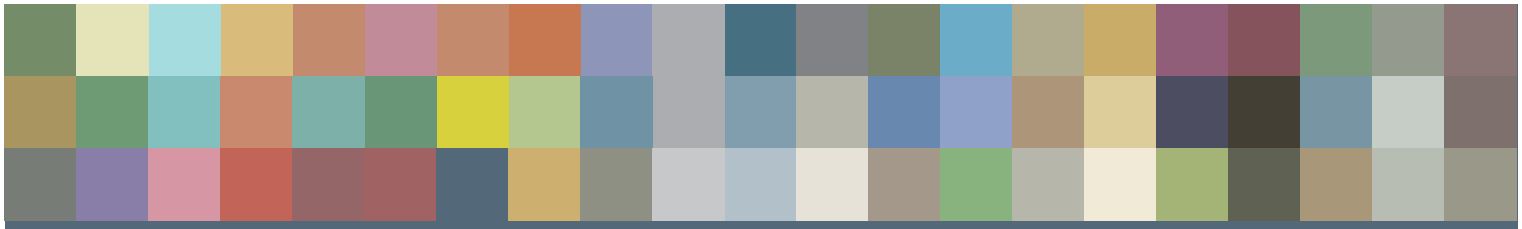

Land use summary 1999–2009

for the Burdekin NRM region

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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Citation

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Acknowledgements

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

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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 the Burdekin NRM region (which in area accounts for 36% of the priority GBR catchments) 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.

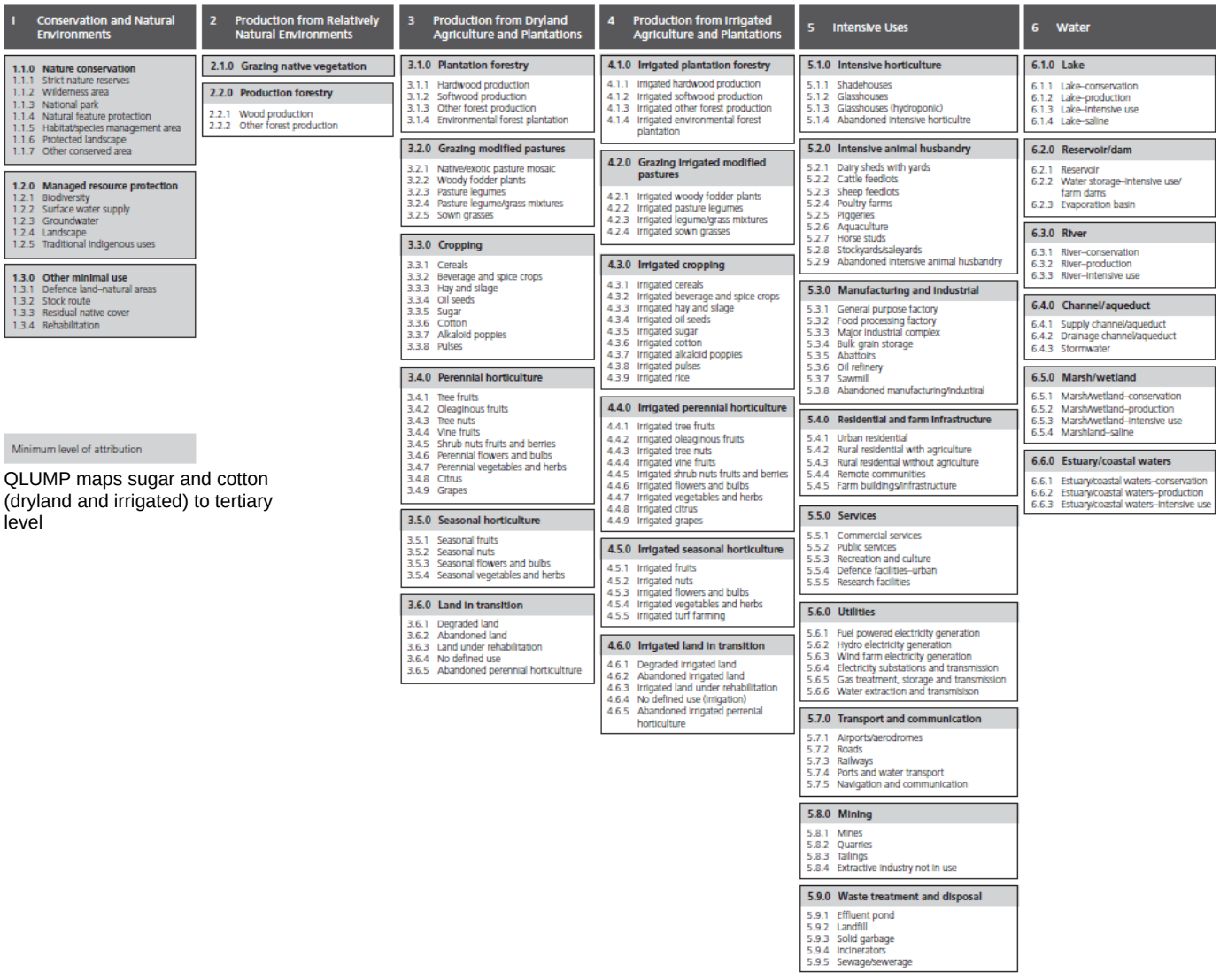
The mapping scale is 1:50 000 with a minimum mapping unit of 2 hectares and a width of 50 metres for linear features.

