An aerial photograph of a vast agricultural landscape. In the foreground, there are green and yellow fields, some with winding irrigation canals. A small farmstead with white buildings is visible. In the middle ground, a large dam spans across a valley, with a reservoir behind it. The background features rolling hills and mountains under a clear blue sky.

CHAPTER 4.1

AGRICULTURE

STATE OF REGION REPORT 2013

ADAPTED LANDSCAPES

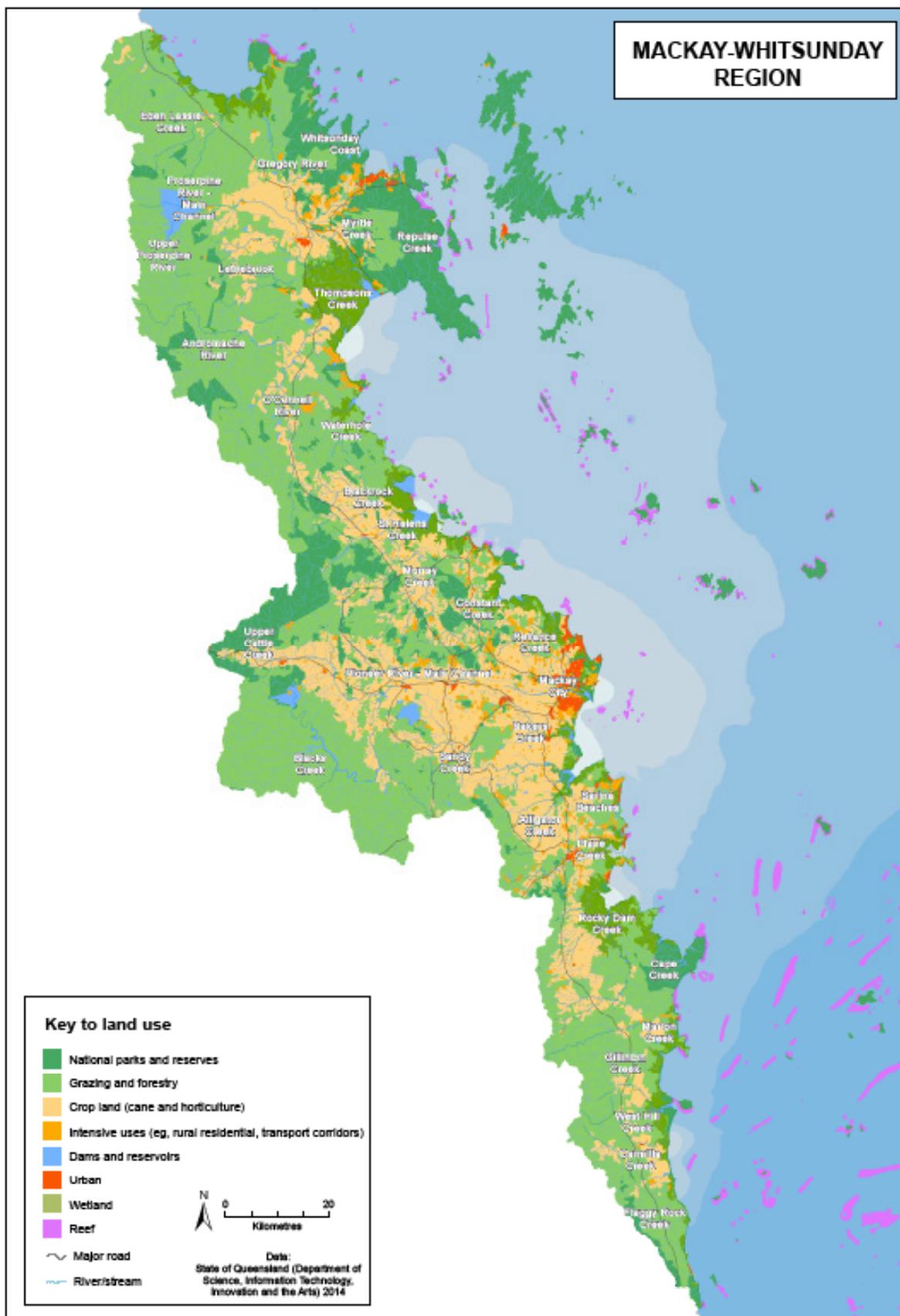


Figure 1 Land use in MWI 2013

N.B. Intensive Agriculture is defined as 1) 'Intensive horticulture' to 'intensive horticulture', 'shadehouses', 'Glasshouses' and 'Glasshouses (hydroponic)'; 2) 'Intensive animal production' to 'intensive animal production', 'Dairy sheds & yards', 'Poultry farms', 'Piggeries', 'Aquaculture', 'Other intensive animal husbandry' and 'Stockyards/saleyards'.

“A farming or grazing system is said to be sustainable at the farm level if it ‘satisfies the farm/grazing manager’s needs over time while conserving the natural resource’ (Gomez et al. 1996). Sustainable production systems include virtually all agriculture related land use enterprises in the landscape that rely on natural resources of land, vegetation, and water, and certainly includes cattle grazing, cropping, horticulture and agroforestry systems.”

Pastures Mackay Whitsunday Region, Bishop (2007, 95)

SUMMARY

The regions agriculture and diverse scenic amenity define the character and image of the area, which is highly valued by both local residents and visitors.

Major intensive agriculture industries in the region are sugarcane, cattle farming and horticulture. The primary intensive agricultural land use is sugarcane which, while only making up about 18 per cent of the catchment area, constitutes land use close to 96 per cent of the intensive agriculture in the region. Grazing has the largest land use in region, accounting for 65 per cent of the region. It is estimated that more than 50 per cent of the regions beef cattle are run by approximately 10 per cent of enterprises and that 11 per cent of grazing is undertaken on improved pastures (Bishop 2007).

SUGARCANE

The Central Region Sugar Industry is located north and south of Mackay in North Queensland (Mackay Regional Advisory Group, 2005). Cane growing areas are situated on the coastal floodplains to the east of the dividing range from Flaggy Rock in Broadsound Shire through Sarina shire, Mirani shire, Mackay City and north to Bowen in Bowen shire. Cane growing is organised around two milling groups; Mackay Sugar Co-operative Association Limited (Mackay) and Wilmar International Limited (Proserpine and Plane Creek).

Each of these milling groups operates mills selling raw sugar to Queensland Sugar Limited which, in turn, is either exported through the Mackay Port or sold to the region’s sugar refinery at Racecourse, owned by CSR Limited.

CATTLE GRAZING

The beef business is centred on breeding and sale of weaners, stores or cull cows, although an increase in fattening operations is occurring. A key influence of this change is the movement of many sugarcane growers toward the use of sown pastures on what was sugarcane production land. The distribution of beef enterprises is approximately 80 per cent coastal and 20 per cent hinterland.

Cattle grazing occurs mainly on improved pastures totalling an area of 74,000 hectares, while both natural or native pasture and agroforestry occupy around 427,000 hectares.

Meat processing is undertaken in the main at Thomas Borthwick & Sons (Borthwicks) abattoir in Bakers Creek south of Mackay, with 90 per cent of throughput exported and 10 per cent retained for domestic sales.

HORTICULTURE

Horticulture comprises 0.7 per cent of the NRM region and approximately 3.6 per cent of intensive agriculture land area. The Mackay Whitsunday council region supply in total more than 60 per cent of Queensland’s horticulture products, the majority occurring within a 50 kilometre coastal strip in and around the townships from Bowen to

Molongle Creek, although the majority of this occurs outside the catchment boundary. Horticulture crops include mangoes, tomatoes, capsicum, green beans, pumpkin and sweet corn, and eggplant. Only a small proportion of horticultural produce from the region (5-10 per cent) is exported.

DAIRY

Dairy is confined in the main to three dairy operations within the Marani shire, which in 2012 generated 3 mega litres of milk (compared with 8.8 mega litres in 2001), before being sent to Rockhampton to be processed

AQUACULTURE

There are 38 approved aquaculture facilities in the region valued at approximately \$8.6 million per annum. The aquaculture species cultured in this region include black tiger prawns (*Penaeus monodon*), barramundi (*Lates calcarifer*) and redclaw crayfish (*Cherax quadricarinatus*).

WATER RESOURCES

The groundwater and waterway systems of the region support the region's agricultural industries. Since European settlement, most of the regional watercourses have been subject to human development inputs including point-source discharges (e.g. sewage, industrial waste) and diffuse (non-point) sources resulting from land clearing and development, agricultural, urban stormwater and recreation activities.

In the region there exist several highly developed catchments with regulated flow, mainly as a result of cane farming. Management areas with high proportions (>40 per cent) of cane farming include Reliance Creek, Sandy Creek, Alligator Creek, Mackay City and Bakers Creek. Management areas with flow regulation include Pioneer River and Rock Dam Creek.

VALUES AND SERVICES

“Land suitable for agricultural production is a valuable, finite commodity that is to be managed to ensure its long-term protection for future generations. Use of land with both agricultural production values and biodiversity values should seek to achieve a balance between the protection of ecological processes and natural systems, economic development and the wellbeing of communities”

(DLGP 2012, 69).

The value of agricultural production in the Mackay, Whitsunday and Isaac council regions was \$891 million in 2010–11, or 9.3 per cent of Queensland’s total value of agricultural production (DAFF, 2013). All agricultural land-use types have seen significant market value increases for the period from 2001 to 2012, ranging from 36 to 456 per cent (DAFF, 2013).

SUGAR CANE

“Cane growing and sugar production underpins the economic stability of many coastal communities. It is the social fabric that has woven itself through the development of coastal townships up and down the coast.”

Canegrowers, n.d.

Sugarcane is grown across 168,000 ha or 15 per cent of the Mackay, Whitsunday and Isaac institutional region (REDC, 2012), and represents 30 per cent of the sugarcane growing area in Queensland. Sugarcane grown in the region in 2011 was worth \$240 million. In 2012 the highest land value was for the irrigated sugarcane land of the Mackay Regional Council at \$18,000 per hectare, which is the highest price for that land type in Queensland.

The central region sugar industry has a value chain which commences with growing of the sugar cane plant and ends with processing of harvested cane into raw and refined sugars, molasses, electricity and ethanol. The value chain has linkages to other suppliers and is contained by the environment and supported by the Central region’s economy.

Mackay Port hosts one of the world’s largest bulk sugar terminals exporting raw and refined sugar totaling close to 2 million tonnes per year.

Mackay Sugar in 2012 completed the construction of a \$120 million power plant at its Racecourse Mill. The power plant will have the capacity to generate one third of the Mackay region’s electricity requirements from bagasse (sugar cane fibre waste), provide power and steam for the Racecourse Mill and Refinery, and allow for the export of 27MW electricity into the national grid.

CATTLE GRAZING

The use of sown pasture systems since the 1960s replaced native pastures that provided low weight gains at low stocking rates (Partridge, 1992). Areas of native pasture in the region occur mainly in the hilly range country where slope and shallow soils, forests and woodland vegetation rule out cropping options and conditions are not favourable for replacement pastures. Historically the three broad native pasture communities in the region are;

1. Pastures sparse or absent, includes two coastal communities (littoral or marine and heath) and closed forests (rain forest) are grouped together as they have limited usefulness for grazing production in the natural state due to low grass cover and or low productive value. An exception is some of the tidal flats where valuable seasonal grazing is obtained from some couch species. Prominent soil in the rainforest areas are friable earths and fertile loams, in littoral areas they soils are grey clay subsoils and heath areas infertile sandy earths dominate.
2. Blady grass (*Imperata cylindrical*) - includes a composite of sandy coastal lowlands and undulating low hills with open forest and woodland communities. The major trees are tea tree/paper bark (*Melaleuca* species), Eucalyptus and *Corymbia* species and swamp Mahogany species (*Lophostemon*). The characteristic grasses are Kangaroo grass (*Themeda triandra*), blady grass (*Imperata cylindrical*) and giant spear grass (*Heteropogon triticeus*). Soils area generally infertile and intensive use of these soils for sown/improved pasture activity is only possible in areas with deeper top soils.
3. Black spear grass (*Heteropogon contortus*) is the most extensive native pasture in the region and is found woodlands and open forests on undulating plains and low hills to higher range areas. Tree vegetation consist of mainly Eucalyptus species such as Iron Bark (*E. creba/E. drepanophylla*), Grey Gum (*E. mollucana*), Blue gum/Forest red gum (*E. tereticornis*), Mortern bay ash/Carbeen (*Corymbia tessellaris*).

In the past the most common grass planted was *Kazungula setaria* and *Rodd's bay plicatum*, which made up more than 90% of the grass component of sown pastures. Over the past decade Rhodes grass and signal grass have been the most planted with Bisset creeping blue also becoming popular. Today the new stylos and four joint vetch legumes are better production options (Bishop, 2007).

There is little intensive grazing in the area in the form of feedlots, for example. However, there are nursery grounds in operation that provide weaner cattle for large cattle farms to the west of the NRM region, due to the regionally reliable feed available for weaning cows.

STATE OF REGION REPORT

Agriculture



	Area harvested for milling (ha)		Percentage for region		Cane crushed (t)		Percentage for region		Commercial Cane Sugar		Sugar Produced (t)		Percentage for region	
	2006	2011	2006	2011	2006	2011	2006	2011	2006	2011	2006	2011	2006	2011
Northern	80,558	68,678	21.26	19.48	5,631,724	3,626,646	17.00	13.77	11.83	12.89	660,370	453,211	14.60	12.94
Herbert-Burdekin	127,321	132,033	33.60	37.44	12,921,548	12,471,413	39.01	47.37	14.06	13.54	1,853,542	1,671,450	40.97	47.72
Mackay Proserpine	116,026	105,796	30.62	30.00	9,745,779	6,697,741	29.42	25.44	13.47	13.35	1,347,357	894,014	29.78	25.52
South Queensland	55,061	46,139	14.53	13.08	4,824,881	3,533,503	14.57	13.42	13.59	13.47	662,389	483,992	14.64	13.82
Queensland	378,966	352,646	100.00	100.00	33,123,932	26,329,304	100.00	100.00	13.44	13.31	4,523,658	3,502,667	100.00	100.00

Table 1 Queensland sugar production statistics, 2012. Source: Australian Milling Council (2012a) N.B: The hectares noted does not include fallow and other farmland i.e. headland, farm sheds/houses included in the 168,000 ha cane area in previous section

Local NRM Body Boundaries	Estimated cattle numbers	No of producers	Estimated gross value \$ M at the farm gate.	Grazing nature vegetation	Grazing modified	Area (ha)
Terrain	1,956,190	35	11	675,600	45,600	893,800
Burdekin Dry Tropics	851,518	510	245	11,196,400	261,400	13,036,500
Mackay Whitsunday	1,150,700	201	326	270,500	29,000	432,700
Fitzroy	1,956,190	2,756	555	9,003,200	1,224,200	12,914,400
Burnett Mary	863,025	910	245	2,479,100	158,500	4,018,800

Table 2 Meat cattle state as at 30th June 2006. Source: Agforce data (composite of DPI & F original data)

HORTICULTURE

Perennial horticulture occurs on 1,534 ha or 0.02 per cent of the Mackay, Whitsunday, Isaac institutional region, while annual horticulture occurs on 8,580 ha or 0.1 per cent of the region. The overall gross value of horticultural crops in the Mackay, Whitsunday Isaac council region for 2010-2011 was around \$207.5 million (previously \$250 million in 2006), with approximately 200 businesses farming around 1,100 ha of productive land, while employing at least 3000 staff during peak season.

However, this boundary includes the highly productive Bowen area north to Gumlu, which overlaps in part yet lies predominantly just outside of the Reef Catchments' area. It is however noteworthy that in 2011 the Bowen area grew 58 per cent of Queensland's capsicums, 41 per cent of the state's beans, 38 per cent of tomatoes, 28 per cent of sweet corn, 20 per cent of mangoes and 17 per cent of melons. Within the NRM area exists one of the biggest egg plant growers in Australia, at Eden Lassie Creek, and numerous small farmers whose produce is sold at local market and as a result is not captured by statistics.

Other perennial horticulture crops in the region include lychees (around Bowen, Proserpine, Mackay and Sarina), bananas (Bowen and north of Mackay), pineapples (Bowen, Sarina and Koumala), macadamias (Bowen and Eton), coffee (Proserpine) and limes (Bowen).

Horticulture produce from the region goes to the domestic fresh markets, with 75 per cent being transported by road (the Bruce Highway) to Brisbane, and 25 per cent to Townsville. Produce is mostly packed on-farm, but there are some packing facilities for vegetables in Gumlu and one in Mackay for bananas.

PRESSURES

LAND CONDITION DECLINE

Decrease in condition occurs as a result of management practices associated with monoculture production systems, excessive cultivation, long term high grazing pressure, increased/prolonged use of inorganic petrochemical crop supplements, more frequent wetting and drying cycles from irrigation, and infrequent use of break cropping.

