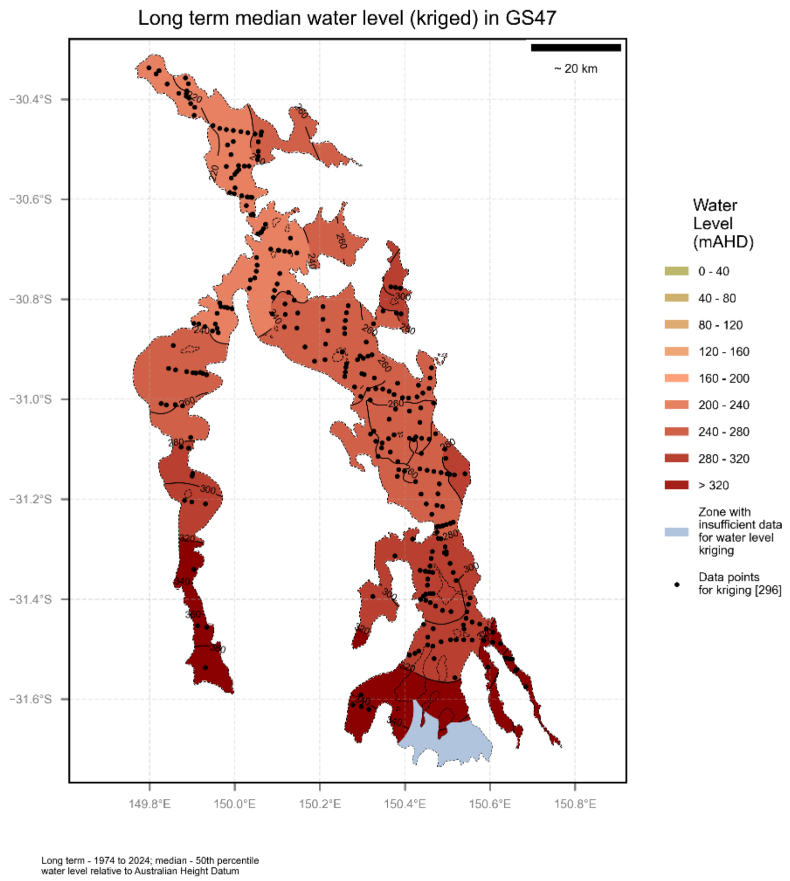


Figure 3 Historical climate trends

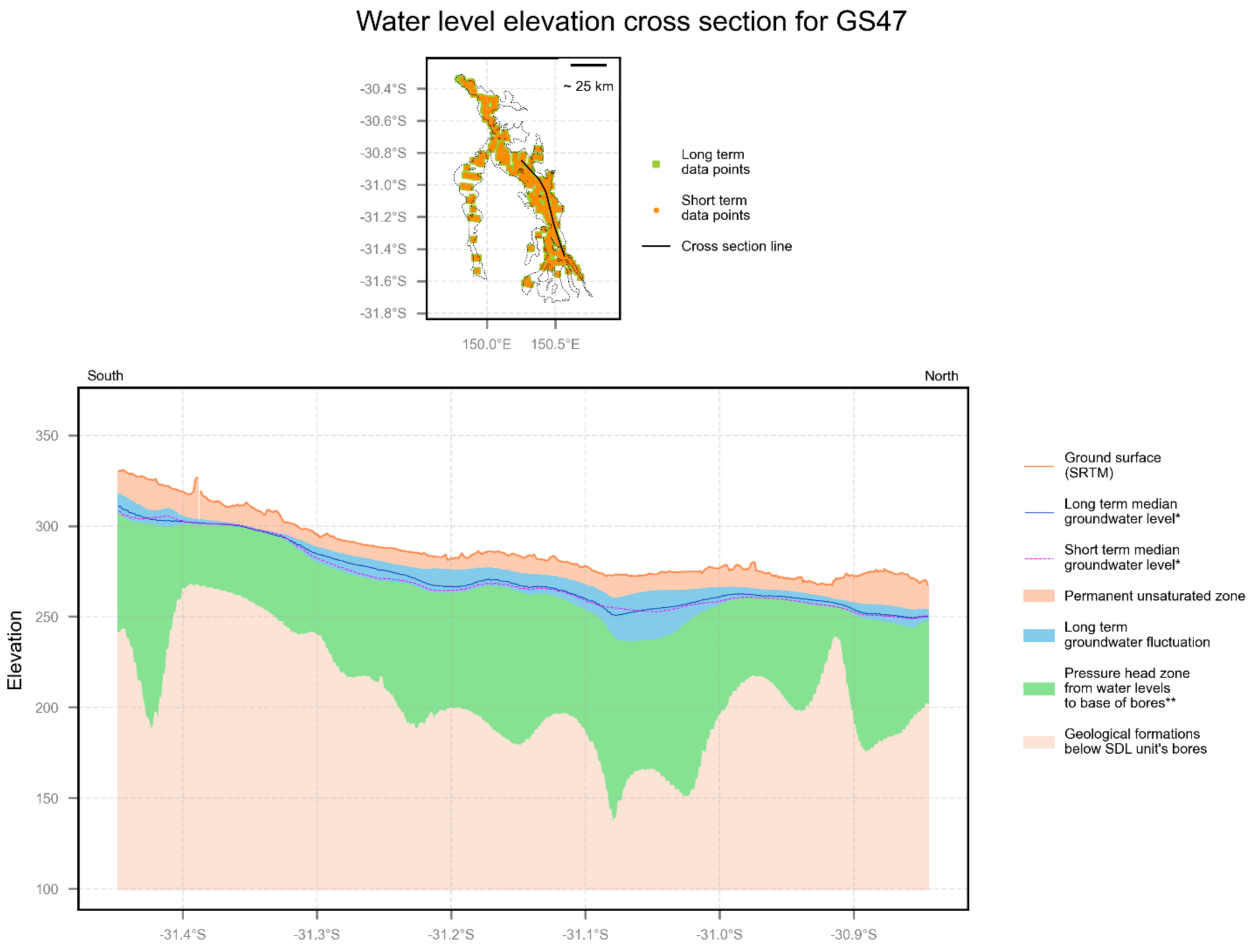


(a)



(b)

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



*Long term - 1974 to 2024; Short term - 2012 to 2024; median - 50th percentile

***This cross-section is a scaled representation of bore data specific to the SDL resource unit.*
The data are temporally and spatially aggregated, resulting in some smoothing of the representation of water levels and aquifer formations that is different from the detail of reality.
The blue zone represents the long term fluctuation in groundwater levels, as indicated by the 5th and 95th percentiles of groundwater levels from 1974 to 2024.
The green pressure head zone may be representative of the total available drawdown (TAD), as it shows the water column in bores of the SDL resource unit (measured as the difference between the long-term 5th percentile groundwater level and the base of the bores of the SDL resource unit).
This cross-section is for interpretation purposes only and should not be used for planning or compliance purposes.

