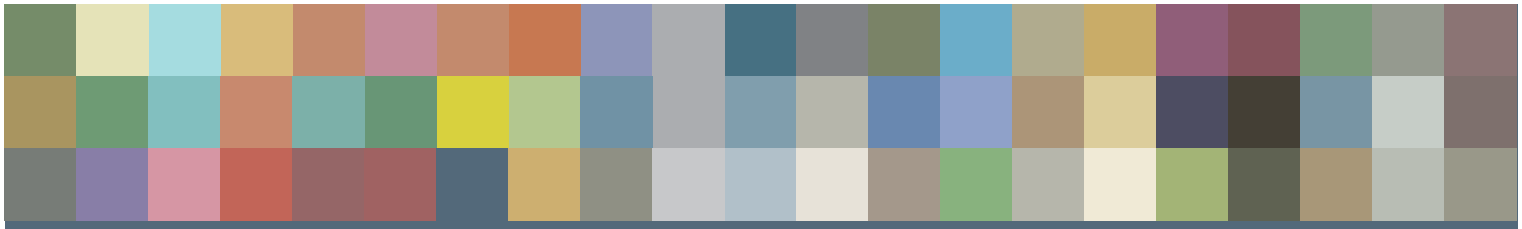

Land use summary 1999–2009

for the Great Barrier Reef catchments

Department of Science, Information Technology, Innovation and the Arts
Department of Natural Resources and Mines

Queensland Government

Prepared by: Remote Sensing Centre, Science Delivery, Department of Science, IT, Innovation and the Arts

To access land use datasets we recommend using the Queensland Government Information Service (QGIS) and simply search for **land use mapping** in the type of data search, after restricting your search to **cadastral and land planning** in the topic category field. Metadata is also available from QGIS.

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The Queensland Land Use Mapping Program (QLUMP) wishes to acknowledge the significant funding provided by the Queensland Government Reef Protection Package to compile updated land use for 2009, improved 1999 land use and 1999–2009 land use change mapping in the catchments adjacent to the Great Barrier Reef stretching from Wet Tropics in the north to the Burnett–Mary in the south.

We also wish to acknowledge the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) who coordinate the Australian Collaborative Land Use and Management Program (ACLUMP).

The QLUMP team includes staff from DSITIA in Brisbane and eight business centres of the Department of Natural Resource and Mines (NRM) throughout Queensland. The input from the regions has been extremely valuable because of their local knowledge and capacity to engage regional experts in compiling updated land use mapping.

June 2012

Table of contents

List of tables

List of figures

Introduction

The Queensland Land Use Mapping Program (QLUMP) is part 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, the environment and agricultural production. The availability of consistent and reliable spatial information on land use is critical for catchment modelling applications to monitor sediment, nutrient and water quality flows discharged to the Great Barrier Reef (GBR).

With the support of the Queensland Government Reef Protection Package, QLUMP has compiled updated land use mapping for the year 2009 in the catchments adjacent to the GBR—stretching from Wet Tropics in the north to the Burnett–Mary in the south. These include the Wet Tropics, Burdekin, Mackay–Whitsunday, Fitzroy and the Burnett–Mary Natural Resource Management (NRM) regions.

This report presents and summarises the land use mapping in all the above NRM regions, including:

- the revised 1999 land use dataset which includes improvements and corrections to the original 1999 dataset
- the 2009 land use dataset
- the land use change dataset from 1999–2009
- summary statistics derived from the above spatial datasets
- the results of the accuracy assessment of the 2009 land use dataset.

Methodology

Mapping is performed 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 has a three-level hierarchical structure (Figure 1). Primary, secondary and tertiary classes are broadly structured by the potential degree of modification or impact in the landscape. The basis of the classification shows five primary classes, identified in order of increasing levels of intervention or potential impact. *Water* is included separately as a sixth primary class. The secondary level in the three-level hierarchical structure is the minimum attribution level for land use mapping in Queensland.

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 vegetation, (e.g. crops such as cereals and oil seeds). Where required[1] and possible, attribution is performed to tertiary level.

