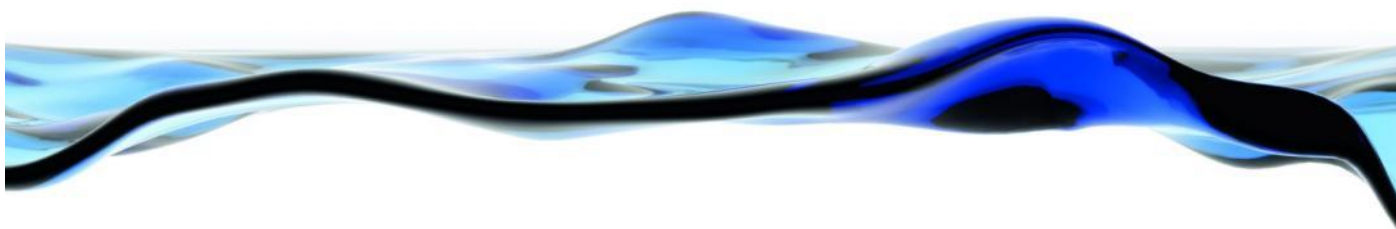


# Development of Preliminary 1969 and 1983 Land Use Maps for the South East of SA

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Goyder Institute for Water Research  
Technical Report Series No. 15/16



[www.goyderinstitute.org](http://www.goyderinstitute.org)

**Goyder Institute for Water Research Technical Report Series ISSN: 1839-2725**

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**Citation**

Harrington, N, Millington, A, Sodahlan, ME and Phillips, D, 2015, Development of Preliminary 1969 and 1983 Land Use Maps for the South East of SA, Goyder Institute for Water Research Technical Report Series No. 15/16.

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# Preface

## South East Regional Water Balance Project Background

The South East Regional Water Balance project is a collaboration between Flinders University, CSIRO and the Department of Environment, Water and Natural Resources (DEWNR), funded by the Goyder Institute for Water Research. The project commenced in September 2012, with the objective of developing a regional water balance model for the Lower Limestone Coast Prescribed Wells Area (LLC PWA). The project was initiated following conclusions from the South East Water Science Review (2011) that, due to a number of gaps in understanding of processes that affect the regional water balance, there is uncertainty about the amount of water that can be extracted sustainably from the Lower Limestone Coast region as a whole. The review also concluded that, because of the close link between groundwater and surface water resources in the region, surface water resources and ecosystems are particularly vulnerable to groundwater exploitation.

The South East Regional Water Balance project follows on from the report of Harrington et al. (2011), which recommended that a consistent framework of models is required to support water management in the South East, with the first step being a regional groundwater flow model to:

- bring together all existing knowledge,
- address regional scale water balance questions
- provide boundary conditions for smaller scale models to address local scale questions, including those around “hotspot” areas and significant wetlands.

Harrington et al. (2011) also identified the critical knowledge gaps that limit the outcomes from a regional scale model. These included but were not limited to:

- Spatial and temporal variability in groundwater recharge and evapotranspiration.
- Interaquifer leakage and the influence of faults on groundwater flow.
- The nature of wetland-groundwater interactions
- Understanding of processes occurring at the coastal boundary
- Surface water-groundwater interactions around the man-made drainage network
- The absence of information on historical land use and groundwater extraction

The South East Regional Water Balance project has included numerous tasks that have sought to improve the conceptualisation of the regional water balance, address some of the critical knowledge gaps, incorporate this and existing information into a regional groundwater flow model and understand how this improved understanding can be used in the management of wetland water levels.

An overview of the project and its output can be found in Harrington et al. 2015. *South East Regional Water Balance Project – Phase 2. Project Summary Report*. Goyder Institute Report 15/39.

# Contents

Preface	iii
South East Regional Water Balance Project Background	iii
Acknowledgments	3
Executive Summary	4
1    Introduction	5
1.1    Background and Objectives	5
1.2    Study Area	6
Associated Reports and Research Papers	6
2    Methodology	9
2.1    Preliminary 1969 Land Use Map from Aerial Photo Interpretation	9
2.2    Refining Irrigation Areas Using Bore Construction Data	10
2.3    Repairing Misaligned Polygon Boundaries Following Modification of the 2008 Land Use Map	11
2.4    Construction of an “Intermediate” Land Use Map for 1983-1990	11
3    Results	13
3.1    1969 and “Intermediate” 1983 Land Use Maps	13
4    Discussion	17
4.1    Uncertainty in the Historical Land Use Maps	17
4.2    Quantifying Land Use Changes Between 1969 and 2008	18
5    Conclusions and Further Work	28
References	29
Appendix A    Table of major historical events related to land cover and land use in the South East	30
Appendix B    Change in Land Use Data	<b>Error! Bookmark not defined.</b>

## Figures

Figure 1.1 Location of the study area and the area of interest, the Lower Limestone Coast Prescribed Wells Area.....	8
Figure 3.1 (a) 1969 land use map constructed by modifying the 2008 land use map based on aerial photograph interpretation. (b) 2008 land use map. ....	15
Figure 3.2 “Intermediate” land use map constructed to be representative of the period from 1983 to 1990. ....	16
Figure 4.1 Changes in area (ha) under each land use category for the whole study area. ....	20
Figure 4.2 Counties located in the study area. ....	22
Figure 4.3 Hundreds within the study area. ....	23
Figure 4.4 Changes in areas (ha) under each major land use class for each hundred in counties (a) Buckingham, (b) Macdonnell, (c) Robe and (d) Grey. ....	27

## Tables

Table 3.1. Land use categories in the 1969, 1983 and 2008 land use maps and the corresponding categories shown in Figure 3.1.....	13
Table 4.1 Estimated confidence (%) in the assignment of land use categories in each of the land use maps developed in this project, using the methodologies described above.....	17
Table 4.2 Reclassification results of land uses classes in the 1969 and 2008 NCGRT land use maps. ....	19

# Acknowledgments

This project was funded by the Goyder Institute for Water Research through the South East Regional Water Balance Project.

Thanks to Jeff Lawson and George Mackenzie (DEWNR) for providing the 1969 aerial photographs and to Jeff Lawson and Dr Harpinder Sandhu (Flinders University) for reviewing the draft report.

# Executive Summary

A preliminary historical 1969 land use map was constructed for a large portion of the South East of South Australia by modifying the existing 2008 digital land use map based on manual interpretation of black and white aerial photographs and interpretation of irrigation bore drilling records. The major land use changes that could be identified between 2008 and the 1969 aerial photos were between native vegetation, general cleared grazing/dryland cropping land uses, plantation forestry, horticulture (mainly vineyards) and to some degree irrigated land uses. Locations of irrigation bores based upon historical bore drilling records were used as a basis for reducing the area under irrigated land uses in the 1969 land use map.

This preliminary product provides an improved basis for modelling of historical groundwater recharge for use in groundwater flow models. It is likely to have other applications outside the groundwater modelling domain. There are significant limitations in the accuracy of the map, associated with the method of visual interpretation of aerial photos. Further work, using a variety of other data sources could significantly improve this preliminary product.

The preliminary 1969 land use map was used to estimate the magnitudes of major land use changes at the scale of hundreds. The hundreds that experienced the greatest land use changes by area between 1969 and 2008 were:

- In the hundreds of Beeamma, Geegeela and Hynam, where there was a lot of land converted from "Conservation and natural environments" to "Grazing modified pastures".
- In the hundreds of Coles, Short, Caroline, Penola and Mount Benson, where large areas of land were converted from "Conservation and natural environments" or "Land in transition" (i.e. land that had obviously been cleared in 1969) to "Plantation forestry".

An "intermediate" land use map has also been constructed as a placeholder to approximately represent the period 1983-1990. This map is based upon the 1969 land use map, with the only additions being the areas affected by the 1983 bushfires (classified as "Burnt Out" and areas affected by vineyard expansion in the late 1970s and early 1980s.

Both of the preliminary land use maps constructed in this study are considered to be more useful in modelling of rainfall recharge to groundwater for the region than using an existing electronic land use map, e.g. 1998. However, refinement of these products using aerial photos and extraction bore drilling records (for the 1983 map) and anecdotal or documented evidence and information from the forestry and viticulture industries would be of great benefit to future applications, including recharge modelling.