Figure 5 South to north distribution of water levels in the SDL resource unit

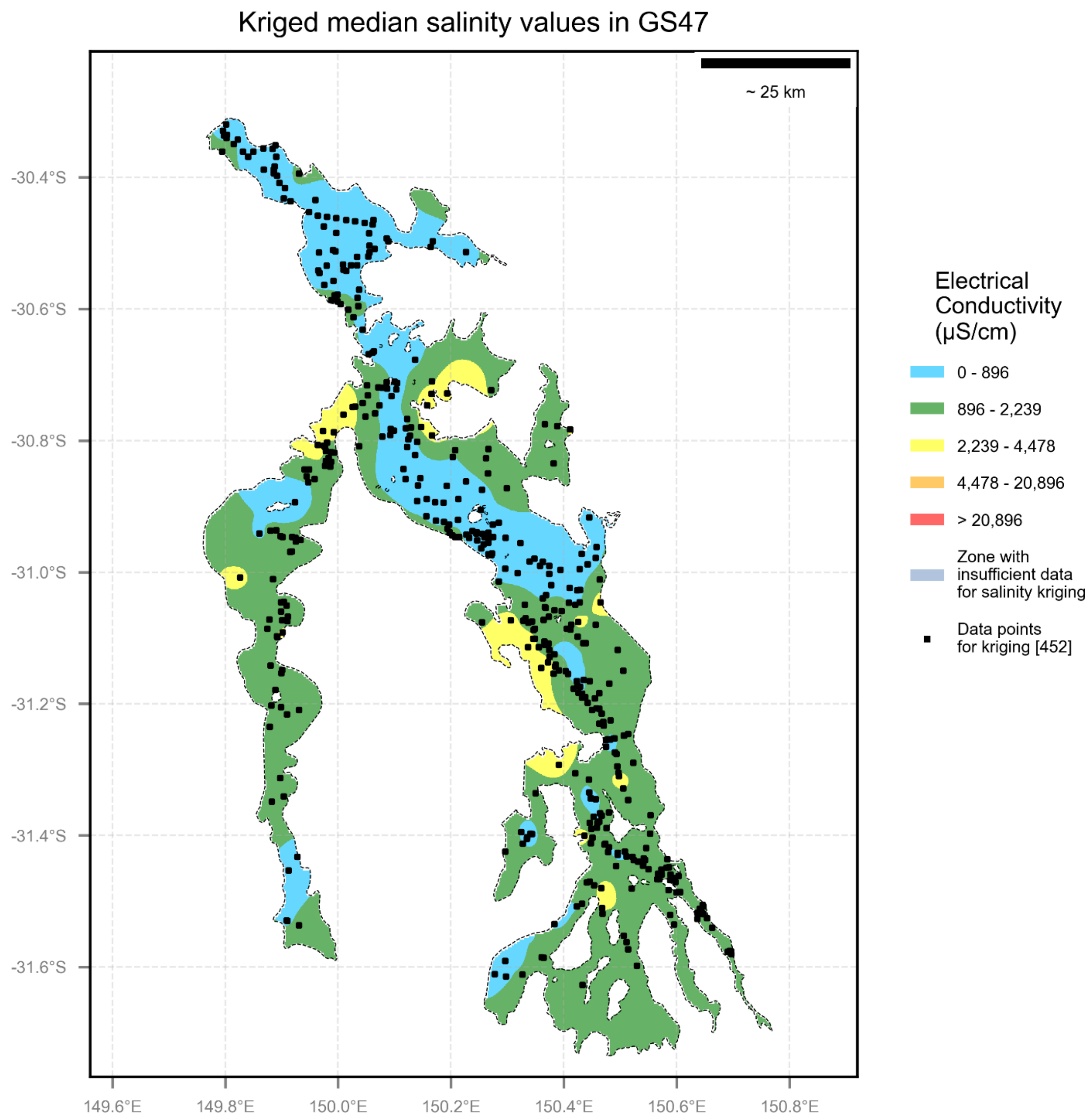


Figure 6 Groundwater salinity distribution

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	-	-	123.40
SDL resource unit area	km²	-	-	3,781
Average annual take (2013 to 2023)	GL/y	-	-	82.71
Number of groundwater entitlement bores	-	-	-	1,109
SDL resource unit storage estimate*	GL	-	-	32,022
Recharge estimate (SY1)	GL/y	-	-	91.00
Recharge estimate (Stage 2)	GL/y	-	-	91.00
Diffuse recharge estimate (SY2 - WAVES)	GL/y	-	-	72.27
Extraction/SDL (E/SDL) (Stage 2 result)	-	-	-	0.67
SDL/Recharge (SDL/R) (Stage 2 result)	-	-	-	1.36
SDL/Recharge (SDL/R) (SY2 or modelled recharge)	-	-	-	1.36
Storage/Stage 2 Recharge (S/R)	-	-	-	352
Storage/SY2 or modelled Recharge (S/R)	-	-	-	352
Number of bores in the SDL unit	-	5,649	5,649	-
Number of bores for water level trend analysis	-	297	284	-
Number of bores for water level trend with sufficient data	-	296	279	-
Number of bores with decreasing water level trend	-	258	92	-
Number of bores with increasing water level trend	-	15	13	-
Number of bores with no statistically significant water level trend	-	23	174	-
Mean water level trend magnitude	m/y	-0.11	-0.03	-
Minimum water level trend magnitude	m/y	-0.64	-1.04	-
5%ile water level trend magnitude	m/y	-0.31	-0.37	-
