# CQSS:2030
# Science synthesis

Compilation of science and knowledge to support the review of the regional NRM Strategy 2013-2014

Fitzroy Basin Authority Incorporated (FBA) would like to acknowledge the invaluable input, advice and technical/scientific knowledge of everyone that has contributed to the review of scientific information. Especially Bruce Forster, John Ross, Bruce Pearce, Daniel Larson, John Platten, Alistair Melzer, Jane Waterhouse, Bob Miles, Adam Northey, Piers Harper, Rachel Bryan, Cassandra Bouna, Shannon van Nunen, Shane Westley and Tom Coughlin. Through their work, the CQSS:2030 has a solid foundation of scientific and technical knowledge and understanding.



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Australian Government

FITZROY BASIN ASSOCIATION

## Contents

# Introduction

The Central Queensland Sustainability Strategy 2030 (CQSS) provides a guiding document for Natural Resource Management (NRM) in central Queensland. Developed by the Fitzroy Basin Association Incorporated (FBA) on behalf of the regional community, the plan outlines:

- the natural assets and values of the region
- the pressures on those assets (including climate change) and associated environmental, social and economic risks
- broad strategies to address these risks.

In 2013-14, FBA has been reviewing the Central Queensland Sustainability Strategy 2004 (CQSS).

This document reports on the science synthesis process that has been used to support the strategy's review. Details of the review process can be found in the document *CQSS:2030 Strategy review process*. Additional scientific review and advice may be sought prior to the completion of the strategy.

# Science framework

The science synthesis process has been undertaken to update the strategy's knowledge base, specifically addressing increasing pressures (coal, infrastructure, coal seam gas and coastal development) and climate change risks. Moving beyond a 'snapshot in time' approach, the process has sought to look forward at emerging and growing issues. This is not without challenges — looking forward involves significant uncertainty in climate change, development, and adaptation in human and natural systems.

The approach adopted seeks to bridge the established natural asset approach and contemporary systems thinking (resilience) concepts. The science framework recognises the importance of the resource base's natural assets and users. These are linked via benefits and impacts that connect both system components, against a backdrop of ongoing change and adaptation to natural and anthropogenic drivers at a range of scales (Figure 1).

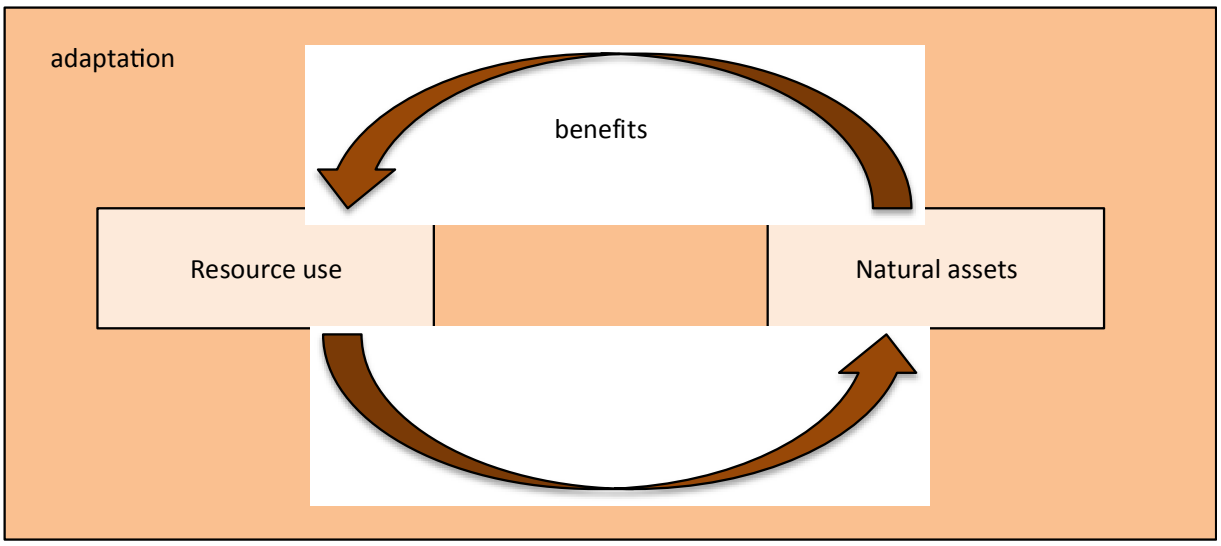


**Figure 1. Science framework for the review of CQSS**

In addition to the natural assets and resource users, there are 'natural' processes that can be exacerbated by human impacts (vectors). Major classes of natural assets, resource users and vectors are listed in Table 1. The science synthesis processes has focussed on an asset-based structure, while strategy development incorporates a greater focus on resource users.

**Table 1. Classes of resource users, environmental vectors and natural assets**

| | |
|---|---|
| **Resource users** | Resource industries: agriculture, mining, fisheries |
| | Urban, industrial, infrastructure, ports |
| | Community and Traditional Owners |
| | Environmental Services: carbon sequestration, conservation, offsets and ecological markets |
| | Other asset users |
| **Environmental vectors** | Drought and floods |
| | Fire |
| | Weeds and pests |
| | Changing climate |
| | Salinity |
| | Erosion |
| **Natural assets** | Soil |
| | Groundwater |
| | Freshwater rivers and wetlands |
| | Terrestrial ecosystems |
| | Coastal and marine ecosystems |
| | Climate and air |

## Approach

The approach taken to the science synthesis process has sought to:

- retain an asset-based approach for continuity with the previous strategy and ready translation to spatial products
- incorporate, where practicable, elements of resilience and broader systems thinking approaches. This has principally occurred through a clearer recognition of the complex linkages and dynamics that operate between human activities and ecosystems at multiple scales.
- provide clear direction for resource management priorities at the regional scale, rather than a comprehensive audit of all assets and issues.
- identify linkages between natural assets and resource users where possible.

The process adopted was designed to do this in a systematic and consistent way across the different asset classes. The science synthesis process focussed on understanding the assets: their values and services, their condition and trend, current and future pressures and climate change risks. The science synthesis process articulated key attributes of the natural assets and NRM objectives, but did not directly draft strategies. This recognises the essential contribution that resource users have to make in the development and review of strategies — their pragmatic knowledge about how to most effectively engage their sector in adopting better practice. Drafting strategies has also been informed by community engagement and consultation processes, and NRM practitioner knowledge. Further consultation will be used to refine the strategy's draft regional objectives.

The science synthesis process has proceeded through the following steps.

**1. Preparation**

The resilience approaches of recent NRM plans from Queensland and NSW were reviewed. Team members participated in workshop on resilience approaches (facilitated by Paul Ryan) and attended a debrief of NSW regions' experience of resilience-based planning. The science framework was developed and the broad process design completed.

**2. Desktop review and compilation exercise**

A comprehensive review of scientific and technical papers and reports since the last strategy review process (2004) was completed. Excerpts, figures and models were compiled for each natural asset. At the same time, relevant spatial information was identified, mapped and collated for easy access. A reference library was built during this process.