# 1 Introduction

## 1.1 Background and Objectives

The calibration of groundwater flow models requires an ability to simulate aquifer hydraulic heads as accurately as possible to as far back as extends the hydraulic observation record. In the South East of SA, this is approximately 1970. Groundwater levels in unconfined aquifers, including that underlying the South East of SA, often respond rapidly to rainfall recharge, and this in turn is greatly affected by changes to land use over time. Over the past 40 years in the South East, there have been significant changes to land use that would have had an obvious impact on rainfall recharge and hence groundwater levels. The most important of these were the conversion of large areas of native vegetation to agricultural land, agricultural land to plantation forestry and non-irrigated crops and pasture to irrigated land uses. A table showing major historical events related to land use and land cover is included as Appendix A of this report.

The centrepiece of the Goyder Institute for Water Research-funded South East Regional Water Balance Project is the development of a regional groundwater flow model (Morgan et al., in prep.). The lack of historical land use information for the South East was identified early in the development of that project as a significant limitation to such a model (Harrington et al., 2011). Digital land use maps of the South East of SA are available only for the years 1998, 2002, 2008 and 2012<sup>1</sup>. However, many of the major land use changes in the South East occurred prior to this. Methods for creating historical land use maps for the South East were investigated in Phase 1 of the Lower South East Regional Water Balance project (Millington et al., 2013). The methods investigated were: (1) the interpretation of Landsat data, which is available in varying extent and quality, back as far as 1975, and (2) collation of Agricultural Census data, which provides information about land use at the hundred-scale, for the years 1857 to 1974. The capabilities of these methods were identified, along with their challenges and limitations. The potential to develop a seamless record of land use in the South East, using these data sources, along with aerial photographs, historical maps and other ancillary information, was also identified. Such a project would be labour intensive and hence require a long-term commitment, putting it outside the scope of the South East Regional Water Balance project. However it would provide a significant contribution not only to the development of groundwater flow models, but in the domains of land change science and ecosystem services.

In lieu of developing a full suite of historical land use maps for the South East, it was decided to develop a land use map for 1969 alone, using available hard copy aerial photographs, to investigate the extents of the major land use changes that had occurred between 1969 and present day, and provide a basis for modelling of rainfall recharge in the early part of the calibration time frame for the groundwater flow model. If this was successful, an “intermediate” land use map could be constructed to approximately represent the period 1983-1990, capturing the two major land use changes that occurred in the late 1970’s to early 1980’s. These were 1) the expansion of the area under vineyards in the Padthaway and Coonawarra areas and 2) the effects of the 1983 “Ash Wednesday” bushfires, which destroyed large areas of pine plantation and native vegetation (Appendix A). It was considered necessary to represent the effects of the bushfires in particular for the purposes of recharge modelling for the area, as the effects of these are prominent in groundwater hydrographs in that immediate area.

This exercise formed a sub-project within Task 1 of the *South East Regional Water Balance project: Development of a regional groundwater flow model*. It is reported separately from the regional model development because of its potential applications outside the development of groundwater flow models.

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<sup>1</sup> The 2012 map only divides the area into very basic land use classes, e.g. Agricultural areas.



The specific objectives of this sub-project were to:

1. Construct a land use map for 1969 using available data that reflects as well as possible the major land use changes that have occurred over the period 1969 – present.
2. Quantify the major land use changes that have occurred over that time frame.
3. Construct a representative “intermediate” land use map for the 1983-1990 period that represents the expansion of vineyard areas in the late 1970s and the effects of the 1983 Ash Wednesday bushfires.

## 1.2 Study Area

The area of interest for the South East Regional Water Balance project is the Lower Limestone Coast Prescribed Wells Area (LLC PWA). However, the study area is broader than this to encompass the whole groundwater flow system, being roughly bounded by the structural highs of the Padthaway Ridge and the Dundas Plateau, extending northward toward Keith and also including parts of western Victoria (Figure 1.1). Hydrogeologically, it includes the Gambier Basin, which is a Tertiary sub-basin of the Otway Basin, and the south-western margins of the Murray Basin. An overview of the physical characteristics, geology and hydrogeology is provided in the Phase 1 report for this project (Harrington and Lamontagne, 2013).

## Associated Reports and Research Papers

The following reports and journal papers are also associated with the South East Regional Water Balance Project.

### *Technical Reports:*

Harrington, N and Lamontagne, S (eds.), 2013, *Framework for a Regional Water Balance Model for the South Australian Limestone Coast Region*. Goyder Institute for Water Research Technical Report 13/14.

Morgan, LK, Harrington, N, Werner, AD, Hutson, JL, Woods, J and Knowling, M, 2015, *South East Regional Water Balance Project – Phase 2. Development of a Regional Groundwater Flow Model*. Goyder Institute for Water Research Technical Report 15/38.

Doble, R, Pickett, T, Crosbie, R, Morgan, L, 2015, *A new approach for modelling groundwater recharge in the South East of South Australia using MODFLOW*, Goyder Institute for Water Research Technical Report 15/26.

Taylor, AR, Lamontagne S, Turnadge, C, Smith, SD and Davies, P, 2015, *Groundwater-surface water interactions at Bool Lagoon, Lake Robe and Deadmans Swamp (Limestone Coast, SA): Data review*. Goyder Institute for Water Research Technical Report 15/13.

Smith, SD, Lamontagne, S, Taylor, AR and Cook, PG, 2015, *Evaluation of groundwater-surface water interactions at Bool Lagoon and Lake Robe using environmental tracers*. Goyder Institute for Water Research Technical Report 15/14.

Turnadge, CJ and Lamontagne, S, 2015, *A MODFLOW-based approach to simulating wetland-groundwater interactions in the Lower Limestone Coast Prescribed Wells Area*. Goyder Institute for Water Research Technical Report 15/12.

Barnett, S, Lawson, J, Li, C, Morgan, L, Wright, S, Skewes, M, Harrington, N, Woods, J, Werner, A and Plush, B, 2015, *A Hydrostratigraphic Model for the Shallow Aquifer Systems of the Gambier Basin and South Western Murray Basin*. Goyder Institute for Water Research Technical Report 15/15.

Harrington, N and Li, C, 2015, *Development of a Groundwater Extraction Dataset for the South East of South Australia: 1970-2013*. Goyder Institute for Water Research Technical Report 15/17.

Harrington, N, Millington, A, Sodahlan, ME and Phillips, D, 2015, *Development of Preliminary 1969 and 1983 Land Use Maps for the South East of SA*. Goyder Institute for Water Research Technical Report 15/16

Harrington, N, Lamontagne, S, Crosbie, R, Morgan, LM and Doble, R, 2015, *South East Regional Water Balance Project: Project Summary Report*. Goyder Institute for Water Research Technical Report 15/39.

*Research Papers:*

Crosbie RS, Davies P, Harrington N and Lamontagne S (2015) *Ground truthing groundwater-recharge estimates derived from remotely sensed evapotranspiration: a case in South Australia*. Hydrogeology Journal 23(2), 335-350.

Lamontagne S, Taylor A, Herpich D and Hancock G (2015) *Submarine groundwater discharge from the South Australian Limestone Coast region estimated using radium and salinity*. Journal of Environmental Radioactivity 140, 30-41.

