Sea level trends of regional Queensland

Report on the trend in sea level 1986–2022

Queensland Government

Prepared by: Queensland Government Hydraulics Laboratory, Coastal and Air, Coastal, Biodiversity and Information, Department of Environment, Tourism, Science and Innovation.

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January 2025

Key Points

- The global average trend in MSL is 3.7 (± 0.5) mm/yr, IPCC (2023)
- The Queensland regional average trend in MSL from 1986 to 2022 is 3.0 (± 0.3) mm/yr
- The Queensland regional average trend in daily maximum sea level from 1986 to 2022 is 3.6 mm/yr
- The Queensland regional average trend in daily minimum sea level from 1986 to 2022 is 1.8 mm/yr.

Executive Summary

An understanding of the distribution of historic sea level trends will aid in refining forecast estimates of sea level change for planning coastal development and mitigation of coastal inundation now and into the future.

Rates of sea level rise or the sea level trend have been determined globally from long-term tide gauge records, and in 2023 the global trend in mean sea level (TMSL) is 3.7 (± 0.5) millimetres per year. The two longest Australian tide gauge records at Fort Denison in Sydney Harbour (1886 to 2018) and at Fremantle in Western Australia (1897 to 2018) indicate a lower trend of 0.8 (± 0.1) mm/yr and 1.8 (± 0.22) mm/yr respectively. The average TMSL around the Australian coastline from tide gauge records 1966 to 2009 was 1.4 (± 0.3) millimetres per year. More recently an acceleration in sea level rise has been observed in Australian tide gauge records, and from 1993 to 2009 the TMSL was 4.5 (± 1.3) millimetres per year.

There are also several long-term tide records in Queensland, the longest from 1959 to 2018 is from Townsville. The TMSL for this record based on monthly means has been estimated as 2.07 (± 0.35) mm/yr. The regional distribution of the sea level trend in Queensland using data from coastal port tide gauges and storm tide gauges is the focus of this report. Time series sea level data from 1986 to 2022 was used in this analysis. The period of the analysis was chosen to ensure that a fair regional comparison in TMSL could be calculated using records of the same period.

The raw tide data was subjected to quality checks. Errors in the form of spikes and datum shifts were identified and removed or fixed respectively. Tide gauges that were used as a port tide gauge were checked regularly against independent tide boards which were checked for stability through levelling to local primary survey marks. These independent checks against actual water level ensure that the tide gauge recorded level is accurate.

Storm tide gauge checks against actual water level were conducted less frequently, and generally competed during bi-annual maintenance visits. Tide gauge errors may not have been completely removed through pre-analysis checks and may be behind outliers found in the data. If data gaps of 3 or more months occurred in any one year, then that year was eliminated from the TMSL analysis. A comparison test was used to check for outliers within each dataset and between each site. Each annual mean sea level data point and each TMSL for each site that were considered outliers were eliminated if the difference varied by more than 2 standard deviations of the mean difference. In total, 25 datasets were analysed for potential to be used for sea level trend calculation, and the site comparison test found that 2 sites were considered outliers. After removal of outliers, calculation of the TMSL was completed. The resulting TMSL was found to be variable along the Queensland coast. It varied from 1.5 mm/yr at Cardwell to 4.2 mm/yr at Bundaberg. The average TMSL for the period 1986 to 2022 for 22 Queensland coastal tide gauges is 3.0 (± 0.3) millimetres per year.

The trend in daily maximum sea level (TDMaxSL) was calculated for each site. Resulting in it also being variable along the Queensland coast, and higher than TMSL at all sites with Karumba the exception. TDMaxSL is lowest at Cairns and Karumba (2.0 mm/yr) and highest at Mackay (5.5 mm/yr). The trend in TDMaxSL is notably larger in the central coast between Bundaberg and Shute Harbour. The trend in daily minimum sea level (TDMinSL) was calculated and was also found to be variable along the Queensland coast. TDMinSL is generally lower than TDMaxSL and TMSL, with Karumba the exception.

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Background

The impacts of sea level rise

Sea level rise is one of the major effects of anthropogenic climate change (Stern, 2006). The impacts of sea level rise may include increased coastal erosion, higher storm-surge flooding, changes in surface water quality and groundwater characteristics, increased loss of property and coastal habitats, impacts on agriculture and aquaculture, and loss of tourism, recreation, and transportation functions (IPCC, 2001). Sea level rise will create serious problems for the coastal regions of Queensland and impact the lifestyle of many Queenslanders. An understanding of the distribution of historic sea level trends will aid in refining forecast estimates of sea level change for planning coastal development and mitigation of coastal inundation now and into the future.

Global sea level trends

The rate of sea level rise or the sea level trend have been determined globally from long term tide gauge records. From 1961 to 1997 global sea level rise was reported at an average rate of 1.8 mm/yr (Douglas, 1997). The trend in mean sea level (TMSL) based on 1961 to 2009 increased to 1.9 mm/yr and sea level rise has been seen to accelerate at a rate of 0.009 mm/yr^{-2} from 1880 to 2009 (Church and White, 2011). In 2023, the global TMSL based on a shorter period of 2006 to 2018, increased to 3.7 (3.2 to 4.2) mm/yr (IPCC, 2023). It is important to note that the sea level trend is not directly related to future sea levels, nor should it be used solely to forecast future sea levels.

Sea level trends in Australia

In Australia, TMSL has been determined from averaged long-term tide gauge records from 1920 to 2000 as 1.2 mm/yr (Church et al., 2006) and seen to be close to global trends from 1966 to 2010 (White et al., 2014). White et al. found that without allowing for Global Isostatic Adjustment (GIA) or atmospheric pressure effects, the average TMSL around the Australian coastline from 1966 to 2009 was 1.4 (± 0.3) mm/yr and for the 1993 to 2009 period the TMSL was 4.5 (± 1.3) millimetres per year. The 2 longest Australian tide gauge records at Fort Denison in Sydney Harbour (1886 to 2022) and at Fremantle in Western Australia (1897 to 2022) indicate a lower trend of 0.80 (± 0.1) mm/yr at Fort Denison and 1.80 (± 0.23) mm/yr at Fremantle (NOAA, 2024). Both are low due to the long records of 122 and 121 years respectively and include changes in the reference datum relative to the International Reference Frame (IRF) due to the vertical movement of land.

Sea level trends in Queensland

There are 6 sites with relatively long-term records between 55 and 61 years long in Queensland and the average linear sea level trend for these sites is 2.19 ± 0.53 mm/yr (NOAA, 2024) over the period 1959 to 2022 (Table 1). It must be noted here that there are gaps in some of the records and that the start and end dates also differ. In 2023 there are more Queensland datasets that have not been considered for sea level rise studies. The regional distribution of the TMSL in Queensland using data from coastal tide gauges coherently over the same period is yet to be determined. This study serves 2 purposes: (a) to identify quality sea level records in Queensland suitable for continued use as sea level monitoring sites through a simple inter-gauge comparison and; (b) to develop a regional view of the distribution of sea level trends in Queensland.

Table 1 Queensland long-term Mean Sea Level trends with confidence interval as mm/yr from NOAA (2024).

Site	Dataset length	Start–end year	% complete	MSL Trend mm/yr (CI ± 95%)	Location (Lat, Long)
Brisbane	57	1966–2022	90	1.54 (0.53)	−27.4017, 153.1574
Bundaberg	57	1966–2022	98	2.22 (0.46)	−24.7704, 152.3819
Mackay	61	1960–2020	79	2.29 (0.4)	−21.1029, 149.2277
Townsville	64	1959–2022	100	2.26 (0.32)	−19.2518, 146.8304
Cairns	61	1960–2020	78	1.74 (0.4)	−16.9277, 145.7788
Weipa	55	1966–2020	80	3.09 (1.09)	−12.67, 141.8623

Queensland sea level data

Time series sea level data from 1986 to 2022 from Queensland storm tide gauges (designed to withstand cyclone strength winds) and port tide gauges (Figure 1 and Table 2) were used in this analysis. The period of the analysis was chosen to ensure that a fair comparison in the regional sea level trends could be undertaken based on archives of similar length. There are many sea level archives between 30 and 36 years in length hence maximising the density of sites in the analysis. There are several archives that exceed this length (see Table 1); these were reduced to the period of 1986 to 2022 for this study.