The key natural resource management pressures linked to the land are the loss of nutrients, pesticides and sediments and export of these into water and waterways that feed into the Great Barrier Reef lagoon, mainly from both diffuse and point sources of pollution (Drewry et al, 2006). The use of inorganic fertilisers and petroleum based pesticides for sustained crop production is associated with loss of direct nutrients/pesticides or their derivatives in soluble forms. Such use is attributed to a lack of targeted application of such supplements, and a lack of awareness or resources to enable compliance with environmental best practice (Fletcher, J. 2013 pers.comms. 4 July 2013).

Intensively cropped and grazed land commonly has a higher percentage of nitrogen and phosphorus in a soluble form than under natural conditions (Mitchell et al 2005; Drewry et al. 2006). As the dominant land use, grazing also contributes about one third of the total regional load of particulate nutrients and sediment (Drewry et al. 2006).

Within the region the loss of sediment and soluble nutrients (e.g. nitrogen) from intensive agriculture production systems is nearing 459,000 tonnes of sediment per annum and 1,920 tonnes of dissolved inorganic nitrogen per annum and 1,510 tonnes of particulate nitrogen per annum (Drewry et al, 2006). While the impact of sediment and nutrient loss from land and its impact on aquatic ecosystem health is relatively well understood, little work has been undertaken in the region to evaluate the impact of soil loss and soluble nutrient loss on the long term impacts toward soil/land fertility and hence land condition sustainability (Hardy, 2004). One can assume however that loss of fertile topsoil and soluble nutrients would have a significant negative impact on soil/land condition and intensive agriculture production.

Further general information on water quality pollutants in this region is available elsewhere (e.g., Faithful 2003; Brodie 2004; Rohde et al. 2008; Australia and Queensland Government, 2012).

Furthermore, yield decline is not always specifically related to fertiliser use. Other factors impact the system including denitrification, soil pathogens, poor variety selection, pH level, and elevation. The focus on reduction in inputs to achieve reduced run-off requires further evaluation with a more holistic approach to multiple and interrelated influencing factors.

Sediment and nutrient quantities in soil are closely related to ground cover and erosion (Rayment and Neil, 1996). Not all the pasture forage grown is to be made available for grazing. Some of the pasture dry matter needs to be retained for soil conservation to achieve more than a 70% ground cover and improved recovery of pastures during spelling or rotation (Weston, 1988).

“Key to land condition is also the prevalence of weeds which impact upon business viability and productivity. Weeds by definition are plants out of place. Weeds in pastures decrease diet quality and animal carrying capacity. Weeds also compete with pasture species for nutrients and moisture. Because most weeds are not grazed they grow faster and can quickly dominate pasture. Weeds can therefore be a cause and symptom of poor pasture and land management. Weeds are also rated by Mackay Whitsunday graziers as one of the major issues with regard to productivity, viability and maintaining sustainable land condition. A highly variable rainfall combined with fluctuating commodity prices places extra pressures on land use management systems. In the main grazing land managers see the implementation of correct stocking rates as critical issues in reducing weed competition on the land and hence competition with pasture species and even stock poisoning from toxic weed pests.”

Bishop, 2007;15

WATER ALLOCATION

Irrigated agriculture accounts for around 80 per cent of water use in the region. Most of this use is associated with sugarcane and horticulture in the Proserpine, Pioneer Valley and Sarina areas. The cost of developing water storage and supply infrastructure is high and many agricultural producers may struggle to afford water from the proposed sources. For example, the expansion of sugarcane west of Proserpine will be limited by access to an affordable irrigation water supply. Existing irrigation allocations are close to being fully committed, however cane growers may not use their full allocations as a result of the increased costs (pumping, equipment maintenance, wages etc.) in applying irrigation.

CLIMATE

Australia already has one of the most variable climates in the world, and Mackay, Whitsunday and Isaac region is one of the most climatically variable in Australia. Even without the threat of a changing climate the region faces challenges to continue the production of agricultural goods. While experienced in flood and drought adaptation efforts, the increased frequency of such events will emerge as one of the key challenges to the future of farming in the region.

Because each region will respond differently to variations in climate, the same can be anticipated of the impact at local mill areas, with the success of crops differing greatly inter-regionally between farms.

“When the sky falls, and cyclones hit, finding the positive side of life can be an industry challenge. When agricultural industries are exposed to the extreme vagaries of climate, productivity is impacted – and recovery is rarely achievable in a single season, particularly in an industry reliant on ratoon crops with new planting only occurring every four to five years. Consequently, there is a need to look more closely at a range of indicators, and recognise the value and investment in industry risk management. In our 2011 Review we estimated that approximately six million tonnes of cane had been left unharvested in the 2010 season as a result of the never-before-seen rainfall during that year’s crushing season. This estimate proved correct with 6.18 million tonnes of stand-over cane being harvested and crushed during the 2011 season. This is a record amount of two year old cane for the Queensland industry to process and created significant challenges to both harvesting and processing. When handling large amounts of stand-over cane, mills’ crushing rates needed to be reduced by up to 25 per cent, to ensure that raw sugar of an acceptable quality continues to be produced. On the upside, industry stakeholders always learn from such experience, and will have an enhanced capacity to adapt response strategies, should wet conditions that prevailed across 2010 — 2012 affect the industry again.”

Australian Sugar Milling Council (2012, 7)

LAND COMPETITION

The following are considered key threats to agricultural production in the region:

- Sugarcane production areas in coastal areas have been impacted by infiltration of seawater into freshwater aquifers and by urban and industrial expansion around Mackay. Urban expansion also affects infrastructure supporting agricultural production;
- There is resistance to plantation forestry from some local governments and some sectors of the sugarcane industry due to perceived competition for land;
- Mining operations in the Bowen Basin and related infrastructure are currently expanding into high-productivity grazing land northwest and southeast of Dysart and along the Isaac River, and this will affect production levels and have flow-on impacts to supply chains. These soils are also suited to cropping, so it also threatens future expansion of cropping in the affected areas;
- The significant expansion of mining infrastructure (including rail and road corridors across high-productivity grazing and cropping areas) reduces production and affects agricultural operations, access to stock routes and stream/water flows.

Land exists that could be developed for agriculture, subject to the provision of a secure water supply (DERM, 2013), however the likelihood of this new land being opened up to account for agricultural land lost is unknown.

Regional water supply infrastructure does not have the capacity to meet present demands. The short-term strategy is to improve the efficiency of existing irrigation systems and to facilitate small-scale infrastructure works (e.g. farm dams).

“Good quality agricultural land is a valuable asset to be recognised and protected. Alienation and loss of this resource through fragmentation, urban development, mining or other high impact development will not be supported, unless there is an overriding need in the public interest for the proposed use, and there are no alternative locations available”

MIW Regional Plan, Department of Local Government and Planning (2012, 69).

COMPETITION FOR QUALIFIED STAFF AND LOSS OF KNOWLEDGE

Grundnoff (2012) states that much of the decline in agriculture and other parts of the economy (tourism, manufacturing, construction) can be attributed as a consequence of the mining boom due to the upward pressure on the exchange rate which in turn reduces the competitiveness of other Australian industries.

Since the beginning of the mining boom Australia's rural sector has lost \$43.5 billion in export income. This includes \$14.9 billion in 2010-2011 alone. These losses have occurred because the mining boom has forced the Australian dollar to historic highs... Within the rural sector the beef and veal industry has also been adversely impacted with exporting income being cut by \$2 billion in 2010-2011 and \$6.2 billion over the boom. The sugar industry lost \$566 million in 2010-2011 and \$1.8 billion over the boom... The growth in the mining sector has come at a cost to other sectors of the economy, especially the rural sector – and these costs are substantial.

The mining boom has not been managed well. It has been allowed to expand with little consideration for the collateral damage it causes to other sectors of the economy. The rural sector is one part of the economy that has been badly affected", Still beating around the bush: The continuing impacts of the mining boom on rural exports,
Grundnoff (2012, 1).

Agriculture has also experienced continued loss of knowledge and skills on farms due to generational changes in interest with fewer young people undertaking studies in agricultural fields and returning to the farm with this knowledge. Key to this is the low productivity and high input required for farming, which can be unattractive to young people commencing their career.

CONDITIONS AND TRENDS

"The Australian economy, like all modern economies, is diverse and ever changing. In 1951 agriculture accounted for just over 30 per cent of Australia's GDP—much bigger than mining has ever been—but today agriculture represents just 2.6 per cent of GDP. Sixty years ago it would have been inconceivable to imagine agriculture shrinking to less than a tenth of its size as a share of the economy. By the same token, nobody would have predicted that the telecommunications sector would become so large; the mobile phone industry employed virtually nobody in the 1980s. But change is a signature feature of a healthy economy, and these things did indeed take place."

Mining the Truth, Richardson and Denniss (2011, 1)

AGRICULTURE IN THE REGION

The value of agricultural production in the Mackay, Whitsunday and Isaac council regions has increased slightly from 8.5 per cent of Queensland's production value in 2006, to 9.3 per cent in 2010 (DAFF, 2013). However, agriculture in Queensland has experienced steady decline since the boom in late 1990s, early 2000s. The Queensland Government's Agricultural Land Audit (2013) focuses on reversing this decline and doubling the value of agricultural production in the state by 2040 as one of the four pillars of the Queensland economy (tourism, agriculture, resources and construction).

INDUSTRY	VALUE \$M	STATUS AT 2013
	2005-2006	
Sugar cane	380	Decline due to multiple factors including weather events, world sugar prices and high Australian Dollar driven by global commodities market
Horticulture and other crops	250	Decline despite an expected growth due to land managers looking at on farm income diversification from sugarcane
Livestock grazing	24.4	Slight increase in production following on from fair seasonal condition and commodity prices. Large numbers of investors/retirees are also entering the commodity with small blocks.
Livestock dairy	3.3	Significant decline in the number of dairies with the likelihood of more losses of dairy enterprises from the region (Fisher 2006).
Aquaculture	1.7	Sustained increase in production over the past few years
Timber and forests	0.5	Strong growth in private plantations and interest in native forest harvesting amongst the grazing sector.

Table 3 Overview of industry gross value and current status

Efforts have been made to identify potential productive agricultural land according to infrastructure capacity. Improvements to transport infrastructure including the Bruce Highway upgrade will enable faster and more efficient transport of agricultural produce and inputs. Infrastructure development as a result of mining growth in surrounding areas are viewed by the Queensland Government as opportunities to improve agricultural commodities transport also.

The Queensland Agricultural Strategy (DERM, 2013) outlines four key pathways to grow the sector; by securing and increasing resources availability, driving productivity growth across the supply chain, securing and increasing market access, and minimising the costs of production.

NUTRIENTS, SEDIMENTS AND PESTICIDES

Loss of key nutrients via rivers has increased from 2-5 times for nitrogen and 4-10 times for Phosphorous over the last 150 years representing the impact of long term intensive agricultural use (Moss et al, 1993).

However, agricultural industries have made significant advances in improving management practices, evidenced by an estimated decrease in fertiliser use by some 15 per cent across the state over the past 5 years. Nitrogen and Phosphorus fertiliser usage rates in sugar cane industry have dropped by 53kg/ha and 15kg/ha respectively in the past 10 years.

2011 - 2012

• Suspended sediment load reduced by approximately	28,328 t/yr
• Particulate Nitrogen load reduced by approximately	98 t/yr
• Particulate Phosphorus load reduced by approximately	91 t/yr
• Dissolved Inorganic Nitrogen load reduced by approximately	86 t/yr
• Filterable Reactive Phosphorus load reduced by approximately	28 t/yr
• Total Pesticides load reduced by approximately	331 kg/yr

2008 - 2012

• Suspended sediment load reduced by approximately	189,380 t/yr
• Particulate Nitrogen load reduced by approximately	399 t/yr
• Particulate Phosphorus load reduced by approximately	222 t/yr
• Dissolved Inorganic Nitrogen load reduced by approximately	240 t/yr
• Filterable Reactive Phosphorus load reduced by approximately	50 t/yr
• Total Pesticides load reduced by approximately	1618 kg/yr

Figure 2 Reef Rescue total Estimated Load Reductions from Current Water Quality Grants New Impact Area, Mackay Whitsunday Isaac (NRM Regions) in 2011-2012 and 2008-2012

Over 40 per cent of sugar cane growers in the region use legume crops on fallow ground and 8 per cent of the sugar cane areas use GPS control traffic technology. Little information on fertiliser usage rates and adoption of new farming technology (e.g. GPS) is known within the horticulture and beef industries within the region.

Mill mud, a nutrient rich by-product of the milling process, was previously blanket spread on the field in an ad hoc manner at a nominal rate of 150 tonnes per hectare (t/ha). With the commission of new spreaders that allow for precision application directly onto rows, mill mud is now applied at a reduced rate of 50t/ha effectively tripling the land one manager can service with their mud allocation.

In October 2003 the Queensland and Australian governments signed the Reef Water Quality Protection Plan (Reef Plan) that aimed to halt and reverse the decline of water quality on the Great Barrier Reef. Since Reef Plan (2003) an updated Reef Water quality Protection plan has been endorsed (Queensland Government, 2009) with a number of implementation and monitoring programs established including Reef Rescue, Reef Regulations and the Paddock to Reef programs, which provide on-ground initiatives necessary to achieve the targets.

As a result of the Reef Plan (2009) and Reef Rescue, since 2008 cane and horticulture farmers have improved management of soil, nutrients and herbicides on more than 75 per cent of the intensive cropping land in the catchment and graziers have improved pasture management on more than 1,000 hectares of pasture. This includes cane farmers purchasing equipment, such as GPS guidance and inter-row spray shields and implementing new farming practices (break cropping, mill mud application, zonal tillage, control traffic via GPS) to reduce inputs such as fuel and/or chemicals while maintaining productivity and ensuring future economic profitability and environmental sustainability.

For cattle farmers this includes stocktake training, land-type fencing, establishing pasture monitoring sites, soil testing, riparian fencing, off-stream watering points and industry/partnership projects. The collective investment in these activities since 2008 has been \$88,085,029 from industries (service providers and landholders) and \$32,480,973 from grants in the Mackay, Whitsunday and Isaac catchments.

According to the Reef Water Quality Projection Plan Report Card (Australia and Queensland Government, 2012), the overall marine condition in the Mackay, Whitsunday, Isaac catchments in 2009–2010 was moderate and that progress toward Reef Plan targets was encouraging, although inshore water quality and coral reefs remained moderate and seagrass meadows remained poor. The report found that:

- 60 per cent of sugarcane growers, 44 per cent of horticulture producers and 15 per cent of graziers have adopted improved land management practices;
- The greatest proportional catchment load reduction was the pesticide load with an estimated 376kg (18 per cent) less;
- Flow management has been improved through waterhole mapping that enables a better understanding of the volumes of water required to maintain critical fish habitat;
- Riparian management has been improved on 33 km of the O’Connell River by graziers who have erected riparian fencing and off stream watering points;
- Barriers to migration have been removed through the construction of fish passage structures on all major barriers and in stream habitat has been restored through the installation of a series of engineered log jams at priority areas.

Targets		Progress and status				
		Region	Catchments			
			O’Connell	Pioneer	Plane	Proserpine
% adoption improved practices	Grazing	17				
	Horticulture	41				
	Sugarcane	17				
% loss	Wetlands	0.01	0	0.27	0.01	0
	Riparian	0.50	0.92	0.08	0.49	0.51
% groundcover		98	99	98	96	98
% load reduction	Nitrogen	4				
	Phosphorus	1				
	Sediment	3				
	Pesticides	18				
Overall marine condition		Moderate				
Water quality		Moderate				
Seagrass		Poor				
Corals		Moderate				

Very good	Poor
Good	Very poor
Moderate	

Figure 3 Progress report for MWI from Reef Water Quality Protection Plan Report Card 2013

"Agriculture has become more diverse and increasingly export-oriented since the 1980s, and now includes some non-traditional commodities and processed products. There are several niche processing facilities for products such as gourmet dairy products, sauces, dried fruit and vegetables, and frozen vegetables.

There are growing market-specific opportunities—for example, grass-fed 'branded' beef and sheep. There are also opportunities for organic produce. In the western regions, organic beef is cost-effective and reliable because drier conditions reduce the risk of pests and diseases" DAFF, 2013; 8.

The current condition of grazing lands in the Mackay Whitsunday Region has not been monitored in any detail since a survey carried out in 1979 (Anderson et al, 1983). Sown pasture development reached a peak in 1974-75 of around 5,000 ha/annum, which corresponded with an increase in beef cattle numbers; from 80,000 in 1967 to 200,000 in 1980 and over 300,000 cattle and calves being sold in 2001. This is compared to 29,000 cattle grazing sown pastures in 2006.

