Department of Science, Information Technology and Innovation

Land Use Summary 1999–2016

for the Mackay Whitsunday NRM Region

Remote Sensing Centre

September 2017

Queensland Government

Prepared by

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Use the Queensland Spatial Catalogue (QSpatial) to access land use datasets. Search for "land use mapping" in the *search term* field, after restricting your search to “Planning Cadastre” in the *categories* field. Metadata is also available from QSpatial.

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Acknowledgements

The Land use of Mackay Whitsunday NRM region is a product of the Australian Collaborative Land Use and Management Program (ACLUMP). ACLUMP, of which QLUMP is a partner, promotes the development of consistent information on land use and land management practices. This consortium of Australian, state and territory government partners is critical to providing nationally consistent land use mapping at both catchment and national scale, underpinned by common technical standards including an agreed national land use classification. ACLUMP provides a national land use data directory and the maintenance of land use datasets on Australian and state government data repositories. More information on ACLUMP available at www.abares.gov.au/landuse. QLUMP acknowledges the assistance of the Australian Government Department of Agriculture and Water Resources in providing funding to complete this work.

Executive summary

The Queensland Land Use Mapping Program (QLUMP) has updated the land use mapping in the Mackay Whitsunday Natural Resource Management (NRM) region to 2016. QLUMP has revised the 1999 and 2009 land use datasets and derived land use change mapping for 1999–2009, 2009–2016 and 1999–2016. Land use is classified under the Australian Land Use and Management (ALUM) classification.

Grazing native vegetation was the dominant land use class in the Mackay Whitsunday NRM region and accounted for 31% in both 1999 and 2009, and 32% in 2016. The remaining land use in Mackay Whitsunday NRM region was dominated by: *other minimal use* (which includes *residual native cover* at tertiary level)—accounting for 19% of the region in 1999, 18% in 2009 and 17% in 2016; and *irrigated cropping – sugar* which accounted for 18% in 1999, 17% in 2009 and 16% in 2016.

Analysis of the **net** change by primary land use class between 1999 and 2016 shows:

- *Conservation and natural environments* increased by 2% or 5265ha for 1999–2009 and a further 4% or 11,999ha for 2009–2016.
- *Production from relatively natural environments* decreased by 2% or 8240ha for 1999–2009 and a further 1% or 3500ha for 2009–2016.
- *Production from dryland agriculture and plantations* increased by 6262ha for 1999–2009, before decreasing by 5809ha for 2009–2016
- *Production from irrigated agriculture and plantations* decreased by 5% or 7994ha for 1999–2009 and a further 3% or 4512ha for 2009–2016.
- *Intensive uses* increased in each era—15% or 4878ha in 1999–2009 and 5% or 1823ha in 2009–2016.
- *Water* decreased by 170ha for 1999–2009 and 1ha in 2009–2016.

The ‘spike’ observed in the 2009 land use map within the *production from dryland agriculture and plantations* primary class was associated with the rise (and subsequent decline) of the *plantation forests* at secondary level. The establishment of new teak plantations (in the north of the region) observed in the 2009 land use map, and their subsequent degradation (or abandonment) has seen the 2016 land use largely return to its original 1999 uses.

Irrigated cropping – sugar decreased by 6% or 10,652ha for 1999–2009 and then a further 2% or 3139ha for 2009–2016.

Land use change mapping products were compiled for the three eras (1999, 2009 and 2016) at the secondary level of the ALUM classification. The total area of land use change observed in each epoch was:

- 1999–2009: 44,873ha (4.8% of the region). Of this, 21,241ha (47% of the total change) is mapped as an increase in land use intensity, whilst 23,632ha (53%) is a decrease.
- 2009–2016: 46,473ha (5% of the region). Of this, 12,206ha (26% of the total change) is mapped as an increase in land use intensity, whilst 34,267ha (74%) is a decrease.
- 1999–2016: 74,969ha (8% of the region). Of this, 24,357ha (32% of the total change) is mapped as an increase in land use intensity, whilst 50,611ha (68%) is a decrease.

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Contents

List of tables

List of figures

Introduction

The Queensland Land Use Mapping Program (QLUMP) is a partner of the Australian Collaborative Land Use and Management Program (ACLUMP) coordinated by the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). ACLUMP promotes nationally consistent land use information.

Land use and land management practices have a profound impact on Queensland's natural resources, agricultural production and the environment. The availability of consistent and reliable spatial information regarding land use is critical for sustainable natural resource management by Australian, Queensland and local governments, Natural Resource Management (NRM) regional groups, industry groups, community groups and land managers.

QLUMP has updated the land use mapping in the Mackay Whitsunday NRM region to 2016. This report presents and summarises land use mapping including:

- a revised 1999 and 2009 land use dataset including improvements and corrections to the originals
- a 2016 land use dataset
- land use change dataset between 1999–2009, 2009–2016 and 1999–2016
- summary statistics derived from the above spatial datasets
- results of the accuracy assessment of the 2016 land use dataset.

Methodology

Mapping is compiled in accordance with ACLUMP guidelines. The methodology is accurate, reliable, cost–effective, and makes best use of available databases, satellite imagery and aerial photography.

The Australian Land Use and Management (ALUM) classification—version 8 (Figure 1, page 7) shows five primary classes, identified in order of increasing levels of intervention or potential impact of land use; water is included separately as a sixth primary class. Within the primary classes is a three-level hierarchical structure. Primary, secondary and tertiary levels broadly describe the potential degree of modification or impact of land use on the landscape.

Primary and secondary levels relate to land use (i.e. the principal use of the land in terms of the objectives of the land manager). The tertiary level includes data on commodities or infrastructure.

The secondary level in the three-level hierarchical structure is the minimum attribution level for land use mapping in Queensland—note that as an exception QLUMP consistently maps the land use classes of sugar and cotton (dryland and irrigated) to tertiary level. Under version 8 we have also mapped all intensive animal husbandry and residential land use classes to tertiary level.

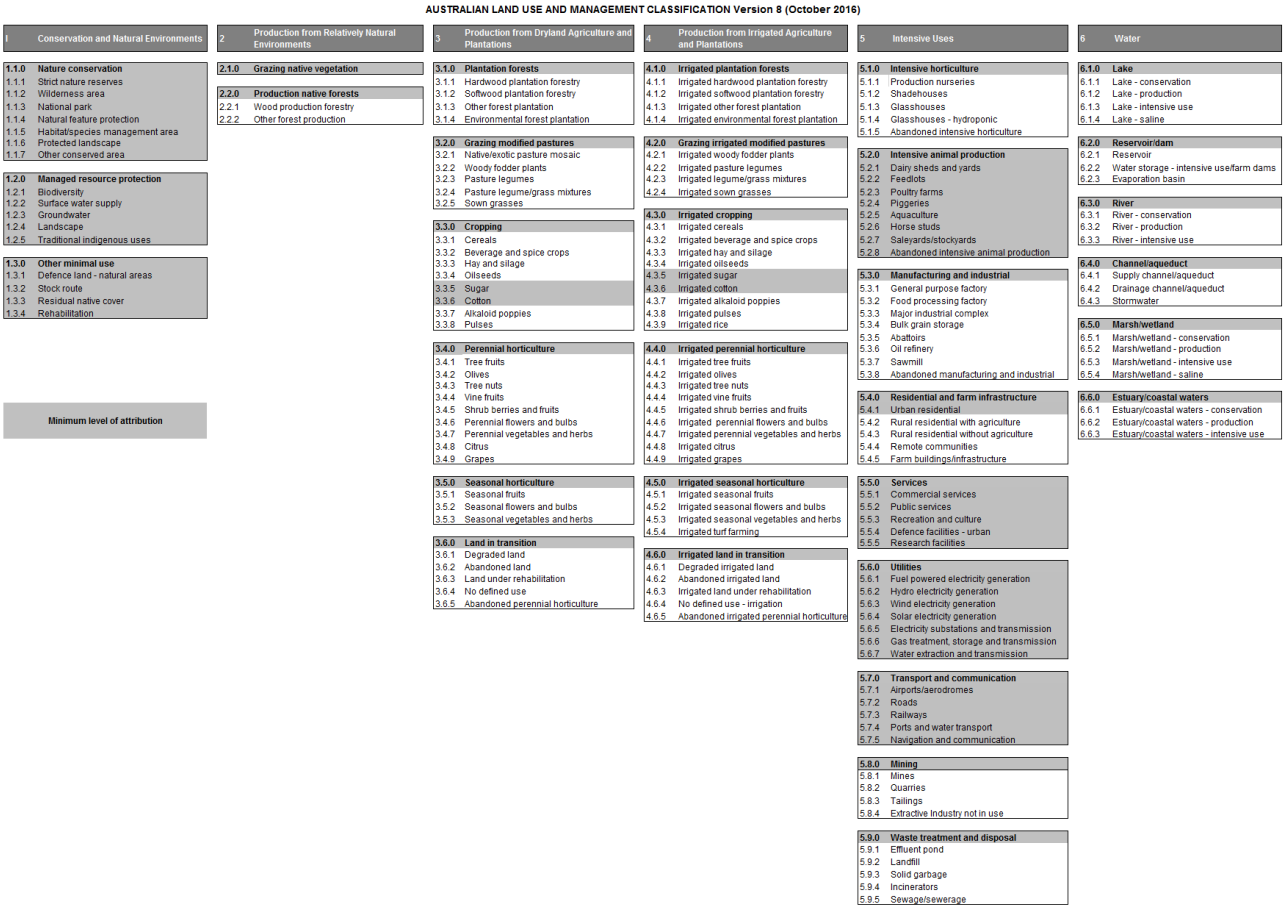
Version 8 of the ALUM classification includes the option to make commodity and land management practice observations. Where possible (generally with the benefit of field work), land use features are attributed to commodity level—including the horticultural tree crops of avocado, banana, mango and macadamia orchards.

The mapping scale is 1:50,000 with a minimum mapping unit of two hectares and a minimum mapping width of 50 metres for linear features.

The 1999 and 2009 land use maps were revised and improved in addition to compiling an updated land use map for 2016. Land use for 2016 was interpreted from ancillary data and imagery including: Landsat 8 Operational Land Imager (OLI), SPOT6/7 and Earth-i satellite imagery; and high–resolution orthophotography. An Esri enterprise geodatabase replication environment was used to overlay land use datasets on ancillary and imagery data and digitise the maps. Land use change maps were then derived (at the secondary level of the ALUM classification) for each era.

Some land uses are difficult to differentiate using ancillary data and satellite imagery, for example, dryland and irrigated agriculture. Therefore, local expert knowledge provided by state government regional staff, natural resource management groups, agricultural industries and landholders was an important component of the mapping methodology. Field surveys were also undertaken to ground-truth the mapping and verify areas of uncertainty.

The land use mapping methods used by QLUMP are described in full in the ABARES handbook: Guidelines for land use mapping in Australia: principles, procedures & definitions – Edition 4 and the addendum.