Table 2 Storm tide gauge and tide gauge locations, STG = Storm tide gauge TG = tide gauge

Site	Location	Location (Lat, Long)	Gauge type
Brisbane Bar	Whyte Island, Port of Brisbane wharf	−27.4017, 153.1574	TG
Mooloolaba	Pilot jetty, Parklyn Parade, Mooloolaba	−26.6842, 153.1334	STG
Urangan	Fuel jetty Urangan boat harbour	−25.2962, 152.9105	STG
Burnett Heads	Public jetty Burnett Heads boat harbour	−26.6842, 153.1334	STG
Bundaberg	Bundaberg Port Sugar Wharf	−24.7704, 152.3819	TG
Gladstone South Trees Wharf	South Trees Island wharf eastern dolphin	−23.8538, 151.3137	STG
Gladstone Auckland Point	Auckland Point wharf	−23.8060, 151.2163	TG
Port Alma	Port Alma cargo wharf	−23.5857, 150.8618	STG
Rosslyn Bay	Rosslyn Bay boat harbour	−23.1667, 150.7917	STG
Mackay	Mackay Outer Harbour wharf number 5	−21.1029, 149.2277	STG
Shute Harbour	Shute Harbour wharf	−20.2932, 148.7862	STG
Bowen	Main wharf Bowen	−20.0225, 148.2514	STG
Cape Ferguson	AIMS wharf Cape Ferguson	−19.2774, 147.0585	STG

Site	Location	Location (Lat, Long)	Gauge type
Townsville	Roll on roll off wharf Townsville Harbour	−19.2518, 146.8304	STG
Lucinda	Bulk sugar terminal wharf Lucinda	−18.5217, 146.3853	STG
Cardwell	Cardwell Jetty	−18.2637, 146.0262	STG
Clump Point	Clump Point Jetty	−17.9515, 146.1053	STG
Mourilyan	Mourilyan Harbour wharf	−17.6012, 146.1238	STG
Cairns	Container wharfs 7–8. Cairns	−16.9277, 145.7788	STG
Cooktown	Railway wharf Cooktown	−15.4608, 145.2487	STG
Weipa	Humbug Point wharf Weipa	−12.67, 141.8623	STG
Karumba	Raptis Fisheries wharf Karumba	−17.4883, 140.8347	STG

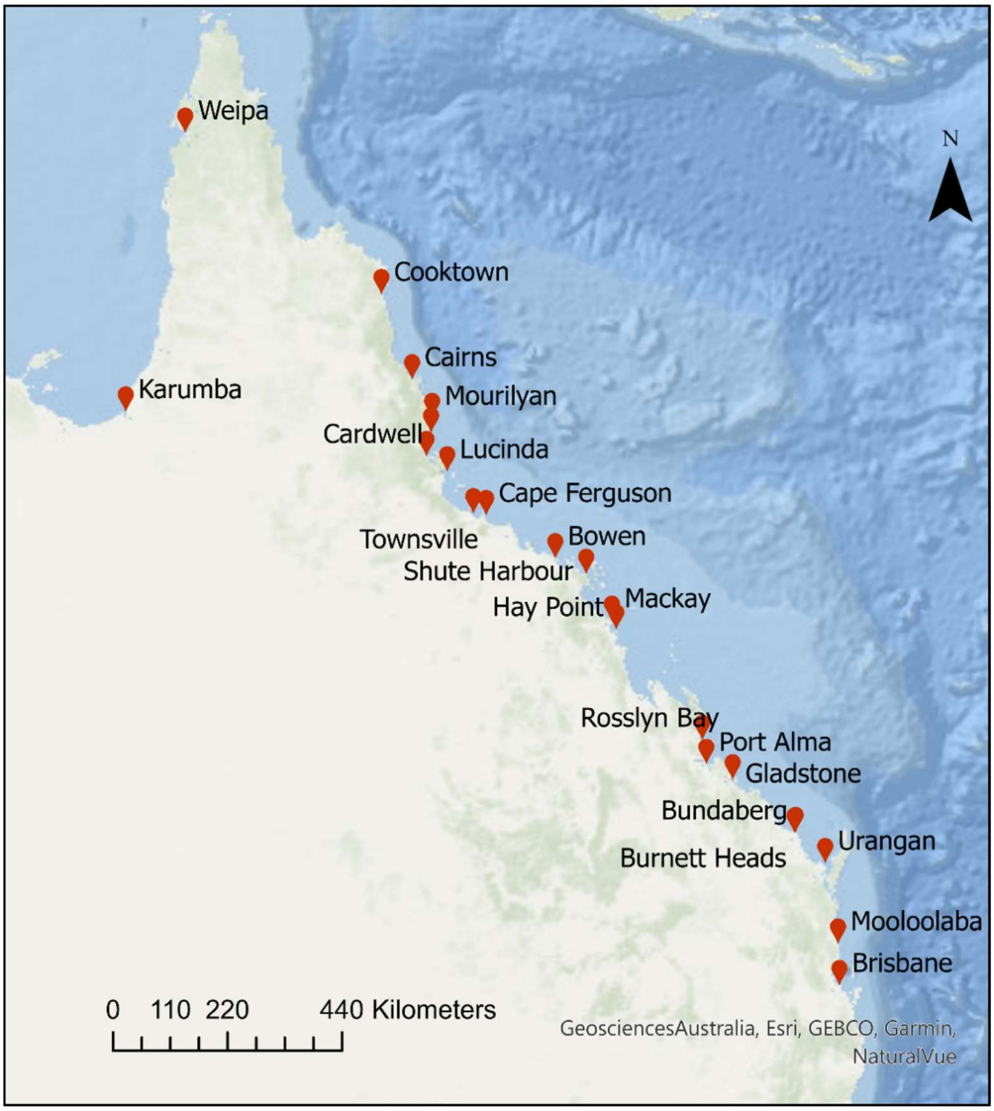

Figure 1 Location of the storm tide gauges and tide gauges in Queensland.

Data quality

The raw data were subjected to thorough (day-by-day) quality checks which included visual checks of the tidal residual (observed level minus tide prediction) and a comparison of the residual between sites that are close in a regional and tidal dynamics sense. Errors in the form of spikes and datum shifts are easily identified by this method and removed if erroneous. This process identifies the majority of errors, however errors that are manifest with small amplitude may be missed.

The tide gauges are also port tide gauges and were checked regularly against a tide board. The tide boards were checked for stability through levelling to primary survey marks. These independent checks against actual water level ensure that the recorded level is close to the actual level. With the storm tide gauges, checks against actual water level were less frequent and generally only done during bi-annual maintenance visits. These checks are also useful in identifying errors, but the date and time that the error(s) began can be difficult to identify. Tide gauge errors in these datasets may not have been completely removed through pre-analysis checks and may be behind outliers found here. If there were data gaps of 3 or more months in any one year, then that year was eliminated from the TMSL analysis.

There are several factors that may introduce errors into a tide gauge record. These are tide gauge errors, datum errors, analysis errors and geophysical errors (Hannah, 2010). The archives analysed here may inherently have all 4 types of error. This report aims to identify tide gauge and datum errors in Queensland sea level archives through a simple inter-archive comparison.

Generating sea level trends

The annual levels were used to calculate TMSL, this reduces the influence of short-term sea-level perturbations such as storm surge and floods on the sea level trend. The raw data were sub-sampled on the hour and the annual mean level based on a calendar year calculated to form the annual mean sea level (AMSL). The TMSL based on AMSL was generated via the slope of the linear regression of this dataset. In determining the trend in the daily minima and daily maxima, hourly data was interrogated to find the daily minimum and maximum level and the trend in daily minima (TDMinSL) and maxima (TDMaxSL) calculated via the slope of the linear regression of each dataset. It is important to note again that the sea level trend is not directly related to future sea levels, nor should it be used solely to forecast future sea levels.