**3. Engagement of expert panel**

An expert panel was chosen to provide regionally specific scientific expertise. Panel members comprised scientists and FBA staff to build capacity and share knowledge. Working in pairs, asset-based teams worked through a series of templates that guided them through a synthesis process. This included:

- contributing to the completion of the desktop reviews
- an asset summary template that included summaries of asset attributes and values, condition and trend
- a 'pressure matrix' that rated the importance of each pressure (resource use and environmental vectors) against the asset components
- advice on measures and indicators of asset health (potential targets)
- recommended strategies to achieve those targets.

Members of the expert panel are listed in Table 2.

**Table 2. Members of the expert panel**

| Natural asset | Independent scientist | FBA theme leader |
|---|---|---|
| Soils | Bruce Forster and John Ross (DNRM) | Adam Northey |
| Groundwater | Bruce Pearce (DSITIA) and Daniel Alarsen (DNRM) | Piers Harper |
| Freshwater rivers and wetlands | John Platten (consultant) | Rachel Bryan and Tom Coughlin |
| Terrestrial ecosystems | Alistair Melzer (CQU) | Cassandra Bouna |
| Coastal and marine | Jane Waterhouse (C2O consulting) | Shannon van Nunen |
| Climate and air | Bob Miles (consultant) | Shane Westley |

**4. Expert panel workshop**

A synthesis workshop brought the expert panel together for two days to review outputs from all themes.

**5. Finalisation of synthesis documentation**

Documentation was finalised with some further clarification, drafting and review of some sections. The final set of documentation includes:

- an evidence library
- the desktop reviews (collation of referenced extracts from reports and maps for each asset)

- summary worksheets that summarise and prioritise information including asset values, trends and benchmarks, pressures and synthesis statements.

### 6. Engagement of Stream 2 projects

Stream 2 research projects were funded by the Australian Government to support the strategy review process. Unfortunately the timing of these projects prevented their direct contribution to the science synthesis process. However, a key output has been the downscaled climate projections work undertaken by BOM and CSIRO. This has been used (in draft form) to update the climate synthesis findings. This and the outputs from other projects (as they become available in the near future) will provide a foundation for ongoing climate adaptation planning and programs in the region.

## Results

The science synthesis process achieved its objectives of a systematic collation and synthesis of contemporary science to support the review of CQSS. In the process, large working documents have been produced. For pragmatic reasons (the information has a limited audience and will rapidly be out of date) only summary information will be prepared for public review. Appendixes A and B provide extracts of these working documents to demonstrate the process used. The details presented there should be treated as draft versions. Further iterations in different formats have subsequently been prepared as part of the draft strategy.

Feedback from stakeholders demonstrated that the collation of contemporary information associated with the last strategy review was highly valued by stakeholders, but that this information (and the strategy itself) rapidly became out of date. CQSS:2030 and its supporting information will be primarily delivered to the public via a web portal. This approach allows key information to be kept current and links to other sites and activities provided. Facilitating open access to relevant information is a foundation principle of natural resource management.

# Appendix A Asset summaries

Note that the following pages contain extracts of working documents. These have not been formatted or edited for general consumption. Rather they are provided as evidence of a systematic process to collate, summarise and synthesise scientific information to support the strategy review process. The final version of this information is included in the draft CQSS:2030 document.

## Soils

| VALUE | DESCRIPTION (SOILS) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Landscape | Galloway (1967) describes the landform of the Fitzroy Basin (Map 2) as "a central lowland surrounded by a highland rim". | The foundation of the region | The foundation of the region |
| Geology | The geological structure of the Fitzroy Basin is dominated by two major sedimentary basins, the Bowen Basin in the north and the Surat Basin in the south, and the New England Fold Belt in the east (Draper 1992; Malone 1966). | The foundation of the region | The foundation of the region |
| Land Description Categorisation | Land has been categorised around the basic natural resources of the central Queensland region. We recognise three formats: Land Systems and Land Resource Areas, Land Zones and Grazing Land Types. All three are based fundamentally on landform and geology, so mapping using the different types is similar across the region. | The foundation of the region | The foundation of the region |

| VALUE | DESCRIPTION (SOILS) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Soil Types | A map of Australian Soil Classification (Ashton and McKenzie 2001) shows that the soils for the area include mainly vertosols, sodosols, dermosols, kandosols, chromosols, tenosols, rudosols and anthroposols, and smaller areas of ferrosols, kurosols, hydrosols, podosols, and calcarosols. | The foundation of the region | The foundation for the region and set the usability for Agriculture in the region<br>• vertosols with their high water-holding capacity are the main soil used for rain-fed cropping<br>• dermosols, kandosols and tenosols with their good drainage are used for tree and vine crops, generally with irrigation<br>• dermosols, kandosols and tenosols with a friable, gravel-free surface are used for peanut cultivation<br>• a wide range of soils are used for grazing, but those with high fertility are most suitable for cattle fattening. |
| Soil Groundcover | Groundcover refers to organic material and consists of senescent and green grasses, forbs, low shrubs, cryptogams and vegetation litter. Groundcover is a contributor to soil carbon. Maximising groundcover is the most critical issue for soil health, land condition and maximising water infiltration. | Groundcover is critical to retaining soil integrity. | Groundcover is critical to maximising agricultural productivity and to reducing sedimentation and contamination of run-off into streams. |

| VALUE | DESCRIPTION (SOILS) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Salinity | Sixty-eight salinity expressions were identified, affecting an area of approximately 2,246 hectares. More than half (38) are located in the high rainfall areas near the coast in the Fitzroy Catchment. Predictive modelling has been completed for the region. | Salinity impacts include:<br>• degraded water quality in aquatic habitats and rivers<br>• reduced growth by crops, pastures and trees<br>• poor quality water for human and stock consumption<br>• deterioration of built and transport assets and infrastructure such as houses, roads and rail.<br>Vertosols — the region's primary soil for agriculture — are where the majority of salinity expressions occur in the region. | Vertosols — the region's primary soil for agriculture — are where the majority of salinity expressions occur in the region.<br>One component of the salinity stage is the time lag between implementation of a land use change and the salinity response. This could be a large emerging issue for the region. |
| Acid Sulfate Soils | Acid sulfate soils are soils or sediments containing sulfides (primarily pyrite) or an acid producing layer as the result of sulfide oxidation. This commonly occurs on tidal land and low-lying, very poorly drained coastal land at elevations less than 5m AHD (Australian Height Datum) in the region. | This land is not hospitable to vegetation. Acid leaching can contaminate water and soil. | Development of these lands is costly and risky. Increasing sea inundation may reduce the amount of available soil to expose; however, it is likely that with sea level rise adjacent soils will deteriorate. |
| Soil Erosion | Soil erosion occurs when soil particles are detached and transported elsewhere. Erosion is a natural process and is non-reversible. There are several types of erosion (rill, sheet, gully, overland, riverbank, wind). Run-off is a dominant feature of the region and consequent water erosion is a major threat to the resource base. Hillslope erosion and hillslope scalds, gully erosion, stream bank erosion occur throughout the region. | Water erosion is a major threat to the resource base. It is estimated that 4 million tonnes of sediment are discharged annually from the Fitzroy River into the Great Barrier Reef lagoon off Keppel Bay. | |