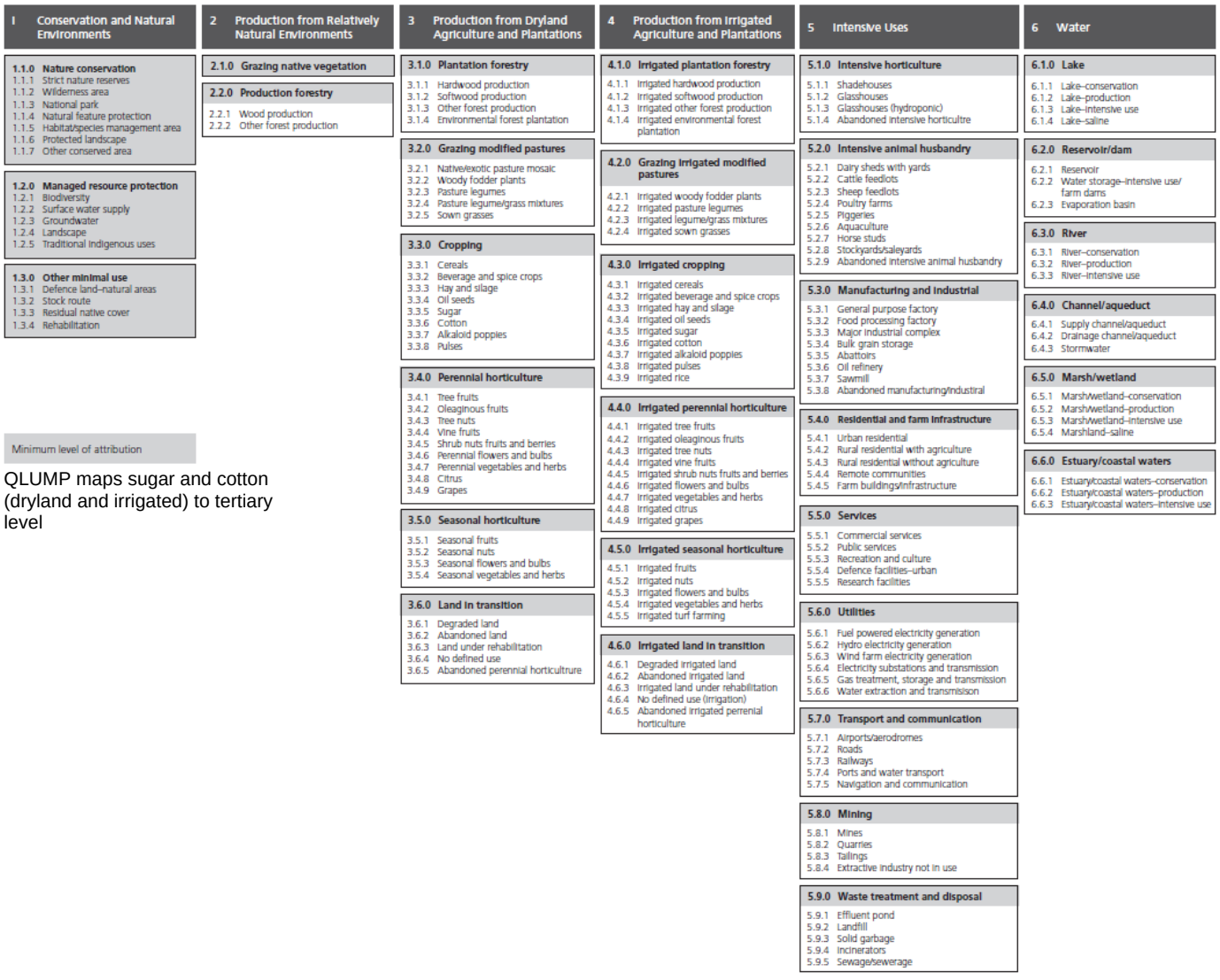
The mapping scale is 1:50 000 with a minimum mapping unit of 2 hectares and a width of 50 metres for linear features.

[1] QLUMP maps the land use classes of *sugar* and *cotton* (dryland and irrigated) to tertiary level.

The existing 1999 baseline (or later where available) land use dataset formed the basis for the 2009 land use dataset. The 1999, 2009 and 1999–2009 change datasets were then updated and improved primarily by interpretation of SPOT5 satellite imagery, high-resolution orthophotography, scanned aerial photography and the inclusion of expert local knowledge. This was performed in an ESRI ArcSDE geodatabase replication environment, by overlaying the land use datasets on imagery and digitising or modifying areas previously omitted or incorrectly mapped in the 1999 mapping, as well as areas of actual land use change (2009).

Some land uses are difficult to differentiate using only satellite imagery and existing databases; for example dryland and irrigated *agriculture*. To overcome this, local expert knowledge has become an important component of the mapping methodology. This is provided by regional staff in state government agencies, natural resource management groups, shires, agricultural industries and landholders. A field survey is also undertaken to verify areas of uncertainty in the land use mapping.

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.



QLUMP maps sugar and cotton (dryland and irrigated) to tertiary level

Figure 1: Australian Land Use and Management (ALUM) classification, Version 7

Data limitations

Land uses that are linear, such as roads and railways, 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 under this land use in Queensland. This is relevant to the following land use classes:

- *transport and communication*
- *utilities*
- *rivers*.

Similarly, land uses that fall under the QLUMP minimum mapping area of 2 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 *cropping – sugar* and *grazing native vegetation*, whereby tracks and farm infrastructure, road reserves and drainage lines are included.

The ALUM secondary classes of *grazing modified pastures* and *irrigated grazing modified pastures* have not been mapped explicitly by QLUMP, due to the difficulty in identifying and separating these classes using satellite imagery and aerial photography alone. On occasion, generally with the benefit of field verification, these classes can be mapped (e.g. dairy pastures and fodder crops including leucaena).

