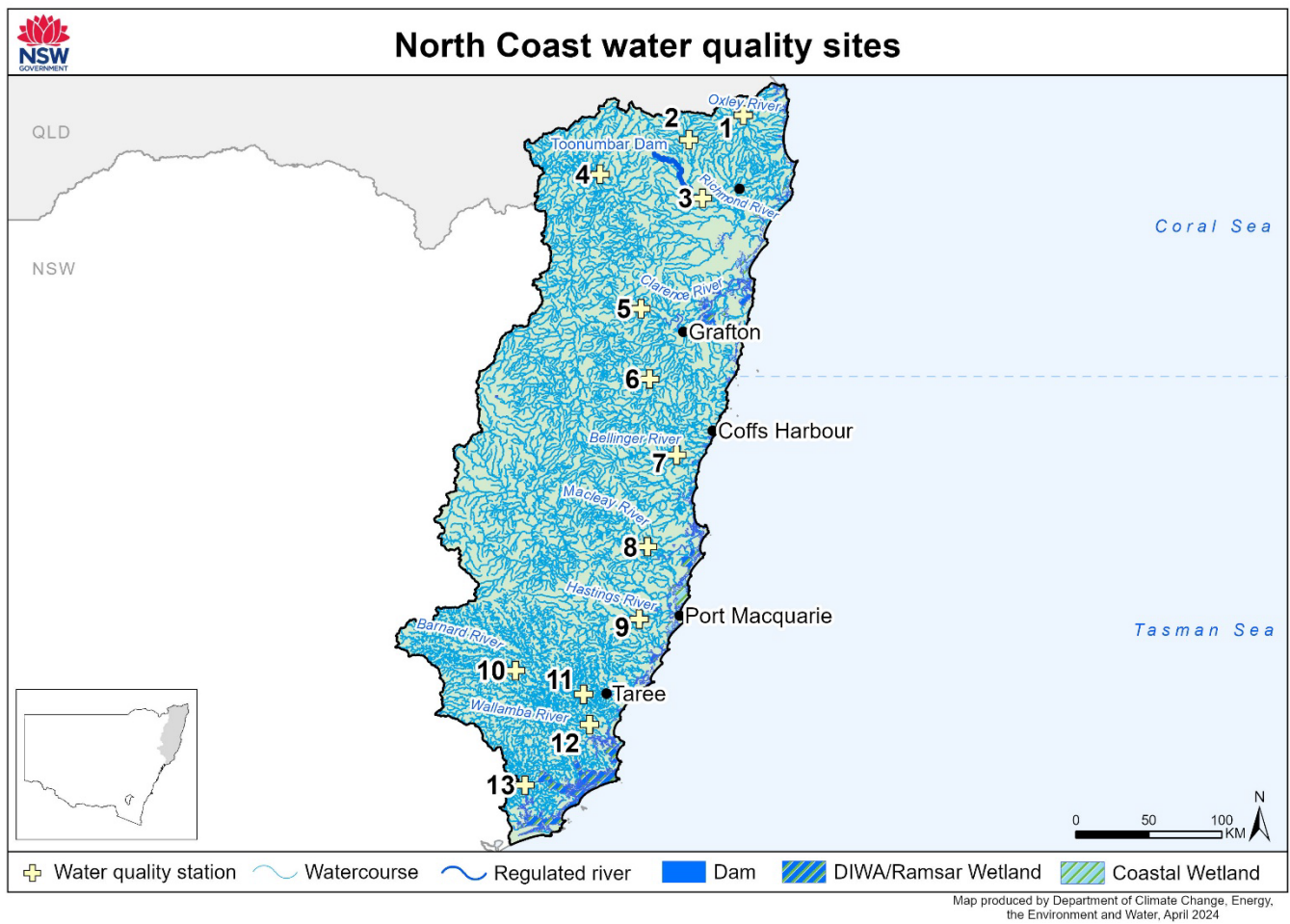


North Coast valleys annual surface water quality report: 2022–2023

Key Points

- Flow during July 2022 to June 2023 was characterised by heavy rain falling across much of the catchment. This heavy rain led to several large flood events on the North Coast in 2022.
- The heavy rains kept water storage levels high throughout the year.
- Flooding was the main driver of water quality in the North Coast catchment. The water quality index indicated that of the 13 sites in the catchment, one was rated as good, 7 as moderate and 5 as poor. Compared to the 2021–2022 results, the water quality index score improved at 7 sites.
- Heavy rainfall and flooding brought freshwater inflows to the Richmond, Clarence and Macleay River tidal pools which kept electrical conductivity low.
- Red alerts for blue-green algae occurred in Toonumbar Dam and downstream of the dam in February and March 2023. Lake Ainsworth recorded red alerts for recreational use during February 2023.