[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 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 it is likely there is 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 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 Burdekin NRM region, 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* (90%) and *nature conservation* (3%) are the major land use classes for 2009 in the Burdekin NRM region.

Analysis of the overall change between the land use from 1999 to 2009 shows that *managed resource protection* has increased significantly by 159% or 81 960 ha since 1999, whilst *nature conservation* increased by 15% or 46 822 ha. Overall, *grazing native vegetation* has remained relatively static, decreasing only marginally by 1% or 97 363 ha in the Burdekin NRM region. *Production forestry* has increased by 14% or 11 616 ha, whilst *mining* has also shown an increase of 36% or 4141 ha in the ten years from 1999–2009. The *residential and farm infrastructure* secondary land use class has increased by 13% or 2868 ha, due almost exclusively to the expansion of urban and rural residential classes, at the tertiary level.

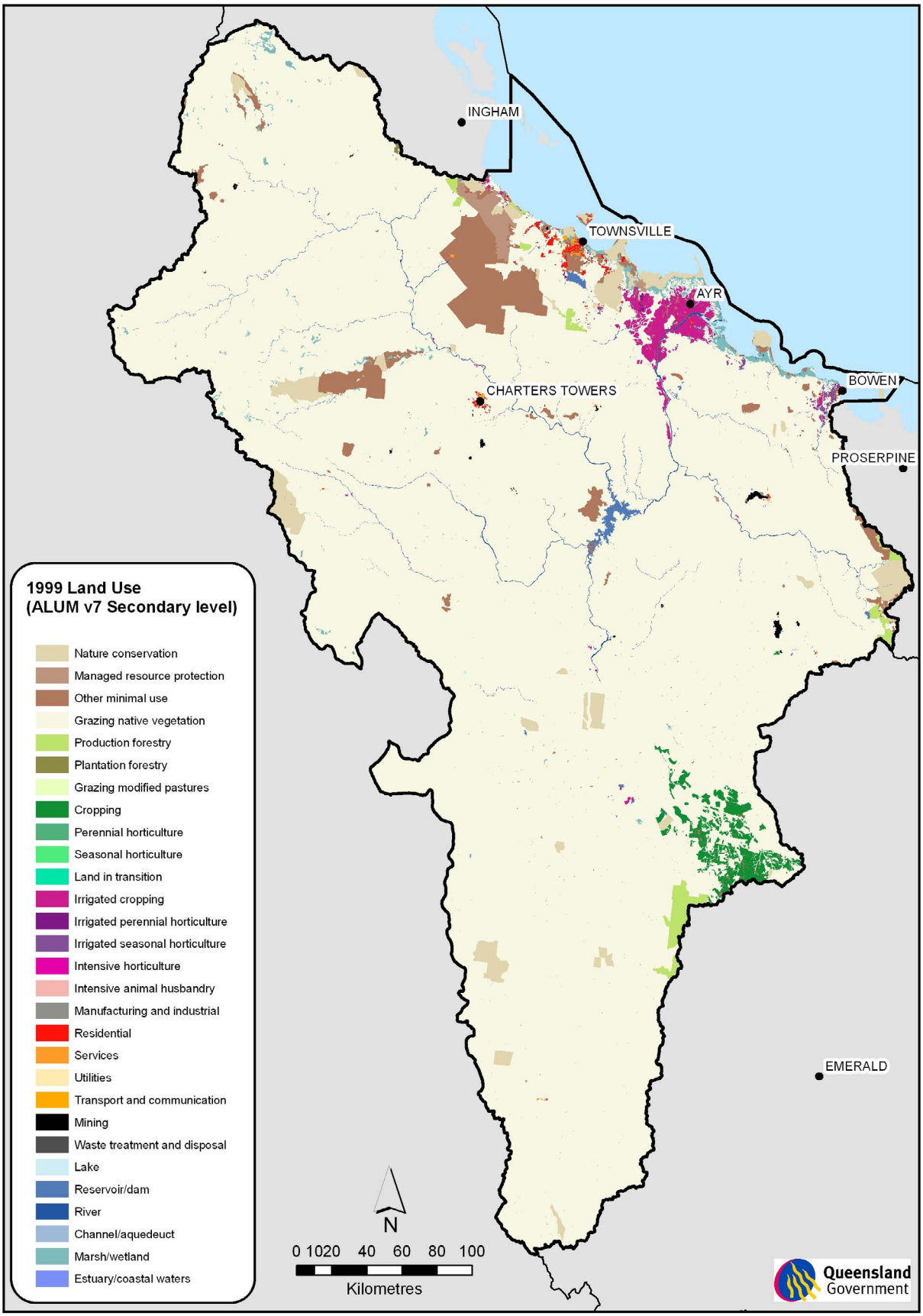


Figure 2: 1999 land use map for the Burdekin NRM region

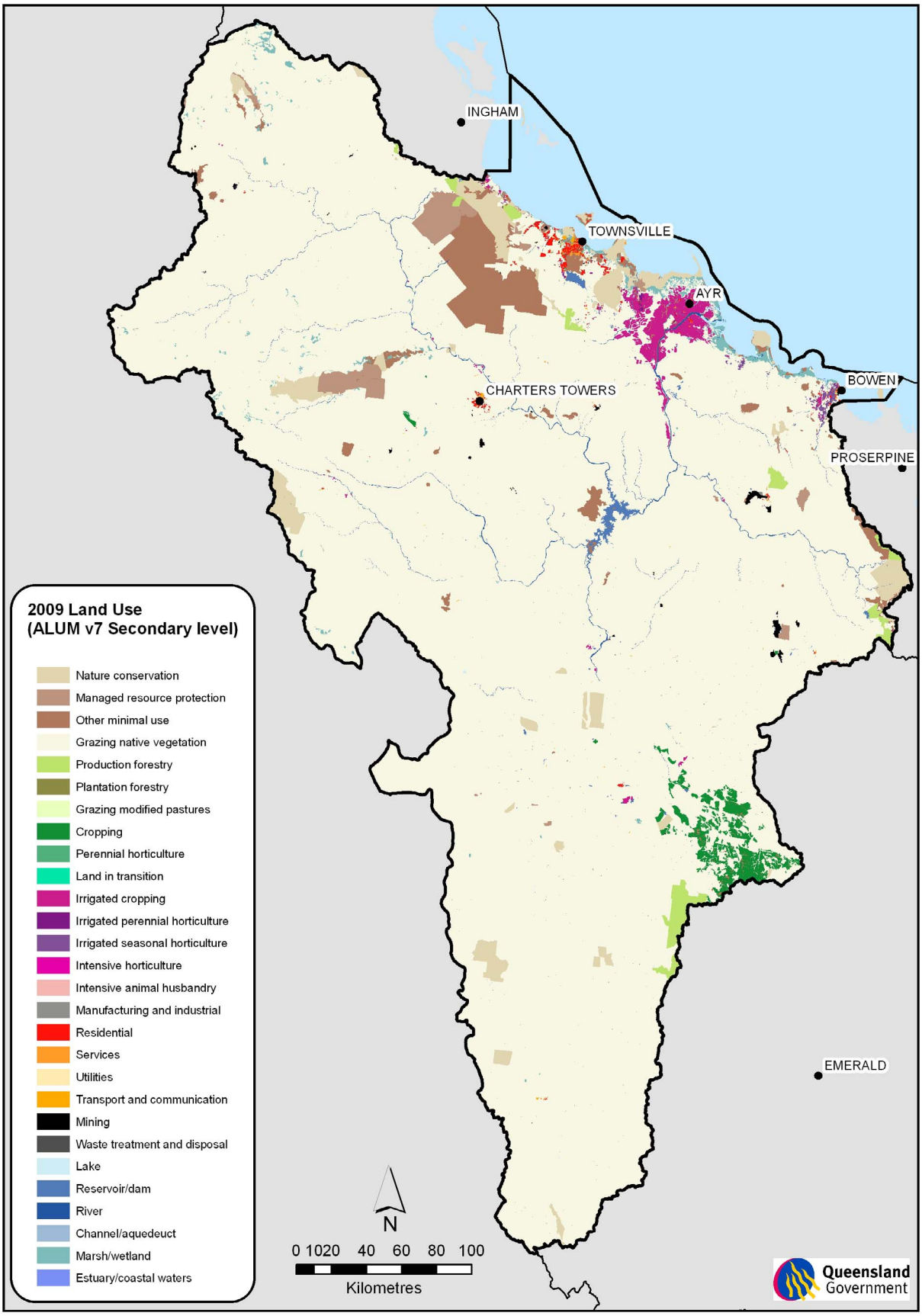


Figure 3: 2009 land use map for the Burdekin NRM region

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

Land use code	Land use class	Area (ha)	Area %
1	Conservation and natural environments	767 110	5.45
1.1	Nature conservation	317 928	2.26
1.2	Managed resource protection	51 516	0.37
1.3	Other minimal use	397 667	2.82
2	Production from relatively natural environments	12 829 982	91.11
2.1	Grazing native vegetation	12 745 051	90.51
2.2	Production forestry	84 930	0.60
3	Production from dryland agriculture and plantations	125 905	0.89
3.1	Plantation forestry	1234	0.01
3.2	Grazing modified pastures[1]	36	<0.01
3.3	Cropping	124 484	0.88
3.4	Perennial horticulture	138	<0.01
3.5	Seasonal horticulture	3	<0.01
3.6	Land in transition	10	<0.01
4	Production from irrigated agriculture and plantations	124 663	0.89
4.3	Irrigated cropping	111 218	0.79
4.3.5	Irrigated cropping – sugar[2]	104 839	0.74
