North East Coast

3 North East Coast

3.1 Introduction

This chapter examines water resources in the North East Coast region in 2011–12 and over recent decades. It starts with summary information on the status of water flows, stores and use. This is followed by descriptive information including the physiographic characteristics, soil types, population, land use and climate of the region.

Spatial and temporal patterns in landscape water flows are presented, and surface and groundwater resources examined. The chapter concludes with a review of the water situation for urban centres and irrigation areas. The Technical Supplement details the sources and methods used in developing the diagrams and maps.

3.2 Key information

Table 3.1 gives an overview of the key components of the data and information in this chapter.

Table 3.1 Key information on water flows, stores and use in the North East Coast region

Landscape water flows

	Region average	Difference from 1911–2012 long-term annual mean	Decile ranking with respect to the 1911–2012 record
Rainfall	1,041 mm	+22%	9th—above average
Evapo-transpiration	814 mm	+18%	9th—above average
Landscape water yield	223 mm	+42%	9th—above average

Streamflow (at selected gauges)

Annual total flow:	Predominantly average to above average flow throughout the region
Salinity:	Annual median electrical conductivity predominantly below 1,000 µS/cm throughout the region
Flooding:	Major floods in many parts of the region

Surface water storage (comprising about 92% of the region's total capacity of all major storages)

Total accessible capacity	30 June 2012		30 June 2011		Change	
	accessible volume	% of total capacity	accessible volume	% of total capacity	accessible volume	% of total capacity
9,516 GL	9,301 GL	98%	9,135 GL	96%	+166 GL	+2%

Wetlands inflow patterns (for selected wetlands)

Bowling Green Bay:	Average flows throughout the year, but very much above average flows in March
Fitzroy River floodplain:	Very much above average flows during February and March 2012
Great Sandy Strait:	Very much above average flows over the January to March 2012 period
Moreton Bay:	Very much above average flows in January and March 2012

Groundwater (in selected aquifers)

Levels:	Predominantly rising trends in the selected watertable aquifers over the 2007–08 to 2011–12 period
Salinity:	Scattered areas of saline groundwater (≥3,000 mg/L) throughout the region

Urban water use (Brisbane and Gold Coast)

Total use in 2011–12	Total use in 2010–11	Change	Restrictions
176 GL	180 GL	–4 GL (–2%)	Permanent Water Conservation Measures

Annual mean soil moisture (model estimates)

Spatial patterns:	Predominantly above average annual mean soil moisture with large inland areas of very much above average soil moisture
Temporal patterns in regional average:	Above average to very much above average soil moisture throughout the year

3.3 Description of the region

The North East Coast region is a 451,000 km² area in Queensland surrounded by the Great Dividing Range in the west, the Coral Sea in the east, Torres Strait in the north and the Queensland–New South Wales border in the south.

River basins in the region vary in size from 400–143,000 km². Major river basins include the Burdekin, Fitzroy, Burnett, Brisbane, Mary and Johnstone, Mulgrave, Barron, Daintree, Bloomfield and Normanby.

The largest river basins are the Burdekin and the Fitzroy (Figure 3.1), which together comprise 64% of the Great Barrier Reef catchment area and impact upon the offshore reef's ecosystems through discharges of sediments and nutrients.

The region includes some of the most topographically diverse terrain in Australia, including high altitudes associated with coastal ranges and tablelands and a retreating escarpment with outcrops on the coastal alluvial plains. The highest mountains in Queensland and the highest rainfall areas in Australia are north of Innisfail. Subsections 3.3.1–3.3.4 give more detail on the physical characteristics of the region.

With a population in excess of 4 million people the region is home to just over 19% of all Australians and 92% of all Queensland residents (Australian Bureau of Statistics [ABS] 2011b). Major population centres within the region include Brisbane, the Gold Coast and the Sunshine Coast as well as the regional centres of Hervey Bay, Bundaberg, Gladstone, Rockhampton, Mackay, Townsville and Cairns (Figure 3.1). Further discussion of the region's population distribution and urban centres can be found in subsection 3.3.6 and section 3.6 respectively.

Most of the region outside the urban centres is used for grazing. In the north this occurs on native rangelands with fewer management inputs and pasture improvement than occur in the southern river basins. Dryland and irrigated agriculture accounts for approximately 0.4% of the land use of the area. Areas of intensive land use such as in urban areas account for 0.2% of the area. Section 3.7 has more information on agricultural activities.

The region's climate is subtropical to tropical with hot, wet summers and cooler, dry winters. The monsoonal summer rainfall is more predictable in the north than in the south. Subsections 3.3.7 and 3.3.8 provide information on the rainfall patterns across the region.

A large area of outcropping fractured basement rock dominates the hydrogeology of the region. The groundwater systems in fractured rock typically offer restricted low-volume groundwater resources. In contrast, large groundwater resources are localised in alluvial valley systems and coastal sand deposits. The status of surface water and groundwater is presented in section 3.5.

Tropical landscape with tree ferns and rain forest, Queensland Tablelands | Dirk Ercken, Dreamstime

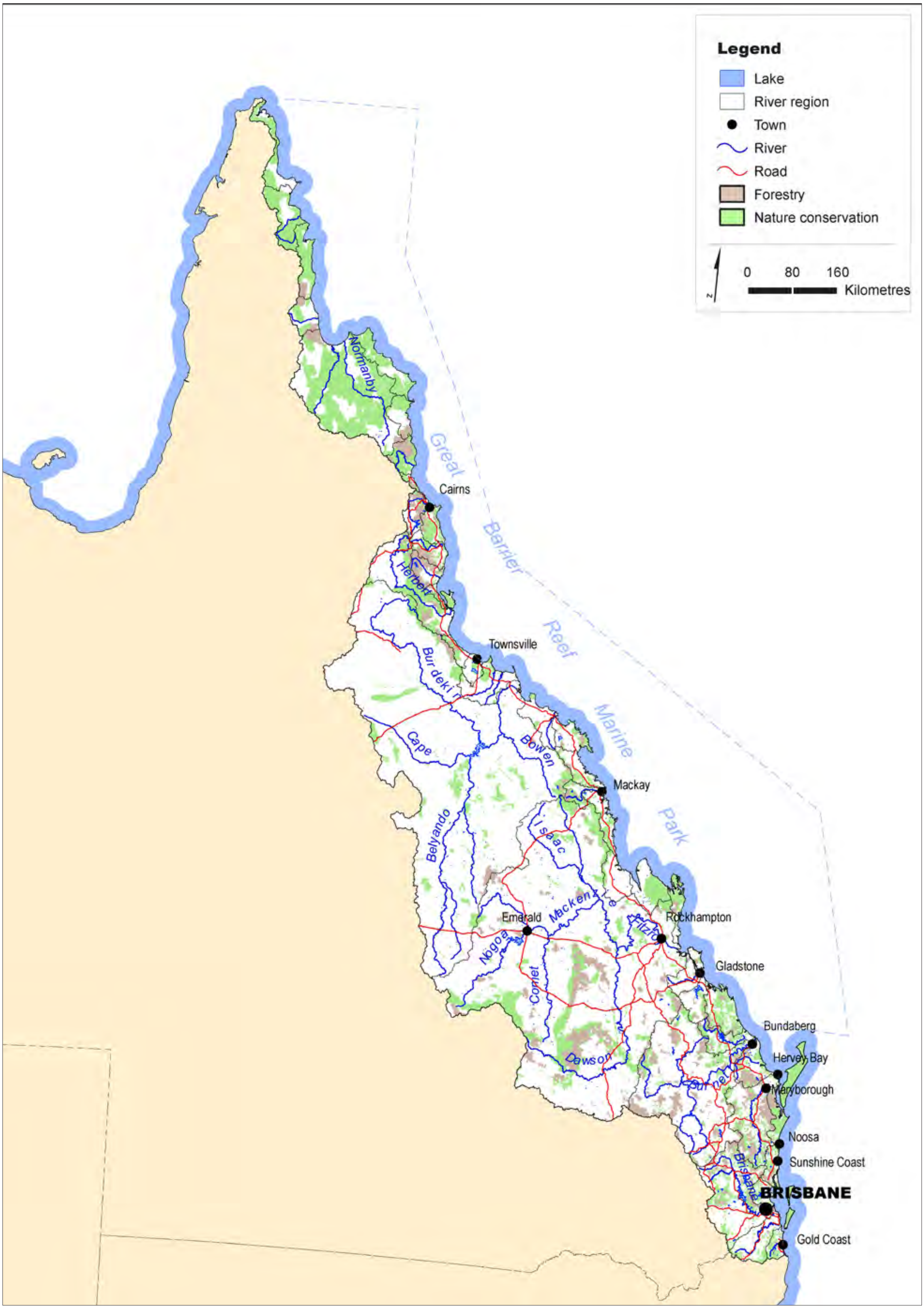


Figure 3.1 The North East Coast region

3.3.1 Physiographic characteristics

Figure 3.2 is a physiographic map indicating areas with similar landform evolutionary histories (Pain et al. 2011). These are related to similar geology and climatic impacts defining the extent of erosion processes.

The areas have distinct physical characteristics that influence hydrological processes.

The North East Coast region has four physiographic provinces. These are described in the following list with the proportion of the region they cover shown in brackets.

- Burdekin Uplands (21%): mixture of hills, plateaus and plains with the highlands chiefly on granite and metamorphic rocks with some young basaltic plateaus;
- Fitzroy Uplands (43%): mixture of hills, plateaus and plains with highlands of sandstone, basalt, granite and metamorphic rocks;
- New England–Moreton Uplands (23%): sandstone and igneous highlands with sedimentary and metamorphic lowlands; and
- Peninsular Uplands (13%): mixture of hills, plateaus and plains with highlands of sandstone as well as volcanic, granitic and metamorphic rocks.

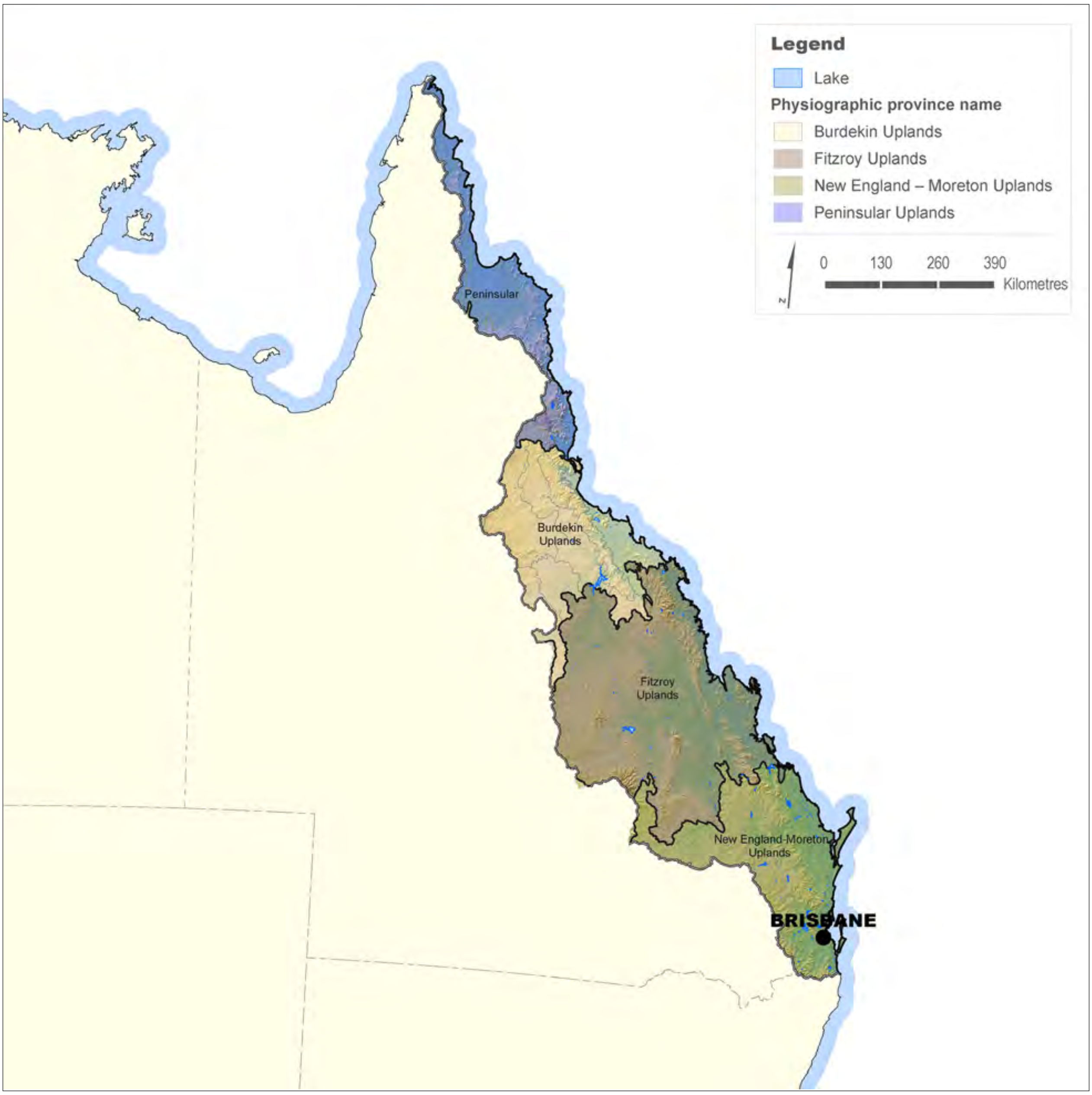


Figure 3.2 Physiographic provinces of the North East Coast region

3.3.2 Elevation

Figure 3.3 presents ground surface elevations in the North East Coast region. Information was obtained from the Geoscience Australia website (www.ga.gov.au/topographic-mapping/digital-elevation-data.html).

The North East Coast region has a very diverse topography and includes high altitudes associated with coastal ranges and tablelands, and a retreating escarpment with residual outliers on the coastal alluvial plains.

The region contains many mountains from part of the Great Dividing Range. It also contains large plateaus and low-lying coastal areas.

The highest mountains in the region can be found south of Cairns, with peaks reaching altitudes of 1,600 m above sea level.

Further south, the peaks of various coastal mountain ranges form water divides between the smaller coastal river basins and the few inland river basins.

The crest of the Great Dividing Range forms the western border of the region. Altitudes on this boundary vary from less than 200 m to more than 1,200 m.

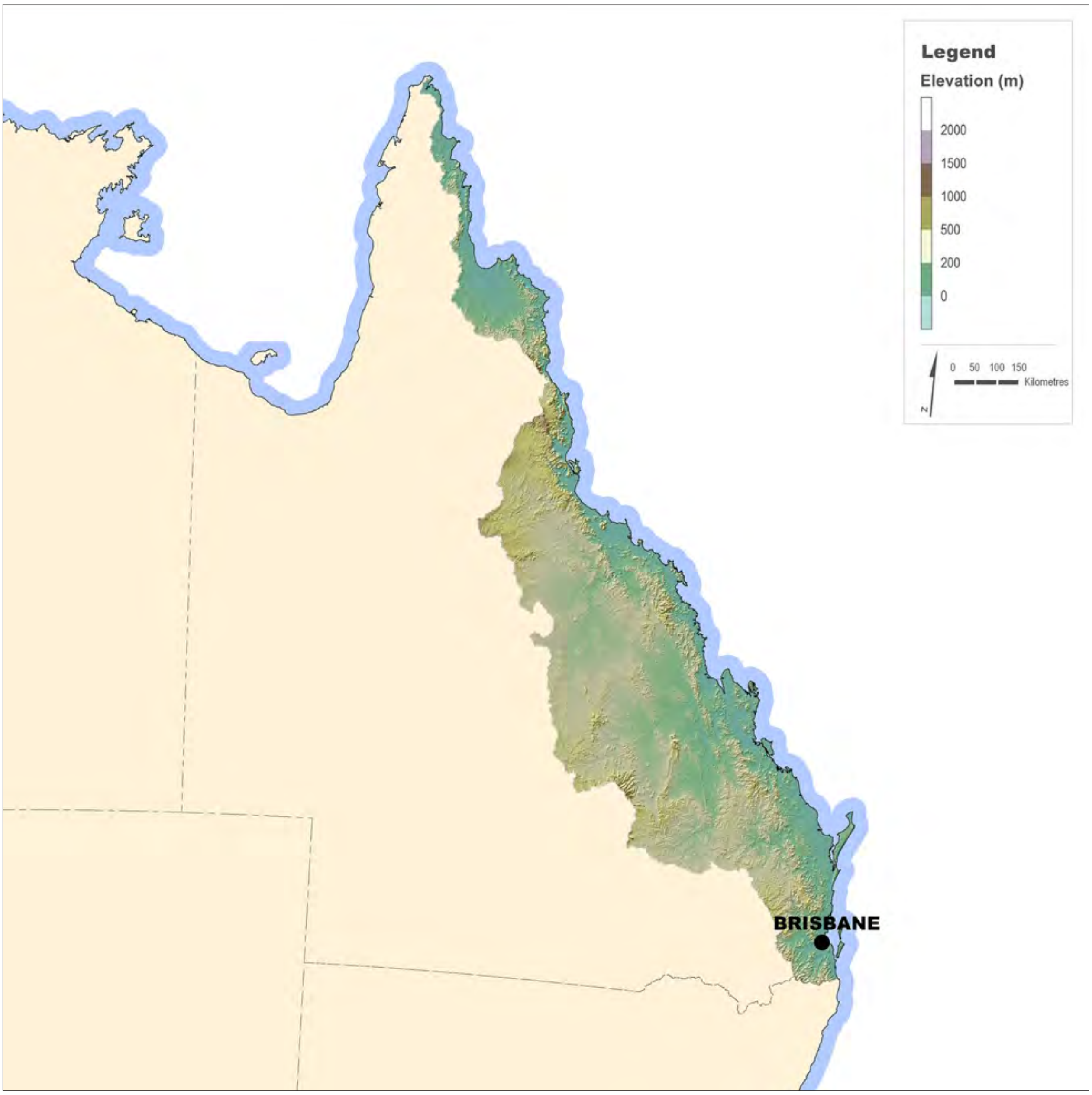


Figure 3.3 Ground surface elevations in the North East Coast region

3.3.3 Slopes

Table 3.2 summarises the proportions of slope classes for the region while Figure 3.4 shows the spatial distribution of the surface slopes. Areas with steep slopes provide higher run-off generating potential than flat areas. The North East Coast region has high slope variability with larger expanses of steeper slopes than most other parts of Australia. The slopes were derived from the elevation information used in the previous section.

Table 3.2 Proportions of slope classes for the region

Slope class (%)	0–0.5	0.5–1	1–5	> 5
Proportion of region (%)	19.0	16.4	43.8	20.8

Slopes are particularly steep along the coastal escarpment. Rivers in both the north and south of the region often have flash flooding under high intensity rainfall. The January 2011 flood in the Brisbane River and March 2012 flood in the Haughton River are examples of such events.

Further inland, slopes are rather gentle (Figure 3.4). At some locations large lakes have formed, both naturally as well as through the construction of dams for water supply.

In the flatter coastal areas many larger rivers form extensive floodplains. These are often identified as wetland areas of conservation significance.

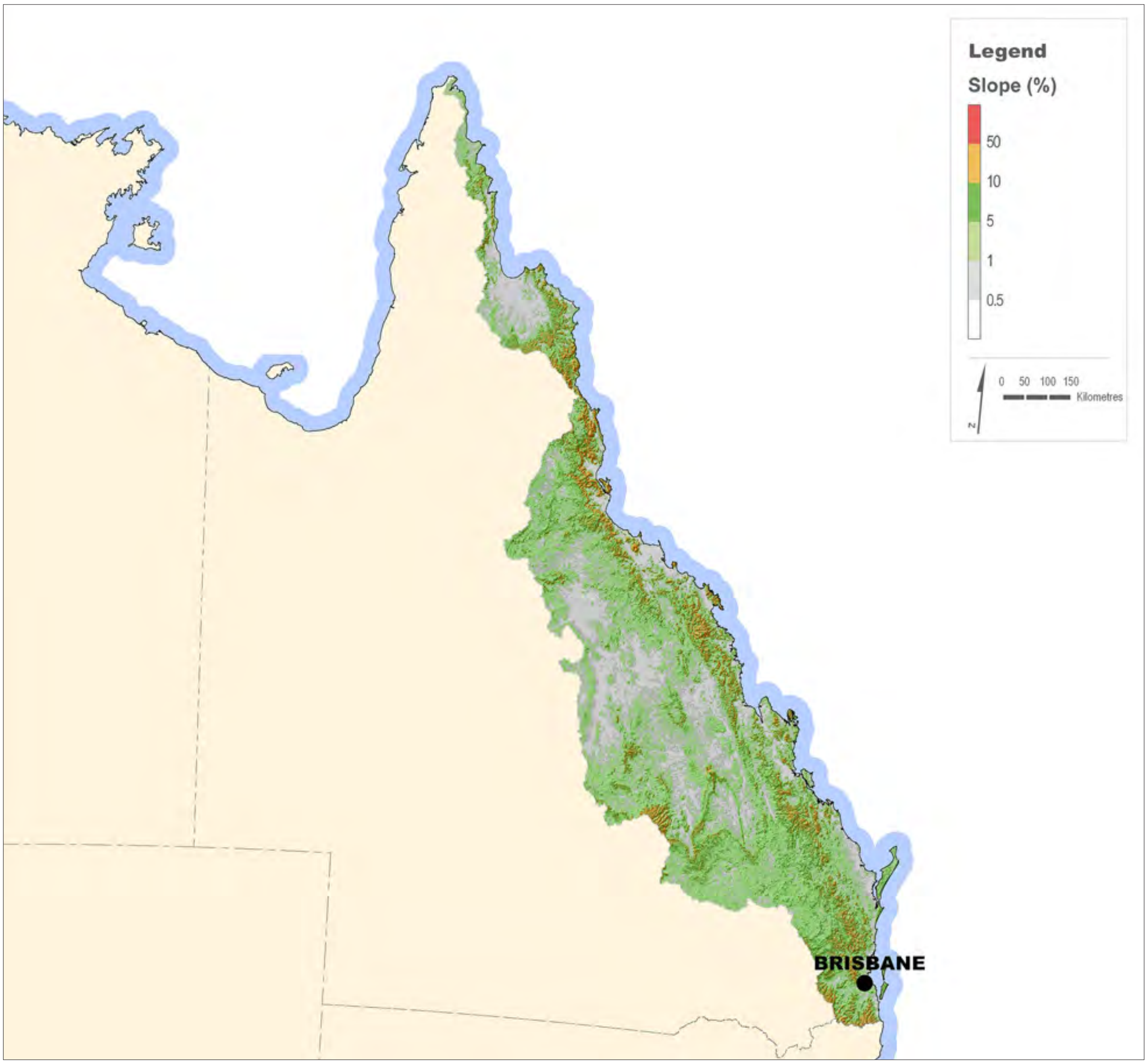


Figure 3.4 Surface slopes in the North East Coast region

3.3.4 Soil types

Soils play an important role in the hydrological cycle by distributing water that reaches the ground. Water can be transported to rivers and lakes via the soil surface as run-off or enter the soil and provide water for plant growth as well as contributing to groundwater recharge.

The nature of these hydrological pathways and the suitability of the soils for agricultural purposes are influenced by soil types and their characteristics.

Soil type information was obtained from the Australian Soil Resource System website (www.asris.csiro.au).

Figures 3.5–3.6 show the distribution of soil types within the North East Coast region. About 80% of the land surface is covered by five soil types, namely sodosols, kandosols, kertosols, tenosols and chromosols. With the exception of vertosols, these soils are widespread across the region, are low in fertility and are mostly used for grazing, dryland agriculture, horticulture and forestry.

Soil types with clear texture contrasts in this region are sodosols and chromosols. These soils can have a propensity to become waterlogged.

Sodosols have impermeable, sodic subsoil due to elevated sodium concentrations. They are susceptible to dryland salinity as well as erosion if vegetation is removed. Chromosols also have an impermeable subsoil that is not strongly sodic or acidic.

Vertosols, only distributed through the middle part of the region, are soils with a high clay content. These are brown, grey or black soils with large water-holding capacity, but can develop large cracks when drying. They are highly fertile and self-mulching.

Soils with little or no changes in soil texture in the region are kandosols and tenosols. Kandosols are usually red, yellow and grey massive earthy soils with a low water-holding capacity; however, a wide range of crops can be grown on them where rainfall is high or irrigation is available. Similarly, tenosols have a weak profile development. Their agricultural use is limited due to their low water-holding capacity and their often shallow or stony material. Soil types with small area coverage in the region are rudosols, dermosols, ferrosols, hydrosols, kurosols, and podosols (1–6%).

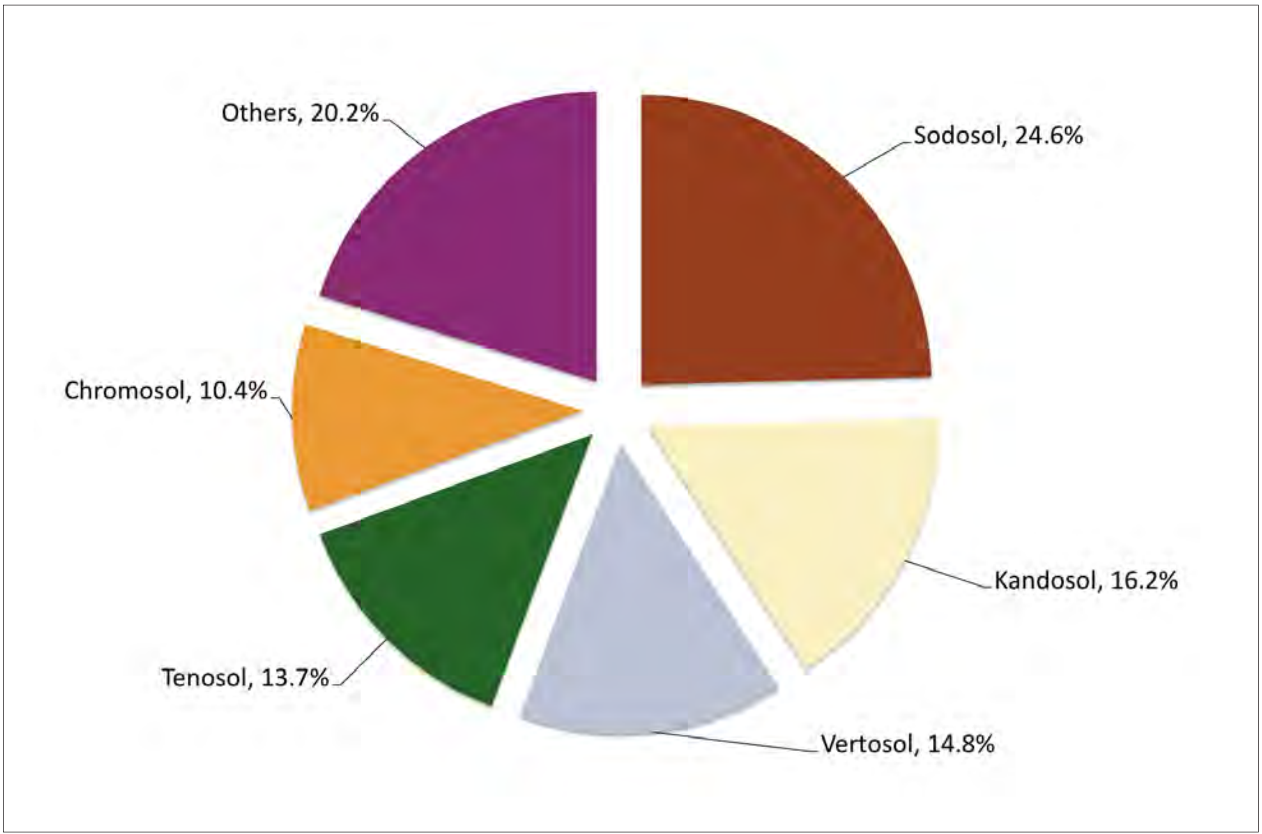


Figure 3.5 Soil types in the North East Coast region

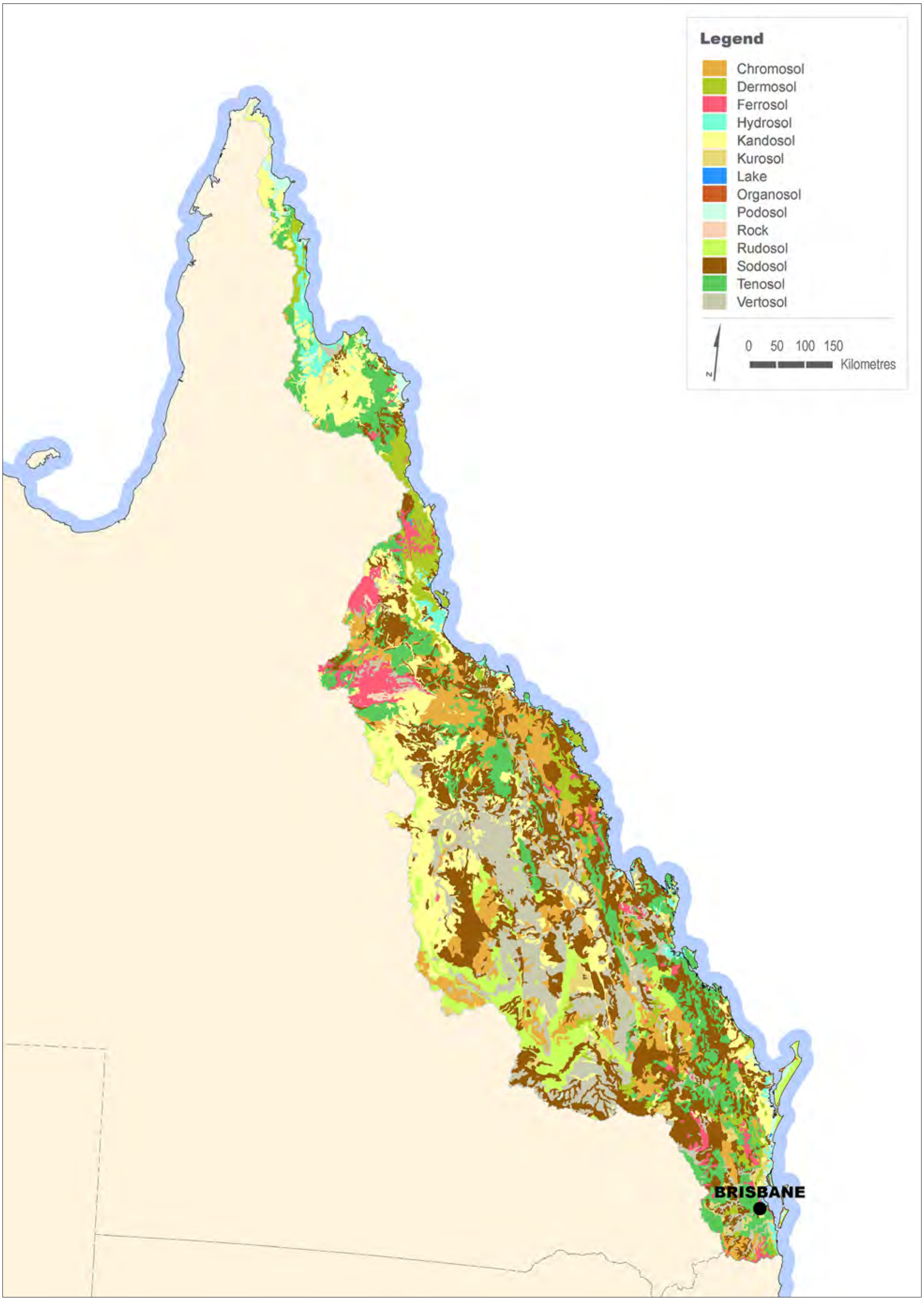


Figure 3.6 Soil type distribution in the North East Coast region

3.3.5 Land use

Most of the North East Coast region is used for grazing. In the north this occurs on native rangelands with fewer management inputs and pasture improvements than in southern river basins.

Figure 3.7 presents land use in the region. Dryland and irrigated agriculture account for approximately 4% of land use, while intensive land uses such as that of urban areas account for 1% of the region (information from data.daff.gov.au/anrdl/metadata_files/pa_luav4g9abl07811a00.xml).

As seen in Figure 3.8 nature conservation areas, such as those on Cape York are an important part of the land cover in the north, where the largest areas of unspoilt rainforests in Australia can be found.