The water quality data used in this report is collected on a monthly frequency at 13 sites in the North Coast valleys for the State Water Quality Assessment and Monitoring Program. The program is responsible for collecting, analysing and reporting the ambient water quality condition of rivers in NSW. This annual report summarises the surface water quality data collected in the North Coast valleys from July 2022 to June 2023. The location of monitoring sites is shown in Figure 1.



Map produced by Department of Climate Change, Energy, the Environment and Water, April 2024

Figure 1: Location of routine water quality monitoring sites in the North Coast valleys

Table 1: Site information for each monitoring site in the North Coast catchments. Refer to Figure 1 and site numbers for location of each site.

Site number	Site name	Water Quality Zone	Station number
1	Oxley River near Eungella	Far North Coast lowlands	20110017
2	Richmond River at Wiangaree	Far North Coast lowlands	203005
3	Richmond River at Casino	Far North Coast regulated	203004
4	Clarence River at Paddy’s Flat	North Coast uplands	204051
5	Clarence River at Lillydale	North Coast lowlands	20410043
6	Nymboida River at Nymboida	North Coast uplands	204001
7	Bellinger River at Bellingen	North Coast lowlands	20510051
8	Macleay River at Turners Flat	North Coast lowlands	206011
9	Hastings River at Kooree Island Road	Lower North Coast lowlands	20710002
10	Barnard River at Mackay	Lower North Coast uplands	208011
11	Manning River at Killawarra	Lower North Coast lowlands	208004
12	Wallamba River at Dargaville Road Crossing	Lower North Coast lowlands	20910017
13	Karuah River at Booral	Lower North Coast lowlands	209003

Catchment description

The North Coast catchment covers an area greater than 27,000 km², extending from the Queensland border to the Hunter Catchment in the south, with the Border Rivers, Gwydir and Namoi catchments to the west. Rugged mountainous areas often characterise the headwaters of North Coast river catchments, which then flow onto large flat coastal floodplains. Many of the rivers on the North Coast are recognised as having high biodiversity and ecological value. The Great Lakes also fall within the North Coast area and include Wallis, Smith and Myall Lakes.

The North Coast catchment contains several river basins which flow east into the Pacific Ocean including the Tweed and Richmond Rivers in the far north coast, the Clarence, Hastings, Bellinger and Macleay Rivers in the mid-north coast, and the Manning and Karuah Rivers on the lower north coast.

Several large towns are present on the North Coast including Port Macquarie, Grafton, Lismore, Ballina and Coffs Harbour. Water use is generally for town water supply with some irrigation present. Major instream storages include Clarrie Hall Dam on the Tweed River and Toonumbar Dam, Rocky Creek Dam and Emigrant Creek Dam on the Richmond River, several smaller weirs and off-stream dams are also present throughout the North Coast.

Catchment conditions during 2022–2023

Flow during 2022–2023 was characterised by extremely heavy rain falling across much of the catchment from July 2022 through to May 2023 (Figure 2A). This heavy rain between July and May (Figure 2C), led to large flood events on the North Coast. During this period, the Manning River at Killawarra peaked at over 230,000 ML/d as did the Macleay River at Turners Flat, reaching almost 90,000 ML/d in July 2022. The Richmond River at Casino experienced its highest peak in October 2022, reaching near 25,000 ML/d.

Toonumbar Dam started and ended the 2022–2023 period at 100% capacity (11GL), dropping to slightly below 98% in early April 2023 (Figure 2B).