4.3.6	Irrigated cropping – cotton[2]	1116	0.01
4.4	Irrigated perennial horticulture	3940	0.03
4.5	Irrigated seasonal horticulture	9506	0.07
5	Intensive uses	47 734	0.34
5.1	Intensive horticulture	33	<0.01
5.2	Intensive animal husbandry	397	<0.01
5.3	Manufacturing and industrial	1936	0.01
5.4	Residential and farm infrastructure	22 726	0.16
5.5	Services	6935	0.05
5.6	Utilities	45	<0.01
5.7	Transport and communication	3762	0.03
5.8	Mining	11 608	0.08
5.9	Waste treatment and disposal	292	<0.01
6	Water	186 553	1.32
6.1	Lake	834	0.01
6.2	Reservoir/dam	39 036	0.28
6.3	River	58 394	0.41
6.4	Channel/aquaduct	264	<0.01
6.5	Marsh/wetland	87 710	0.62
6.6	Estuary/coastal waters	315	<0.01
	Total	**14 081 947**	**100.00**

[1]*Grazing 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 *irrigated cropping – sugar* and *irrigated cropping – cotton* are subsets of the total area of *irrigated cropping*.

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

Land use code	Land use class	Area (ha)	Area %
1	Conservation and natural environments	840 264	5.97
1.1	Nature conservation	364 750	2.59
1.2	Managed resource protection	133 476	0.95
1.3	Other minimal use	342 037	2.43
2	Production from relatively natural environments	12 744 234	90.50
2.1	Grazing native vegetation	12 647 688	89.81
2.2	Production forestry	96 546	0.69
3	Production from dryland agriculture and plantations	126 277	0.90
3.1	Plantation forestry	40	<0.01
3.2	Grazing modified pastures[1]	74	<0.01
3.3	Cropping	125 437	0.89
3.4	Perennial horticulture	268	<0.01
3.6	Land in transition	459	<0.01
4	Production from irrigated agriculture and plantations	129 420	0.92
4.3	Irrigated cropping	115 491	0.82
4.3.5	Irrigated cropping – sugar[2]	105 033	0.75
4.3.6	Irrigated cropping – cotton[2]	1314	0.01
4.4	Irrigated perennial horticulture	4712	0.03
4.5	Irrigated seasonal horticulture	9189	0.07
4.6	Irrigated land in transition	28	<0.01
5	Intensive uses	55 593	0.39
5.1	Intensive horticulture	40	<0.01
5.2	Intensive animal husbandry	689	<0.01
5.3	Manufacturing and industrial	2239	0.02
5.4	Residential and farm infrastructure	25 594	0.18
5.5	Services	6865	0.05
5.6	Utilities	39	<0.01
5.7	Transport and communication	4057	0.03