Removal of outliers

A comparison test was used to check for outliers in each dataset, this involved checking the average annual level of each archive against the average annual level of all other archives. This was done as the difference between the standardised annual mean for each year (see equation 1). Data points that were considered outliers were eliminated if the difference varied by more than 2 standard deviations of the mean difference.

Equation (1) $Ld = |(La - MWL) - (Loa - MWL)|$, if $Ld > Lmd + 2Lsd$ then Ld is an outlier.

Where: La = annual water level, MWL = average of all annual water levels for each archive, Loa = annual water level for all other sites, Ld = water level difference, Lmd = average of all Ld, Lsd = standard deviation of Ld.

Twenty-five datasets were analysed for potential to be used for sea level trend calculation. A second outlier test on TMSL at the site level found that the Gold Coast Seaway, Hay Point and Port Douglas sites should be rejected due to being considered outliers. These sites are not presented in the results here; hence 22 sites were analysed.

Sea level trends of regional Queensland

TMSL is considerably variable along the Queensland coast (Figure 2 and Table 3) and ranged from 1.4 mm/yr at Burnett Heads to 4.2 mm/yr at Bundaberg. The average sea level trend for the period 1986 to 2022 for 22 Queensland coastal tide gauges is 3.0 ± 0.3 millimetres per year. The trend in the TMSL from south to north suggests higher rates of rise at the northern sites, e.g., there is an increase in TMSL towards the north.
The average TMSL for the sites with long-term datasets (listed in Table 1) is 3.43 ± 0.66 mm/yr, this constitutes an increase in the average TMSL from the longer-term datasets which is 2.19 ± 0.53 mm/yr.

The trend in daily maximum sea level (TDMaxSL) was also determined for each site and is also variable along the Queensland coast and higher than TMSL at all sites with the exception of Karumba. The average TDMaxSL is 3.59± 0.37 mm/yr TDMaxSL and is lowest at Cairns and Karumba (2.0 mm/yr) and highest at Mackay (5.5 mm/yr). The trend in TDMaxSL from south to north is negative, i.e., TDMaxSL is larger in regional southern Queensland particularly in the central coast between Bundaberg and Shute Harbour. The trend in daily minimum sea level (TDMinSL) was determined and is also variable along the Queensland coast. The average TDMinSL is 1.77± 0.41 mm/yr and the trend in TDMinSL from south to north is positive, i.e., TDMinSL is larger in northern Queensland from Mourilyan to Karumba. TDMinSL is generally lower than TDMaxSL and TMSL, with Karumba the exception. For a more detailed graphic view of the data see the Appendix.

Table 3 Trends of annual mean sea level (TMSL), daily maximum sea level (TDmaxSL), and daily minimum sea level (TDminSL), expressed as mm/year. Brackets indicate TMSL where outliers were removed.

Site	Trend: mean sea level (TMSL)	Trend: daily maximum sea level (TDMaxSL)	Trend: daily minimum sea level (TDMinSL)
Brisbane Bar	4.0 (3.6)	4.4	2.4
Mooloolaba	2.3	2.5	1.6
Urangan	2.7 (2.8)	3.3	1.9
Burnett Heads	1.4 (1.5)	2.4	0.3
Bundaberg	4.2 (4.0)	4.6	3.0
Gladstone South Trees Wharf	2.1 (2.2)	3.5	0.1
Gladstone Auckland Point	3.4	4.2	1.8
Port Alma	3.1	3.8	0.2
Rosslyn Bay	3.4	4.6	2.0
Mackay	3.8 (3.5)	5.2	2.0
Shute Harbour	3.3 (2.8)	4.0	1.3
Bowen	3.2 (3.0)	3.7	1.6
Cape Ferguson	2.8 (3.0)	3.6	1.9
Townsville	3.7	4.2	2.4
Lucinda	4.0 (3.8)	4.4	2.3
Cardwell	1.6 (1.5)	2.6	0.2
Clump Point	2.8	3.3	1.3
Mourilyan	3.3 (3.2)	3.4	2.2
Cairns	1.7 (2.0)	2.5	0.9
Cooktown	3.6 (3.4)	3.5	2.6
Weipa	3.4 (3.8)	3.8	3.7
Karumba	3.4 (3.0)	1.5	3.2

After removal of outliers the sea level trend was recalculated and 12 out of 23 archives expressed a change in the sea level trend. The change in trend ranged between −0.9 and 0.6 millimetres per year.

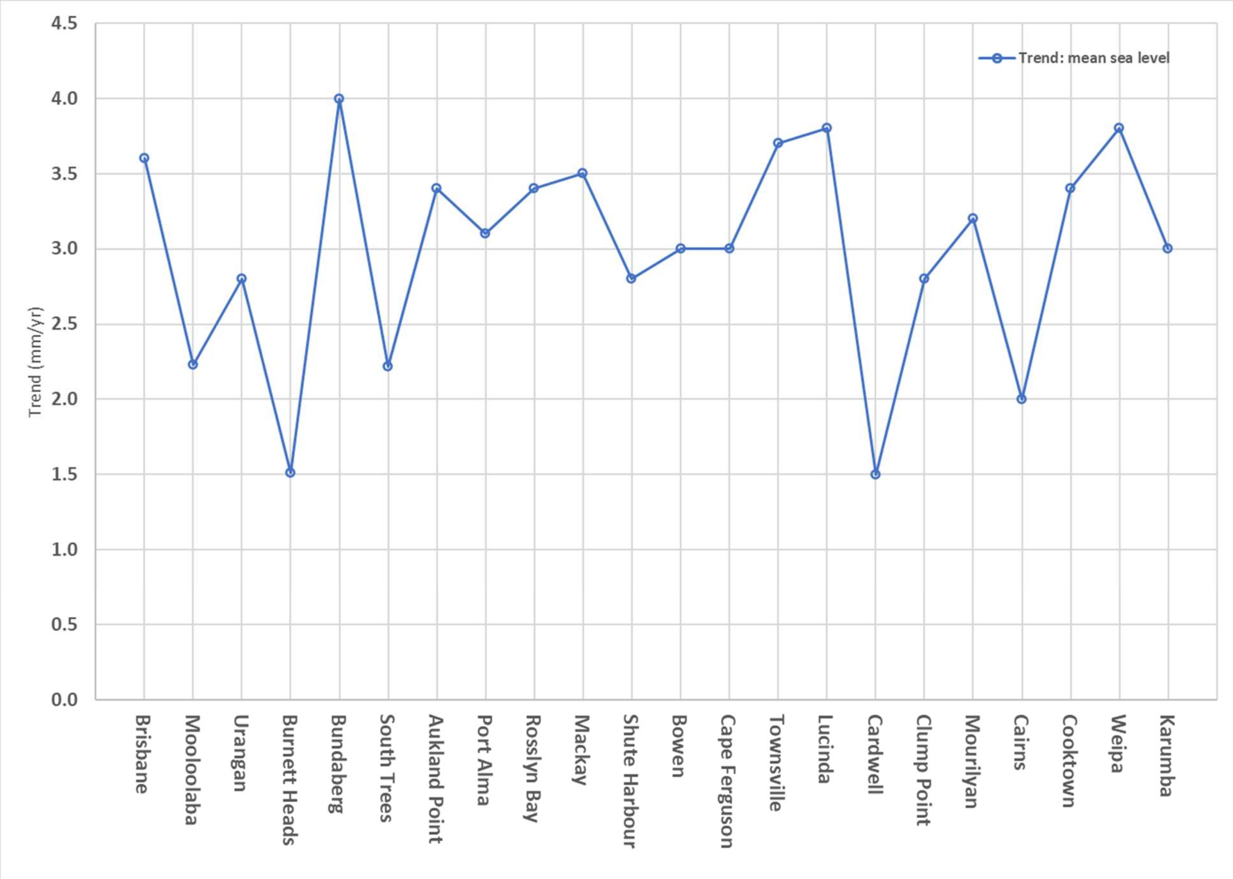

Figure 2 Trend in mean sea level 1986 to 2022 with outliers removed.