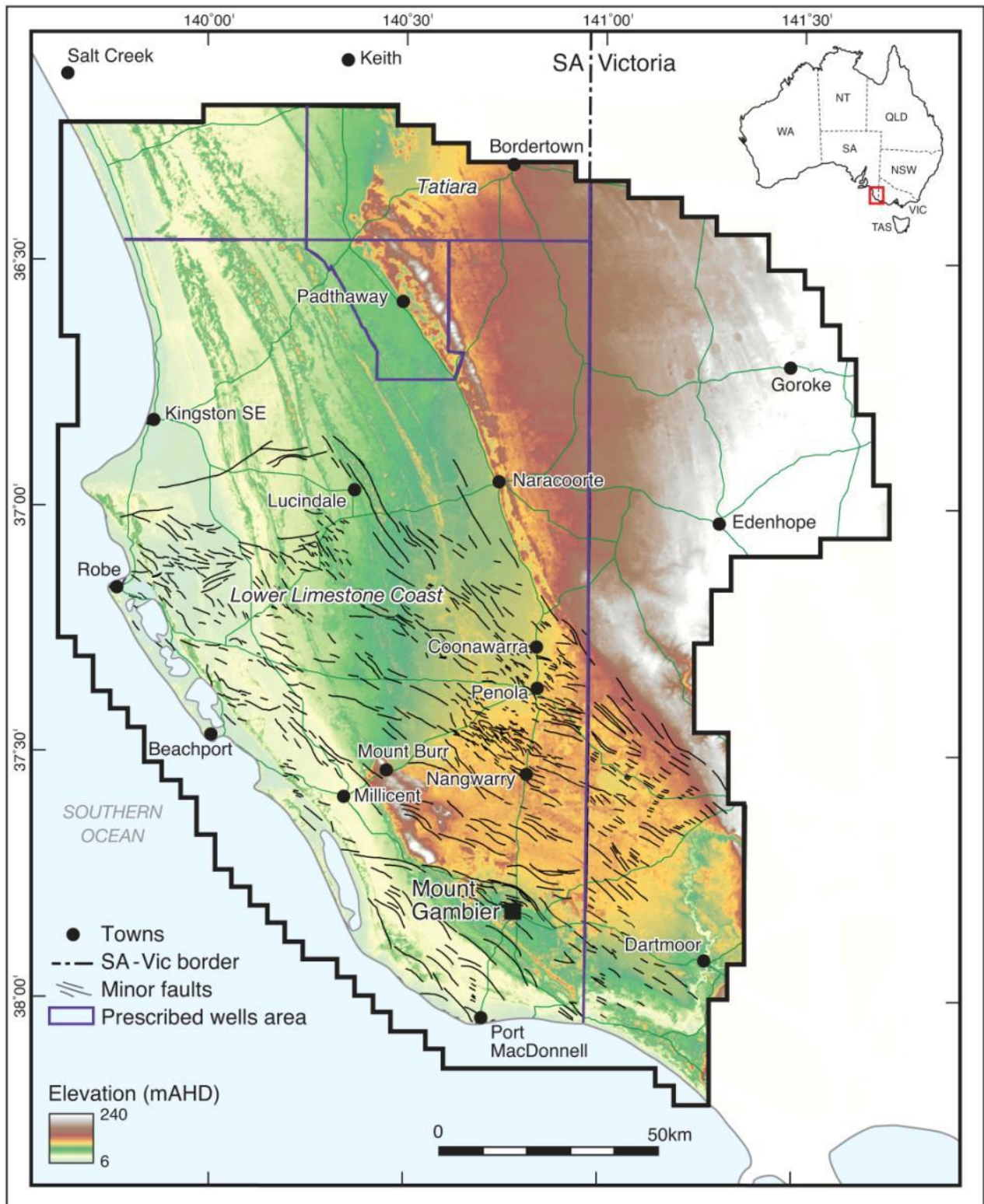


Figure 1.1 Location of the study area and the area of interest, the Lower Limestone Coast Prescribed Wells Area.

## 2 Methodology

### 2.1 Preliminary 1969 Land Use Map from Aerial Photo Interpretation

A complete set of hard copy black and white aerial photographs taken in January to March 1969 was provided by the Department of Environment, Water and Natural Resources (DEWNR) Mt Gambier and Naracoorte offices. These covered the whole South Australian portion of the study area with the exception of the most northern areas. In some areas, the photos also extended up to 10 km across the South Australian – Victorian border. As the photographs were only available in hard copy, and the cost of scanning and geo-rectifying them was considered to be prohibitive, it was decided to investigate the effectiveness of using visual interpretation of the photos to modify the 2008 land use polygon shapefile to reflect major land use changes. Although this was a time consuming process, it was quicker and cheaper than scanning, geo-rectifying and then interpreting the electronic products. Visual inspection of the aerial photos allowed clear identification of the following land uses:

- Native vegetation (both dense native forest and areas of scattered native vegetation).
- Plantation forestry (seedling, almost closed canopy and closed canopy plantations could be distinguished)
- Recently cleared land (for both forestry and agricultural land uses)
- Vineyards

In some cases, irrigated agriculture could be clearly identified, being much darker than surrounding paddocks. In others, the interpretation of this was ambiguous and this uncertainty was recorded in the 'confidence' field.

The 2008 land use polygon shapefile (SA Dept. of Environment Water and Natural Resources, 2008) was used as the basis for the 1969 interpreted land use map. This was printed out by Management Area on A3 paper, overlain with parcel boundaries and roads to assist with position referencing. Aerial photographs are collected in linear flight "runs", and each one overlaps significantly with the previous one. The photos were inspected along these flight runs so that roads could be followed across adjoining aerial photos and the land use maps. Annotations were made on the Management Area scale land use map print outs where changes in land use could be clearly identified. If no change could be identified, the land use was left at the 2008 category. For example, if a parcel that was classed as "irrigated cropping" in the 2008 land use map could not be clearly identified as being otherwise from the 1969 aerial photo, the irrigated cropping land use was left in place.

The following section describes a further method used to refine the extent of irrigation areas in the 1969 land use map based on irrigation well drilling records. Note that only major land use changes could be identified, i.e. changes between cleared pasture/crop, native vegetation, forestry, vineyard, and possibly irrigation. Changes in crop or pasture types, and even occasionally from dryland crop to pasture, could not be identified through this method.

The 2008 land use shapefile was modified based on these annotated maps. In most cases, the land use attribute of an existing polygon was simply changed. However, in some cases, polygons required splitting to record two different land uses. Information on this was recorded in the 'Confidence' and 'Comment' fields. If an interpretation was uncertain, "uncertain" was recorded under the "Confidence" attribute with a comment for future reference.

To facilitate the future distinction of parcels that still retain the 2008 land use classifications from those that were changed to the same land use classification based on aerial photo interpretation, the following land use classes were added:

- Cleared or modified pasture (essentially the same as ‘Grazing Modified Pastures’ land use, but also recognising the difficulty in distinguishing this from land that is simply cleared of native vegetation, perhaps for uses other than grazing, e.g. cropping. However, grazing was the most likely land use for ‘cleared’ land without an obvious crop).
- Interpreted crop
- Interpreted irrigation
- Interpreted dryland vineyard (i.e. most vineyards present in 1969 were grown under dryland conditions, with small amounts of drip irrigation occurring (Appendix A )).

For visual display of the land use map, these categories could be merged with their counterparts from the 2008 land use map, or displayed as the same colour, as they represent the same land use with a different interpretation status.

The following land use categories were also added to the 1969 land use map, as they could be additionally identified in the aerial photographs:

- Scattered native vegetation – there were few stands of dense woodland present in the region. A large proportion of un-cleared land was vegetated by scattered trees or shrubs, possibly due to issues with waterlogging during the wet months. This type of vegetation coverage would have different recharge characteristics from native vegetation that is present as dense forests; these are not distinguished in the 2008 land use maps.
- Recently Cleared – land that had been recently cleared could be identified as a very disturbed, barren sandy (white) landscape, often with remnant stumps.
- Cleared for Forestry – identified as above for recently cleared, but these areas were identified as forestry land use in the 2008 land use map.
- Young Forestry (seedling) – identified as very small plants in neat rows, with large areas of bare soil (white) in between.
- Young Forestry (almost closed canopy) – identified as larger plants in neat rows, with less bare soil in between, but clearly not as dense as mature forests.
- Crop or irrigation (as these were sometimes ambiguous to identify; this class was subsequently eliminated using the irrigation bore construction data – see below).

## 2.2 Refining Irrigation Areas Using Bore Construction Data

As described above, the presence of irrigation was difficult to confirm in many areas from visual interpretation of the black and white aerial photographs from 1969. The difference between an irrigated crop and a very green dryland crop was often difficult to distinguish. A separate task in the South East Regional Water Balance project was to build up a dataset of historical time series groundwater extraction for use in the regional groundwater flow model (Harrington and Li, 2015). Irrigation bore construction data was collected as part of that task and it was considered that this information could be used to refine the extents of irrigated areas in the 1969 land use map. The logic applied was that areas remaining with irrigated land use classifications from the 2008 land use map (i.e. where there had been no clear evidence in the 1969 aerial photos to change this) that did not have any irrigation wells located in their immediate vicinity, were probably not irrigated. Therefore, irrigated areas with no irrigation bore nearby were changed to a non-irrigated land use, either that of the surrounding non-irrigated land use, or the non-irrigated equivalent of the 2008 land use, i.e.:

- Cleared or modified pasture (if irrigated pasture in 2008)
- Interpreted crop (i.e. dryland) (if irrigated crop in 2008)
- Interpreted dryland vineyard (if irrigated horticulture in 2008) – some ‘irrigated horticulture’ in 2008 may have been fruit trees etc, but these would be very small areas and, for the purposes of recharge estimation, probably behave in a similar way to vines.