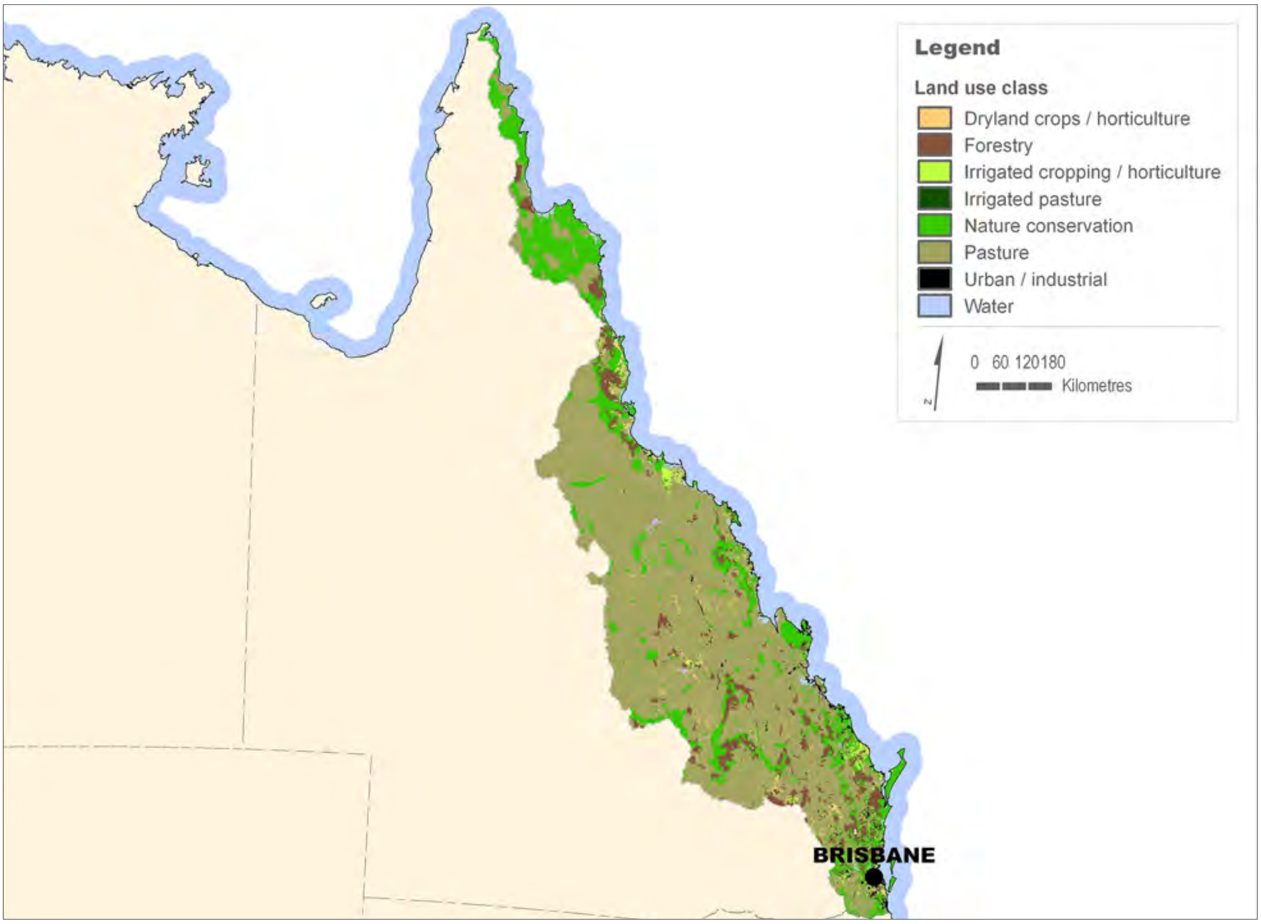


Figure 3.7 Land use distribution in the North East Coast

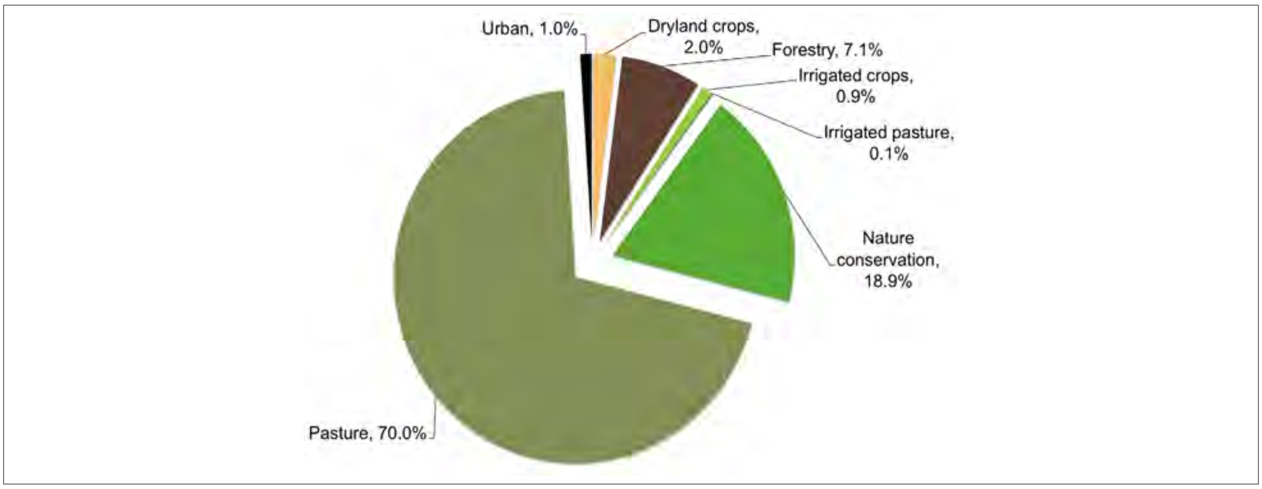


Figure 3.8 Land use in the North East Coast region

3.3.6 Population distribution

Figure 3.9 shows the population density and distribution in the North East Coast region. Urban areas account for less than 1 % of the total land area of this region. South East Queensland, which includes Brisbane, Gold Coast, and the Sunshine Coast, is the most heavily urbanised and populated area and constitutes over 65% of the region's total population.

Agriculture, fishing, mining and tourism are the major drivers for the many population centres in the north and largely along the coastal fringes, estuaries and alluvial plains of the region. Coal mining in the Bowen basin in the central eastern part of the region has been a major driver for many small inland towns as well as the larger coastal regional cities that lie on or adjacent to its eastern boundary (Gladstone, Rockhampton and Mackay).

Further north, the coastal cities of Townsville and Cairns provide the focal points for the major population concentrations of the region's northern population.

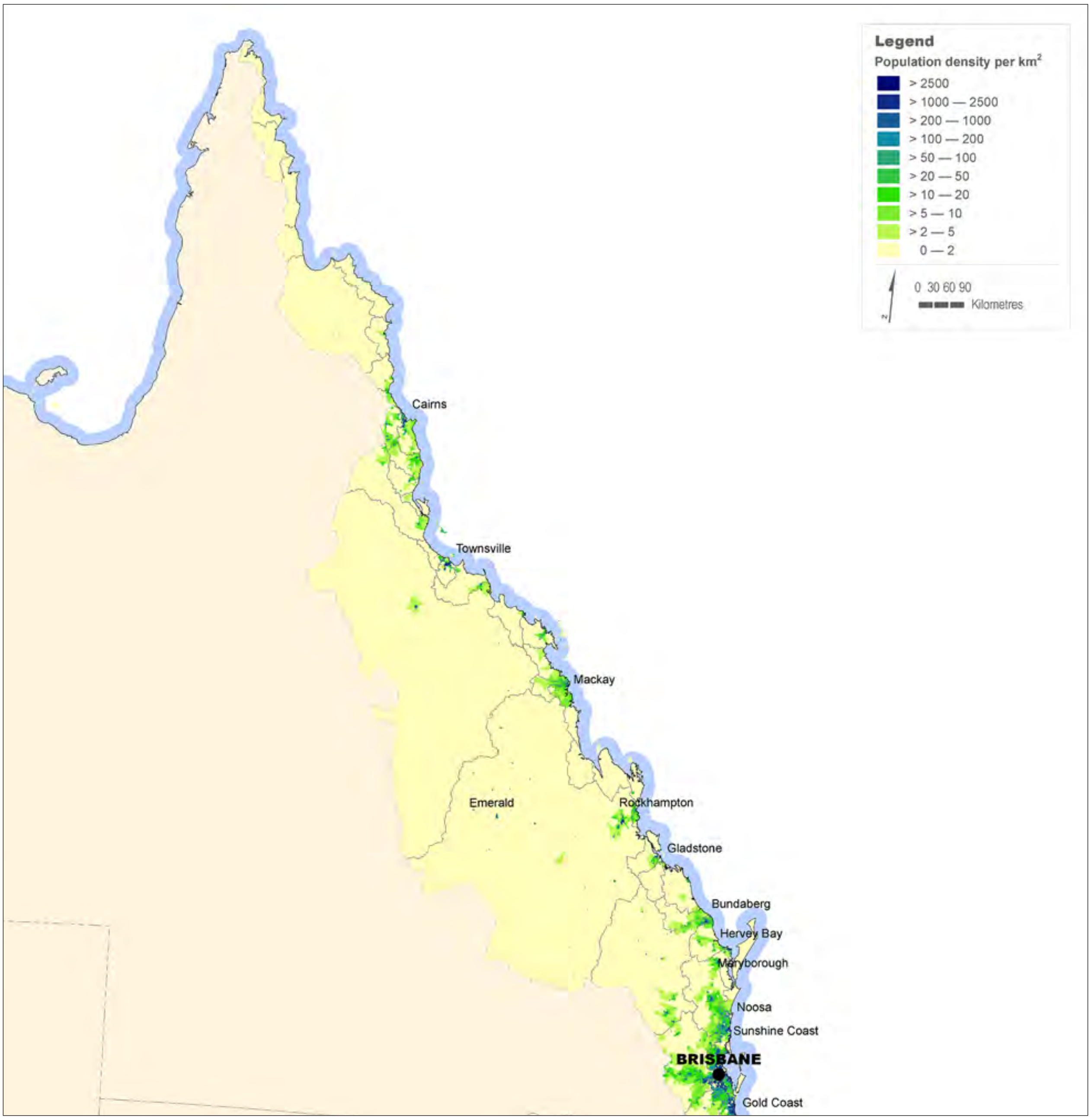


Figure 3.9 Population density and distribution in the North East Coast region

3.3.7 Rainfall zones

Figure 3.10 represents median rainfall zones in the North East Coast region, which has a subtropical to tropical climate and receives most of its rainfall in summer. Median rainfall exceeds 350 mm throughout the region.

The northern half of the region receives summer dominant rainfall with a marked wet summer and dry winter as well median rainfall decreasing westwards from over 1,200 mm per annum along the coast to between 350 mm and 650 mm inland.

The southern part of the region has a summer rainfall season (wet summer and low winter rainfall) with localised areas along the coast north of Brisbane having average annual rainfalls of over 1,200 mm. For more information on this and other climate classifications, visit the Bureau of Meteorology's (the Bureau's) climate website: www.bom.gov.au/jsp/ncc/climate_averages/climate-classifications

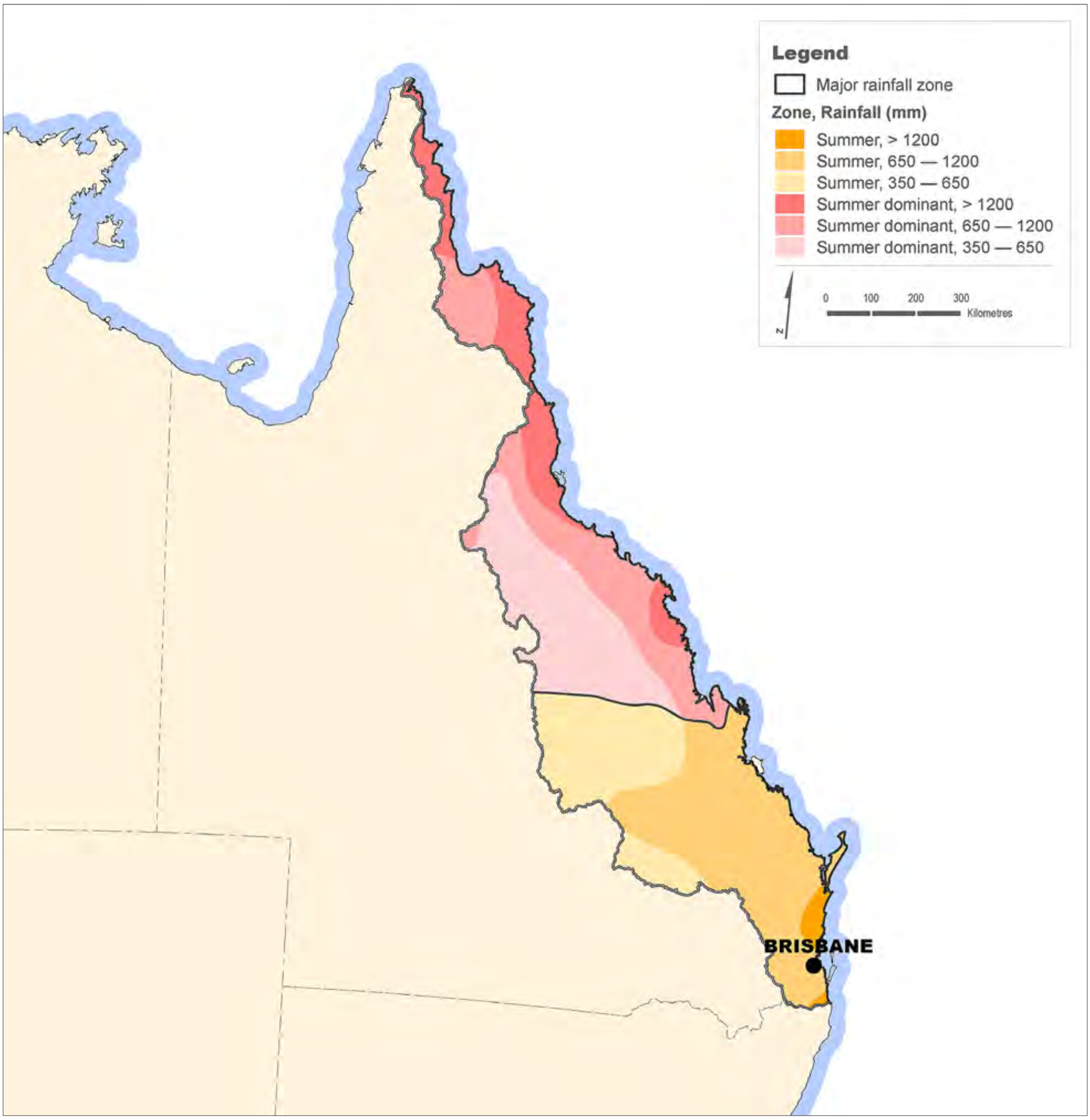


Figure 3.10 Rainfall zones in the North East Coast region

3.3.8 Rainfall deficit

The rainfall deficit indicator, that is, rainfall minus potential evapotranspiration, gives a general impression about which parts of the region are likely to experience moisture deficits over the period of a year. The North East Coast has a distinct rainfall deficit pattern.

As shown in Figure 3.11, serious deficits can be expected in large parts of the inland areas where the major land use is grazing.

Along the coast, some areas experience abundant water over the year. Rivers carry this water to the Coral Sea and are an important source of fresh water for many estuarine wetlands.

For more information on rainfall and evapotranspiration, see the Bureau's maps of average conditions: www.bom.gov.au/climate/averages/maps.shtml

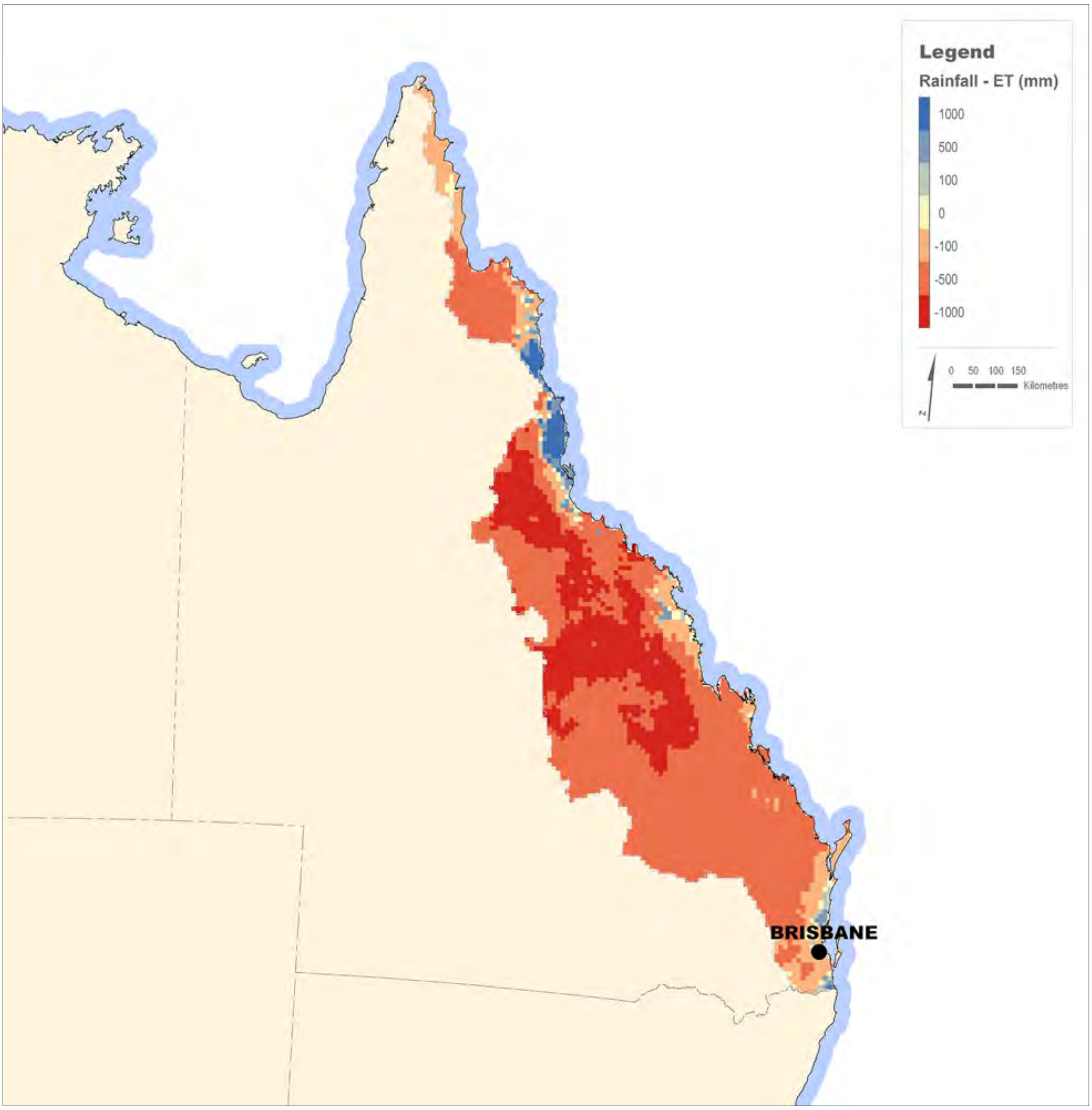


Figure 3.11 Rainfall deficit distribution in the North East Coast region

3.4 Landscape water flows

This section presents analyses of the spatial and temporal variation of landscape water flows (rainfall, evapotranspiration and landscape water yield) across the North East Coast region in 2011–12. National rainfall grids were generated using data from a network of persistent, high-quality rainfall stations managed by the Bureau.

Figure 3.12 shows the region has a highly seasonal rainfall pattern with a wet period from December–March and a particularly dry period from July–September. Evapotranspiration in the dry period generally exceeds rainfall. After the wet period the soils normally contain moisture that is available for evapotranspiration.

The monthly landscape water yield history for the region shows a stable pattern of very low yield in the dry period. It gradually increases during summer months and subsides during autumn.

The 2011–12 year was relatively wet, particularly between December 2011 and March 2012, when rainfall was much greater than the historic median. An active monsoon in the north of the region contributed to particularly high rainfall totals for March 2012.

With wet soil conditions present at the start of the year, evapotranspiration rates were higher than rainfall rates for the first five months of 2011–12. With the exception of January 2012, evapotranspiration rates remained above the 75th percentile for the rest of the year as a result of the higher than usual rainfall in most parts of the region.

The landscape water yield for 2011–12 closely followed the historic pattern with the exception of March 2012, when very high rainfall generated a much higher landscape water yield than the historic average.

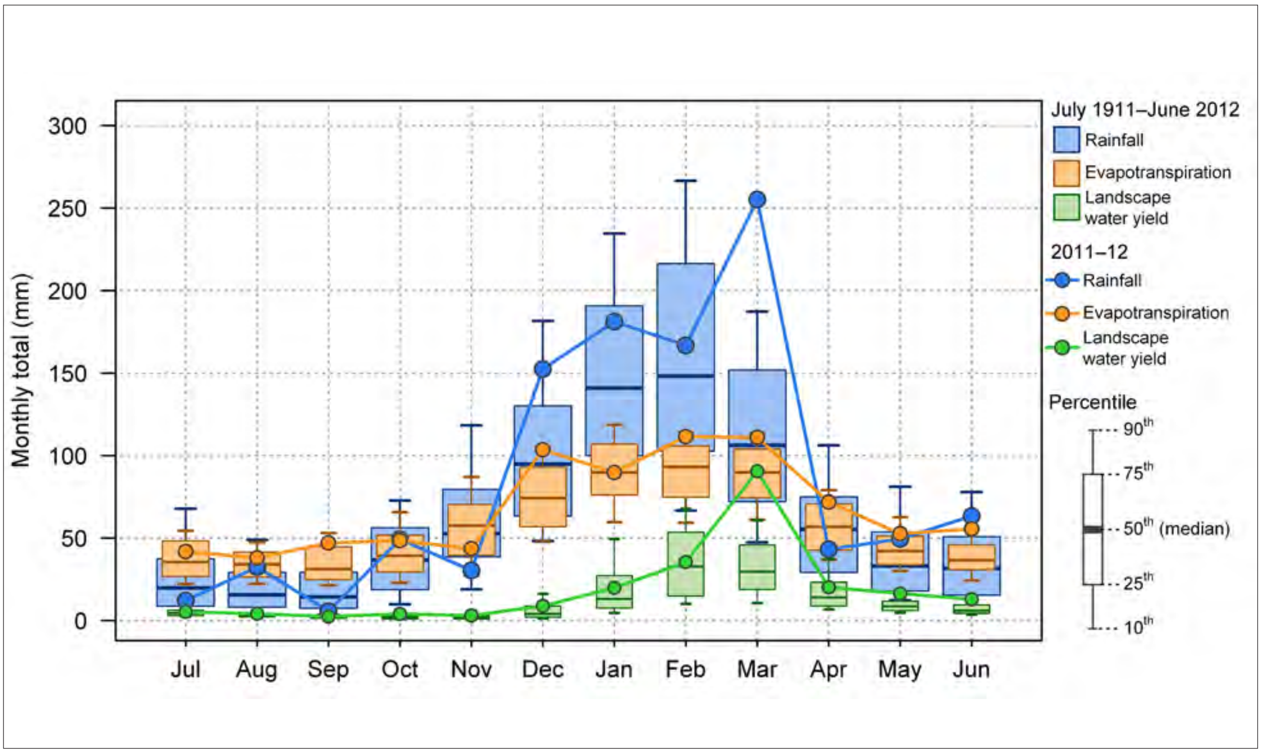


Figure 3.12 Landscape water flows in 2011–12 compared with the long-term record (July 1911– June 2012) for the North East Coast region

3.4.1 Rainfall

Rainfall for the North East Coast region for 2011–12 is estimated to be 1,041 mm. This is 22% above the region's long-term average (July 1911–June 2012) of 853 mm. Figure 3.13a shows that the highest rainfall occurred along the coastal areas with annual totals exceeding 2,400 mm in many areas for 2011–12. The majority of the inland areas had rainfall ranging from 600–900 mm for 2011–12. However, in some areas along the western border, rainfall exceeded 900 mm.

Rainfall deciles for 2011–12 indicate average to above average rainfall for the entire region (Figure 3.13b). Most of the inland parts of the region received above average rainfall with some parts in the west receiving very much above average rainfall. The southern coastal area north of Brisbane, including Fraser Island, also received very much above average rainfall.

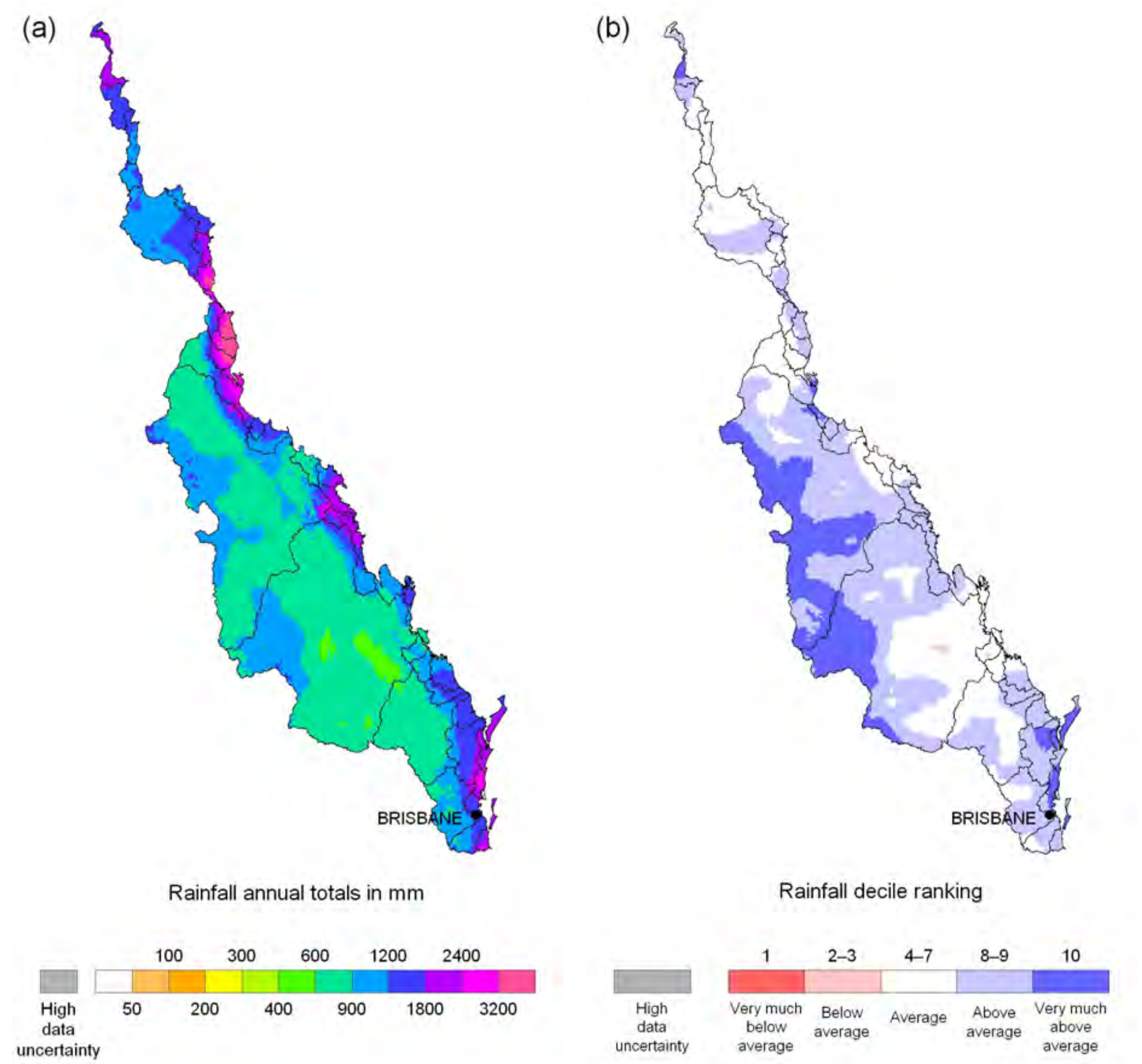


Figure 3.13 Spatial distribution of (a) annual rainfall in 2011–12, and (b) their decile rankings over the 1911–2012 period for the North East Coast region

Rainfall variability in the recent past

Figure 3.14a shows annual rainfall for the region from July 1980 onwards. Over this 32-year period the annual average was 851 mm, varying from 551 mm (1992–93) to 1,586 mm (2010–11). Temporal variability and seasonal patterns since 1980 are presented in Figure 3.14b. The graphs indicate the presence of cyclical patterns typical of the region's annual rainfall over these 32 years, which are particularly noticeable in the summer period. This pattern is closely linked to the occurrence of El Niño and La Niña periods and correlates well with the Southern Oscillation Index (see National Overview chapter).

A strong La Niña period typically delivers above average rainfall to this region, which is clearly highlighted by the recent 2010–11 La Niña period.

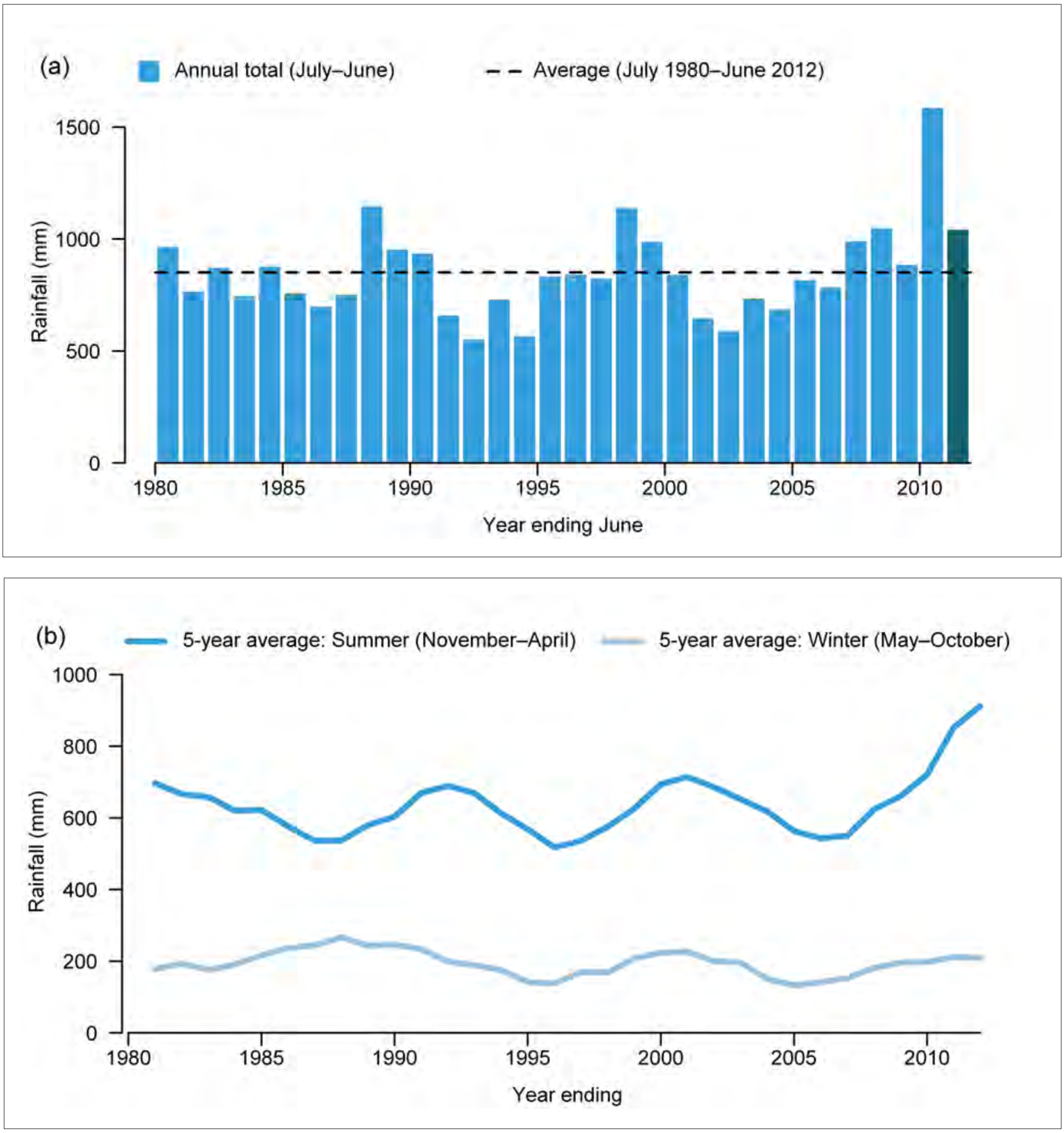


Figure 3.14 Time-series of (a) annual rainfall, and (b) five-year retrospective moving averages for the summer (November–April) and winter (May–October) periods for the North East Coast region

Recent trends in rainfall

Figure 3.15a presents the spatial distribution of the trends in annual rainfall for July 1980–June 2012. These are derived from linear regression analyses on the time-series of each model grid cell. The statistical significance of the trends is provided in Figure 3.15b.

Figure 3.15a shows that since 1980 a strong increase in rainfall has occurred in large parts of the region particularly towards the north. These trends are strongly significant in 22% of the region (Figure 3.15b).

The trends are largely a result of the cyclic rainfall pattern shown in Figure 3.14 and the particularly high rainfall of the past two years.

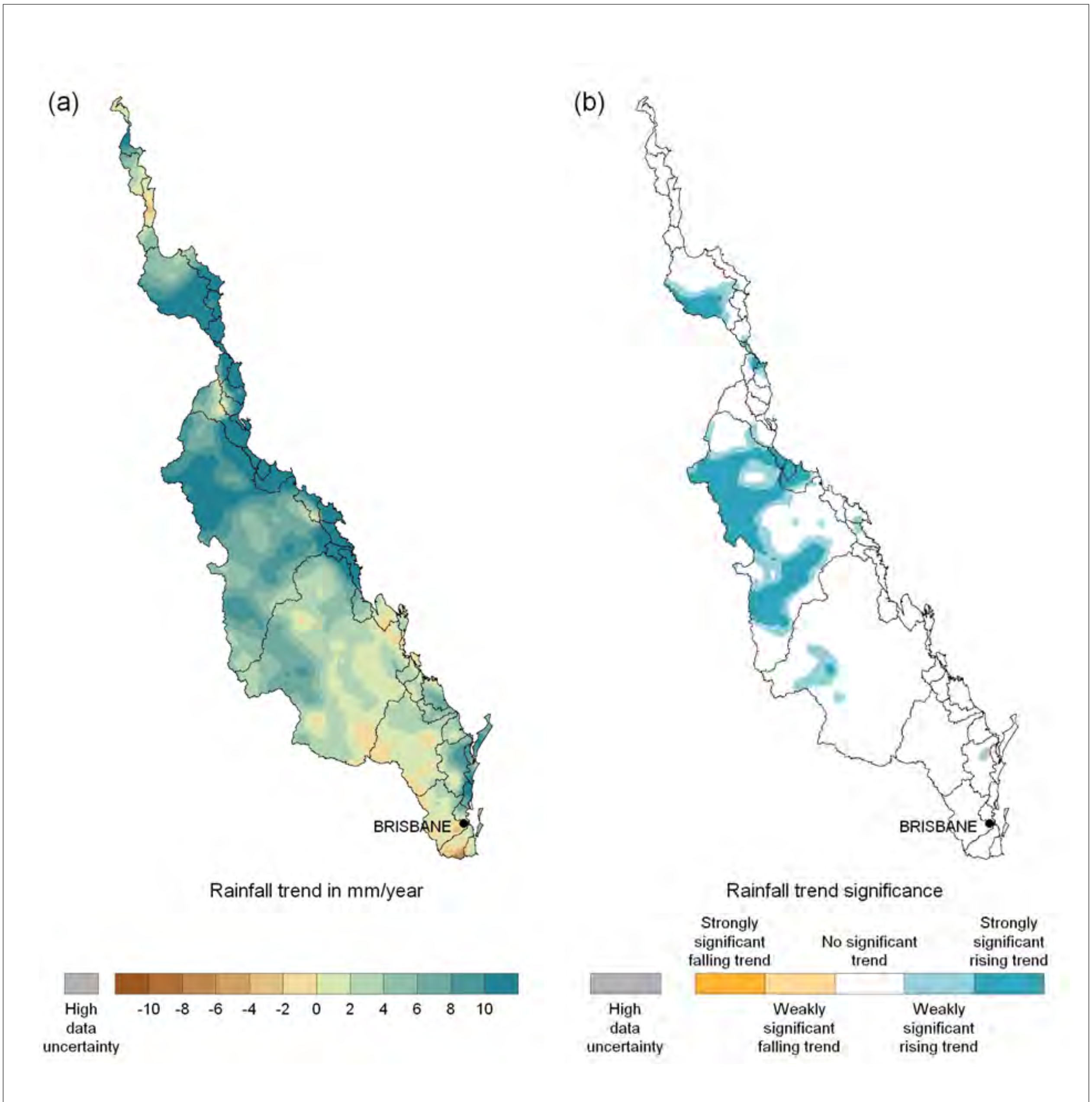


Figure 3.15 Spatial distribution of (a) trends in annual rainfall from 1980– 2012, and (b) their statistical significance at 90% (weak) and 95% (strong) confidence levels for the North East Coast region

3.4.2 Evapotranspiration

Modelled annual evapotranspiration for the North East Coast region for 2011–12 is estimated to be 814 mm. This is 18% above the region's long-term (July 1911– June 2012) average of 692 mm.