GOVERNANCE

All agricultural enterprises in the region are supported/influenced by a number of state and federal government Acts and operational policies and guidelines including:

- Sugar Industry Act 1999: The principal objective of which is to facilitate an internationally competitive, export oriented sugar industry based on sustainable production the benefits those in the industry and the wider community. Key amendments to the Sugar Act were made in 2004 resulting from the sugar industry reform act 2004.
- Land Protection (Pest and stock Route Management) Act 2002: This Act declares invasive species and requirements for landholders to control them.
- Integrated planning Act 1999: A whole of government approach to identifying the risks of impacts from agriculture and to develop a planned framework for agricultural industries. General development of the environment is assessed against a code (Integrated development Assessment scheme – IDAS) under the Act to protect biodiversity, prevent land degradation and ensure development is sustainable.
- Environmental Protection Act 1994: This Act specifies a general environmental duty whereby a person must not carry out an activity that causes or is likely to cause environmental harm unless the person takes all reasonable and practical measures to prevent or minimise the harm. Several polices provide more detail for achieving the objectives of the Environmental Protection Act 1994, i.e. The Environmental (Water) Policy 1997 which includes guidelines, indicators and monitoring procedures for management of issues such as storm water and acid sulphate soils.
- Great Barrier Reef Marine Park Act 1975: This includes management of perceived risk of damage to the Great Barrier Reef from runoff and sediment discharge from farms.
- Great Barrier Reef Protection Amendment Act 2009
- Chemical Usage (Ag and Vet) Control Act 1988 and Regulation 1999: These outline farm use of chemicals such as; use of chemicals as per label instructions; Require a permit for off label use; Must specify hazard areas for spray drift and permit and license needs; Require material safety data sheets (MSDS) for all chemical used.
- Vegetation Management Act 1999: Regulates native vegetation on freehold land by: Providing a state policy and code accessing clearing applications; regional vegetation management plans; declaration of areas of high conservation value or areas subject to degradation.

In addition, agricultural industries have guidelines for best management practice focusing on a wide range of farming practices and inputs, which are updated regularly and endorsed by industry. All the programs in place operate within an agricultural natural resource management framework called “Farm Management Systems” or FMS (e.g. Growcom, 2006). The FMS approach is designed to support agricultural enterprises by having better planning, risk assessment, management actions, monitoring and review of farm operations. The system therefore supports growers to;

- Better plan their farm management processes;
- Assess their individual management performance and effectiveness of management practices;
- Identify opportunities for improvements or efficiencies;
- Demonstrate management practices and outcomes to external stakeholders.

INDICATORS

Key indicators of land condition that can be evaluated over time fit into two broad categories of measurement:

- Directly definable land condition parameters which can be easily measured;
- Practice changes associated with known land condition improvements.

The requirement for these broad categories is reflective of the fact that changes/improvements in land condition may not be measurable for a significant period of time despite the positive changes in land management being undertaken. Remembering that it may take some time for the biological processes associated with land condition to reach an optimum balance.

Key symptoms of declining land/soil condition as a result of poor land management include:

- Increase in pest competition (e.g. weeds, insects);
- Decrease in organic carbon based levels in soil;
- Decreased in water holding capacity and water infiltration rates;
- Increased wind and water induced erosion;
- Increased rates of fertiliser to maintain production standards; and
- Decrease in agricultural production.

All intensive agricultural industries have in place natural resource management frameworks via the Farm Management Systems (FMS) program. The FMS program seeks to support farm operations in improved planning, risk assessment, management actions, monitoring and review of farm operations. The key focus areas of operations for improved land management in intensive agriculture industries are:

- Improvements in soil structure (biological and physical);
- Improvements in nutrient management;
- Improvements in water use management; and
- Improvements in the use of pesticides.

To assess the effectiveness of improved land management practices and land condition, targets set need to benchmark land manager adoption rates and land condition (physical, nutrient and biological), to assist producers and communities to understand the improved practices are improving land condition. Setting key adoption targets is a collaborative process and the scale of monitoring important as it enables land managers and agriculture commodity groups to evaluate improvements in shorter time frames than monitoring at a catchment scale. Reference farms or trial sites provide indicators of success, while qualitative social data will best capture trending community attitudes that might influence adoption.

A well accepted agricultural best practice framework is the ABCD, which outlines a suite of practices that are 'Aspirational', 'Best Practice', 'Current' or 'Dated' related to nutrient, pesticide, soil and water management at the farm scale. A benchmark study was undertaken to relate water quality in 2007 to the percentage of industry that were adhere to the defined principals of either A, B, C or D for each of the management areas. This allowed the effort needed (i.e. moving from Dated to Best Practice for nutrient management), to be quantified for each area to achieve the water quality targets

The Water Quality Improvement Plan for the region (Drewry et al, 2007 currently being updated) measures water quality in a number of locations, which can be used to target management actions to improve water quality and ecosystem health. For example, at Carmila Creek (figure 4) ambient water quality was generally good in this catchment in 2007 with a low level of management action required to keep water quality in good condition.

Myrtle Creek (figure 5) in contrast is substantially more developed than Carmila Creek, with 31 per cent sugarcane production in this management area. Nutrients such as DIN, dissolved and particulate phosphorus were above water quality objectives in 2007, and therefore management was recommended to improving water quality such as increasing the level of adoption of best management practices.

Key Pollutant	Ambient Freshwater Quality Values			
	Objective 2050	Current Condition 2007	Target 2014	Action
Dissolved Inorganic Nitrogen µg/L	CC	8	CC	L H
Particulate Nitrogen µg/L	CC	78	CC	L H
Dissolved Inorganic Phosphorus µg/L	CC	5	CC	L H
Particulate Phosphorus µg/L	CC	10	CC	L H
Total Suspended Sediment mg/L	CC	3	CC	L H
Ametryn µg/L	CC	<LOD	CC	L H
Atrazine µg/L	CC	<LOD	CC	L H
Diuron µg/L	CC	<LOD	CC	L H
Hexazinone µg/L	CC	0.01	CC	L H
Tebuthiuron µg/L	CC	<LOD	CC	L H
Dissolved Oxygen % saturation	40-120	12-89	40-120	L H
pH	CC	7.3-7.8	CC	L H
Electrical Conductivity µS/cm	CC	279	CC	L H

CC = Current condition; LOD is Limit of detection which is 0.01 µg/L for all herbicides

Key Pollutant	Ambient Freshwater Quality Values			
	Objective 2050	Current Condition 2007	Target 2014	Action
Dissolved Inorganic Nitrogen µg/L	30	154	77	L H
Particulate Nitrogen µg/L	CC	112	CC	L H
Dissolved Inorganic Phosphorus µg/L	25	34	25	L H
Particulate Phosphorus µg/L	20	41	20	L H
Total Suspended Sediment mg/L	5	7	5	L H
Ametryn µg/L	CC	0.04	CC	L H
Atrazine µg/L	CC	0.11	CC	L H
Diuron µg/L	CC	0.11	CC	L H
Hexazinone µg/L	CC	0.08	CC	L H
Tebuthiuron µg/L	CC	<LOD	CC	L H
Dissolved Oxygen % saturation	85-120	12-56	85-120	L H
pH	CC	7.2-7.3	CC	L H
Electrical Conductivity µS/cm	CC	654	CC	L H

CC = Current condition; LOD is Limit of detection which is 0.01 µg/L for all herbicides

Figure 4 Ambient Water Quality Carmilla Creek

Figure 5 Ambient Water Quality Myrtle Creek

Under continuous heavy grazing any surviving desirable pasture plants will have a small root system and be slow to restart growing with the resulting bare ground left vulnerable to erosion and chemical and nutrient runoff (Aisthorpe and Paton, 2004; Schulke, 2003). The Grazing Land Management Program provides participants the tools and skills to monitor and manage land condition via adult action learning, including grazing pressure with variable rainfall, grass/tree balance, pastures and weeds and fire. The Stocktake Workshop provides a tool for balancing pasture supply with forage demand while still maintaining good land condition.

Monitoring currently occurs as part of the Australian Government's Reef Rescue initiative. The Reef Plan (2009) aims to improve the quality of water entering the reef and maintain its health and resilience. Positive changes have been observed in the catchments across the Great Barrier Reef region, and there has been good progress by land managers towards Reef Plan targets. As a result of this change, the estimated average annual pollutant loads entering the reef have reduced as outlined in table 4. Ongoing on ground activities and monitoring as part of Reef Rescue will continue to indicate the condition and trends of improved land management practices and the resulting impact on water quality in the Great Barrier Reef lagoon (Brodie et al., 2013).

POLLUTANT	UNIT	OBJECTIVE	CURRENT CONDITION	TARGET 2013	ACHIEVED	REDUCTION	PERCENTAGE OF TARGET
Dissolved Inorganic Nitrogen	Tonnes/year	1310	2100	1550	1666	435	69% of target due to cane nutrients
Particulate Nitrogen	Tonnes/year	1210	1770	1410	1568	202	56% of target due to combined cane and grazing soil
Filterable Reactive Phosphorus	Tonnes/year	130	350	250	271	79	69% of target due to cane nutrients
Particulate Phosphorus	Tonnes/year	280	650	500	566	84	56% of target due to combined cane and grazing soil
Total Suspended Sediment	Tonnes/year	520000	528000	520000	523520	4480	56% of target due to combined cane and grazing soil
Ametryn	Kg/year	120	160	120	134	26	65% of target due to cane pesticide
Altrazine	Kg/year	1210	1620	120	645	975	65% of target due to cane pesticide
Diuron	Kg/year	2870	4680	3510	3920	761	65% of target due to cane pesticide
Hexazinone	Kg/year	890	1190	890	995	195	65% of target due to cane pesticide

Table 4 Exert from forthcoming Water Quality Improvement Plan Review (2014). Includes only voluntary adoption programs such as Reef Rescue and supporting industry programs. T

REFERENCES

Aisthorpe, J.L. and Paton, C. J (2004). Stocktake, a monitoring package that 'takes stock' of your grazing resources and points to improved management decisions. Department of Primary Industries, Queensland.

Anderson, ER, Russell, FJ, Scanlan, JC and Fossett, GW. (1983). Pastures under development in central Queensland Part 1: Mackay region. Queensland Department of Primary Industries Land Resource Bulletin QV83002.

Australia and Queensland Government, 2012, Paddock to Reef Technical Report, available at <http://www.reefplan.qld.gov.au/measuring-success/report-cards/assets/mackay-whitsunday-region.pdf>, Last accessed 18 April 2013.

Australia Sugar Milling Council, 2012, Annual Review, Brisbane, available at <http://asmc.com.au/wp-content/uploads/2013/08/2012-ASMC-Annual-Review.pdf> Last accessed 2 April 2013.

Australia Sugar Milling Council, n.d. Sugarcane Statistics, Available at <http://asmc.com.au/industry-overview/statistics/> Last accessed 2 April 2013

Bishop, H. G., 2007 Pastures: Mackay Whitsunday region A guide for developing productive and sustainable pasture-fed grazing systems, Department of Primary Industries and Fisheries, Brisbane.

Brodie, D, Waterhouse, J, Schaffelke, J, Kroon, F, Thorburn, F, Rolfe, J, Johnson, J, Fabricius, K, Lewis, S, Devlin, M & Warne, M 2013, Scientific Consensus Statement Land use impacts on Great Barrier Reef water quality and ecosystem condition, last accessed 17 October 2013, <http://www.reefplan.qld.gov.au/about/assets/scientific-consensus-statement-2013.pdf>

Cangrowers, n.d. Sugarcane Industry – Now and Then, available at http://www.canegrowers.com.au/page/Industry_Centre/Publications/about-sugarcane/ Last accessed 14 April 2014.

Department of Agriculture, Forestry and Fishing (DAFF), 2013, Queensland Agricultural Land Audit, Queensland Government. Available at http://www.daff.qld.gov.au/4789_22534.htm, Last accessed 13 April 2013.

Department of Environment and Resource Management (DPIF), 2013, Queensland Agricultural Strategy, Available at, http://www.daff.qld.gov.au/__data/assets/pdf_file/0016/81070/2320-qld-ag-strategy-v15.pdf last accessed 17 October 2013

Department of Local Government Planning (DLGP), 2012, Mackay, Isaac and Whitsunday Regional Plan, Queensland Government, Brisbane.

Drewry, J. Higham, W. & Mitchell, C. 2007. Water Quality Improvement Plan. Draft Regional Report. Mackay Whitsunday Natural Resource Management Group. <http://reefcatchments.com.au/files/2013/02/MWNRM-WQIP-total-report-2008.pdf> Last accessed 14 April 2014.

Faithful, J 2003, Water quality in the Whitsunday rivers catchments. Surface water quality – December 2000 to August 2002. Volume 1 and 2. ACTFR Report No. 02/13, Australian Centre for Tropical Freshwater Research, James Cook University, Townsville.

GrowCom, (2006) Land and Water fact sheet – Farm Management Systems (FMS), Brisbane, Available at <http://www2.growcom.com.au/home/inner.asp?pageID=102&main=25> Last accessed 22 April 2014.

Grundoff, M., 2013 Still beating around the bush; the continuing impacts of the mining boom on rural exports, Policy Brief No. 47, available at http://www.tai.org.au/sites/default/files/research/PB%2047%20Still%20beating%20around%20the%20bush_0.pdf Last accessed 2 July 2014.

Hardy, S. M. (2004) Soils and land suitability of the Whitsunday Coast Area, Whitsunday Shire Council, Proserpine.

Mackay Regional Advisory Group, 2005, Sugar Industry Strategic Plan Central Region 2005-2009, Available online: http://www.daff.gov.au/__data/assets/pdf_file/0020/183440/mackay_sept_2005.pdf

Mitchell, C., Brodie, J., White, I., 2005, Sediments, nutrients and pesticide residues in event flow condition in streams of the Mackay Whitsunday region, Australia. *Marine Pollution Bulletin*, 51, 23-36

Moss, A., Brodie, J. and Furnas, M., 2005, Water quality guidelines for the Great Barrier Reef World Heritage Area: a basis for development and preliminary values, *Marine Pollution Bulletin* 51: 76-88.

Partridge, Ian., 1992, Managing native pastures, a grazier's guide. Department of Primary Industries Information Series QI92009, Queensland Government, Brisbane 1992.

Queensland Government (Department of the Premier and Cabinet), 2009, Reef Water Quality Protection Plan, Reef Water Quality Protection Plan Secretariat, Brisbane, available at <http://www.reefplan.qld.gov.au/resources/assets/reef-plan-2009.pdf> Last accessed 18 April 2014

Rayment, G.E. and Neil, D.T. (1996). Sources of material in river discharge. In "The Great Barrier Reef – Science, Use and Management". Proceedings of a National Conference, Townsville 25-29 November 1996. pp 42-58. (Reef CRC, GBRMPA and James Cook University, Townsville).

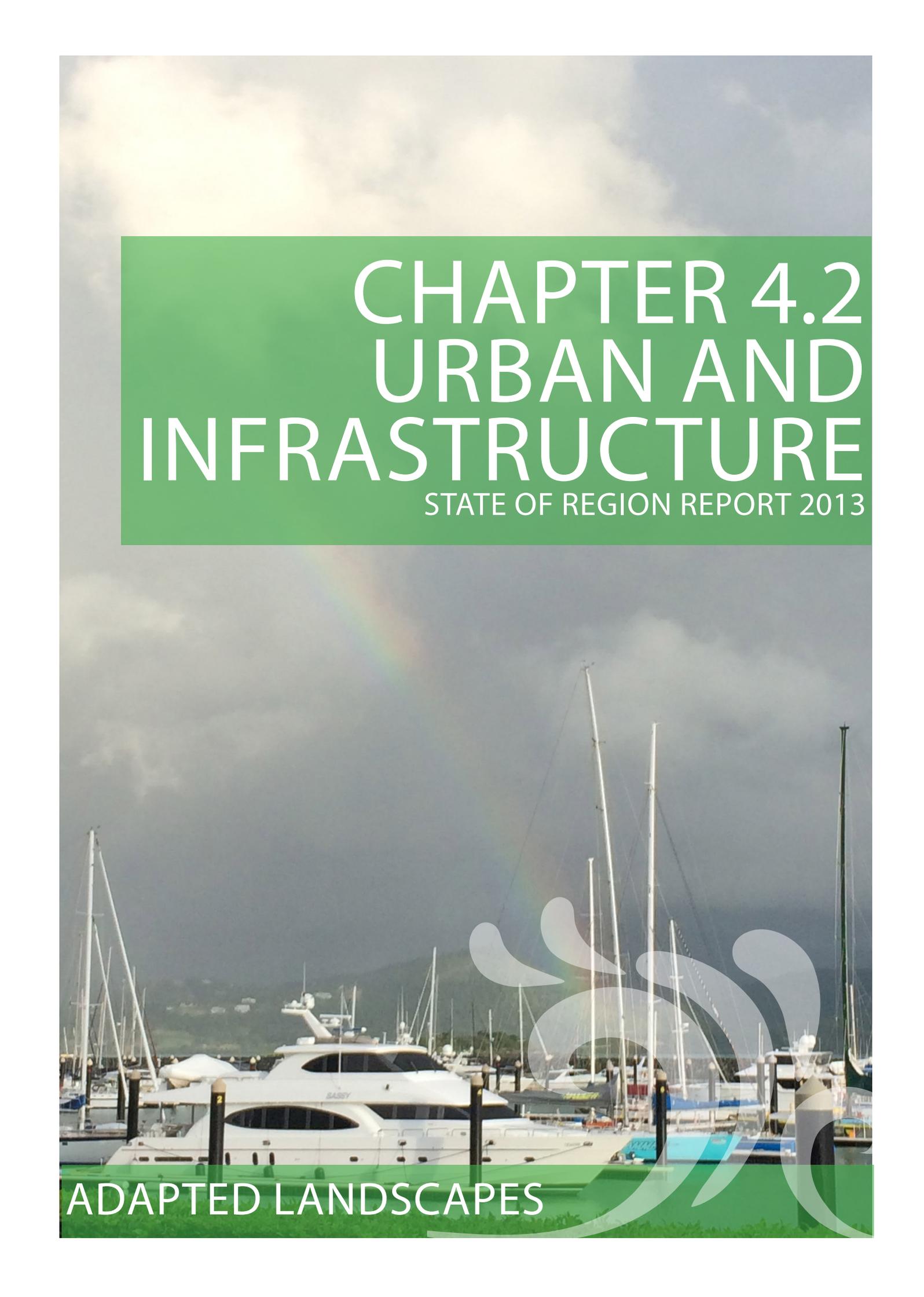
Regional Economic Development Corporation, 2013, Economic Profile, Mackay, Whitsunday and Isaac, available at <http://www.mwredc.org.au/index.php/publications/economic-profile/finish/4-economic-profiles/158-economic-profile-miw-region-march-2013> Last accessed 18 April 2013.