10%ile water level trend magnitude	m/y	-0.28	-0.28	-
50%ile water level trend magnitude	m/y	-0.1	-0.03	-
90%ile water level trend magnitude	m/y	0	0.16	-
95%ile water level trend magnitude	m/y	0.04	0.31	-
Maximum water level trend magnitude	m/y	0.45	1.14	-
Number of bores for salinity trend analysis	-	472	2	-
Number of bores for salinity trend with sufficient data	-	85	0	-
Number of bores with decreasing salinity trend	-	2	0	-
Number of bores with increasing salinity trend	-	14	0	-
Number of bores with no statistically significant salinity trend	-	69	0	-
Mean salinity trend magnitude	µS/cm/y	-2	N/A	-
Minimum salinity trend magnitude	µS/cm/y	-257	N/A	-
5%ile salinity trend magnitude	µS/cm/y	-75	N/A	-
10%ile salinity trend magnitude	µS/cm/y	-17	N/A	-
50%ile salinity trend magnitude	µS/cm/y	2	N/A	-
90%ile salinity trend magnitude	µS/cm/y	18	N/A	-
95%ile salinity trend magnitude	µS/cm/y	25	N/A	-
Maximum salinity trend magnitude	µS/cm/y	234	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	5,867,401,047	15%	58%	26%	Deteriorating	50%	23%	27%	Improving / stable
GDEs	5,582,048,488	16%	57%	27%	Deteriorating	51%	21%	28%	Improving / stable
River connectivity	3,715,169,324	15%	63%	22%	Deteriorating	58%	19%	23%	Improving / stable
Water quality	5,861,358,616	31%	2%	67%	Uncertain	0%	0%	100%	Uncertain