Figure 3.16a shows that spatial distribution of annual evapotranspiration in 2011–12 is similar to that of rainfall Figure 3.13a. Evapotranspiration rates are highest along the coast with annual totals exceeding 1,200 mm in some areas for 2011–12. Evapotranspiration averaged around 750 mm for the inland parts of the region.

Figure 3.16b shows that evapotranspiration deciles for 2011–12 indicate above average or very much above average totals across most of the region. This coincides with the very much above average rainfall observed largely along the western border (Figure 3.15b). Most coastal areas are estimated to have had average evapotranspiration.

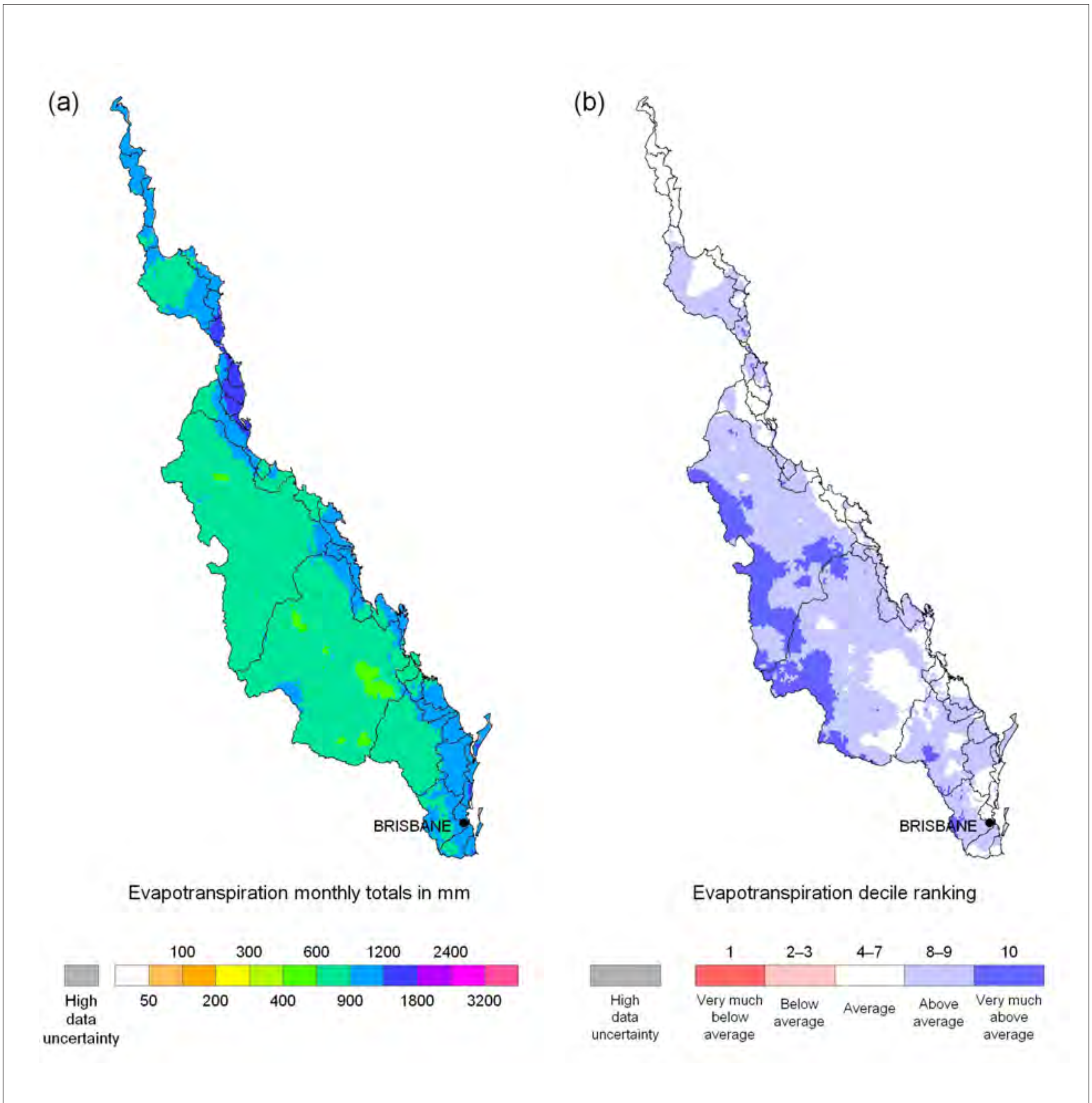


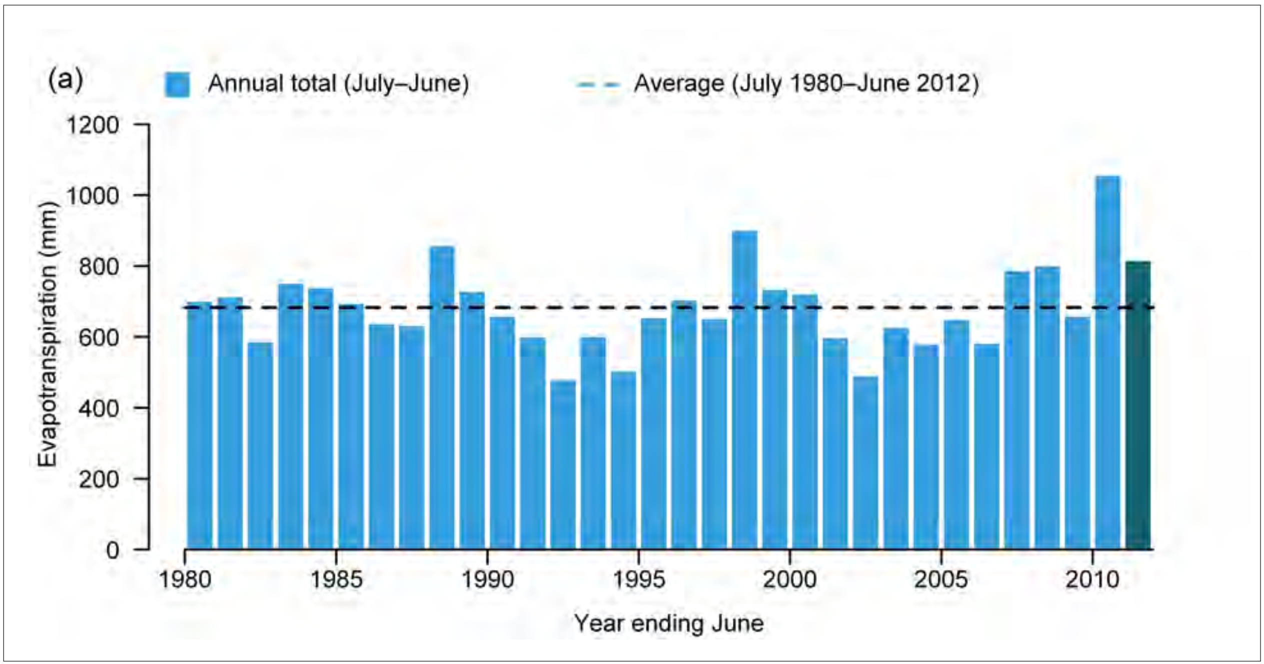
Figure 3.16 Spatial distribution of (a) modelled annual evapotranspiration in 2011–12, and (b) their decile rankings over the 1911–2012 period for the North East Coast region

Evapotranspiration variability in the recent past

Figure 3.17a shows annual evapotranspiration for the region from July 1980 onwards. Over this 32-year period the annual evapotranspiration average was 682 mm, varying from 477 mm (1992–93) to 1,054 mm (2010–11). Temporal variability and seasonal patterns since 1980 are presented in Figure 3.17b.

Summer periods showed consistently higher evapotranspiration rates than the winter period.

The higher temperatures and the higher rainfall amounts during these periods contribute to this. Compared with the seasonal rainfall (Figure 3.14b), the cyclical time-series of seasonal evapotranspiration is less pronounced (Figure 3.17b).



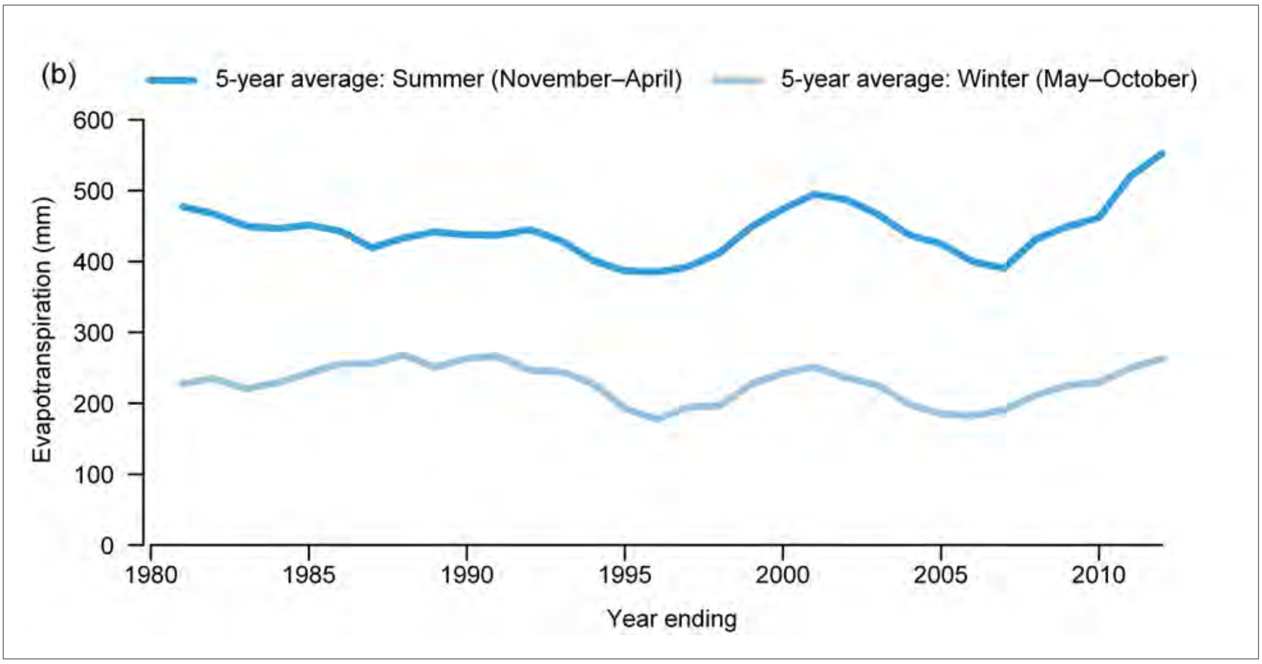


Figure 3.17 Time-series of (a) annual evapotranspiration, and (b) five-year retrospective moving averages for the summer (November–April) and winter (May–October) periods for the North East Coast region

Recent trends in evapotranspiration

Figure 3.18a presents the spatial distribution of the trends in modelled annual evapotranspiration for 1980– 2012. These are derived from linear regression analyses on the time-series of each model grid cell. The statistical significance of the trends is provided in Figure 3.18b.

Figure 3.18a shows that since 1980 trends are mostly rising in the central northern part of the region. In the south, the trends are more neutral to weakly falling.

As shown in Figure 3.18b, the trends are generally only statistically significant in some inland parts of the region. In the south of the region the falling trends have no statistical significance.

As evapotranspiration is driven by the availability of moisture, the trends are related to the cyclic pattern in the rainfall shown in Figure 3.14 and the particularly high rainfall of 2010–11 and 2011–12.

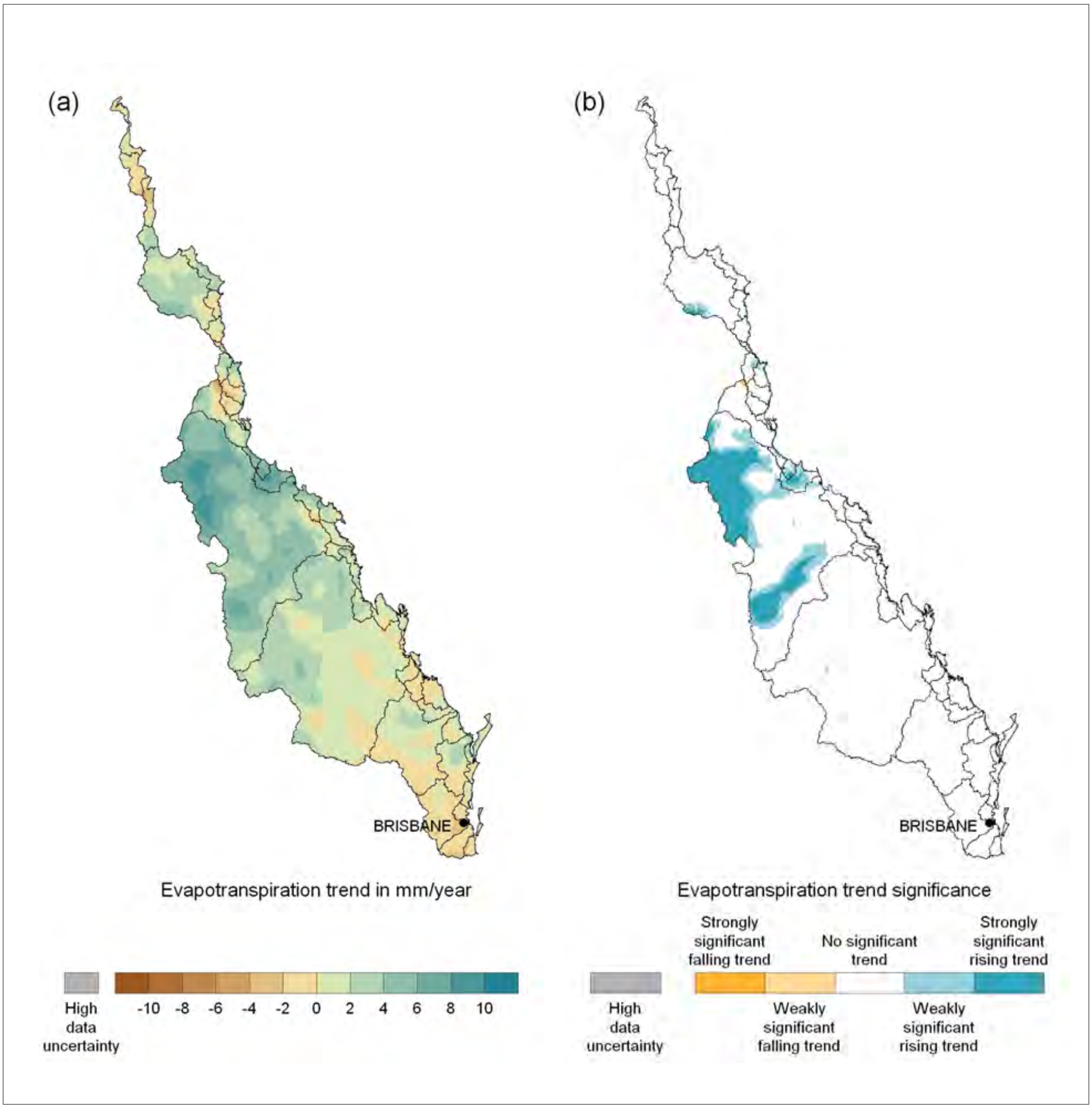


Figure 3.18 Spatial distribution of (a) trends in annual evapotranspiration from 1980–2012, and (b) their statistical significance at 90% (weak) and 95% (strong) confidence levels for the North East Coast region

3.4.3 Landscape water yield

Modelled landscape water yield for the North East Coast region for 2011–12 is estimated to be 223 mm. This is 42% above the region's long-term (July 1911–June 2012) average of 157 mm.

Figure 3.19a shows the spatial distribution of landscape water yield for 2011–12, which is similar to that shown in Figure 3.14a, annual rainfall distribution. This is a result of rainfall intensity and volume being the dominant drivers for generating landscape water yield.

The highest landscape water yields in 2011–12 are observed in areas along the mid-north and south coast, locally exceeding 1,200 mm. For the rest of the region, the landscape water yield did not exceed 400 mm.

Figure 3.19b is the decile-ranking map for 2011–12 and shows average to very much above average landscape water yields.

Above average water yields are found across much of the inland areas, with very much above average yields along the western border, as well as along the southern coast.

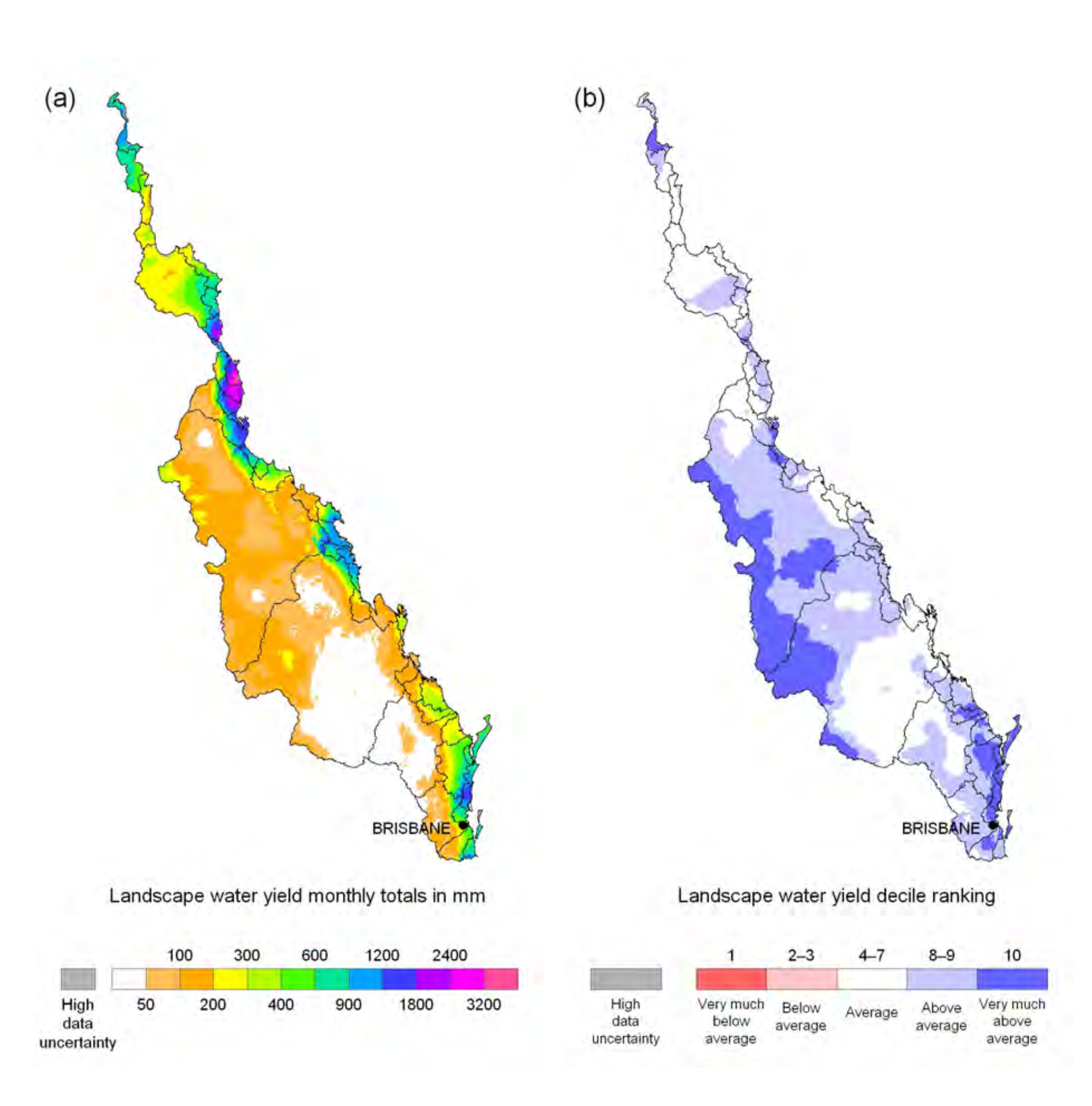


Figure 3.19 Spatial distribution of (a) modelled annual landscape water yield in 2011–12, and (b) their decile rankings over the 1911–2012 period for the North East Coast region

Landscape water yield variability in the recent past

Figure 3.20a shows annual landscape water yield for the North East Coast region from July 1980 onwards. Over this 32-year period, annual landscape water yield was 162 mm, varying from 58 mm (2001–02) to 481 mm (2010–11).

Temporal variability and seasonal patterns since 1980 are presented in Figure 3.20b.

As shown in Figure 3.20b, landscape water yield is consistently higher during the summer period compared to the winter period.

The summer period's average also exhibits a greater inter-annual and cyclical variability driven by the region's rainfall dynamics.

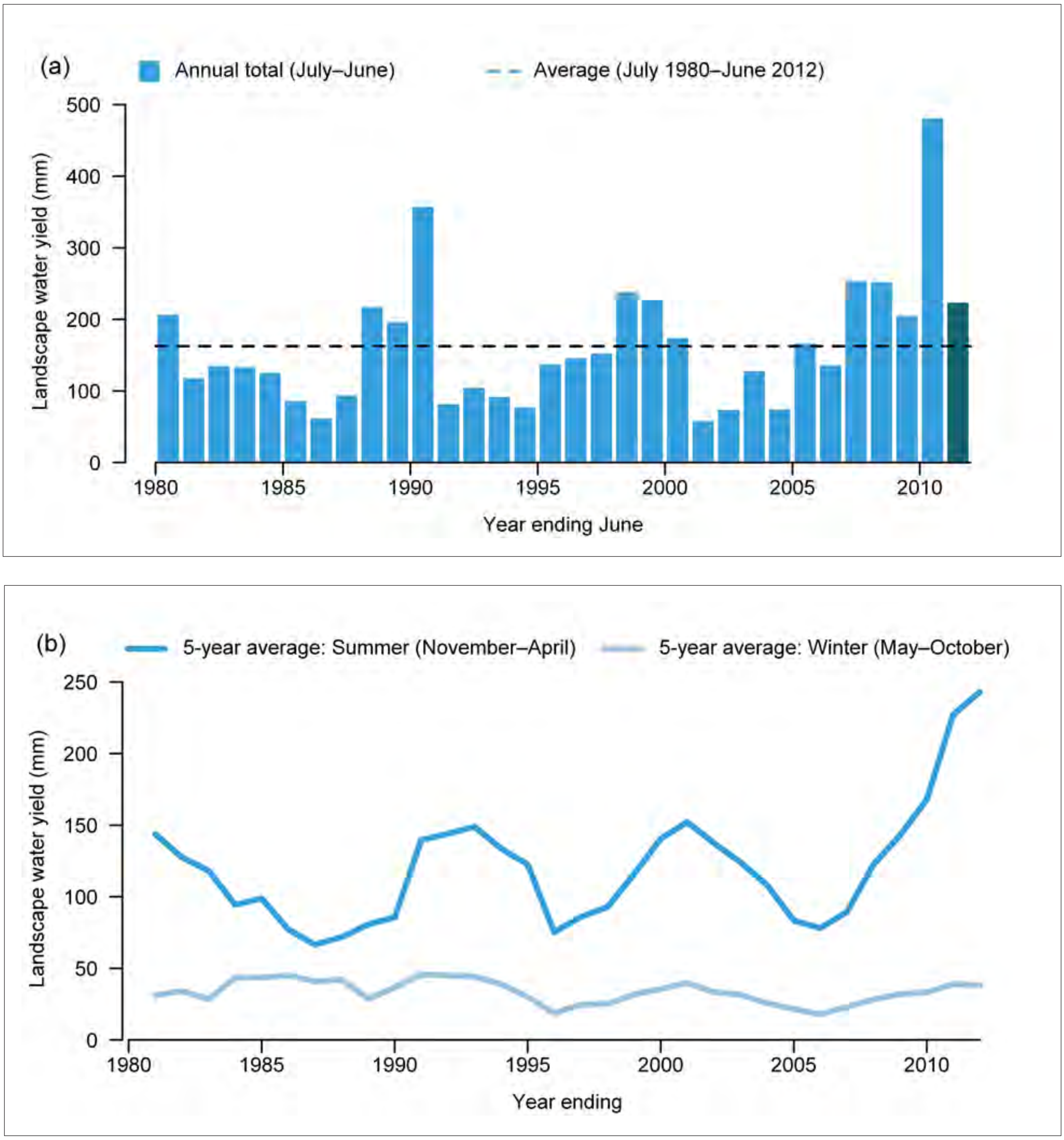


Figure 3.20 Time-series of (a) annual landscape water yield, and (b) five-year retrospective moving averages for the summer (November–April) and winter (May–October) periods for the North East Coast region

Recent trends in landscape water yield

Figure 3.21a presents the spatial distribution of the trends in modelled annual landscape water yield for 1980–2012. These are derived from linear regression analyses on the time-series of each model grid cell. The statistical significance of the trends is provided in Figure 3.21b.

Figure 3.21a shows that since 1980 rising trends occur along the coast, particularly in areas where annual rainfall normally exceeds 1,200 mm. In the inland part of the region, weaker rising trends occur.

Figure 3.21b shows strongly significant trends occur mainly in the inland parts of the region. The high landscape water yields between 2007–08 and 2011–12 (Figure 3.20a) contributed appreciably to these rising trends.

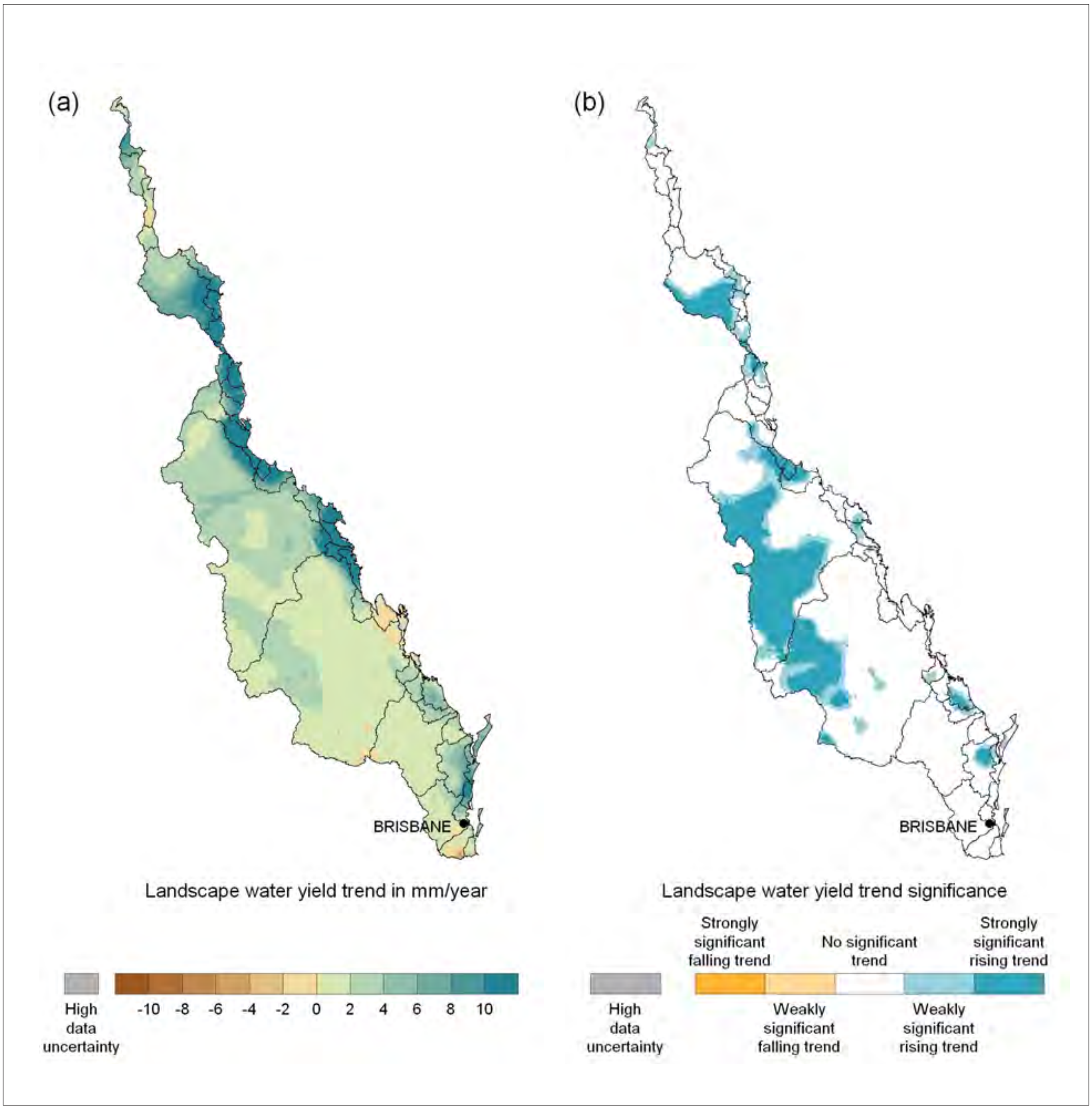


Figure 3.21 Spatial distribution of (a) trends in annual landscape water yield from 1980– 2012, and (b) their statistical significance at 90% (weak) and 95% (strong) confidence levels for the North East Coast region

3.5 Surface water and groundwater

This section examines surface water and groundwater resources in the North East Coast region in 2011–12. An analysis of rivers, wetlands and water storages are discussed to illustrate the state of the region's surface water resources. The region's watertable aquifers and salinity are described and the groundwater status is illustrated by showing changes in groundwater levels at selected sites.

3.5.1 Rivers

All the rivers in this region drain to the Coral Sea with many of the rivers having outflows that can impact on the Great Barrier Reef.

Figure 3.22 shows the 45 river basins in the region, which vary in size from 400–143,000 km^2.

Many of the rivers have high summer flows with relatively long periods of low or zero flows in winter, especially to the mid-north of the region. Streams in the southeast of the region generally flow all year round but still show distinct seasonal variation.

The Burdekin and the Fitzroy rivers are amongst the largest Australian rivers in terms of their total flow volumes. The Burdekin River is a south-flowing ephemeral river which often dries to just a series of disconnected water holes, and runs over 300 km before turning east to the sea.

The lower reaches of the Fitzroy River are perennial but a large proportion of the tributaries in the catchment are ephemeral.

The lower Burdekin, Nogoa and Mackenzie rivers run through highly modified catchments. The Burnett River basin is the third largest basin in the region.

The Fitzroy River, east of Rockhampton | John Casey, Dreamstime

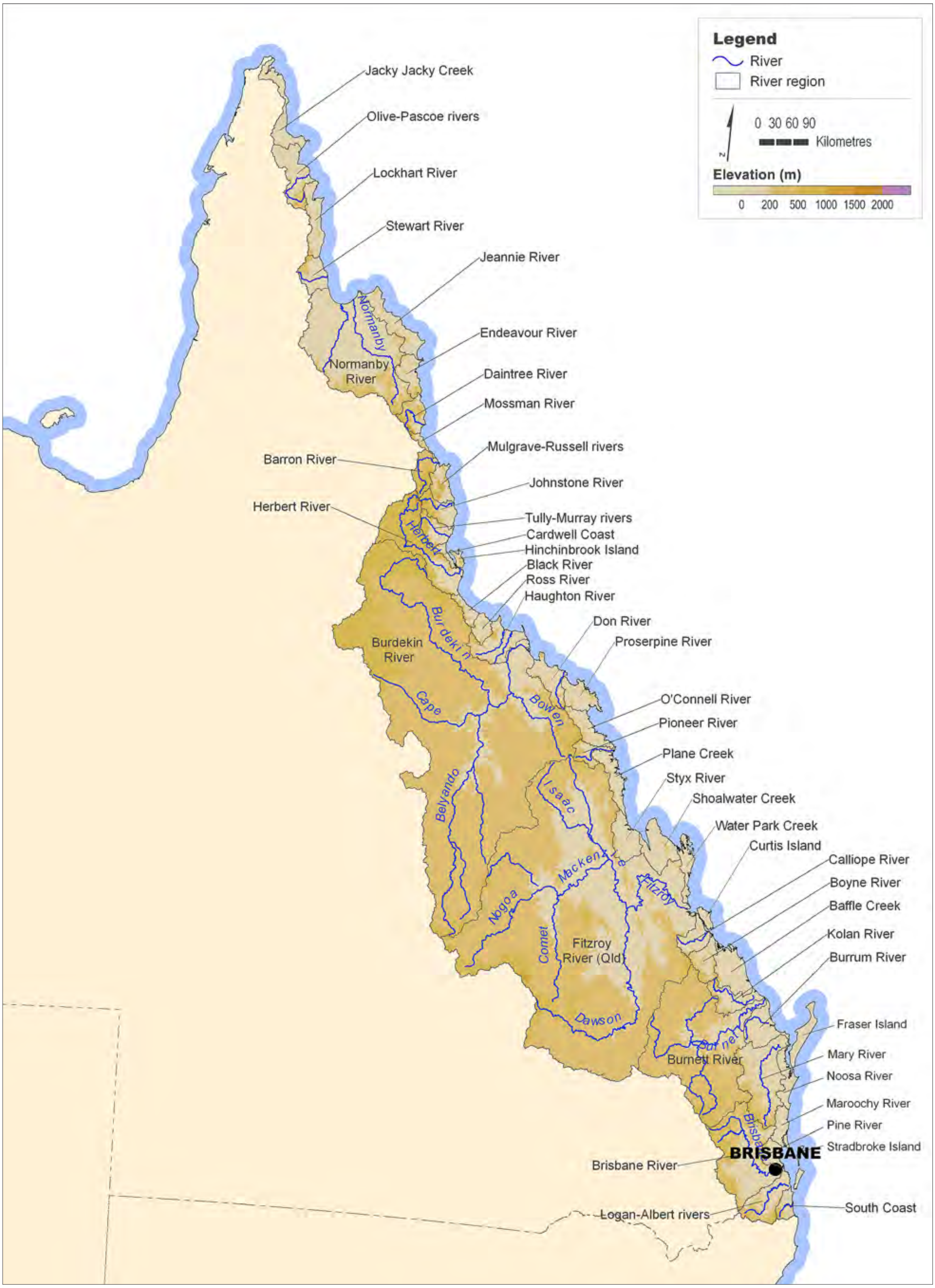


Figure 3.22 Rivers and catchments in the North East Coast region

3.5.2 Streamflow volumes

Figure 3.23 presents an analysis of flows at 46 monitoring sites during 2011–12 relative to annual flows for the period from July 1980–July 2012. Monitoring sites with relatively long records across 20 geographically representative rivers were selected (see Technical Supplement for details).

The annual flows for 2011–12 are colour-coded according to the decile rank at each site over the 1980–2012 period. The flows generally reflect the mostly average to above average modelled landscape water yield results shown in Figure 3.19b.

High run-off, generated in the upstream reaches of the rivers, caused above average to very much above average flows in many rivers in the central part of the North East Coast region.

Very much above average flows were observed at five monitoring sites located on rivers in the west: the north Johnstone River in the central north and the Gregory River in the southeast of the region.

Above average total flows were recorded at 23 monitoring sites. These were mainly located on the rivers to the south, some centrally located rivers, and in some river basins to the central north of the region.

Average flows occurred at 17 sites in the region that were on the rivers in the southwest and far south of the region, and among river basins in the central north and far north of the region.