Richardson, D., and Denniss, R., 2011, Mining the truth; the rhetoric and reality of the commodities boom, the Australia Institute Paper No. 7, available at <http://www.tai.org.au/node/1777> last accessed 4 April 2013.

Rohde K, Masters B, Gurner N, Higham W & Drewry J 2008, Sediment, nutrient and herbicide runoff from canefarming practices in the Mackay Whitsunday region: a field-based rainfall simulation study of management practices, Queensland Department of Natural Resources and Water for the Mackay Whitsunday Natural Resource Management Group, Australia.

Schulke, Bill., 2003, Grazing land production systems, the gateway model. *BeefTalk Autumn/Winter 2003*, Department Primary Industries, Gympie, Queensland.

Weston, E.J (1988) Native Pasture Communities; in *Native pastures in Queensland, the resources and their management*, p 21-33, edited by WH Burrows, JC Scanlan and MT Rutherford, Department of Primary Industries Information Series Q187023, Queensland Government, Brisbane 1988.



CHAPTER 4.2 URBAN AND INFRASTRUCTURE

STATE OF REGION REPORT 2013

ADAPTED LANDSCAPES

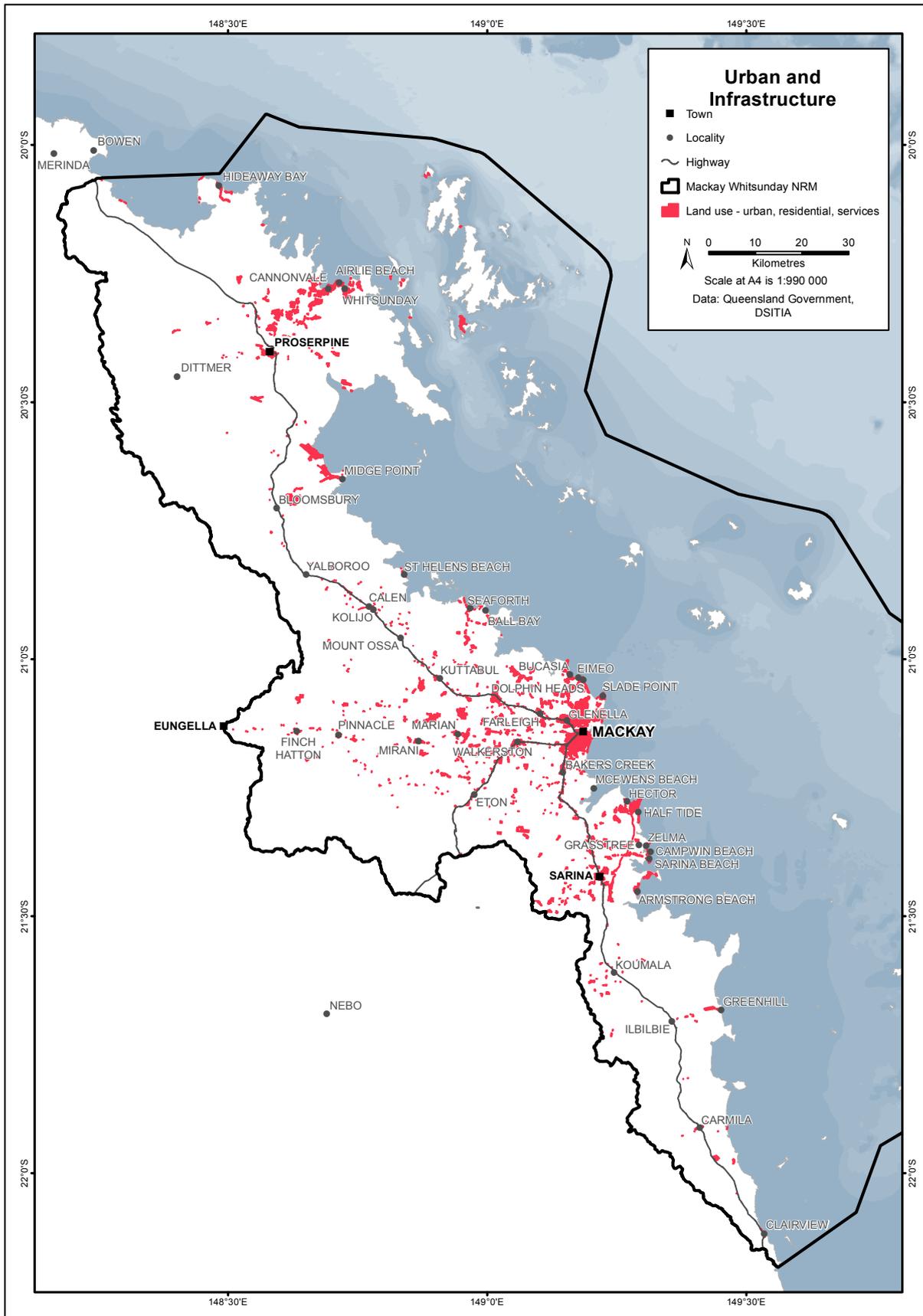


Figure 1
Urban,
industrial,
services and
other built
areas

SUMMARY

Mackay, Whitsunday and Isaac region has experienced significant economic, urban and population growth in the last 30 years. The settlement pattern consists of several well-dispersed regional communities, with the majority of growth in coastal communities and Mackay City, the main urban population centre (Queensland Government, 2012). Other important centres are Bowen, Proserpine, Cannonvale and Sarina, which provide services to surrounding rural communities populations. Airlie Beach maintains its role as the centre for tourism.

As at 30 June 2012, the resident population of Mackay, Whitsunday and Isaac catchment region was 139,320 persons, comprising 52 per cent males and 48 percent females with the majority of people are aged between 35 and 54 years. 80 per cent of people were born in Australia and Indigenous people represent 4.2% of the total population. Nearly 60 per cent of the total population, or 78,200 people, live in Mackay City, where the majority of future growth is expected to be hosted.

Mackay Harbour imports petroleum and sugar and exports sugar and grain, while Hay Point 25 km south of Mackay is the largest coal terminal in the world, exporting nearly 90 million tonnes of coal per annum via 900 bulk shipping carriers.

Other vital infrastructure networks include the Bruce Highway, which runs the length of the region, and a series of railway networks comprising a main multiple use track running often in parallel with the Bruce Highway, railways to the north and south that connect coalfields with ports, and the intricate railway networks that service the cane industry.

There are no official estimates of Gross Regional Product (GRP) for the Mackay, Whitsunday and Isaac catchment region therefore estimates of GRP are based on administrative boundaries such as local government areas.

Gross Regional Product for the region is estimated at around \$6.8 billion per annum. The economy of the region is still heavily influenced by the mining sector through the provision of inputs (labour, transport, support services such as construction), despite the location of such mines being in the Central Queensland Coalfields, outside of the region. Primary industries and tourism are also major contributors to GRP.

Educational attainment regionally reflects the needs of the dominant industries in the region, which are trade-based and have generally lower percentages of year 12 qualifications, tertiary qualifications and higher levels of certificate qualifications.

Level	Region	Queensland
Year 10	22.8%	18.8%
Year 12	29.0%	36.8%
Certificate	19.6%	15.9%
Undergraduate	5.8%	9.3%
Postgraduate	0.8%	2.2%

Table 1 Education attainment in region compared with State average

Industry	Value added (\$ million)	% of regional value added
Agriculture, forestry & fishing	306	4.5%
Mining	927	13.7%
Manufacturing	517	7.6%
Electricity, gas, water & waste services	122	1.8%
Construction	679	10.0%
Wholesale trade	595	8.8%
Retail Trade	438	6.5%
Accommodation and Food Services	287	4.2%
Transport, Postal and Warehousing	620	9.2%
Information Media & telecommunications	72	1.1%
Financial & insurance services	297	4.4%
Rental, hiring and real estate services	225	3.3%
Professional, scientific & technical services	344	5.1%
Administrative & support services	133	2.0%
Public administration & safety	244	3.6%
Education & training	274	4.0%
Healthcare & social assistance	397	5.9%
Arts & recreation services	15	0.2%
Other services	207	3.1%
Non classifiable industry	71	1.0%
Total Industry Value Added	6,770	100.0%

Table 2 Value add of industries in Mackay, Whitsunday and Isaac

VALUES AND SERVICES

As at June 2012, 70 per cent of the Australian population resided in major cities, compared with just 2.3 per cent living in regional Australia (Australian Government, 2012). Regional centres are highly valued human environments, ideally providing residents with a useful, attractive, safe, environmentally sustainable, economically successful and socially equitable place to live, instilling a sense of place and cultural identity.

The MIW Region has one of the fastest growing economies in Queensland, attributed by Regional Development Australia (2013) to increased activity in resource mining in the Bowen Basin and Galilee Basin and the resulting activity in supporting industries, such as construction and infrastructure.

EMPLOYMENT

The dominant industries in the area are construction (10.3 per cent) driven by resource sector and population growth, retail trade (10.2 per cent) driven by population and tourism growth, mining (10 per cent) with rapid growth in recent years which is now slowing, and primary industries (3.9 per cent).

The structure of industry employment regionally differs significantly from the State in some areas. Based on percentage of workforce:

- Primary industries are almost 1.5 times as important as in the State
- Mining is almost four times as important as in the State
- Manufacturing is similar levels to the State (indicating many mining inputs are imported)
- Many white collar sectors are only half as important (media, telecommunications, insurance, finance, public administration, arts and recreational services)
- Most other sectors relatively similar.

2011	Region		QLD	
	Persons	%	Persons	%
Agriculture, forestry and fishing	2,755	3.91%	55,416	2.7%
Mining	7,059	10.0%	52,955	2.6%
Manufacturing	6,188	8.8%	171,669	8.4%
Electricity, gas, water and waste services	593	0.8%	24,828	1.2%
Construction	7,249	10.3%	183,780	9.0%
Wholesale trade	2,904	4.1%	74,288	3.6%
Retail trade	7,204	10.2%	217,610	10.7%
Accommodation and food services	5,525	7.8%	141,855	7.0%
Transport, postal and warehousing	4,936	7.0%	107,072	5.3%
Information media and telecommunications	415	0.6%	25,358	1.2%
Financial and insurance services	955	1.4%	54,153	2.7%
Rental, hiring and real estate services	1,329	1.9%	37,007	1.8%
Professional, scientific and technical services	3,113	4.4%	132,754	6.5%
Administrative and support services	1,927	2.7%	65,015	3.2%
Public administration and safety	2,788	4.0%	136,818	6.7%
Education and training	3,907	5.5%	160,921	7.9%
Health care and social assistance	5,877	8.3%	242,559	11.9%
Arts and recreation services	409	0.6%	28,444	1.4%
Other services	3,593	5.1%	78,713	3.9%
Inadequately described/Not stated	1,762	2.5%	48,060	2.4%
Total	70,488	100.0%	2,039,275	100.0%

Table 3
Employment by
Industry 2011

The mining industry has a greater proportion of higher wages than any other industry, with 58 per cent of mining employees earning more than \$2,000 per week, compared with 5.3 per cent in agriculture and 1.8 per cent in accommodation services.

	\$1-\$299	\$ 3 0 0 - \$599	\$600-\$799	\$800-\$999	\$ 1 , 0 0 0 - \$1,249	\$ 1 , 2 5 0 - \$1,499	\$ 1 , 5 0 0 - \$1,999	\$2000+
Primary industries	9.5%	25.2%	20.6%	14.6%	12.6%	6.9%	5.4%	5.3%
Mining	0.5%	1.6%	2.1%	2.8%	5.5%	7.6%	21.5%	58.3%
Accommodation & food services	21%	31.5%	20.2%	12.8%	7.3%	3.1%	2.4%	1.8%

Table 4 Wages per week according to key sectors. Source: ABS, 2011.

The development of infrastructure associated with mines has the potential to be valuable to other industries, in particular agriculture, by increasing access to markets. Improvements to transport infrastructure including the Bruce Highway upgrade will enable faster and more efficient transport of agricultural produce and inputs.

Recent and planned infrastructure projects provide for current growth pressures, for example the new Marian water treatment plant which will service the townships of Marian and Mirani with a more reliable potable water supply. Mackay Council determine that there is sufficient raw water availability to meet the regions needs, with developments since 2007 included below.

	Capacity	Service areas	Comments
Water Asset			
Nebo Road WTP upgrade	74 ML/day	Mackay	Significant upgrade to existing plant
South Mackay Trunk Main and Mackay to Sarina Pipeline	100L/s to Sarina	Sarina	Security of supply to Sarina township
Upgrade to Dumbleton Road Raw Water Intake	65 ML/day	Mackay	Significant upgrade to pumping capacity
Various water main upgrades and extensions across the region (\$30m)		All	Condition and capacity upgrade
Sewer Assets			
Mackay South STP upgrade	100,000 EPs	Mackay	Significant upgrade which included the Water Recycling Scheme
Mackay North STP upgrade	25,000 EP	Northern Beaches	Significant upgrade
Numerous upgrades to existing sewerage pump stations and new pump stations totalling \$43million	various	Various across the networks	Works are combination of new, refurbishment and upgrades
Developments in progress			
Marian WTP	4 ML/ day treatment capacity	Mirani and Marian townships	Future infrastructure currently in tender phase for completion 2014

Table 5 Current and future upgrades in Mackay Region.

PRESSURES AND THREATS

Urban activities can degrade the regions natural ecosystem and environmental values. Critical issues in urban and infrastructure development include;

- Competition between land use predominantly urban/industrial development in competition with agricultural use of available land;
- Land degradation caused by poorly planned development works, for example erosion, inappropriate land clearing and land fill;
- Loss of ecologically sensitive habitats which provide critical ecosystem services such as wetlands and riparian vegetation;
- Exposure of Acid Sulphate Soils;
- Changes in land use practices that influence significant changes to drainage patterns and distribution.

LAND COMPETITION

Urban development issues are predominantly focused on overall land use planning operations and the ability to preserve good quality agricultural or other productive land and key habitat areas, including the downstream marine environment. The planning process should be robust enough to provide for urban expansion, tourism, industrial development and recreational needs while still upholding the environmental values that the community wishes to maintain.

The increasing regional population threatens to reduce good quality agricultural land from agricultural uses. With an estimate of only 3 per cent of Queensland land area suited to agriculture operations there is a need to protect food production and economic viability for the region and the state.

However, in the short term Mackay region retains enough residential, commercial and industrial land to accommodate future growth and, with clear boundaries for urban areas, avoid encroachment on agricultural areas.

“The Mackay cane supply region has reduced by approximately 10,000 ha over the past 10 years. These losses are widely distributed across the region and are due to a number of causal factors. With the region’s growing population, driven by the coal mining boom, housing developments remain one of the primary influences to cane land loss. A large portion of the land has simply gone out of cane and remains underutilised due to farmers being unable to maintain the farm for various reasons. The inability to retain skilled workers to assist with farming the properties and our aging grower population also continue to play a part in the decline of cane land” Mackay Sugar (2012; 21).

LAND DEGRADATION

Urban and industrial development have been identified as a major contributors of sediment and other pollutants to the region’s waterways and this is a significant concern for the region given the current amount of construction activity.

Legislative based controls to reduce the potential for soil erosion on urban and industrial development sites exists with local governments. In 2012, for example, Mackay Regional Council introduced an Erosion and Sediment Control Compliance Program (ESCCP), targeting projects in the construction phase of development with typical fines of \$2000 issued where sediment loss and erosion is evidenced.