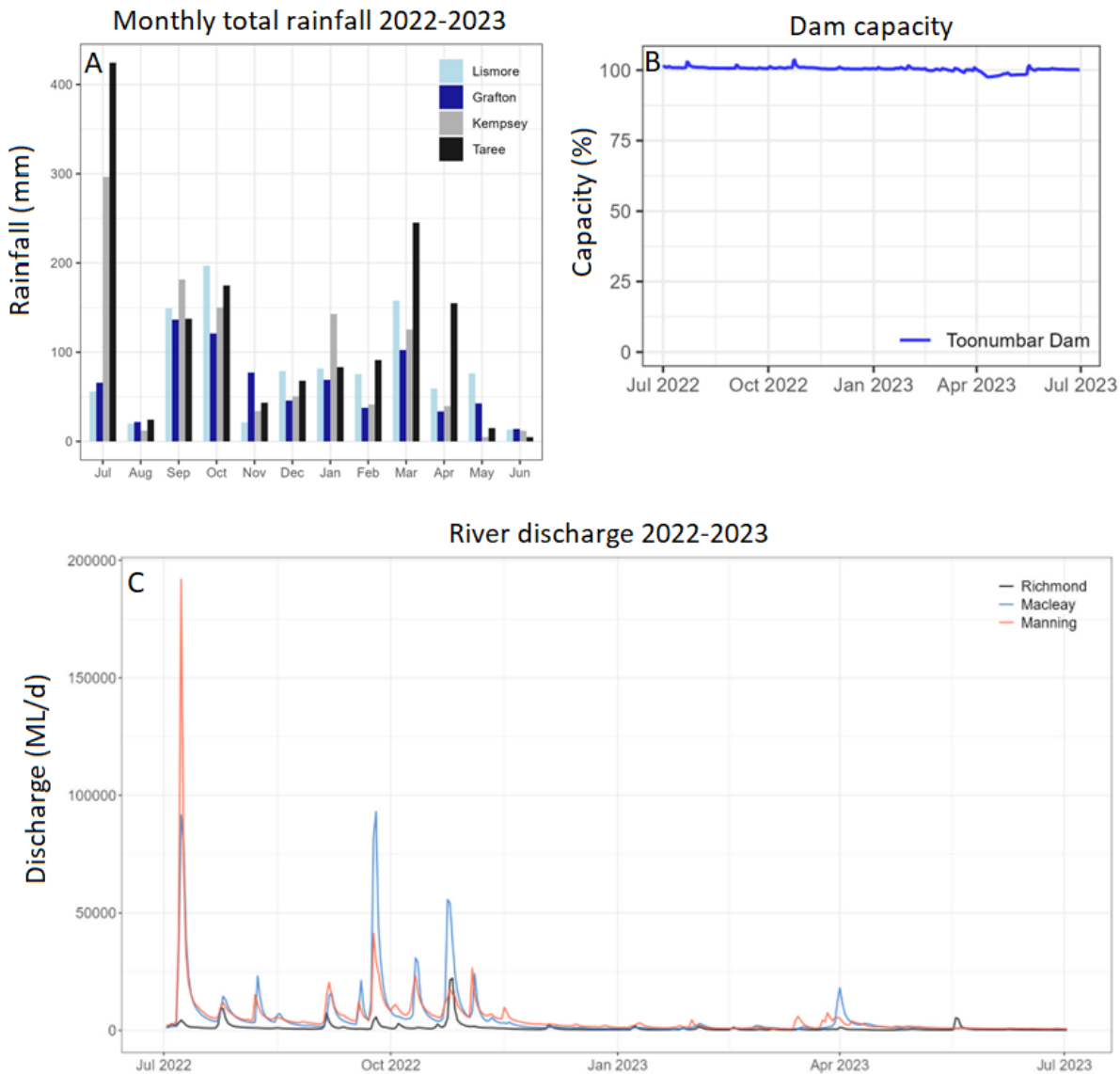


Figure 2: Catchment conditions for selected stations in the North Coast catchment from July 2022 to June 2023 for A: Monthly total rainfall (mm) B: Dam capacity (%) and C: River discharge (ML/day).

Water quality for water dependent ecosystems

NSW uses a Water Quality Index (WaQI) as a tool to communicate complex and technical water quality data in a simple and consistent way. The WaQI score was calculated for each monitoring site using total nitrogen, total phosphorus, turbidity, pH, dissolved oxygen and electrical conductivity. The index compares the monthly water quality results against a set of predetermined water quality targets to calculate a score between 1 and 100. A score of 100 represents a site in pristine condition, while a score of one is a very highly degraded site. This value can then be categorised to rate the

general water quality at a monitoring site. The results from the WaQI are summarised in Figure 3. Sites where there has been a change of less than 5 points in WaQI score, have been identified with horizontal arrows. Up or down arrows indicate the score has changed by more than 5 points.

The water quality index category ratings in the North Coast Valley improved in 2022–2023 for 3 of the 13 sites while 2 sites declined compared to 2021–2022. The ratings remained the same for the other 8 sites.

- Oxley River near Eungella remained good.
- Richmond River at Wiangaree, Casino and the Manning River at Killawarra improved from poor to moderate.
- Bellinger River at Bellingen declined from good to moderate.
- Nymboida River at Nymboida and Barnard River at Mackay remained moderate.
- All other sites remained poor.

The improvement in the Richmond and Manning rivers from poor to moderate was due to lower turbidity and lower nutrient levels. Bellinger River at Bellingen declined to moderate due to higher turbidity and nutrient levels.

Compared to the 2021–2022 results, the water quality index scores improved for 7 sites. Increased sediment loads caused by flooding resulted in a decline in index scores at 2 sites while the remaining 4 sites showed minimal change in water quality.