AUSTRALIAN LAND USE AND MANAGEMENT CLASSIFICATION Version 8 (October 2016)

1 Conservation and Natural Environments	2 Production from Relatively Natural Environments	3 Production from Dryland Agriculture and Plantations	4 Production from Irrigated Agriculture and Plantations	5 Intensive Uses	6 Water
1.1.0 Nature conservation	**2.1.0 Grazing native vegetation**	**3.1.0 Plantation forests**	**4.1.0 Irrigated plantation forests**	**5.1.0 Intensive horticulture**	**6.1.0 Lake**
1.1.1 Strict nature reserves		3.1.1 Hardwood plantation forestry	4.1.1 Irrigated hardwood plantation forestry	5.1.1 Production nurseries	6.1.1 Lake - conservation
1.1.2 Wilderness area	**2.2.0 Production native forests**	3.1.2 Softwood plantation forestry	4.1.2 Irrigated softwood plantation forestry	5.1.2 Shadehouses	6.1.2 Lake - production
1.1.3 National park	2.2.1 Wood production forestry	3.1.3 Other forest plantation	4.1.3 Irrigated other forest plantation	5.1.3 Glasshouses	6.1.3 Lake - intensive use
1.1.4 Natural feature protection	2.2.2 Other forest production	3.1.4 Environmental forest plantation	4.1.4 Irrigated environmental forest plantation	5.1.4 Glasshouses - hydroponic	6.1.4 Lake - saline
1.1.5 Habitat/species management area		**3.2.0 Grazing modified pastures**	**4.2.0 Grazing irrigated modified pastures**	5.1.5 Abandoned intensive horticulture	**6.2.0 Reservoir/dam**
1.1.6 Protected landscape		3.2.1 Native/exotic pasture mosaic	4.2.1 Irrigated woody fodder plants	**5.2.0 Intensive animal production**	6.2.1 Reservoir
1.1.7 Other conserved area		3.2.2 Woody fodder plants	4.2.2 Irrigated pasture legumes	5.2.1 Dairy sheds and yards	6.2.2 Water storage - intensive use/farm dams
1.2.0 Managed resource protection		3.2.3 Pasture legumes	4.2.3 Irrigated legume/grass mixtures	5.2.2 Feedlots	6.2.3 Evaporation basin
1.2.1 Biodiversity		3.2.4 Pasture legume/grass mixtures	4.2.4 Irrigated sown grasses	5.2.3 Poultry farms	**6.3.0 River**
1.2.2 Surface water supply		3.2.5 Sown grasses	**4.3.0 Irrigated cropping**	5.2.4 Piggeries	6.3.1 River - conservation
1.2.3 Groundwater		**3.3.0 Cropping**	4.3.1 Irrigated cereals	5.2.5 Aquaculture	6.3.2 River - production
1.2.4 Landscape		3.3.1 Cereals	4.3.2 Irrigated beverage and spice crops	5.2.6 Horse studs	6.3.3 River - intensive use
1.2.5 Traditional indigenous uses		3.3.2 Beverage and spice crops	4.3.3 Irrigated hay and silage	5.2.7 Saleyards/stockyards	**6.4.0 Channel/aqueduct**
1.3.0 Other minimal use		3.3.3 Hay and silage	4.3.4 Irrigated oilseeds	5.2.8 Abandoned intensive animal production	6.4.1 Supply channel/aqueduct
1.3.1 Defence land - natural areas		3.3.4 Oilseeds	4.3.5 Irrigated sugar	**5.3.0 Manufacturing and industrial**	6.4.2 Drainage channel/aqueduct
1.3.2 Stock route		3.3.5 Sugar	4.3.6 Irrigated cotton	5.3.1 General purpose factory	6.4.3 Stormwater
1.3.3 Residual native cover		3.3.6 Cotton	4.3.7 Irrigated alkaloid poppies	5.3.2 Food processing factory	**6.5.0 Marsh/wetland**
1.3.4 Rehabilitation		3.3.7 Alkaloid poppies	4.3.8 Irrigated pulses	5.3.3 Major industrial complex	6.5.1 Marsh/wetland - conservation
		3.3.8 Pulses	4.3.9 Irrigated rice	5.3.4 Bulk grain storage	6.5.2 Marsh/wetland - production
		3.4.0 Perennial horticulture	**4.4.0 Irrigated perennial horticulture**	5.3.5 Abattoirs	6.5.3 Marsh/wetland - intensive use
		3.4.1 Tree fruits	4.4.1 Irrigated tree fruits	5.3.6 Oil refinery	6.5.4 Marsh/wetland - saline
		3.4.2 Olives	4.4.2 Irrigated olives	5.3.7 Sawmill	**6.6.0 Estuary/coastal waters**
		3.4.3 Tree nuts	4.4.3 Irrigated tree nuts	5.3.8 Abandoned manufacturing and industrial	6.6.1 Estuary/coastal waters - conservation
		3.4.4 Vine fruits	4.4.4 Irrigated vine fruits	**5.4.0 Residential and farm infrastructure**	6.6.2 Estuary/coastal waters - production
		3.4.5 Shrub berries and fruits	4.4.5 Irrigated shrub berries and fruits	5.4.1 Urban residential	6.6.3 Estuary/coastal waters - intensive use
		3.4.6 Perennial flowers and bulbs	4.4.6 Irrigated perennial flowers and bulbs	5.4.2 Rural residential with agriculture	
		3.4.7 Perennial vegetables and herbs	4.4.7 Irrigated perennial vegetables and herbs	5.4.3 Rural residential without agriculture	
		3.4.8 Citrus	4.4.8 Irrigated citrus	5.4.4 Remote communities	
		3.4.9 Grapes	4.4.9 Irrigated grapes	5.4.5 Farm buildings/infrastructure	
		3.5.0 Seasonal horticulture	**4.5.0 Irrigated seasonal horticulture**	**5.5.0 Services**	
		3.5.1 Seasonal fruits	4.5.1 Irrigated seasonal fruits	5.5.1 Commercial services	
		3.5.2 Seasonal flowers and bulbs	4.5.2 Irrigated seasonal flowers and bulbs	5.5.2 Public services	
		3.5.3 Seasonal vegetables and herbs	4.5.3 Irrigated seasonal vegetables and herbs	5.5.3 Recreation and culture	
		3.6.0 Land in transition	4.5.4 Irrigated turf farming	5.5.4 Defence facilities - urban	
		3.6.1 Degraded land	**4.6.0 Irrigated land in transition**	5.5.5 Research facilities	
		3.6.2 Abandoned land	4.6.1 Degraded irrigated land	**5.6.0 Utilities**	
		3.6.3 Land under rehabilitation	4.6.2 Abandoned irrigated land	5.6.1 Fuel powered electricity generation	
		3.6.4 No defined use	4.6.3 Irrigated land under rehabilitation	5.6.2 Hydro electricity generation	
		3.6.5 Abandoned perennial horticulture	4.6.4 No defined use - irrigation	5.6.3 Wind electricity generation	
			4.6.5 Abandoned irrigated perennial horticulture	5.6.4 Solar electricity generation	
				5.6.5 Electricity substations and transmission	
				5.6.6 Gas treatment, storage and transmission	
				5.6.7 Water extraction and transmission	
				5.7.0 Transport and communication	
				5.7.1 Airports/aerodromes	
				5.7.2 Roads	
				5.7.3 Railways	
				5.7.4 Ports and water transport	
				5.7.5 Navigation and communication	
				5.8.0 Mining	
				5.8.1 Mines	
				5.8.2 Quarries	
				5.8.3 Tailings	
				5.8.4 Extractive Industry not in use	
				5.9.0 Waste treatment and disposal	
				5.9.1 Effluent pond	
				5.9.2 Landfill	
				5.9.3 Solid garbage	
				5.9.4 Incinerators	
				5.9.5 Sewage/sewerage	

Minimum level of attribution

Figure 1: Australian Land Use and Management (ALUM) classification, Version 8

Data limitations

Land use features that are narrow and linear such as roads, railways and rivers are not mappable at a scale of 1:50,000 with a specified minimum mapping width of 50 metres. As a result, the area estimates of these **linear features** represent only a small proportion of the actual area within the following land use classes: (Figure 2a, page 10)

- *transport and communication*
- *rivers*
- *channel/aqueduct.*

Similarly, features that fall under the QLUMP minimum mapping area of two hectares are not explicitly mapped but aggregated into the surrounding land use class. This will have the effect of over-estimating the area of some land use classes—for example, *irrigated cropping – sugar* and *grazing native vegetation* where tracks and farm infrastructure, road reserves, drainage lines, creeks, rivers and land immediately adjacent to (or between) paddocks are included (Figure 2b).

The 1999, 2009 and 2016 land use datasets are a snapshot of what was interpreted as the primary land use in these years**.** However, effort was given to distinguish between an actual land use change and a rotation. For example, an area that is usually cropped, but is not used for that particular purpose in the year of interest, was still mapped as *cropping* in the 2016 dataset even though no crop was present in that year. This was not considered an actual land use change, but rather cropping rotation, as the primary land use for that field would still be *cropping.*

Livestock grazing occurs on a range of pasture types including native and exotic as well as mixtures of both. Identifying and separating these pasture types using imagery, aerial photography and field observation is difficult and unreliable. Therefore, the ALUM classification secondary land use classes of *grazing modified pastures* and *grazing irrigated modified pastures* have not been mapped explicitly from the *grazing native vegetation* class. On occasion with the benefit of field verification these two classes have been mapped, including dairy pastures and fodder crops (Figure 2c). Areas of pasture which appeared to be harvested for fodder were mapped as *cropping.* This may contribute to an over-estimation of cropping in the region. The appearance of these can be highly variable therefore classification may not be consistent.

The distinction between (dryland) *cropping* and *irrigated cropping* was not always evident and it is likely there is some misclassification in these classes. QLUMP undertook field surveys and together with local knowledge confirmed areas of irrigation where possible. A feature's proximity to water sources (watercourse or dam) was also used. In addition, areas mapped as *irrigated cropping – sugar* are potentially only irrigated on a supplementary basis and may not have been irrigated in 1999, 2009 or 2016 (Figure 2d).

The mapping of the *other minimal uses* land use class—specifically *residual native vegetation* at the tertiary level, was a source of misclassification throughout the region. The accuracy assessment (Appendix B, page 30) revealed that many features mapped as *residual native vegetation* were grazed.

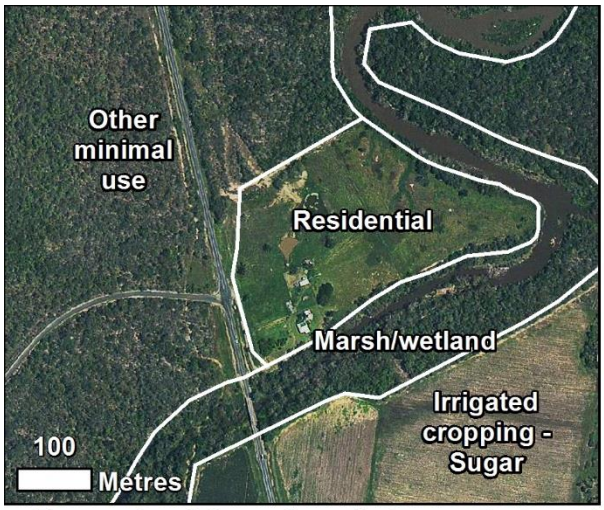
The *rural residential* land use class is a source of possible thematic error. Properties on the fringes of suburban settlements, hobby farms and subdivisions in isolated localities with comparatively small lot sizes were mapped to this class. The use of the Queensland Valuation and Sales (QVAS) database was helpful in mapping this class, based on whether or not the land owner was classified as a primary producer. Residential features greater than 0.2 hectares and less than 16 hectares

were mapped as rural residential. This class may be misclassified with *grazing native vegetation* and *other minimal use*, especially on larger properties (Figure 2e).

A combination of the Queensland Herbarium's wetlands datasets provided the basis for mapping *marsh/wetlands*, *lakes*, *rivers* and *reservoir/dams*. The ephemeral nature of many of these water features can lead to confusion as they may be present in one image and either absent or different in subsequent or earlier dated imagery. As a result, there may be errors in the mapping of features such as farm dams, reservoirs, lakes, wetlands and other water features. The mapping of all *water* land use class features was greatly aided by the interpretation of 2016 Landsat 8 OLI satellite imagery.