There was only one below average flow recorded for the 46 monitoring sites examined across the region. This was on the Normanby River in the north.

As shown in Figure 3.23, deciles in the summer (November 2011–April 2012) were very similar to total annual flows for 2011–12. This is not surprising given that the greatest volume of flows in the region, particularly in the central north, occurred over the summer months. There are a few monitoring sites that did not show this pattern, such as the relatively low flows observed in the summer period on the Stewart River in the far north of the region.

3.5.3 Streamflow salinity

Figure 3.24 shows an analysis of streamflow salinity for 2011–12 at 79 monitoring sites throughout the North East Coast region. Monitoring sites with at least a five-year data record were selected for analysis. The results are shown as electrical conductivity (EC, µS/cm). This is a commonly used surrogate for the measurement of water salinity in Australia. Standard EC levels for different applications, such as for drinking water or types of irrigation are provided in the Technical Supplement. The median annual EC values are shown as coloured circles. The circle size depicts the variability in annual EC, shown as the coefficient of variation (CV), being the standard deviation divided by the mean.

The median EC values for most of the selected monitoring sites fall in the range 0–1,000 µS/cm, an amount that is suitable for most irrigation uses. Some results for small rivers and creeks in the Fitzroy River basin and the Logan River basin fall outside this range (see Figure 3.24). Of the 79 monitoring sites, 53% had median EC values below 500 µS/cm and 33% were between 500–1,000 µS/cm. Only 14% of the monitoring sites had a median EC above 1,500 µS/cm.

Rivers with higher (>1,000 µS/cm) median salinities all occur in the southern half of the region. They are typically associated with low annual flows. Median stream salinity was above 2,000 µS/cm at three of the 79 monitoring sites. These were from one monitoring site on the Dee River that is a tributary of the Dawson River, and two creeks in the Fitzroy River basin. High salinity in the Dee River is influenced by the decommissioned Mount Morgan gold mine, from which leachates enter the Dee River.

The salinity CV values vary widely across the North East Coast region. The CV is high at a few monitoring sites in the south and northwest, and in the Dee River in the east. In contrast, the CV is relatively low for most rivers in the south, northeast, and central parts of the region. The CV of salinity is typically related to the variability in annual flow at the monitoring site.

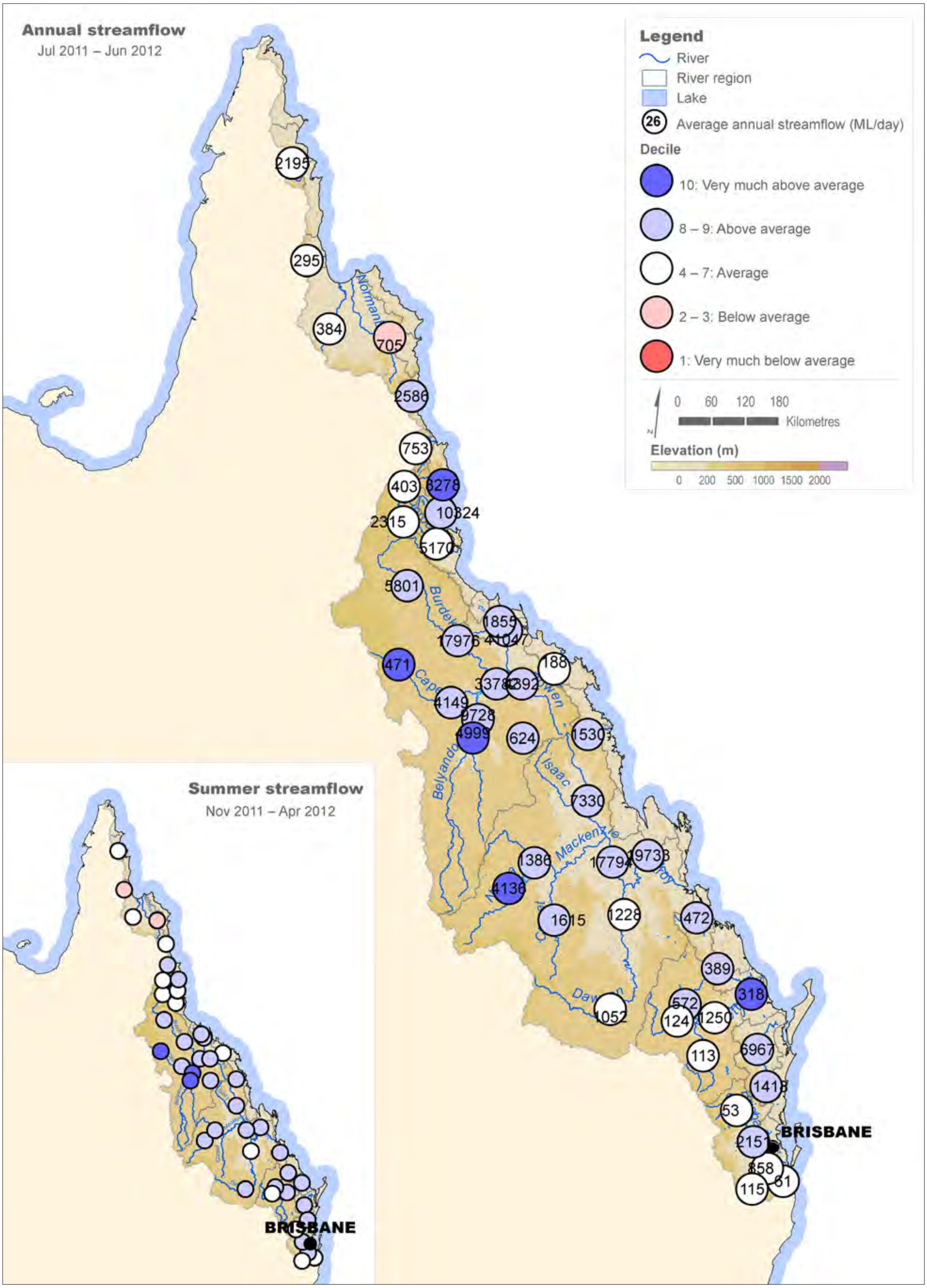


Figure 3.23 Average annual and summer period flow volumes of selected gauges for 2011–12 and their decile rankings over the 1980–2012 period in the North East Coast region

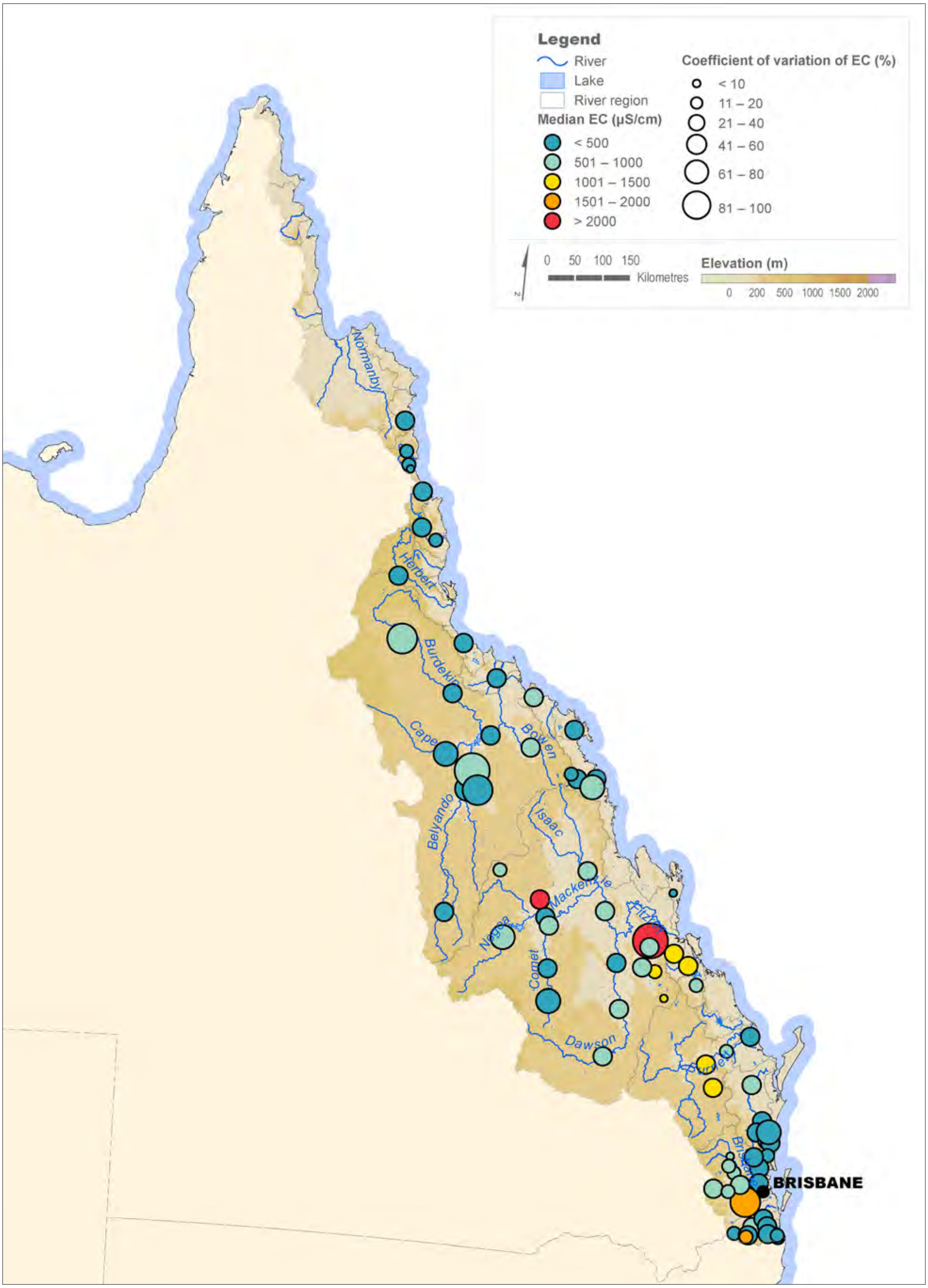


Figure 3.24 Salinity as electrical conductivity and its associated coefficient of variation for 2011–12 in the North East Coast region

Of the 79 monitoring sites, 27% had a coefficient of variation below 20%; 67% of the sites had CV between 20% and 60%; and only 6% of the sites had CV above 60%. These were on the Suttor River in the Burdekin River basin in the centre of the region, Dee River in the central east and Purga Creek in the Brisbane River basin in the south of the region.

Stream salinity variation was above 80% at one of the 79 monitoring sites. This was on the Suttor River in the Burdekin River basin in the centre of the region.

3.5.4 Flooding

Floods in the North East Coast region are mainly caused by two rainfall types. These are localised high intensity rainfall (for example, thunderstorms) or prolonged periods of rainfall (for example, frontal rainfall, monsoon, tropical storms). While the first rainfall type often results in localised flash flooding, the prolonged rainfall can cause sustained floods over large areas.

The region has a seasonal pattern of rainfall, with most rainfall occurring in summer, in which both rainfall types occur frequently.

Figure 3.25 shows the locations where the Bureau monitors river levels in the region as part of its flood forecasting services. The highest flood levels experienced during 2011–12 are shown in terms of the flood classification levels established in consultation with emergency management and local agencies to describe flood impacts at each location (see Technical Supplement).

A large number of major floods occurred in 2011–12 (Figure 3.25). In large rivers to the central west of the region major floods were observed during January and February 2012. The prolonged rainfall in the last week of January resulted in high water levels in the southern tributaries of the Burdekin River and most of the upstream tributaries of the Fitzroy River.

The prolonged January rainfall also impacted the rivers around Brisbane in the southern part of the region. Although not as severe as the January 2011 floods, some areas in the Brisbane and Logan river basins experienced major flooding; however the impacts in suburban Brisbane and surrounds were less severe with only minor to moderate flooding.

In March, the monsoon in the northern part of the region delivered large amounts of rainfall to the coastal areas of north Queensland. Major flooding occurred in many small rivers. Flooding also occurred further south in some rivers between Brisbane and Rockhampton, where rainfall for this month was up to 400 mm.

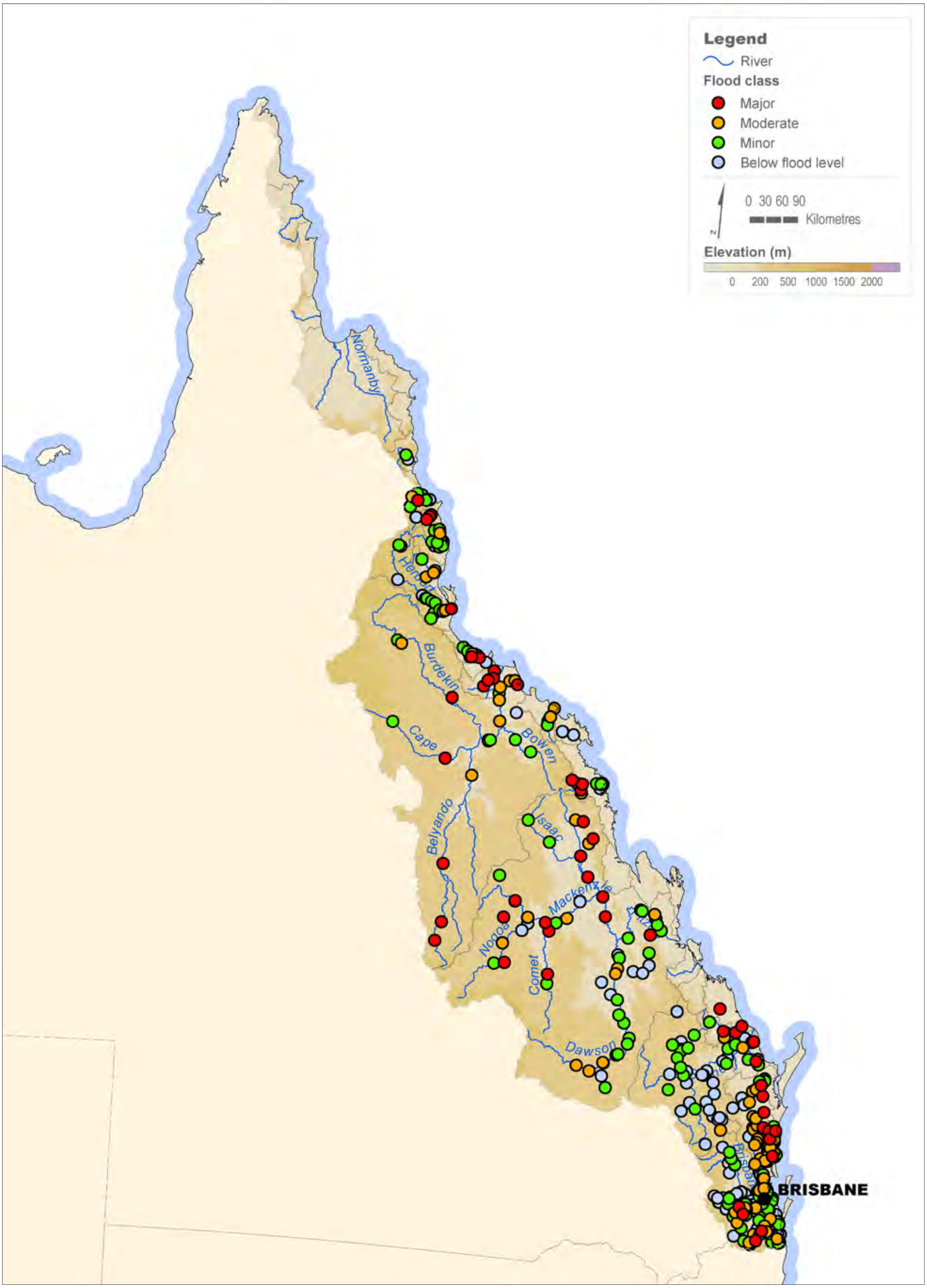


Figure 3.25 Flood occurrence in 2011–12 for the North East Coast region, with each dot representing a river level monitoring station and the colour of the dot representing the highest flood class measured

3.5.5 Storage systems

There are over 100 major, publicly-owned water storages in the North East Coast region with a total accessible capacity in excess of 10,400GL.

The Bureau's water storage information (as at August 2012) covers approximately 92% of the region's publicly owned storage capacity. Storages supply 17 irrigation areas as well as the city of Brisbane.

Table 3.3 gives a summary of the major storage systems together with an overview of the storage levels at the end of 2010–11 and the end of 2011–12. The location of all the systems and associated storages are shown in Figure 3.26.

Total accessible storage in the region for the 2011–12 year increased marginally, with most storages close to full capacity. The major increase was in the Brisbane system, where volumes went up from 85 to 94%. The only substantial drop in storage levels was in the Callide system.

More details on the Brisbane and Burdekin Haughton systems is provided in the 'Water for cites and towns' and 'Water for agriculture' sections in this chapter.

Further information on the past and present volumes of the storage systems and the individual storages can be found on the Bureau's water storage website: water.bom.gov.au/waterstorage/awris/

Table 3.3 Major public storage systems in the region as identified in the Bureau's water storage website (August 2012), with 'non-allocated' accounting for the storages not allocated to a particular system

System name	System type	System capacity	Accessible volume at 30 June 2011	Accessible volume 30 June 2012
Brisbane	urban	2,220 GL	1,882 GL — 85%	2,093 GL — 94%
Burdekin Haughton	rural	1,868 GL	1,866 GL—100%	1,868 GL—100%
Nagoa Mackenzie	rural	1,305 GL	1,296 GL—99%	1,297 GL—99%
Bundaberg	rural	909 GL	908 GL—100%	906 GL—100%
Proserpine	rural	490 GL	490 GL—100%	480 GL—100%
Mareeba Dimbulah	rural	438 GL	433 GL—99%	437 GL—99%
Boyne Tarong	rural	196 GL	195 GL—100%	196 GL—100%
Upper Burnett	rural	187 GL	182 GL—97%	182 GL—97%
Callide	rural	148 GL	140 GL—95%	105 GL—71%
Pioneer	rural	147 GL	146 GL—99%	146 GL—99%
Barker Barambah	rural	134 GL	134 GL—100%	134 GL—100%
Bowen Broken	rural	116 GL	115 GL—99%	116 GL—100%
Three Moon Creek	rural	88 GL	88 GL—100%	88 GL—100%
Warrill valley	rural	86 GL	83 GL—97%	82 GL—95%
Eton	rural	62 GL	61 GL—98%	62 GL—100%
Mary river	rural	56 GL	56 GL—100%	56 GL—100%
Logan river	rural	44 GL	44 GL—100%	44 GL—100%
Non-allocated	—	1,022 GL	1,016 GL—99%	1,009 GL—99%
Total		**9,516 GL**	**9,135 GL—96%**	**9,301 GL—98%**

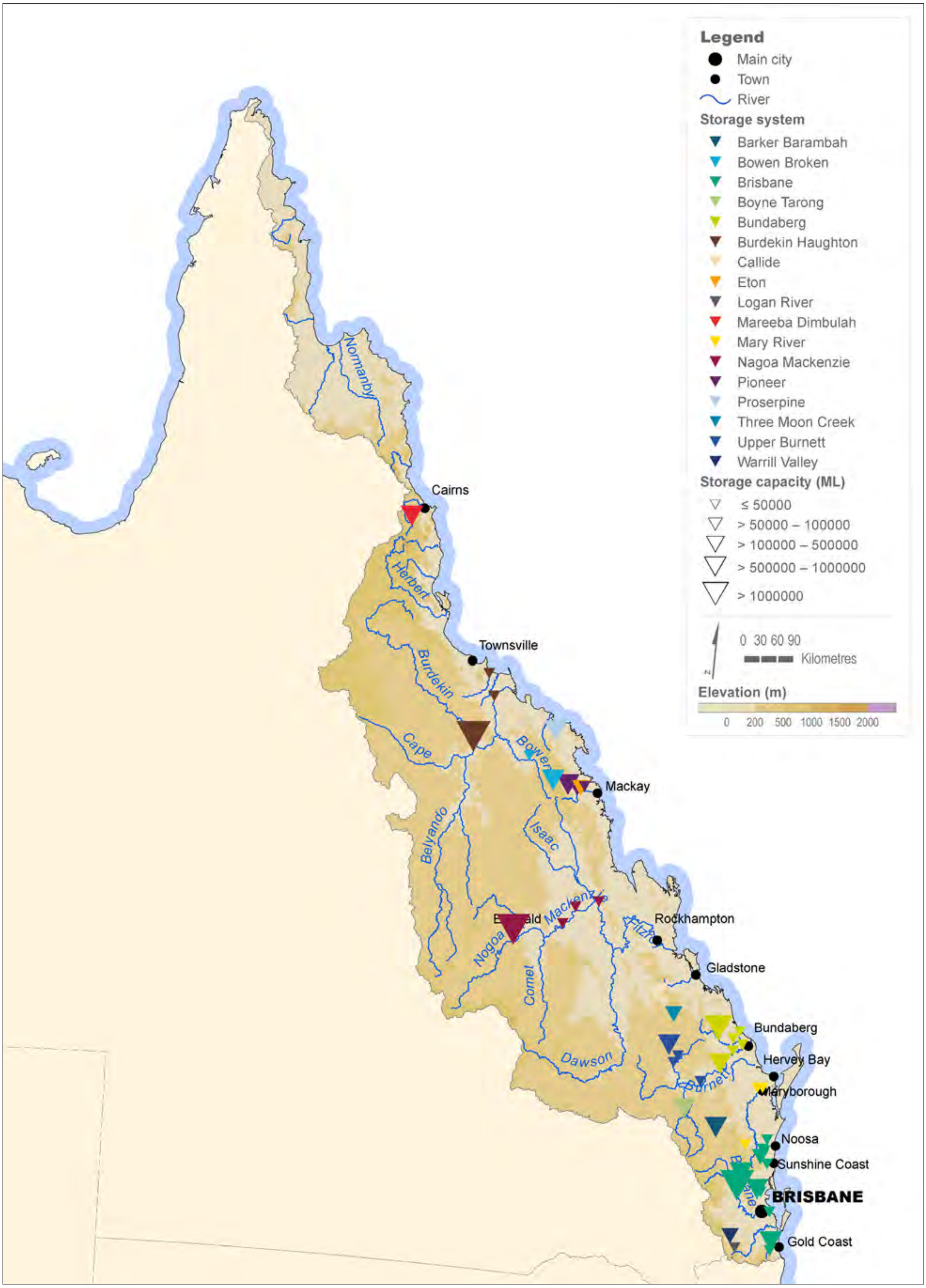


Figure 3.26 Storage systems in the North East Coast region (information extracted from the Bureau of Meteorology's water storage website in August 2012)

3.5.6 Wetlands

Important wetlands

As seen in Figure 3.27, there are a large number of wetlands of national and international importance in the North East Coast region that encompass a wide diversity of wetland types, from coastal floodplains to higher altitude freshwater streams and waterfalls. The wetlands create a mosaic of temporally and spatially dynamic habitats within this part of Australia. The most spatially extensive wetland types in the region are artificial freshwater storages and the marine-influenced coastal flats and mangroves.

The artificial wetlands, despite being constructed from dammed watercourses for urban and rural water supply and flood retardation purposes, provide recreational and ecosystem values such as aquatic habitat for a number of important flora and fauna species. The brackish to saline coastal wetlands in this region provide ecosystem services such as mangrove and salt-marsh habitat as well as acting as filters reducing sediment discharges to the Great Barrier Reef.

Inflows to selected wetlands

The state of the biodiversity in a wetland is linked to the way water is stored within the area and the temporal variability of inflows. An analysis of historic and recent inflows into wetlands forms an informative picture of potential changes.

Three internationally-recognised Ramsar wetland sites (Bowling Green Bay, Great Sandy Strait and Moreton Bay) and one nationally-listed freshwater wetland (the Southern Fitzroy River wetland complex) were selected for hydrological analysis of major inflows. More information about the region's wetlands is available from the *Australian Directory of Important Wetlands* (www.environment.gov.au/water/topics/wetlands/database/diwa.html)

Seven upstream monitoring gauges were selected to enable the analyses and interpretation of inflows to these four wetlands. The gauges used in the analyses are the closest upstream gauges that have largely continuous discharge records since 1980.

Though the analyses do not capture the total inflows, they are indicative of the temporal patterns of freshwater surface flows to these wetlands.

Woodhouse Lagoon | NQ Dry Topics

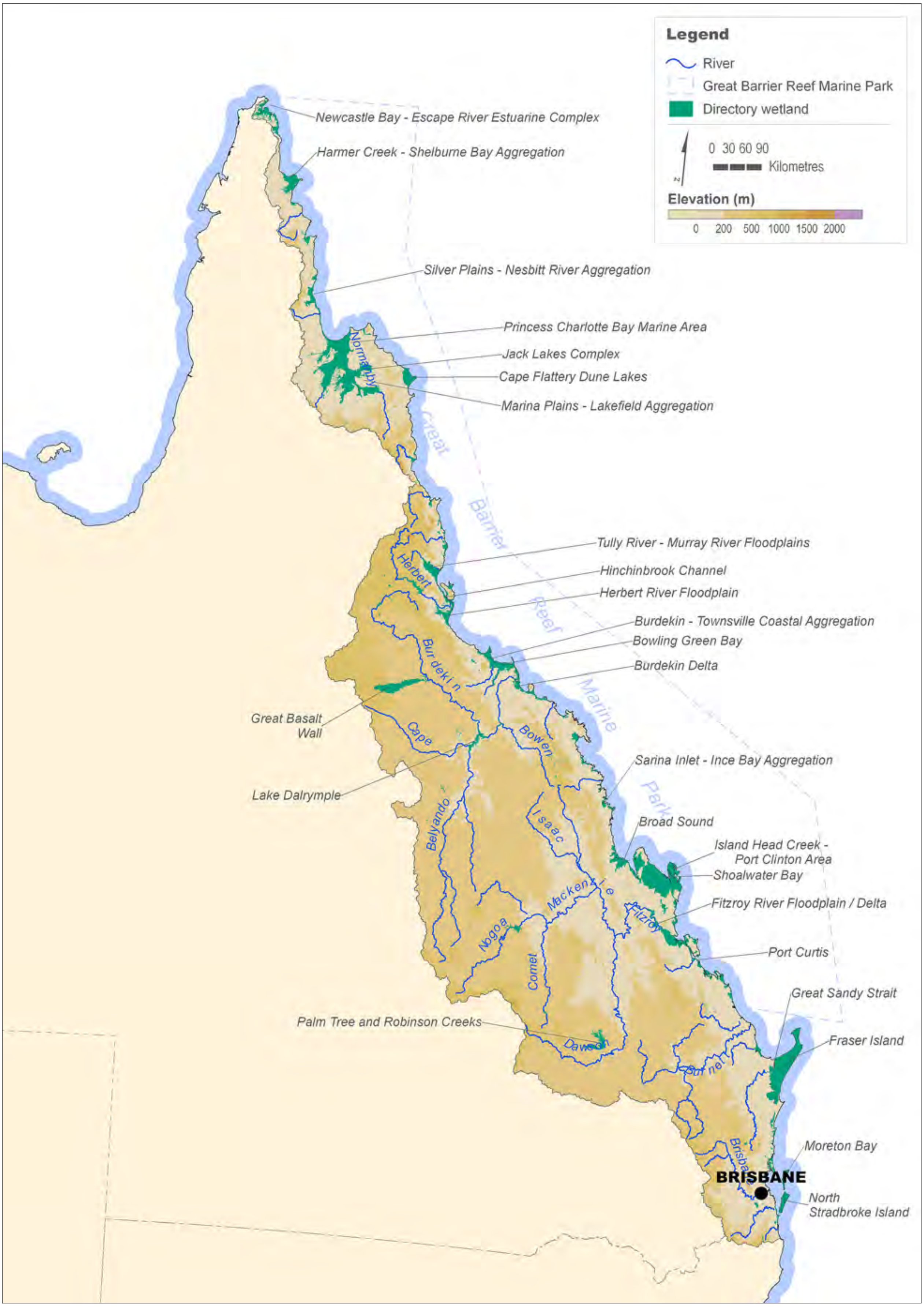


Figure 3.27 Location of important wetlands in the North East Coast region

Bowling Green Bay

Wetlands centred on Bowling Green Bay, south of Townsville, form one of tropical Australia's largest and most diverse coastal wetlands. The wetlands are mostly coastal plains covered in tidal mudflats, mangrove forest and salt marshes. River channels and freshwater marshes also form part of this large wetland complex.

Daily discharge data for the monitoring gauges on the Haughton River at Powerline and on the Barratta Creek at Northcote have been combined to provide a temporal pattern of freshwater inflows into Bowling Green Bay (Figure 3.28).

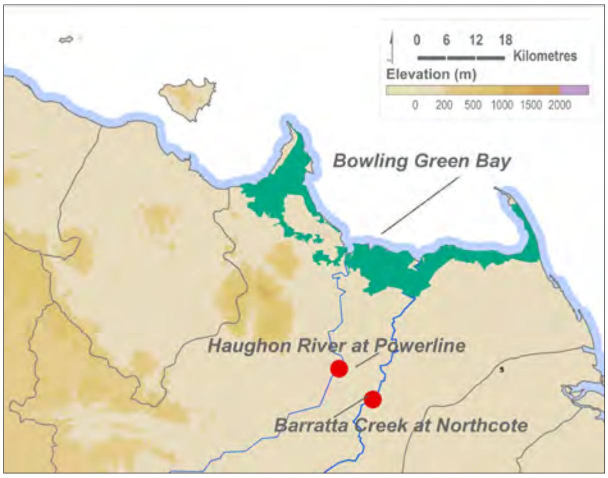


Figure 3.28 Location of the monitoring sites in relation to Bowling Green Bay

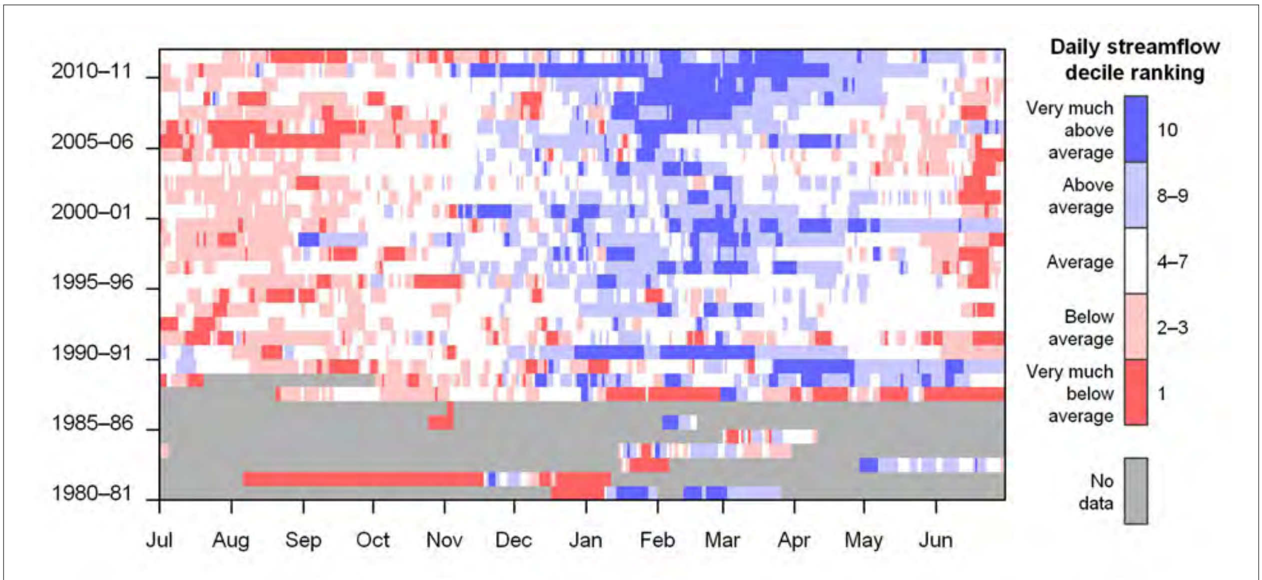


Figure 3.29 Daily flows of the Haughton River at Powerline and on the Barratta Creek at Northcote between 1980 and 2012, ranked in decile classes

Figure 3.29 presents an overview of the distribution of daily streamflow decile rankings for the period between 1980 and 2012. The data is fairly sparse until 1987. Thereafter one can see a pattern of wet periods in blue of varying length usually between November and May. From 2008–09 there has been an increase in the length of the period of very much above average flows.

Figure 3.30 compares monthly discharges from 2011–12 with the flow statistics from 1980 onwards. The March 2012 flows well exceeded the ninth decile of the 32-year record and contributed a substantial amount of freshwater to Bowling Green Bay.

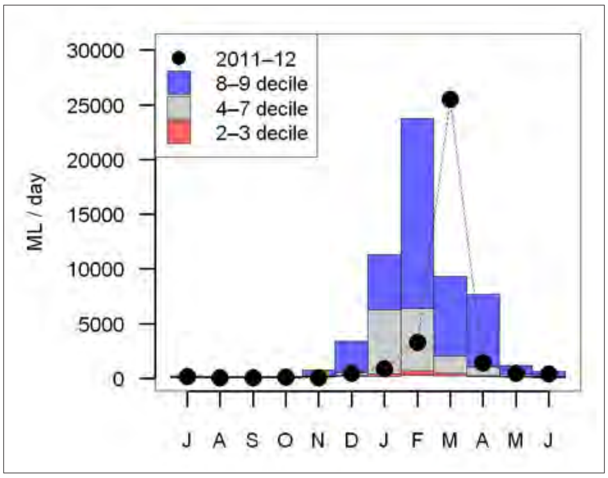


Figure 3.30 Combined monthly flows at Haughton River and Barratta Creek from 2011–12 compared with the 1980–2012 decile rankings

Southern Fitzroy River floodplain complex

The Fitzroy catchment is the second largest in the region, at nearly 150,000 km², and is dominated by agriculture and mining including coal mining. Inter-tidal wetlands are present particularly around the lower reaches of the river and south of the mouth. These wetlands typically consist of extensive saltpans fringed by mangroves.

Daily discharge data for the monitoring gauge on the Fitzroy River at The Gap provides a temporal pattern of freshwater inflows into the southern Fitzroy River floodplain complex (Figure 3.31).