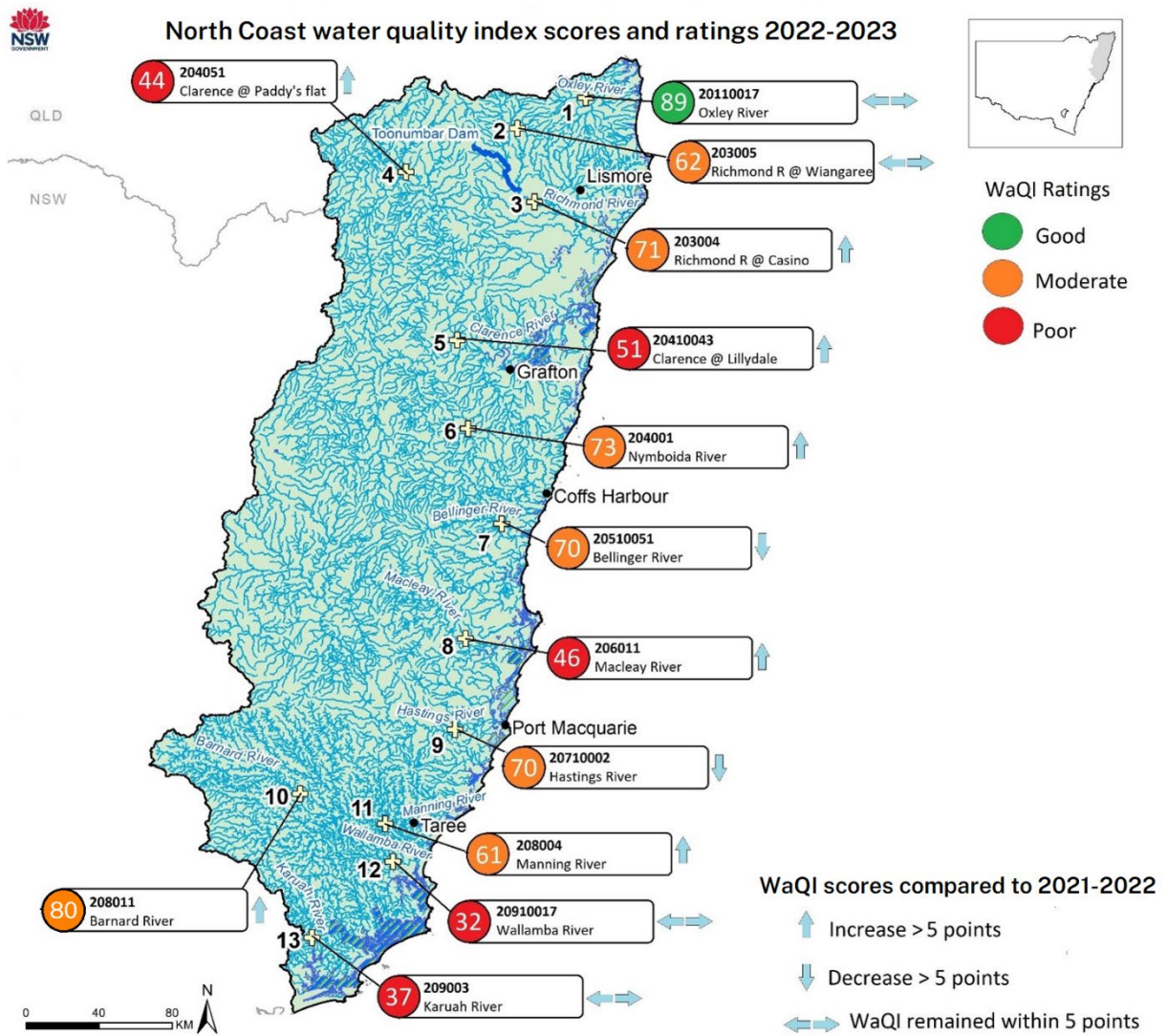


Figure 3: Water quality index scores and ratings for the North Coast valleys

The majority of the monitoring sites on the North Coast are located in the lower catchment where the quality of the water is impacted by the cumulative effects of land use, soil and vegetation disturbance and human activity occurring in the catchment.

There was some variability in pH results between the North Coast valleys. The median results for all sites except for the Manning and Karuah rivers were between 7 and 8, which is safe for water-dependent ecosystems.

The highest turbidity and nutrient concentrations were detected in the Richmond River at Casino.

Hypoxic, or low oxygen blackwater is a feature of Australian lowland river systems and occurs when organic material, such as sticks, leaves, bark, grass or crops are broken down in floodwater or washed off the floodplain into the river. The breakdown of this material by bacteria can rapidly use up all the oxygen in the water. Despite the flooding, dissolved oxygen levels were relatively stable across most sites, with median levels above 90% saturation for all sites except Wallamba River. The median dissolved oxygen in the Wallamba River remained above the critical thresholds for fish health.

Electrical conductivity is low across all the North Coast catchments and would not impact on agricultural use or aquatic ecosystems. The highest readings were in Wallamba River. The Wallamba River monitoring site is located close to the upper tidal limit, which can result in increased electrical conductivity during periods of very low flows and high tides.

Summary statistics for the key water quality parameters at each monitoring site on the North Coast have been displayed as box plots (Figure 4). The box plots show the annual 25th, 50th and 75th percentile values, with error bars indicating the 10th and 90th percentile values for each site.