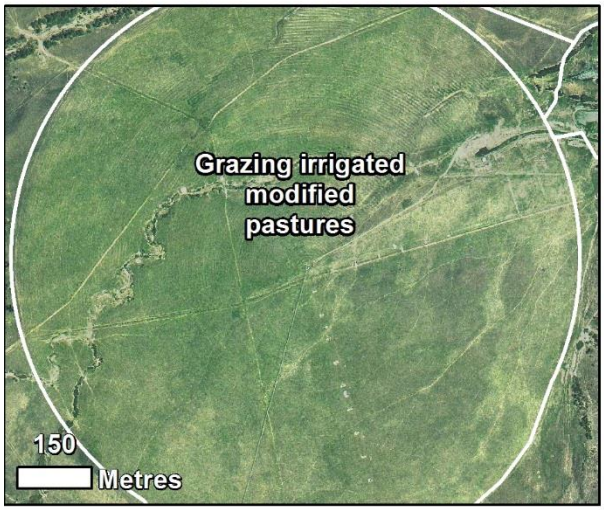
The 1999 land use mapping has been revised and improved through the interpretation of the most suitable imagery available. On occasion this was Landsat 7 Enhanced Thematic Mapper Plus (ETM+) (30m), which causes uncertainty in classifying the intensive land use classes. The minimum mapping unit (2ha) also contributes to the uncertainty through the aggregation of otherwise individual land use features, particularly at the cadastral parcel level. These limitations may therefore lead to omission and commission errors in the classification of the intensive land use classes in earlier mapping products and the land use change products (Figure 2f).

The 2009 land use map has been revised and improved through interpretation of high-resolution (50cm) aerial orthophotography. The higher spatial resolution imagery was not available at the time the original mapping was compiled, which has greatly improved the spatial and thematic accuracy of the 2009 land use map.

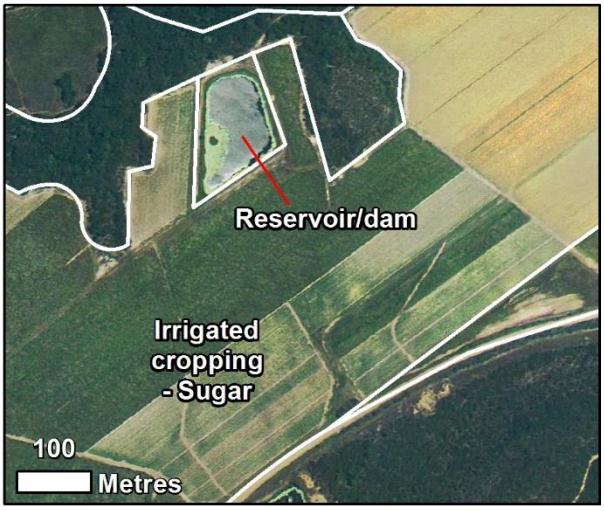


a. Transport and river – linear features not mapped

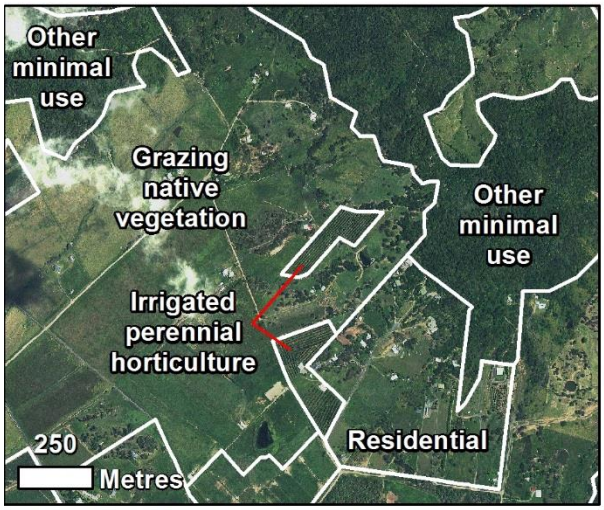
b. Drainage, road and small dam features are aggregated into the surrounding land use



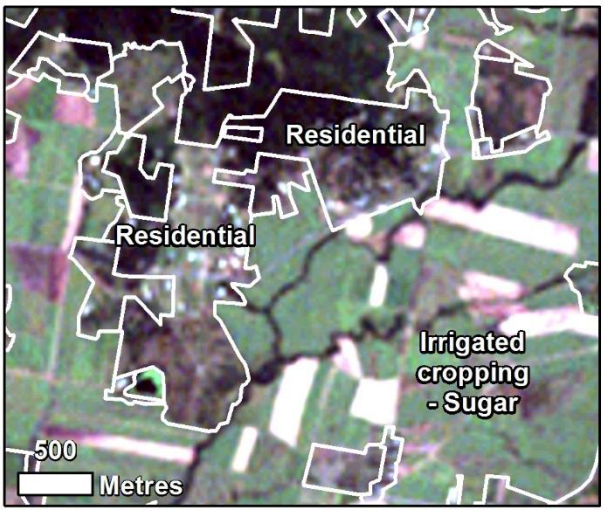
c. Grazing irrigated modified pastures showing irrigation infrastructure (Central pivot)



d. Irrigation infrastructure



e. Rural residential aggregated into surrounding land use



f. 1999 Land use map - Landsat ETM+ (30m) image

Satellite image sources: (a-e) © Earth-i Ltd, 2016; (f) © USGS/NASA Landsat 7 ETM+ 1999

Figure 2: Examples (a–f) of land use features

Products

1999, 2009 and 2016 land use datasets

Land use datasets for the Mackay Whitsunday NRM region are presented at the secondary level of the ALUM classification (Figure 1, page 7):

- the 1999 land use dataset—Figure 3 (page 12)
- the 2009 land use dataset—Figure 4 (page 14)
- the 2016 land use dataset—Figure 5 (page 16).

Summary statistics are presented for:

- 1999 land use—Table 1 (page 13)
- 2009 land use—Table 2 (page 15)
- 2016 land use—Table 3 (page 17).

All statistics presenting the area of land use classes are reported in hectares (ha).

Analysis of the summary statistics by secondary land use class for each mapping year (Tables 1–3) shows that *grazing native vegetation* was the dominant land use class in the Mackay Whitsunday NRM region and accounted for 31% of the region in both 1999 and 2009, and 32% in 2016.

Following *grazing native vegetation* the land use was dominated by: *other minimal use* (which includes *residual native cover* at tertiary level)—which accounted for 19% in 1999, 18% in 2009 and 17% in 2016; and *irrigated cropping – sugar* which accounted for 18% in 1999, 17% in 2009 and 16% in 2016 of the region.

Analysis of the specific land use changes from one secondary class to another for 1999–2009 and 2009–2016 is presented on page 20. Analysis of the land use change for 1999–2016 has been included as Appendix A on page 27.

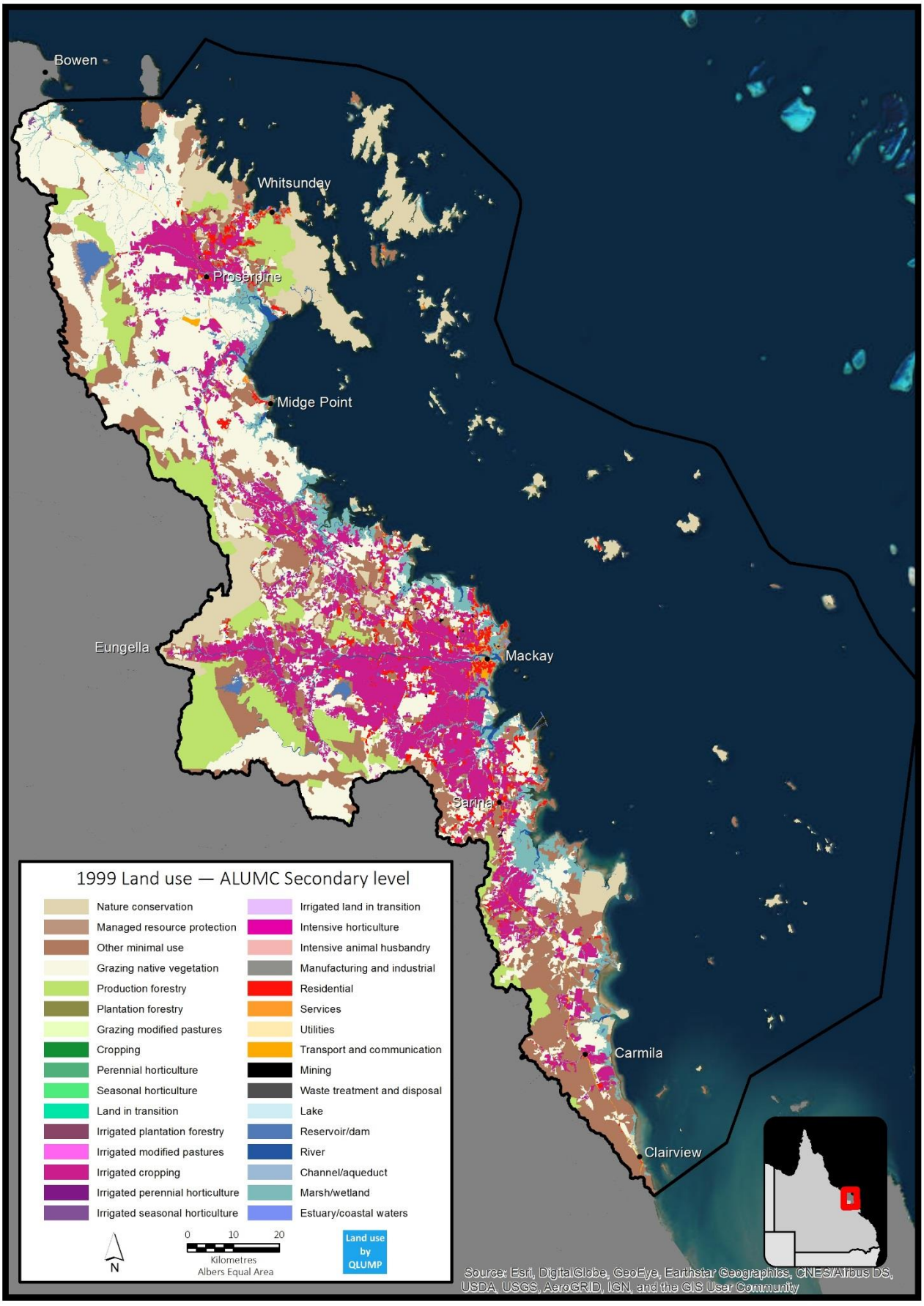


Figure 3: 1999 land use map for the Mackay Whitsunday NRM region

Table 1: Summary statistics of land use in 1999 in the Mackay Whitsunday NRM region

Land use code	Land use class	Area[3] (ha)	Area[3] (%)
1	**Conservation and natural environments**	**280,644**	**29.96**
1.1	Nature conservation	102,171	10.91
1.2	Managed resource protection	2,359	0.25
1.3	Other minimal use	176,114	18.80
2	**Production from relatively natural environments**	**386,253**	**41.24**
2.1	Grazing native vegetation[1]	292,741	31.25
2.2	Production native forests	93,512	9.98
3	**Production from dryland agriculture and plantations**	**347**	**0.04**
3.1	Plantation forests	133	0.01
3.3	Cropping	22	<0.01
3.4	Perennial horticulture	152	0.02
3.6	Land in transition	40	<0.01
4	**Production from irrigated agriculture and plantations**	**167,142**	**17.84**
4.2	Grazing irrigated modified pastures[2]	46	<0.01
4.3	Irrigated cropping	166,210	17.75
4.3.5	Irrigated cropping – Sugar	166,072	17.73
4.4	Irrigated perennial horticulture	378	0.04
4.5	Irrigated seasonal horticulture	451	0.05
4.6	Irrigated land in transition	57	0.01
5	**Intensive uses**	**33,257**	**3.55**
5.1	Intensive horticulture	55	0.01
5.2	Intensive animal production	556	0.06
5.3	Manufacturing and industrial	1,261	0.13
5.4	Residential and farm infrastructure	23,733	2.53
5.5	Services	3,198	0.34
5.6	Utilities	109	0.01
5.7	Transport and communication	3,708	0.40
5.8	Mining	506	0.05
5.9	Waste treatment and disposal	132	0.01
6	**Water**	**69,003**	**7.37**
6.1	Lake	543	0.06
6.2	Reservoir/dam	8,021	0.86
6.3	River	8,227	0.88
6.5	Marsh/wetland	51,973	5.55
6.6	Estuary/coastal waters	239	0.03
Total		**936,645**	**100.00**

[1]*grazing native vegetation* includes all pastures (modified and unmodified). No distinction is made in respect of tree cover.