5.8	Mining	15 749	0.11
5.9	Waste treatment and disposal	321	<0.01
6	Water	186 158	1.32
6.1	Lake	836	0.01
6.2	Reservoir/dam	40 086	0.28
6.3	River	58 394	0.41
6.4	Channel/aquaduct	271	<0.01
6.5	Marsh/wetland	86 266	0.61
6.6	Estuary/coastal waters	305	<0.01
	Total	**14 081 947**	**100.00**

[1]*Grazing 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 *irrigated cropping – sugar* and *irrigated cropping – cotton* are subsets of the total area of *irrigated cropping*.

1999–2009 land use change dataset

Figure 4 shows the 1999–2009 land use change dataset for the Burdekin NRM region. The data have 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 at the secondary level from 1999–2009 is 243 775 ha. This is equivalent to 1.73% of the region. Of this 44 937 ha (18% of the total change) is mapped as an increase in land use intensity, whilst 198 838 ha (82%) is a decrease.

Summary statistics presenting the land use change classes at the secondary level are shown in Table 3. The significant land use changes are from *grazing native vegetation* (73 612 ha) and *other minimal use* (54 081 ha) to *managed resource protection*. Collectively they account for 52% of the total land use change within the Burdekin NRM region. These changes can be attributed to the establishment of numerous nature refuges through out the region. The other major change was seen from *managed resource protection* to *nature conservation* (48 097 ha or 20% of the total change), which can be attributed to the conversion of forest reserves (mapped as *managed resource protection*) to *national parks*, under the Queensland Government's Statewide Forests Process. This conversion of state forests to protected areas directly contributes to the government’s commitments to protect Queensland’s biodiversity and to increase the state’s total area of lands protected for conservation purposes. Interestingly, some 3768 ha of *grazing native vegetation* changed to *mining*, accounting for 2% of the total change in the region, whilst 1864 ha changed to *residential and farm infrastructure*, due almost exclusively to the expansion of urban and rural residential land use classes, at the tertiary level.