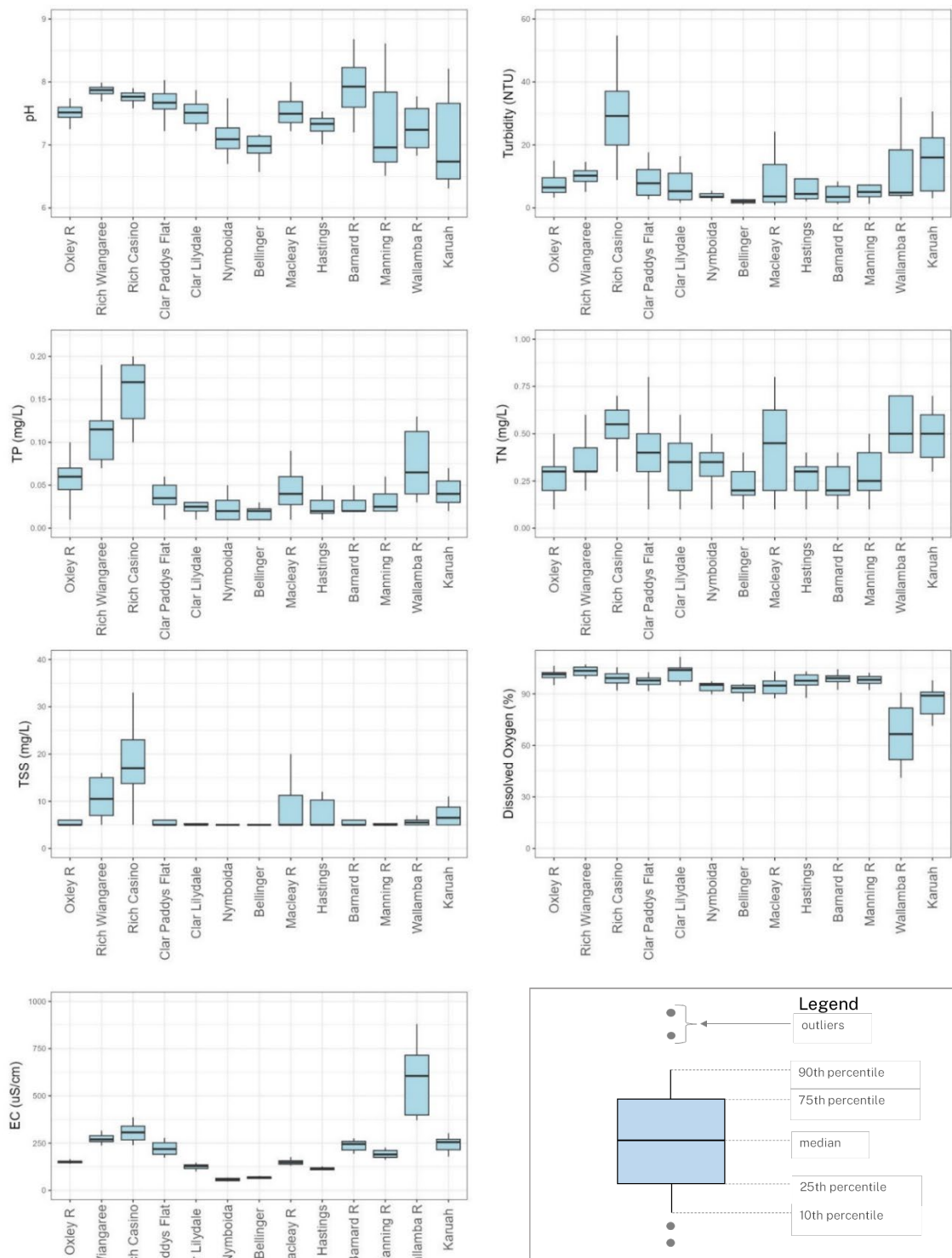


Figure 4: Water quality data by site, moving upstream to downstream from left to right. The water quality parameters shown are pH, Turbidity, Total phosphorus (TP), Total nitrogen (TN), Total suspended solids (TSS), Dissolved oxygen, and electrical conductivity (EC).

Irrigation and salinity

During periods of low flow in the Richmond, Clarence and Macleay rivers, salt water from the sea is able to push further up the estuaries where it can impact water users. Monitoring in the Richmond, Clarence and Macleay tidal pools (Figure 5) shows heavy rainfall and flooding brought freshwater inflows to these tidal pools which kept electrical conductivity at safe levels for agricultural use in the upper reaches of the tidal pool. Electrical conductivity at Coraki and Kempsey remained low throughout 2022 and 2023. There was an increase in electrical conductivity at Grafton in June 2023 but remained in the safe range.