[2]*grazing irrigated modified pastures* are not mapped explicitly. In this case the areas mapped are generally dairy pastures.

[3]total figures for primary land use classes may contain rounding errors.

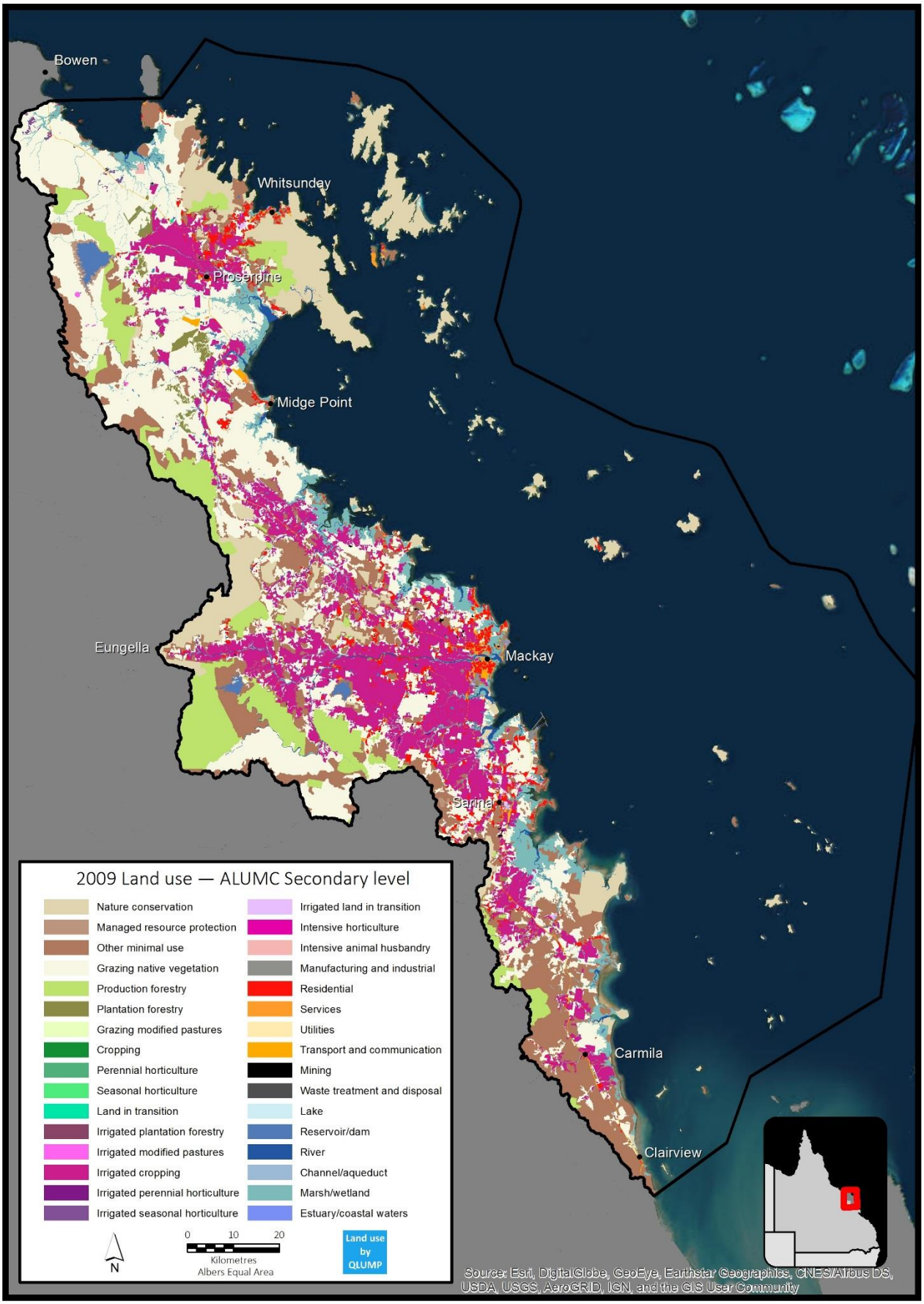


Figure 4: 2009 land use map for the Mackay Whitsunday NRM region

Table 2: Summary statistics of land use in 2009 in the Mackay Whitsunday NRM region

Land use code	Land use class	Area[3] (ha)	Area[3] (%)
1	**Conservation and natural environments**	**285,909**	**30.52**
1.1	Nature conservation	113,625	12.13
1.2	Managed resource protection	2,787	0.30
1.3	Other minimal use	169,497	18.10
2	**Production from relatively natural environments**	**378,012**	**40.36**
2.1	Grazing native vegetation[1]	292,252	31.20
2.2	Production native forests	85,761	9.16
3	**Production from dryland agriculture and plantations**	**6,609**	**0.71**
3.1	Plantation forests	6,393	0.68
3.3	Cropping	22	<0.01
3.4	Perennial horticulture	109	0.01
3.6	Land in transition	84	0.01
4	**Production from irrigated agriculture and plantations**	**159,147**	**16.99**
4.2	Grazing irrigated modified pastures[2]	207	0.02
4.3	Irrigated cropping	156,055	16.66
4.3.5	Irrigated cropping – Sugar	155,420	16.59
4.4	Irrigated perennial horticulture	635	0.07
4.5	Irrigated seasonal horticulture	856	0.09
4.6	Irrigated land in transition	1,700	0.18
5	**Intensive uses**	**38,135**	**4.07**
5.1	Intensive horticulture	58	0.01
5.2	Intensive animal production	709	0.08
5.3	Manufacturing and industrial	1,513	0.16
5.4	Residential and farm infrastructure	27,016	2.88
5.5	Services	3,803	0.41
5.6	Utilities	73	0.01
5.7	Transport and communication	4,157	0.44
5.8	Mining	628	0.07
5.9	Waste treatment and disposal	179	0.02
6	**Water**	**68,833**	**7.35**
6.1	Lake	543	0.06
6.2	Reservoir/dam	8,590	0.92
6.3	River	8,227	0.88
6.4	Channel/aqueduct	11	<0.01
6.5	Marsh/wetland	51,259	5.47
6.6	Estuary/coastal waters	203	0.02
Total		**936,645**	**100.00**

[1]*grazing native vegetation* includes all pastures (modified and unmodified). No distinction is made in respect of tree cover.

[2]*grazing irrigated modified pastures* are not mapped explicitly. In this case the areas mapped are generally dairy pastures.

[3]total figures for primary land use classes may contain rounding errors.

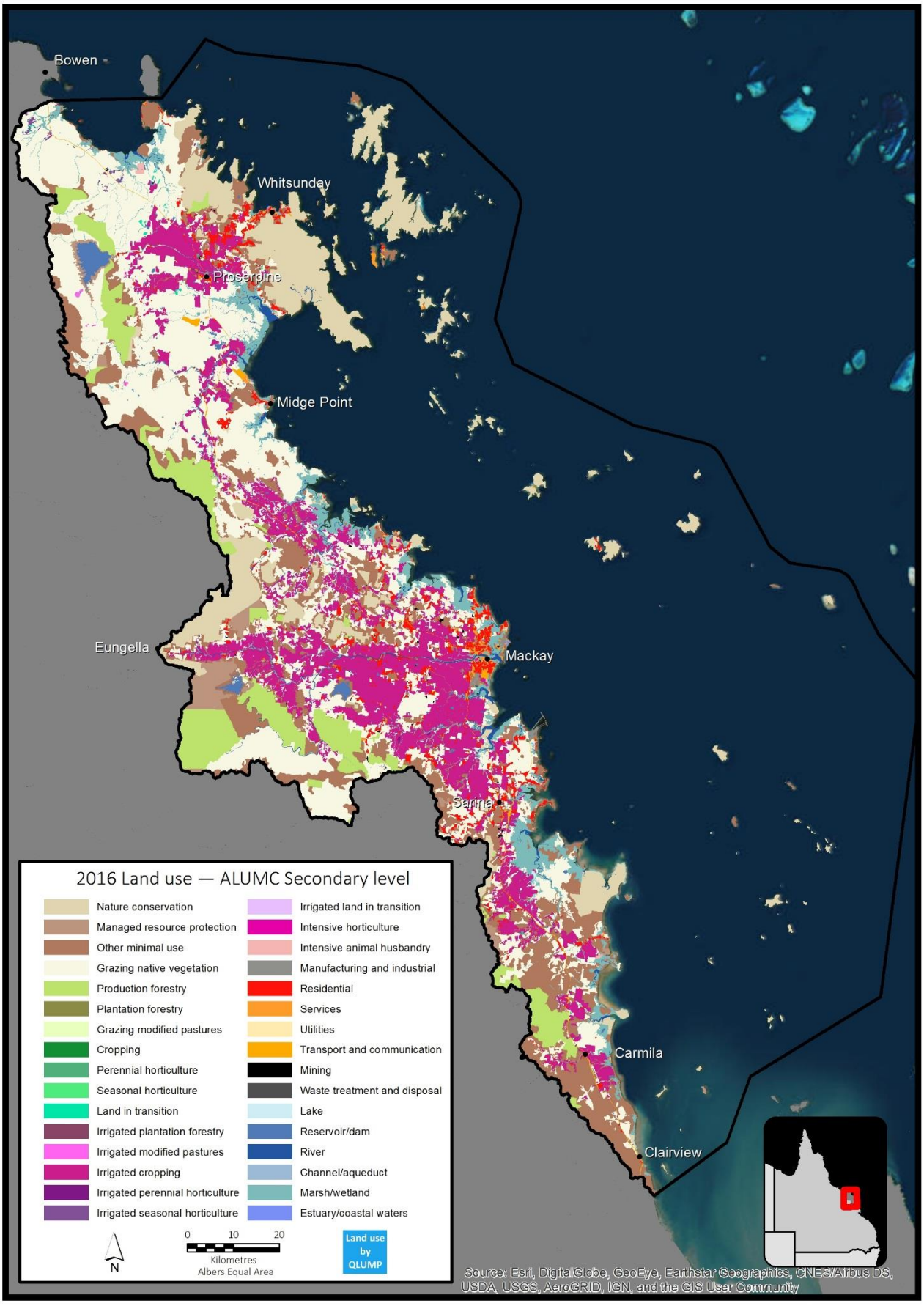


Figure 5: 2016 land use map for the Mackay Whitsunday NRM region

Table 3: Summary statistics of land use in 2016 in the Mackay Whitsunday NRM region