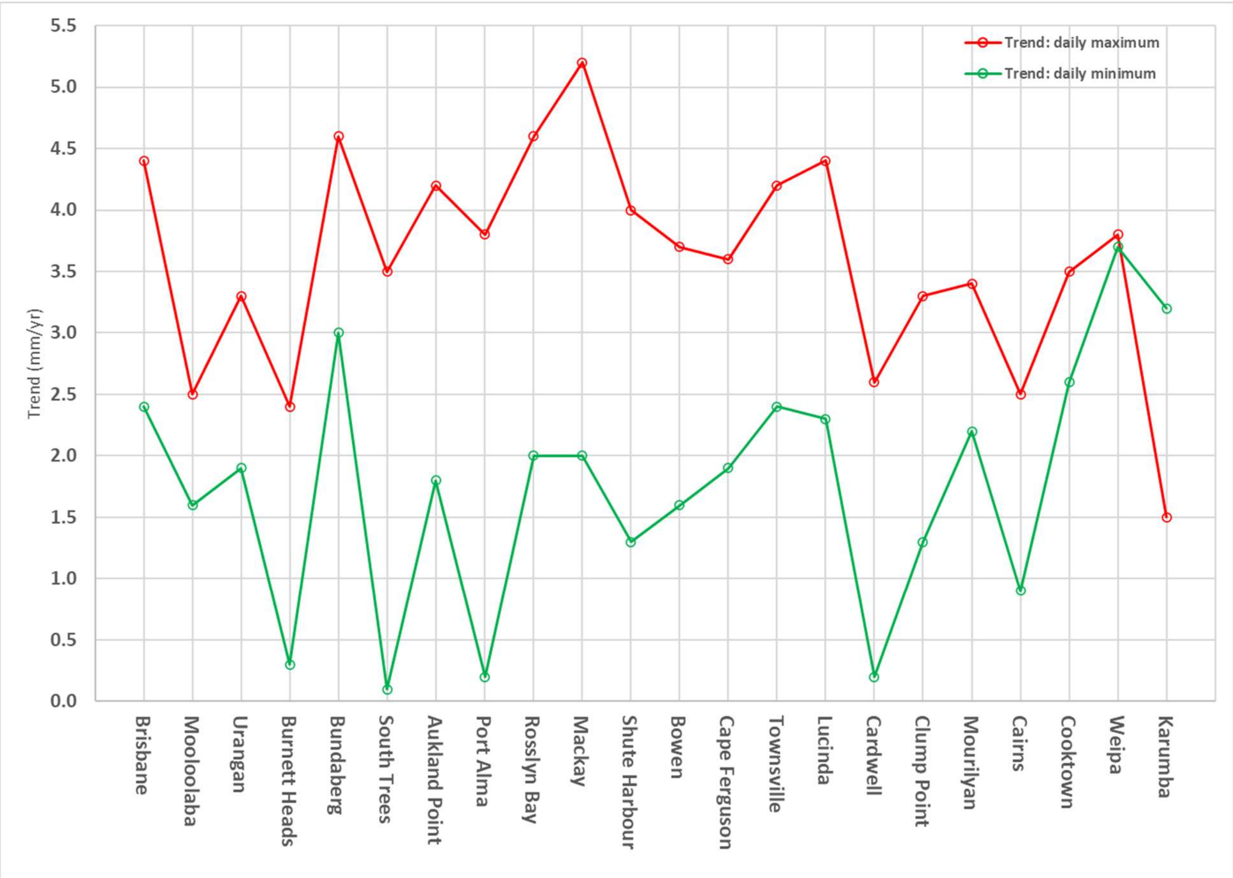

Figure 3 Trends in daily minimum and maximum 1986 to 2022 with outliers removed.

Conclusions

The average TMSL of 3.0 (± 0.3) mm/yr seen here for 22 regional Queensland sites for the period 1986 to 2022 is higher than the long-term Queensland trend for the period 1959 to 2022 of 2.19 (± 0.53) mm/yr. However, the confidence intervals are overlapping so the TMSL calculated here for all sites is not significantly different to the average long-term trend for 6 sites. The average TMSL of 3.43 (± 0.66) mm/yr for just the long-term sites is also higher than the longer datasets but gives a statistically significant increase. This therefore suggests that there has been an acceleration in sea level rise since 1986. The average TMSL for all sites is lower than the IPCC current trend from 2006 to 2018 of 3.7 ± 0.5 mm/yr but also with overlapping confidence intervals (so not significantly different). The trend is however higher than long-term trends in sea level at Sydney of 0.8 mm/yr and Fremantle 1.8 mm/yr and for Australia (1.2 mm/yr) (Church et al., 2006). This variation may be due to the use of shorter datasets here. It is apparent that sea level rise has accelerated since 2010 (Church and White, 2006) and must be considered a contributing factor in the average regional Queensland trend.

The sea level trends estimated here are relative to the local tide gauge datum. The absolute sea level trend cannot be determined as the degree of stability of each tide gauge datum relative to the Terrestrial Reference Frame (TRF) is not known with certainty. Hence, the sea level archives used in this study may have been influenced by crustal movements. The value in any sea level trend lies in its general purpose (Camuffo and Sturaro, 2004), the purpose here is for use in coastal protection, hence the relative sea level trend is important. Although one of the main purposes of the sea level trend is coastal protection, it is important to quantify crustal movements before use in sea level change forecasts. With a knowledge of whether crustal movements are intermittent or a constant change with quantification of the magnitude will allow for a more accurate sea level forecast. Tide gauge records provide a very important tool in sea level change research. The obvious application is in identifying a regionally based coastal sea level change. Willis et al. (2010) provides a review of recent progress and challenges for the decade to come (2010–2020), the secondary value of tide gauge records is in calibrating satellite altimetry records and in investigations into decadal variations in sea level and the relationship between sea level and sea surface temperature (Willis et al., 2010).

The simple outlier method used here is a valuable tool for verifying annual sea levels for archives that fall short of the requirement of greater than 60 years of sea level data proposed by Douglas (1997). Criteria for determining the sea level trend from tide gauge data were proposed by Douglas. Douglas suggested that a long-term data set of 60 years in length is required to reduce the irregular variance in sea level caused by floods and storms. The data points that were classified as outliers in this comparison may have resulted from elevated levels during floods and storms. A longer dataset may smooth the influence of these points. The recalculated sea level trend, after removal of outliers changed for 16 out of 22 archives. Irrespective of the cause of the outliers, inclusion of these data points has affected the change in sea level by between 0.50 and −0.40 mm/yr over the 30–36 year period investigated here. Tide gauge errors may have resulted through the use of mechanical tide gauges and stilling wells and through incorrect calibration of paper charts in the earlier records. Many of the tide gauges prior to 1994 were within stilling wells and of the mechanical shaft encoder and float type. These gauges are known to introduce errors due to factors such as stilling well blockage, float friction (Hannah, 2010) and slippage of the cable on the encoder. Datum errors may also be the cause of error at some sites particularly where checks against actual water level and tide board levelling weren't undertaken regularly or where the tide gauge may have been moved (Hannah, 2010). Data points that were greater than two standard deviations from the mean may have resulted from datum errors and the datasets that were considered outliers (and not analysed here) were at sites where the tide gauge was moved at least once between 1986 and 2022.

The use of short-term datasets of 30 to 36 years in this study may have introduced a bias into the trend. Non-cyclic sea level fluctuations such as shallow water effects, storm surges, wind setup and river flooding may not be completely smoothed by using a short-term dataset (Hannah, 2010). Longer period climate-based anomalies such as El Nino Southern Oscillation and the Pacific Decadal Oscillation may also influence the sea level trend in a shorter (30–35) than 60-year dataset. Royston et al. (2018) found that by including these climate indices in the trend analysis reduces the time for the sea level trend to emerge from the noise by up to two decades (Royston et al., 2018).