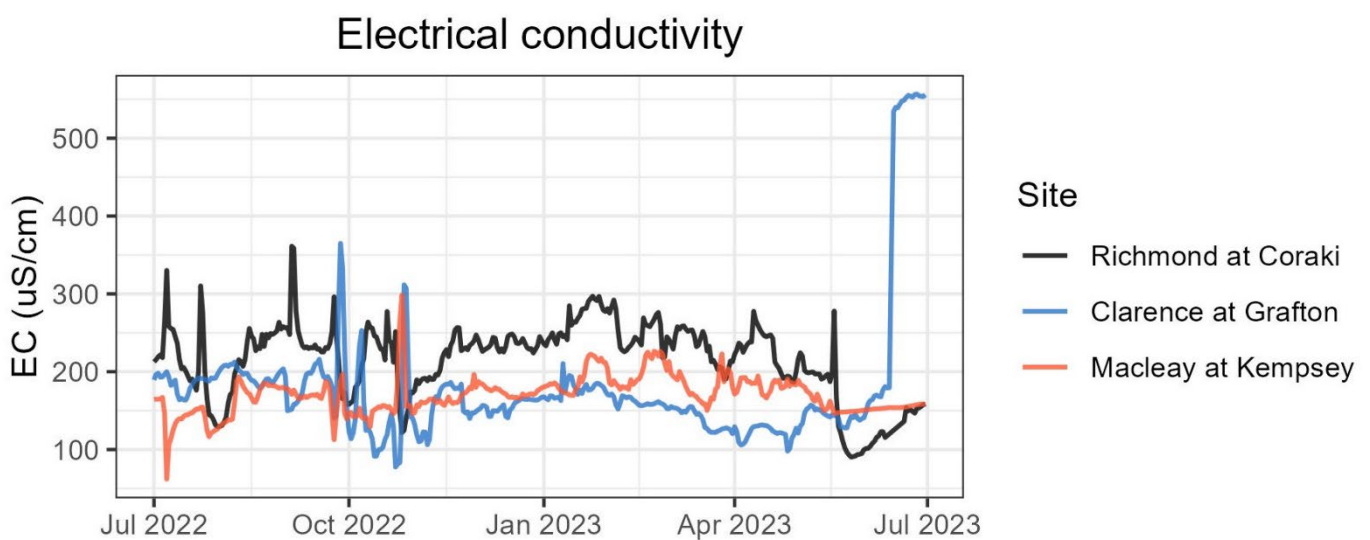


Figure 5: Electrical conductivity in the North Coast valleys

Recreation

Exposure to blue-green algae (cyanobacteria) through ingestion, inhalation or contact during recreational use of water can impact human health. A colour alert scale is used with a green alert warning indicating low numbers of blue-green algae but requiring monitoring, an amber alert warning being a heightened level of alert with increased sampling and surveillance, and a red alert warning being a state of action where waters are unsuitable for recreational use. For more information about blue-green algae and algal alerts see the WaterNSW algae web page ([Algae - WaterNSW](#)).

Blue-green algae have historically been a major issue in Toonumbar Dam during the high-risk summer period. Lake Ainsworth is also prone to algal blooms during summer due to high temperatures and extended dry periods. Table 1 indicates the distribution of algal alerts during July 2022 to June 2023. Due to heavy rainfall events, Lake Ainsworth only recorded red alerts for



recreational use during February 2023. Toonumbar Dam and downstream of Toonumbar Dam were on red alert for recreational use during February and March 2023. Myall Lakes also received a red alert for recreational use at the beginning of July until August 2022 due to high nutrient loads.

Table 2: Distribution of algal alert levels in the North Coast valleys July 2022 to June 2023

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
Clarrie Hall Dam	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	2 2 2 2	2 2 2 2
Tweed River at Uki Pool	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *
Emigrant Creek Dam	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	1 1 2 2	2 2 2 2
Lake Ainsworth	* * * * *	* * * * *	* * * * *	1 1	* 1	* * * * *	1 * * * *	1 3 3	2 * * * *	* * * * *	2 2 2 2	* * * * *
Toonumbar Dam	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	1 1 1 1	1 1 1 1	2 2 3 3	3 3 3 3	3 3 3 3	3 2 2 1	2 * * * *
Toonumbar Downstream	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	1 1	* * * * *	2 2 3 3	3 2 2 3	2 2 1 1	1 1 2 2	* 1 1 1
Richmond River at Casino	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	2 * 1 1	* * 1 1	2 * * * *	* * * * *	* * * * *
Malpas Dam	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *
Duchess Creek (Port Macquarie)	* * * * *	* * * * *	* * * * *	* * * * *	1 1	* * * * *	1 2 2	* * 1 *	1 * 1 1	1 1 * * *	* * * * *	* * * * *
Myall Lakes	3 3 3 3	3 3 3 3	1 1 1 1	1 1 1 1	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *	* * * * *

Key : * = Nil/Low alert 1 = green alert 2 = amber alert 3 = red alert

Extreme water quality events

Spring 2022 was the wettest spring on record (since 1900) for New South Wales. For the east coast of New South Wales, several days of very heavy rain in July resulted in major flooding of the Hawkesbury–Nepean River and extended along the New South Wales coast. A natural disaster was declared for New South Wales following the flooding from heavy rainfall. Numerous locations set new daily July rainfall records, mostly in coastal areas from the Illawarra to the Mid North Coast (Figure 6 - BoM, 2023 and Figure 7). Further flooding occurred in the Northern Rivers with increased rainfall over September 2022.