While regulated in terms of minimising impact, the review of development in the coastal zone has potential to be undertaken in favour of the developer, a process that threatens key animal and plant ecosystem and species diversity. The net effect has seen the development of coastal environments with minimal planning associated with conservation or restoration of important habitat to maintain species diversity and land condition.

WATER SUPPLY AND QUALITY

The city of Mackay is supplied potable water by the Pioneer River and the majority of rural schemes within the region are either wholly or partially reliant on groundwater for their water supply. The townships of Marian and Mirani will benefit from a river water supply as a result of the Marian Water Treatment Plant, which will be built in 2014.

Salinity, reduced flows and over-allocation of groundwater resources have become regional issues, particularly along the coast (Drewry et al., 2007). Management strategies are required to ensure that the use of underground water resources is within sustainable limits and that underground water quality is not degraded.

Within the Pioneer Valley, the current extraction regime has resulted in extensive and ongoing saltwater intrusion and reduced water levels and reliability of supply in some areas. In the Proserpine area similar issues, impacts and threats such as saltwater intrusion, excessive use and groundwater-dependent ecosystems are relevant, but have not manifested to the same degree. This has been a result of the provision of an alternate surface water supply from Peter Faust Dam, which has since 1991 significantly relieved the pressure on the demand from the groundwater system. However, in areas not supplied from the surface water scheme, some of these management concerns still exist to varying degrees.

The ecological condition of the rivers and streams in the region are influenced by a range of factors, including urban land use, riparian zone management, direct modifications to river and stream channels, level of water resource infrastructure development within the rivers and streams, and the level of water infrastructure developed to take water from the rivers and streams. Environmental flows are crucial to the maintenance of healthy riverine habitats and systems and in maintaining stream geomorphology and ecology. Changes in flow regimes have potentially wide-ranging ramifications.

Urban development is a major diffuse source of nutrients, sediments and pesticides entering watercourses. This can be attributed to a lack of stormwater management, erosion and sediment control measures for land development and construction and a high percentage of directly connected impervious surfaces (Drewry et al., 2007)

Point sources of pollution locally are significant, especially from major urban centres such as Mackay city and Cannonvale/Airlie Beach (Drewry et al., 2007). There are other pollutants associated with urban areas, transport corridors, waste disposal areas and sewage treatment plants. These include organic compounds, hydrocarbons and heavy metals (Rohde et al. 2006).

Urban waste management issues are focused on overall planning and management processes established to deal with waste products generated from urban populations and their activities. Potential sources of pressure include:

- Sewage collection and treatment and associated risk strategies in relation to meeting population growth, systems failures and natural disaster issues such as flooding and its impact on sewage treatment facilities;
- Treatment and disposal of solid waste amid a growing population;
- Storm water runoff including not only polluted water but also non polluted water and its impact at the interface of storm water outlets and tidal estuarine areas;
- Air quality, particularly pollution of air from industrial process and transport.

Adoption rates for urban development management practices outlined in the WQIP (Drewry et al., 2007) have been deemed poor, with movement through the ABCD framework for green and brownfield management and accompanying implementation activities considered unsuccessful in many cases.

“Urban management comprises two phases: new development (‘Greenfields’) and existing urban management (‘Brownfields’). The major diffuse pollutants during new development are sediments and particulate nutrients. The major diffuse pollutants from existing urban areas are sediments, nutrients and heavy metals. In addition to the impact on water quality, urban development can have an ecologically significant impact on in-stream habitat. Urbanisation increases impervious surfaces which increases the number of surface runoff events, resulting in regular disturbance of in-stream ecosystems and ecosystem degradation”

Drewry, et al., 2011; 1

CAPACITY TO GROW

As the population continues to growth, the pressures on water and waste facilities increase. Challenges of supplying potable water to a growing population include aging infrastructure and the removal of State Government subsidies, which has added pressure to upgrade and replace infrastructure and continues to have major influence on Council’s capital program. Servicing growth areas into the future will require significant capital investment, while escalating costs associated with key inputs into the provision of water and wastewater services such as Sunwater raw water price and electricity price is placing upward pressure on the cost to provide services to the community.

6 per cent of energy substations in the region are nearing constraint, with 12 per cent already constrained (REDC, 2012). Energy supply has been noted as a major challenge for the region, and a long term energy supply strategy is required in order to better plan for growth.

Investment in infrastructure has been strong since 2007 however the region is still suffering from an infrastructure lag, a regional challenge in keeping up with the population growth. Infrastructure lags also have a significant effect on industry growth in the short term, particularly in the areas of energy and water which are essential for new investment. Rising costs to bring infrastructure to market is a major concern, as the opportunity cost of investment not coming to market in the short term has a long term economic effect, particularly on employment.

CAPACITY TO GROW

There are currently 32 operating coal mines in the Mackay, Whitsunday, Isaac council regions with 35 new projects (including new mines and expansions of existing mines) planned for the future.

The Dudgeon Point Coal Terminals development project proposes the development of two new coal export terminals and associated infrastructure at Hay Point with a combined capacity of up to 180 million tonnes per annum. This \$10-12 billion investment will feature six rail loops and train unloading facilities, a rail connection to Goonyella rail system, offshore wharf facilities for up to eight ship berths, and expansion of tug facilities to accommodate up to 10 extra tug and service berths. The project will also require dredging of approximately 13-15 million m3 to create berth pockets and a departure apron for ships.

The primary environmental concerns for port development are that ecosystems in port areas form a critical connection between land and sea with vulnerable habitats and species in these and adjacent areas, including dredging and ship anchorage sites. The Hay Point zoning which incorporates Dudgeon Point includes 45 percent of shorebird feeding sites. Community concern includes the potential for increased noise in suburban areas and particulate dust increase in the surrounding area (Mackay Conservation Group, 2013).

Further to the environmental impacts of mining development, rapid growth in a single industry can also create offsetting economic and social consequences. Referred to as 'Dutch Disease', this rapid growth in one industry can drive up the cost of labour and production and increase costs for all industries by drawing on the same labour pool, transport infrastructure, and other inputs. Additional and related problems include labour competition, shortages in housing and labour markets, bottlenecks in the provision of infrastructure, high housing and rental prices, and uneven distribution of socio-economic benefits (Rolfe et al, 2007; Richardson and Denniss, 2011).



Figure 2 Natural resource deposits and projected infrastructure development. Source Landtrak Corporation (n.d.)

CONDITION AND TRENDS

“Between 2006 and 2011 population growth slowed to an average of 1.4% per annum, slightly below the State average of 1.8%. The Mackay-Isaac-Whitsunday region had previously been experiencing stronger population growth (3.1% per annum) between 2001 and 2006, exceeding the State average for this period. Over the long term, the region’s population is projected to grow at a faster rate than the State average (1.8% compared to 1.7%)”

REDC Regional Report Card, 2012; 13

POPULATION GROWTH

The Mackay, Whitsunday and Isaac economic region was Queensland’s fastest growing in 2010-2011, with an average annual growth of 13.7 per cent. On an individual basis Mackay ranked third at 8.5 per cent for production behind Brisbane (48.1 per cent) and the Gold Coast (9.4 per cent) (OESR, 2012b).

The Mackay, Whitsunday and Isaac catchment population is projected to grow by 47% by 2031, compared to a total Great Barrier Reef population growth of 40% over the same period (Figure 3).

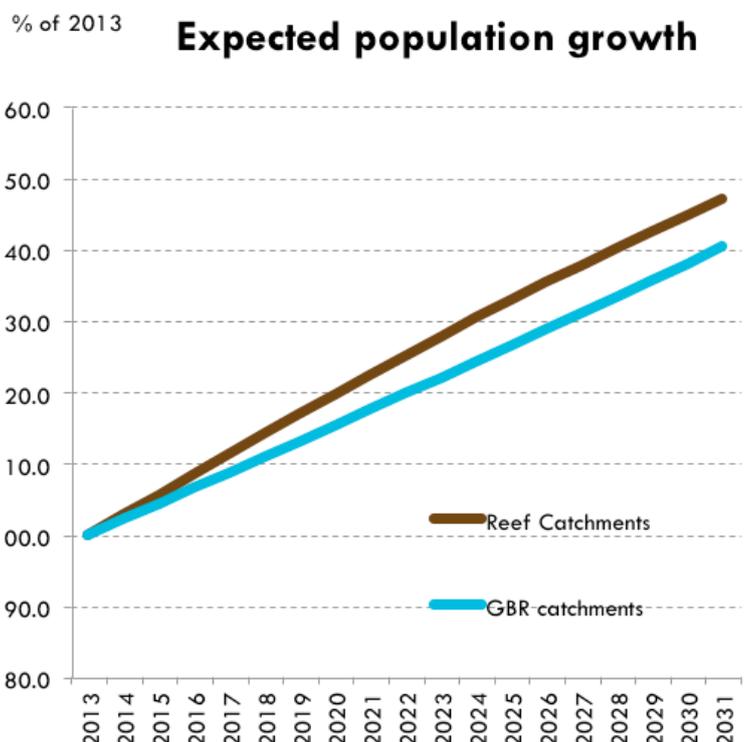


Figure 3 Mackay, Whitsunday and Isaac catchment area projected population growth related to GBR wide catchment areas 2013-2031. Source: ABS, 2011.

STATE OF REGION REPORT

Urban and Infrastructure



Council Area	Population	Increase Since Previous Year	Projected Population 2031	Additional Dwellings Forecast by 2031
Mackay	121,072	2.1%	187,400	43,300
Whitsunday	35,065	1.1%	55,500	10,200
Isaac	22,956	1.6%	37,000	5,800

Table 6 Dwelling and population forecast for Mackay, Whitsunday and Isaac Council Areas. Source: ABS, 2011.

"Broadhectare land refers to residential greenfield and brownfield land (greater than 2,500 m²) that is currently suitable for residential development. In December 2012, there were approximately 3,570 hectares of broadhectare land suitable for residential development in MWI. Based on the planning scheme intent, existing approvals, and an analysis of residential densities by location, this supply is expected to yield some 23,000 dwellings. This expected yield takes into account ownership and land fragmentation issues which often reduce the yield. In the year to December quarter 2012, MWI councils approved the development of 1,012 residential lots. This was a decrease of 49 per cent compared with the same period last year when 1,996 lots were approved", OESR 2012a; 3.

EMPLOYMENT

Regionally, the structure of employment has changed between 2006 and 2011 with the following points:

- Significant decline in relative importance of primary industries (down 2.8 percentage points to 3.9 per cent), which is a reduction of approximately 2,100 jobs
- Mining has declined in relative importance, despite the mining boom, partially due to mining FIFO, DIDO trends, and movements from construction to operational phases of mines
- Transport has increased in relative importance as more mines move to operational phase
- Manufacturing has increased slightly (while State-wide it has declined).

	Region (2006)	Region (2011)	% point change
Agriculture, forestry & fishing	6.7%	3.9%	-2.8%
Mining	11.7%	10.0%	-1.7%
Manufacturing	8.1%	8.8%	0.7%
Electricity, gas, water & waste services	0.8%	0.8%	0.0%
Construction	9.6%	10.3%	0.7%
Wholesale trade	3.9%	4.1%	0.3%
Retail trade	10.8%	10.2%	-0.6%
Accommodation & food services	8.3%	7.8%	-0.4%
Transport, postal & warehousing	6.0%	7.0%	1.0%
Information media & telecommunications	0.7%	0.6%	-0.1%
Financial & insurance services	1.5%	1.4%	-0.2%
Rental, hiring & real estate services	1.8%	1.9%	0.1%
Professional, scientific & technical services	3.7%	4.4%	0.7%
Administrative & support services	2.4%	2.7%	0.3%
Public administration & safety	3.7%	4.0%	0.2%
Education & training	5.9%	5.5%	-0.3%
Health care & social assistance	7.0%	8.3%	1.4%
Arts & recreation services	0.6%	0.6%	0.0%
Other services	4.1%	5.1%	1.0%
Inadequately described/Not stated	2.8%	2.5%	-0.3%
Total	100.0%	100.0%	0.0%

Table 7 Employment by Industry changes 2006-2011

Socio-economic Indicators for Areas (SEIFA) indicate that Mackay is relatively advantaged compared with the State, while Whitsunday is at a relative disadvantage. Mackay has higher income resources than the State, while Whitsunday is below the State. Both Mackay and Whitsunday are below the State in terms of education/occupation, meaning residents have a relatively lower education and occupation status.

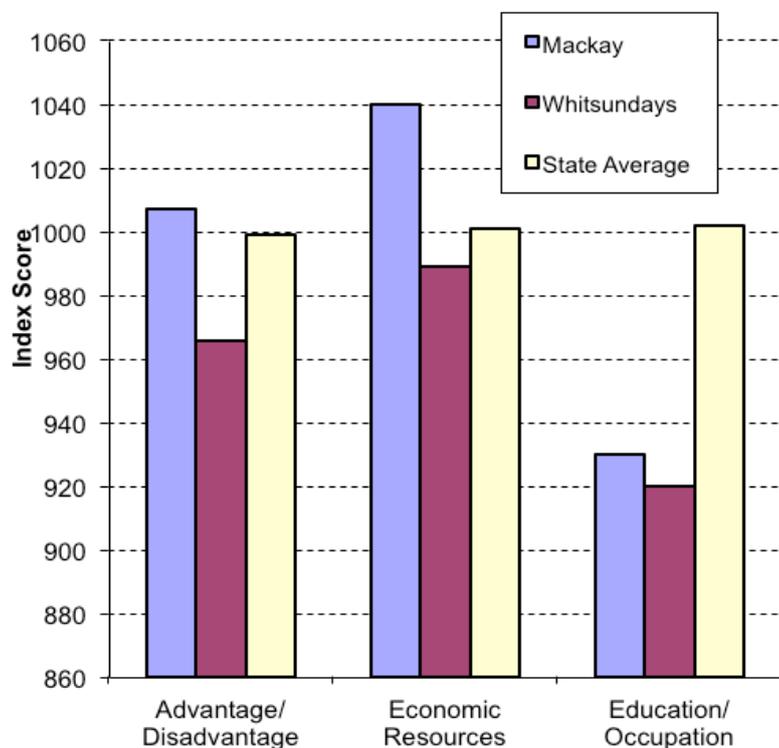


Figure 4 Relative advantage of Mackay and Whitsunday. Source: ABS, 2011

The region has seen a 21.9 per cent increase in the labour force since 2007, with a slight increase in unemployment of 0.9 per cent. Growth in the population is strongly correlated with consistent growth in employment across all sectors other than Agriculture, which decreased its workforce by 15.1 per cent. However, the GRP for Agriculture has increased by 22.7 per cent, indicating strong productivity gains in the sector (DLGP, 2012). The mining sector has experienced the largest increase in employment of 44.1 per cent.

The largest amount of investment was recorded in the Port sector, with more than \$36.5 billion of new projects planned for the region. Mining investment remains strong with \$32.5 billion planned over the next decade, complemented by \$12 billion in rail projects. The strongest increase in investment is planned in the Whitsunday Regional Council area, driven by Port expansions at Abbot Point and new rail corridors from the Galilee Basin (REDC, 2012).

VISITATION

As occurred at a state level, domestic visitation to the region increased over the year. Mackay was the only region in the state to have recorded growth in holiday, visiting friends or relatives (VFR) and business markets. A key driver of the domestic growth was the recovery in business travel (which accounted for 45% of all domestic visitors to the region), and particularly from regional Queenslanders (REDC, 2012).

In the year ended June 2011, there were a total of 1,298,000 visitors to the Mackay, Whitsunday and Isaac council regions, of which 233,000 were overseas travellers. The majority of visitors to the Whitsunday region were leisure travellers whilst the majority of visitors to the Mackay Tourism Region were Business travellers. In 2012 there were 1,124,000 passengers through Mackay Airport, of which 45 per cent were workers from the resource sector.

Due to growth in the resource sector, there is high demand for hotels, motels, serviced apartments and houses. Occupancy rates are particularly strong during the business week, with many accommodation providers in Mackay averaging in excess of 90 per cent Monday to Thursday and a yearly average of 69.8 per cent (REDC, 2013). Competition for land in the region is significant and is greatest between primary production and urban development and between all developed land uses and habitat preservation.

WATER RESOURCES

Allocation of sufficient water resources that meet community needs while maintaining environmental integrity is an ongoing challenge. This involves minimising offsite impacts of land and water use, managing natural habitat to conserve and enhance ecosystems, enhancing and maintaining water quality to maintain healthy ecosystems, and managing waterways and wetlands for the protection, enhancement and maintenance of aquatic ecosystems and the protection of public and private assets.

There are currently approximately 82,200 megalitres (ML) a year of groundwater allocated within the proposed Pioneer Valley Plan area and small volumes of groundwater accessed for domestic and pastoral purpose, which do not require licensing. Groundwater use for the majority of irrigation, industrial and municipal users of the Pioneer Valley amounted to approximately 52,395 ML during the 2002-2003 water year. The high levels of use have played a significant role in the current condition of the aquifer system.