In some cases, the irrigated or non-irrigated land uses, as interpreted from the aerial photos, had been highlighted as “uncertain”, particularly in the Lower South East, where rainfall is higher and it was difficult



to distinguish between irrigated and non-irrigated crops/pastures. The bore locations were used to assist with the decisions about land use for these parcels. In the case where there was not a bore anywhere near the parcel, the land use was assumed to be “interpreted crop”. Where there was a bore adjacent, or at least nearby (within approximately 1 km), the land use was assumed to be “interpreted irrigation” and “bore interp” was listed under the ‘Comments’ attribute.

Note that there were some situations where an extraction bore was present based on the construction date data, but the surrounding area had been interpreted as being non-irrigated based upon the aerial photos. This may mean that either:

- The aerial photo interpretation was incorrect
- The bore construction date was incorrect
- The bore was constructed at that time but not used for irrigation.

It should be noted that there is a large uncertainty in the database of irrigation bores that were present in 1969 and that this was, therefore, only used as a rough guide to the locations of irrigation areas. There are very limited records of bores that were drilled prior to 1969, and therefore the existing dataset may not be exhaustive (J. Lawson, DEWNR, pers. comm. May 2015).

## 2.3 Repairing Misaligned Polygon Boundaries Following Modification of the 2008 Land Use Map

Editing of the 2008 land use shapefile to create the 1969 land use shapefile had caused accidental shifting of some polygons. These shifts were very small, such that they could not be seen unless zoomed in on the polygon boundary, but they resulted in gaps on one side of the polygon, and overlaps on the other side.

The dataset was edited using ArcMap, to attempt to correct these errors. A topology layer was created to identify the location of gap and overlap errors. Spatial adjustment was then used to shift the polygons back to their correct location. These spatial adjustments used an affine transformation, with at least 4 control points. Using this method, the gap and overlap errors were reduced from 50,000 to 4,000 (many of the polygons were quite large, meaning one spatial adjustment could solve many errors).

However, most of the remaining gap and overlap errors could not be resolved through a simple spatial adjustment. To bulk-correct the remaining errors, topology auto-fixes were used to create new polygons where overlaps and gaps existed. This removed all errors, but resulted in “sliver” polygons (with null attribute values) where the gap and overlap errors previously existed. These sliver polygons needed to be merged into their appropriate neighbour polygons. To do this by bulk, the sliver polygons were selected (using their null values in the attribute table), and the ‘eliminate’ tool was used to merge them into the neighbouring polygon with which they shared the most boundary. This may or may not be the correct polygon in reality, and this will have introduced a small amount error into the land use map produced. A small sample of the polygon slivers showed that the mean width of polygon slivers corrected using this method was 19.6 m, considered to be acceptable in a study area that is 183 km wide. The maximum width of a sliver in the sample was 48m. In many cases, the sliver polygon would have merged with the correct neighbouring polygon and no error would have been introduced.

## 2.4 Construction of an “Intermediate” Land Use Map for 1983-1990

For the purposes of estimating historical rainfall recharge to the unconfined aquifer in the South East, an “intermediate” land use layer was considered to be useful. This layer would represent some key land use changes between the preliminary 1969 layer and the next available digital land use layer, which was for 1998. These changes are (a) the burning of plantation forests and native vegetation by the Ash Wednesday

bushfires in 1983 and (b) the expansion of vineyards in the Coonawarra and Padthaway areas, which occurred in the late 1970s and 1980s (see Appendix A ).

To represent the expansion of vineyards between 1969 and 1983, the area of vineyard in the 1998 land use layer was added to the 1969 land use layer. The vineyard (“irrigated vine fruits”) areas were exported from the 1998 map, with scattered smaller vineyards outside the Coonawarra and Padthaway Regions removed to leave only the two main blocks of vineyards at those towns. A union operation was then used to combine the new vineyard area with the 1969 Land Use shapefile. A shapefile of the area burnt by the 1983 bushfires was available from DEWNR. This was also incorporated into the “intermediate” land use layer using a union operation. The union operations had not incorporated the vineyard and bushfire data into the existing land use field of the 1969 land use map layer. Rather, they had created new fields which contained whether each polygon did or did not contain bushfire or vineyard expansion. A new column was created in the attribute table of this layer, titled “LU\_1983”. This field contains values from the original 1969 land use field, but these values have been changed appropriately where the polygon was in a bushfire or vineyard expansion area. Polygons within the bushfire zone were only changed to the “Burnt Out” land use category if they were previously one of the following land uses:

- Hardwood plantation
- Softwood plantation
- Land in transition
- Native Vegetation
- Nature conservation
- Other minimal use
- Other protected areas
- Production forestry
- Scattered Native Vegetation
- Young Forestry (almost closed canopy)
- Young Forestry (seedling)

All polygons lying within the ‘Vineyard\_Expansion’ zone had their “New Landuse” field converted to “Vineyard (expansion from 1998 LU map)”.

## 3 Results

### 3.1 1969 and “Intermediate” 1983 Land Use Maps

The 1969 land use map, constructed using the above methodology, is shown in Figure 3.1 along with the 2008 land use map for comparison. A number of land use categories that exist in the land use shapefiles have been grouped together to allow easier visual interpretation and comparison of the maps. However, the original categories are retained in the spatial datasets. The strategy for combining these categories is shown in Table 3.1.

**Table 3.1. Land use categories in the 1969, 1983 and 2008 land use maps and the corresponding categories shown in Figure 3.1.**

Land Use Classes in the 1969 and 1983 Layers	Secondary Land use Classes in the 2008 Layer	New Classification for Visualisation
Native Vegetation	1.0 Conservation and natural environments	Conservation and natural environments
Scattered native vegetation		
Nature conservation	1.1 Nature conservation	
Other protected areas		
	1.2 Managed resource protection	
Other minimal use	1.3 Other minimal use	
Grazing modified pastures	3.2 Grazing modified pastures	Grazing modified pastures
Cleared or modified pastures		
Grazing native vegetation	2.1 Grazing natural vegetation	Grazing natural vegetation
Dryland cropping	3.3 Cropping	Dryland cropping
Interpreted crop		
Dryland horticulture	3.4 Perennial horticulture	Horticulture
Interpreted dryland vineyard	3.5 Seasonal horticulture	
Vineyard (expansion from 1998 LU Map)	4.4 Irrigated perennial horticulture	Irrigated horticulture
Irrigated horticulture	4.5 Irrigated seasonal horticulture	
Irrigated pastures	4.2 Grazing irrigated modified pastures	Grazing irrigated modified pastures
Irrigated cropping	4.3 Irrigated cropping	Irrigated cropping
Crop or Irrigation		
Interpreted Irrigation	4.6 Irrigated land in transition	Irrigated land in transition
Burnt out		Burnt out
Rural residential	5.4 Residential and farm infrastructure	Intensive uses
Intensive uses (mainly urban)	5.3 Manufacturing and industrial	
	5.5 Services	
	5.6 Utilities	
	5.7 Transport and communication	
Intensive animal and plant production	5.2 Intensive animal husbandry	
	5.1 Intensive horticulture	



	3.0 Production from dryland agriculture and plantations	
Mining and waste	5.8 Mining	Mining and waste
	5.9 Waste treatment and disposal	
Land in transition	3.6 Land in transition	Land in transition
Recently cleared		
Cleared for forestry		
Hardwood plantation	3.1.1 Hardwood plantation**	Hardwood plantation
Softwood plantation	3.1.2 Softwood plantation**	Softwood plantation
Production forestry	2.2 Production forestry	Production forestry
	3.1.3 Other forest plantation**	Plantation forestry
	3.1.0 Plantation forestry**	
	3.1.4 Environmental forest plantation**	
Young forestry (almost closed canopy)		Young Forestry (almost closed canopy)
Young forestry (seedling)		Young Forestry (seedling)
Water	6.1 Lake	Water (W)
	6.2 Reservoir	
**In the 2008 dataset, tertiary (rather than secondary) land use classification was used to group plantation forestry values into their new classifications.		