Livestock grazing occurs on a range of pasture types including native and exotic as well as mixtures of both. Identifying and separating these using imagery, aerial photography and field observation is difficult and unreliable. Areas of pasture which appeared to be harvested for fodder or grazed off were mapped as *cropping*. This may contribute to an over-estimation of cropping in the region. Other areas mapped as *grazing native vegetation* include road reserves, cleared and uncleared land adjacent to rivers, as well as land immediately adjacent to or between cropped paddocks. *Other minimal use* may also be confused with this class. The appearance of these can be highly variable and classification may therefore not be consistent.

The distinction between (dryland) *cropping* and *irrigated cropping* was not always evident and there is likely to be some misclassification in these classes. Proximity to water sources (watercourse or dam), water entitlements (irrigation licences), field survey and local knowledge were used to confirm areas of irrigation as much as possible. Potentially areas mapped as *irrigated cropping* are only irrigated on a supplementary basis and were not actually irrigated in either 1999 or 2009.

A combination of the Queensland Herbarium's wetlands and regional ecosystem 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 in that they may be present in imagery of one date and either absent or of differing extent in imagery of subsequent or previous dates. As a result, there are likely to be errors and omissions and some disagreement in the mapping of features such as farm dams, reservoirs, lakes, wetlands and other water features. Many water features exceed the minimum mappable area requirements, but do not meet the criteria for linear or uniform features.

The 1999 and 2009 land use datasets are both a **snapshot in time** showing what was considered the land use for each of those years. However, some effort was given to distinguishing between an actual land use change and a rotation. For example, an area that is usually cropped, but is not

used for a particular purpose in the year of interest, was still mapped as *cropping* in the 2009 dataset even though no crop was present in that year. This was not considered an actual land use change, but rather a rotation, as the primary land use for that paddock would still be *cropping*.

Please refer to the metadata for details on the mapping of specific classes.

Products

1999 and 2009 land use datasets

Figure 2 and Figure 3 show the 1999 and 2009 land use datasets respectively, for the GBR catchments, presented at the secondary level of the ALUM classification (Figure 1). Table 1 and Table 2 provide the summary statistics for each. All statistics presenting the area of land use classes are reported in hectares (ha).

Table 2 shows that *grazing native vegetation* (76%) and *nature conservation* (6%) are the major land use classes for 2009 in the GBR catchments.

Analysis of the overall change in the land use class extents from 1999 to 2009 shows a 1% decrease in the *grazing native vegetation* class of 343 867 ha, whilst *other minimal use* has also decreaed by 8% or 107 664 ha. Collectively, *cropping – sugar* (both dryland and irrigated) has decreased by 3% or 19 135 ha since 1999. The land uses that have increased in area since 1999 include *nature conservation*, which increased significantly by 14% or 298 764 ha, and *production forestry* which increased by 2% or 40 166 ha. The *mining* land use class has increased by 40% or 35 610 ha since 1999, where in area it accounted for 0.23% of the GBR catchments, increasing to 0.33% in 2009. *Residential and farm infrastructure* increased by 11% or 23 898 ha, due almost exclusively to the expansion of urban and rural residential classes, at the tertiary level.