This report has demonstrated that there are at least 22 datasets that (after an inter-archive comparison) are of reasonable quality to be considered for monitoring sea level change at a regional level in Queensland. It is also clear that the trend in sea level is not regionally coherent but variable along the Queensland coast. It would be pertinent, therefore, to recommend that the port tide gauge and storm tide gauge sites identified to be of reasonable quality here, be considered as long-term sea level monitoring sites and if not up to the standard of high precision sea level monitoring stations as outlined in the Australian Tide manual (ICSM, 2021) then upgraded to this standard. The criteria set out by Hannah (2010) should also be considered in the gauge operation and design.

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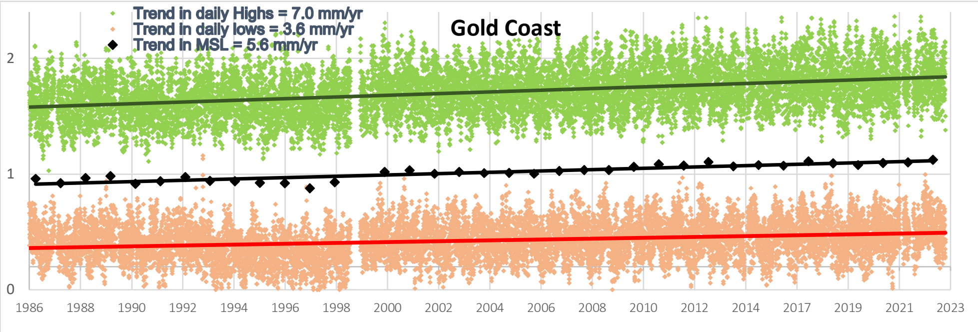
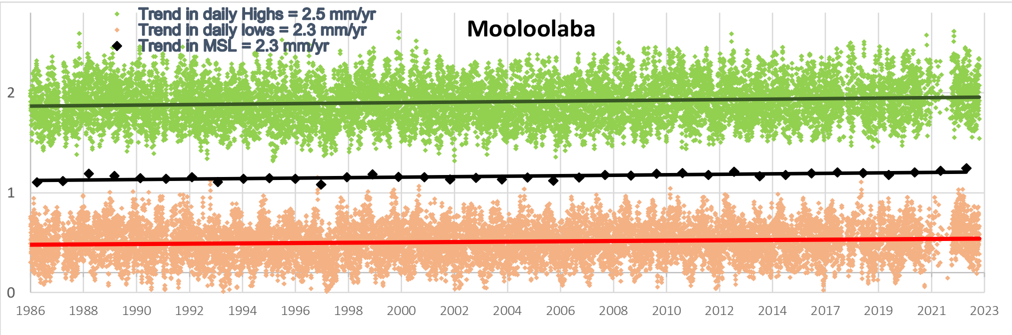
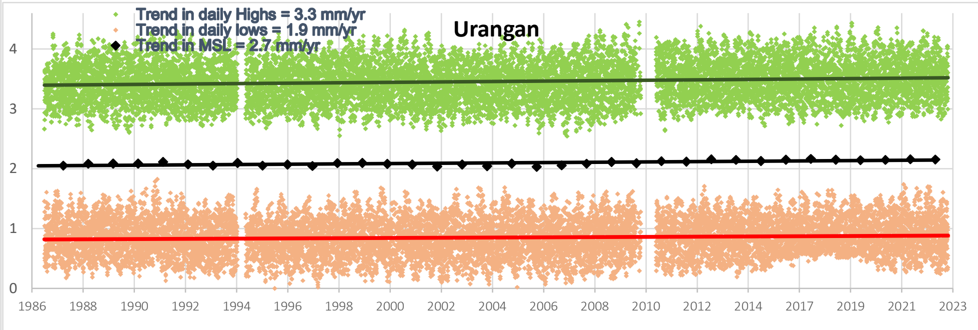
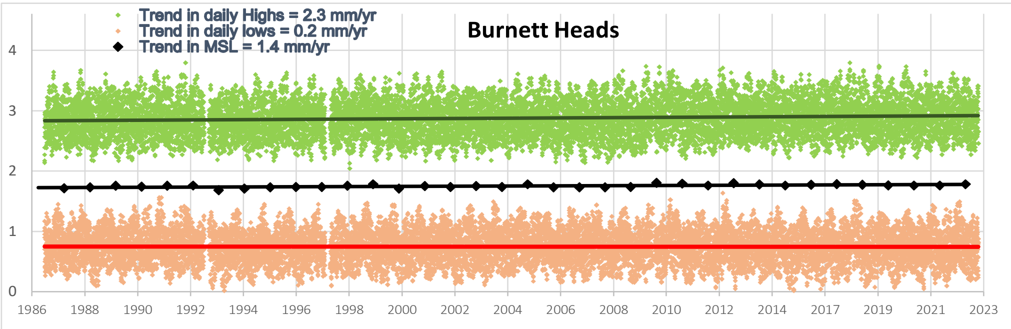
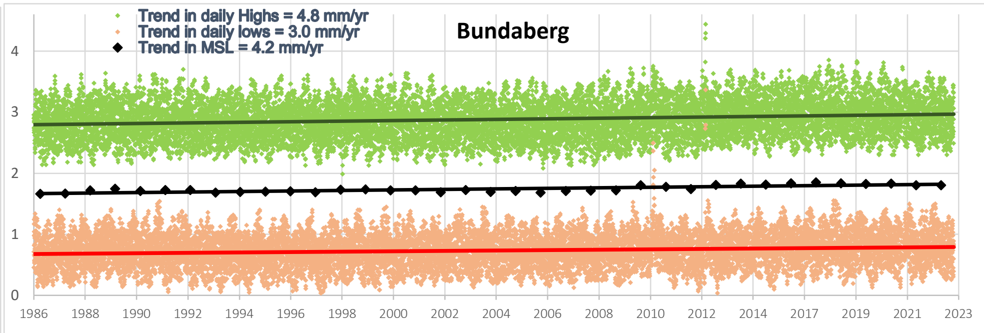
Appendix A

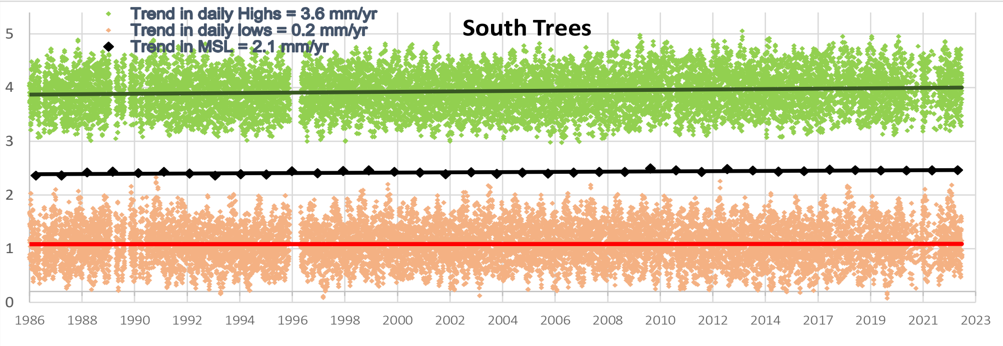

Trend in daily Highs = 7.0 mm/yr
Trend in daily lows = 3.6 mm/yr
Trend in MSL = 5.6 mm/yr
Gold Coast