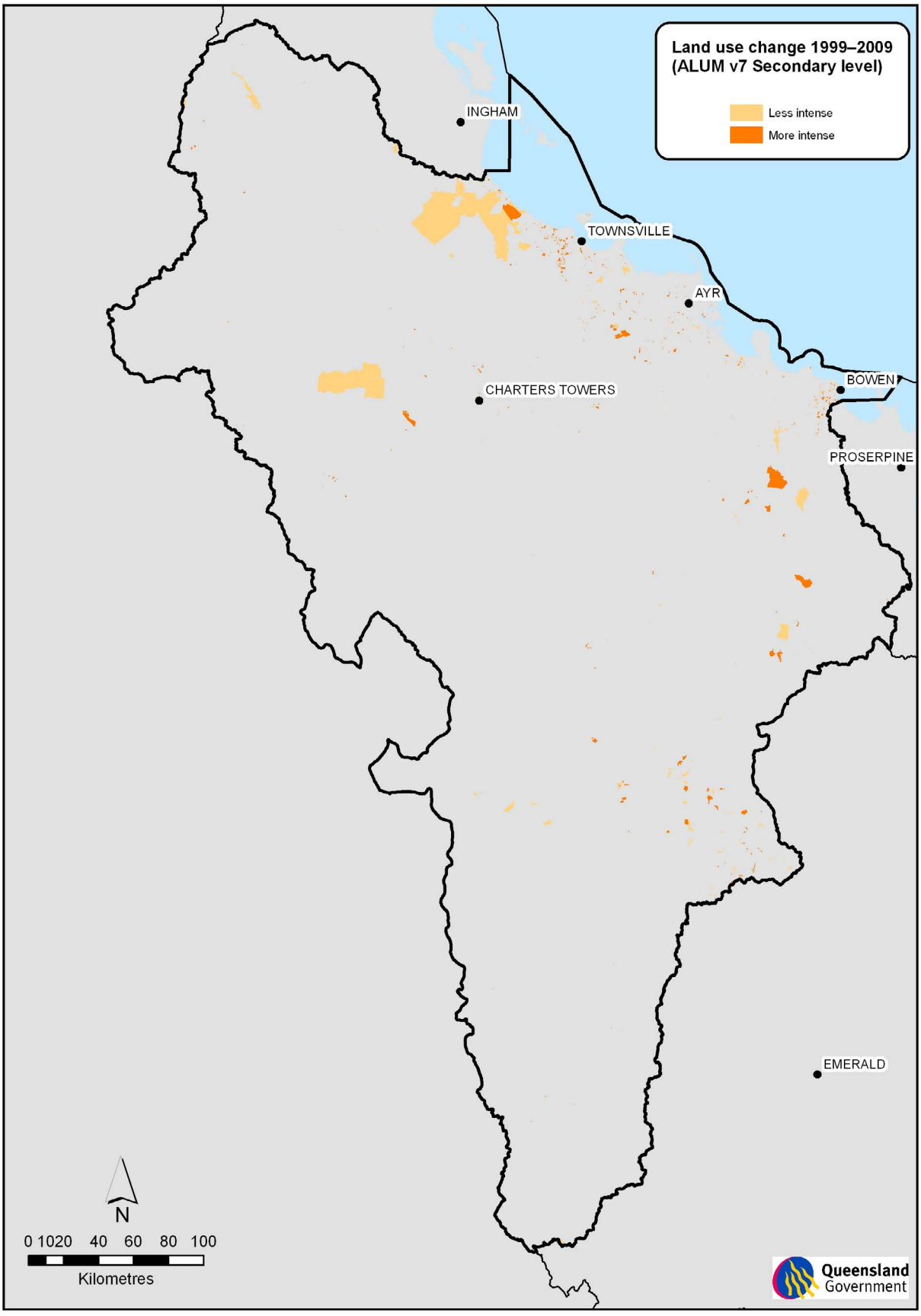


Figure 4: 1999–2009 land use change map at secondary level for the Burdekin NRM region

Table 3: Summary statistics for land use change at secondary level for 1999–2009 in the Burdekin NRM region (showing only the land use changes >210 ha)