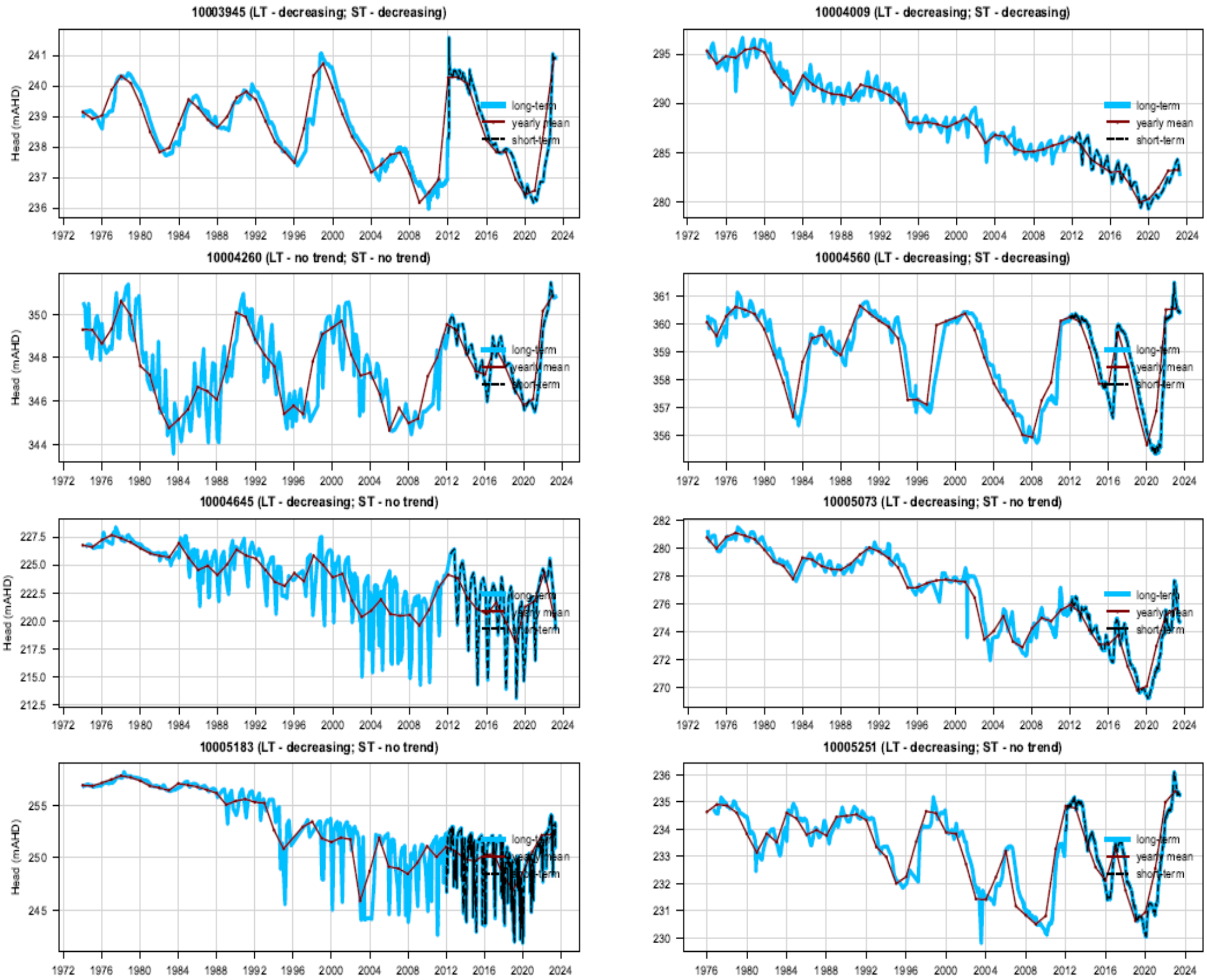


Figure 7 Representative groundwater hydrographs for the