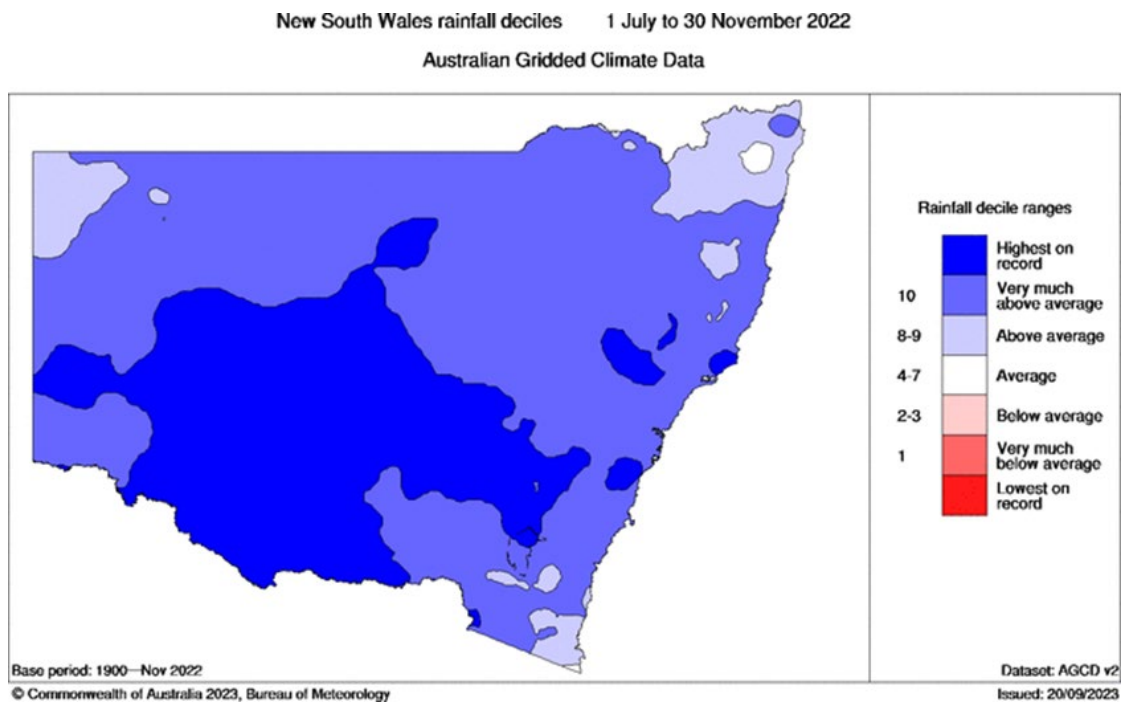


Figure 6: NSW rainfall deciles from July to November 2022. (Source: BoM)



Figure 7: Manning River near Taree after heavy rainfall, 10 July 2022. (Source: Planet Explorer)

With flooding on this scale came an increased risk of poor water quality events and a high risk of significant fish deaths. Despite widespread flooding, no fish kills were reported in North Coast catchments for 2022/2023. Fish kills in NSW are listed on [Department of Primary Industries website](#).

Summary

The quality of the water in a river or stream is a reflection of underlying climate and geology and the multiple activities and land uses occurring in a catchment area. Numerous factors contribute to the observed results.

In 2022 and 2023, flooding was the main water quality driver. Increased runoff carries high volumes of sediment and attached nutrients such as nitrogen and phosphorus into waterways. This resulted in 5 of the 13 water quality monitoring sites being rated as having poor water quality, 6 as moderate and 2 as good. Although 7 sites returned a higher water quality index score in 2022–2023 than the previous year, 3 of these sites remained in the poor category.

Although these hypoxic blackwater events may result in the loss of fish and other aquatic life, the impacts on the environment are usually short-term, as the river water re-oxygenates again as the flooding subsides. No fish deaths were reported in 2022–2023.

Long-term water quality trends

Analysis of WaQI scores from 2012–2013 to 2022–2023 shows the majority of sites have a long term median WaQI rating of moderate or good (Figure 8). The highest scores were in the Oxley, Nymboida and Bellinger rivers. The lowest median score was in Wallamba River followed by the Karuah and Macleay rivers and both monitoring sites on the Clarence River.