| VALUE | DESCRIPTION (SOILS) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Good Quality Agricultural Land and Strategic Cropping Land | Land capability and land suitability classification schemes are used in Queensland as the basis for identifying Good Quality Agricultural Land (GQAL). Strategic Cropping Land (SCL) is an important, finite resource that must be conserved and managed for long-term food and fibre production and regional growth. Currently, the state's SCL resources are subject to a range of competing land-use activities, including agriculture, mining, infrastructure and urban development. | GQAL and SCL have distinct soil and land properties that meet the requirement for agricultural crops. | Identifying and preserving these lands for sustainable production of food is important. |
| Soil Structure (Local Scale) | Soil structure influences pasture growth by controlling the movement of water, nutrients, air and root penetration. Surface soil structure influences water infiltration, soil erosion (including scalding) and seedling emergence. Sub-surface soil structure influences soil aeration, water storage and root penetration. | N/A | Critical to maintain in productive lands<br>More important in cropping than grazing. |
| Soil Moisture (Local Scale) | Soil water is the main limiting factor for pasture growth and animal productivity. The ability of a soil to capture and store water so it is available for use by pasture for an extended time will depend on its inherent characteristics (soil texture, structure) in combination with its overall health. There is some regional mapping. | N/A | Critical to maintain in productive lands |
| Soil pH (Local Scale) | Soil pH influences nutrient supply, plant growth and the soil's ability to grow desirable pasture species. There is some regional mapping. | Can impact natural vegetation | Critical to maintain in productive lands |
| Soil Nutrients (Local Scale) | Pastures need an adequate supply of soil nutrients to make best use of soil water, to grow quality feed for stock, and to ensure good ground cover. Pastures grow poorly if the soil cannot supply adequate amounts of these nutrients. While geology and soil development determine the total amount of nutrients in soils, in the short term, the amounts of nutrients available for growth are largely determined by the breakdown of organic material and the subsequent release of nutrients. | N/A | Critical to maintain in productive lands |
| Soil Biology (Local Scale) | Soil organisms help maintain soil fertility and health by regulating nutrient cycling, maintaining soil structure and interacting with plants in the ecosystem. Healthy populations of soil organisms require adequate supplies of plant organic matter, which is their main source of food. | N/A | Critical to maintain in productive lands |

| VALUE | DESCRIPTION (SOILS) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Soil Contamination (Local Scale) | Contamination of soil is a significant issue due to the large amount of heavy industry mainly on the coast. Also mining can leave significant contamination scars on the landscape as well as inversion or burial of soil profiles.. | Can impact natural values | Can impact human use |
| Soil Carbon | Soil carbon is the carbon stored within soil. Soil carbon is important for understanding soil health. Soil carbon is a balance between inputs (such as plant shoots, roots and leaves) and outputs (such as decomposition and conversion into carbon dioxide). The amount of soil carbon is determined by soil characteristics, climate and management practices. | Unknown | Unknown |

## Groundwater

| VALUE | DESCRIPTION (GROUNDWATER) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Groundwater Systems | The geological formations underlying the Fitzroy River surface water basin are dominated by two major sedimentary basins: the Bowen Basin in the north and the Surat Basin in the south. Other geological structures include the Drummond Basin in the west and the New England Fold Belt in the east. Within these geological structures, as well as overlying alluvial and tertiary systems, groundwater can be present. | N/A | In areas where groundwater is of reasonable quality and quantity, it is used for varied uses such as stock watering, agriculture and mining and industrial uses. |
| Groundwater Flow | Groundwater flow generally follows topography in local systems; however, can follow the direction of structural dip of deeper systems. | The flow of groundwater is particularly important to natural resources where it relates to discharge. Disruption to flow lines can disconnect interaction with Groundwater-Dependent Ecosystems. | The disruption of flow, primarily due to extraction, can cause drawdown effects on other users. |
| Groundwater Recharge | Recharge can occur through direct infiltration of rainfall or through recharge through stream systems. Direct recharge is generally low for most of the region. Major rainfall events recharge alluvium and tertiary layers through stream systems. | Balance of recharge to groundwater systems versus run-off to surface water systems. | Balance of recharge to groundwater systems versus run-off to surface water systems. |
| Groundwater-Dependent Biodiversity | Groundwater can typically support Groundwater-Dependent Ecosystems (GDEs) such as wetlands, riverine environments and dependent vegetation. | Supports natural environment | Wetlands and streams with base flow can provide water sources for human use; however, overall it would be minimal and localised in its benefit. |

| VALUE | DESCRIPTION (GROUNDWATER) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Groundwater Water Quality | Water quality naturally varies between different aquifers from good quality to brackish and salty water in some deeper systems. Natural water quality is dependent on the environment in which the stratum was formed, the mineral composition of the host rock, as well as the extent of recharge (link to fresher quality). | The functioning of natural resources is dependent on water quality. Decrease in quality can be adverse to certain species. | Industry, agriculture, domestic and stock watering supplies all depend on a level of quality. The quality required for each industry can vary; however, decrease in quality can make water unusable for some purposes. |
| Water Resource Extraction | The larger projects such as mining developments and the growing coal seam gas industry are predominantly located in the Bowen Basin. There are also clusters of agricultural development in some areas, usually associated with alluvial systems. | Extraction of groundwater can cause drawdowns in water levels. These drawdowns can alter movement of water to Groundwater-Dependent Ecosystems. | The extraction of groundwater can cause drawdown in groundwater levels. Depending on the extent, this can decrease the available supply. |
| Salinity | Land clearing over the catchment can cause rising water tables. | Salinity impacts include:<br>• degraded water quality in aquatic habitats and rivers<br>• reduced growth by crops, pastures and trees<br>• poor quality water for human and stock consumption<br>• deterioration of built and transport assets and infrastructure such as houses, roads and rail.<br>Vertosols — the region's primary soil for agriculture — are where the majority of salinity expressions occur in the region. | Vertosols — the region's primary soil for agriculture — are where the majority of salinity expressions occur in the region.<br>One component of the salinity stage is the time lag between implementation of a land use change and the salinity response. This could be a large emerging issue for the region. |
| Ecosystem Services | Sub-surface systems provide functions such as filtering, decontamination, re-mineralisation and cycling of nutrient functions. Vegetation also has a role in maintaining ecosystem services. | Provides for potential bio-degradation of organic contaminants and decrease in nitrates | |