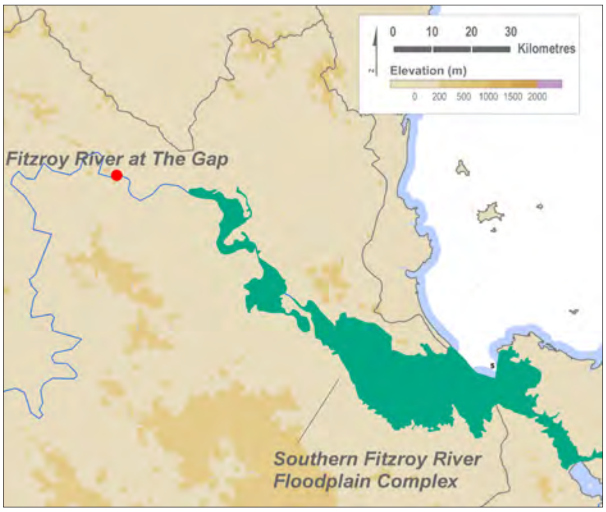


Figure 3.31 Location of the monitoring site in relation to the southern Fitzroy River floodplain complex

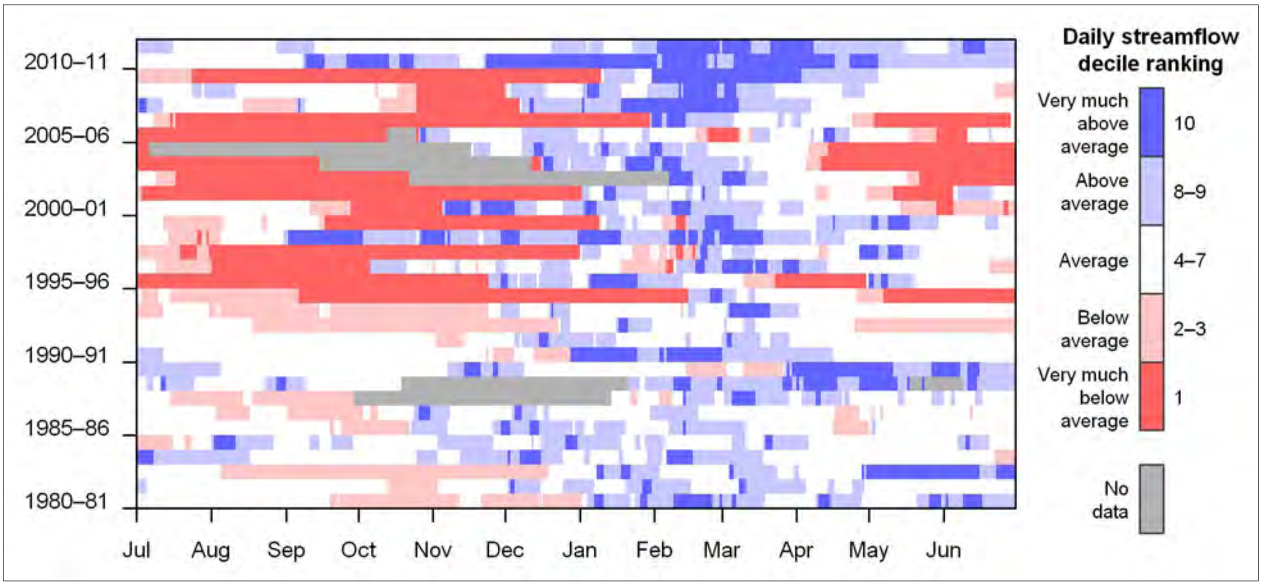


Figure 3.32 Daily flows of the Fitzroy River at The Gap between 1980 and 2012, ranked in decile classes

Figure 3.32 presents an overview of the distribution of daily streamflow decile rankings for the period between 1980 and 2012. From 1994 onwards, flows were generally very much below average during the dry period, except for the last two years. Additionally, there were extended periods of very much above average flows during the wet months of 2009–10 to 2011–12.

Figure 3.33 compares monthly discharges from 2011–12 with the flow statistics from 1980 onwards. The February and March 2012 flows contributed a substantial amount of freshwater to the floodplain complex.

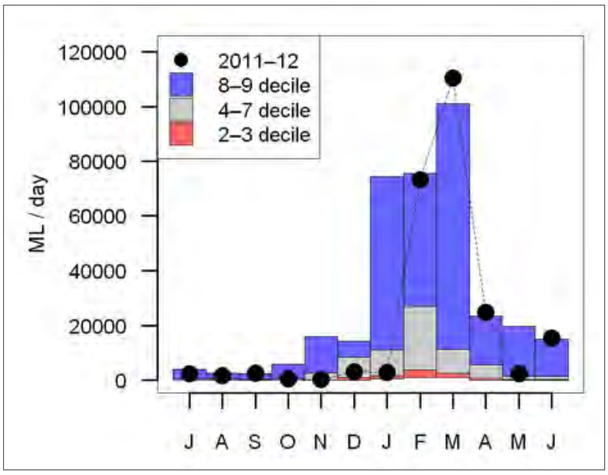


Figure 3.33 Monthly flows at the Fitzroy River monitoring site at The Gap from 2011–12 compared with its 1980–2012 decile rankings

Great Sandy Strait

The Great Sandy Strait is enclosed between the Australian mainland and Fraser Island. The Mary River enters the strait at River Heads. The Strait is a complex landscape of mangroves, sandbanks, inter-tidal sand, mud islands, salt marshes and sea grass beds. It forms an important habitat for breeding fish, crustaceans, dugongs, dolphins and marine turtles.

Daily discharge data for the monitoring gauge on the Mary River at Miva (see Figure 3.34) provide a temporal pattern of freshwater inflows into the Great Sandy Strait.

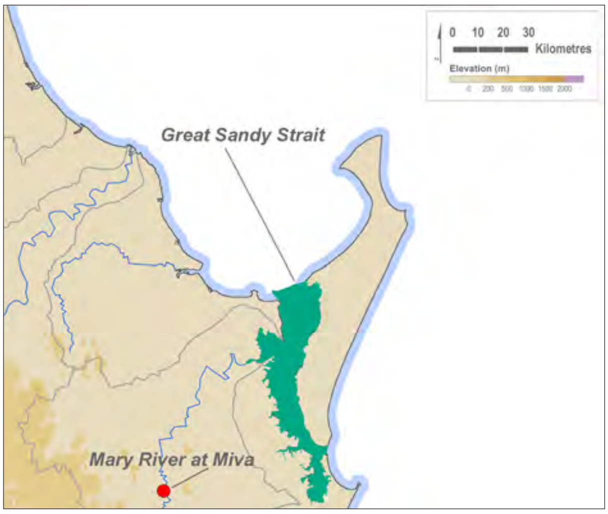


Figure 3.34 Location of the monitoring site in relation to the Great Sandy Strait

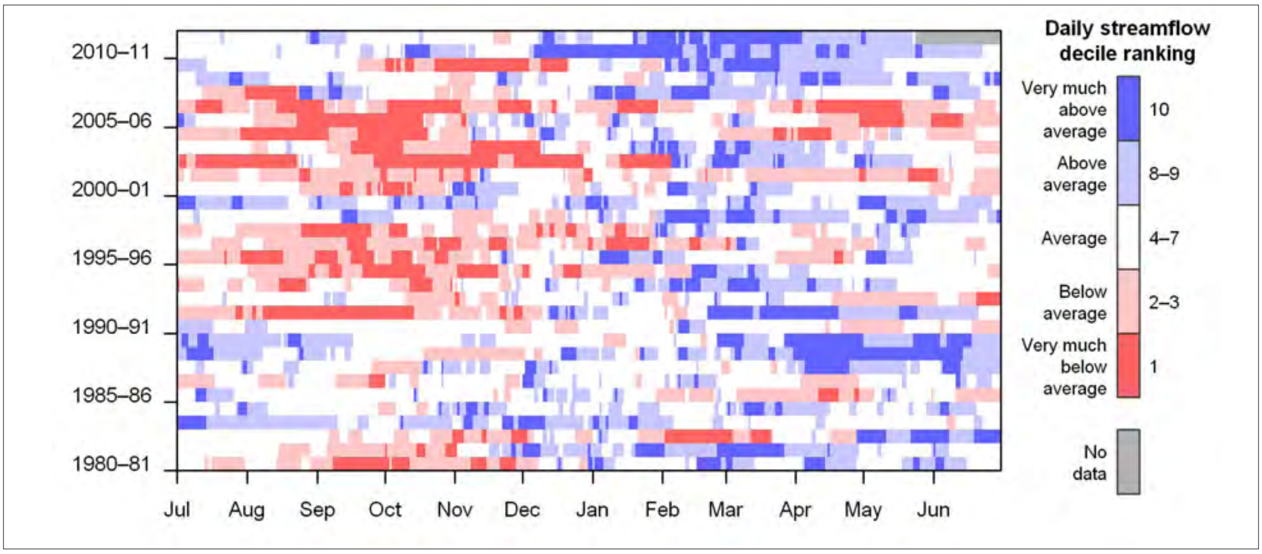


Figure 3.35 Daily flows of the Mary River at Miva between 1980 and 2012, ranked in decile classes

Figure 3.35 presents an overview of the distribution of daily streamflow decile rankings for the period between 1980 and 2012. An irregular pattern of high and low flows occurs throughout most years. There were extended periods of very much above average flows during the wet months of 2010–2012. Extended periods of very much below average flows occurred during 2002–03 to 2006–07.

Figure 3.36 compares monthly discharges from 2011–12 with the flow statistics from 1980 onwards. The January–March 2012 flows well exceeded the ninth decile of the 32-year record and contributed a substantial amount of freshwater to the wetland.

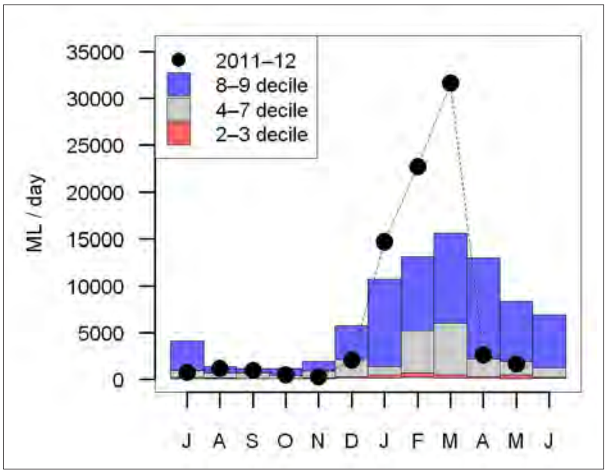


Figure 3.36 Monthly flows at the Mary River monitoring site at Miva from 2011–12 compared with its 1980–2012 decile rankings

Moreton Bay

Because of the existence of a series of off-shore barrier islands that restrict the flow of oceanic water, Moreton Bay acts similar to a lagoon. The wetlands in the bay range from perched freshwater lakes and sedge swamps on the offshore sand islands, to inter-tidal mudflats, marshes, sandflats and mangroves on the shores of the bay's islands and the mainland. The major rivers flowing into the bay pass through Brisbane.

Daily discharge data for the monitoring gauges on the Brisbane, Logan and Nerang rivers (Figure 3.37) have been combined to provide a temporal pattern of freshwater inflows into Moreton Bay.

Figure 3.37 Location of the monitoring sites in relation to Moreton Bay

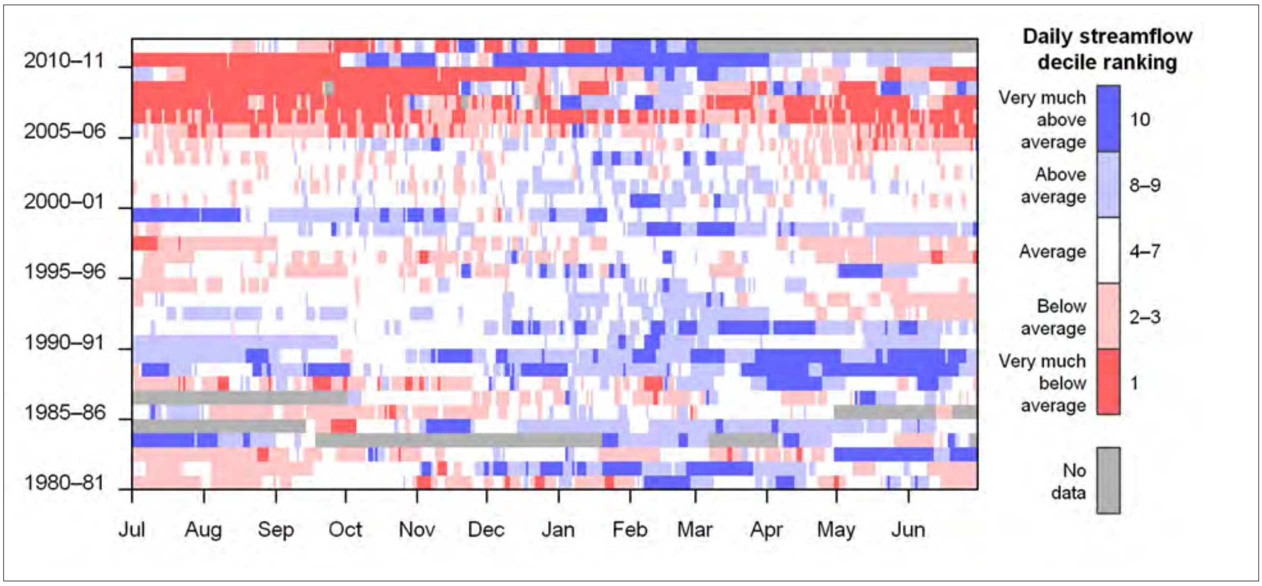


Figure 3.38 Combined daily flows of Brisbane, Logan and Nerang rivers between 1980 and 2012, ranked in decile classes

Figure 3.38 presents an overview of the distribution of daily streamflow decile rankings for the period between 1980 and 2012, ranked in decile classes. The Wivenhoe Dam in the Brisbane River was completed in 1985 and from then onwards flows in the river became increasingly regulated. Prolonged periods of very much below average inflows to the bay occurred between 2006–07 and 2010–11. The Brisbane floods of December 2010 broke this pattern.

Figure 3.39 compares monthly discharges from June 2011–March 2012 with the flow from 1980 onwards. Data was not available beyond March 2012. The March 2012 flows contributed a substantial amount of freshwater to the wetland.

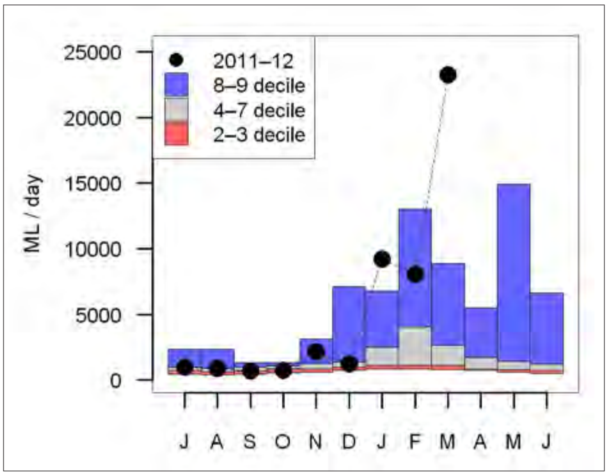


Figure 3.39 Combined monthly flows of Brisbane, Logan and Nerang rivers from 2011–12 compared with the 1980–2012 decile rankings

3.5.7 Hydrogeology

As seen in Figure 3.40, the North East Coast region is dominated by fractured rock groundwater systems that provide a low-volume groundwater resource. Greater resource potential is associated with the following aquifer groups:

- Surficial sediment aquifer (porous media—unconsolidated);
- Tertiary basalt aquifer (fractured rock); and
- Mesozoic sediment aquifer (porous media —consolidated).

Figure 3.40 shows that sediments of the Great Artesian Basin, which is one of Australia's largest and most significant groundwater basins, are present along the western border of the region; however, these sediments are not extensive in the North East Coast region.

3.5.8 Watertable salinity

Figure 3.41 shows the classification of watertable aquifers as fresh (total dissolved solids (TDS) < 3,000 mg/L) or saline (TDS ≥ 3,000 mg/L). The salinity was interpolated from bores less than 40 m deep using the long-term average groundwater salinity for all bores. Most parts of the region have fresh groundwater. Salty groundwater occurs in localised areas in the central highlands and the coast.

3.5.9 Groundwater management units

In Queensland, a number of groundwater areas have been established by the State government to protect underground water resources.

A groundwater area in Queensland is an area identified in the Water Regulation 2002 as a water resource plan or a wild river declaration. Within these areas authorisation is required to access groundwater or construct works to take groundwater for certain purposes.

The groundwater management units within the region are presented in Figure 3.42. This dataset is extracted from the Bureau's Interim Groundwater Geodatabase as compiled in 2009 (currently under revision).

Most groundwater management units are relatively small in area. In large areas, groundwater resources are used outside of groundwater management units (unincorporated areas). This pattern of groundwater use reflects the hydrogeology in the region, which is dominated by a large area of outcropping fractured basement rock typically offering restricted low-volume groundwater resources.

In contrast, significant groundwater resources are localised in alluvial valley systems and coastal sand deposits.

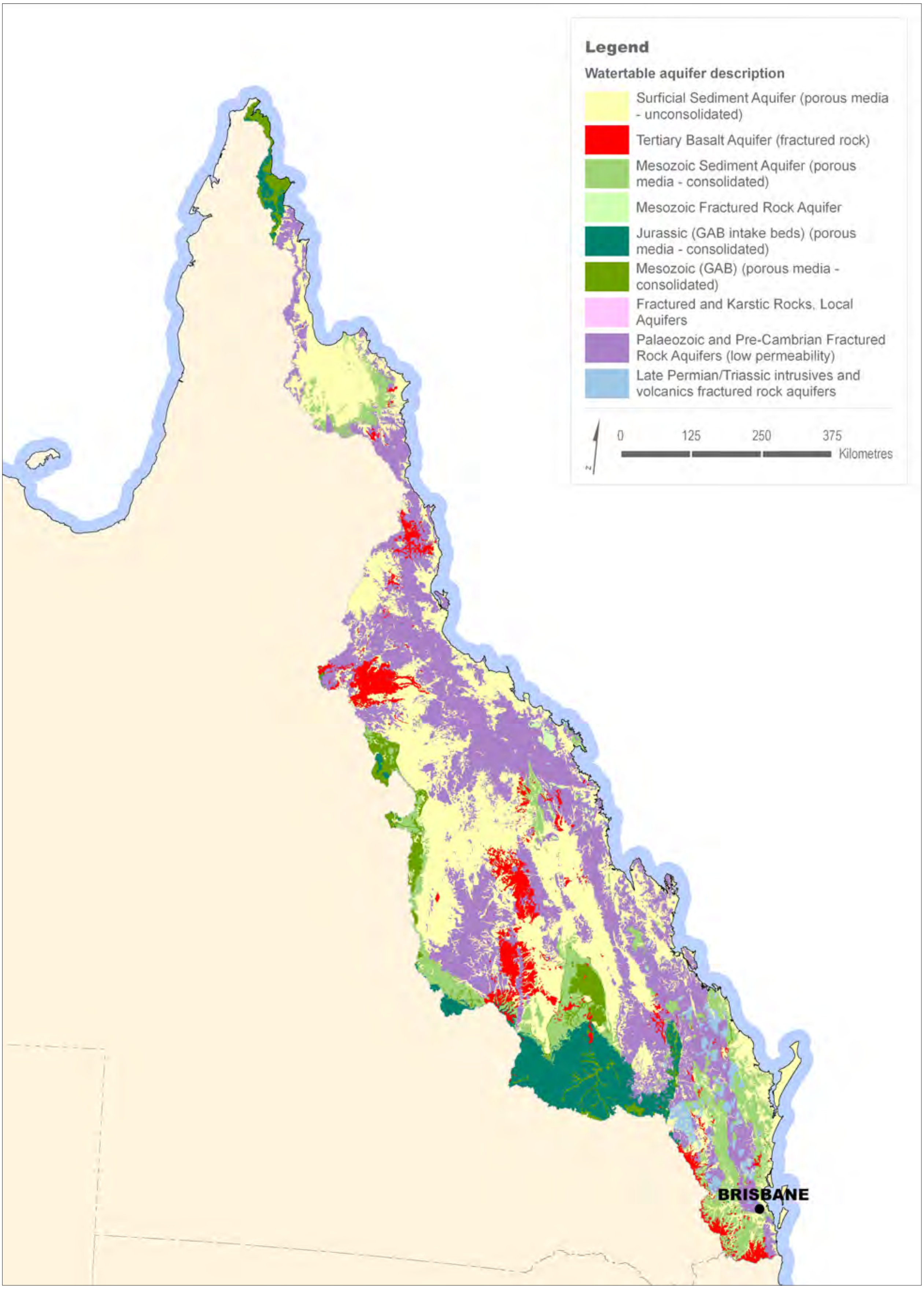


Figure 3.40 Watertable aquifers of the North East Coast region, data extracted from the Groundwater Cartography of the Australian Hydrological Geospatial Fabric (Bureau of Meteorology 2012)

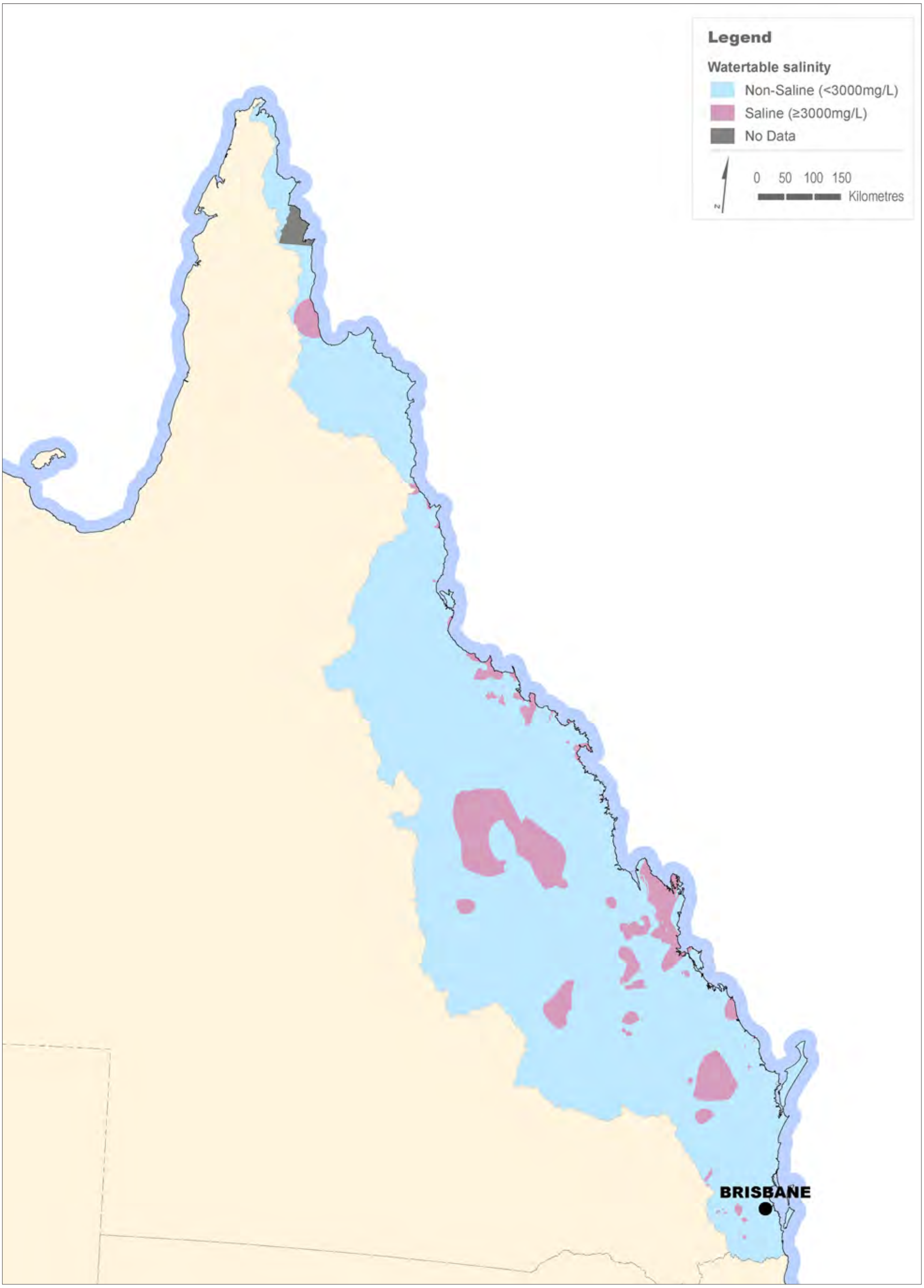


Figure 3.41 Watertable salinity classes in the North East Coast region; data extracted from the Groundwater Cartography of the Australian Hydrological Geospatial Fabric (Bureau of Meteorology 2012)

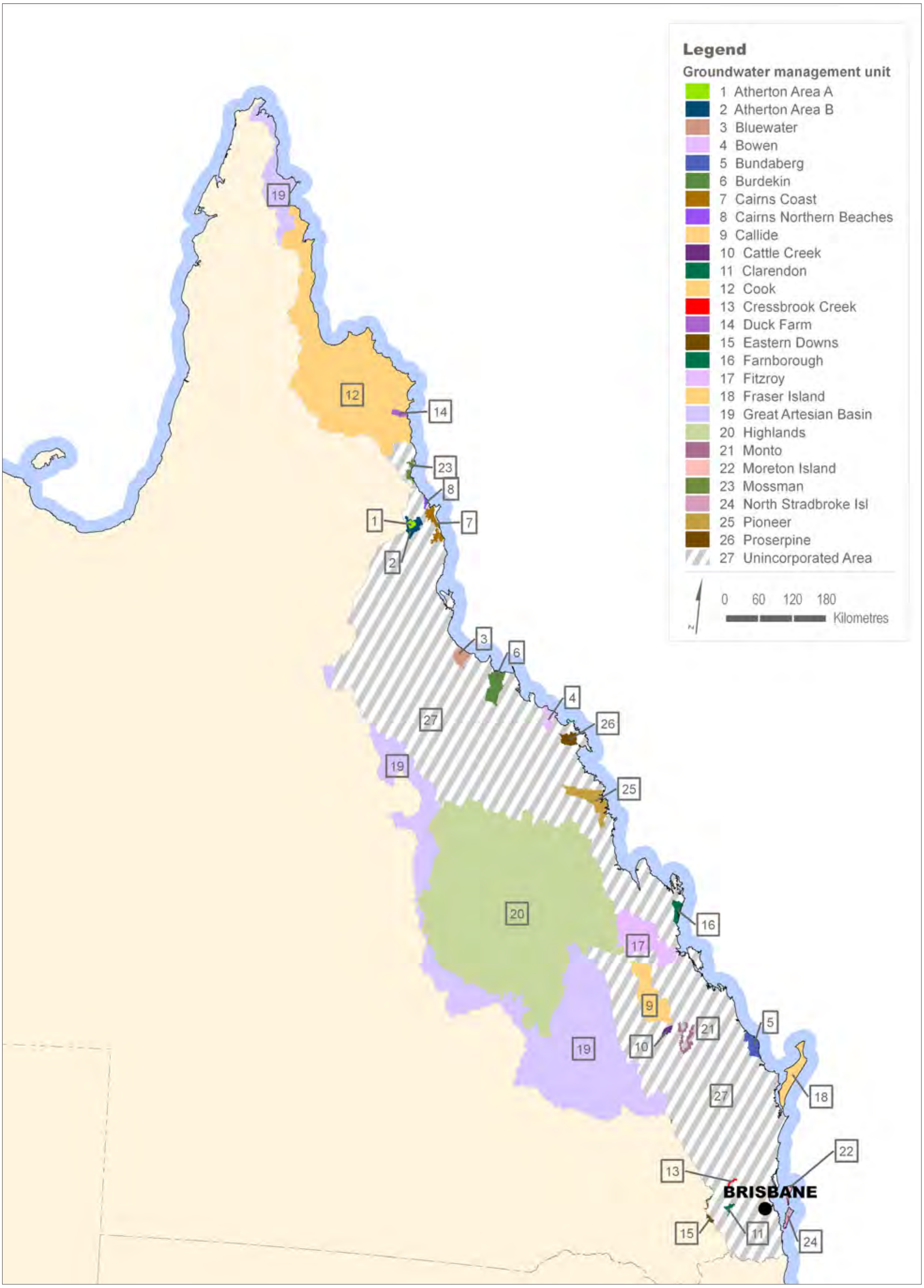


Figure 3.42 Groundwater management units in the North East Coast region, data extracted from the National Groundwater Information System (Bureau of Meteorology 2013)

3.5.10 Groundwater status of selected aquifers

The status of groundwater levels is analysed at each bore throughout the North East Coast region. This assessment evaluates trends in groundwater levels over the five-year period 2007–08 to 2011–12.

The trends in groundwater levels over the five years are investigated using a 5 km x 5 km grid across data rich areas usually associated with the major groundwater management units (see Figure 3.42). This scale reflects the mostly local to intermediate flow system of the alluvial and tertiary basalts aquifers in the region.

The linear trend in groundwater levels for a grid cell is assessed as:

- decreasing (where more than 60% of the bores have a negative trend in levels lower than –0.1 m/year);
- stable (where more than 60% of the bores have a trend lower than 0.1 m/year and higher than –0.1 m/year);
- increasing (where more than 60% of the bores have a positive trend in levels higher than 0.1 m/year); and
- variable (where there is no dominant trend in groundwater levels amongst the bores within a grid cell).

Example bore hydrographs are presented for each sub-region over the entire record length and trends are discussed with a focus on the 2007–08 to 2011–12 period. The selected bore hydrographs represent mostly bores with high data density that were used in the 2010 Assessment.

Northern aquifers

The map in Figure 3.43 illustrates the spatial and temporal trends in groundwater levels in the major alluvial aquifers along the coast (shown in brown) and in the main inland basalt aquifer (shown in pink), over the 2007–08 to 2011–12 period, in the north of the region. Many of the grid cells show a rising trend with a minority of cells showing a stable trend.

Selected Bore 1 shows a stable trend while bores 2 and 3 show a rising trend in groundwater levels over the last five years. This reflects the local groundwater use and the rising trend in rainfall for the northern part of the region. Irrigation in the Burdekin irrigation area may also be affecting groundwater levels in Bore 2. Groundwater levels in the last five years are within the shallowest levels on record.

Central aquifers

The map in Figure 3.44 illustrates the spatial and temporal trends in groundwater levels in the major alluvial (shown in brown) and basalt aquifers (shown in pink), over the 2007–08 to 2011–12 period, in the central area of the region. Many of the grid cells show either a rising or stable trend.

Selected Bore 4 shows a rising trend in groundwater levels over the analysis period. The Bore 4 hydrograph is similar in nature to the behaviour of groundwater levels in the northern coastal aquifers. Bores 5 and 6, located in the inland alluvium of the Callide groundwater management unit, show an increase in groundwater level from end 2010 to early 2011 in contrast to the long-term declining trend suggesting recent high recharge to groundwater. This reflects the high rainfall and flooding that occurred since 2010.

Southern aquifers

The map in Figure 3.45 illustrates the spatial and temporal trends in groundwater levels in the major alluvial (shown in brown) and basalt (shown in pink) aquifers inland and along the coast, over the 2007–08 to 2011–12 period. Many of the grid cells show a rising trend with a minority of cells showing a stable trend.

Selected bores 7, 8 and 9 show a rising trend in groundwater levels over the analysis period, especially in Bore 9, representing the Lockyer valley alluvium aquifer; this is in contrast to the long-term declining trend. It suggests recent high recharge to groundwater, reflecting the high rainfall and flooding since 2010.