SDL resource unit

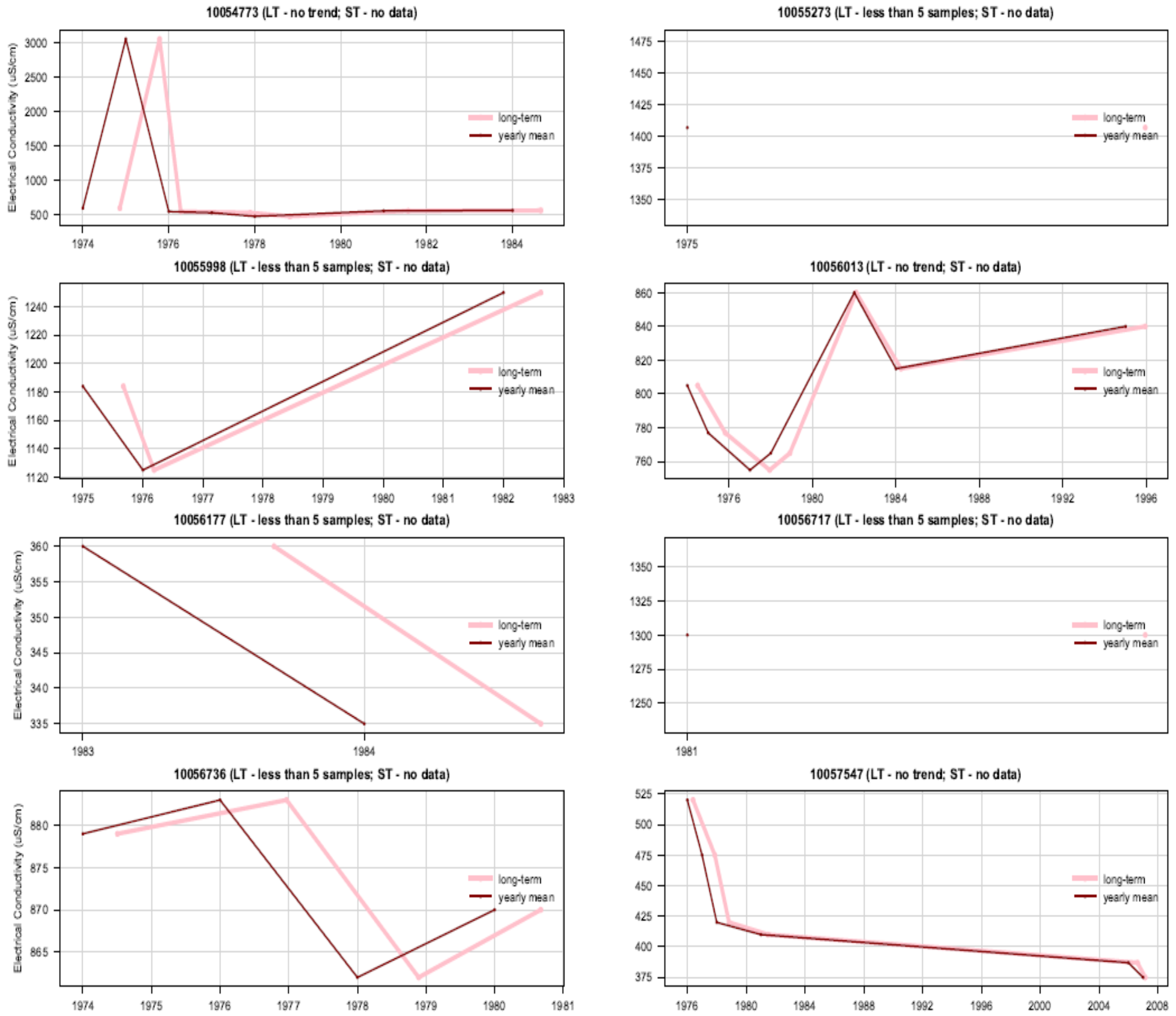
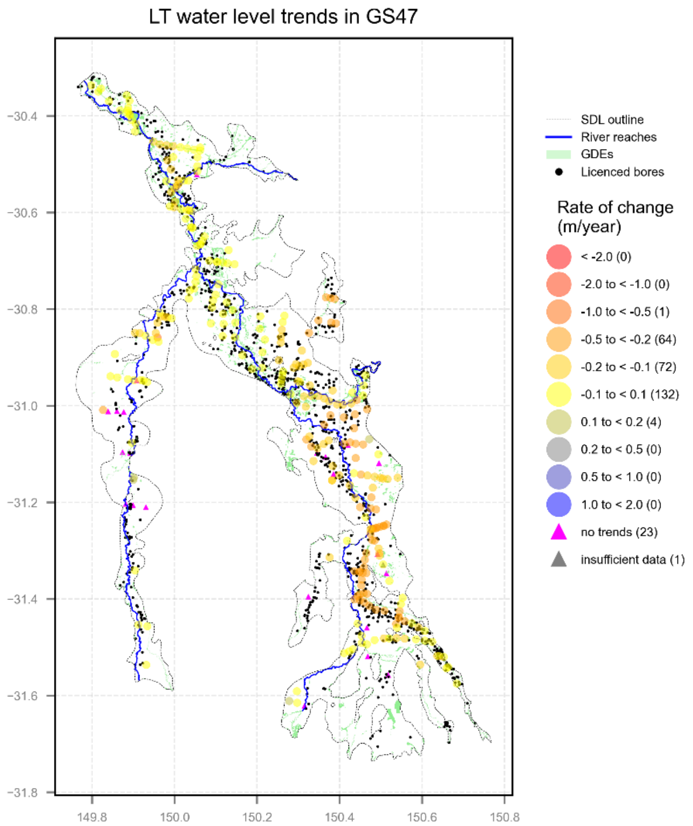