## Freshwater rivers and wetlands

| VALUE | DESCRIPTION (FRESHWATER RIVERS & WETLANDS) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Overview | The Fitzroy is the largest east coast catchment in Australia with highly variable flow and extensive areas of ephemeral streams. Rainfall is highly seasonal with most major flows from January to March. Wetlands are found on floodplains and as perched lakes in the upper catchments. | Very significant | Very significant in the supply of drinking water, stock water and irrigation waters |
| Catchments and Wetlands | There are nine major catchments/sub-catchments in the strategy's area, all except the Calliope, Curtis Island and several small coastal catchments (Shoalwater and Water Park Creek) have been modified by dams and/or weirs. | Very significant | Very significant in the supply of drinking water, stock water and irrigation waters |
| | The strategy's area has extensive palustrine and lacustrine wetland systems. In the Fitzroy Basin 6,539 wetlands have been mapped and there are additional wetlands in the Boyne, Calliope and Curtis Island catchments. A number of these once natural wetlands have been modified by land use. There are also a number of constructed wetlands such as farm dams. | Very significant | Utilised as significant water source for agriculture |
| Habitat Availability | A variety of habitat types are required to support local aquatic plants and animals. | Very significant | Significant in maintenance of significant fish species |
| | Shallow flowing water/shallow pools are often highly oxygenated and critical to many species. | Very significant | Significant for stock watering |
| | Deep riverine pools provide refuge in low flow and drought periods. | Very significant | Very significant in the supply of drinking water, stock water and irrigation waters |
| | Palustrine and lacustrine wetlands are used by several species requiring water with slow flows. To function correctly they need to be connected to streams periodically. | Very significant | Significant in maintenance of significant fish species |
| | Streamside (riparian) vegetated habitat provides bank stability, a food source for aquatic animals and is important in the life cycles of many aquatic insects. | Very significant | Significant in maintenance of significant fish species |
| | Sand and gravel banks provide nesting sites and locations for reptiles | Very significant | N/A |

| VALUE | DESCRIPTION (FRESHWATER RIVERS & WETLANDS) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| | to warm themselves. | | |
| | Current regional data sets on habitat condition are lacking (earlier habitat assessments in State of Rivers 1995-2005, Coastal Cooperative Research Council). Some riparian and wetland condition assessments are planned across the Great Barrier Reef under the Paddock to Reef Program. | Very significant | Significant in maintenance of significant fish species |
| Habitat Connectivity | Connectivity between different sections of a stream is important in maintaining biodiversity. Some fish require access between freshwater and estuaries to complete their breeding cycle, while others move to particular spawning sites on a stream. Movement between different river sections is also important to allow groups of each species to mix during breeding. This may be compromised by barriers such as weirs, crossings, fords etc. Changes to flow regimes can also compromise the triggers for spawning and other migrations as well as connectivity to wetlands. | Very significant | Very significant in maintenance of significant fish species |
| Significant Fauna and Flora | The Fitzroy is home to two fish species and one turtle species found nowhere else (endemic). Wetlands support a number of migratory birds and birds of conservation importance. The Fitzroy is the southern-most breeding site of the estuarine crocodile. Several fish of recreational and commercial importance use freshwaters at least as part of their life cycle. One critically endangered snail lives associated with mound springs. *Eucalyptus raveretiana* (black iron box) is a large eucalypt, listed as vulnerable, restricted to riparian zones and like all riparian species susceptible to loss by inundation and clearing associated with dams and weirs. | Very significant | Several fish of recreational and commercial importance use freshwaters at least as part of their life cycle. |
| Wetlands | There are nationally and internationally listed significant wetlands within the Fitzroy Basin. | Very significant | Very significant |
| Water Resources | There are three major dams and a number of weirs used to provide water for a variety of uses. | Very significant | Very significant |
| | There are three water resource plans developed to regulate water use to provide water for sustainable consumptive use and the environment. | Very significant | Very significant |
| | Change in the timing and volume of flows can impact the ecology of | Very significant | Very significant |

| VALUE | DESCRIPTION (FRESHWATER RIVERS & WETLANDS) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| | streams and wetlands. | | |
| Water Quality | The highly seasonal and variable flows, along with erodible soils, result in relatively high sediment loads and turbidity in most streams. | Very significant | Very significant |
| | Salinity of waters is usually low; however, there are locations where salinity can be high, particularly in low flow periods and when groundwater is contributing to stream flows. | Very significant | Very significant |
| | Seasonal blue-green algal blooms can cause water quality problems, particularly in dams and weirs. | Very significant | Very significant |
| | Nutrient levels can be high and associated with some riparian land uses. | Very significant | Very significant |
| | Elevated dissolved metal levels and low pH can be found associated with some riparian land uses. | Very significant | Very significant |
| | Local water quality guidelines have been developed for the Fitzroy Basin. | Very significant | Very significant |

## Terrestrial ecosystems

| VALUE | DESCRIPTION (TERRESTRIAL ECOSYSTEMS) | SIGNIFICANCE TO NATURAL RESOUCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Bioregions | Bioregional composition of the strategy's area<br>Brigalow 96 %, South East Queensland 1.5%, Central Queensland Coast 2.5% | Very significant | Very significant — bioregions define agricultural and living environment for human activity. |
| Regional Ecosystems | In the Fitzroy Basin NRM Region, 248 Regional Ecosystems (REs) align to the Brigalow Belt North, 116 to the Central Queensland Coast and 64 to the South East Queensland bioregions.<br><br>*Note that only dominant Regional Ecosystems (RE) were used in this analysis (the greatest percentage of a combined RE); the large number of dominant/sub-dominant RE combinations would have made the data very complicated.<br><br>Biodiversity (BD) Status<br>Dominant REs BD stat="Endangered" Number 110; Area 414,398.8ha<br>Dominant REs BD stat="Least Concern" Number 160; Area 4,994,230.6ha<br>Dominant REs BD stat="Of Concern" Number 158; Area 1,331,517.5ha<br>_____<br><br>Vegetation Management (VM) Class<br>Dominant REs VM class="Endangered": 60 Area: 326,108.7ha<br>Dominant REs VM class="Least Concern": 208 Area: 5,430,197.7ha<br>Dominant REs VM class="Of Concern": 160 Area: 983,840.6ha<br><br>For more information about the above classifications please visit www.qld.gov.au/environment/plants-animals/plants/ecosystems/biodiversity-status/ | Very significant<br>A few REs support high levels of endemism and species of conservation significance. | REs provide ecosystem services. |

| VALUE | DESCRIPTION (TERRESTRIAL ECOSYSTEMS) | SIGNIFICANCE TO NATURAL RESOUCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Flora and Fauna Diversity | See WildNet data (DSITIA) for numbers of species (flora and fauna). A number of species are at their distribution limits in the catchment area. Some are endemic to the region.<br><br>There is a high degree in variability of species richness in sub-catchments, depending on land use history. | Very significant | High cultural significance<br><br>Biodiversity has an important role in maintaining soil fertility, nutrient cycling, and other ecosystem services.<br><br>Historically important in development of human solutions |
| Habitat Availability | Land under conservation tenure provides the core refugia for species in the region, although most available habitat exists outside of protected areas, and in retained assets (e.g. remnant vegetation) in agribusiness, mining, industrial and peri-urban land. This is best assessed in terms of mapped remnant vegetation and high value regrowth. | Very significant | Habitat availability is the foundation of the above values. |
| Habitat Condition | Most habitats are fragmented due to land use. Condition within fragments and remnants is determined by on-ground management and environmental effects, but is generally poor. | Very significant | Habitat availability is the foundation of the above values. |