Land use code	Land use class	Area[3] (ha)	Area[3] (%)
1	**Conservation and natural environments**	**297,908**	**31.81**
1.1	Nature conservation	121,868	13.01
1.2	Managed resource protection	14,888	1.59
1.3	Other minimal use	161,152	17.21
2	**Production from relatively natural environments**	**374,513**	**39.98**
2.1	Grazing native vegetation[1]	300,938	32.13
2.2	Production native forests	73,575	7.86
3	**Production from dryland agriculture and plantations**	**800**	**0.09**
3.1	Plantation forests	138	0.01
3.4	Perennial horticulture	109	0.01
3.6	Land in transition	552	0.06
4	**Production from irrigated agriculture and plantations**	**154,635**	**16.51**
4.2	Grazing irrigated modified pastures[2]	257	0.03
4.3	Irrigated cropping	152,905	16.32
4.3.5	Irrigated cropping – Sugar	152,281	16.26
4.4	Irrigated perennial horticulture	571	0.06
4.5	Irrigated seasonal horticulture	843	0.09
4.6	Irrigated land in transition	59	0.01
5	**Intensive uses**	**39,958**	**4.27**
5.1	Intensive horticulture	59	0.01
5.2	Intensive animal production	749	0.08
5.3	Manufacturing and industrial	1,639	0.17
5.4	Residential and farm infrastructure	28,328	3.02
5.5	Services	4,024	0.43
5.6	Utilities	74	0.01
5.7	Transport and communication	4,165	0.44
5.8	Mining	723	0.08
5.9	Waste treatment and disposal	198	0.02
6	**Water**	**68,831**	**7.35**
6.1	Lake	552	0.06
6.2	Reservoir/dam	8,773	0.94
6.3	River	8,227	0.88
6.4	Channel/aqueduct	11	<0.01
6.5	Marsh/wetland	51,105	5.46
6.6	Estuary/coastal waters	163	0.02
Total		**936,645**	**100.00**

[1]*grazing native vegetation* includes all pastures (modified and unmodified). No distinction is made in respect of tree cover.

[2]*grazing irrigated modified pastures* are not mapped explicitly. In this case the areas mapped are generally dairy pastures.

[3]total figures for primary land use classes may contain rounding errors.

Overall (net) land use change

Analysis of the overall (**net**) land use summary for each land use map (1999, 2009 and 2016) by **primary land use class** (Table 1–3, pages 13, 15, 17) shows:

- *Conservation and natural environments* increased by 2% or 5265ha for 1999–2009 and a further 4% or 11,999ha for 2009–2016.
- *Production from relatively natural environments* decreased by 2% or 8240ha for 1999–2009 and a further 1% or 3500ha for 2009–2016.
- *Production from dryland agriculture and plantations* increased by 6262ha for 1999–2009, before decreasing by 5809ha for 2009–2016.
- *Production from irrigated agriculture and plantations* decreased by 5% or 7994ha for 1999–2009 and a further 3% or 4512ha for 2009–2016.
- *Intensive uses* increased in each era—15% or 4878ha in 1999–2009 and 5% or 1823ha in 2009–2016.
- *Water* decreased by 170ha for 1999–2009 and 1ha in 2009–2016.

Figure 6 presents the overall (net) changes in land use within the Mackay Whitsunday NRM region by primary land use class. The chart shows the net reduction or gain for 1999–2009 and 2009–2016. Note that the first bar for each primary land use class is the 1999–2009, whilst the second is the 2009–2016 and each series sums to zero.

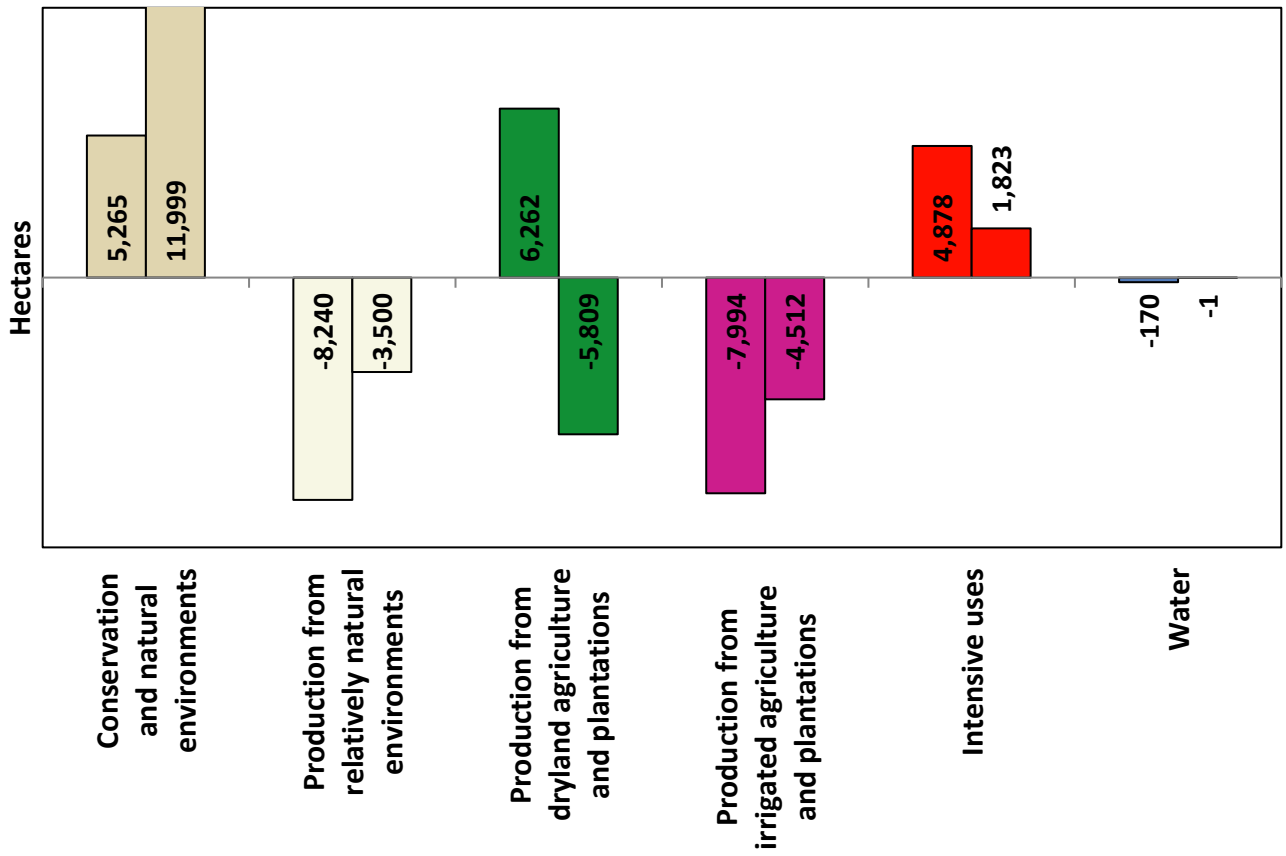


Figure 6: Net land use change by primary class (1999–2009 and 2009–2016) in the Mackay Whitsunday NRM region

Further analysis of the **net** land use change at the **secondary land use class** level (Table 1–3, pages 13, 15, 17) shows:

- *Nature conservation* increased by 11% or 11,453ha in 1999–2009 and a further 7% or 8244ha in 2009–2016.
- *Managed resource protection* increased by 18% or 429ha in 1999–2009 and then increased significantly by 434% or 12,101ha in 2009–2016.
- *Production native forests* decreased in both eras—8% or 7751ha for 1999–2009 and 14% or 12,186ha in 2009–2016.
- *Plantation forestry* increased by 6261ha in 1999–2009 and then decreased by 6255ha in 2009–2015, as a result of the establishment of new teak plantations observed in the 2009 land use map, and their subsequent removal in the 2016 land use map.
- *Residential and farm infrastructure* increased by 14% or 3283ha in 1999–2009 and 5% or 1312ha in 2009–2016.
- *Reservoir/dam* increased in each era—7% or 569ha in 1999–2009 and 2% or 183ha in 2009–2016.
- The net loss of *estuary/coastal waters* observed in both eras—36ha in 1999–2009 and 40ha in 2009–2016 was from the development of port infrastructure associated with the coal export terminal at Hay Point.

QLUMP consistently maps the **tertiary land use class** of *irrigated cropping – sugar*. The **net** land use change was:

- *Irrigated cropping – sugar* decreased by 6% or 10,652ha for 1999–2009 and then a further 2% or 3139ha for 2009–2016.

Land use change datasets (1999–2009, 2009–2016 and 1999–2016)

Summary statistics presenting the land use change at secondary level for 1999–2009 and 2009–2016 are presented in Table 4 and Table 5 (pages 22 and 24). The land use change from 1999–2016 is presented in Appendix A (page 27).

Figure 7 and 8 (pages 23 and 25) present the land use changes within the Mackay Whitsunday NRM region relative to the **change in intensity** of the land use at the secondary level of the ALUM classification. For example, change from 2.1.0 *(*grazing native vegetation*)* to 3.3.0 *(cropping)* is an increase in land use intensity, whilst change from 2.1.0 *(*grazing native vegetation*)* to 1.1.0 *(*nature conservation*)* is a decrease. This is highlighted in the ALUM classification (Figure 1, page 7). Moving down and from left to right through the classification, the level of intervention or potential impact of land use increases.

Land use change mapping products have been compiled for three eras (1999, 2009 and 2016). At the secondary level of the ALUM classification, the total area of land use change is:

- 1999–2009: 44,873ha (4.8% of the region). Of this, 21,241ha (47% of the total change) is mapped as an increase in land use intensity, whilst 23,632ha (53%) is a decrease.
- 2009–2016: 46,473ha (5% of the region). Of this, 12,206ha (26% of the total change) is mapped as an increase in land use intensity, whilst 34,267ha (74%) is a decrease.
- 1999–2016: 74,969ha (8% of the region). Of this, 24,357ha (32% of the total change) is mapped as an increase in land use intensity, whilst 50,611ha (68%) is a decrease.

The land use change totals between the two eras (1999–2009 and 2009–2016) will not add up to match those compiled for the 1999–2016 era. This is because land use change mapping only accounts for land use at a specific moment in time; some change will result from rotation, whilst some may be the result of more than one change event. For example, an area mapped as *grazing native vegetation* in 1999 may have been mapped as *plantation forests* in 2009 before finally becoming *irrigated cropping – sugar* in 2016. These changes would be reflected in each of the land use change mapping products as change from *grazing native vegetation* to *plantation forests* in the 1999–2009, and change from *plantation forests* to *irrigated cropping – sugar* in 2009–2016, and lastly change from *grazing native vegetation* to *irrigated cropping – sugar* in 1999–2016.

Tables 4 and 5 illustrate all the land use changes mapped at the secondary land use class level (plus sugar)—for example, Table 4 shows: 5350ha of *grazing native vegetation* in 1999 changed to *plantation forests* in 2009; whilst 3905ha of *grazing native vegetation* in 1999 changed to *irrigated cropping – sugar* in 2009.

1999–2009 Land use change

The highest totals of land use change from 1999–2009 in Mackay Whitsunday NRM region were observed in the *irrigated cropping – sugar* (14,825ha or 33% of the total change) and *grazing native vegetation* (12,203ha, 27%) land use classes. 9700ha (22%) of *production native forests* changed to *nature conservation*—associated with the conversion of state forests into new national parks including: Conway National Park (south of Whitsunday); Bluff Hill National Park and Mt Martin National Park (north of Mirani); and Kelvin National Park (in the south).

Further analysis of the major fluxes of land use change (Table 4) shows that of the 14,825ha of *irrigated cropping – sugar* in 1999, 10,051ha changed to *grazing native vegetation* and 1696ha changed to *irrigated land in transition* in 2009.