Figure 8 Representative groundwater salinity time series for the SDL resource unit



a)

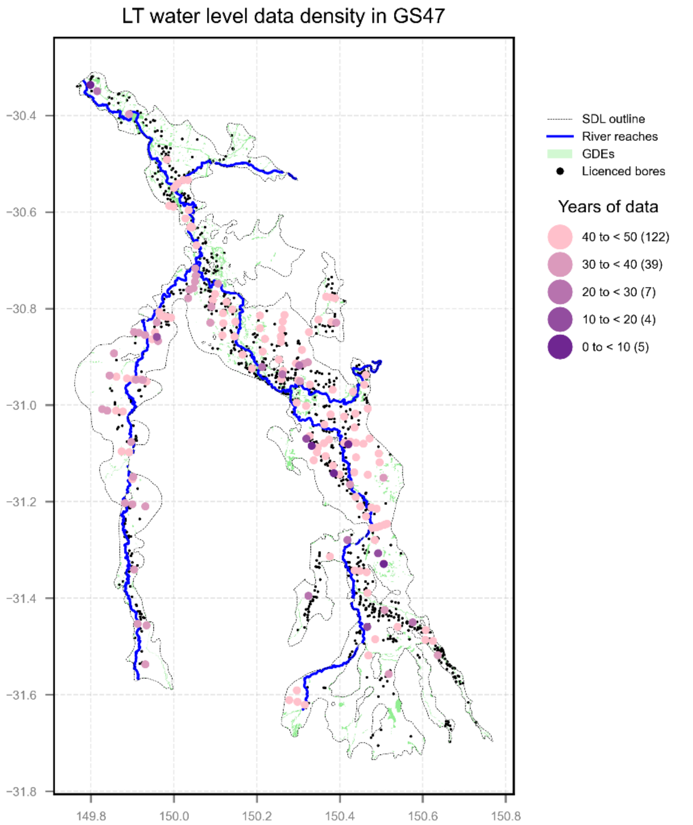


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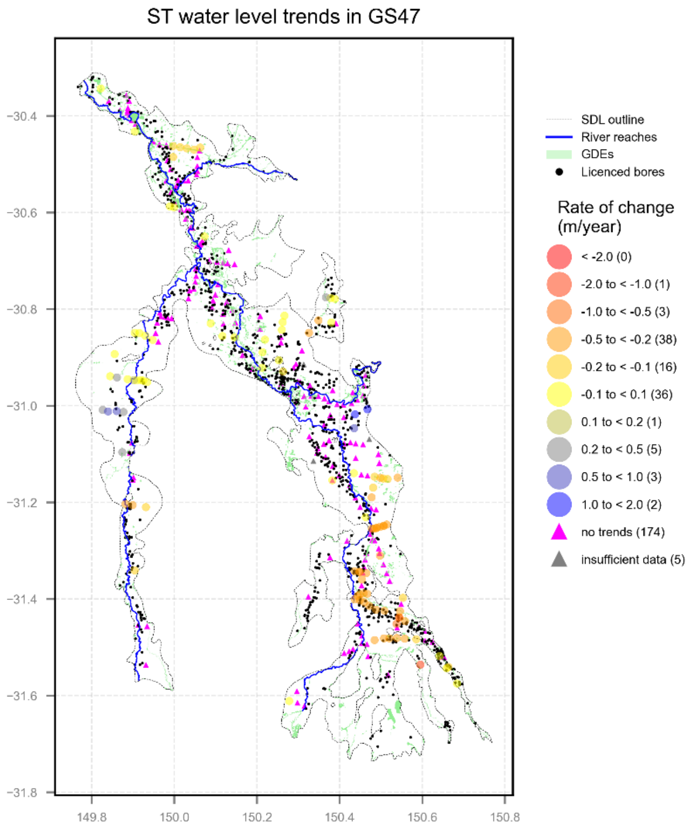
Figure 9 Long-term (1974 to 2024) groundwater level trends (a) and data availability (b)



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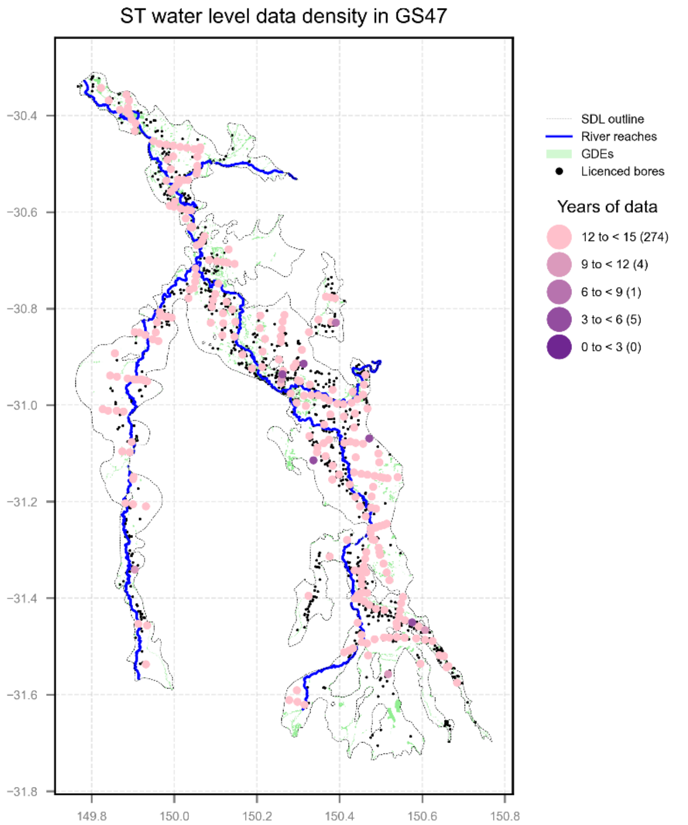