| VALUE | DESCRIPTION (TERRESTRIAL ECOSYSTEMS) | SIGNIFICANCE TO NATURAL RESOUCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Habitat Connectivity | Connectivity of habitats is poor at the local level. Opportunities remain to maintain or restore connectivity at the regional level.<br>Key regional corridors, identified at the 2013 'Brigalow Belt Strategic Offsets Corridors Workshop' include:<br>-Great Dividing Range, both north and south<br>-Kroombit and Connors ranges<br>-Carnarvon to Kroombit link east to west<br>-Blackdown to Taunton to Fitzroy<br>-Coastal plains from St Lawrence and west to Clark and Connors ranges<br>-Shoalwater Bay to Junee Tableland, including Torilla Plains<br>-Shoalwater to Nebo/Connors Range<br>-Kroombit to Burnett<br>-Taroom Wetlands to Carnarvon<br>-Castlevale Hub<br>Fitzroy Delta (Directory of Important Wetlands)<br>-many opportunities at the local scale | Very significant | Habitat availability is the foundation of the above values. |
| Species Adaptability | Different species are resilient at different levels to change. Each species will respond differently and at different rates to impacts and environmental pressures. For example, a species that exists only on top of a mountain range would have very low resilience as there are no further habitats to move to. Consequently, climate change effects will be difficult to manage and require considerable investigation. | Very significant | Likely very significant (high uncertainty) |
| Significant Fauna | Species lists need to be updated. Significant fauna includes species under threat as well as iconic species such as koalas, echidnas, platypus, and those of economic benefit through providing key ecosystem services and attracting tourism).<br><br>The Brigalow Belt and South East Queensland bioregions have 12-13% of their vertebrate animal species threatened, that is in the order of 101-120 threatened species in each region — the highest in Queensland. There are 45 priority species in the region. There are 15 well-known species with high conservation status. | Very significant | Iconic species are of cultural significance and contribute to tourism. Economic benefits are derived from some species e.g. kangaroos. |

| VALUE | DESCRIPTION (TERRESTRIAL ECOSYSTEMS) | SIGNIFICANCE TO NATURAL RESOUCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Significant Flora | Species list needs to be updated. Significant flora includes species under threat as well as iconic species such as the Byfield fern, and of economic benefit such as cycads, forest species and native species with potential horticultural significance.<br><br>There are 12 iconic and threatened species and 36 species on the Priority Species list. | Very significant | Iconic species are of cultural significance, including Indigenous interests, and contribute to tourism. Economic benefits are derived from some species e.g. cycads. |

| VALUE | DESCRIPTION (TERRESTRIAL ECOSYSTEMS) | SIGNIFICANCE TO NATURAL RESOUCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Significant Ecosystems | Iconic ecosystems in the region are Brigalow, Serpentine, Semi-evergreen vine thicket and Natural grasslands of the Central Highlands.<br><br>Assemblages of ecosystems that support significant species such as fruit pigeons and flying foxes should be considered significant ecosystems.<br>All rainforest types should be considered significant ecosystems (not only Semi-evergreen vine thicket).<br><br>Biodiversity (BD) Status<br>Dominant REs BD stat="Endangered" Number 110; Area 414,398.8ha<br>Dominant REs BD stat="Least Concern" Number 160; Area 4,994,230.6ha<br>Dominant REs BD stat="Of Concern" Number 158; Area 1,331,517.5ha<br>_____<br>Vegetation Management (VM) Class<br>Dominant REs VM class="Endangered" Number 60; Area 326,108.7ha<br>Dominant REs VM class ="Least Concern" Number 208; Area 5,430,197.7ha<br>Dominant REs VM class ="Of Concern" Number 160; Area 983,840.6ha<br><br>For more information about the above classifications please visit www.qld.gov.au/environment/plants-animals/plants/ecosystems/biodiversity-status/ | Very significant | Iconic ecosystems are important for recreation, tourism and cultural purposes. Some provide the basis for economic returns as well as providing ecosystem services. They also support key flora and fauna. |

## Coastal and marine

| VALUE | DESCRIPTION (COASTAL & MARINE) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Coastal and Marine Systems | The region has diverse coastal and marine ecosystems with high social and ecological value. It includes coastal wetlands and floodplains, estuaries, mangroves, fish habitat, coastal dunes, coral reefs, seagrass meadows, island communities. Coastal and marine systems are under increasing threat from declining water quality, coastal development and changing climate and are generally in declining condition. | Very significant | High social and economic value for local and regional communities |
| Ocean Systems | The region is characterised by several large and shallow bays and large tidal cycles. The estuarine environment is relatively large and highly dynamic. The area has had some of the most significant coral bleaching events due to elevated sea temperatures. Ocean acidification is likely to be an increasing threat to coral reefs in the region. | Very significant | High social and economic value for local and regional communities |
| Weather and Coastal Erosion | Expanding coastal development and changes in coastal erosion rates associated with a changing climate are likely to place increasing pressure on the coastline. In cases where tidal/hydrological regimes will change rapidly there is a risk that the change from a freshwater species dominated to brackish/marine dominated species may lead to significant destabilisation of ecosystem services. Significant perturbation events during this transition may lead to significant changes to topography/bathymetry of systems and the type of systems they can support long-term. | Very significant | High social and economic value for local and regional communities |
| Acid Sulfate Soils | Acid sulfate soils pose a threat to coastal and marine ecosystems when exposed and not managed appropriately. Detailed mapping of acid sulfate soils in the region has been completed. | Very significant in coastal environments. | High social and economic value for local and regional communities |

| VALUE | DESCRIPTION (COASTAL & MARINE) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Biodiversity: Overall Habitat | A diversity of high value coastal and marine habitats exist in the region. Habitat types include coral reefs, seagrass meadows, coastal wetlands, estuaries, coastal dunes, floodplains, coral cays and islands. These provide habitat for a wide range of fish, marine mammals, reptiles, water birds, macroalgae and others. Habitats are generally under increasing threat from degraded water quality, extreme weather events, expanding coastal development and infrastructure and increasing sea surface temperature. Regionally specific information on some species was difficult to source. | Very significant | High social and economic value for local and regional communities |
| Biodiversity: Habitat Connectivity and Condition | Coastal ecosystems provide an important link between terrestrial and marine ecosystems. GBRMPA has generated maps of connectivity of hydrological and ecosystem function which show significant modification of habitat connectivity in the region. | Very significant | High social and economic value for local and regional communities |
| Biodiversity: Fish | The health and resilience of fish assemblages in central Queensland is average. In areas that receive waters from highly modified catchments (or regular dredging) fish health is most likely impacted from a decline in water quality leading to increases in disease and stress. Many high value commercial fish species exist in the region. For commercial marine fish species, reef-wide figures indicate that target species are sustainably fished although regional data has not been accessed. Fish barriers in coastal areas pose significant threats to habitat connectivity and fish life cycles. | Very significant | High social and economic value for local and regional communities |
| Biodiversity: Reptiles | The island groups in the region (particularly Peak, Wild Duck, Curtis) and the islands and cays of the Capricorn-Bunker group (e.g. Heron and Lady Musgrave islands) provide important nesting sites for loggerhead, green, hawkesbill and flatback turtles. Populations are under threat from large-scale flood events (particularly 2011) and loss of seagrass meadows as a major food source, and issues associated with coastal and port development including increased lighting, boat strike, marine debris and noise. Crocodiles also inhabit the region and habitat loss is most likely the greatest threat to their health. | Very significant | N/A |