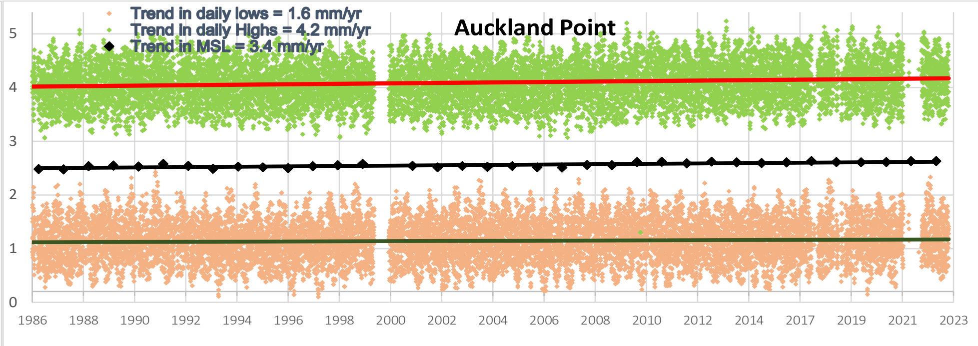

Trend in daily Highs = 2.5 mm/yr
Trend in daily lows = 2.3 mm/yr
Trend in MSL = 2.3 mm/yr
Mooloolaba

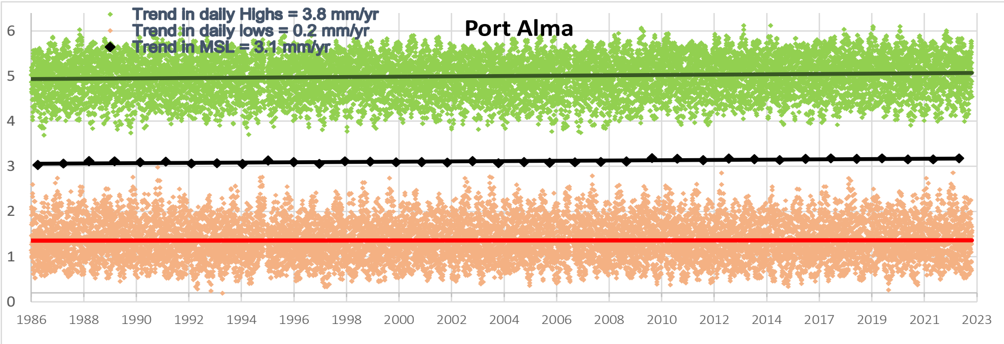

Trend in daily Highs = 3.3 mm/yr
Trend in daily lows = 1.9 mm/yr
Trend in MSL = 2.7 mm/yr
Urangan

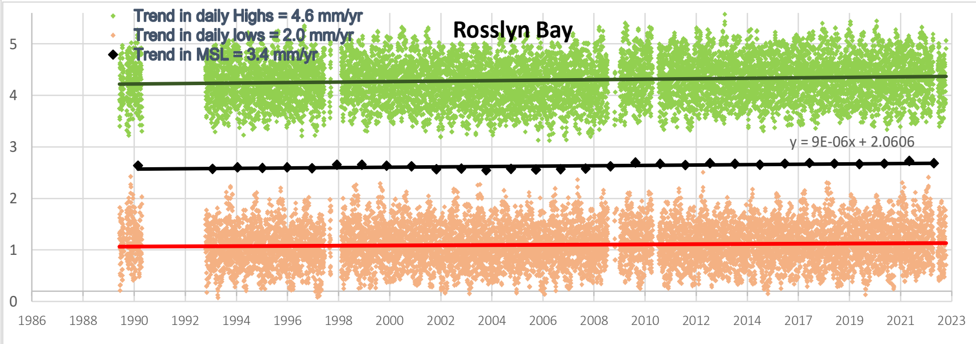

Trend in daily Highs = 2.3 mm/yr
Trend in daily lows = 0.2 mm/yr
Trend in MSL = 1.4 mm/yr
Burnett Heads

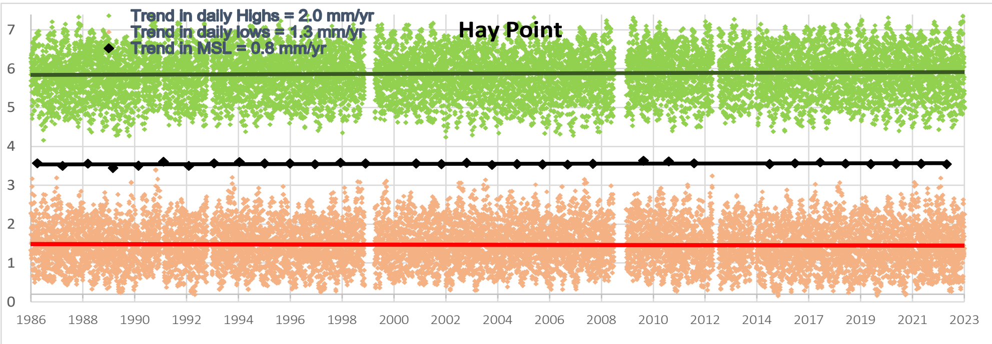

Trend in daily Highs = 4.8 mm/yr
Trend in daily lows = 3.0 mm/yr
Trend in MSL = 4.2 mm/yr
Bundaberg

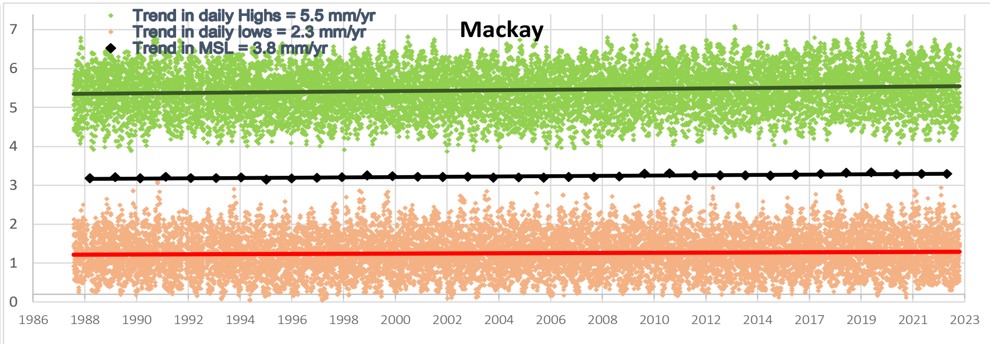

South Trees
Trend in daily Highs = 3.6 mm/yr
Trend in daily lows = 0.2 mm/yr
Trend in MSL = 2.1 mm/yr

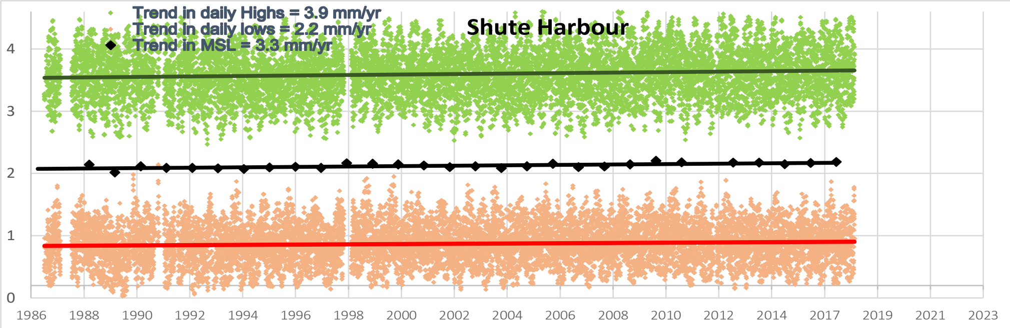

Auckland Point
Trend in daily lows = 1.6 mm/yr
Trend in daily Highs = 4.2 mm/yr
Trend in MSL = 3.4 mm/yr