The Whitsunday Water Resource Plan (Queensland Government, 2010) includes the Proserpine and O'Connell river catchments which flow into Repulse Bay. The water resource plan includes management of the Proserpine River Water Supply Scheme operated by Sun Water, as well as un-supplemented water and sub-artesian water. The supply scheme is supplied by water from the Peter Faust Dam on the Proserpine River.

In 1996 the Mackay Tourism and Development Bureau engaged consulting engineers to develop a regional resource strategy for the greater Mackay area. The result of the consultancy was a report titled Mackay Water Resources Strategy Volumes 1, 2 & 3 (Wagner, 1996). The report provides an overview of the water resources within the study area, the level of water infrastructure development and possible future water infrastructure development.

A comprehensive assessment of the region's water resources was outlined in a report "Overview of Water Resources and Related Issues – The Mackay Whitsunday Region" (DPI, 1993), which stated that the total groundwater yield for the region was estimated to be 164,200 ML per annum. It is further estimated that 86% of the supplies available have a water quality with less than 3,000 milligrams per litre total dissolved salts. Alluvium provides the bulk of groundwater supplies with approximately 110,900 Megalitres per annum available from this source.

Stream flow records are available from over 20 stream gauging stations throughout the region. The locations of the gauging stations are available online for stream catchments at Proserpine River, O'Connell River, Pioneer River and Plane River (Queensland Government, 2012). Water quality and water levels, from which volumes of water flows may be derived are monitored as part of the State wide ambient monitoring program.

Groundwater Dependant Ecosystems are an issue requiring further in-depth investigation and analysis. The way in which these ecosystems are managed in the context of consumptive groundwater uses will become increasingly important.

Achievements Water Quality Improvement Plan 2008-2013 (in publication)

- 5 stormwater modelling & management plans for 5 major urban catchment management areas;
- 16 site urban waterway health monitoring program;
- 3 Mackay Whitsunday Isaac regional councils received Reef Guardian Council accreditation;
- 2 sewerage treatment works funded for upgrades;
- 4 storm water solid waste traps installed with quantity and type monitoring program;
- New Urban ABCD Management Framework developed;
- "Best Practice Guidelines for Controlling Stormwater Pollution from Building Sites" published;
- Pilot Essential Services Commission development compliance program launched.

All The Water Quality Improvement Plan (Drewry et al., 2007) was reviewed in 2013-2014, with good progress modelled across several key areas, such as cane and grazing land management. The urban deliverables were however less successful. Of the 42 activities required to bring urban development in line with standards, while 17 commenced, 19 have not been completed and only 6 were noted as complete.

URBAN WASTE AND LANDFILL

Key urban waste management issues as outlined are predominantly linked to land clearing landfill, sewage collection, treatment and disposal and solid waste disposal. Current conditions indicate that substantial improvements have been made in the management of urban waste especially that linked to sewage collection and treatment. However some regional treatment facilities still require upgrades to new technology sewage treatment facilities, therefore declining water quality associated with sub standard sewage based treatment facilities is occurring.

Landfill issues as with most regional and metropolitan areas continues to be a challenge. Mackay Council operates a best practice landfill and transfer station model with front end recycling and waste diversion such as curbside recycling and resource recovery at all disposal facilities, while processing green waste into landscaping mulch. For the past decade, Council has prioritised the closing of poor performing landfills and replacing these with a regional facility that meets environmental standards, in addition to a progressive remediation program of the former landfills that will cost more than \$40 million over the coming years.

Another regional focus of Councils is waste diversion activities and the recovery of construction and demolition waste (i.e. timber, concrete), which represents up to 30 per cent of the total waste stream. If a successful recovery service was introduced the current landfill would be reduced from approximately 114,000 tonnes per annum to 80,000 tonnes per annum. Construction may begin in 2014, subject to feasibility studies and development approvals.

Long term organic waste options at a local government level have undergone disruption as the Queensland Government withdrew the waste levy, the financial driver for successful organic waste collection and processing programs as evidenced in the southern states where levies make organic waste solutions viable.

Proposed expansion projects at Hay Point will add 110 million tonnes per annum (mtpa) of coal exports in a new coal port terminal, bringing the complex of coal ports (Hay Point 44 mtpa and Dalrymple Bay 85 mtpa) to 239 mtpa, making it the largest coal export port complex in the world, although the Hay Point proposal is currently on hold.

GOVERNANCE

Urban development assessment and approval processes are highly regulated with numerous pieces of legislation and State Planning Policy applied. However, the application and interpretation of the legislation and policy to individual development sites may vary depending on the site and the Local Government and State Government staff assessing the proposal.

Development and planning of urban growth is predominantly under the management of local government policy and planning which is facilitated by the Sustainable Planning Act 2009. In addition the Vegetation Management Act 1999 was amended in 2013 and provides a basis for land planning.

In 2013, the Queensland Government introduced a new approach to state planning policies with a single state planning policy (SPP) to replace the various state planning policies with. The SPP sets out policies about matters of state interest in relation to planning and development, and is a key framework of the government's broader commitment to planning reform. Land development in relation to coastal environments is a key issue within the region and the extent of the area is controlled by local government development requirements within the state government legislative requirements linked to development and vegetation management.

The primary source of surface water resource entitlements in the Mackay Whitsunday area is the water licensing and technical data stored in NRW's Water Entitlements Registration Database (WERD).

Two primary aquifers of importance occur in the Pioneer Valley and Proserpine Low lands. The importance of the groundwater resource in these two areas is underpinned by the designation under the Water Act 2000 (Water Regulation 2002), as Declared Subartesian Areas. For subartesian areas defined in the Water Regulation 2002, a water licence is required to take or interfere with subartesian water, other than for the purposes specified within Schedule 11 of the Water Regulation 2002. Works constructed or installed to take subartesian water in declared subartesian areas are assessable development under the Integrated Planning Act 1997, other than works constructed or installed solely for a purpose mentioned in Schedule 11 of the Water Regulation 2002. Outside of the Pioneer and Proserpine Declared Subartesian Areas regulation of groundwater does not occur. This is generally because the aquifers are of minor significance and discontinuous.

The Water Resource Planning process is the primary tool for sustainable water management, which:

- allows transparent sharing of water to protect environmental and human interests
- makes sure water users' allocations are secure for the life of the Water Resource Plan
- ensures that new allocations will be issued only if they can be sustained without undue environmental harm
- establishes a basis for water allocations in nominated areas to be permanently traded (transferred to another site or use), subject to important safeguards
- protects the health of rivers and underground water reserves.

Many of the decisions potentially impacting upon natural resource condition can be managed by having a more coordinated approach to;

- Land use planning – Including the use of model scheme provisions, standard conditions of consent and benchmarking operational practices to known best management practice;
- Urban population education and skills development associated with;
 - o Natural resource use ie. Water
 - o Use of pesticides and the cumulative effect of pesticide use and subsequent runoff from high level intensive use of pesticides on small land areas.

INDICATORS

In valuing a sustainable urban environment at a time of growth, the Urban Development Institute of Australia (UDIA) developed a system of 'EnviroDevelopment' indicators so developers are able to promote environmental outcomes of projects, which can be used as a benchmark of a sustainable urban values (EnviroDevelopment, 2011). The six signs of sustainability are as follows:

Water	Improved water use through water efficiency mechanisms and/or source substitution such as rainwater and stormwater harvesting;
Energy	Reduced production of greenhouse gases and reduced use of fossil fuels. This is achieved through greater efficiencies in energy useage and use of renewable and non-polluting energy sources such as solar power;
Ecosystems	Protected and enhanced health and sustainability of natural systems and the encouragement of native biodiversity and rehabilitation of degraded sites;
Community	Vibrant, cohesive, sustainable communities with good community design the provision of community facilities and networks; safe, accessible housing and options for reduced use of private motor vehicles;
Materials	Environmentally responsible material usage including reuse of materials, recycled materials and consideration of the life cycle environmental costs of materials;
Waste	Comprehensive waste management procedures and practices to reduce the amount of waste to landfill.

A need has been identified for a guiding document or system which summaries what is meant by implementing best practise urban development, or ecologically sustainable development, such as this example from UDIA's EnviroDevelopment Technical standards. The development of a quick look up guideline for development assessment staff and developers may ensure the right information is gathered from studies to determine the best way to develop a site.

Such a tool has been developed as part of the Healthy Waterways Alliance and ABCD Urban Framework that is a model of best practice for development as follows (note that each council has individual planning schemes independent to this that may incorporate elements best practice for implementation but not every item).

DEVELOPMENT AND ASSESSMENT STAGE

Issues to be addressed at the development assessment phase of a development may lead to an improved knowledge of possible environmental impacts. Improved environmental outcomes can be grouped into themes.

Ecosystem

1. Stormwater
 - i. Stormwater management plan submitted which complies with State Planning Policy 4/10
 - ii. Studies conducted designed to implement Water Sensitive Urban Design
2. Vegetation management
 - i. Comprehensive vegetation study including this identification of threatened species
 - ii. Wildlife corridors identified and retained/ incorporated
 - iii. Bushfire assessment
3. Fauna management
 - i. Fauna study conducted to identify important fauna
4. Water quality
 - i. Collection of baseline water quality data for site
5. Soil management
 - i. Investigation of soils to inform ESCP
 - ii. ESCP submitted for site

Waste Management

- i. Concept plan for waste management storage and collection for the development
- ii. Litter management plan for site

Development site suitability

- i. Assessment conducted on site suitability including physical constraints
- ii. Visual amenity assessment

Transport

- i. Submission of a transport network plan showing vehicle and pedestrian connectivity

Materials sourcing plan

- i. Plan on where materials will be sourced from to ensure materials are sourced from sustainably managed sources

Open space management

- i. Contribute significantly more than statutory required

Landscaping

- i. 90% of plant species are locally native
- ii. No weed species

Energy assessment of site

- i. Lighting
- i. Water use efficiency planning
- i. Grey water re-use
- ii. Rainwater

CONSTRUCTION PHASE

The construction phase of the development has the greatest possible impact of the site and downstream ecosystems. It is at this stage of the development that impacts can be measured and mitigated.

Ecosystem

1. Stormwater
 - i. Stormwater management plan implemented
 - ii. Construction drainage plan implemented for site to separate clean and dirty water
2. Vegetation management
 - i. Clearing completed in stages
 - ii. Cut down vegetation mulched on site for latter use
 - iii. Vegetation retention maximised on site
 - iv. Damage to trees is minimised by machinery
 - v. Vegetation retained on building envelopes maximised
3. Fauna management
 - i. Designated fauna spotter who will relocate fauna from development site
4. Water quality
 - i. Collection of water samples during construction phase to determine compliance with agreed site water quality discharge guidelines
 - ii. Collation of water quality sample data and reporting
5. Soil management
 - i. Topsoil stockpile areas managed and fenced
 - ii. Minimisation of exposed soil areas
 - iii. exposed soil areas progressively stabilised
 - iv. Erosion measures implemented
 - v. Sediment interception measures implemented

Waste management

- i. Collection for construction waste centralised and contained
- ii. Litter management plan for site – construction phase implemented

Development timing and staging

- i. Consideration of wet season
- ii. Earthwork construction and development staging

SITE CLOSURE AND POST CONSTRUCTION

The rapid closure of a development site can minimise the risk of off-site impacts. It is tempting to developers to cut corners in the closure phase to save money. Equally, developers want to produce a good saleable product which they can maximise their profits.

Ecosystem

1. Stormwater
 - i. All stormwater drainage paths vegetated
2. Vegetation management
 - i. Landscaping completed
 - ii. Protection measures in place to ensure retained vegetation stay
3. Fauna management
 - i. Implementation of possum boxes?
4. Water quality
 - i. Collection of baseline water quality data for site after construction to ensure compliance with agreed guidelines
5. Soil management
 - i. All exposed soil now vegetated

Waste management

- i. Waste management storage and collection for the development completed and functional
- ii. Kerbside recycling and green waste recycling
- iii. Litter management and interception devices installed

Transport

- i. Public transport is close by and available

Open space

- i. Landscaping and turfing

Reporting and evaluation

- i. A final report is developed to evaluate the compliance of the development against the development approval and environmental outcomes originally sought

The key indicator to managing natural resource condition linked to urban growth is associated with population settlement plans and planning schemes developed by local councils. By managing population growth, plans can better predict the likely impacts on natural resource condition. In having a settlement program, planners have the ability to reduce the development of quality agricultural land into housing and industrial developments and also plan to manage population waste.

Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software is the industry standard predictive modelling software throughout Australia, and is being used by Mackay Council to determine appropriate stormwater management measures. Developments that are considered high risk are to demonstrate the achievement of council's water quality.

REFERENCES

Australian Bureau of Statistics (ABS), 2011, Annual Census Quickstats – Mackay, Whitsunday, Isaac. Available <http://www.abs.gov.au/websitedbs/censushome.nsf/home/quickstats?opendocument&navpos=220> Last accessed 14 August 2014.

Australian Government, 2012, Australian Bureau of Statistics, Regional Population Growth Australia 2011-2012, available at <http://www.abs.gov.au/ausstats/abs@.nsf/Products/3218.0~2011-12~Main+Features~Main+Features?OpenDocument> Last accessed 24 April 2013

Department of Local Government and Planning (DLGP), Queensland Government (2012) Mackay, Isaac and Whitsunday Regional Plan, Brisbane, available at <http://www.dsdp.qld.gov.au/resources/plan/miw/miw-regional-plan.pdf> Last accessed 22 October 2013.

Department of Primary Industry (DPI), 1993, Overview of Water Resources and Related Issues: the Mackay-Whitsunday Region, DPI Publishing, Queensland Government, Brisbane.

Drewry, J. Higham, W. & Mitchell, C. 2007. Water Quality Improvement Plan. Draft Regional Report. Mackay Whitsunday Natural Resource Management Group. <http://reefcatchments.com.au/files/2013/02/MWNRM-WQIP-total-report-2008.pdf> Last accessed 14 April 2014.

Landtrak Corporation, n.d., Bowen Basin Infrastructure, available at <http://www.landtrakcorp.com/australian-mining-landscape/rockhampton/> Last accessed 10 January 2014.

Mackay Conservation Group, 2013, Dudgeon Point coal terminal extension: Petition to Queensland Coordinator General, online report, available at http://www.mackayconservationgroup.org.au/dudgeon_point_extension_petition Last accessed 2 August 2014.

Mackay Sugar, 2012, Annual Report. Available online at http://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&ved=0CDwQFjAC&url=http%3A%2F%2Fwww.mackaysugar.com.au%2Fnews%2FDocuments%2FMKS4485_AR_2012_C31_FINAL_WEB.pdf&ei=6vcCUtf3IM-XkgWB74DYDA&usg=AFQjCNENA00Mlpn1vSXbuhRldSCug_c_xQ&bvm=bv.50310824,d.dGI Last accessed 8 August 2013.

Mackay Whitsunday Regional Economic Development Corporation (REDC) (2012) Regional Report Card, Mackay Isaac Whitsunday 2006-2011, available online at <http://www.mwredc.org.au/index.php/publications/regional-report-card>, last accessed 2 August 2014.

Mackay Whitsunday Regional Economic Development Corporation (REDC) (2013) Mackay Economic Profile, <http://www.mwredc.org.au/index.php/publications/economic-profile>

Office of Economic and Statistical Research, 2012a, Residential land development activity profile, December quarter 2012, Available at <http://www.oesr.qld.gov.au/products/profiles/res-land-dwelling-activity-reg-plan/res-land-dwelling-activity-miw.pdf> Last accessed 2 April 2013.

Office of Economic and Statistical Research, 2012b, Mackay, Whitsunday Isaac Regional Profile. <http://statistics.oesr.qld.gov.au/qld-regional-profiles>

Queensland Government (2012) Water Monitoring Data Portal, Available online at <http://watermonitoring.dnrm.qld.gov.au/host.htm>

Queensland Government (2010) Water Resource (Whitsunday) Plan 2010, available at <https://www.legislation.qld.gov.au/LEGISLTN/CURRENT/W/WaterReWhP10.pdf> Last accessed 2 August 2014.

Regional Development Australia (RDA), 2013, Regional Roadmap Mackay-Whitsunday-Isaac, available at http://www.rdamackaywhitsunday.org.au/images/stories/MIW_Regional_Roadmap_Edition_2012-13_double_page.pdf, last accessed 8 August 2013.