The 1969 land use map shows that large areas of the South East had already been cleared of native vegetation by 1969 (Figure 3.1). The major land use changes that are obvious from the two maps are the increase in areas under the various types of forest plantation and the increase in the areas of vineyard around the Padthaway and Coonawarra (north of Penola) areas. The latter is also accompanied by a change in classification from “horticulture” to “irrigated horticulture”. A number of the forestry areas had obviously been recently planted in 1969, and these are identified using the new classifications of “Young forestry (seedling)” or “Young forestry (almost closed canopy)”. The area under irrigation is greatly reduced in the 1969 land use map compared to the 2008 map. Irrigated areas in the 1969 map are very small and difficult to identify visually in Figure 3.1(a). Identification of irrigated areas from the black and white aerial photos was very difficult and there is a large uncertainty in this for the 1969 map (see Section 4.1). Additionally, the use of the irrigation well dataset for 1969 to help decide the irrigation status of land parcels may be flawed as the dataset is known to be incomplete for the late 1960s and early 1970s (J. Lawson, DEWNR, pers. comm., May 2015). The use of additional information sources may be required to improve the certainty in irrigated land use categories for the 1969 land use map.

The “intermediate” land use map, constructed as a placeholder representation of conditions in the 1983-1990 period, is shown in Figure 3.2. The key feature of this map, for use in recharge modelling of the region, is the “Burnt out” area associated with the 1983 bushfires. This map also has an expanded area of vineyards, with the area for this taken from the 1998 land use map, as vineyard area is believed to have expanded in the late 1970s and early 1980s (Appendix A). This is also associated with the change from “Horticulture” to “Irrigated horticulture”, as irrigation of vineyards is believed to have increased in the 1980s (Appendix A).

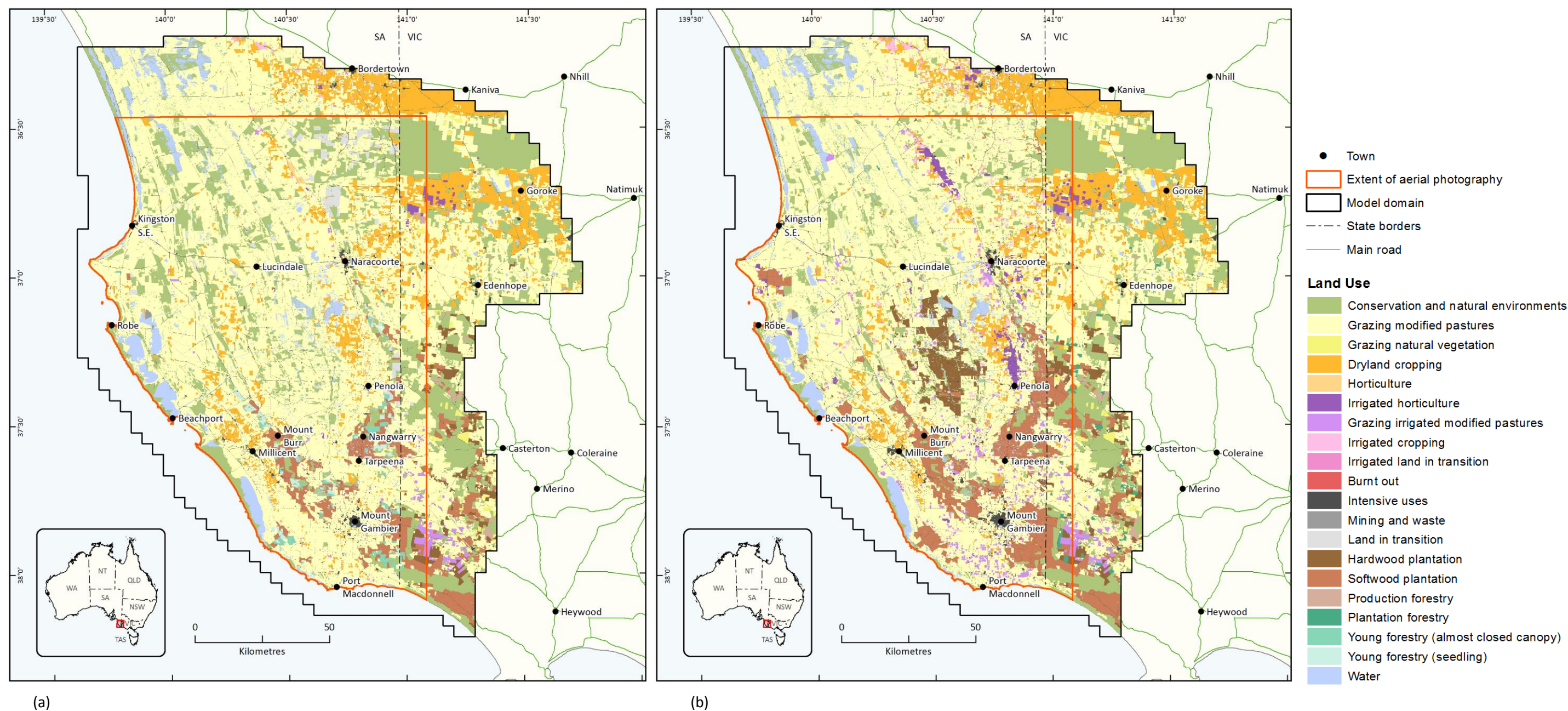


Figure 3.1 (a) 1969 land use map constructed by modifying the 2008 land use map based on aerial photograph interpretation. (b) 2008 land use map.