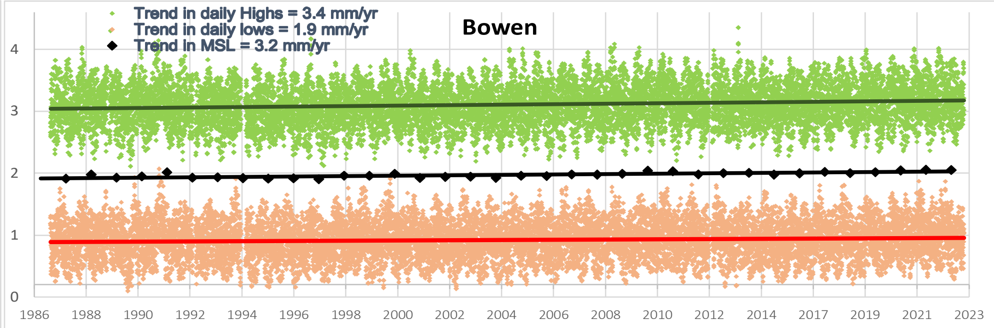

Port Alma
Trend in daily Highs = 3.8 mm/yr
Trend in daily lows = 0.2 mm/yr
Trend in MSL = 3.1 mm/yr

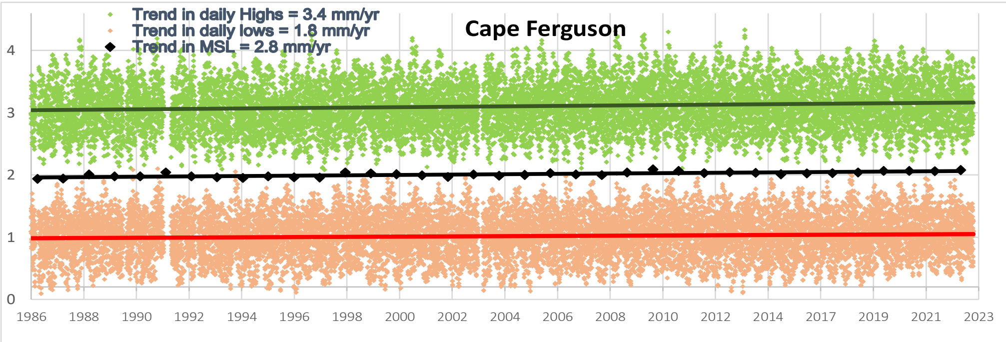

Rosslyn Bay
Trend in daily Highs = 4.6 mm/yr
Trend in daily lows = 2.0 mm/yr
Trend in MSL = 3.4 mm/yr
y = 9E-06x + 2.0606

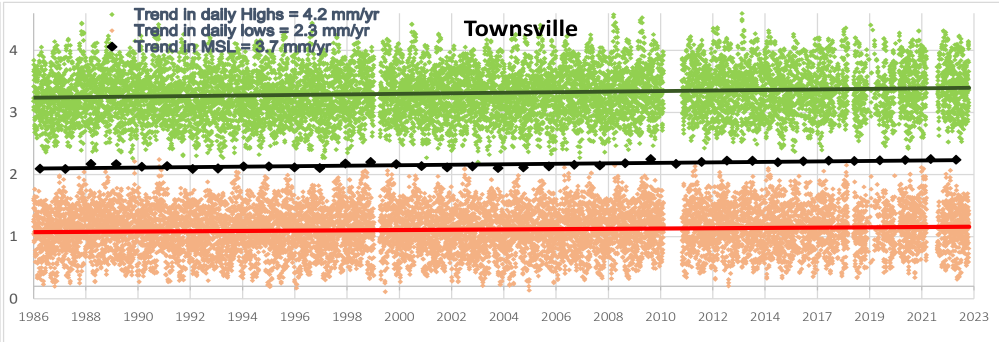

Hay Point
Trend in daily Highs = 2.0 mm/yr
Trend in daily lows = 1.3 mm/yr
Trend in MSL = 0.8 mm/yr

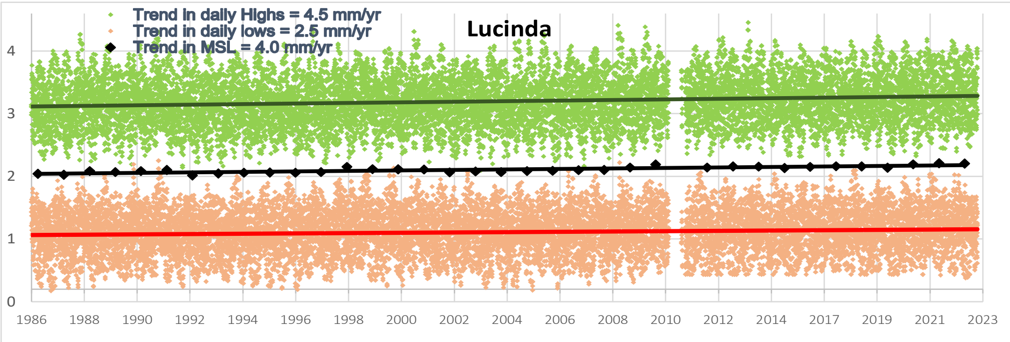

Mackay
Trend in daily Highs = 5.5 mm/yr
Trend in daily lows = 2.3 mm/yr
Trend in MSL = 3.8 mm/yr

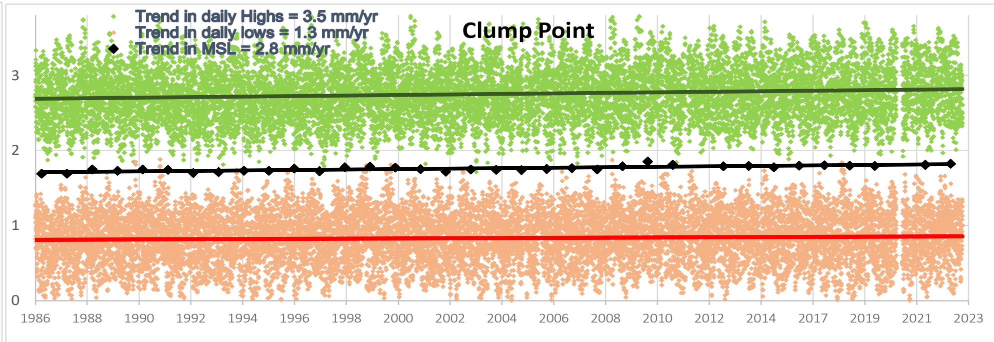

Trend in daily Highs = 3.9 mm/yr
Trend in daily lows = 2.2 mm/yr
Trend in MSL = 3.3 mm/yr
Shute Harbour

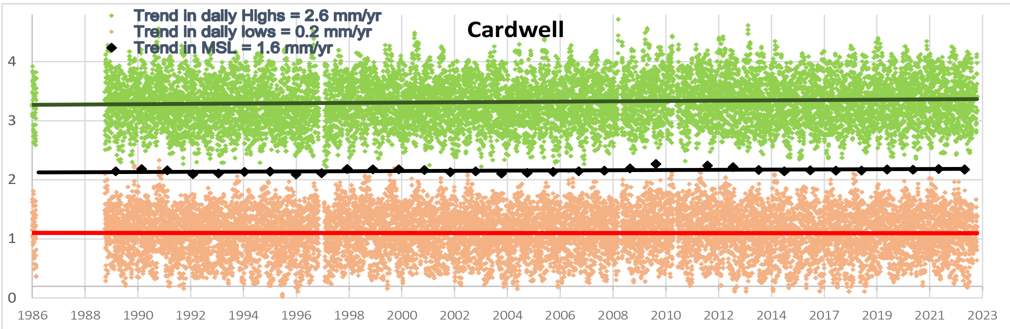

Trend in daily Highs = 3.4 mm/yr
Trend in daily lows = 1.9 mm/yr
Trend in MSL = 3.2 mm/yr
Bowen