Land use code 1999	Land use class 1999	Land use code 2009	Land use class 2009	Area (ha)	Area (%)	Total change (%)
2.1.0	Grazing native vegetation	1.2.0	Managed resource protection	73 612	0.52	30.20
1.3.0	Other minimal use	1.2.0	Managed resource protection	54 081	0.38	22.18
1.2.0	Managed resource protection	1.1.0	Nature conservation	48 097	0.34	19.73
2.1.0	Grazing native vegetation	2.2.0	Production forestry	9108	0.06	3.74
2.1.0	Grazing native vegetation	3.3.0	Cropping	6452	0.05	2.65
3.3.0	Cropping	2.1.0	Grazing native vegetation	5602	0.04	2.30
1.1.0	Nature conservation	2.2.0	Production forestry	5562	0.04	2.28
2.1.0	Grazing native vegetation	4.3.0	Irrigated cropping	4850	0.03	1.99
2.1.0	Grazing native vegetation	1.1.0	Nature conservation	4049	0.03	1.66
2.1.0	Grazing native vegetation	5.8.0	Mining	3768	0.03	1.55
1.1.0	Nature conservation	2.1.0	Grazing native vegetation	3541	0.03	1.45
2.2.0	Production forestry	1.2.0	Managed resource protection	2362	0.02	0.97
2.2.0	Production forestry	1.1.0	Nature conservation	1928	0.01	0.79
2.1.0	Grazing native vegetation	5.4.0	Residential & farm infrastructure	1864	0.01	0.76
2.1.0	Grazing native vegetation	6.2.0	Reservoir/dam	1491	0.01	0.61
2.1.0	Grazing native vegetation	4.3.5	Irrigated cropping – sugar	1431	0.01	0.59
3.1.0	Plantation forestry	2.2.0	Production forestry	1232	0.01	0.51
6.5.0	Marsh/wetland	1.1.0	Nature conservation	1078	0.01	0.44
1.3.0	Other minimal use	1.1.0	Nature conservation	994	0.01	0.41
4.5.0	Irrigated seasonal horticulture	2.1.0	Grazing native vegetation	969	0.01	0.40
2.1.0	Grazing native vegetation	4.5.0	Irrigated seasonal horticulture	799	0.01	0.33
4.3.0	Irrigated cropping	2.1.0	Grazing native vegetation	649	<0.01	0.27
4.3.5	Irrigated cropping – sugar	2.1.0	Grazing native vegetation	621	<0.01	0.25
1.3.0	Other minimal use	5.4.0	Residential & farm infrastructure	490	<0.01	0.20
2.1.0	Grazing native vegetation	4.4.0	Irrigated perennial horticulture	490	<0.01	0.20
1.3.0	Other minimal use	3.3.0	Cropping	448	<0.01	0.18
6.2.0	Reservoir/dam	5.4.0	Residential & farm infrastructure	443	<0.01	0.18
5.5.0	Services	1.3.0	Other minimal use	432	<0.01	0.18
2.1.0	Grazing native vegetation	4.3.6	Irrigated cropping – cotton	378	<0.01	0.16
6.5.0	Marsh/wetland	2.1.0	Grazing native vegetation	366	<0.01	0.15
4.3.0	Irrigated cropping	4.5.0	Irrigated seasonal horticulture	365	<0.01	0.15
2.1.0	Grazing native vegetation	3.6.0	Land in transition	314	<0.01	0.13
4.5.0	Irrigated seasonal horticulture	4.4.0	Irrigated perennial horticulture	262	<0.01	0.11
2.1.0	Grazing native vegetation	5.2.0	Intensive animal husbandry	242	<0.01	0.10
4.5.0	Irrigated seasonal horticulture	1.3.0	Other minimal use	238	<0.01	0.10
2.1.0	Grazing native vegetation	1.3.0	Other minimal use	221	<0.01	0.09
4.4.0	Irrigated perennial horticulture	2.1.0	Grazing native vegetation	220	<0.01	0.09
4.3.5	Irrigated cropping – sugar	4.4.0	Irrigated perennial horticulture	217	<0.01	0.09
1.3.0	Other minimal use	5.3.0	Manufacturing and industrial	217	<0.01	0.09
1.1.0	Nature conservation	1.3.0	Other minimal use	213	<0.01	0.09
Total				**243 775**	**1.73**	**100**

Data format and availability

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.

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 of the sample points, 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 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. 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.

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 we estimated the user's accuracy of class A to be 0.84, then from a random sample of 100 points chosen from areas on the map in this class, around 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 around 84 would also be in class B according to the map. An accurate map should have both high user's and producer's accuracies.

Within the user and producer accuracy assessment, the per-class estimates of accuracy are often not very precise, since only part of the total sample points are used to estimate them. As a guide, if the upper bound of the interval for either the user's or producer's accuracy is less than 0.5, this can indicate a true misclassification problem, rather than one due to inadequacies in sample size.

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 data and the 1999–2009 land use change datasets were not accuracy assessed.

2009 land use dataset

The 2009 land use dataset was accuracy assessed with 441 points based on a random sampling strategy, using the map classes (area and frequency) as the strata. The stratified estimate of total accuracy is 0.96 (0.91, 0.98) and Kappa is 0.76 (0.58, 0.86). As the lower bound of the confidence interval for total accuracy is greater than 0.8, the mapping meets ACLUMP specification.