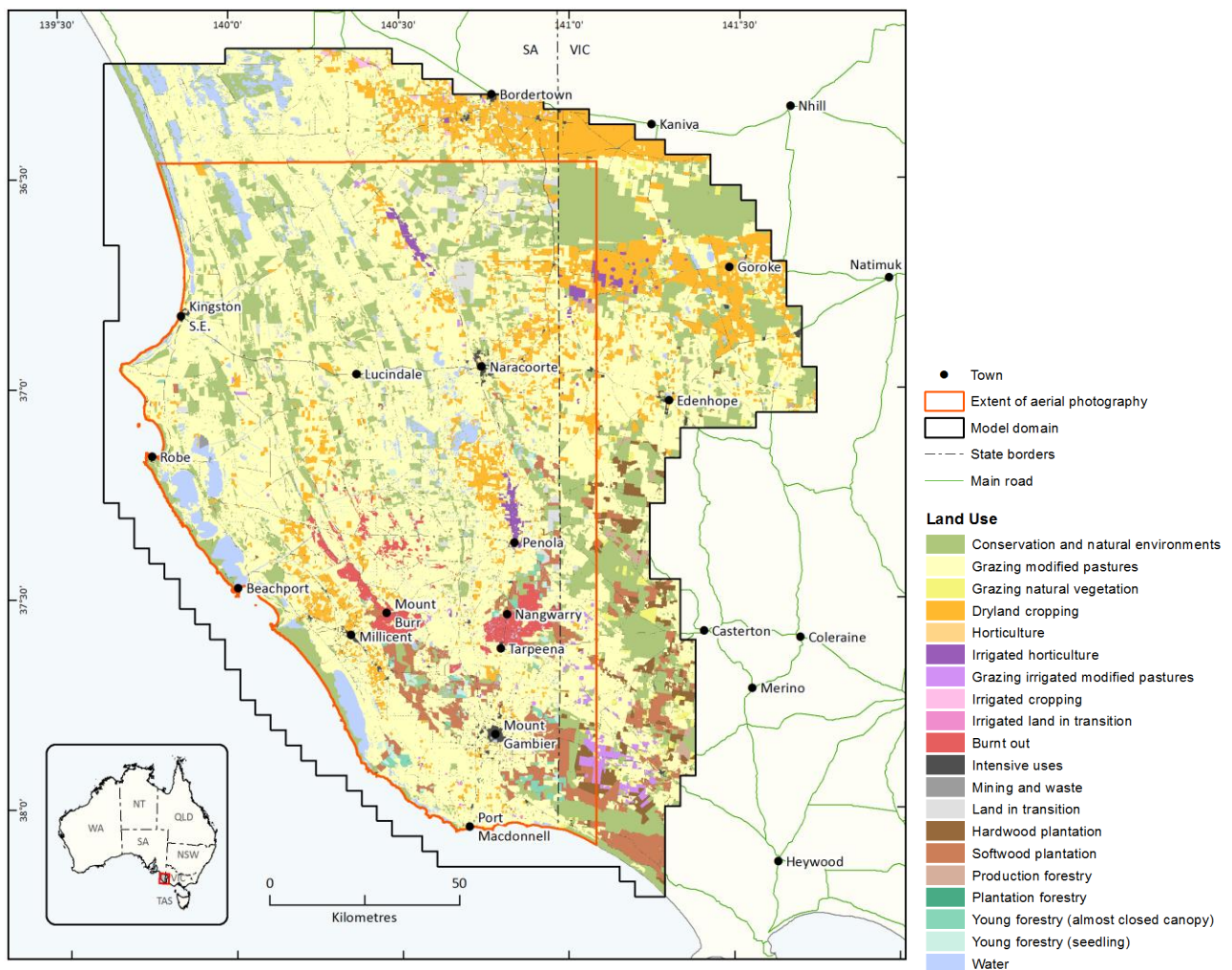


Figure 3.2 “Intermediate” land use map constructed to be representative of the period from 1983 to 1990.

## 4 Discussion

### 4.1 Uncertainty in the Historical Land Use Maps

The limitations of both land use map products should be recognised. Those of the 1969 map arise from the subjective nature of the assignment of land use categories from aerial photo interpretation, and uncertainties in the historical groundwater extraction dataset (See Section 2). An attempt has been made to quantify this uncertainty by assigning a confidence to each land use category in Table 4.1. The assignment of these confidence levels is also subjective and is based upon how easy it was to identify certain land uses in the black and white aerial photographs, coupled with how accurate the historical groundwater extraction dataset is likely to have been in clarifying the existence of irrigated land uses. These confidence levels apply only to the areas covered by the 1969 aerial photographs. The aerial photographs did not cover the entire study area, as shown in Figure 3.1. As the 2008 land use map was used as the basis for the 1969 land use map, the areas outside this extent retain the 2008 land use characteristics and the confidence in the land use categories assigned outside this area is much lower than those listed in Table 4.1. The confidence levels for the 1983 land use map are much lower due to the methodology used to create this “intermediate” representation of the major land use change between 1969 and 1983 (see Section 2.4). The only land use changes identified between the 1969 and 1983 maps were from Conservation and natural environments / forestry to “Burnt out” and Dryland cropping or Grazing modified pastures to Horticulture / Irrigated horticulture. Besides a possible slight increase in the area under various forestry land uses, there were not likely to be large areas of change in the other land uses.

Despite its current limitations, and because of the significant land use change that has occurred since 1970, the new 1969 land use map is considered to be a better basis for many applications, including groundwater recharge estimation for the 1970s, than using a recent land use map, e.g. 1998, which would be the alternative methodology. Both land use map products are considered to be preliminary and can be refined using various other types of data as resources become available (See Section 5).

**Table 4.1 Estimated confidence (%) in the assignment of land use categories in each of the land use maps developed in this project, using the methodologies described above.**

Land Use Category	1969 Land Use Map	1983 Land Use Map	Comments
Conservation and natural environments	90	60	
Grazing modified pastures	80	60	Occasionally difficult to distinguish from Dryland cropping.
Grazing natural vegetation	80	70	
Dryland cropping	60	50	Sometimes difficult to distinguish from Irrigated cropping or Grazing modified pastures.
Horticulture	70	60	In both land use maps, there is high confidence in the presence of horticulture (dominantly grapevines), but there is uncertainty in whether these were irrigated.
Irrigated horticulture	70	60	As above

<b>Grazing irrigated modified pastures</b>	20	20	Impossible to distinguish from Irrigated cropping and occasionally difficult to distinguish from non-irrigated cropping or pasture land uses.
<b>Irrigated cropping</b>	20	20	Impossible to distinguish from Grazing irrigated modified pastures and occasionally difficult to distinguish from non-irrigated cropping or pasture land uses.
<b>Irrigated land in transition</b>	0	0	Impossible to identify from aerial photos, but likely to be a very small area.
<b>Burnt out</b>	NA	95	
<b>Intensive uses</b>	90	70	
<b>Mining and waste</b>	90	70	
<b>Land in transition</b>	60	0	
<b>Hardwood plantation</b>	90	80	Forestry land uses easily identified from aerial photographs, although the type of plantation not always obvious. Softwood plantations are the most likely for 1969. Possibly a small and unidentified increase in forestry land uses between 1969 and 1983.
<b>Softwood plantation</b>	95	50	As for “Hardwood plantation”.
<b>Production forestry</b>	70	40	As for “Hardwood plantation”.
<b>Plantation forestry</b>	95	50	As for “Hardwood plantation”.
<b>Young Forestry (almost closed canopy)</b>	95	0	
<b>Young Forestry (seedling)</b>	95	0	
<b>Water (W)</b>	80	80	Some areas classified as “water” in the 2008 land use map were obviously not permanent water bodies in the 1969 aerial photos, but more likely perennial swamps or wetlands with significant (at least grassy) vegetation, and in some cases grazed when dry.

## 4.2 Quantifying Land Use Changes Between 1969 and 2008

Changes in the areas under the major land use types between 1969 and 2008 were quantified based upon the differences between the 1969 land use map, constructed as part of this project, and the pre-existing 2008 digital land use map. This work was carried out as a student project towards a Master of Environmental Management and is also reported in a thesis (Sodahlan, 2014). In order to make the

comparisons between the two maps, equivalent land use classes or groups of land use classes that could be directly compared between the two maps were again identified, as shown in Table 4.2. This classification scheme is similar to the one used for visual presentation of the maps shown in Figure 3.1 and Figure 3.2 above with the following minor differences (highlighted in table):

- “Horticulture” is separated into “Perennial Horticulture” and “Seasonal Horticulture”.
- “Irrigated Horticulture” is separated into “Irrigated Perennial Horticulture” and “Irrigated Seasonal Horticulture”
- “Intensive Uses” are divided into “Intensive Horticulture”, “Intensive Animal Husbandry”, “Intensive Uses” and “Production from dryland agriculture and plantations”.
- All forestry categories are classified into one category “Plantation Forestry”.

**Table 4.2 Reclassification results of land uses classes in the 1969 and 2008 NCGRT land use maps.**

No.	Land use classes in the 1969 map	Secondary Land use classes in the 2008 map	New Classification
1	Native Vegetation	1.0 Conservation and natural environments	Conservation and natural environments (CNE)
	Scattered Native Vegetation		
	Nature conservation	1.1 Nature conservation	
	Other protected areas		
		1.2 Managed resource protection	
	Other minimal use	1.3 Other minimal use	
2	-	2.1 Grazing natural vegetation	Grazing natural vegetation (GNV)
3	Production forestry	2.2 Production forestry	Plantation forestry (PLF)
4	-	3.0 Production from dryland agriculture and plantations	Production from dryland agriculture and plantations (DAP)
5	Hardwood plantation	3.1 Plantation forestry	Plantation forestry (PLF)
	Softwood plantation		
	Young Forestry (almost closed canopy)		
	Young Forestry (seedling)		
6	Grazing modified pastures	3.2 Grazing modified pastures	Grazing modified pastures (GMV)
	Cleared or Modified Pasture		
7	Dryland cropping	3.3 Cropping	Dryland cropping (DC)
	Interpreted Crop		
8	Dryland horticulture	3.4 Perennial horticulture	Perennial horticulture (PH)
	Interpreted dryland vineyard		
9	-	3.5 Seasonal horticulture	Seasonal horticulture (SH)
10	Land in transition	3.6 Land in transition	Land in transition (LT)
	Recently Cleared		
	Cleared for Forestry		
11	Irrigated pastures	4.2 Grazing irrigated modified pastures	Grazing irrigated modified pastures (IMP)
12	Irrigated cropping	4.3 Irrigated cropping	Irrigated cropping (IC)
	Crop or Irrigation		
13	Irrigated horticulture	4.4 Irrigated perennial horticulture	Irrigated perennial horticulture (IPH)