Of the 12,203ha of *grazing native vegetation* land use in 1999, 5350ha changed to *plantation forests* in 2009 (after the establishment of many new teak plantations in the north of the region) and 3905ha changed to *irrigated cropping – sugar.*

The Behn Mohr State Forest (south–west of Mackay), expanded in 2014 which contributed 1889ha of land use change from *other minimal use (residual native vegetation)* in 1999 to *production forestry* in 2009.

Land use changes into the *intensive uses* class was dominated by 3345ha of *residential and farm infrastructure*, the majority of which changed from:

- *other minimal uses* (1189ha)—mostly around Whitsunday and Sarina
- *grazing native vegetation* (1138ha)—throughout the region
- *irrigated cropping – sugar* (934ha)—mostly around Mackay.

Interestingly, a total of 569ha of land use change was observed in the *reservoir/dam* land use class in 2009 as new irrigation infrastructure was established in the region. 318ha was converted from the *grazing native vegetation* and 162ha came from *irrigated cropping – sugar* in 1999.

2009–2016 Land use change

The conversion of state forests into the protected area estates dominates the 2009–2016 land use change map. The largest changes observed (9,593ha or 21% of the total change mapped) were from *production native forests* in 2009 to *managed resource protection* in 2016—including Crediton and Pelion Forest Reserves (east of Eungella). Also contributing was land use change to *nature conservation* (7596ha or 16% of the total)—including: Conway National Park (south of Whitsunday) and the expansion of Dryander National Park (west of Whitsunday) (Table 5, page 24).

The land use change identified in the 1999–2009 mapping associated with the establishment of new teak plantations *(plantation forests)* was again observed in the 2009–2016 land use change, with a complete reversal of 6268ha of *plantation forests* in the region, as 5200ha changed to *grazing native vegetation* and 1011ha changed to *irrigated cropping – sugar.*

The large (more intense) land use change of 5003ha north–west of Carmila is a result of the change from *residual native vegetation* (tertiary level) which falls within the *other minimal use* secondary land use class to *production native forests*, namely West Hill Forest Reserve, established in 2011.

Land use change from *irrigated cropping – sugar* to *grazing native vegetation* accounted for 6157ha which was observed throughout the region. This change was offset elsewhere in the region whereby 2607ha changed from *grazing native vegetation* to *irrigated cropping – sugar.*

The land use change to *intensive uses* primary class totalled 1747ha across the region, with the *residential and farm infrastructure* class contributing most (1346ha)—589ha of which came from *grazing native vegetation*, 448ha from *other minimal uses* (mostly *residual native vegetation)* and 281ha came from *irrigated cropping – sugar.*

Table 4: Summary statistics for land use change at secondary level for 1999–2009 in the Mackay Whitsunday NRM region

Land use change 1999–2009		2009 land use (ha)																							
		Nature conservation	Managed resource protection	Other minimal use	Grazing native vegetation	Production native forests	Plantation forests	Land in transition	Grazing irrigated modified pastures	Irrigated cropping	Irrigated cropping – Sugar	Irrigated perennial horti.	Irrigated seasonal horti.	Irrigated land in transition	Intensive horticulture	Intensive animal production	Manufacturing .& industrial	Residential & farm infra.	Services	Utilities	Transport & communication	Mining	Waste treatment & disposal	Reservoir/dam	Channel/aqueduct	Total[1]
1999 land use (ha)	Nature conservation		3	19															5							**28**
	Other minimal use	1,126	345		1,584	1,949	31	1		19	185	9				12	44	1,189	462	1	3	15		25		**6,999**
	Grazing native vegetation	88	43	51			5,350	60	149	134	3,905	62	314		3	103	36	1,138	49	7	327	65		318	2	**12,203**
	Production native forests	9,700																								**9,700**
	Plantation forests										17							8								**25**
	Perennial horticulture				26			17																		**42**
	Land in transition						32											8								**40**
	Irrigated cropping										8								3							**11**
	Irrigated cropping – Sugar	4		271	10,051		868	6	12	50		211	99	1,696		38	164	934	55	6	112	42	36	162	9	**14,825**
	Irrigated perennial horti.				27									4				8								**38**
	Irrigated seasonal horti.			6	4																					**10**
	Irrigated land in transition										52	5														**57**
	Intensive horticulture																	2	1							**3**
	Manufacturing & industrial														2			1						4		**7**
	Residential & farm infra.			12	22		4				1	9	2		1				7		1			3		**61**
	Services			6														7					11			**24**
	Utilities																	50								**50**
	Marsh/wetland	563	38								6								44		7			56		**714**
	Estuary/coastal waters			18													15		4							**36**
	Total	**11,481**	**429**	**382**	**11,713**	**1,949**	**6,285**	**84**	**161**	**203**	**4,172**	**295**	**415**	**1,700**	**6**	**153**	**259**	**3,345**	**630**	**14**	**449**	**122**	**47**	**569**	**11**	**44,872**

[1]total figures may contain rounding errors.

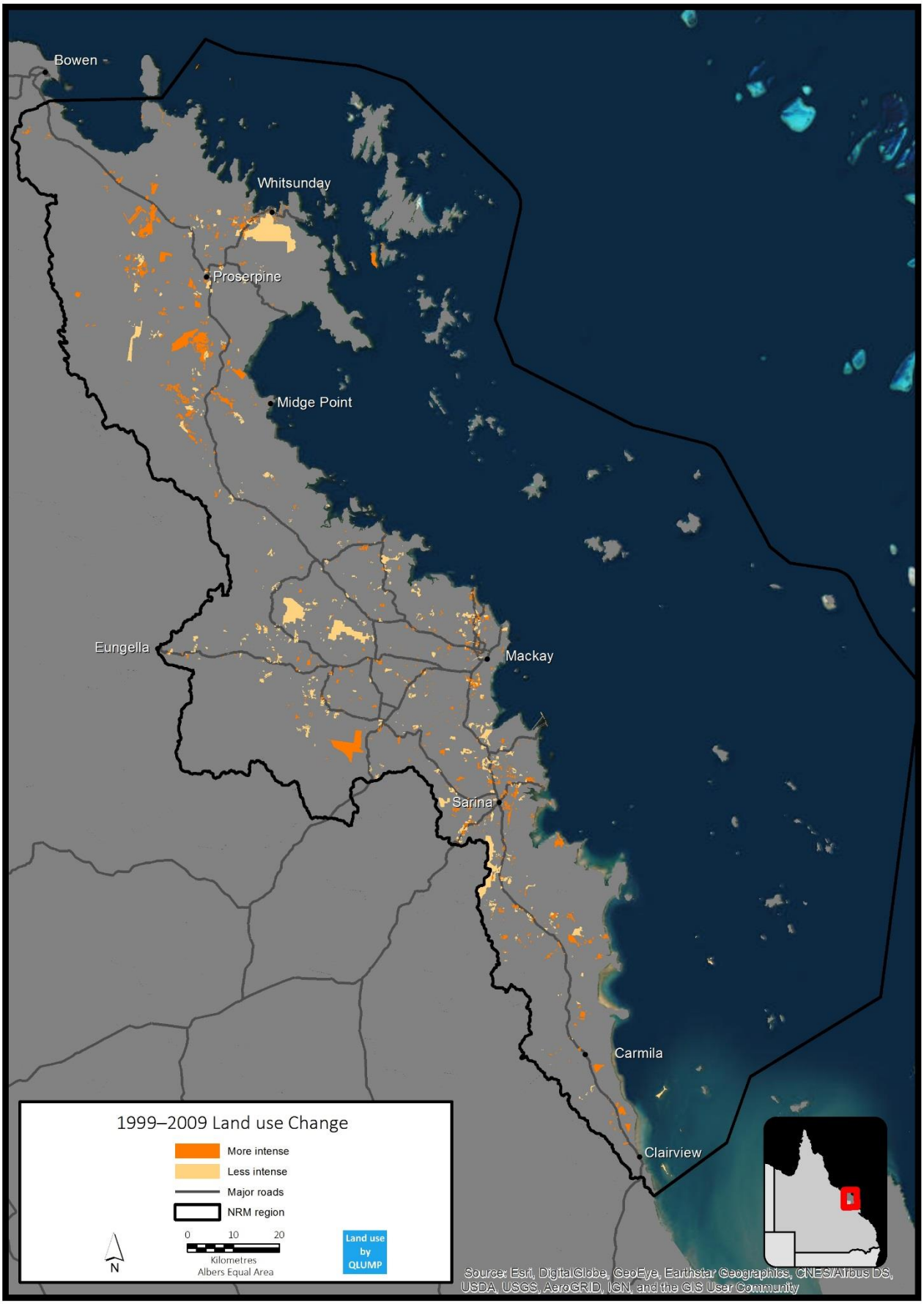


Figure 7: 1999–2009 land use change map at secondary class

Table 5: Summary statistics for land use change at secondary level for 2009–2016 in the Mackay Whitsunday NRM region

Land use change 2009–2016		2016 land use (ha)																						
		Nature conservation	Managed resource protection	Other minimal use	Grazing native vegetation	Production native forests	Plantation forests	Land in transition	Grazing irrigated modified pastures	Irrigated cropping	Irrigated cropping – Sugar	Irrigated perennial horti.	Irrigated seasonal horti.	Irrigated land in transition	Intensive animal production	Manufacturing & industrial	Residential & farm infra.	Services	Transport & communication	Mining	Waste treatment & disposal	Lake	Reservoir/dam	Marsh/wetland	Total[1]
2009 land use (ha)	Nature conservation			1																				**1**
	Managed resource protection			63																			36	**99**
	Other minimal use	314	2,453		291	5,003	11	88			130		2			33	448	49	14	24	3				**8,864**
	Grazing native vegetation	327		102				410	42	209	2,607	1	75		9	2	589	81		82	26	9	92		**4,664**
	Production native forests	7,596	9,593																					**17,189**
	Plantation forests				5,200			2			1,011												55		**6,268**
	Cropping				22																			**22**
	Land in transition				9						51	1												**61**
	Irrigated cropping			1	31						16										0			**48**
	Irrigated cropping – Sugar			254	6,157			16	8	95		8	2	32	33	25	281	91		10	7		18		**7,038**
	Irrigated perennial horti.			4	8					5	36			18			2	0					0		**74**
	Irrigated seasonal horti.			37	34						8					12	1								**93**
	Irrigated land in transition	1		18	1,577					33	9					36	17								**1,691**
	Intensive animal production										2														**2**
	Manufacturing & industrial			5													7						15		**27**
	Residential & farm infra.			6	11		2				9							6							**34**
	Services	7		1																					**8**
	Transport & communication															5		1							**6**
	Mining				4						3										5		9		**20**
	Waste treatment & disposal			23																					**23**
	Reservoir/dam			4	5						1										1				**11**
	Marsh/wetland		154					13			18												5		**190**
	Estuary/coastal waters															39			1						**40**
	Total	**8,245**	**12,200**	**518**	**13,350**	**5,003**	**13**	**530**	**50**	**343**	**3,899**	**10**	**79**	**50**	**42**	**152**	**1,346**	**228**	**15**	**115**	**42**	**9**	**194**	**36**	**46,473**

[1]total figures may contain rounding errors.