| VALUE | DESCRIPTION (COASTAL & MARINE) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Biodiversity: Mammals | Three species of inshore dolphins inhabit the Fitzroy estuary: two are listed as 'near threatened' under Qld legislation. Genetically unique populations inhabit areas of increasing port activity — particularly the Fitzroy estuary and delta area. These species are under increasing threat from noise, loss of habitat and potential bioaccumulation of contaminants. Dugongs inhabit the region but are generally sparsely distributed and threatened by loss of seagrass meadows caused by terrestrial run-off and dredging activities, boat strike and noise, and potential bioaccumulation of contaminants. Whales also transit the area in August to October and populations are increasing. There is evidence that changing sea surface temperatures are influencing foraging behaviours and reproductive success of marine mammals. | Very significant | N/A |
| Biodiversity: Water Birds | Wetlands of the delta and floodplain systems support a wide diversity of coastal and migratory birds. Important populations of migratory seabirds also inhabit the islands and sand cays, particularly in the Capricorn-Bunker group. Major threats are habitat loss and warming climates, which are likely to affect breeding and feeding patterns, and for seabirds, possibly access to food sources. Large declines in populations of some species have been recorded in recent years. | Very significant | N/A |
| Biodiversity: Fauna Invertebrates | Islands support a wide diversity of invertebrate populations, and benthic invertebrates are important species in the marine food chain. These species are highly sensitive to increasing sea temperatures. Loss of these species will have consequences for reef structure, nutrient cycling and biofiltration of sediments and nutrients. | Significant | N/A |
| Biodiversity: Flora Macroalgae | Increased nutrient inputs can affect the presence and growth of macroalgae and shift the balance in coral reef communities. | Significant | N/A |
| Biodiversity: Marine Microbes | Marine microbes are a fundamental part to ecosystem function and a critical component to food webs. Disease events are reported to be increasing and have been linked to warmer sea temperatures. | Significant | N/A |

| VALUE | DESCRIPTION (COASTAL & MARINE) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Ecosystems: Coastal Terrestrial | Beach scrub: Patches occur on Balaclava Island and more widely on Curtis Island. This vegetation type is threatened by coastal development, pests, weeds. Other vegetation types are covered in terrestrial assets. | Very significant | N/A |
| Ecosystems: Coastal and Marine Wetlands | Important mosaic of coastal and estuarine wetlands exist in the region, many within the delta area. Shoalwater Bay and Corio Bay are Ramsar-listed wetlands. Several nationally listed wetlands also occur in the region. Marine wetlands incorporate reef, seagrass and pelagic communities. These assets are under increasing threat from pests and weeds, terrestrial run-off, catchment and hydrological modification, increased frequency of extreme weather events and increasing temperatures. | Very significant | Very significant in maintenance of significant fish species |
| Ecosystems: Mangroves and Tidal Saltmarshes | At least 13 species of mangroves occur throughout the lower reaches of the estuary and along minor tidal creeks and provide important refuge and feeding grounds for marine fauna. Saltmarsh wetlands are found on the landward side of mangroves, and may be bare (salt flats) because of high salinity, or vegetated. The Fitzroy River Delta, including Balaclava Island, is dominated by saltmarshes, with fringing mangrove communities. Mangroves and saltmarshes will be affected by sea level rise, reduced rainfall, increasing temperature, and changes to ocean circulation in the medium to longer term. | Very significant | Very significant in maintenance of significant fish species |
| Ecosystems: Pelagic Environments | The region's pelagic environments are diverse and organisms interact with the physical environment. Pelagic environments will be most affected by changes to ocean circulation, increasing sea temperature, ocean acidification and changes in sea surface temperature and currents, as measured by the El Nino-Southern Oscillation Index (ENSO). Their vulnerability is moderate, particularly because of the sensitivity of plankton to environmental changes, and the consequent implications for the productivity of the Great Barrier Reef ecosystem. | Significant | Significant in maintenance of significant fish species |

| VALUE | DESCRIPTION (COASTAL & MARINE) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Ecosystems: Seagrass | The area of monitored sub-tidal seagrass and modelled deep water (>15m) seagrass in the Fitzroy marine NRM region is estimated at 5,775 $km^2$. The Reef Rescue Marine Monitoring Program includes three monitoring locations in the Fitzroy Region: Shoalwater Bay, Great Keppel Island and Gladstone Outer Harbour. Each has received an overall rating of poor or moderate, taking into account several indicators of seagrass health. The reproductive effort measured at the coastal intertidal sites was reported as very poor, which is particularly concerning. Recent losses are caused by water quality impacts — particularly turbidity (terrestrial run-off and dredging), also recent cyclones in localised areas. | Very significant | Significant in maintenance of significant fish species |
| Ecosystems: Coastline Ecosystems | Coastal habitats are an important interface between land and sea. They have a critical role in the connectivity of the Great Barrier Reef ecosystem, and provide nutrient cycling, primary production, biofiltration, critical habitat and coastal protection. They are moderately vulnerable to climate change, particularly sea level rise, changes to rainfall regimes and flood events, and increases in sea temperature. Human-induced changes to dune systems and degraded dune vegetation can significantly limit the protection provided to development from coastal hazards, worsen wind erosion problems and adversely impact neighbouring landforms. | Significant | Significant in maintenance of significant fish species |

| VALUE | DESCRIPTION (COASTAL & MARINE) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Ecosystems: Coral Reefs | The condition of coral reefs in the Great Barrier Reef is generally declining, with large scale reductions in coral cover measured through long-term monitoring programs. Inshore monitoring results show a decline in coral cover at the monitoring locations in the Fitzroy region from around 45% in 2005 at the commencement of the program, to around 25% in 2012. The presence of juvenile coral colonies has remained relatively stable. Hard coral cover has also declined at a similar rate in the same period, with strong influence of bleaching, cyclones and storms, and freshwater inputs in this period. The overall score for coral community for 2012 (relative to the baseline) is very poor. Over the period 2005-2011, coral communities in this region have been impacted by a severe coral bleaching event in 2006 (although recovery from this specific event was considered to be relatively rapid), and a combination of floods of the Fitzroy River and storms in both 2008 and 2010 and then major flooding in 2011. The proximity to the Fitzroy River, differences in community composition, and subtle differences in the directional aspect of the reefs largely explain the variable impacts of these disturbances across the monitored reefs. All of these threats will continue to influence the status and health of coral reefs in the region. | Very significant | Significant in maintenance of significant fish species |
| Ecosystems: Lagoon Floor | The lagoon floor includes the non-reef seafloor inside the outer barrier reef. It is a variable habitat and includes many species important for marine health. The lagoon floor is impacted by trawling, and (closer to the coast) dredging, disposal and re-suspension of dredge material, land-based run-off and anchoring. | Very significant | Significant in the maintenance of trawl fisheries |