14	-	4.5 Irrigated seasonal horticulture	Irrigated seasonal horticulture (ISH)
15	Interpreted Irrigation	4.6 Irrigated land in transition	Irrigated land in transition (ILT)
16	-	5.1 Intensive horticulture	Intensive horticulture (IH)
17	Intensive animal and plant production	5.2 Intensive animal husbandry	Intensive animal husbandry (IAH)
18	Rural residential	5.4 Residential and farm infrastructure	Intensive uses (IU)
	Intensive uses (mainly urban)	5.3 Manufacturing and industrial	
		5.5 Services	
		5.6 Utilities	
		5.7 Transport and communication	
19	Mining and waste	5.8 Mining	Mining and Waste (MW)
		5.9 Waste treatment and disposal	
20	Water	6.1 Lake	Water (W)
		6.2 Reservoir/dam	
		6.3 River	
		6.4 Channel/aqueduct	
		6.5 Marsh/wetland	
		6.6 Estuary/coastal waters	

Figure 4.1 shows that the major land use changes across the study area between 1969 and 2008 were from Conservation and Natural Environments, Grazing Modified Pastures and Land in Transition to Plantation Forestry and a variety of irrigated land uses. There were small increases in the areas under Intensive Uses (i.e. residential infrastructure) and Water. The latter was due to the fact that some areas that had been classified as water land use types in the 2008 land use map were wetlands and swamps that appeared as dry land in the 1969 aerial photographs, which were taken in January to March. Some of them were obviously ephemeral lakes or wetlands, and possibly dry for a lot of the time.

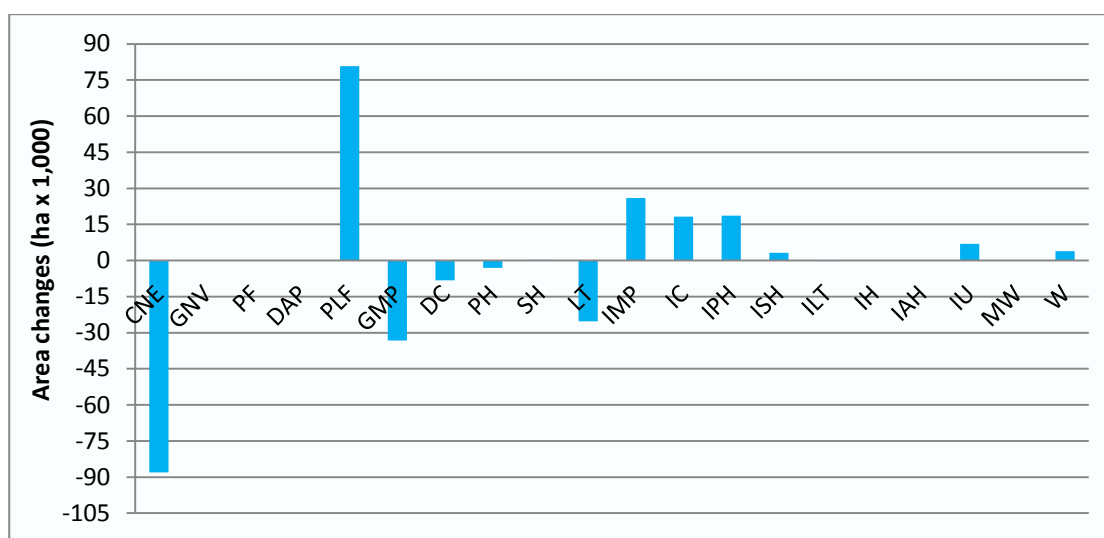


Figure 4.1 Changes in area (ha) under each land use category for the whole study area.

For the purpose of looking at land use changes at the smaller hundred-scale, the study area is divided up into counties (Figure 4.2) and hundreds (Figure 4.3). The data are presented by county and hundred in Figure 4.4. Only a small portion of County Buckingham is included in the study area and the hundreds in that county were not covered by the aerial photos that were interpreted to create the 1969 land use map. Hence, the changes for those hundreds are only small and are based predominantly on historical bore construction records. The land use changes identified are therefore dominated by changes from non-irrigated to irrigated agricultural land uses. In reality, there was probably a significant amount of clearing of native vegetation in those areas, but there is currently no aerial photography to support this and it is believed that most of the clearing occurred in the 1960s. The data from which the graphs in Figure 4.4 are derived are included as Appendix B.

Figure 4.4 shows that the hundreds that experienced the greatest land use changes by area between 1969 and 2008 were:

- In the hundreds of Beeamma, Geegeela and Hynam, where there was a lot of land converted from “Conservation and natural environments” to “Grazing modified pastures”.
- In the hundreds of Coles, Short, Caroline, Penola and Mount Benson, where large areas of land were converted from “Conservation and natural environments” or “Land in transition” (i.e. land that had obviously been cleared in 1969) to “Plantation forestry”.



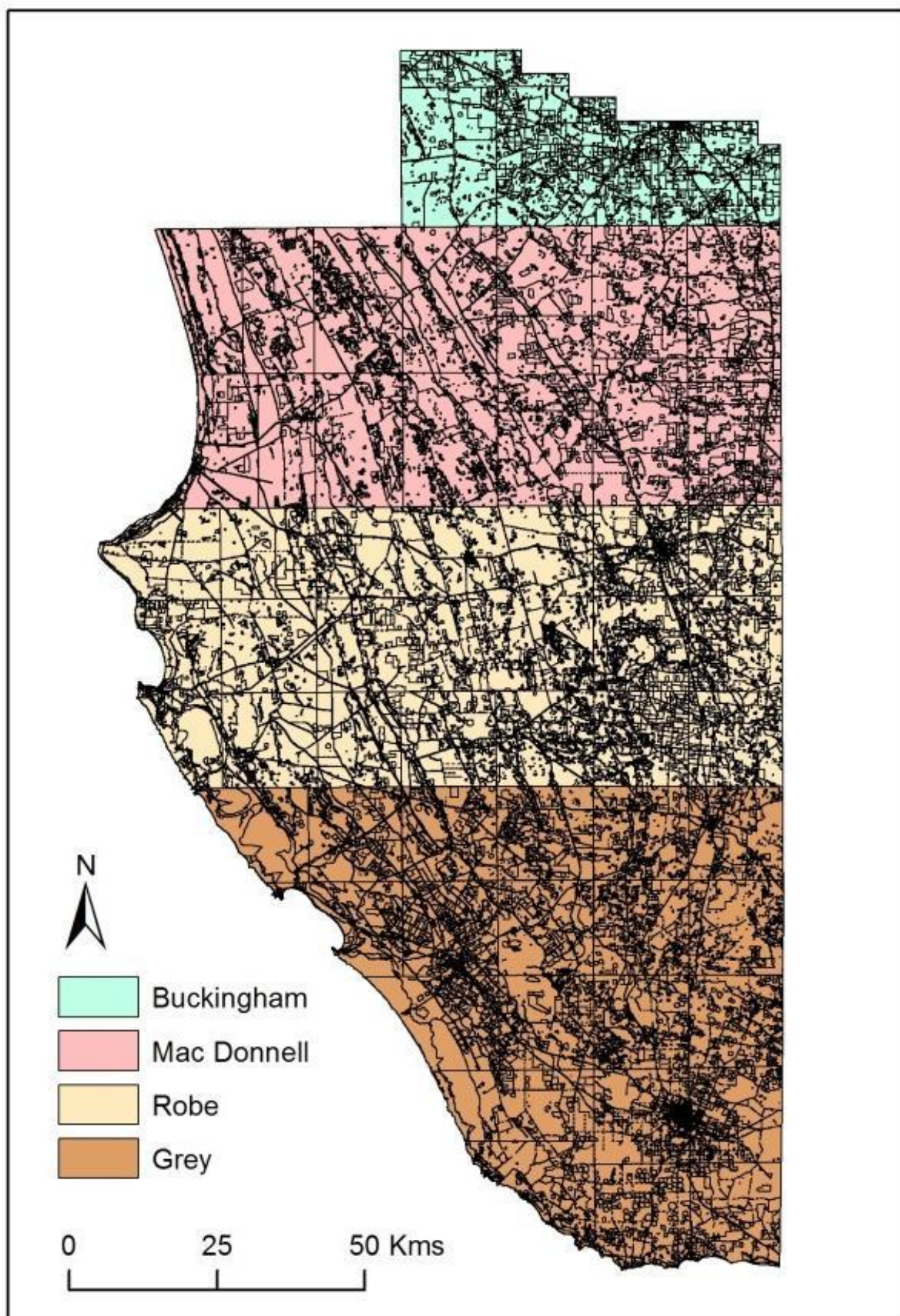


Figure 4.2 Counties located in the study area.