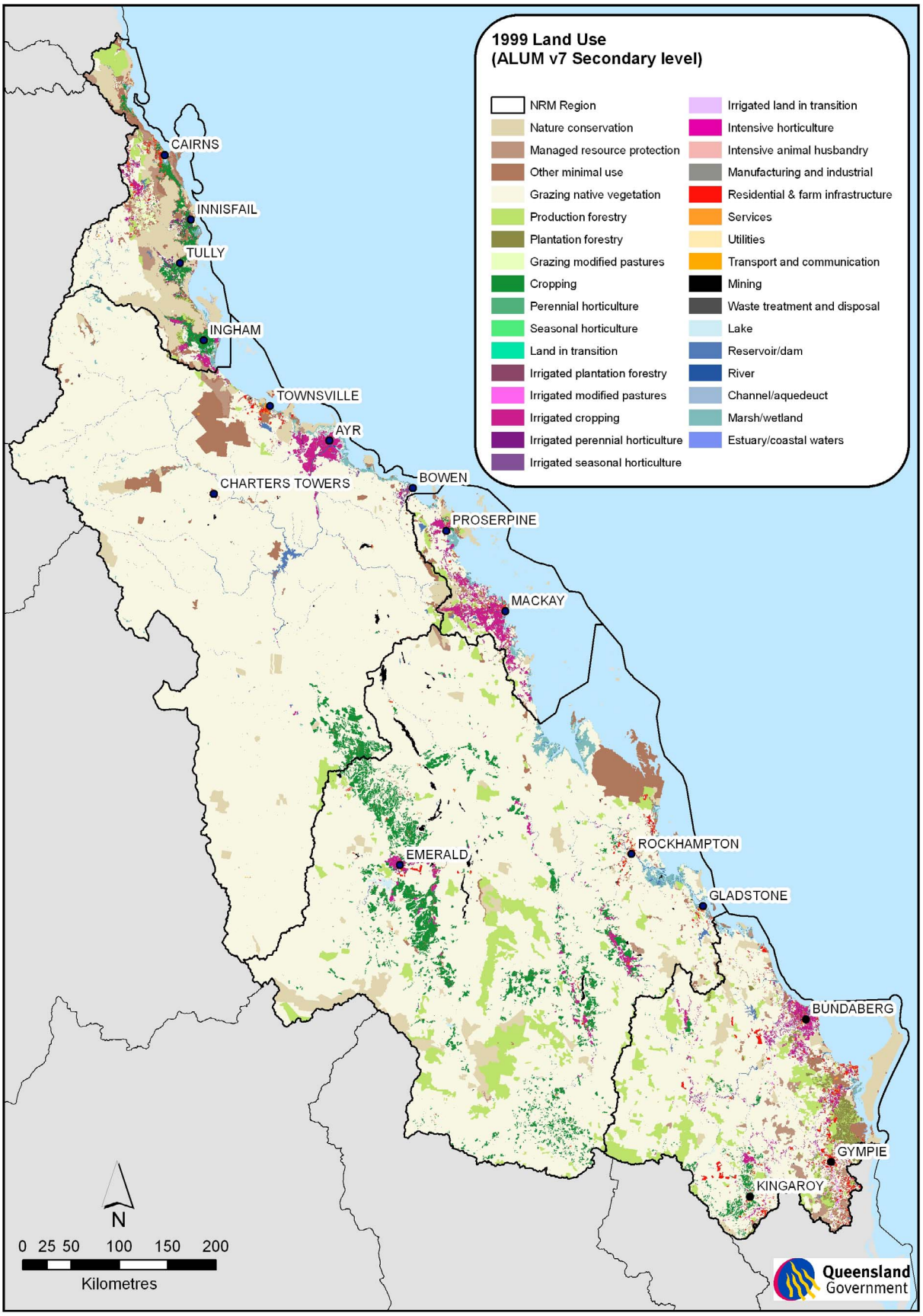


Figure 2: 1999 land use map for the GBR catchments

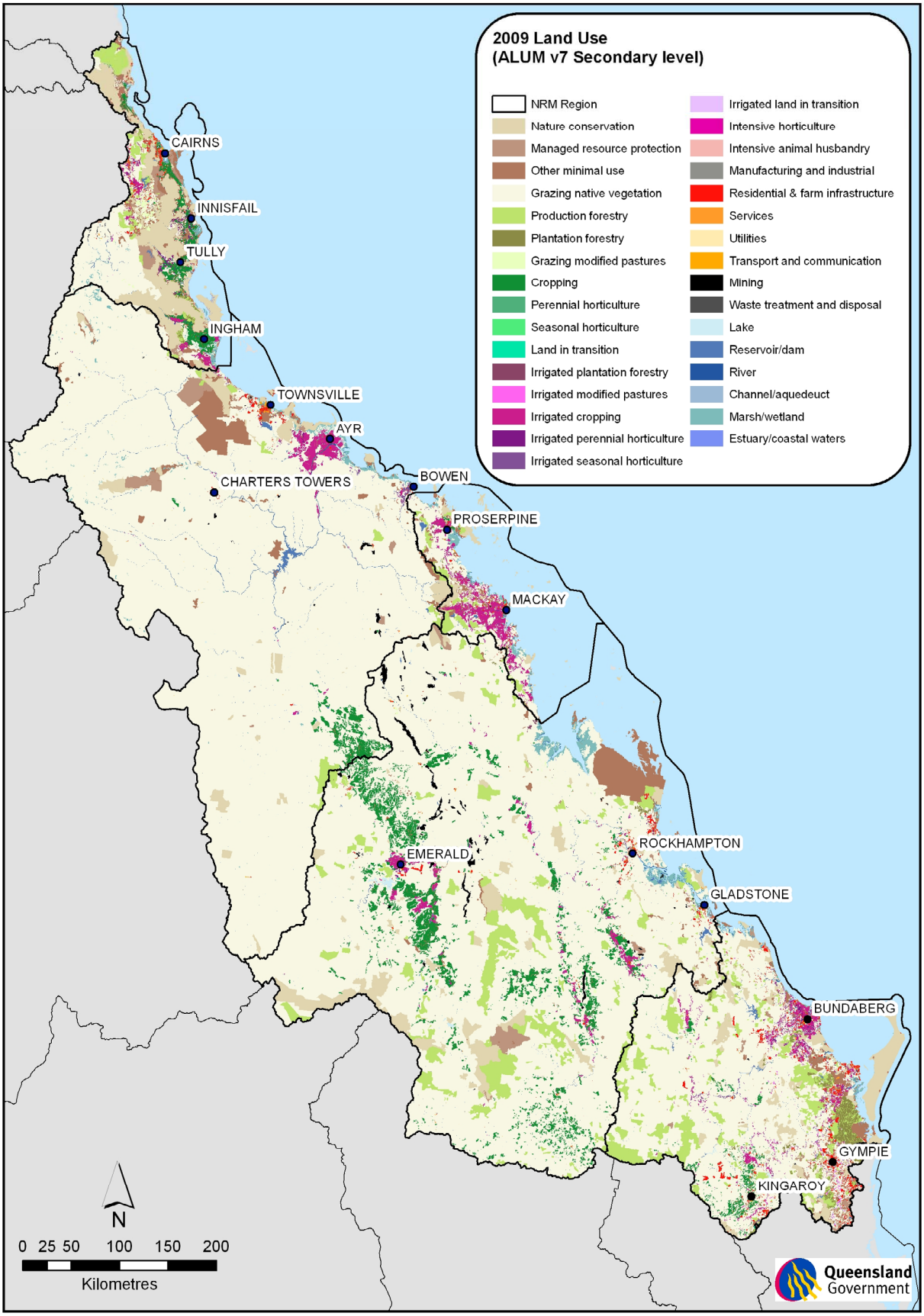


Figure 3: 2009 land use map for the GBR catchments

Table 1: Summary statistics of land use in 1999 in the GBR catchments

Land use code	Land use class	Area (ha)	Area %
1	Conservation and natural environments	3 726 279	9.66
1.1	Nature conservation	2 131 447	5.52
1.2	Managed resource protection	307 265	0.80
1.3	Other minimal use	1 287 567	3.34
2	Production from relatively natural environments	31 742 037	82.26
2.1	Grazing native vegetation	29 848 450	77.35
2.2	Production forestry	1 893 587	4.91
3	Production from dryland agriculture and plantations	1 374 447	3.56
3.1	Plantation forestry	142 502	0.37
3.2	Grazing modified pastures[1]	40 071	0.10
3.3	Cropping	1 184 406	3.07
3.3.5	Cropping – sugar[2]	166 047	0.43
3.4	Perennial horticulture	6013	0.02
3.5	Seasonal horticulture	110	<0.01
3.6	Land in transition	1345	<0.01
4	Production from irrigated agriculture and plantations	630 631	1.63
4.1	Irrigated plantation forestry	46	<0.01
4.2	Grazing irrigated modified pastures[1]	11 339	0.03
4.3	Irrigated cropping	563 036	1.46
4.3.5	Irrigated cropping – sugar[2]	392 399	1.02
4.3.6	Irrigated cropping – cotton[2]	25 135	0.07
4.4	Irrigated perennial horticulture	40 699	0.11
4.5	Irrigated seasonal horticulture	14 831	0.04
4.6	Irrigated land in transition	680	<0.01
5	Intensive uses	381 224	0.99
5.1	Intensive horticulture	513	<0.01
5.2	Intensive animal husbandry	6660	0.02
5.3	Manufacturing and industrial	14 787	0.04
5.4	Residential and farm infrastructure	221 321	0.57
5.5	Services	35 032	0.09
5.6	Utilities	1375	<0.01
5.7	Transport and communication	10 156	0.03
5.8	Mining	90 035	0.23
5.9	Waste treatment and disposal	1344	<0.01
6	Water	733 736	1.90
6.1	Lake	22 207	0.06
6.2	Reservoir/dam	97 850	0.25
6.3	River	185 587	0.48
6.4	Channel/aquaduct	2023	0.01
6.5	Marsh/wetland	385 500	1.00
6.6	Estuary/coastal waters	40 569	0.11
	Total	**38 588 359**	**100.00**