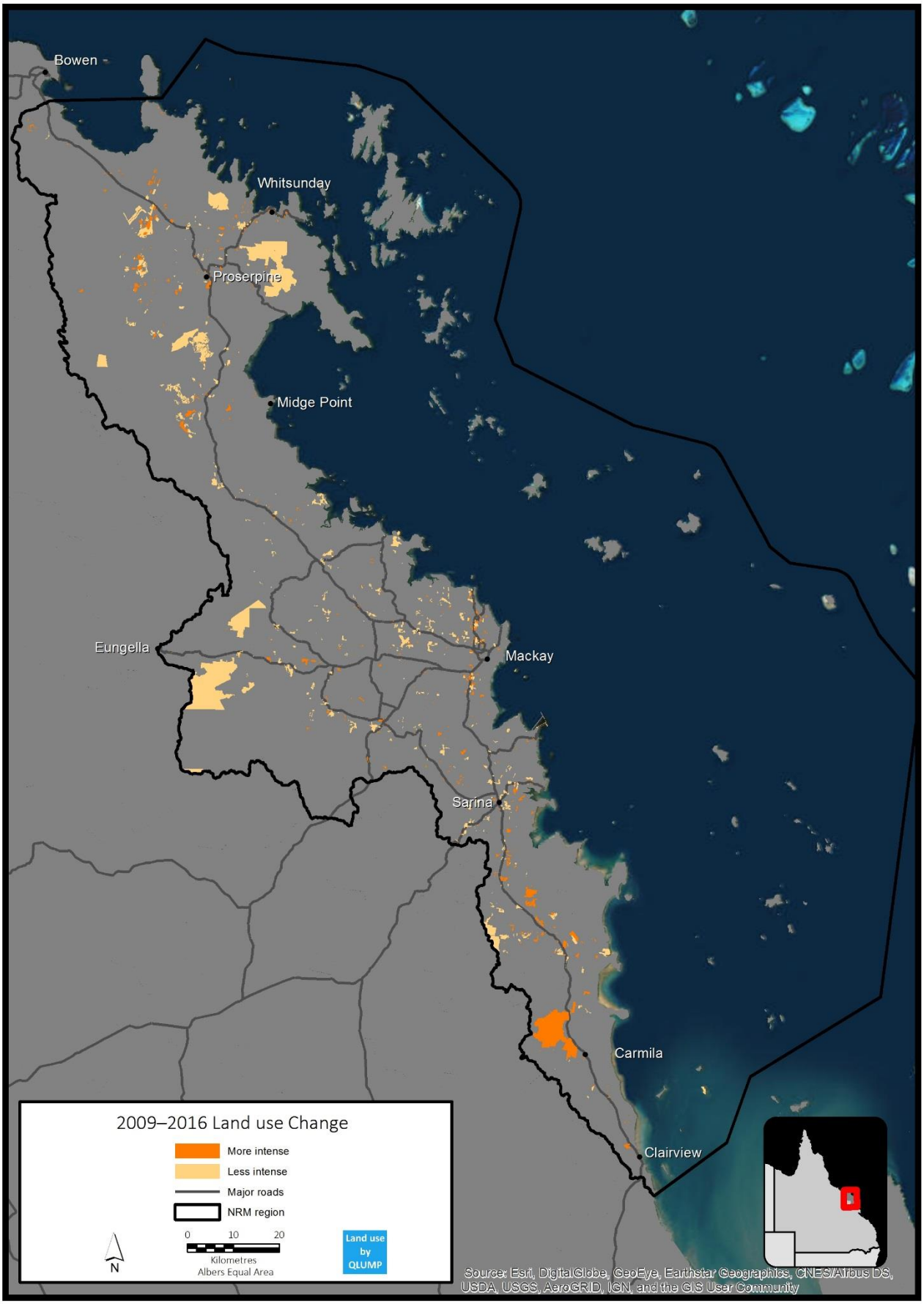


Figure 8: 2009–2016 land use change map at secondary class

Data format and availability

Download land use datasets

Use the Queensland Spatial Catalogue QSpatial to access land use data sets. Search for **"land use mapping"** in the *search term* field then refine your results by selecting the **“Planning Cadastre”** filter from the *choose categories* field. Metadata is also available from QSpatial.

The dataset comprises an ESRI vector geodatabase at a nominal scale of 1:50,000. Within this are six feature classes: 1999 improved land use, 2009 improved land use, 2016 updated land use and the 1999–2009, 2009–2016, 1999–2016 land use change. The feature classes are polygon datasets with attributes describing land use. Land use is classified according to the Australian Land Use and Management Classification (ALUMC) Version 8, October 2016. Note: a representation showing land use at secondary level is available when working within a geodatabase. Layer files are also available to present the land use mapping at primary, secondary or tertiary level.

Digital Data is supplied with a licence and by using the data you confirm that you have read the licence conditions included with the data and that you agree to be bound by its terms.

View land use data online

The most current land use web map can be viewed online via the QLUMP website. (https://www.qld.gov.au/environment/land/vegetation/mapping/qlump)

Map and feature services

Use the Queensland Spatial Catalogue QSpatial to access the web mapping services of the state-wide land use layer. Search for **"land use mapping"** in the *search term* field then refine your results by using the *choose content type* filter and selecting **“Service”**.

Request a land use map

It is possible to request a land use map from the QLUMP website based upon a specific location (lot on plan, street address or central latitude/longitude coordinates) in Queensland. The land use maps are emailed in portable document format (PDF).The maps present the most recent land use information available at the secondary level of the ALUMC.

Appendix A 1999–2016 Land use change

For 1999–2016, the largest land use changes were observed from the conversion of state forests into the conservation estates. Collectively for 1999–2016, all the land use change to *nature conservation* (19,725ha) and *managed resource protection* (12,583ha) accounted for 43% of the total land use change in the region—26,889ha of which came from *production native forests.* (Table 6, page 28)

Land use changes observed between the *irrigated cropping – sugar* and *grazing native vegetation* land use classes across the region showed that 16,817ha of *irrigated cropping – sugar* changed to the *grazing native vegetation* class, whilst 5783ha of *grazing native vegetation* changed to *irrigated cropping – sugar*, presenting an overall loss of *irrigated cropping – sugar* in the region of 11,034ha.

Associated with the State-wide Forests Process, land use changes from *other minimal use (residual native vegetation)* to *production forestry* accounted for 6952ha. This occurred west of Carmila (West Hill Forest Reserve, gazetted in 2011) and also south-west of Mackay (expansion of Ben Mohr State Forest, gazetted in 2014).

Land use change to the *intensive uses* primary land use class totalled some 6935ha in the region. Of this, 4674ha (67%) changed to *residential and farm infrastructure*—which in 1999 came from *other minimal use* (1629ha), *grazing native vegetation* (1601ha) and *irrigated cropping – sugar* (1348ha).

Throughout the region 754ha of *reservoir/dams* were constructed since 1999.

Note that the change within the *plantation forestry* land use class which featured in both the 1999–2009 and 2009–2016 land use change mapping is not evident in the 1999–2016 data. The establishment of many teak plantations and their subsequent degradation (or abandonment) has seen the 2016 land use largely return to its original 1999 uses.

Table 6: Summary statistics for land use change at secondary level for 1999–2016 in the Mackay Whitsunday NRM region

Land use change 1999–2016		2016 land use (ha)																							
		Nature conservation	Managed resource protection	Other minimal use	Grazing native vegetation	Production native forests	Plantation forests	Land in transition	Grazing irrigated modified pastures	Irrigated cropping	Irrigated cropping – Sugar	Irrigated perennial horti.	Irrigated seasonal horti.	Irrigated land in transition	Intensive horticulture	Intensive animal production	Manufacturing & industrial	Residential & farm infra.	Services	Utilities	Transport & communication	Mining	Waste treatment & disposal	Reservoir/dam	Channel/aqueduct	Total[1]
1999 land use (ha)	Nature conservation		3	19															5							28
	Managed resource protection			54																						54
	Other minimal use	1,438	2,798		1,805	6,952	17	88		19	338	10	1			12	56	1,629	517	1	15	39	3	25		15,762
	Grazing native vegetation	415	34	138			30	412	191	334	5,783	55	359	4	4	112	38	1,601	105	7	327	136	26	463	2	10,584
	Production native forests	17,296	9,593																							26,889
	Plantation forests				22						29							8								59
	Cropping				22																					22
	Perennial horticulture				26			17																		42
	Land in transition										32							8								40
	Irrigated cropping				13														11							24
	Irrigated cropping – Sugar	6		501	16,817		13	22	20	157		205	79	41	1	71	243	1,348	159	7	112	51	43	187	9	20,090
	Irrigated perennial horti.			4	33					1	29			14				8								89
	Irrigated seasonal horti.			30	9												9	1								49
	Irrigated land in transition										52	5														57
	Intensive horticulture																	3	1							4
	Manufacturing & industrial														2			8						19		28
	Residential & farm infra.			10	32		4				10	7	2		1				10		1			3		80
	Services	7		7														7		0			11			32
	Utilities																	50								50
	Mining				4																		5			9
	Waste treatment & disposal			23																						23
	Marsh/wetland	563	156	4				13			23								44		7			57		868
	Estuary/coastal waters			11													54	4	4		3					76
	Total	**19,725**	**12,583**	**800**	**18,781**	**6,952**	**64**	**552**	**211**	**510**	**6,299**	**282**	**440**	**59**	**8**	**195**	**406**	**4,674**	**858**	**16**	**463**	**226**	**89**	**754**	**11**	**74,968**

[1]total figures may contain rounding errors.

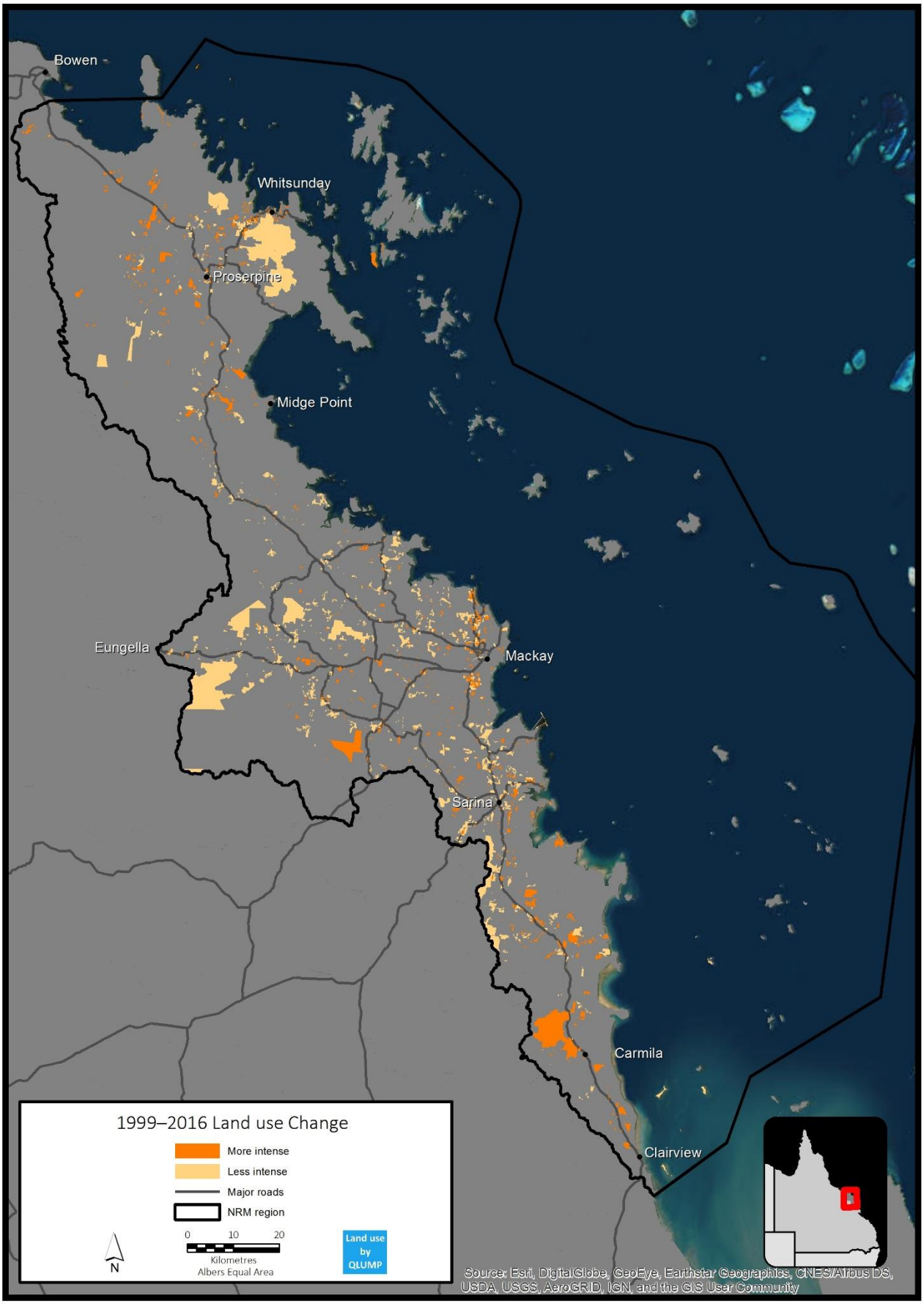


Figure 9: 1999–2016 land use change map at secondary class

Appendix B Accuracy assessment

The accuracy assessment provided reference data suitable for assessing the 2016 land use map. For each of the sample points, the land use class was independently determined (this provided the reference data) based on desktop interpretation of the same imagery and ancillary datasets available to the mapper. These points were then compared to the mapped class (map data) and the information summarised in the error matrix. The accuracy is summarised in terms of total accuracy, Kappa and user's and producer's accuracies. Each accuracy parameter is reported using a point estimate and a 95% posterior interval. Accuracy figures are provided as probabilities between 0 and 1.