Table 4 provides the error matrix for the accuracy assessment of the 2009 land use data. For the majority of classes, the reference data agreed with the map data. For example, *residential and farm infrastructure* had 30 sample points identified. For 26 of those points, the map data were also *residential and farm infrastructure* and therefore correct. For four of the points, the map data were incorrect with a point falling in each of the mapped classes *grazing native vegetation*, *land in transition, services* and *reservior/dam*.

The column 'proportion' in Table 4 is the relative proportion in area of the classes that were assessed, and not of the catchment as a whole. The areas of other classes that are not amenable to assessment—for example, *nature conservation*—are removed from the total area before the proportions are calculated. This column will thus sum to 100%.

The error matrix (Table 4) shows that the land use class of *managed resouce protection* has been misclassified in the mapping as *other conserved area*, specifically relating to nature refuges. Note that this was corrected in the final mapping products. The error matrix also highlights the confusion between mapping the dryland and irrigated *perennial horticulture* land use classes, which was noted in the data limitations (page 6).

Table 5 provides the user's and producer's accuracy for the 2009 Burdekin NRM land use dataset. The majority of land use classes in this catchment have been mapped accurately. The largest assessable land use class in this catchment is *grazing native vegetation* which has been mapped with a very high user's and producer's accuracies of 0.977 and 0.995 respectively. The next largest class by area is *other minimal use* which also returned a high user's and producer's accuracy. The error matrix (Table 4) provides more detail on the misclassifications.

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. Examples of this are *managed resource protection*.

The user's and producer's accuracy results should be interpreted individually for their respective classes—noting that the smaller classes proportionally to the overall 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. The producer's accuracy for *residential and farm infrastructure* is 0.133; however, from the 95% interval (0.030, 0.718) we see that more sample points would be required to confidently determine how accurate this class is. The other classes with a relatively low accuracy and very large confidence intervals constitute a small proportion (<0.2% each) of the area assessed.

Table 4: Error matrix for the Burdekin NRM region 2009 land use dataset

		Reference data																									
	2009 land use class	Other conserved area	Managed resource protection	Other minimal use	Grazing native vegetation	Production forestry	Cropping	Perennial horticulture	Land in transition	Irrigated cropping	Irrigated cropping – sugar	Irrigated perennial horticulture	Irrigated seasonal horticulture	Intensive animal husbandry	Manufacturing & industrial	Residential & farm infrastructure	Services	Transport and communications	Mining	Waste treatment & disposal	Lake	Reservoir/dam	River	Channel/aquaduct	Marsh/wetland	Total	Proportion (%)
Map data	Other conserved area	**0**	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0.27
	Managed resource protection	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	0.87
	Other minimal use	0	0	**58**	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	2.59
	Grazing native vegetation	0	0	0	**68**	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	69	91.98
	Production forestry	0	0	0	0	**15**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0.69
	Cropping	0	0	0	1	0	**25**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0.91
	Perennial horticulture	0	0	0	0	0	0	**4**	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	7	<0.01
	Land in transition	0	0	3	0	0	0	0	**6**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	<0.01
	Irrigated cropping	0	0	0	1	0	0	0	0	**9**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.07
	Irrigated cropping – sugar	0	0	0	0	0	0	0	0	0	**29**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	0.76
	Irrigated perennial horticulture	0	0	0	1	0	0	0	0	0	0	**6**	0	0	0	2	0	0	0	0	0	0	0	0	0	9	0.03
	Irrigated seasonal horticulture	0	0	0	0	0	0	0	0	2	0	1	**5**	0	0	0	0	0	0	0	0	0	0	0	0	8	0.07
	Intensive animal husbandry	0	0	0	0	0	0	0	0	0	0	0	1	**9**	0	0	0	0	0	0	0	0	0	0	0	10	<0.01
	Manufacturing & industrial	0	0	0	0	0	0	0	1	0	0	0	0	0	**7**	0	1	0	0	0	0	0	0	0	0	9	0.02
	Residential & farm infrastructure	0	0	0	1	0	0	0	1	0	0	0	0	0	0	**26**	1	0	0	0	0	1	0	0	0	30	0.19
	Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**10**	0	0	0	0	0	0	0	0	10	0.05
	Transport & communications	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	**6**	0	0	0	0	0	0	0	10	0.03
	Mining	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**13**	0	0	1	0	0	0	14	0.11
	Waste treatment & disposal	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	**8**	0	0	0	0	0	9	<0.01
	Lake	0	0	0	4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**4**	0	0	0	0	9	0.01
	Reservoir/dam	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**24**	0	0	0	29	0.3
	River	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**13**	0	0	15	0.42
	Channel/aquaduct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**8**	0	9	<0.01
	Marsh/wetland	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	**24**	30	0.63
	Total	0	12	63	94	15	25	4	8	11	30	10	6	9	8	29	12	6	13	8	4	29	13	8	24	**441**	100

Table 5: User's and producer's accuracy for the Burdekin NRM region 2009 land use dataset