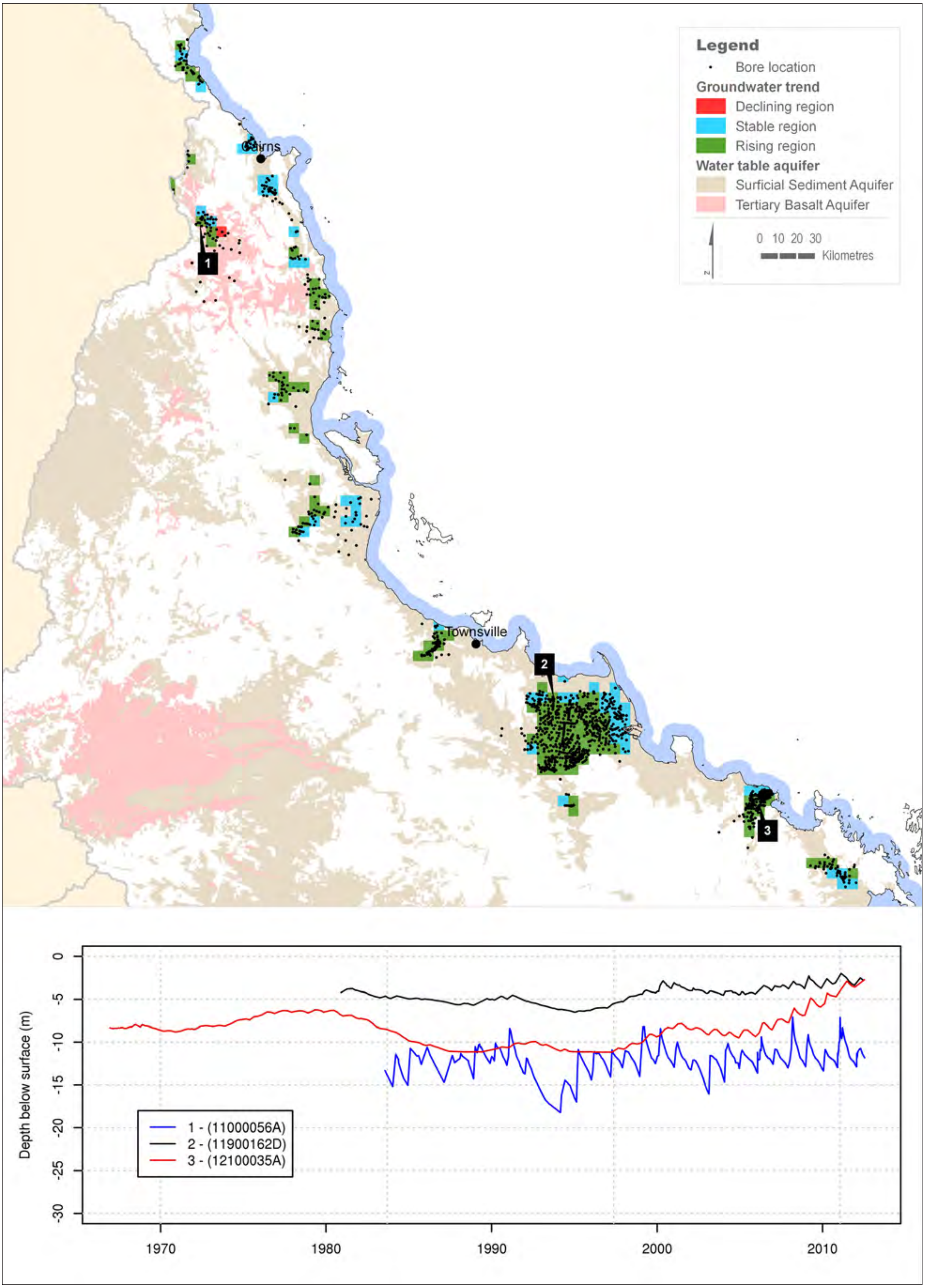


Figure 3.43 Spatial distribution of trends in groundwater levels for the surficial sediments and tertiary basalt aquifers in the northern North East Coast region for 2007–08 to 2011–12 with selected hydrographs showing groundwater levels

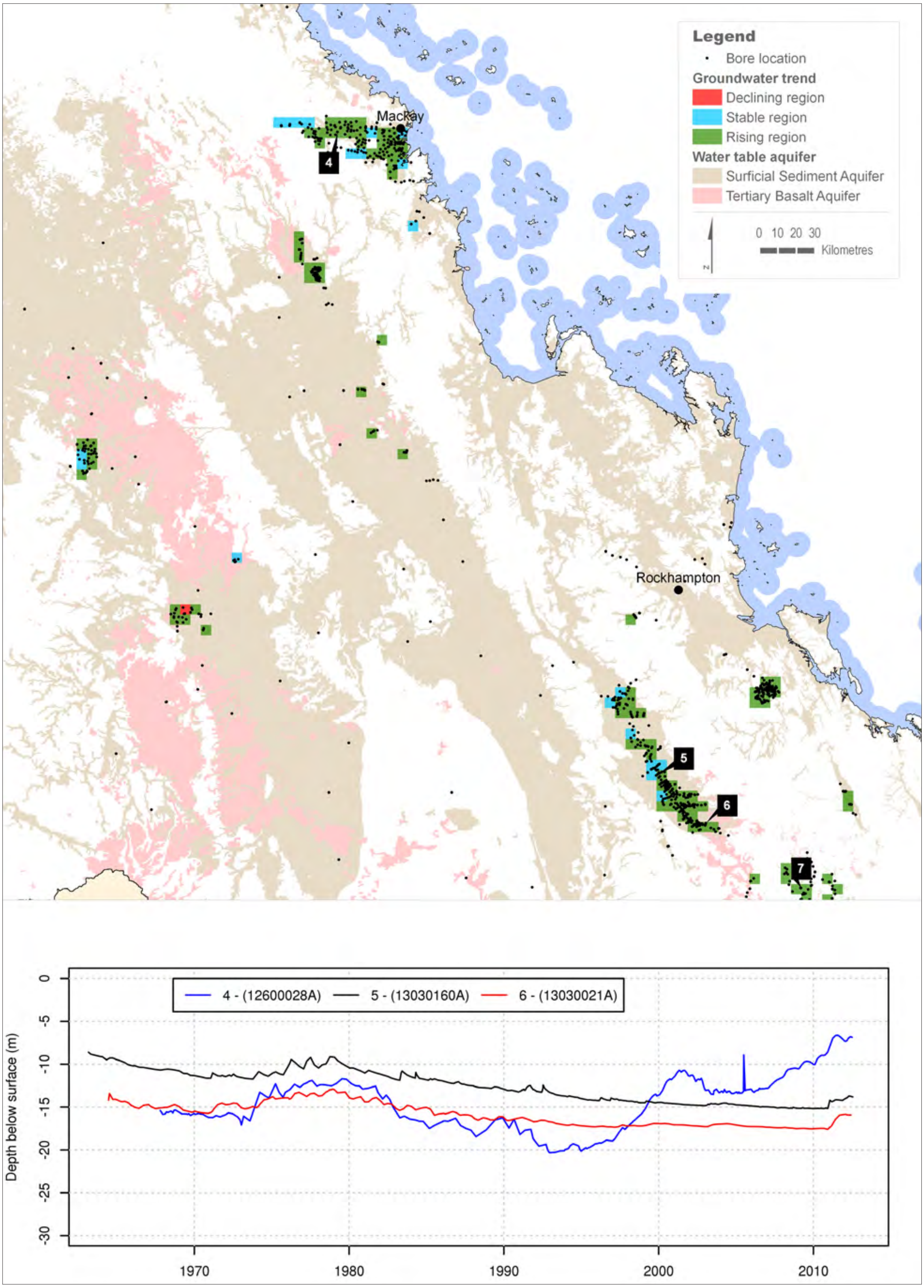


Figure 3.44 Spatial distribution of trends in groundwater levels for the surficial sediments and tertiary basalt aquifers in the central North East Coast region for 2007–08 to 2011–12 with selected hydrographs showing groundwater levels

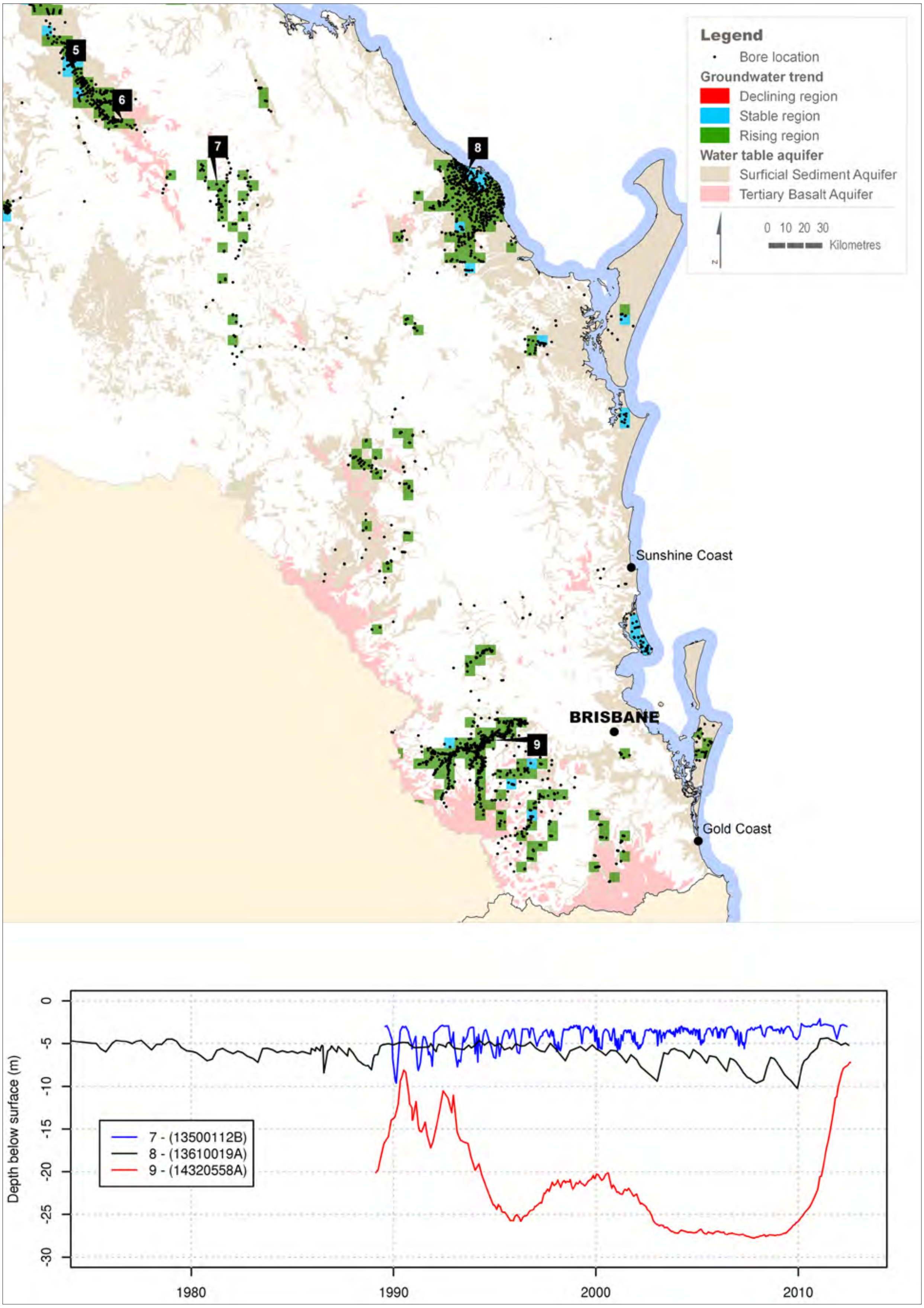


Figure 3.45 Spatial distribution of trends in groundwater levels for the surficial sediments and tertiary basalt aquifers in the southern North East Coast region for 2007–08 to 2011–12 with selected hydrographs showing groundwater levels

3.6 Water for cities and towns

This section examines urban water in the North East Coast region in 2011–12. The large urban centres in the region, their water supply systems and water storage situations are briefly described. The main urbanised area, southeast Queensland, is addressed in more detail and the history of water restrictions over recent years is discussed. A breakdown is provided for water obtained for and delivered to Brisbane and the Gold Coast.

3.6.1 Urban centres

Straddling the Brisbane River, the city of Brisbane is the largest city in the region and with a population of over 1.8 million people it is the third largest in Australia. The Sunshine Coast and Gold Coast, to the respective north and south of Brisbane, are home to a further 743,000 people.

Outside of the heavily populated southeast coast, the region has a large number of urban centres and towns. In particular, a number of coastal cities that support adjoining areas within the region.

Cairns is the northern most and second largest of these cities. From north to south between Cairns and Brisbane these cities include Townsville, the largest regional city outside of southeast Queensland, Mackay, Rockhampton, Gladstone and Bundaburg. These cities, along with Brisbane, The Gold Coast and the Sunshine Coast are shown in Figure 3.46 in conjunction with their population ranges.

Table 3.4 summarises the major urban centres of the region with populations of over 25,000 people and provides information on the population, surrounding river basin and significant water storages for each of the major urban centres.

Table 3.4 Cities and their water supply sources in the North East Coast region

City	Population[1]	River basin	Major supply sources
Brisbane	1,874,000	Brisbane River	Wivenhoe, Somerset and North Pine reservoirs (part of SEQ Water Grid)
The Gold Coast	534,000	South Coast	Hinze reservoir (part of SEQ Water Grid)
The Sunshine Coast	209,000	Mary River	Lake Macdonald, Baroon Pocket, Ewen Maddock, Cooloolabin and Wappa reservoirs
Townsville	158,000	Ross River	Ross River and Paluma reservoirs
Cairns	134,000	Mulgrave–Russell Rivers	Tinaroo Falls and Copperlode reservoirs
Mackay	74,000	Pioneer River	Teemburra and Kinchant reservoirs
Rockhampton	62,000	Fitzroy River	Fitzroy River Barrage and Eden Bann Weir
Bundaberg	50,000	Burnett River	Ben Anderson Barrage, Ned Churchward Weir, Paradise and Fred Haigh reservoirs
Hervey Bay	49,000	Mary River	Lake Lenthall
Gladstone	32,000	Calliope River	Awoonga Reservoir

[1] Australian Bureau of Statistics (2011b)

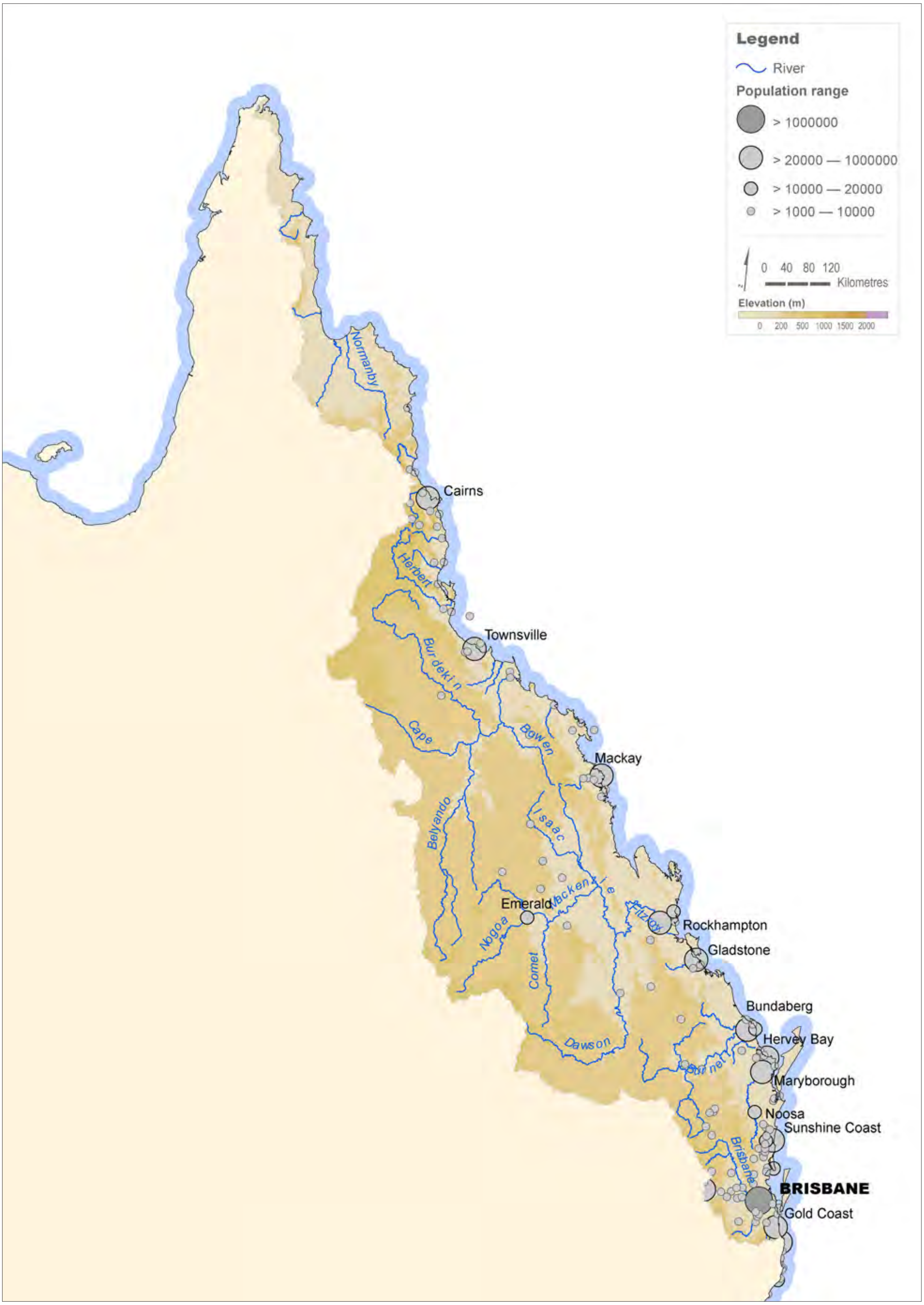


Figure 3.46 Population range of major urban centres in the North East Coast region

3.6.2 Sources of water supply

Surface water is the major source of supply for the cities and towns of the region. It has over 70 major water storages, each with a capacity of over 1 GL, that supply a combination of urban, agricultural, industrial and mining demands.

Supplying Brisbane and surrounding populations, Wivenhoe is arguably the most well known surface water storage in the region; however, with respect to size it ranks third behind Fairbairn and Burdekin Falls. The latter, being the largest surface water storage in the region, supplies both irrigation and urban demands, including those of the City of Townsville.

Figure 3.47 shows major surface water storages in the region, including Wivenhoe and Burdekin Falls, that are partly in use for urban water supply.

In addition to surface water storages the region utilises direct river extractions (including extractions of upstream storage releases), groundwater, desalination, recycled water, and harvested storm and rainwater to supply its urban demands.

3.6.3 Southeast Queensland

Southeast Queensland (SEQ) is serviced by what is arguably the most complex water supply system in Australia. Known as the SEQ Water Grid, the supply area it covers is about 22,000 km^2, extending 240 km from the Shire of Noosa in the north to the Gold Coast and the New South Wales border in the south. It encompasses the ten local government areas of Brisbane, the Gold Coast, Ipswich, Lockyer Valley, Logan, Moreton Bay, Redland, Scenic Rim, Somerset and the Sunshine Coast.

New institutional arrangements for the management and operation of the region's water services came into effect on 1 January 2013. Seven separate authorities and utilities are collectively responsible for the SEQ Water Grid and are comprised of a bulk water authority (Seqwater), a network controller for bulk supplies (Link Water) a water grid operator (SEQ Water Grid Manager), an operator for the region's desalination and recycled water plants (Secure Water), and three retail suppliers (Unity Water, Queensland Urban Utilities and Allconnex Water).

Seqwater is responsible for the collection and storage of surface water, extraction of groundwater, operation of the desalination facilities and the area's Western Corridor Recycled Water Scheme. In addition, Seqwater is the catchment manager for the area's surface water and groundwater supply catchments.

Link Water operates and maintains the bulk water supply network and is responsible for the transportation of water supplies to treatment plants and between storages.

As the owner of urban water entitlements in the SEQ region the SEQ Water Grid Manager operates the SEQ Water Grid to supply the council-owned retail authorities and industry with potable water.

Secure Water operates the Gold Coast desalination plant and the Western Corridor Recycled Water Scheme.

The region's urban water utilities are Unity Water (Moreton Bay and Sunshine Coast), Queensland Urban Utilities (Brisbane, Scenic Rim, Ipswich, Somerset and the Lockyer Valley) and Allconnex Water (Gold Coast, Logan and Redland). In addition to the provision of water supply services these utilities are responsible for the collection and treatment of wastewater.

Figure 3.47 Urban supply storages in the North East Coast region

Supply system

The region's water supplies are drawn from a complex network of surface water storages, water treatment plants, groundwater bore fields and recycled and desalinated water plants.

Over ten major surface water storages, including Wivenhoe, Somerset and North Pine, a series of small storages and weirs, the Stradbroke Island and Bribie Island bore fields, the Tugan desalination plant, the Western Corridor Recycled Water Scheme and a complex network of pipes, service reservoirs, pump stations and treatment plants make up the SEQ Water Grid.

Figure 3.48 outlines the major water infrastructure in southeast Queensland and illustrates urban flow pathways between local government and other main customers.

Some water is exported to costumers beyond this system, the largest being the Tarong Power Station.

Storage volumes

In combination, the Wivenhoe, Hinze, Somerset and North Pine storages provide over 90% of the total accessible surface water storage for SEQ, with Wivenhoe contributing over half of this total.

Figure 3.49 presents the total accessible volume held in these storages over the past 18 years (1984–2012) and clearly illustrates the impacts of the millennium drought with storages levels reaching critically low levels in 2008. A shift in climatic conditions in 2009 and a series of wetter years, including Australia's wettest two-year period on record in 2010 and 2011, saw storage levels recover from their historic lows. Continued good rainfall in the region's catchments has seen storage levels maintained at or near capacity throughout 2011–12.

The observed step change in the accessible volumes of the Hinze storage is explained by an increase in the storage's total capacity. Coming into effect in December 2011, the Hinze Dam was raised to increase the total accessible storage from 161 GL to 311 GL.

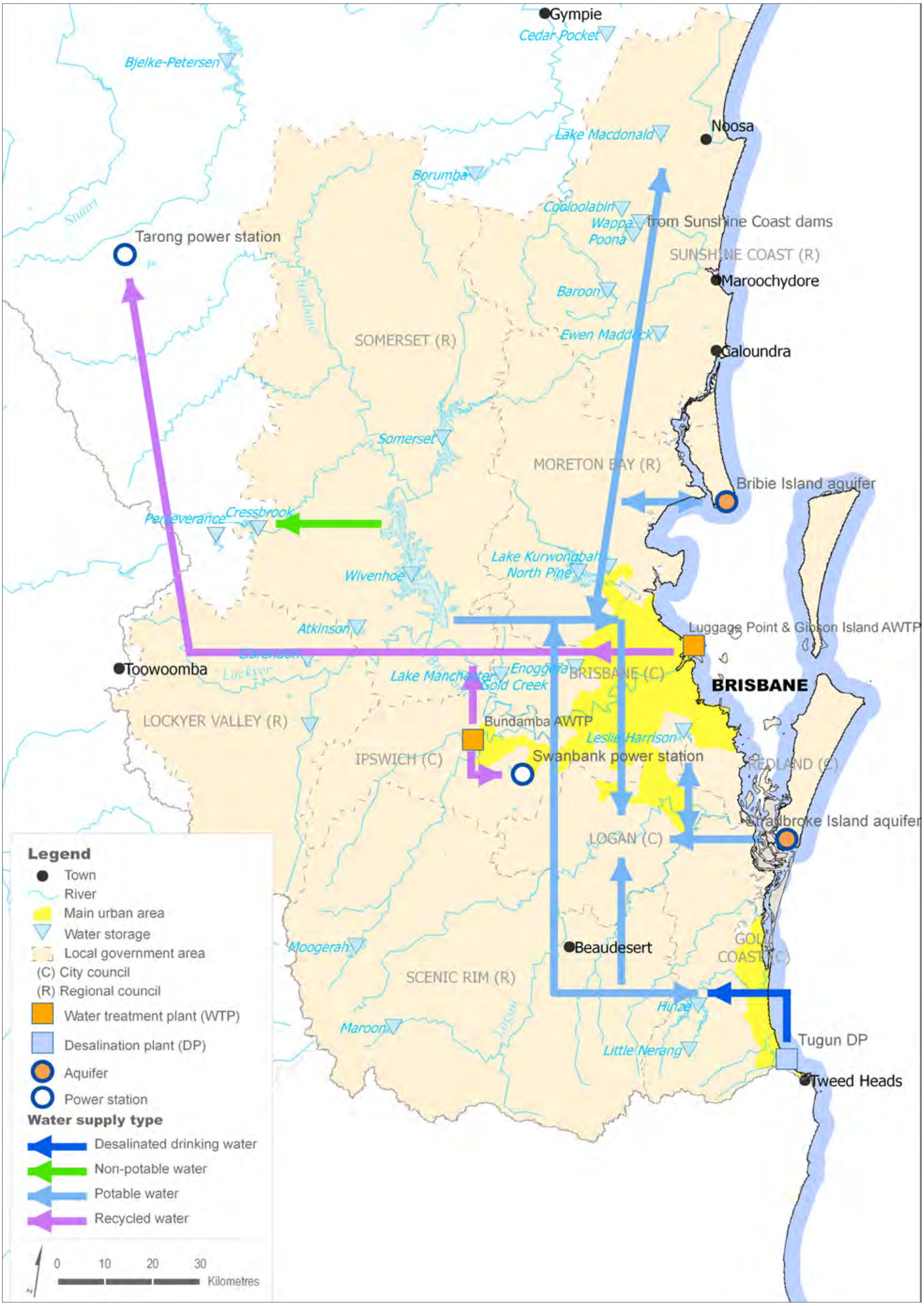


Figure 3.48 Water supply schematic for southeast Queensland

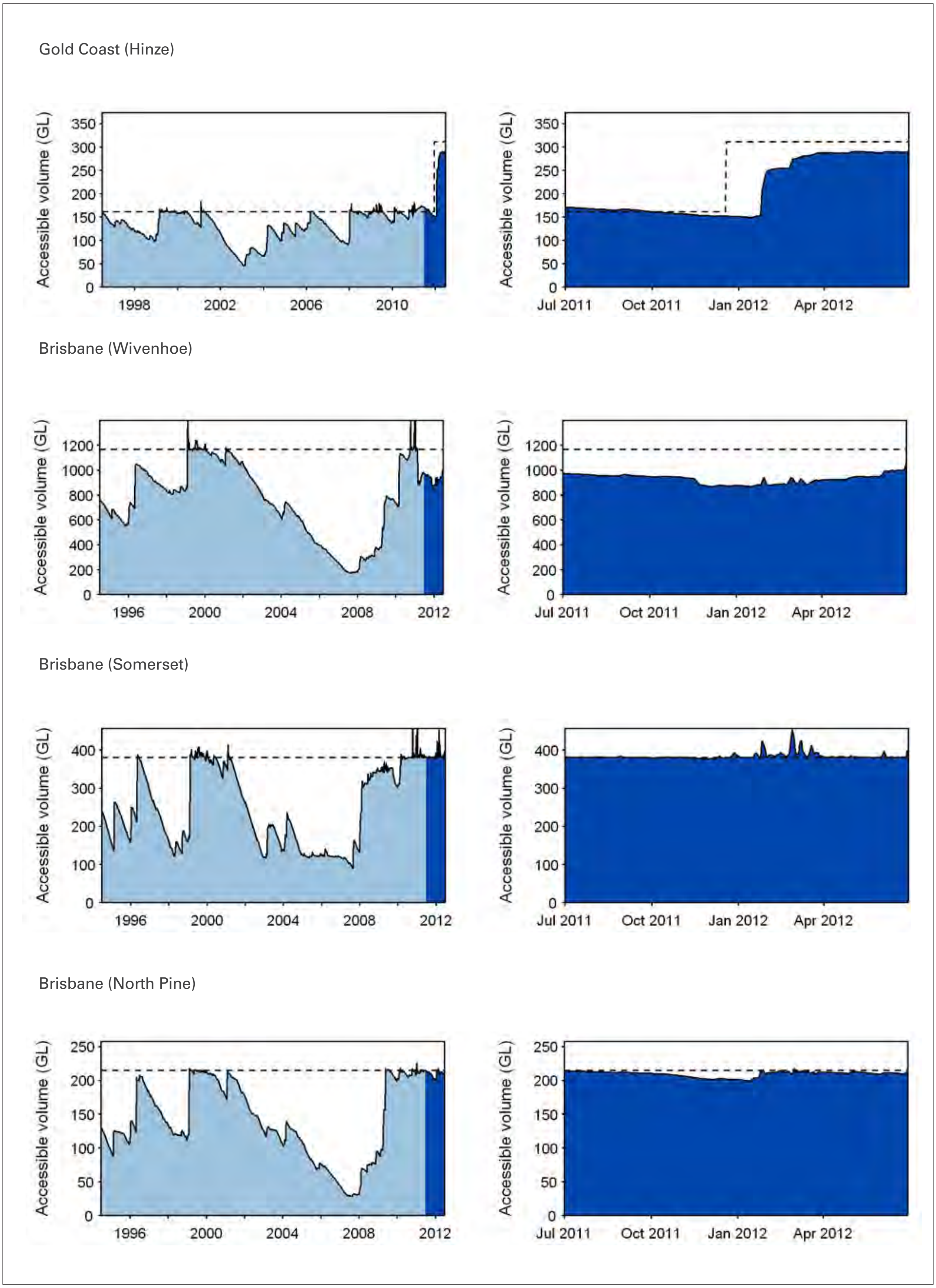


Figure 3.49 Variation in the amount of water held in storage over recent years (light blue) and over 2011–12 (dark blue) for the Hinze, Wivenhoe, Somerset and North Pine storages, as well as total accessible storage capacity (dashed line)

Water restrictions

Following its formation on 1 January 2013, Seqwater has taken over the water security and efficiency responsibilities previously performed by the Queensland Water Commission.

Water restrictions have been in place since 2005, and applied throughout SEQ, excluding Redland, Sunshine Coast Council and Toowoomba until December 2009. They are shown with the combined storage levels in Figure 3.50.

Between 2005 and 2008 combined storage levels steadily decreased resulting in the introduction of more stringent water restrictions.

Permanent water conservation measures (PWCM) were introduced in December 2009 across southeast Queensland including the Sunshine Coast. Although the combined storage level remained above 80% during 2011–12, PWCM remained in place. These measures encouraged the use of a maximum of 200 litres per person per day.

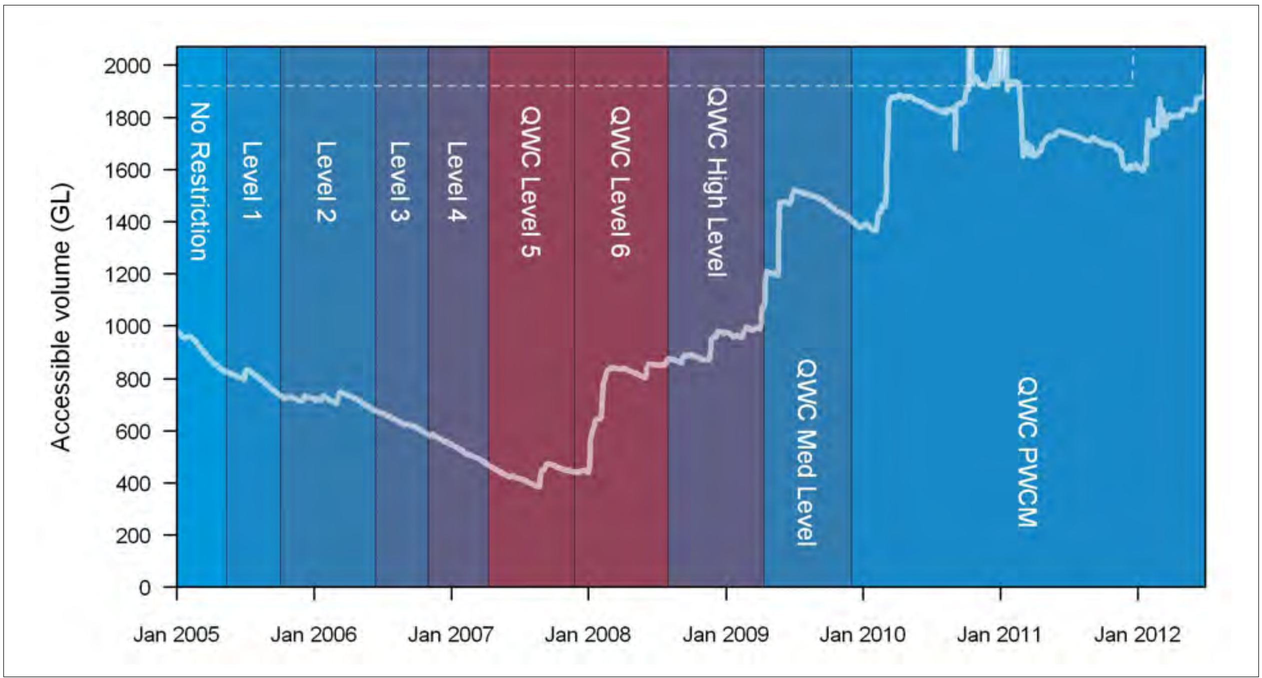


Figure 3.50 Urban water restriction levels across southeast Queensland since 2005 shown against the combined accessible water volume of Wivenhoe, Somerset and North Pine storages

Sources of water obtained

Because of data limitations the following discussion of sources of water obtained pertains only to the Brisbane, Logan and Gold Coast City Council areas. For the purposes of this and the following sections this supply area is referred to as the 'combined area' and represents the central and southern extents of the SEQ Water Grid.

Figure 3.51 shows the total volume of water sourced from surface water extractions, groundwater, recycling, and bulk water transfers to the combined area for the last eight years (2005–06 to 2011–12).

Following changes to the management of bulk water resources in SEQ with the creation of the SEQ Water Grid in 2008, reported data no longer distinguishes between locally sourced surface water and surface water imported to the area.

The observed downward trend in the total volume of water sourced for urban supply is attributable to demand management and water conservation measures put in place in response to dwindling surface water storage levels.

A shift in climatic conditions in 2009 and a series of wetter years has seen storages in SEQ recover to at or near full supply levels and resulted in an easing of water restrictions. These conditions have seen a gradual increase in the total amount of water sourced for urban supply to the area and a reduction in the volume of recycled water used to meet the areas demand.

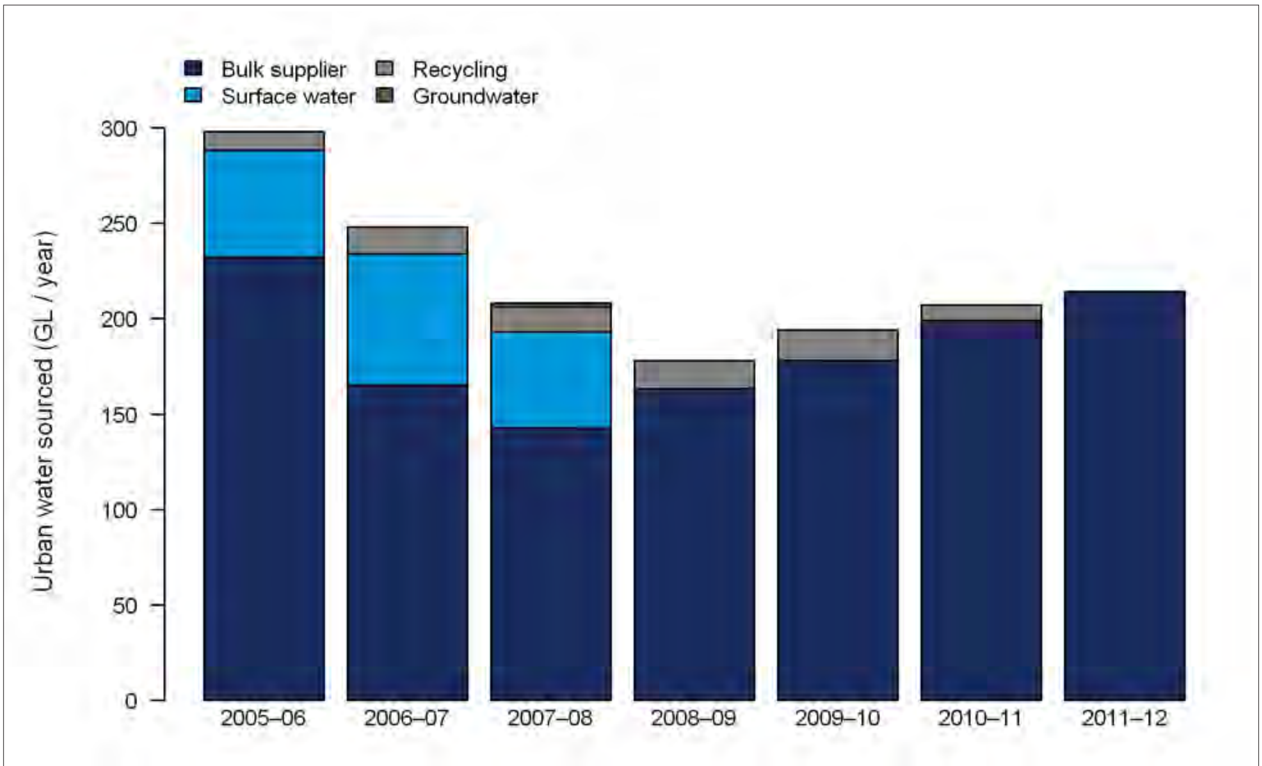


Figure 3.51 Total urban water sourced for the combined area from 2005–06 to 2011–12

Categories of water delivered

As in the previous discussion this section reports on water usage for the 'combined area' comprising Brisbane, Logan and Gold coast councils.

Figure 3.52 shows the total volume of water delivered to residential, commercial, municipal, industrial, and other consumers, such as nurseries, parks, gardens and cemetaries, in the combined area.

Total water supplied was 220 GL in 2005–06 that then decreased for two consecutive years due to water restrictions. Between 2007–08 and 2009–10, total water supplied increased slightly due to the easing of water restrictions and the reintroduction of outdoor watering. The total volume of water supplied to urban customers in 2011–12 was 176 GL. Recent water use is low compared to that in 2005–06.

Average total residential water consumption of the combined area in 2011–12 was 297 ML/d or 158 litres per person per day (L/p/d). The residential sector accounted for 62% of total potable water consumption (similar to the previous year when residential consumption was estimated to be 59%). The commercial, municipal and industrial sectors accounted for 26% of urban water consumption.