Total accuracy provides an estimate of the overall accuracy of the map, and can be expressed as the probability that a point is mapped correctly. However, the total accuracy may be misleading, particularly when a dominant class exists. The Kappa statistic attempts to overcome this problem by adjusting for chance agreement. It is generally accepted that a value of Kappa between 0.6 and 0.8 represents moderate agreement between the map and the reference data, a value greater than 0.8 suggests strong agreement. Values less than 0.2 suggest the map is only marginally improved compared to a map produced by random allocation.

The user's and producer's accuracies summarise the map's accuracy on a per–class basis. User's accuracy for class A is the probability that a point mapped as A is truly in class A. If the user's accuracy of class A is estimated to be 0.84, then from a random sample of 100 points chosen from areas on the map in this class, approximately 84 would be found to be correct when checked in the field. Producer's accuracy for class B is the conditional probability that the map will show a site as class B given its true state is class B. If the producer's accuracy for class B were 0.84, then from a random sample of 100 points known to be in class B, approximately 84 would also be in class B according to the map. An accurate map should have both high user's and producer's accuracies.

The per–class estimates of accuracy are often not precise, as only part of the total sample points are used to estimate them. As a guide, if the upper bound of the interval for either user's or producer's accuracy is less than 0.5, this may indicate a misclassification problem rather than inadequacies in sample size.

Points that differ between the map and the reference data may be due to positional or spatial errors. Inaccurate registration of datasets is an example of spatial error. Spatial errors influence thematic accuracy. Thematic errors are the incorrect labelling of an area due to difficulties in determining the true land use in that area, or by oversight or other operational errors. The purpose is to assess the thematic accuracy of land use data. However, as described above, the separation of spatial and thematic errors may be difficult and were not undertaken. As a result, the accuracy assessment reflects properties of the land use data as a whole.

Note: the revised 1999 and 2009 land use and the land use change data were not accuracy assessed.

2016 land use dataset

The 2016 land use dataset was accuracy assessed with 530 points based on a stratified random sampling strategy, using the map classes (area and frequency) as the strata. The estimate of total accuracy is 0.87 (0.84, 0.90) and Kappa is 0.84 (0.81, 0.87). As the lower bound of the confidence interval for total accuracy is greater than 0.8, the mapping meets the ACLUMP specification.

Table 7, page 32 shows the error matrix for the accuracy assessment of the 2016 land use data. For the majority of classes, the reference data agreed with the map data. For example, *marsh/wetland* had 30 sample points identified. For 28 of those points, the map data was also *marsh/wetland* and therefore correct. For the two points where the map data was incorrect, the points were assessed as *grazing native vegetation*. Misclassifications reflect both thematic and spatial errors.

The error matrix illustrates the difficulty in mapping (classifying) *grazing native vegetation* and *other minimal uses* (specifically *residual native vegetation* at tertiary level) land use classes in the Mackay Whitsunday NRM region. Of the 70 sample points identified in the *other minimal uses* land use class, 33 were assessed as *grazing native vegetation.* This misclassification is discussed further in the data limitations section on page 8.

The column ‘Proportion’ in Table 7 is the relative proportion in area of the classes that were assessed, not of the catchment as a whole. The areas of other classes that are not assessed, for example, *grazing irrigated modified pastures* are removed from the total area before the proportions are calculated. This column totals 100%.

Table 8, page 33 provides the user’s and producer’s accuracy for the 2016 Mackay Whitsunday NRM region land use dataset. This demonstrates the majority of land use classes in the catchment have been mapped accurately. The largest assessable land use class in this catchment is *grazing native vegetation* which has been mapped with very high producer’s accuracy of 0.904 and a lower user’s accuracies of 0.782, which reflects the misclassification observed in the map of the *other minimal use* land use class.

Accuracy estimates based on samples with fewer than two points are not considered sufficiently reliable, and are presented as NA (not available) in the table, an example being *production native forests.*

The user’s and producer’s accuracy results should be interpreted individually for their respective classes. It should be noted that the classes with a small area in proportion to the total area assessed, and also a small sample size, will return a wide confidence interval. The overall accuracy shows a much tighter confidence interval as it effectively summarises the accuracy results for all the assessable classes.

Some classes with low accuracies have insufficient sample points to provide precise estimates. For example, the user’s accuracy for *residential and farm infrastructure* is 0.782, however from the 95% interval (0.614, 0.902) it can be seen that more sample points would be required to confidently determine class accuracy.

Table 7: Error matrix for the Mackay Whitsunday NRM region 2016 land use dataset

		Reference data																													
		Nature conservation	Managed resource protection	Other minimal uses	Grazing native vegetation	Production native forests	Plantation forests	Perennial horticulture	Land in transition	Irrigated cropping	Irrigated sugar	Irrigated perennial horti.	Irrigated seasonal horti.	Irrigated land in transition	Intensive horticulture	Intensive animal production	Manufacturing & industrial	Residential & farm infra.	Services	Utilities	Transport & communication	Mining	Waste treatment & disposal	Lake	Reservoir/dam	River	Channel/aqueduct	Marsh/wetland	Estuary/coastal waters	Total	Proportion (%)
Map data	Nature conservation	**30**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	13.01
	Managed resource protection	0	**15**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	1.59
	Other minimal uses	0	0	**34**	33	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	70	17.24
	Grazing native vegetation	0	0	1	**69**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70	32.16
	Production native forests	0	0	0	0	**15**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	7.86
	Plantation forests	0	0	1	0	0	**9**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.01
	Perennial horticulture	0	0	0	0	0	0	**10**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.01
	Land in transition	0	0	0	2	0	0	1	**6**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	10	0.06
	Irrigated cropping	0	0	0	0	0	0	0	0	**10**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.07
	Irrigated sugar	0	0	0	0	0	0	0	0	0	**70**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70	16.26
	Irrigated perennial horti.	0	0	0	0	0	1	0	0	0	0	**8**	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	10	0.06
	Irrigated seasonal horti.	0	0	0	0	0	0	0	0	0	0	0	**10**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.09
	Irrigated land in transition	0	0	2	0	0	0	0	0	0	0	1	0	**7**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.01
	Intensive horticulture	0	0	0	0	0	0	0	0	0	0	0	0	0	**10**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.01
	Intensive animal production	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**9**	0	0	0	0	0	0	0	0	1	0	0	0	0	10	0.08
	Manufacturing & industrial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**10**	0	0	0	0	0	0	0	0	0	0	0	0	10	0.17
	Residential & farm infra.	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	**24**	0	0	1	0	0	0	0	0	0	0	0	30	3.02
	Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**15**	0	0	0	0	0	0	0	0	0	0	15	0.43
	Utilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**10**	0	0	0	0	0	0	0	0	0	10	0.01
	Transport & communication	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**9**	0	0	0	0	0	0	0	0	10	0.41
	Mining	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**9**	0	0	0	0	0	0	0	10	0.08
	Waste treatment & disposal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**9**	0	0	0	0	0	0	9	0.02
	Lake	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**	2	0	0	5	0	10	0.06
	Reservoir/dam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**15**	0	0	0	0	15	0.94
	River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**9**	0	1	0	10	0.88
	Channel/aqueduct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	1	0	1	<0.01
	Marsh/wetland	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**28**	0	30	5.46
	Estuary/coastal waters	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**10**	10	0.02
	Total	**30**	**15**	**40**	**111**	**15**	**10**	**11**	**6**	**10**	**71**	**9**	**10**	**7**	**10**	**9**	**10**	**26**	**15**	**10**	**10**	**9**	**9**	**3**	**19**	**9**	**0**	**36**	**10**	**530**	**100**

Table 8: User's and producer's accuracy for the Mackay Whitsunday NRM region 2016 land use dataset

Class	User's			Producers		
	Estimate	95% interval		Estimate	95% interval	
Nature conservation	0.978	0.885	0.999	0.998	0.963	1.000
Managed resource protection	0.957	0.790	0.998	0.983	0.720	1.000
Other minimal uses	0.479	0.362	0.593	0.931	0.795	0.983
Grazing native vegetation	0.976	0.922	0.997	0.781	0.740	0.824
Production native forests	0.959	0.790	0.999	0.997	0.940	1.000
Plantation forests	0.844	0.549	0.976	0.268	0.021	0.835
Perennial horticulture	0.937	0.687	0.998	0.241	0.019	0.820
Land in transition	0.549	0.263	0.813	0.531	0.050	0.988
Irrigated cropping	0.935	0.704	0.998	0.691	0.094	0.995
Irrigated sugar	0.991	0.950	1.000	0.985	0.939	0.999
Irrigated perennial horticulture	0.747	0.448	0.936	0.623	0.069	0.982
Irrigated seasonal horticulture	0.934	0.690	0.998	0.753	0.128	0.996
Irrigated land in transition	0.648	0.362	0.879	0.127	0.007	0.901
Intensive horticulture	0.938	0.702	0.998	0.178	0.010	0.941
Intensive animal production	0.841	0.550	0.976	0.710	0.102	0.994
Manufacturing & industrial	0.937	0.697	0.998	0.854	0.227	0.998
Residential & farm infra.	0.782	0.614	0.902	0.904	0.682	0.990
Services	0.958	0.775	0.999	0.932	0.403	0.999
Utilities	0.934	0.690	0.998	0.202	0.012	0.936
Transport and communication	0.838	0.561	0.975	0.715	0.319	0.967
Mining	0.841	0.565	0.977	0.702	0.099	0.993
Waste treatment and disposal	0.929	0.674	0.997	0.401	0.035	0.981
Lake	0.262	0.062	0.565	0.342	0.019	0.979
Reservoir/dam	0.957	0.779	0.999	0.945	0.599	0.986
River	0.838	0.561	0.974	0.967	0.578	1.000
Channel/aqueduct	NA	NA	NA	NA	NA	NA
Marsh/wetland	0.915	0.778	0.980	0.934	0.802	0.983
Estuary/coastal waters	0.938	0.705	0.998	0.364	0.027	0.976