[1]*Grazing modified pastures* and *grazing irrigated modified pastures* are not mapped explicitly. In this case the areas mapped are generally dairy pastures and fodder crops including leucaena.

[2]The area of *cropping – sugar* and *irrigated cropping – sugar* and *cotton* are subsets of the total area of *cropping* and *irrigated cropping* respectively.

Table 2: Summary statistics of land use in 2009 in the GBR catchments

Land use code	Land use class	Area (ha)	Area %
1	Conservation and natural environments	3 936 401	10.20
1.1	Nature conservation	2 430 211	6.30
1.2	Managed resource protection	326 286	0.85
1.3	Other minimal use	1 179 903	3.06
2	Production from relatively natural environments	31 438 336	81.47
2.1	Grazing native vegetation	29 504 583	76.46
2.2	Production forestry	1 933 753	5.01
3	Production from dryland agriculture and plantations	1 376 706	3.57
3.1	Plantation forestry	162 147	0.42
3.2	Grazing modified pastures[1]	42 033	0.11
3.3	Cropping	1 160 265	3.01
3.3.5	Cropping – sugar[2]	157 881	0.41
3.4	Perennial horticulture	7334	0.02
3.5	Seasonal horticulture	68	<0.01
3.6	Land in transition	4858	0.01
4	Production from irrigated agriculture and plantations	655 513	1.70
4.1	Irrigated plantation forestry	2506	0.01
4.2	Grazing irrigated modified pastures[1]	11 105	0.03
4.3	Irrigated cropping	574 219	1.49
4.3.5	Irrigated cropping – sugar[2]	381 430	0.99
4.3.6	Irrigated cropping – cotton[2]	26 340	0.07
4.4	Irrigated perennial horticulture	52 259	0.14
4.5	Irrigated seasonal horticulture	14 969	0.04
4.6	Irrigated land in transition	456	<0.01
5	Intensive uses	443 411	1.15
5.1	Intensive horticulture	742	<0.01
5.2	Intensive animal husbandry	6335	0.02
5.3	Manufacturing and industrial	14 695	0.04
5.4	Residential and farm infrastructure	245 219	0.64
5.5	Services	36 835	0.10
5.6	Utilities	1607	<0.01
5.7	Transport and communication	10 833	0.03
5.8	Mining	125 645	0.33
5.9	Waste treatment and disposal	1499	<0.01
6	Water	737 972	1.91
6.1	Lake	22 246	0.06
6.2	Reservoir/dam	106 918	0.28
6.3	River	184 140	0.48
6.4	Channel/aquaduct	2063	0.01
6.5	Marsh/wetland	382 011	0.99
6.6	Estuary/coastal waters	40 594	0.11
	Total	**38 588 359**	**100.00**