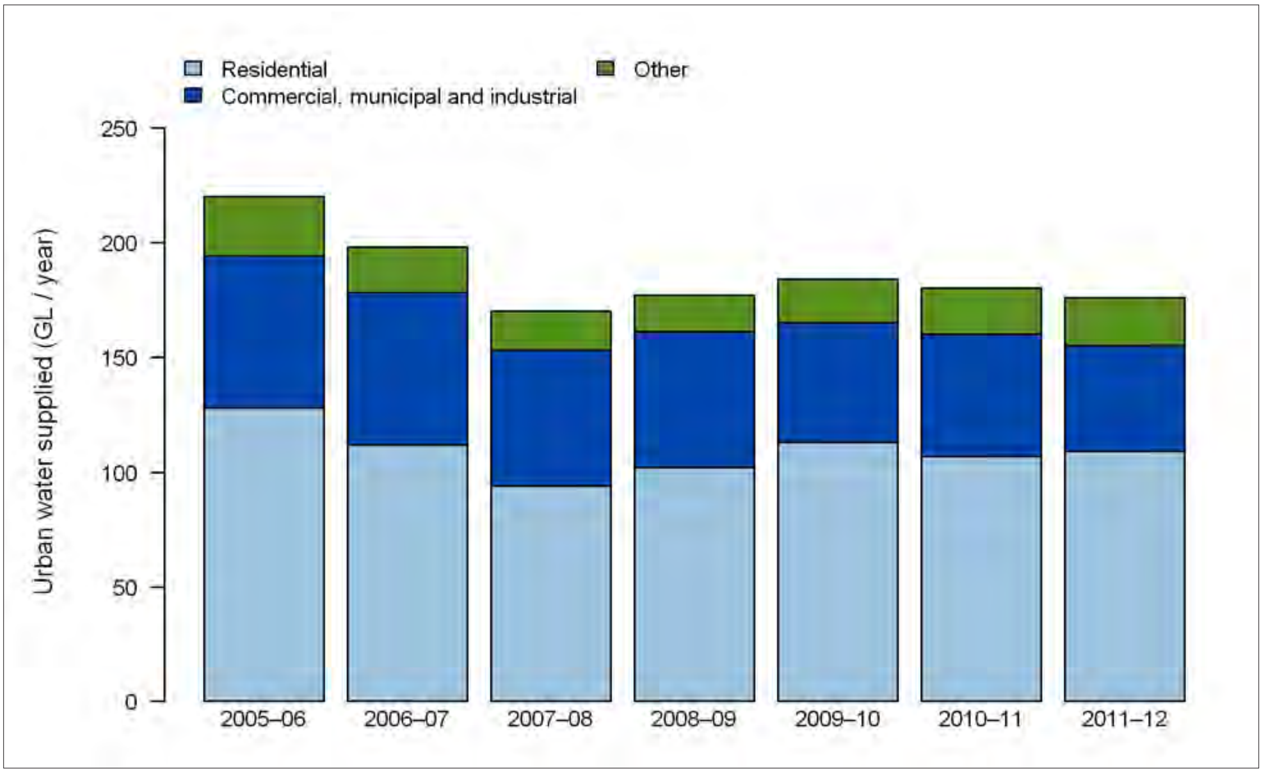


Figure 3.52 Total urban water supplied to the combined area from 2005–06 to 2011–12

3.7 Water for agriculture

This section describes the water situation for agriculture in the North East Coast region during the 2011–12 year compared with the past. Soil moisture conditions are presented and important irrigation areas are identified. The Burdekin irrigation area is described in more detail and information is provided regarding surface water storage and groundwater.

3.7.1 Soil moisture

Since model estimates of soil moisture storage volumes are based on a simple conceptual representation of soil water storage and transfer processes averaged over a 5km x 5km grid cell, they are not suitable for comparison with locally measured soil moisture volumes. This analysis, therefore, presents a relative comparison only, identifying how modelled soil moisture volumes of 2011–12 relate to modelled soil moisture volumes of the 1911–2012 period, expressed in decile rankings.

Figure 3.53 gives an overview of the decile ranking of modelled annual average soil moisture for 2011–12 with respect to the 1911–2012 period. It shows that the majority of the region had above average or very much above average soil moisture conditions. The latter conditions were more prominent in the western pastoral and cropping areas of the region where very much above average rainfalls occurred in that period.

Above average soil moisture conditions in the region were dominant in the wet months of November 2011–March 2012 (Figure 3.54). Soil moisture remained very much above average in all other months of the year. It created beneficial water conditions for dryland cropping across the inland and western parts of the region which are normally drier.

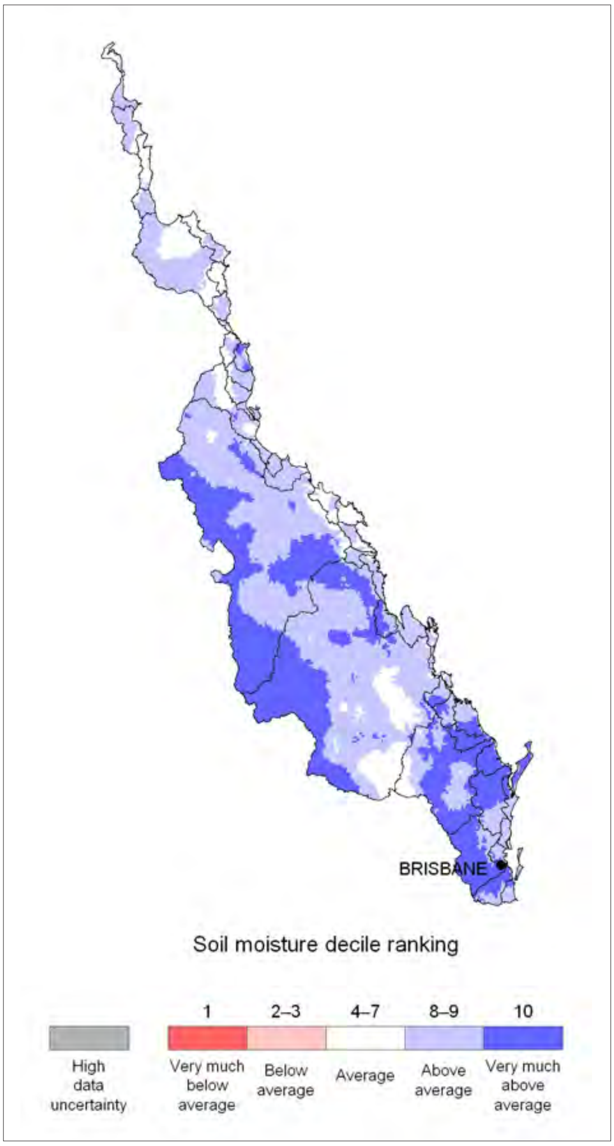


Figure 3.53 Deciles rankings of annual average soil moisture for 2011–12 with respect to the 1911–2012 period for the North East Coast region

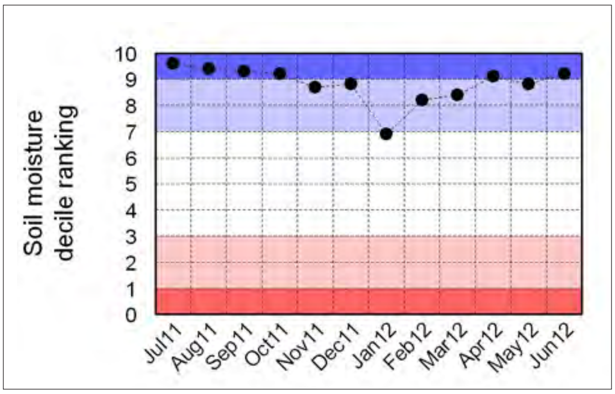


Figure 3.54 Decile ranking of the monthly soil moisture conditions during the 2011–12 period with respect to the 1911–2012 period in the North East Coast region

3.7.2 Irrigation water

The Department of Energy and Water Supply, established in April 2012, provides policy and regulation for the delivery of water to Queensland.

SunWater is a government-owned corporation, which is the main supplier of bulk water, bulk water storage and delivery of services for regional Queensland. In the southeast, Seqwater provides bulk water supply and services to around 1,000 rural communities in five water supply schemes in the Upper Mary, Logan, Central Brisbane, Warrill valley and Lockyer valley areas.

A comparison of water use in irrigated catchments by natural resource management (NRM) regions in the region over the period 2005–06 to 2010–11 is shown in Figure 3.55. Figure 3.56 shows the map of the water use per NRM region in 2010–11.

As with the previous years Burdekin had the highest irrigation water consumption among other NRM regions, but the water use during the 2010–11 in all regions had dropped due to increased availability of water through rainfall. At the time of writing the report data was not available for 2011–12.

The Burdekin River Irrigation Area is described in more detail in subsection 3.7.4

3.7.3 Irrigation areas

Most of the North East Coast region is used for grazing. Dryland and irrigated agriculture account for only 0.4% of the land use of the region. The greatest area of dryland agriculture, 1.8 million hectares, is located in the Fitzroy River basin.

As shown in Figure 3.57, the largest irrigation areas are located in the Brisbane, Mary, Burnett, Burrum and Kolan river basins in the south; the Fitzroy, Plane Creek and Pioneer river basins in the centre of the region; and the Haughton and Burdekin river basins in the north.

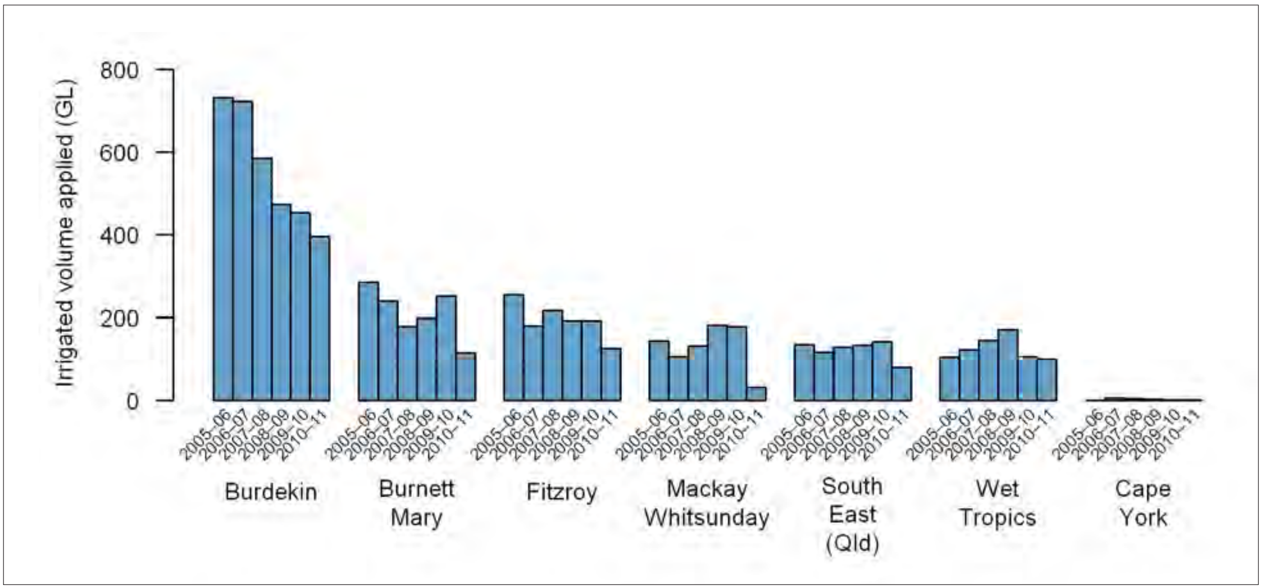


Figure 3.55 Total annual irrigation water use for 2005–06 to 2010–11 for natural resource management regions in the North East Coast region (ABS 2006–2010; 2011a)

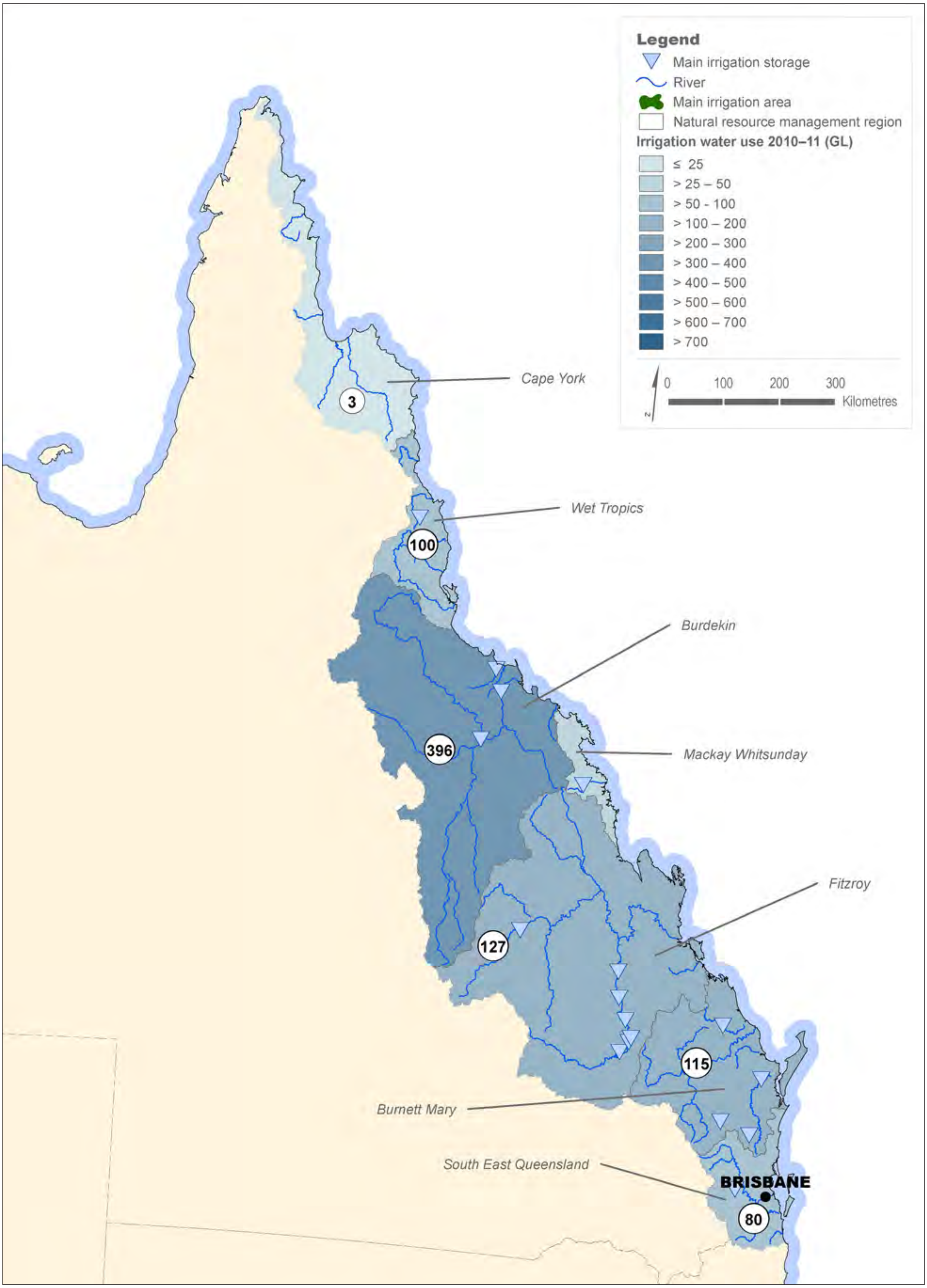


Figure 3.56 Annual irrigation water use (GL) per natural resource management region for 2010–11 in the North East Coast region (ABS 2011a)

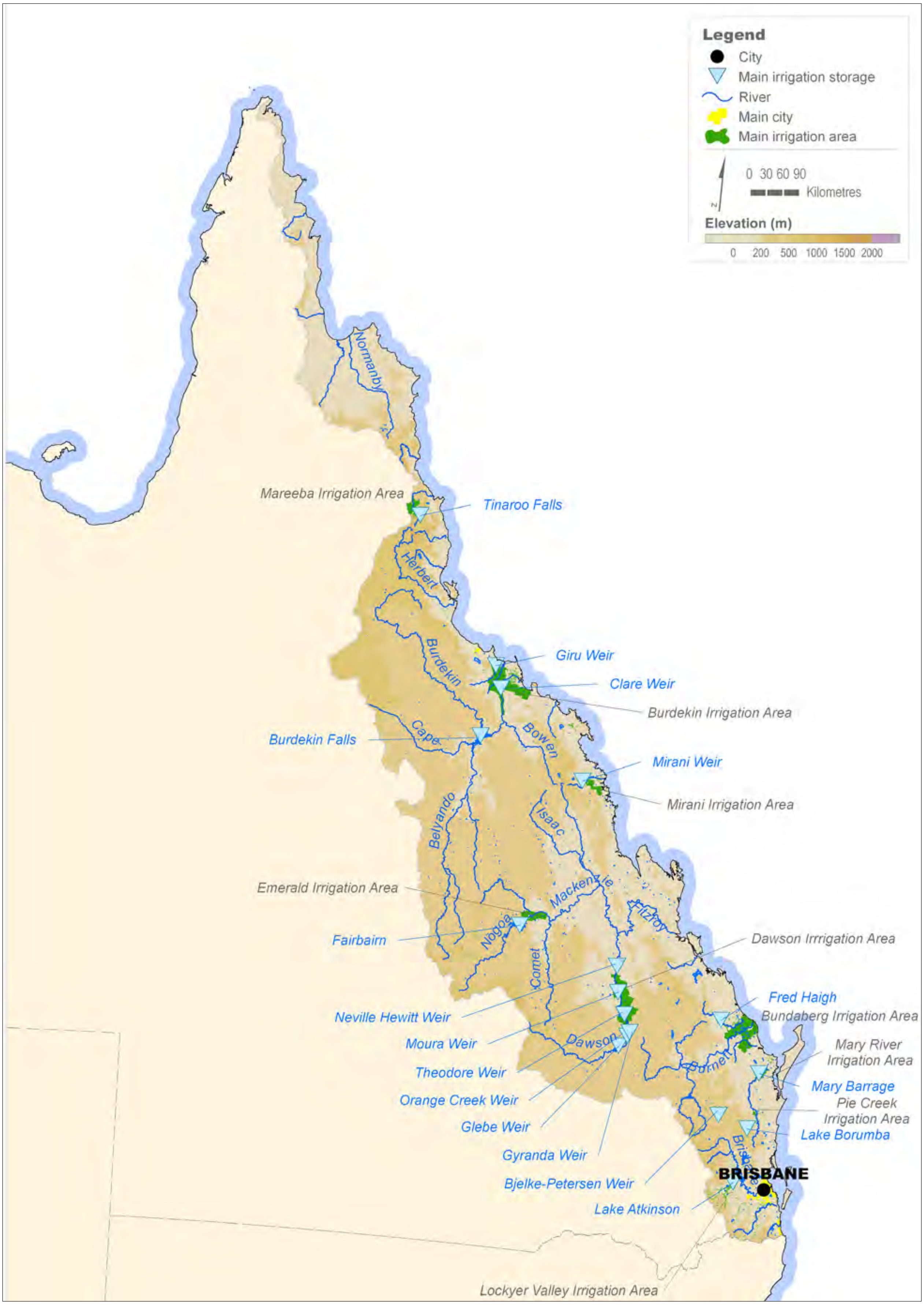


Figure 3.57 Irrigation areas in the North East Coast region

3.7.4 Burdekin River Irrigation Area

The Burdekin River basin is located in the dry tropics on the North East Coast region, covering a total catchment area of approximately 133,000 km^2.

The basin's assets include water, biodiversity, national parks, grazing, fertile soil and crops (Figure 3.58).

The Lower Burdekin in the basin is the largest irrigation area in northern Australia, predominantly growing sugarcane. This part of the region can receive more than 300 days of sunshine each year, which is a primary reason for the highly productive agricultural sector. This can be tempered, however, by the traditional wet season, which runs from November–March each year with the wettest months typically being January and February.

Lower Burdekin comprises two schemes: the Burdekin River Delta, and the Burdekin–Haughton Water Supply Scheme.

The Burdekin Delta downstream of the Burdekin River is a groundwater-dominated scheme, with more than 35,000 ha of irrigated sugarcane and other crops. This system overlies major groundwater supplies.

The Burdekin–Haughton Water Supply Scheme is surface water dominated and receives significant volumes of water from Burdekin Falls storage. Groundwater supplies supplement irrigation.

Burdekin Falls on the Burdekin River is one of the largest surface water storages in Queensland covering 22,000 ha and is supplied by an upstream catchment area of approximately 120,000 km^2. The total accessible storage capacity of Burdekin Falls is 1,850 GL.

Total water delivery in the Burdekin–Haughton scheme in 2011–12 was 455 GL, which was 41 per cent of the water available to the scheme (SunWater 2012).

For the purpose of this report, the Burdekin River Irrigation Area was selected as an example of groundwater use for irrigation in the North East Coast region.

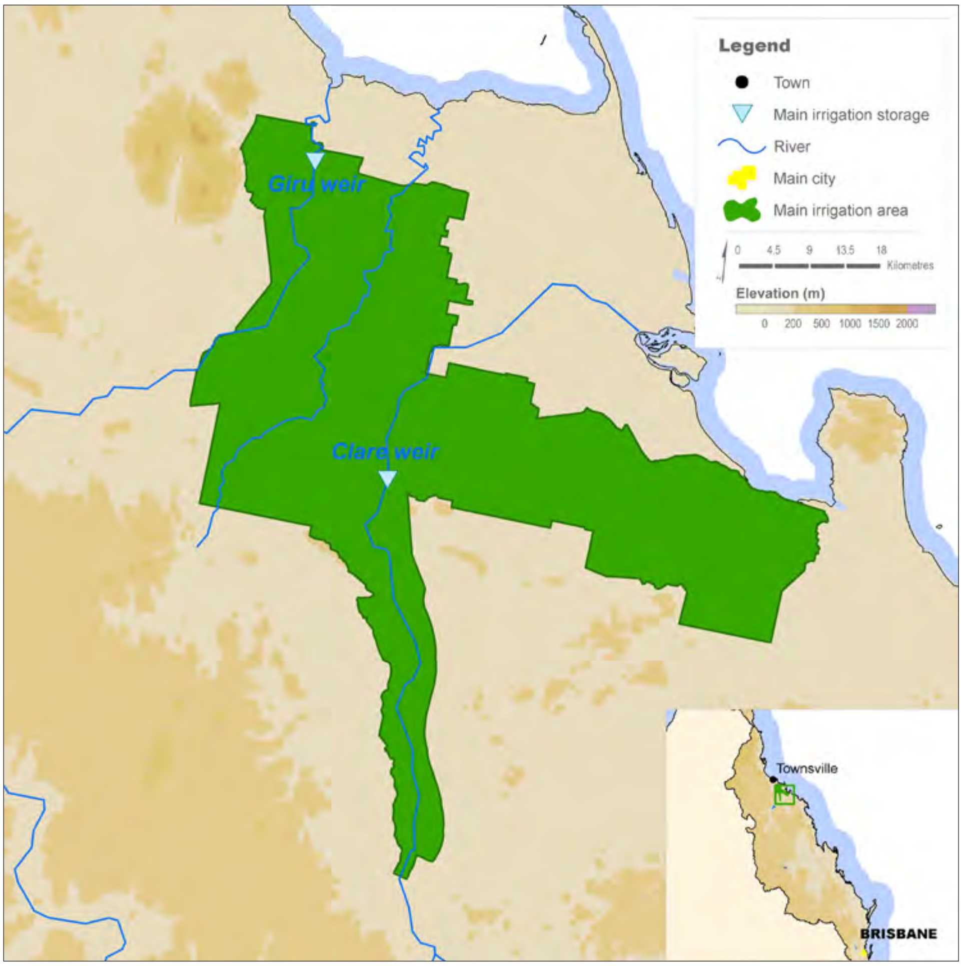


Figure 3.58 Burdekin River Irrigation Area

Surface water storage inflows

The highly seasonal rainfall pattern of the region, which is characteristic of the tropics of northern Australia, is highlighted by the historical streamflow discharge records of gauging stations on the Suttor River at St Anns, Cape River at Taemas and Burdekin River at Sellheim (Figure 3.59).

The seasonal rainfall pattern is linked to the El Niño Southern Oscillation, tropical cyclones and monsoonal activity.

The majority of the recorded discharge in the three catchments upstream of Burdekin Falls for the period 1980–2012 occurred during the months of January through to the end of March, which is the wet season in the region.

The discharge hydrographs of 2011–12 show a lag in peak flow compared with the historical patterns. This is consistent with the overall pattern of rainfall in the region; showing gradual ascent with a peak in March that subsides afterwards.

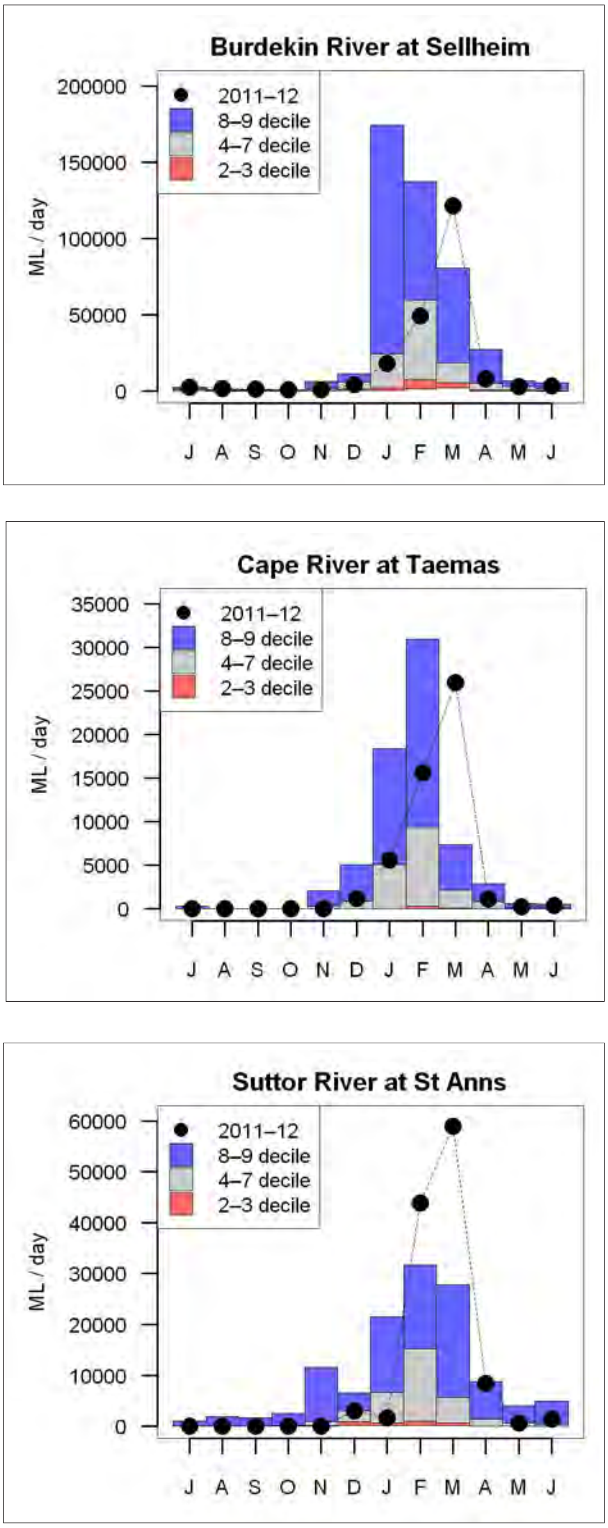


Figure 3.59 Monthly inflows to Burdekin Falls for 2011–12 with respect to the 1980–2012 decile rankings

Surface water storage volumes

Despite the large storage capacity of Burdekin Falls, the significant seasonal discharge from the upstream catchments has resulted in an almost periodic spilling of the dam every wet season since construction (Figure 3.60). In wet years, the spilling can continue for months. In 2011–12, the dam overflowed from January 2012 and continued to spill in June 2012.

Between January and June 2012, more than 29,000 ML of water passed over the spillway. The full storage and wet weather conditions ensured 100% of water allocations were available to local irrigators.

Local hydrogeology

Irrigation areas in the Burdekin River Delta are underlain by a relatively shallow watertable. Lower Burdekin Water manages a groundwater-dominated irrigation system downstream and east of Mount Kelly (Figure 3.61). More than 1,400 groundwater pumps are in operation applying 10–40 ML/ha/yr to crops (McMahon et al. 2002). This is equivalent to 1,000–4,000 mm/year.

The water source used for irrigation (groundwater or surface water) depends on proximity to the river or irrigation channels and on groundwater salinity and yield.

The coastal floodplain is mostly unconfined and has up to 100 m of sediments overlying the basement. The shallow groundwater in this system is in direct hydraulic connection with the Burdekin River.

Typically, during the dry season, groundwater elevation is higher than surface water levels in the river upstream of the Rocks weir allowing groundwater discharge into the river. During occasional high flows in the wet season, the direction of flow is reversed allowing surface water to recharge groundwater (Lenahan and Bristow 2010). This activity indicates a high connectivity between surface water and groundwater.

Lateral groundwater flow is northerly towards the coast. However, groundwater pumping causes large fluctuations in groundwater levels that can change the local groundwater flow direction.

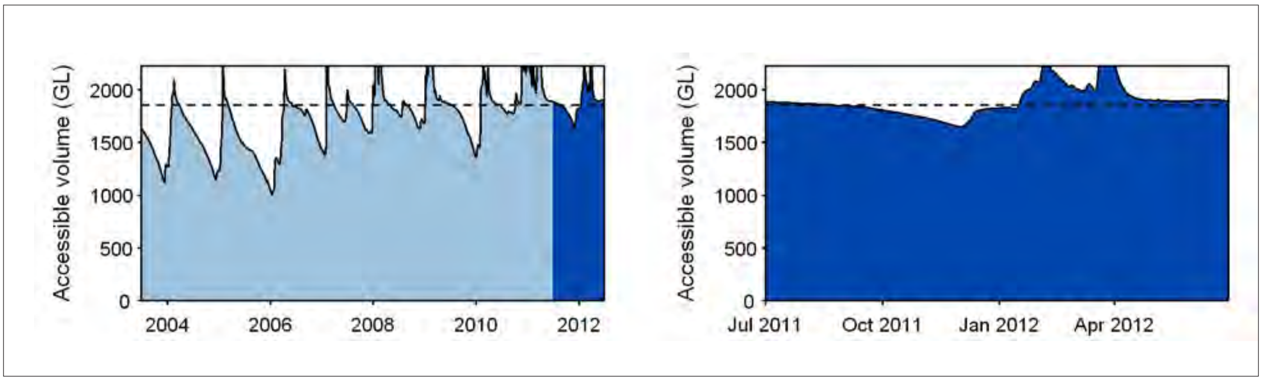


Figure 3.60 Variation in the amount of water held in storage over recent years (light blue) and over 2011–12 (dark blue) for Burdekin Falls storage, as well as total accessible storage capacity (dashed line)

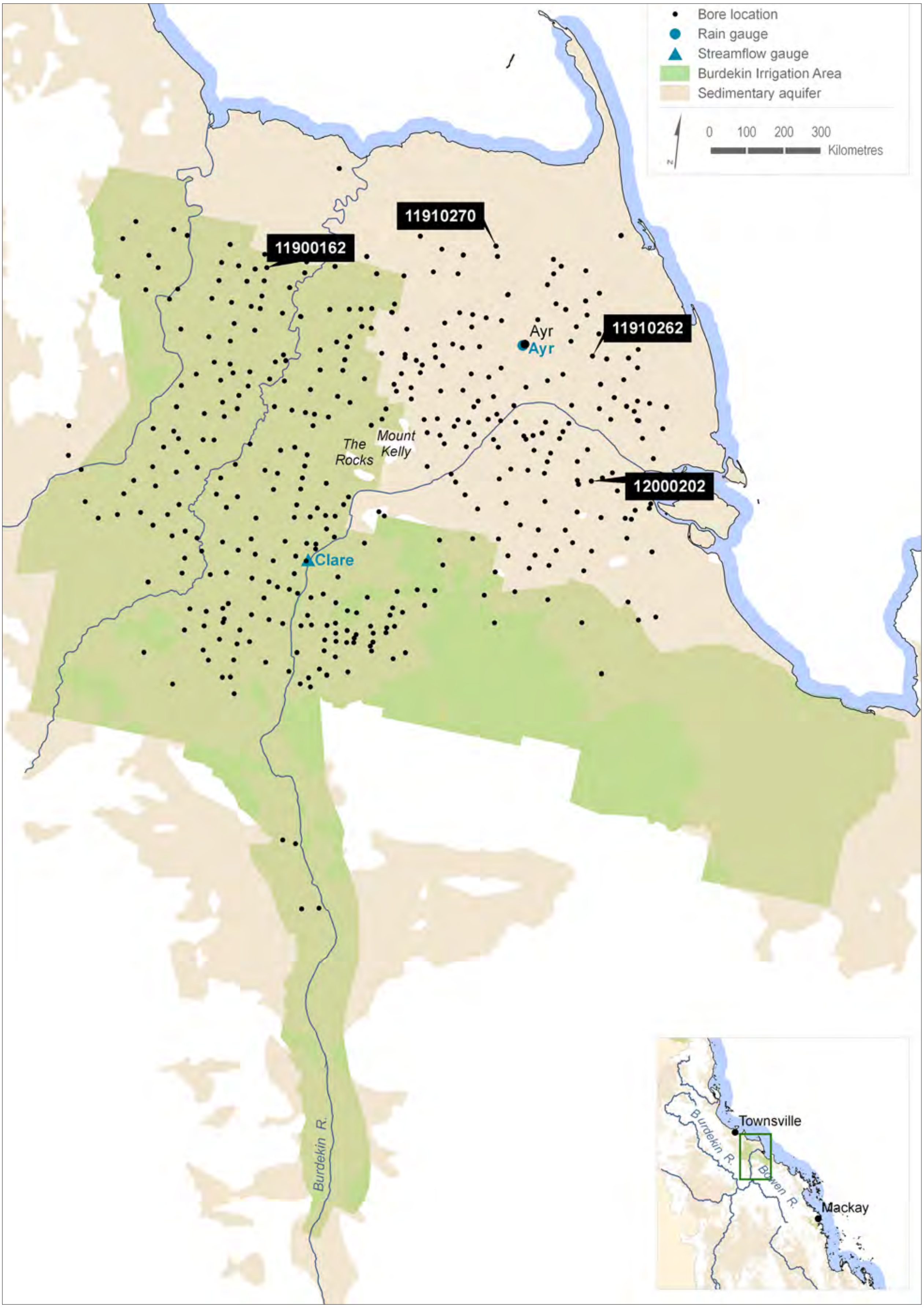


Figure 3.61 The Burdekin River Irrigation Area showing the location of groundwater bore sites, river gauge and rain gauge

Influences on shallow groundwater

Figure 3.62 shows the fluctuations in shallow groundwater levels at selected sites. From 2003 groundwater levels show a rising trend.

Figure 3.62 also illustrates the drivers of the groundwater level by comparing fluctuation in shallow groundwater levels with the monthly cumulative rainfall residual at Ayr and the monthly discharge of the Burdekin River at Clare (Figure 3.62). The location of gauges and bores is shown in Figure 3.61.

Periods in which the cumulative rainfall residual curve rises indicate wetter than average conditions. Periods with a falling trend indicate drier than average conditions.

Figure 3.62b shows a drier than average period up to 2007, followed by a wetter than average period.

Both rainfall and streamflow appear to be drivers for groundwater levels. Peaks in streamflow and in the rainfall residual curve correspond to peaks in groundwater. There are, however, some inconsistencies between the rainfall and groundwater level cycles. For example, groundwater levels start rising in 1995 and 2003 even though the rainfall residual mass curve is still falling.