| VALUE | DESCRIPTION (COASTAL & MARINE) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Ecosystems: Cays and Reef | There are several important island groups in the region including the Percy Islands, Curtis Island, Keppel Islands, and the Capricorn-Bunker group, which consists of several sand islands and cays. All of these islands provide important habitat and feeding grounds for a range of seabirds and terrestrial fauna. Islands and cays are particularly sensitive to sea level rise, changes to sea surface temperatures and currents (as measured by ENSO), increasing air temperature and changes to rainfall patterns. Due to their isolation and frequent remoteness, islands and cays are moderately to highly vulnerable to climate change. Implications for the Great Barrier Reef ecosystem include loss of critical habitat and breeding sites, particularly for protected species, and degradation of a unique component of the reef's seascape. | Very significant | Significant for tourism, social and recreational values |

| VALUE | DESCRIPTION (COASTAL & MARINE) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Water Quality | The decline of marine water quality associated with terrestrial run-off from the adjacent catchment is a major cause of the current poor state of many of the Great Barrier Reef's key marine ecosystems. Monitoring results indicate that the overall condition of water quality in the region is moderate. As part of the Reef Rescue Marine Monitoring Program, the most inshore location, Pelican Island had a water quality index of very poor. The long-term means of all four indicators (turbidity, chlorophyll, particulate phosphorus, particulate nitrogen) exceeded the guidelines. Barren Island and Humpy Island were rated as good and very good respectively, in line with their increasing distance from river influence. The main sources of sediments and particulate nutrients in the region are from grazing lands. Point sources of pollution contribute known contaminants to waterways and are usually from industrial processes, mining operations and sewerage treatment plants. Trace metals have been found in sediments analysed from the Fitzroy estuary; the main sources of these materials are likely to be industrial and port activities. Pesticide monitoring in the region has shown concentrations of tebuthiuron (used for woody weed control in grazing management) that exceed the Great Barrier Reef Water Quality Guidelines. At smaller scales, particularly in coastal seagrass habitats and freshwater and estuarine wetlands, pesticides can pose a high risk. Recent extreme weather — heavy rainfall, floods and tropical cyclones — have had severe impacts on marine water quality and reef ecosystems. Climate change is predicted to increase the intensity of extreme weather events. | Very significant | Very significant for marine dependent social, economic and cultural values |
| Water Quality: Pollution from Contaminants and Eutrophication | From end of catchment monitoring data in 2010-11, the largest loads of TSS (20Mt), Total N (35.8kt), total P (15t) and PSII herbicides (6kt) were greatest from the Fitzroy River compared to all monitoring locations in the GBR catchments. These loads are mainly associated with erosion from large areas of grazing lands, fertiliser application in dryland cropping (grains) and irrigated cropping (cotton) and pesticide use in cropping and grazing lands. | Significant | Very significant for marine dependent social, economic and cultural values |

| VALUE | DESCRIPTION (COASTAL & MARINE) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Water Quality: River Plumes etc. | Variability in rainfall and river flows is a feature of the catchment. The Fitzroy River catchment is well known to produce major flooding after heavy rain events. The highest recorded flood in January 1918 reached 10.11 m on the Rockhampton City flood gauge, then a 9.3 m flood in January 1991 and the recent 9.2 m flood in December 2010/January 2011. The Fitzroy River's flood plume extends over a wide area of Keppel Bay and east across the Capricorn-Bunker group. Significant coral mortality has been recorded following flood events, including the January 1991 flood and across the reef during the 2010/11 flood. It is predicted that there will be increased frequency of extreme weather events in the region with a changing climate. | Significant | Very significant for marine dependent social, economic and cultural values |
| Coastal and Marine Health | The overarching consensus is that key reef ecosystems are showing declining trends in condition due to continuing poor water quality, cumulative impacts of climate change and increasing intensity of extreme events. This is correct for the Fitzroy region more specifically. | Very significant | Very significant for marine dependent social, economic and cultural values |

## Climate and air

**Note that the latest regional climate scenarios have been modeled by CSIRO and BOM. These will be available from October 2014 and will provide more —recent information on climate trends and projections than the information provided below. Please refer to the climate asset information at www.cqss2030.com.au**

| VALUE | DESCRIPTION (CLIMATE & AIR) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Rainfall and Evaporation | Modelling by the Queensland Centre for Climate Applications (QCCA) predict that by 2030, the coastal areas of Queensland are expected to experience a decrease in mean annual rainfall of 15%. It is expected that the decrease could be as much as 40% by 2070. | Many plant communities will change in both structure and form. The hardy, more widely distributed species are more likely to expand due to their inherent adaptability and capacity to cope with extreme variability in climate. Such plant species are likely to increase in dominance. | The reduction in rainfall will result in a drier change for many inland areas. This drying of the environment may result in further migration of residents to coastal and urban regions. Periodic water shortages can be expected. |
| Temperature and Solar Radiation | Temperatures are steadily increasing with prediction of an increase of up to 4 to 6 degrees Celsius by 2100. Evapotranspiration rates will rise up to 40%. | Most plant communities and animals will experience increased heat stress. Reduced frosting will have positive and negative impacts on plant communities. | A range of crop species such as cotton and grapes will decline in productivity in extreme temperatures and go into water deficit, causing production to decline. This will impact producer viability. |
| Wind | Average daily wind speeds have increased seasonally by up to 50% near coastal communities. This trend is expected to increase with increasing temperatures (due to atmospheric volatility). | The increase in wind will result in increased evapotranspiration and dust incidence throughout the region. | Dust and drying conditions are expected to increase. This is already resulting in increased rates of dust-related health conditions such as asthma. |

| VALUE | DESCRIPTION (CLIMATE & AIR) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Seasonality | Shifting seasons of between 4 to 6 weeks are being recorded regionally with summer rainfall periods now occurring in late summer, early spring. | Changing seasonality of rainfall will lead to changes in cropping regimes. Some impact on reproductive success in some plant and animal species can be expected. | Potential shifts in cropping regimes and crop type, such as shifting from sorghum production to pulse crops. |
| Sea Level | Sea levels have risen by up to 20cm regionally in the past 30 years in Australia and the trend is expected to continue. Sea level rises of up to 0.68m by 2050 and 0.9m by 2100 have been predicted for the central Queensland region. | The ingress of saltwater on the region's coastal marine plains will alter local fresh and saltwater ecosystems and cause some coastal salinisation. Fish fecundity (fresh and saltwater species and their survival will be impacted). | Some loss of prime grazing lands on the coastal margins and impacts on coastal urban communities is expected. The Fitzroy River Delta is also highly exposed to saltwater ingress. |
| Sea Temperature | Sea temperatures are rising and this trend is expected to continue. | Increases in sea temperatures will result in increased coral bleaching and sea algal blooms. | Impact on tourism, fishing and recreational use of the coastal ecosystems |
| Coastal Sea Flows | Coastal currents are expected to be affected, influencing warm water distribution on the Capricorn-Bunker Group and associated coral reefs. | Upwelling of warm ocean currents may influence and exacerbate coral bleach specifically in the Capricorn-Bunker and Keppel groups. | Increased impacts on recreational and commercial fishing likely, as well as coastal tourism |
| Ocean Chemistry | Increased absorption of $CO_2$ is resulting in a decline in ocean pH (ocean acidification). | Through a series of chemical reactions that increases the concentration of carbonic acid, this in turn reduces the concentration of carbonate ions in seawater. This process has significant implications for marine organisms that form calcium carbonate shells/structures (such as coral). | Impact on coral reef ecosystems and the commercial usage of these zones — such as fisheries, recreation and tourism |