[1]*Grazing modified pastures* and *grazing irrigated modified pastures* are not mapped explicitly. In this case the areas mapped are generally dairy pastures and fodder crops including leucaena.

[2]The area of *cropping – sugar* and *irrigated cropping – sugar and cotton* are subsets of the total area of *cropping* and *irrigated cropping* respectively.

1999–2009 land use change dataset

Figure 4 shows the 1999–2009 land use change dataset for the GBR catchments. The data has been presented 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 2.2.0 (*production forestry*) is an increase in land use intensity, whilst change from 2.1.0 (*grazing native vegetation*) to 1.1.7 (*nature conservation*) is a decrease. See Figure 1 for the classification, noting that as you move down and from left to right in the classification the level of intervention or potential impact on the natural landscape increases.

The total area of land use change from 1999–2009 in the GBR catchments is 1 037 919 ha. This is equivalent to 2.69% of the region. Of this 376 704 ha (36% of the total change) is mapped as an increase in land use intensity, whilst 661 216 ha (64%) is a decrease.

Summary statistics presenting the land use change classes at the secondary level are shown in Table 3. The largest land use change at the secondary level was of 185 966 ha from *managed resource protection* to *nature conservation,* accounting for 18% of the total change. This change can be attributed to the Queensland Government's Statewide Forests Process. This conversion of state forests to protected areas directly contributes to the government's commitment to protect Queensland's biodiversity and to increase the state's total area of lands protected for conservation purposes. The next largest change mapped was of 98 577 ha of *grazing native vegetation* to *production forestry*, which represents 10% of the total change in the GBR catchments—which again is an outcome of the Statewide Forests Process. Note that 46% of this land use change (*grazing native vegetation* to *production forestry*) occurred within the Burnett–Mary NRM region. The land use change of 79 153 ha (8%) from *grazing native vegetation* to *nature conservation* can be attributed to the creation of new and expansion of existing *national parks* in the region. Note that 86% of this land use change (*grazing native vegetation* to *nature conservation*) occurred within the Fitzroy NRM region. The change in the land use classes from *grazing native vegetation* and *other minimal use* to *managed resource protcection*—77 827 ha (8%) and 62 402 ha (6%) respectively—can be attributed to the establishment of numerous nature refuges throughout the GBR catchments.

Other significant land use changes were from *grazing native vegetation* to *mining*—32 526 ha (3%) and *residential and farm infrastructure*—20 660 ha (2%). The increase in the *residential and farm infrastructure* secondary land use class is due almost exclusively to the expansion of the urban and rural residential land use classes, at the tertiary level.

Interestingly, 17 811 ha (2%) of *grazing native vegetation* changed to *plantation forestry*, which was often observed in the field as teak plantations.

The common rotation between the production of sugar and bananas is also evident in the land use change summary statistics. Collectively, some 10 631 ha of *cropping – sugar* (both dryland and irrigated) changed to *irrigated perennial horticulture*, whilst the inverse of 2169 ha changed from *irrigated perennial horticulture* to *cropping – sugar.*