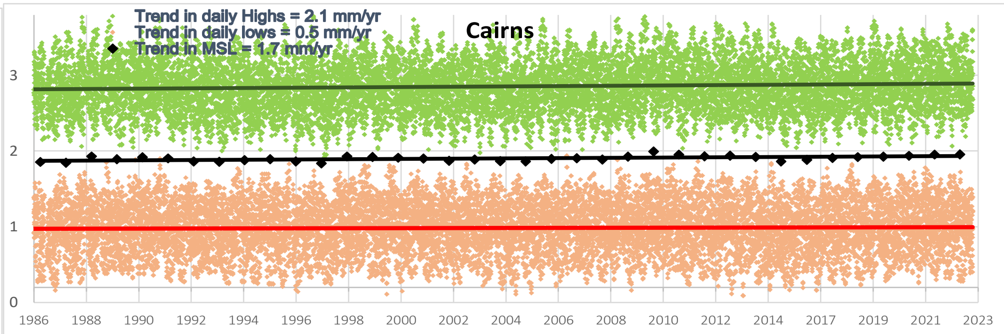

Trend in daily Highs = 3.4 mm/yr
Trend in daily lows = 1.8 mm/yr
Trend in MSL = 2.8 mm/yr
Cape Ferguson

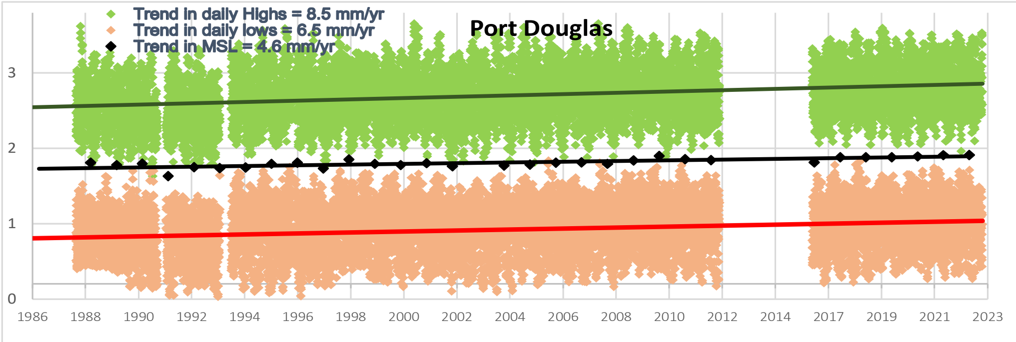

Trend in daily Highs = 4.2 mm/yr
Trend in daily lows = 2.3 mm/yr
Trend in MSL = 3.7 mm/yr
Townsville

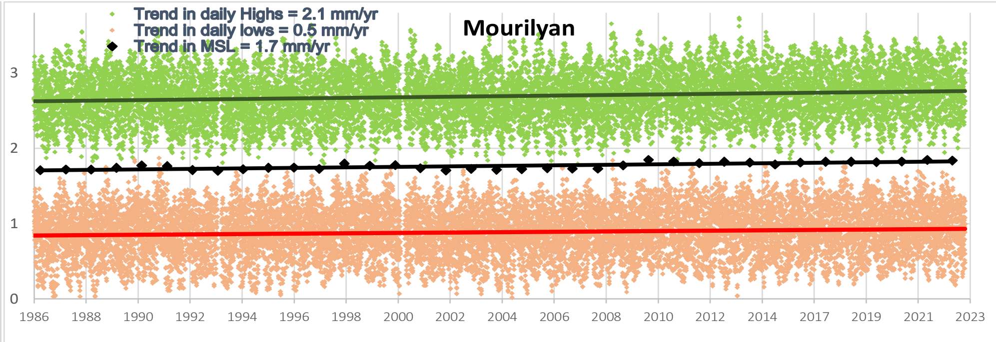

Trend in daily Highs = 4.5 mm/yr
Trend in daily lows = 2.5 mm/yr
Trend in MSL = 4.0 mm/yr
Lucinda

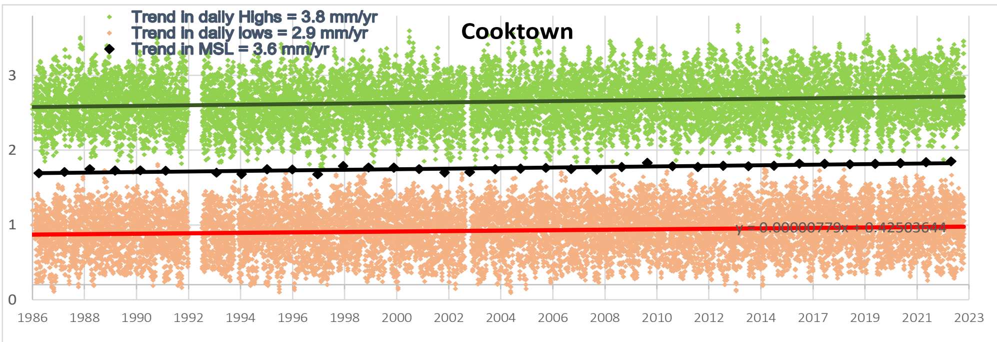

Trend in daily Highs = 3.5 mm/yr
Trend in daily lows = 1.3 mm/yr
Trend in MSL = 2.8 mm/yr
Clump Point

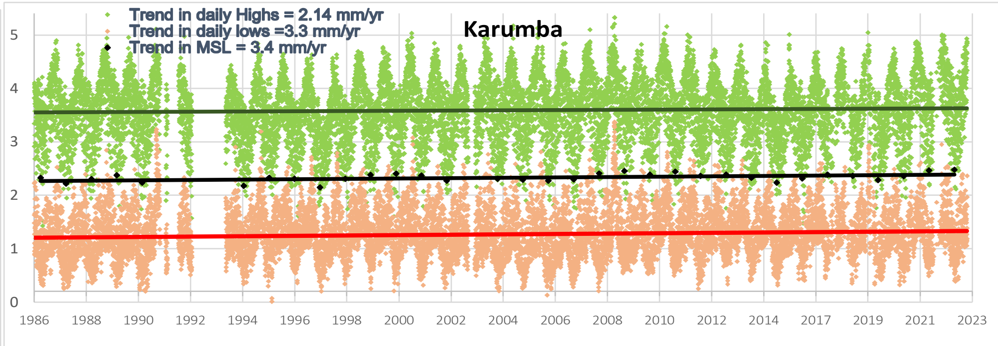

Trend in daily Highs = 2.6 mm/yr
Trend in daily lows = 0.2 mm/yr
Trend in MSL = 1.6 mm/yr
Cardwell

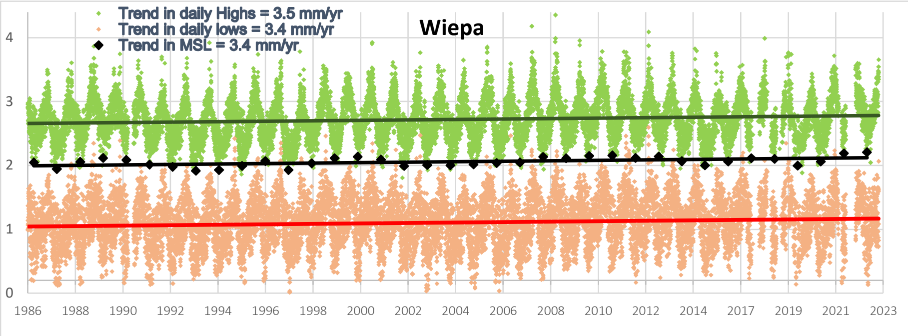

Trend in daily Highs = 2.1 mm/yr
Trend in daily lows = 0.5 mm/yr
Trend in MSL = 1.7 mm/yr
Cairns


Trend in daily Highs = 8.5 mm/yr
Trend in daily lows = 6.5 mm/yr
Trend in MSL = 4.6 mm/yr
Port Douglas


Trend in daily Highs = 2.1 mm/yr
Trend in daily lows = 0.5 mm/yr
Trend in MSL = 1.7 mm/yr
Mourilyan


Trend in daily Highs = 3.8 mm/yr
Trend in daily lows = 2.9 mm/yr
Trend in MSL = 3.6 mm/yr
Cooktown


Trend in daily Highs = 2.14 mm/yr
Trend in daily lows =3.3 mm/yr
Trend in MSL = 3.4 mm/yr
Karumba


Trend in daily Highs = 3.5 mm/yr
Trend in daily lows = 3.4 mm/yr
Trend in MSL = 3.4 mm/yr
Wiepa
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