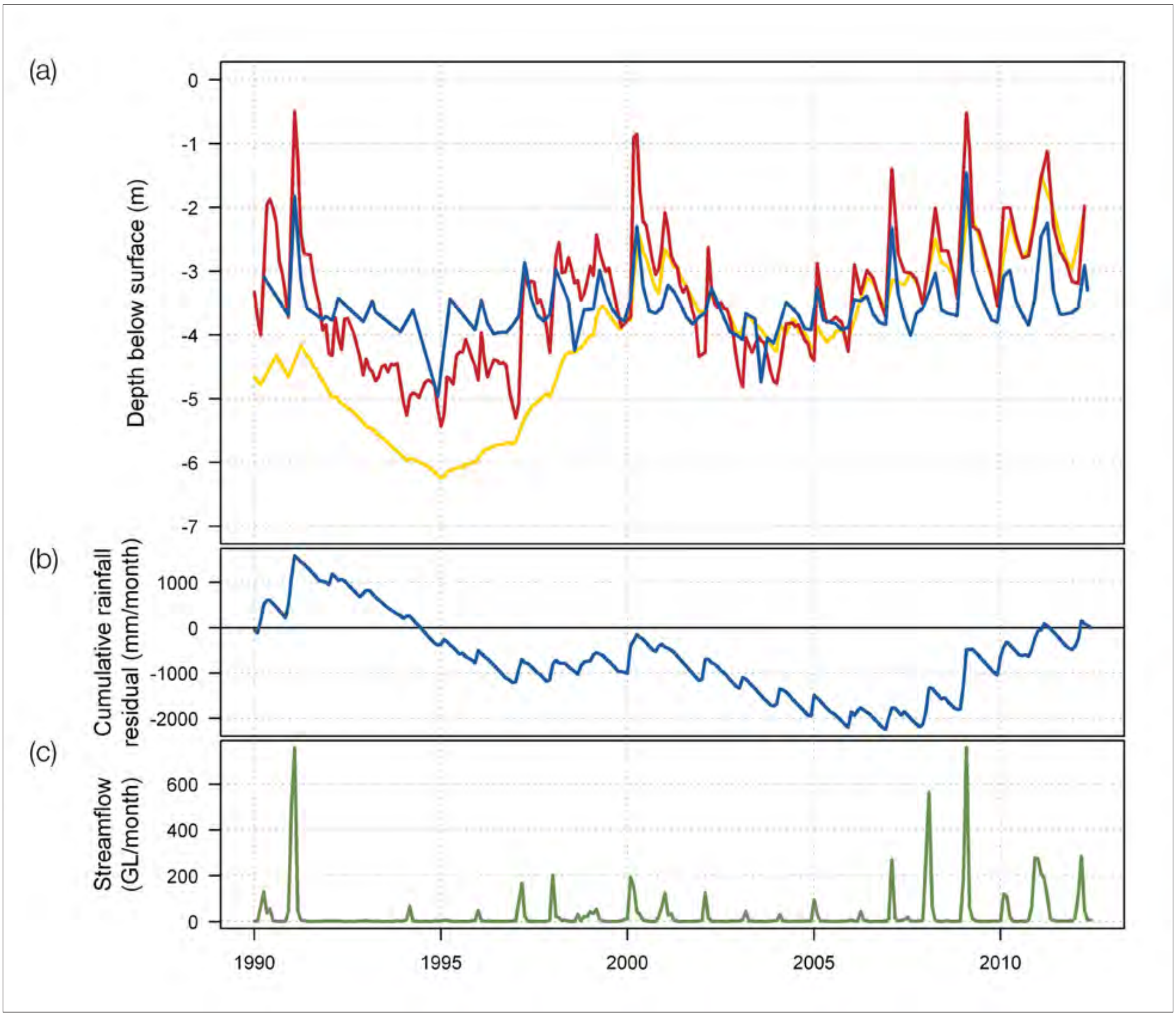


Figure 3.62 Comparison of shallow groundwater levels recorded at nested bore sites with rainfall and streamflow in the Burdekin River Irrigation Area to June 2012, showing (a) top panel: Bore 11910262 pipe D (red), Bore 12000202 pipe D (blue), Bore 11900162 pipe D (yellow); (b) cumulative rainfall residual mass at Ayr, Station 33002; and (c) lower panel: Burdekin River discharge at Clare, Station 120006B)

Groundwater level

Groundwater level measurement is an important source of information about hydrological and anthropogenic influences on the groundwater in an area, including recharge.

Figure 3.63 presents groundwater levels recorded in bores of different depth at the same site, a nested bore site, in the Lower Burdekin area. Groundwater level fluctuations are similar at all depths indicating that deeper and shallower groundwater is hydraulically connected. Vertical groundwater gradients are mostly downward indicating possibility of flow from the watertable to the deepest part of the aquifer.

Figure 3.64(a) shows the median groundwater depths in the upper groundwater aquifer in the Burdekin River Delta in 2011–12; Figure 3.64(b) shows the decile ranks of 2011–12 median groundwater levels compared to annual median groundwater levels in the last 22 years (1990–2012).

In general, in the upper aquifer, groundwater levels vary from quite shallow near the coast to deeper than 10 m further inland. Median groundwater depths in the upper aquifer in 2011–12 are mostly above the average of recorded levels within the irrigation area and are a mix of above average and below average northeast of the irrigation areas.

As shown in Figure 3.65(a), groundwater levels in the lower aquifer are generally between one and five meters below the surface. Median groundwater levels in the lower aquifer in 2011–12 are mostly above the average of recorded levels of the last 22 years Figure 3.65(b).

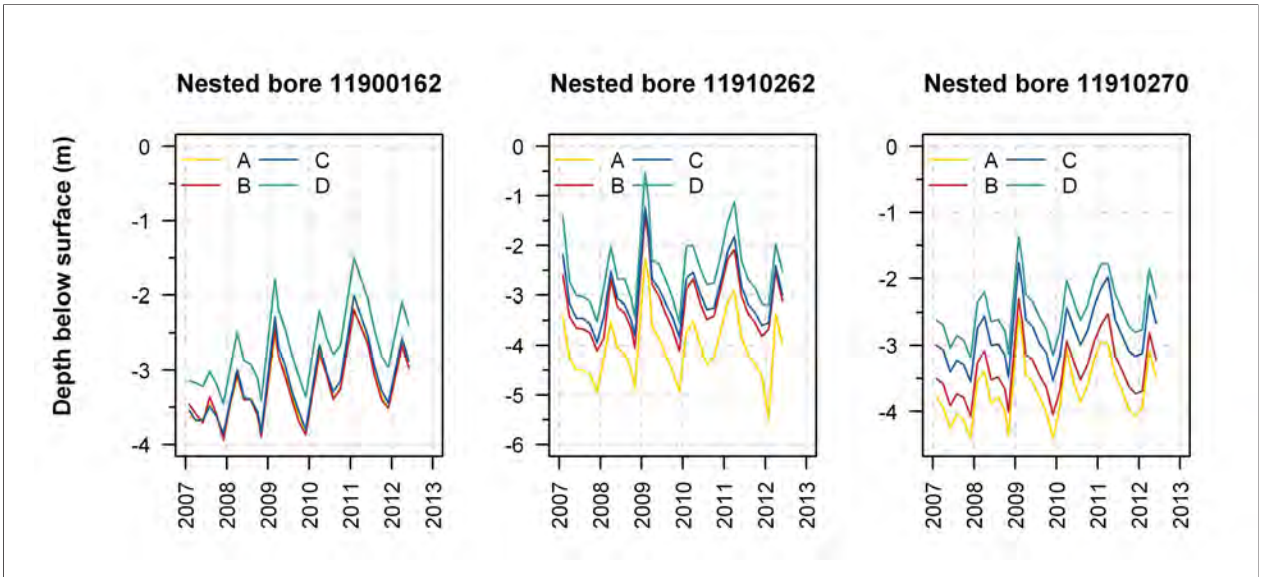


Figure 3.63 Groundwater levels between 2007 and 2012 recorded at selected nested bore sites in the Lower Burdekin area, depth of the screen interval increases from pipe D (shallow) to pipe A (deep)

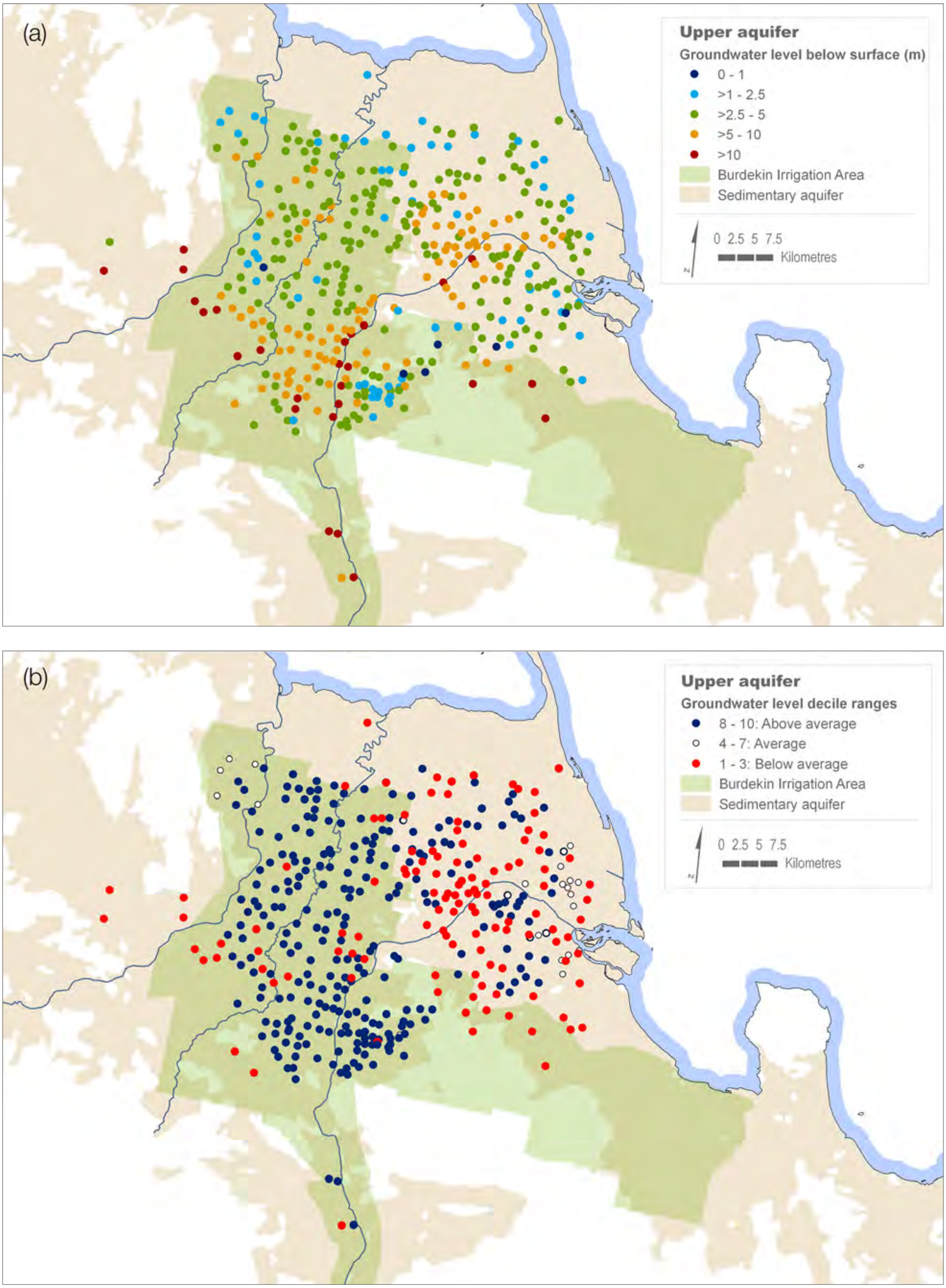


Figure 3.64 (a) Upper aquifer median groundwater depths for the Burdekin River Delta in 2011–12, and (b) decile ranks of depth in 2011–12 compared to the 1990–2012 period. Deciles 1–3 are shown as below average (greater depth below surface), deciles 4–7 as average and deciles 8–10 as above average

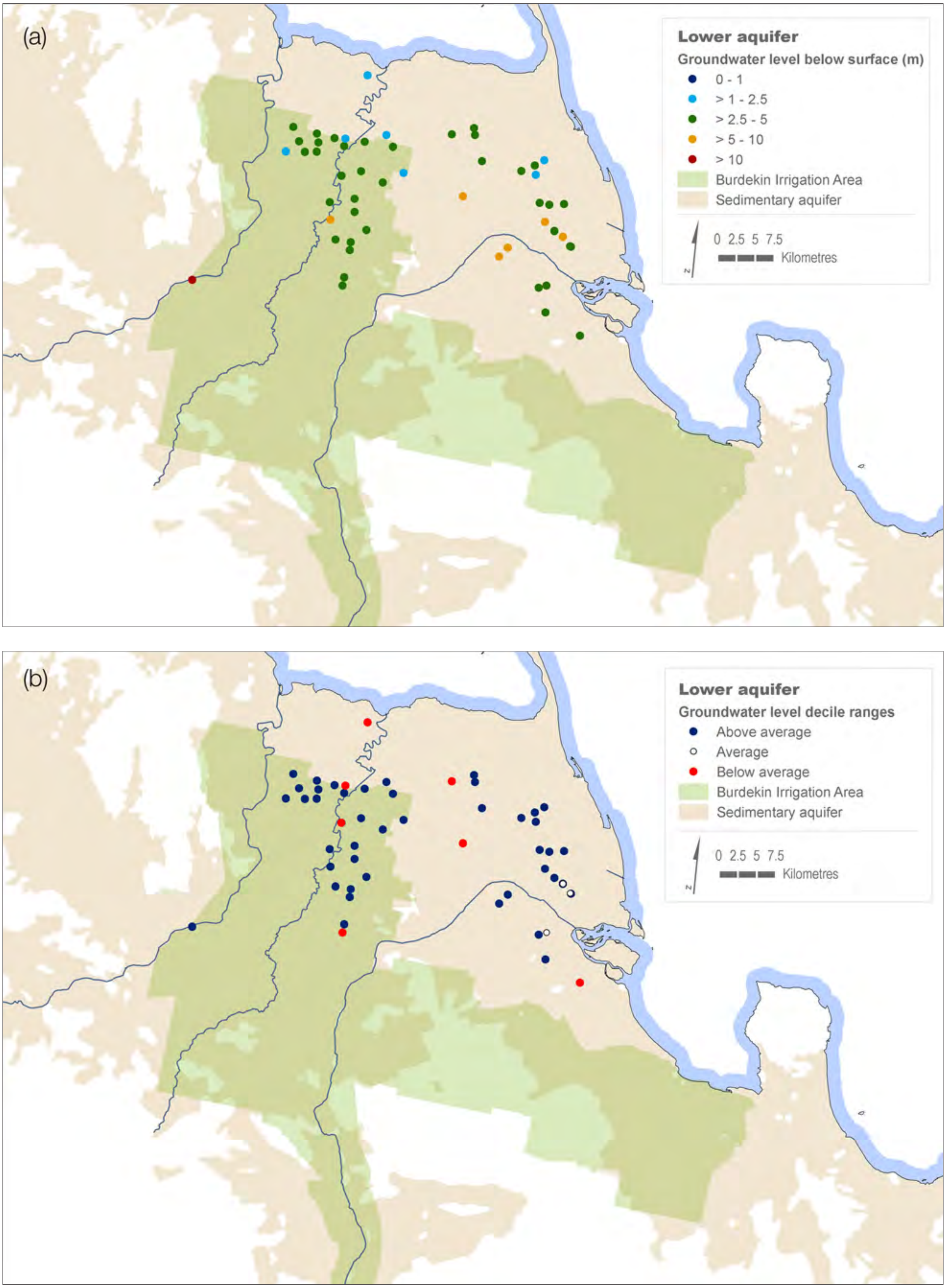


Figure 3.65 (a) Lower aquifer median groundwater depths for the Burdekin River Delta in 2011–12, and (b) decile ranks of depth in 2011–12 compared to the 1990–2012 period. Deciles 1–3 are shown as below average (greater depth below surface), deciles 4–7 as average and deciles 8–10 as above

Groundwater salinity

Since the 1960s, when the Queensland Government commenced regular monitoring of groundwater quality, an increase in salinity has been reported at many sites. Two main issues linked to degrading groundwater quality highlighted by Lenahan and Bristow (2010) are:

- an increase in groundwater salinity beyond irrigated crop tolerance level reducing the groundwater resource volume available for irrigation; and
- ecosystems in decline due to greater influx of solutes from the aquifers into the surface water and ultimately into the Great Barrier Reef.

Increasing groundwater salinity at some locations is caused by influences on the hydrological cycle, such as land clearing and irrigation, which mobilise subsurface solute stores.

Increases in groundwater pumping can result in seawater intrusion or upward movement of deeper salty groundwater. In contrast, decreasing groundwater salinities in the shallow system can result from dilution by irrigation drainage or leakage from the river.

Figure 3.66 shows groundwater salinity, expressed in units of electrical conductivity, at four depths for each of three nested bore sites in the lower Burdekin River Delta (for bore locations, see Figure 3.61).

Groundwater salinity in the deep bores is usually very high compared to the shallow bores. At these nested sites, the shallow groundwater salinity is more than an order of magnitude lower than salinity in deeper bores.

Figure 3.66 also shows that groundwater salinity at these sites has been relatively stable since 2007. In general groundwater salinity is slow to change.

Figure 3.67 and Figure 3.68 show the median groundwater salinities in the upper and lower groundwater aquifers in 2011–12 and the ranking of these salinities compared to 22-year annual averages for the 1990–2012 period.

The Burdekin River Delta groundwater in the upper aquifer is saltier in the north, in the southeast near the coast and close to the bedrock outcrops in the south. Median groundwater salinities in the upper aquifer in 2011–12 do not show any consistent trend from the long-term averages.

In the lower aquifer, salty groundwater appears to define the distance from the coast where seawater intrusion may have occurred. Median groundwater salinities in the lower aquifer in 2011–12 again do not show any consistent trend from the long-term average.

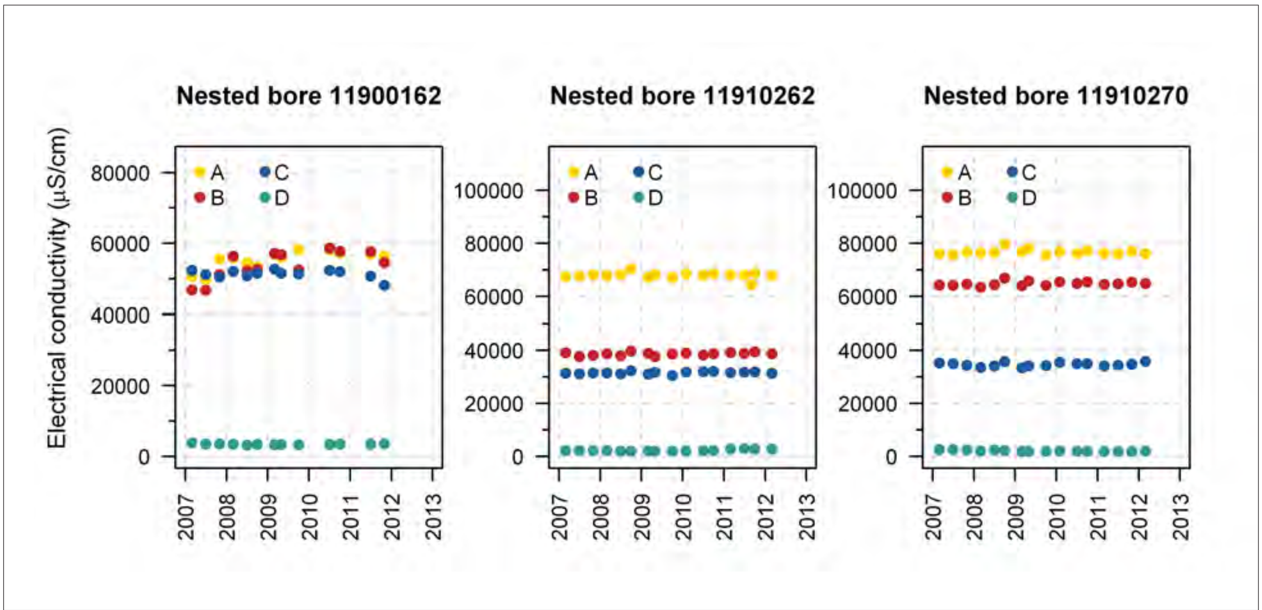
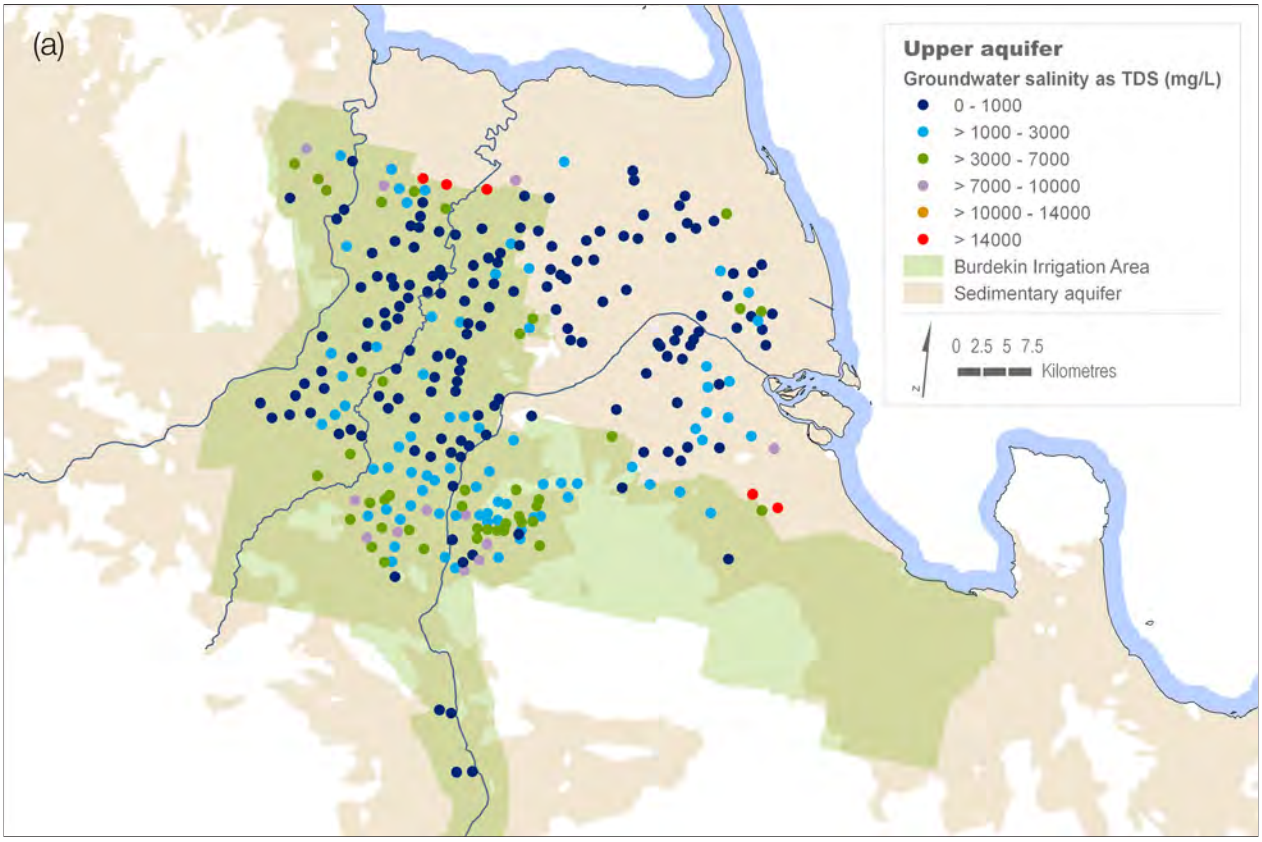


Figure 3.66 Groundwater salinity recorded at selected nested bore sites in the lower Burdekin area between 2007 and 2012, with depth of the screen increasing from pipe D (shallow) to pipe A (deep)



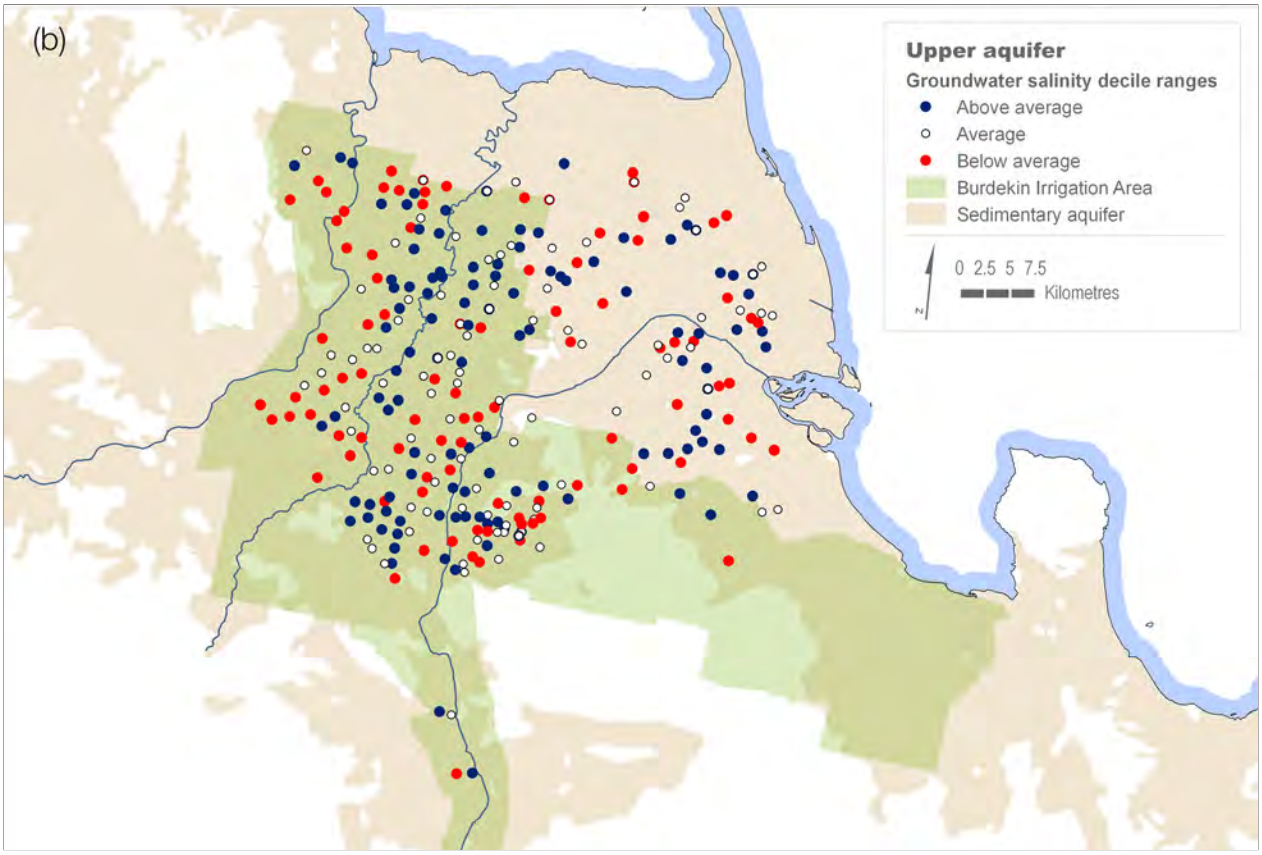
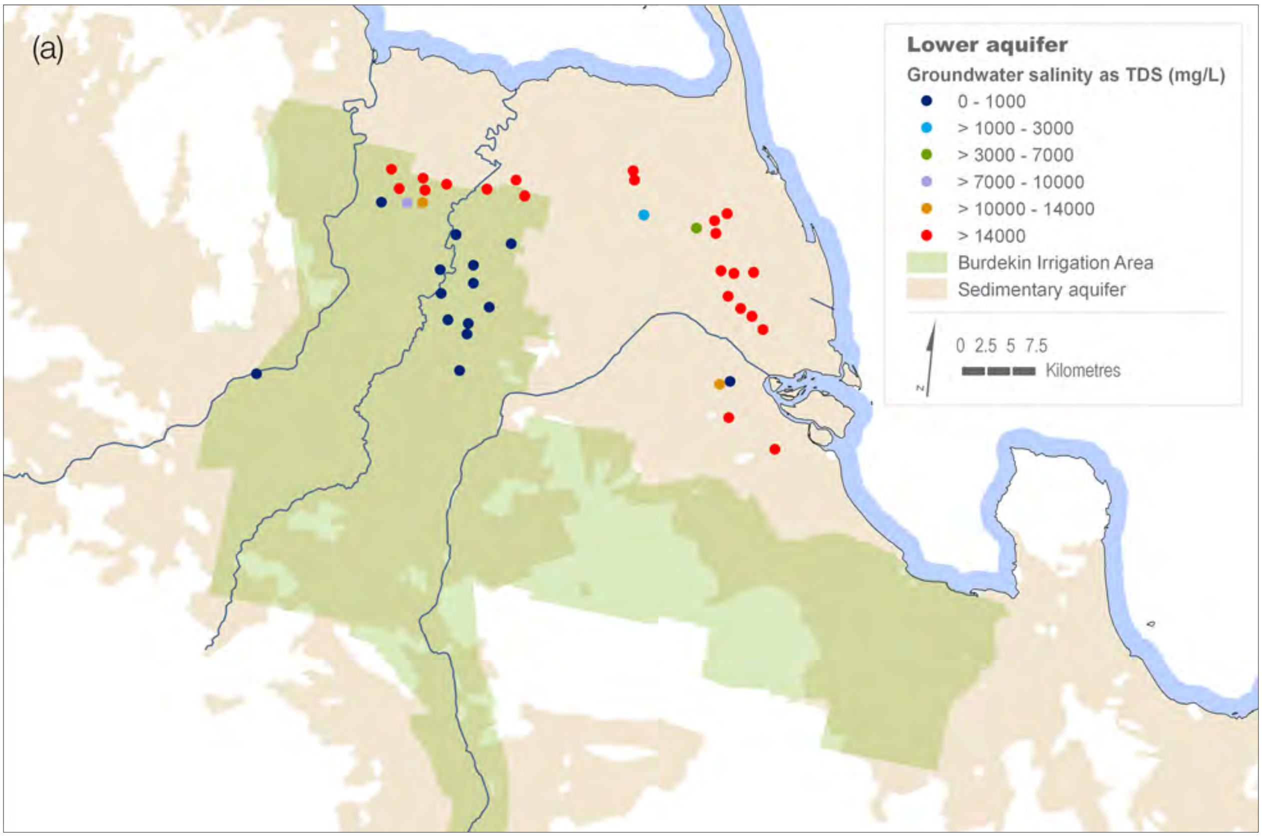


Figure 3.67 (a) Upper aquifer median groundwater salinity for the Burdekin River Delta in 2011–12, and (b) groundwater salinity in 2011–12 compared to the 1990–2012 period. Deciles 1–3 are shown as below average (greater depth below surface), 4–7 as average and deciles 8–10 as above average



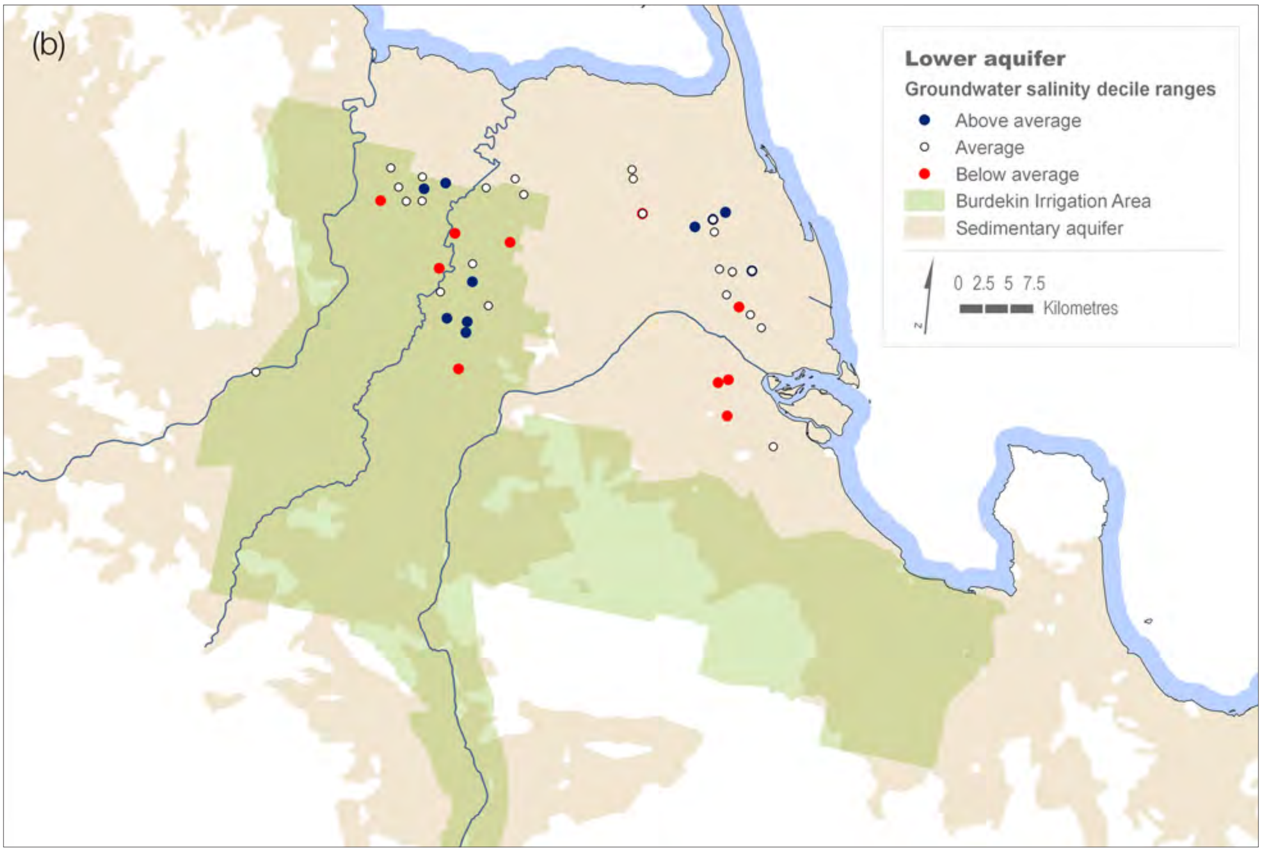


Figure 3.68 (a) Lower aquifer median groundwater salinity for the Burdekin River Delta in 2011–12, and (b) groundwater salinity in 2011–12 compared to the 1990–2012 period. Deciles 1–3 are shown as below average (greater depth below surface), deciles 4–7 as average and deciles 8–10 as above average