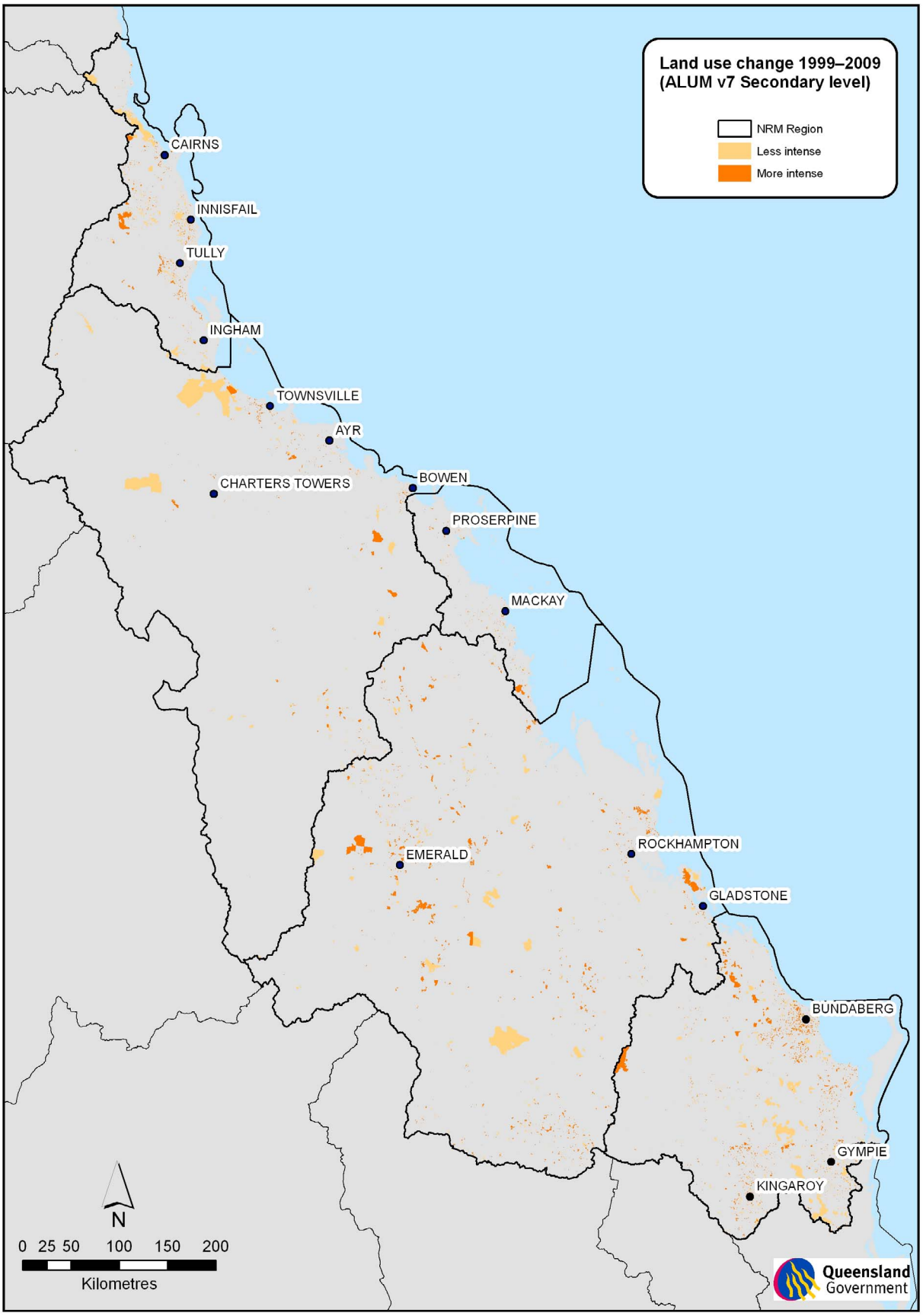


Figure 4: 1999–2009 land use change map at secondary level for the GBR catchments

Table 3: Summary statistics for land use change at secondary level for 1999–2009 in the GBR catchments (showing only the land use changes >2000 ha)