| VALUE | DESCRIPTION (CLIMATE & AIR) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Drought | Regional warming has increased the intensity of recent droughts in south-eastern Australia. In general, the term 'drought' means an acute water shortage caused by a serious or severe rainfall deficiency (lowest 10% of records) over a period of three months or more. | Droughts reduce vegetation growth and surface cover for all vegetation types, leaving the catchment highly susceptible to the erosive effects of high intensity wind and rainfall. Infiltration is lower and run-off is higher under lowered ground cover. | Droughts cause a high financial and emotional burden to the wider business community. The effects of some major droughts can severely impact the Australian economy. |
| Bushfires | Extreme fire weather has increased since the 1970s. Bushfire weather and fire danger is expected to increase alongside the increases in temperature and drier conditions. With a doubling of carbon dioxide concentrations in the atmosphere, the number of days of very high and extreme fire danger increases, due largely to the higher temperatures. However, the actual bushfire risk also depends on fuel load, which could be less in drier conditions. | Fire is an integral component of the Australian landscape. Many plant communities depend on fire for reproduction or have adaptations to cope with it. However, the increased incidence of fire is likely to change the floristic composition and ecology of the area. | In grazing, the reduced incidence of fire has historically resulted in woody thickening, which negatively affects ecosystem viability and biodiversity. It is not known to what extent human intervention will have on the presence or absence of fire in the region's ecosystems in the future. Wild fires in southern states have had catastrophic effects on communities through their loss of housing and lives. Such wildfires follow extreme wet periods and subsequent dry periods. Such weather conditions are expected to increase in the region. |

| VALUE | DESCRIPTION (CLIMATE & AIR) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| High Intensity Storms | Regional areas have experienced increases in the frequency, intensity or amount of heavy precipitation. This means that there is a trend toward heavier rainfall events. In the future, extreme rainfall events are likely to become more intense and frequent over many regional areas. | High intensity storms will produce high volumes of run-off into local streams and creeks. High rates of run-off can also lead to a loss of water infiltration that can be stored in the soil profile for potential production. High intensity rainfall events are the main provider of run-off or transport mechanism for downstream impacts of soil, nutrients and pesticides in the landscape. | A higher incidence of flooding and a disruption to transport and community functionality is expected, with increased insurance premiums in flood-prone areas. Loss of livestock and crops as well as the stripping of top quality agricultural soils from the alluvial plains in particular, is expected. |
| Extreme Temperatures | Heatwaves and hot days and nights have increased over most land areas regionally. Many areas have experienced longer and more intense heatwave conditions. As temperatures continue to increase globally, heatwaves are expected to occur frequently and persist for longer. | Productivity of native communities will be affected. Many native plant communities will change in both structure and form. Native birds and animals will suffer heat stress and increased mortality due to extreme heat. | The region's liveability will be heavily impacted if the predicted increases are realised. The death rate in the young, infirm and elderly will increase during these extreme events. Water usage and power demands for cooling will rise rapidly during these events. |

| VALUE | DESCRIPTION (CLIMATE & AIR) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Flooding | The incidence of coastal flooding has increased since 1970. This flooding has been exacerbated by rising sea levels. If emissions continue to increase unabated, the region's sea level could rise by nearly 1 m by 2100, compared to its average level between 1986 and 2005. Flooding within the region will increase due to high intensity rainfall events. | The Fitzroy River catchment has historically produced severe flooding following heavy rainfall. The Fitzroy River's major tributaries are the Dawson, Mackenzie, Isaacs, Connors and Nogoa rivers. These rivers rise in the eastern coastal ranges and in the Great Dividing Range and join together about 100 km west of Rockhampton. Major floods can result from either the Dawson or the Connors/Mackenzie rivers. Significant flooding in the Rockhampton area can also occur from heavy rain in the local area below Riverslea. | Flooding will have a major effect on communities and their wellbeing. Any incidence of increased flooding will cause economic hardship through the loss and damage to community infrastructure, as well as crop and livestock losses. |
| Cyclones | There is mounting evidence that the destructive potential of tropical cyclones globally has increased in recent decades. For the Australian region, there is evidence from the period 1970 to 1997 that although there was a decrease in the number of tropical cyclones was recorded, the number of intense cyclones increased. | Destructive winds and heavy rainfall will lead to major impacts on affected plant and animals communities. | Significant economic impact through the loss of property and infrastructure<br><br>Loss of life likely |

| VALUE | DESCRIPTION (CLIMATE & AIR) | SIGNIFICANCE TO NATURAL RESOURCES | SIGNIFICANCE FOR HUMAN USE |
|---|---|---|---|
| Extreme Sea Level Events | Many of the risks due to sea level rise are associated with inundation events caused by high tides and storm surges that are amplified by sea level rises. Such events are very sensitive to small increases in sea level, and the probability of these events increases in a highly non-linear as sea levels increase. These events damage human settlements and infrastructure in low-lying coastal areas, and can lead to erosion of sandy beaches and soft coastlines. While a sea level rise of 0.5 m — less than the average waist height of an adult human — may not seem like a matter for much concern, such modest levels of sea level rise can lead to unexpectedly large increases in the frequency of extreme high sea level events. | Extreme sea level events will result in saltwater ingress into highly sensitive freshwater coastal systems such as the marine plains of the Broadsound region, resulting in significant loss of these habitats. | Low lying coastal communities will be affected — notable in the Capricorn and Broadsound regions. |
| Atmospheric Carbon | Many of the region's key industries are carbon-intensive, or rely on carbon-intensive inputs. The Fitzroy division represents over 10% of Queensland's $CO_2$ emissions, mostly from a small number of large emitters. | For many plants, $CO_2$ enrichment has the potential to increase productivity. However, the consequential increase in temperature and continental drying may negate any positive effect. | The price on carbon as a pollutant is expected to increase globally and regional industries, as disproportionate emitters, are likely to be hard hit by any cross-compliance or penalty cost measures. This could lead to a change in industry structure and form in the region. |
| Air Quality | The region's air quality is likely to be affected by increased dust haze and periodic dust storms associated with increasing aridity and extreme events. In addition, significant impacts on the air shed are expected through the rapid regional expansion of heavy industry and mining. This increase in heavy industry will result in significant increases in the regional contribution of $NO_x$, $SO_x$ and particulate matter and specifically an increase in $CO_2$ equivalents. This will also attract global interest in the region's air pollution stream. | There will be significant regional contribution to greenhouse gases. In addition, the major impact of declining air quality will be on human health, most affecting those suffering from diseases such as asthma. | Reduced air quality and increased dust haze linked to drying conditions will result in increased chronic respiratory disorders and demand for health care. |