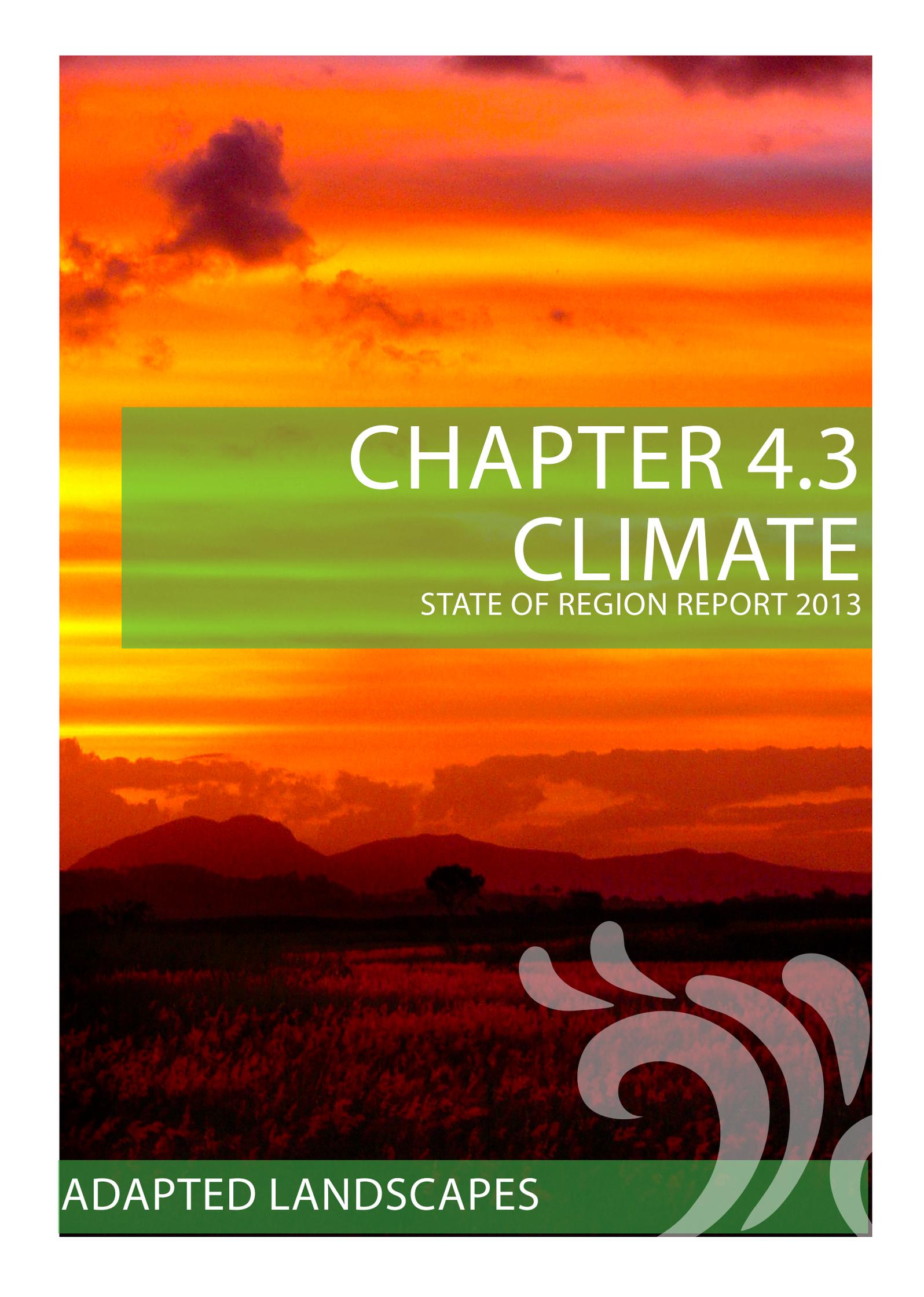
Richardson, D. and Denniss, R. (2011) Mining the Truth, the Rhetoric and Reality of the Commodities Boom. The Australian Institute, Institute Paper No 7. Available at <https://www.tai.org.au/index.php?q=node%2F19&pubid=913&act=display>, last accessed 8 August 2013.

Rolfe, J., Miles, B., Lockie, S., and Ivanova, G. (2007) Lessons from the Social and Economic Impacts of the Mining Boom in the Bowen Basin 2004-2006, *Australasian Journal of Regional Studies*, Vol. 13, No. 2

Rohde, K., Masters, B., Brodie, J., Faithful, J., Noble, R., Carroll, C., Shaw, C. Dekker, A. and Brando, V., 2006. Fresh and Marine Water quality in the Mackay Whitsunday Region, 2004/2005. Volume 1 Main Report. Volume 2, Mackay Whitsunday Natural Resource Management Group, Mackay, Australia, Available at <http://nrmonline.nrm.gov.au/catalog/mql:1538> Last accessed 2 August 2014.

Urban Development Institute of Australia, 2011, *EnviroDevelopment Technical Standards; Living for the Future Today*, National Version 1.0, available at <http://www.envirodevelopment.com.au> Last accessed 14 August 2014.

Wagner, C., 1996, *Mackay Water Resources Strategy: Working Paper, Issue 5*, Mackay Regional Development Bureau, Mackay.



CHAPTER 4.3

CLIMATE

STATE OF REGION REPORT 2013

ADAPTED LANDSCAPES

SUMMARY

Australia is historically known as a continent with high natural climate variability. Climate change impacts are evident with increasing annual maximum and minimum temperatures, number of hot days and reduced rainfall in the southern, eastern and south western parts of the continent.

The Mackay Whitsunday Isaac (MWI) region has high natural climate variability and only short-term historical records, which makes it difficult to discern climate change. However, there is evidence that there has been an increase in annual maximum and minimum temperatures that is unlikely to reverse. A drying trend has occurred south of Cairns for the last 30 years, which includes decreasing rainfall in MWI region.

Climate change and climate variability is a highly topical, global issue that will take the concerted efforts of communities, industries and governments to decarbonise the economy and mitigate and adapt to the inevitable effects of a changing climate. Maintenance, expansion and preservation of the integrity of natural carbon stores will assist in mitigation as well as continue to provide other ecosystem services vital for sustaining communities.

VALUES AND SERVICES

The climate is influenced by global scale processes that are dominated by interactions between the ocean and atmosphere (IPCC 2007a). In the Australian and local context there are a number of atmospheric and oceanic phenomena operating on varying time scales that influence local and regional weather and longer term climatic patterns. These include the Southern Annular Mode (SAM), El Nino Southern Oscillation (ENSO), the Pacific Decadal Oscillation (PDO), the Madden Julian Oscillation (MJO) and the Indian Ocean Dipole (IOD). For further information on these phenomena refer to the Australian Bureau of Meteorology (<http://www.bom.gov.au/watl/about-weather-and-climate/australian-climate-influences.shtml>).

The current climate in the Mackay Whitsunday Isaac region influences the complexity and condition of natural assets and provides an enviable lifestyle for the community that live here. The region has unique values that range from mountain ranges to coastal and marine communities that support climatically distinct and unique biodiversity values. It is also adjacent to the World Heritage listed Great Barrier Reef that is renowned internationally for its ecological importance and the beauty of its seascapes and landscapes (Johnson and Marshall, 2007).

The natural assets within the region have high biodiversity value and also provide natural stores for carbon in terrestrial vegetation, soils, wetlands and coastal and marine communities. Carbon stocks in different ecosystems have not been estimated on a national, state or regional scale to date; however global estimates of carbon stores in different ecosystems (in plants and soil) vary considerably. Tropical rainforests tend to have equal amounts of carbon stored in plants and soil; however wetlands and coastal and marine communities may store up to 10 times more carbon in sediments than in above-ground biomass (Pidgeon 2009). Furthermore, carbon stored in marine communities is stored over longer time scales than that in above-ground biomass as sediments will accrete vertically in response to rising sea levels (McLeod et al. 2011).

Natural assets can also assist in the mitigation of damage from extreme weather events and can be more cost effective than using only structural approaches (Mangi et al. 2011, Queensland Government 2012a). Coastal and marine communities absorb the energy of storm-driven waves and wind and can reduce storm surge water levels by slowing the flow of water and reducing surface waves (McIvor et. al 2012). Mangrove communities therefore play a vital role in protecting coastal natural and community assets.

In response to the cyclones and flooding in 2010/11 the Queensland Government initiated a synthesis of literature to review the role of natural ecosystems to mitigate the impacts of natural hazards (Queensland Government 2012a). General findings from this review are summarised below:

- Vegetation interventions can reduce flooding; however local studies are essential to understand the catchment context;
- There is a clear link between riparian vegetation, reduced flood velocity, changed downstream flood peak and increased upstream flooding. The increased localised flooding spreads the flood flow, removing systemic energy and reducing flood-velocity damage;
- There is clear evidence that coastal vegetation systems such as mangroves and saltmarsh can attenuate storm surges; however they need to be significantly broad to attenuate storm surge;
- Trees, especially younger but well established, strong and well-managed trees, can trap debris and reduce wind energy to limit cyclone damage.

PRESSURES

The Mackay, Whitsunday and Isaac local government areas have experienced large population growth, averaging 2.5% annual growth from 2007 to 2011 (Queensland Government 2012b). The majority of growth has been around Mackay (Queensland Government 2012c) as it is a major support centre for extractive industries. Increased population growth is directly related to higher energy usage, rising CO₂ levels in the atmosphere and pressures on natural resources from increased human activity (Crutzen and Steffen 2003). Natural hazards such as bushfires, flooding and cyclones are a part of the environmental history for Australia and Queensland and will continue into the future. Not all natural hazards are disastrous, they only become disasters when they impact on vulnerable communities or environments.

An area of concern for this region is much of the urban population and ongoing development is sited in the floodplain and coastal zone, putting increasing pressure on coastal and marine natural assets, as well as altering the natural hydrology and drainage patterns. These areas are also likely to be the most affected by climate change (IPCC 2012). There are a number of strategies that can be implemented via statutory and land use planning processes to reduce the vulnerability and risk to communities (e.g. Palazzo and Steiner 2011) as well as improving energy efficiencies and impacts on the natural environment.

Over the relatively short span of 250 years, and for the first time in human history, we have changed and are continuing to change the composition of the atmosphere on a global scale.

The region supports productive agriculture including sugarcane, horticulture and extensive grazing. Shifts in the climate have potential consequences and/ or opportunities for productive agriculture through increased intensity of extreme weather events, biosecurity risks, increased solar radiation and higher CO₂ levels. Direct greenhouse gas emissions from the agriculture, forestry and fishing sectors contributed 18.8% of the total national greenhouse gas emissions in 2009/2010 (Commonwealth of Australia 2012) with the largest quantity of net emissions attributed to Queensland. In 2009 agricultural emissions were 17% of Queensland total emissions with nearly 80% accounted for through enteric fermentation from cattle and sheep (Queensland Government 2011). There are potentially a large number of opportunities for these industries in carbon sequestration and emissions mitigation in the future; however, there are still large knowledge gaps in quantifying net sinks and sources for different agricultural commodities.

CONDITIONS AND TRENDS

“Over the relatively short span of 250 years, and for the first time in human history, we have changed and are continuing to change the composition of the atmosphere on a global scale. Levels of carbon dioxide, the most important greenhouse gas have increased by around 39% above pre-industrial levels, principally due to burning fossil fuels. This has led to a clearly defined trend of increasing average global temperatures, and there is growing evidence of consequent changes in the complex interlinked atmospheric, oceanic and terrestrial processes that shape climate at a global, continental and regional scale.

From 1970-2010, Australia’s mean daily temperature rose in almost all parts of the country... The 13 year period from April 1997 to March 2010 was characterised by severe rainfall deficiencies that covered much of south-western and south Australia. For many places, the severity and duration of drought were unprecedented, with profound environmental, social and economic implications. Then in the 12 months from March 2010, large parts of the continent experienced above-average rainfall associated with an extremely strong La-Niña event. Most notably, eastern Australia received widespread record breaking rains, with associated loss of life and massive damage to agriculture, homes and infrastructure” Australia State of the Environment 2011; 16

Climate change is a global issue and is accepted by the majority of scientists to be caused primarily by human activity, primarily through burning of fossil fuel and land clearing. Increasing levels of greenhouse gases (carbon dioxide, methane and nitrous oxide) in the atmosphere is interfering with the Earth’s energy balance. Global temperature increases are locked in at a minimum of 2oC even if emissions ceased immediately due to the lag time between atmosphere and ocean interactions and impacts on the global climate (IPCC 2007b).

The 2007 IPCC reports document direct observations in increases of global air and ocean temperatures, widespread melting of snow and ice and rising global average sea level (IPCC 2007b). The Great Barrier Reef ecosystem is considered highly vulnerable to climate change, as a result of increasing air and sea temperatures, ocean acidification, nutrient enrichment, altered light levels, more extreme weather events, changes to ocean circulation and sea level rise (Marshall and Johnson 2007). Johnson and Marshall (2007) also document the changes already evident in different ecosystems within the GBR.

GHG concentrations have continued to rise since the 2007 IPCC reports (Figure 1). There is an abundance of literature documenting additional impacts on global ecosystems and further loss of ice sheets since 2007. These reports will be synthesised as part of the IPCC's Fifth Assessment Report (AR5) due to be completed in 2013/2014. Globally, there has also been a large increase over the last decade in the number of extreme weather events. Recent analyses of the increased incidence of extreme weather events indicate that there is strong evidence that heatwaves and precipitation extremes are strongly linked to human influence on the climate (Coumou and Rahmstorf 2012).

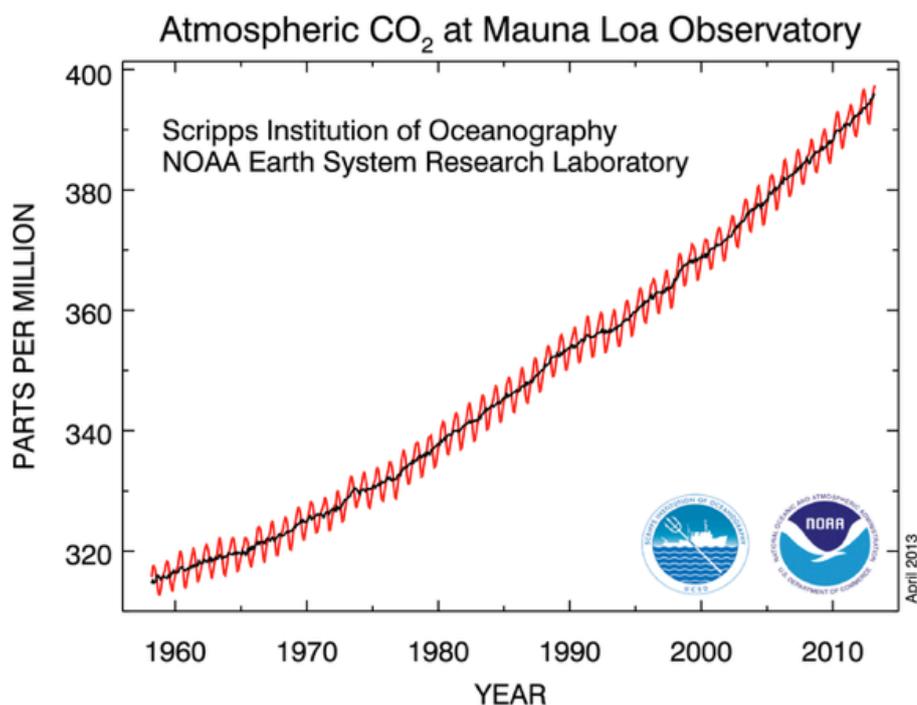


Figure 1: Monthly mean atmospheric CO₂ measured at the Mauna Loa Observatory, Hawaii. Mauna Loa constitutes the longest record of direct measurement of CO₂ in the atmosphere, Source: http://www.esrl.noaa.gov/gmd/ccgg/trends/mlo.html#mlo_growth, accessed 30 April 2013.

Internationally, Australia is recognised as a continent with high natural climate variability. Analysis of historical climate data for Queensland has shown that the Mackay Whitsunday Isaac region has much higher natural climate variability that makes it difficult to discern natural variability from climate change (Queensland Government 2009).

The high variability in annual and seasonal rainfall and distinct climatic zones within the Mackay Whitsunday Isaac region is demonstrated by rainfall data from selected weather stations (Figures 2 and 3).