Class	User's			Producer's		
	50%	95% interval		50%	95% interval	
Other conserved area	0.000	0.000	0.034	0.000	0.000	0.731
Managed resource protection	NA	NA	NA	NA	NA	NA
Other minimal use	0.911	0.824	0.964	0.984	0.735	0.997
Grazing native vegetation	0.977	0.923	0.997	0.995	0.989	0.997
Production forestry	0.957	0.783	0.999	0.984	0.451	1.000
Cropping	0.938	0.804	0.992	0.986	0.512	1.000
Perennial horticulture	0.506	0.182	0.832	0.076	0.001	0.864
Land in transition	0.613	0.311	0.873	0.082	0.002	0.407
Irrigated cropping	0.841	0.552	0.976	0.639	0.060	0.902
Irrigated cropping – sugar	0.978	0.878	0.999	0.984	0.476	0.999
Irrigated perennial horticulture	0.613	0.305	0.869	0.475	0.023	0.879
Irrigated seasonal horticulture	0.560	0.250	0.847	0.730	0.039	0.989
Intensive animal husbandry	0.842	0.549	0.976	0.235	0.005	0.958
Manufacturing and industrial	0.719	0.405	0.934	0.463	0.013	0.970
Residential & farm infrastructure	0.848	0.695	0.944	0.133	0.030	0.718
Services	0.936	0.696	0.998	0.670	0.054	0.942
Transport and communications	0.551	0.258	0.811	0.553	0.017	0.990
Mining	0.885	0.663	0.983	0.888	0.113	0.998
Waste treatment and disposal	0.828	0.524	0.972	0.137	0.002	0.930
Lake	0.399	0.143	0.710	0.152	0.003	0.930
Reservoir/dam	0.809	0.648	0.920	0.761	0.227	0.919
River	0.829	0.596	0.958	0.967	0.300	1.000
Channel/aquaduct	0.826	0.519	0.972	0.112	0.002	0.895
Marsh/wetland	0.781	0.620	0.902	0.976	0.368	1.000

Table 4: Error matrix for the Burdekin NRM region 2009 land use dataset

		Reference data																								
	2009 land use class	Other conserved area	Managed resource protection	Other minimal use	Grazing native vegetation	Production forestry	Cropping	Perennial horticulture	Land in transition	Irrigated cropping	Irrigated cropping – sugar	Irrigated perennial horticulture	Irrigated seasonal horticulture	Intensive animal husbandry	Manufacturing & industrial	Residential & farm infrastructure	Services	Transport and communications	Mining	Waste treatment & disposal	Lake	Reservoir/dam	River	Channel/aquaduct	Marsh/wetland	Total	Proportion (%)
Map data	**Other conserved area**	**0**	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0.27
	Managed resource protection	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	0.87
	Other minimal use	0	0	**58**	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	2.59
	Grazing native vegetation	0	0	0	**68**	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	69	91.98
	Production forestry	0	0	0	0	**15**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0.69
	Cropping	0	0	0	1	0	**25**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0.91
	Perennial horticulture	0	0	0	0	0	0	**4**	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	7	<0.01
	Land in transition	0	0	3	0	0	0	0	**6**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	<0.01
	Irrigated cropping	0	0	0	1	0	0	0	0	**9**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0.07
	Irrigated cropping – sugar	0	0	0	0	0	0	0	0	0	**29**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	0.76
	Irrigated perennial horticulture	0	0	0	1	0	0	0	0	0	0	**6**	0	0	0	2	0	0	0	0	0	0	0	0	0	9	0.03
	Irrigated seasonal horticulture	0	0	0	0	0	0	0	0	2	0	1	**5**	0	0	0	0	0	0	0	0	0	0	0	0	8	0.07
	Intensive animal husbandry	0	0	0	0	0	0	0	0	0	0	0	1	**9**	0	0	0	0	0	0	0	0	0	0	0	10	<0.01
	Manufacturing & industrial	0	0	0	0	0	0	0	1	0	0	0	0	0	**7**	0	1	0	0	0	0	0	0	0	0	9	0.02
	Residential & farm infrastructure	0	0	0	1	0	0	0	1	0	0	0	0	0	0	**26**	1	0	0	0	0	1	0	0	0	30	0.19
	Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**10**	0	0	0	0	0	0	0	0	10	0.05
	Transport & communications	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	**6**	0	0	0	0	0	0	0	10	0.03
	Mining	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**13**	0	0	1	0	0	0	14	0.11
	Waste treatment & disposal	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	**8**	0	0	0	0	0	9	<0.01
	Lake	0	0	0	4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**4**	0	0	0	0	9	0.01
	Reservoir/dam	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**24**	0	0	0	29	0.3
	River	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**13**	0	0	15	0.42
	Channel/aquaduct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**8**	0	9	<0.01
	Marsh/wetland	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	**24**	30	0.63
	Total	0	12	63	94	15	25	4	8	11	30	10	6	9	8	29	12	6	13	8	4	29	13	8	24	**441**	100