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Figure 10 Short-term (2012 to 2024) groundwater level trends (a) and data availability (b)

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

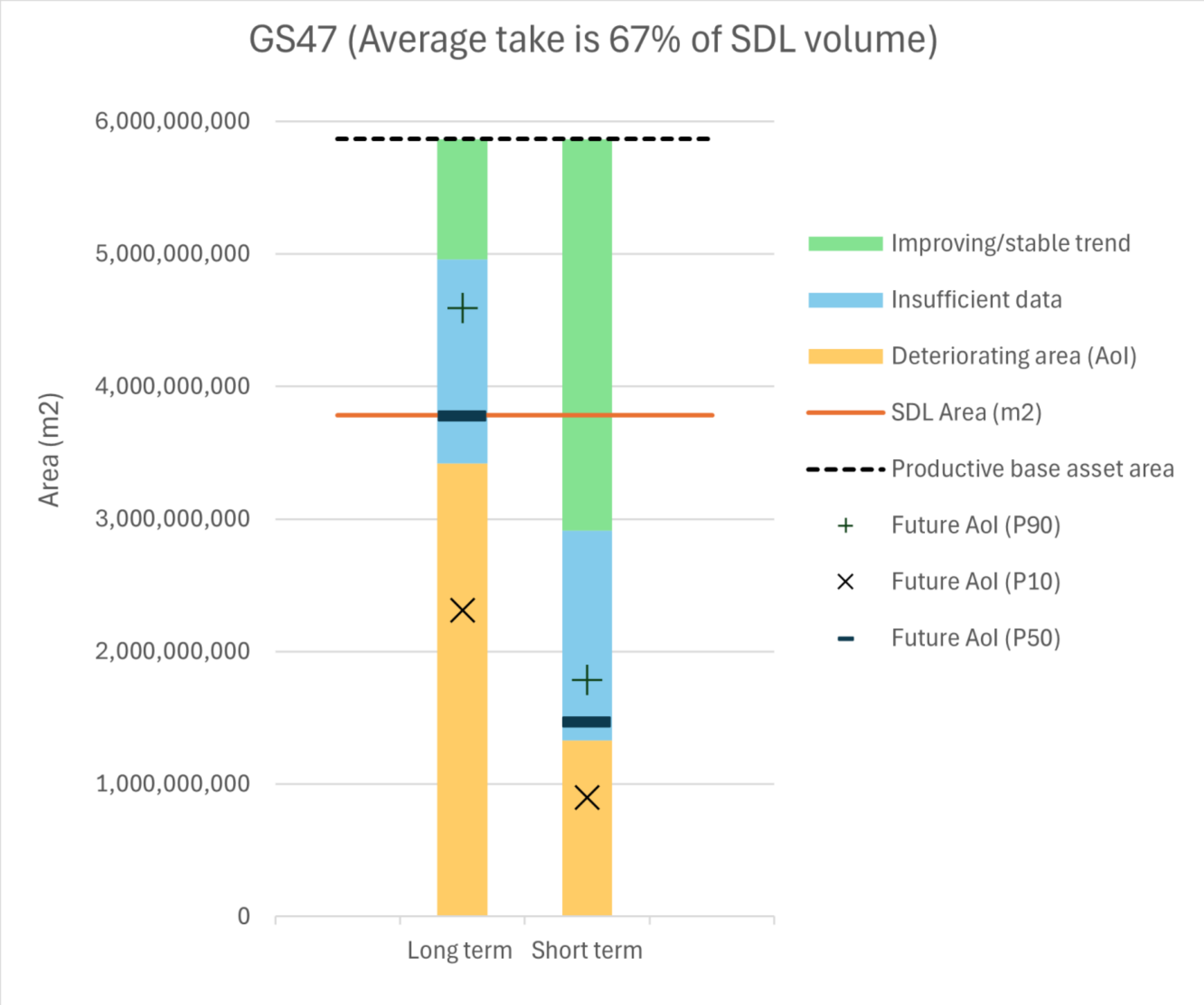

Figure 12 Estimates for change in area of influence (AoI) due to climate change

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