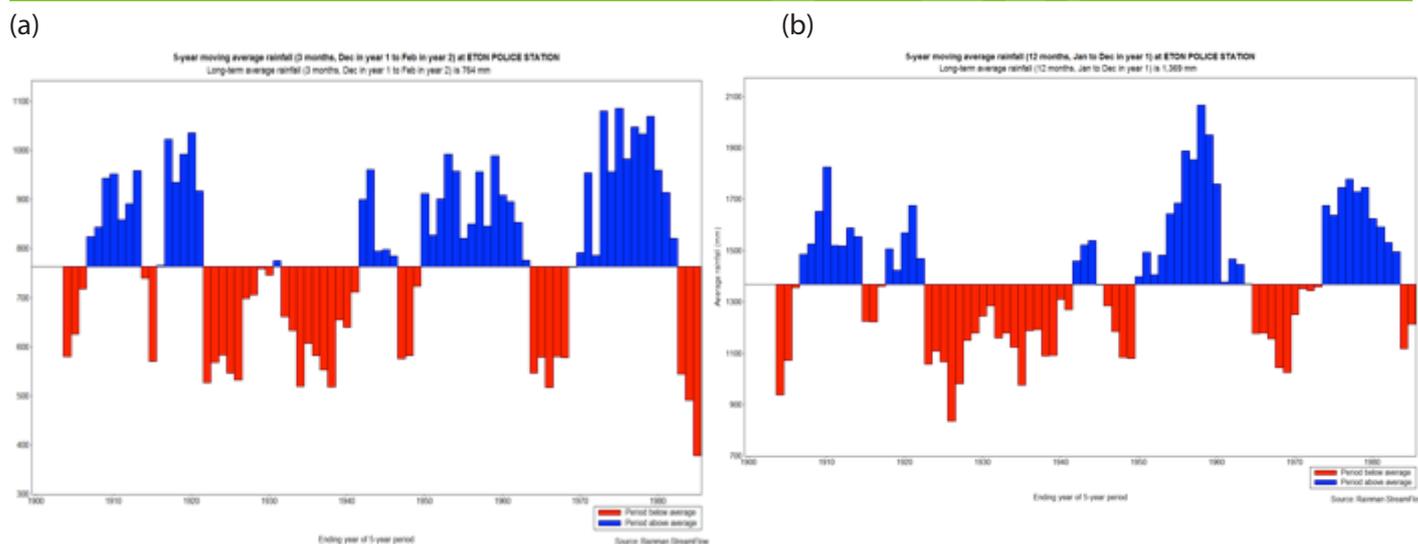


Figure 2: Five-year rolling average for historical rainfall from the Eton police station for a) December to February (summer) and b) total annual rainfall since 1900. Data source: Rainman

Eton is a drier part of the region with average annual rainfall of around 1380mm per annum. Historical records (since 1900) show the seasonal variability that has been experienced in summer months (Figure 2a) with distinctly dry summers (red areas) from the early 1920's to the early 1940's and wetter summers (blue areas) from the early 1950's to early 1960's and 1970's to early 1980's. Total annual rainfall has also been highly variable with distinctly drier periods (Figure 2b) from the early 1920's to the early 1940's.

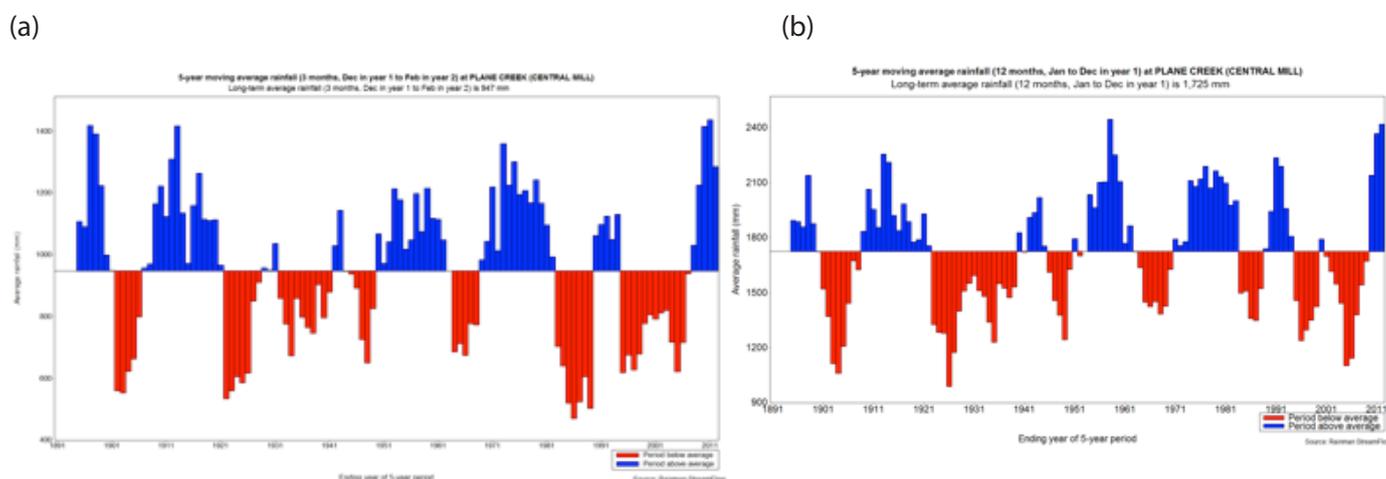


Figure 3: Five-year rolling average for historical rainfall from the Plane Creek Mill for a) December to February (summer) and b) total annual rainfall since the late 1890's. Data source: Rainman

Plane Creek (Sarina) has an average annual rainfall of around 1700 mm per annum and historical records also show high variability in summer months (Figure 3a) and in annual rainfall (Figure 3b). The periods where drier summers have been experienced and total annual rainfall lower than respective averages are consistent between the two climatic zones.

Changes to the current climate of the Mackay Whitsunday Isaac NRM region is inevitable as emissions from burning of fossil fuels and land clearing have not reduced at a global scale (see Figure 1). Despite the short-term nature of climate data in the Australian, state and local context there are some distinct trends that have arisen, particularly in the latter part of the 20th century. Reports prepared by the Queensland Climate Change Centre of Excellence (Queensland Government 2008, 2009) examined historical climate data and the projected impacts of climate change on the Whitsunday, Hinterland and Mackay region. Key findings are outlined below.

- Annual mean surface temperatures increased by around 1.1oC (from 1950-1970) which is significantly larger than the Australian annual average increase of 0.8oC and annual mean temperature increased 0.3oC over the period 1999-2009
- Maximum temperatures (annual average) increased by 0.9oC and minimum temperatures increased by 1.4oC from 1950-2007
- Projections indicate an increase in annual mean temperature of up to 4.2oC by 2070
- By 2070, Mackay may have 12 times the number of days over 35oC than is currently experienced
- Average annual rainfall fell nearly 14% (1999-2009) compared with the previous 30 years. This was, however, generally consistent with natural variability experienced over the last 110 years and does not take into account the high rainfall experienced in 2010-2011
- Climate models projected a range of rainfall changes from +17% to -35% by 2070
- Climate projections indicate annual potential evaporation could increase by 7-15% by 2070
- The 1-in-100-year storm tide event is projected to increase by 36 cm in Mackay and 31 cm at Airlie Beach if certain conditions eventuate. These conditions are a 30 cm sea-level rise, a 10 per cent increase in cyclone intensity and frequency, as well as a 130 km shift southwards in cyclone tracks.

Recent research funded by the Sugar Research Development Corporation has examined the projected impacts of climate change on the Australian sugar industry. Findings to date are contrary with previous projections, concluding that there is insufficient evidence for major shifts in rainfall patterns for the Mackay sugar industry (Everingham et. al 2013).

Increasing maximum and minimum temperatures trends are also evident from the five-year rolling averages for temperature anomalies (departure from the long-term average) from the Australian Climate Change Observations Reference Network Mackay site (Figure 4).

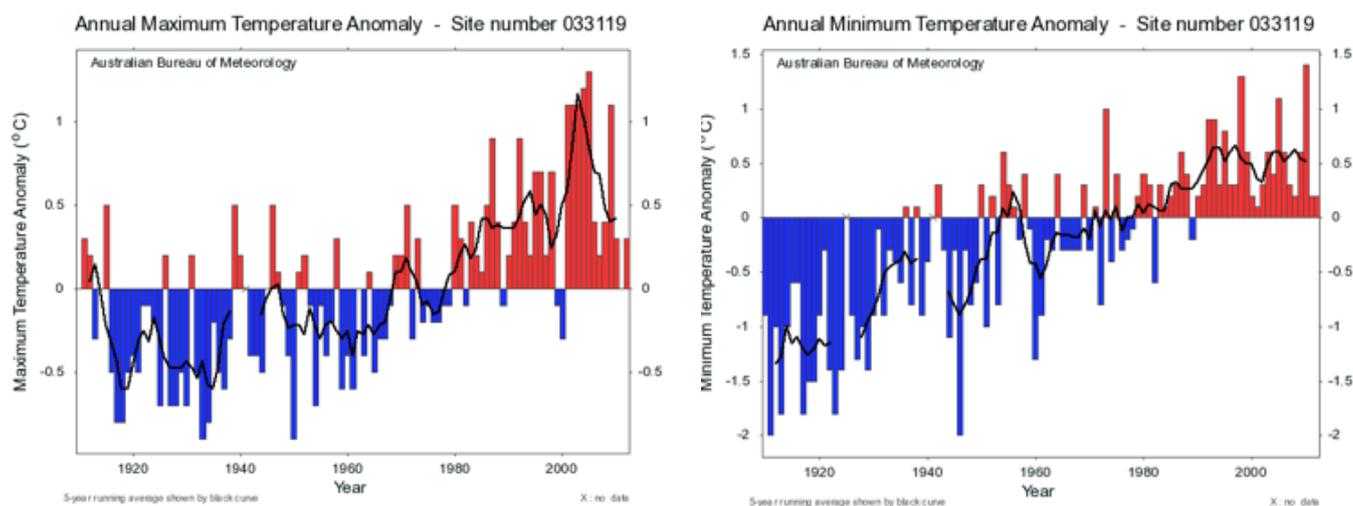


Figure 4: Historical maximum and minimum temperature anomalies from the Mackay Australian Climate Change Observations Reference Network (source: <http://www.bom.gov.au/cgi-bin/climate/hqsites/> accessed 16 April 2013)

Updated climate change projections are currently being developed for the Mackay Whitsunday Isaac NRM Region and are expected to be available in mid-2013. A recent summary of climate change impacts on a national basis (CSIRO/ BOM 2012) state that:

- Global temperatures were the warmest on record in 2010
- Australia experienced record rainfalls and the coolest temperatures since 2001 due to a very strong La Niña event in 2010 and 2011
- Concentrations of long-lived greenhouse gases in the atmosphere reached a new high in 2011
- Australian temperatures are projected to increase in coming decades
- Rising CO₂ emissions from the burning of fossil fuels has affected global temperature much more than natural climate variability during the past century.

GOVERNANCE

The United Nations Framework Convention on Climate Change is an international environmental treaty that came into force in 1994 with the ultimate objective of stabilising greenhouse gas concentrations in the atmosphere. Through the Convention the Kyoto Protocol was developed as a legally binding mechanism where countries ratifying the Protocol, committed to reducing their emissions by an average of 5% by 2012 against 1990 levels. Australia ratified the Kyoto Protocol in 2008. The Ad Hoc Working Group on the Durban Platform for Enhanced Action was established to develop a protocol as a follow-up to Kyoto by no later than 2015.

The Australian Government released the Clean Energy Plan on 10 July 2011 which outlines a number of mechanisms to assist in meeting agreed international targets and support Australian communities and businesses in transitioning to a low carbon economy. A long-term target of 80% reduced emissions from 2000 levels by 2050 has also been adopted by the Australian Government.

The Land Sector Package of the Clean Energy Plan has committed to action on the land to improve carbon sequestration and mitigation activities. These programs are:

- Biodiversity Fund. Support to plant, restore, manage and enhance biodiverse carbon stores
- Carbon Farming Futures. Support for research, extension and demonstration of new and innovative practices
- Regional NRM Planning. Funds to regional NRM Groups and supporting research institutions to assist in identifying in the landscape where adaptation and mitigation activities should be undertaken

The Carbon Farming Initiative (CFI) is a carbon offsets scheme that was passed by Parliament on 23 August 2011 and received royal assent on 15 September 2011. The CFI allows farmers and land managers to earn carbon credits by storing carbon or reducing greenhouse gas emissions on the land. To participate in the CFI there must be an approved offsets methodology; methodologies approved to date applicable to the MWI NRM region are; environmental plantings, reforestation and afforestation. These methodologies can be accessed through <http://www.climatechange.gov.au/reducing-carbon/carbon-farming-initiative/methodologies/methodology-determinations>

Key areas that will influence climate change adaptation and mitigation for the Mackay Whitsunday Isaac region include:

- Local government, state and federal government policy that recognises the role and maintenance of marine and terrestrial natural assets in storing carbon and mitigating the effects of extreme weather events
- Local and state planning policies recognise and limit development in potential risk areas
- Policies and strategies in place to relocate vulnerable and at risk infrastructure/ human settlements
- An increase in land area for vulnerable/ at risk ecosystems (e.g. saltmarsh, mangroves, coastal vegetation)
- An increase in CFI offset methodologies suited to the MWI region (e.g. reduced emissions from fertilisers)
- Community acceptance and commitment in their role to assist in climate change mitigation and adaptation

INDICATORS

Government policy reflects the need to protect natural marine and terrestrial ecosystems to maintain and increase carbon storage and reduce impacts from extreme weather events. The region's community acknowledges and supports action at all levels to reduce the impacts of human activity, promotes and uses energy derived from renewable resources and the resilience of the natural landscape is improved.

REFERENCES

- Commonwealth of Australia 2012. Australian National Greenhouse Accounts; National Inventory by Economic Sector 2009-2010. Department of Climate Change and Energy Efficiency: <http://www.climatechange.gov.au/emissions>. Accessed 14 March 2013.
- Coumou, D. and Rahmstorf, S. 2012. A decade of weather extremes. *Nature Climate Change* 2, 491-496.
- Crutzen, P.J. and Steffen, W. 2003. How long have we been in the Anthropocene Era? *Climatic Change*, 61, 251-257.
- CSIRO/ BOM 2012. State of the Climate 2012. <http://www.csiro.au/Outcomes/Climate/Understanding/State-of-the-Climate-2012.aspx>
- Everingham, Y., Sexton, J. and Timbal, B. 2013. Downscaled rainfall projections for the Burdekin, Mackay and NSW. *Proc Aust Soc Sugar Cane Technol* Vol 35
- IPCC, 2007a: Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- IPCC, 2007b: *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, Pachauri, R. K. and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.
- IPCC, 2012: Summary for Policy Makers. In: *Managing the Risks of Extreme Events and Disasters to Advance Climate Adaptation* [Field, C. Barros, B.V., Stocker, T.F., Qin, D., Dokken, D.J., Ebi, K.L., Mastrandrea, M.D., Mach, K.J., Platner, G.K., Allen, S.K., Tignor, M. and Midgley, P.M. (eds.)] A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, USA, pp. 1-19.
- Johnson, J. E. and Marshall, P.A. (eds) 2007. *Climate Change and the Great Barrier Reef*. Great Barrier Reef Marine Park Authority and Australian Greenhouse Office, Australia
- Marshall, P.A. and Johnson, J. E. 2007. Chapter 24 The Great Barrier Reef and Climate Change: vulnerability and management implications. In *Climate Change and the Great Barrier Reef*, eds. Johnson J. E and Marshall P.A. Great Barrier Reef Marine Park Authority and Australian Greenhouse Office, Australia
- Mcleod, E., Chmura, G.L., Bouillon, S., Salm, R., Björk, M., Duarte, C. M., Lovelock, C. E., Schlesinger, W. E. and Silliman B. R. 2011. A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequestering CO₂. *Frontiers in Ecology and the Environment* 9: 552-560.
- Mangi, S. C., Davis, C. E., Payne, L. A. Austen, M. C., Simmonds, D., Beaumont, N. J. and Smyth, T. 2011. Valuing the regulatory services provided by marine ecosystems. *Environmetrics* 22:686-698
- Mclvor A, Spencer T, Moller I and Spalding M. 2012. Storm surge reduction by mangroves. *Natural Coastal Protection Series: Report 2*. <http://conserveonline.org/workspaces/naturalcoastalprotection/documents/storm-surge-reduction-by-mangroves>. Accessed 9 April 2013

Palazzo, D. and Steiner, F. 2011. Urban Ecological Design: A process for Regenerative Places. Island Press 300p.

Pidgeon, E. 2009. Carbon Sequestration by Coastal Marine Habitats: Important Missing Sinks. In: Laoley, D. & Grimsditch, G. (eds). 2009. The management of natural coastal carbon sinks. IUCN, Gland, Switzerland. 53 pp.

Queensland Government 2008. Potential Effects of Climate Change on Water Resources in the Mackay-Whitsunday Region. Prepared by the Queensland Climate Change Centre of Excellence for the Department of Natural Resources and Water. Mackay-Whitsunday Water Supply Strategy December 2008.

Queensland Government 2009. Climate Change in the Whitsunday, Hinterland and Mackay region. WHM2 Climate Q: toward a greener Queensland. <http://www.ehp.qld.gov.au/climatechange/regional-summaries.html>.

Queensland Government 2012a. Natural assets for flood and cyclone resilience: synthesis of scientific evidence on the role of natural assets to reduce the human impacts of floods and cyclones. Department of Environment and Heritage Protection.

Queensland Government 2012b. Population and Dwelling Profile Mackay, Isaac and Whitsunday (MIW). Queensland Treasury and Trade www.oesr.qld.gov.au

Queensland Government 2012c. Population and Dwelling Profile Mackay Regional Council. Queensland Treasury and Trade www.oesr.qld.gov.au

Queensland Government 2011. Queensland's emissions profile: National Greenhouse Gas Inventory. Information Paper August 2011. <http://www.ehp.qld.gov.au/climatechange/pdf/qld-emmission-profile.pdf>