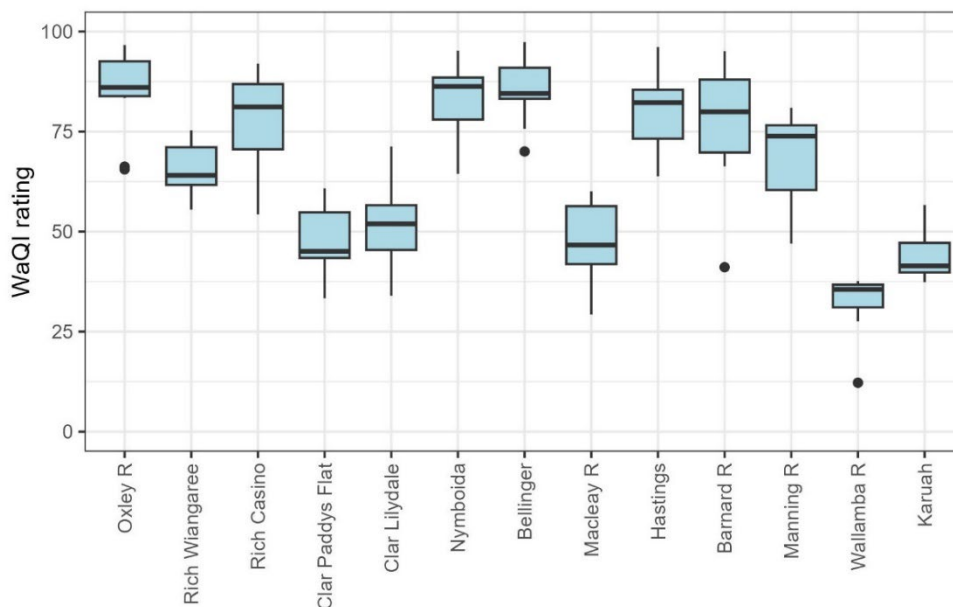


Figure 8: Boxplots showing long-term (2012–2013 to 2022–2023) WaQI scores for the North Coast

The number of sites with a good rating declined from 6 in 2013–2014 down to one in 2022–2023 (Figure 9). Over this time the number sites with a moderate rating increased from 2 up to 7. There was an increase in the number of poor sites from 3 in 2018–2019 up to 8 in 2021–2022. The decline in water quality over this time coincides with extensive areas burnt by bushfires followed by heavy rain and flooding.

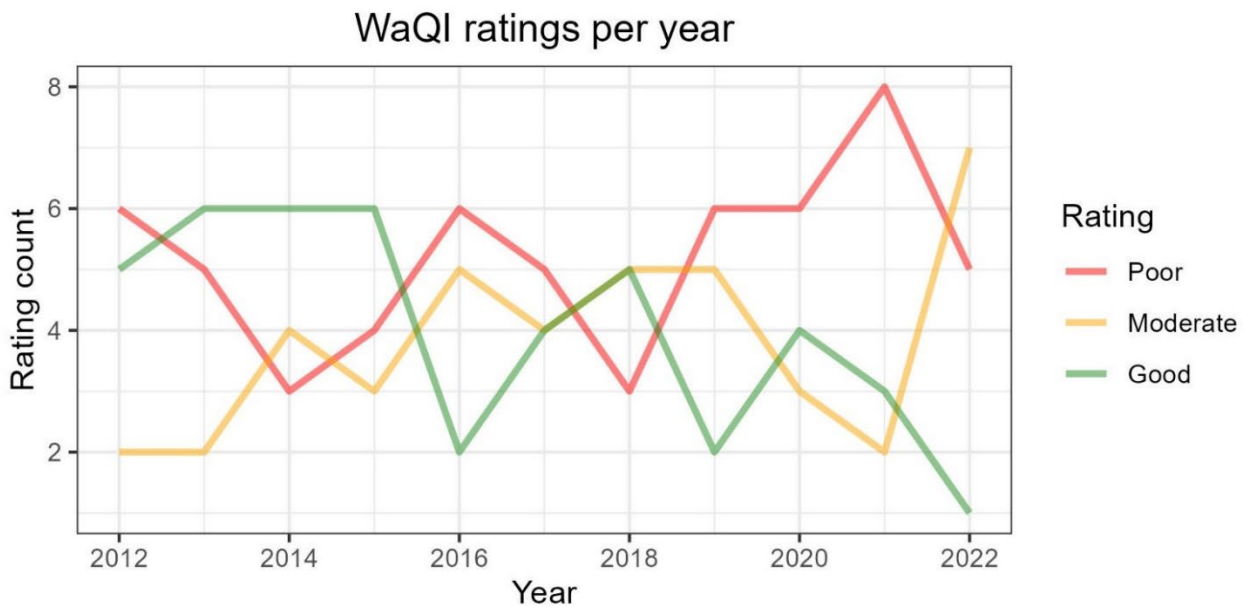


Figure 9: Graph summarising long-term water quality index ratings (2012–2013 to 2022–2023) for every site on the North Coast by year

References and further information

Bureau of Meteorology, (BoM). 2023. Financial year Australian climate and water statement 2023. Financial year climate and water report 2023. <http://www.bom.gov.au/climate/current/financial-year/aus/summary.shtml#tabs=Water>

Bureau of Meteorology, (BoM). Recent and historical rainfall maps: <http://www.bom.gov.au/climate/maps/rainfall/?variable=rainfall&map=totals&period=daily®ion=nat&year=2023&month=10&day=13>

Fish kills in NSW: <https://www.dpi.nsw.gov.au/fishing/habitat/threats/fish-kills>