Land use code 1999	Land use class 1999	Land use code 2009	Land use class 2009	Area (ha)	Area (%)	Total change (%)
1.2.0	Managed resource protection	1.1.0	Nature conservation	185 966	0.48	17.92
2.1.0	Grazing native vegetation	2.2.0	Production forestry	98 577	0.26	9.50
2.1.0	Grazing native vegetation	1.1.0	Nature conservation	79 153	0.21	7.63
2.1.0	Grazing native vegetation	1.2.0	Managed resource protection	77 827	0.20	7.50
2.2.0	Production forestry	1.2.0	Managed resource protection	68 948	0.18	6.64
1.3.0	Other minimal use	1.2.0	Managed resource protection	62 402	0.16	6.01
2.1.0	Grazing native vegetation	3.3.0	Cropping	54 733	0.14	5.27
3.3.0	Cropping	2.1.0	Grazing native vegetation	47 214	0.12	4.55
1.3.0	Other minimal use	1.1.0	Nature conservation	40 258	0.10	3.88
2.1.0	Grazing native vegetation	5.8.0	Mining	32 526	0.08	3.13
1.1.0	Nature conservation	2.2.0	Production forestry	26 738	0.07	2.58
2.2.0	Production forestry	1.1.0	Nature conservation	22 437	0.06	2.16
2.1.0	Grazing native vegetation	5.4.0	Residential & farm infrastructure	20 660	0.05	1.99
2.1.0	Grazing native vegetation	3.1.0	Plantation forestry	17 811	0.05	1.72
3.3.0	Cropping	4.3.0	Irrigated cropping	16 029	0.04	1.54
2.1.0	Grazing native vegetation	4.3.0	Irrigated cropping	15 478	0.04	1.49
4.3.0	Irrigated cropping	2.1.0	Grazing native vegetation	8686	0.02	0.84
4.3.5	Irrigated cropping – sugar	2.1.0	Grazing native vegetation	8510	0.02	0.82
2.1.0	Grazing native vegetation	4.3.5	Irrigated cropping – sugar	8365	0.02	0.81
4.3.5	Irrigated cropping – sugar	4.4.0	Irrigated perennial horticulture	6590	0.02	0.63
2.1.0	Grazing native vegetation	6.2.0	Reservoir/dam	6477	0.02	0.62
2.1.0	Grazing native vegetation	4.4.0	Irrigated perennial horticulture	6397	0.02	0.62
1.3.0	Other minimal use	2.1.0	Grazing native vegetation	5825	0.02	0.56
2.1.0	Grazing native vegetation	1.3.0	Other minimal use	5230	0.01	0.50
1.2.0	Managed resource protection	2.2.0	Production forestry	4981	0.01	0.48
3.3.5	Cropping – sugar	2.1.0	Grazing native vegetation	4698	0.01	0.45
3.2.0	Grazing modified pastures	2.1.0	Grazing native vegetation	4439	0.01	0.43
2.1.0	Grazing native vegetation	3.2.0	Grazing modified pastures	4217	0.01	0.41
1.1.0	Nature conservation	2.1.0	Grazing native vegetation	4105	0.01	0.40
3.3.5	Cropping – sugar	4.4.0	Irrigated perennial horticulture	4041	0.01	0.39
4.4.0	Irrigated perennial horticulture	2.1.0	Grazing native vegetation	3237	0.01	0.31
3.3.0	Cropping	3.1.0	Plantation forestry	2957	0.01	0.28
1.3.0	Other minimal use	5.4.0	Residential & farm infrastructure	2951	0.01	0.28
6.5.0	Marsh/wetland	1.1.0	Nature conservation	2849	0.01	0.27
3.1.0	Plantation forestry	2.1.0	Grazing native vegetation	2761	0.01	0.27
2.1.0	Grazing native vegetation	4.1.0	Irrigated plantation forestry	2477	0.01	0.24
3.3.0	Cropping	5.8.0	Mining	2278	0.01	0.22
5.4.0	Residential & farm infrastructure	2.1.0	Grazing native vegetation	2172	0.01	0.21
4.4.0	Irrigated perennial horticulture	3.3.5	Cropping – sugar	2033	0.01	0.20
Total				**1 037 919**	**2.69**	**100**

Data format and availability

To access land use datasets we recommend using the Queensland Government Information Service (QGIS)—simply search for **land use mapping** in the type of data search, after restricting your search to **cadastral and land planning** in the topic category field. Metadata is also available from QGIS.

The dataset comprises an ESRI vector geodatabase at a nominal scale of 1:50 000. The feature classes are each a polygon dataset with each class having attributes describing land use. Land use is classified according to the Australian Land Use and Management Classification (ALUMC) Version 7, May 2010. Note that a representation showing land use at the secondary level is available when working within a geodatabase.

Digital data are 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.

Appendix A Accuracy assessment

The accuracy assessment provided reference data suitable for assessing the 2009 land use map. For each sample point, the true land use class was determined (reference data) based on aerial photograph interpretation, landholder contact or expert knowledge. These points were then compared to the mapped class (map data) and the information was summarised in the error matrix. The overall accuracy is summarised in terms of total accuracy and Kappa. 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. Total accuracy can be misleading, particularly when one class dominates the others. The Kappa statistic attempts to overcome this problem by adjusting for chance agreement. A common rule of thumb suggests a value of Kappa between 0.6 and 0.8 represents moderate agreement between the map and the ground truth; a value greater than 0.8 suggests strong agreement. Values less than 0.2 suggest the map is little better than a map produced by random allocation.

Sometimes points that differ between the map and the reference data are due to positional or spatial errors. Inaccurate registration of datasets is an example of spatial error. 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. Spatial errors influence thematic accuracy. The purpose here is to assess the thematic accuracy of land use data. However, the separation of spatial and thematic errors can be difficult and has not been undertaken. As a result, the accuracy assessment reflects properties of the land use data as a whole.

Note that the revised 1999 land use and the 1999–2009 land use change datasets were not accuracy assessed.

2009 land use dataset

The 2009 land use dataset was accuracy assessed for each NRM region within the GBR catchments, based on a random sampling strategy and using the map classes (area and frequency) as the strata. The stratified estimate of total accuracy and the Kappa are presented in Table 4 below. As the lower bound of the confidence interval for total accuracy in each region is greater than 0.8, the mapping meets ACLUMP specification.

Table 4: Summary of accuracy parameters by NRM region for 2009 land use in the GBR catchments

NRM region	Total accuracy	95% interval		Kappa	95% interval	
Burnett–Mary	0.89	0.83	0.93	0.70	0.59	0.80
Fitzroy	0.87	0.81	0.92	0.69	0.58	0.79
Burdekin	0.96	0.91	0.98	0.76	0.58	0.86
Mackay–Whitsunday	0.91	0.86	0.94	0.87	0.81	0.91
Wet Tropics	0.90	0.87	0.92	0.86	0.82	0.90