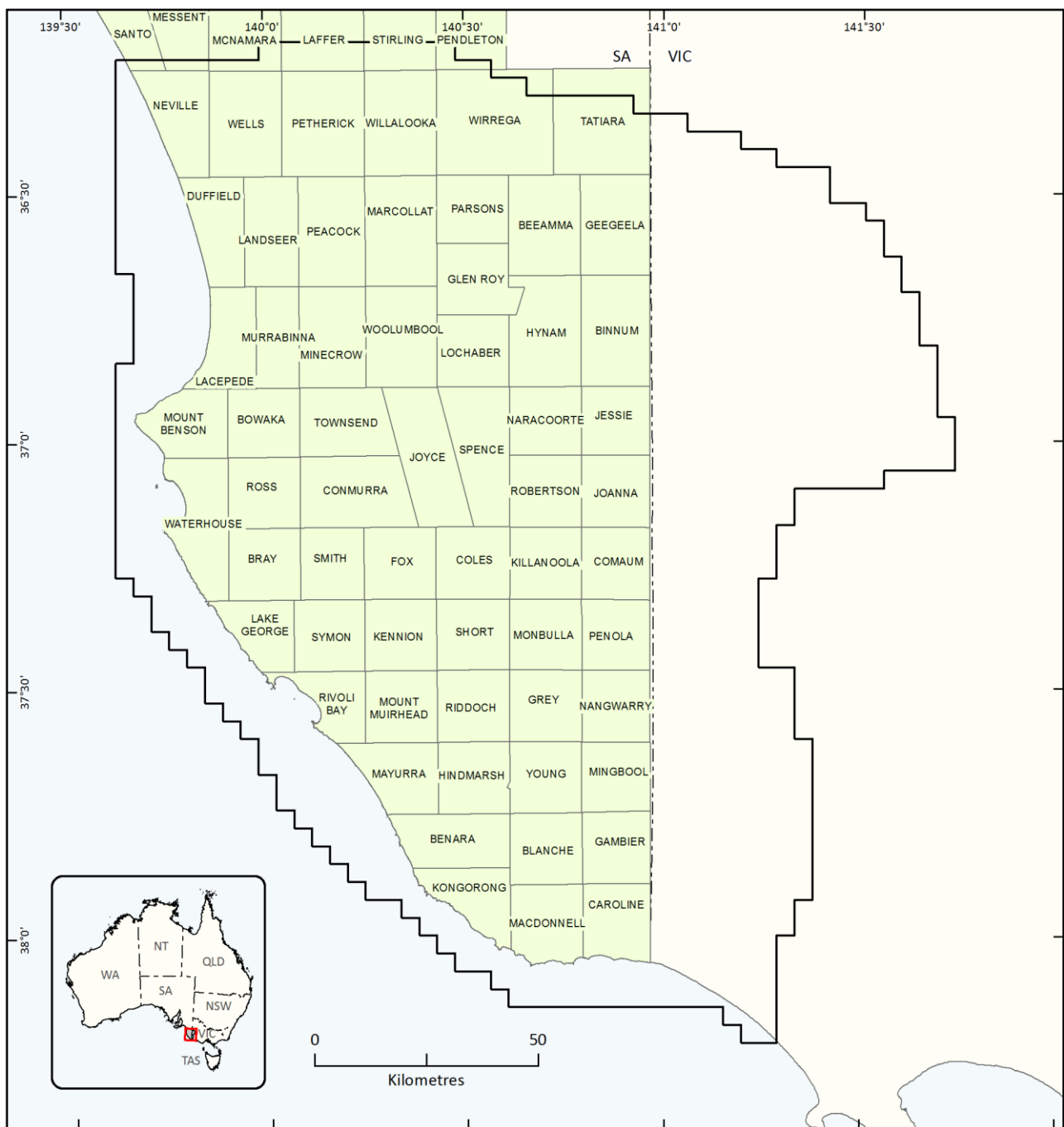
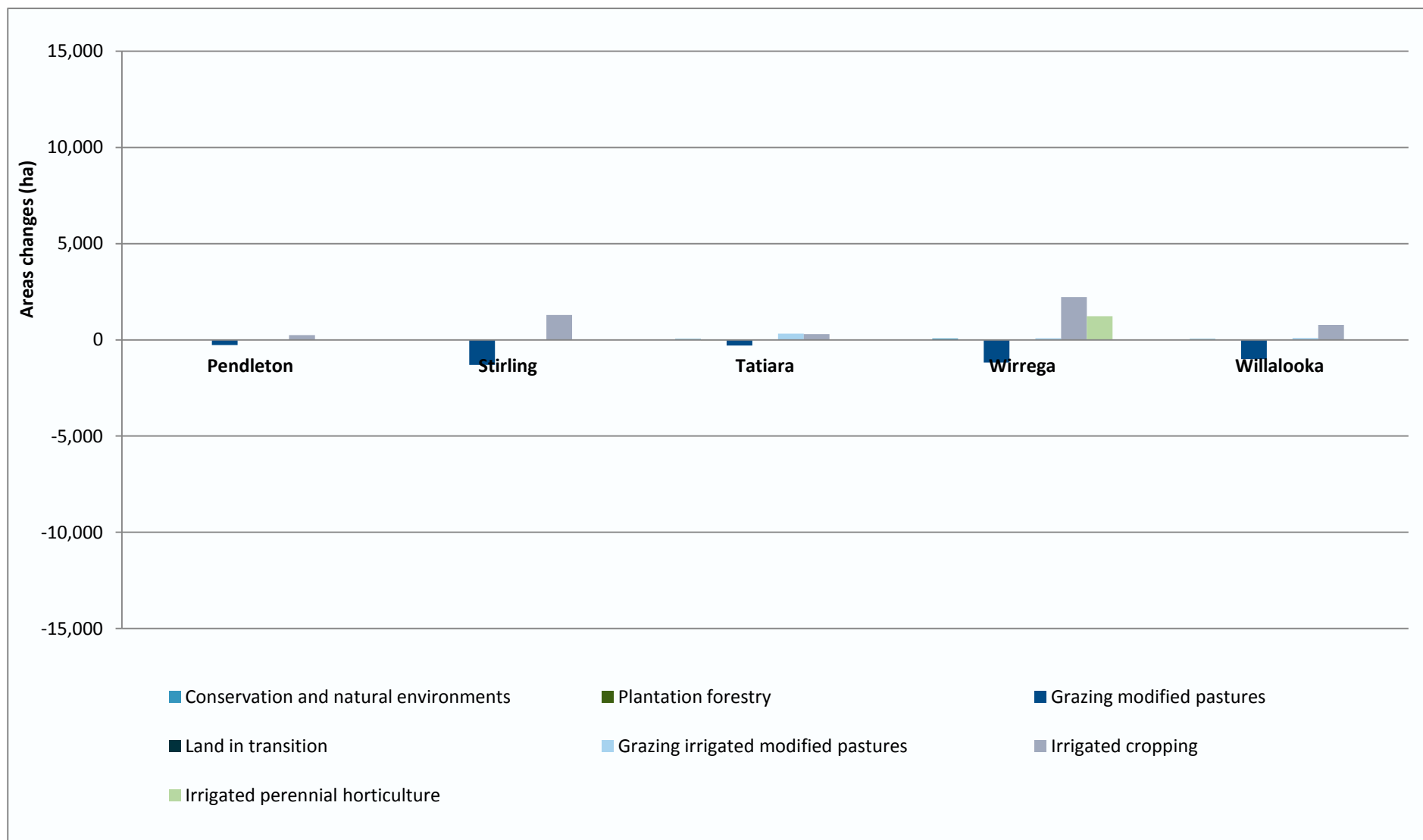
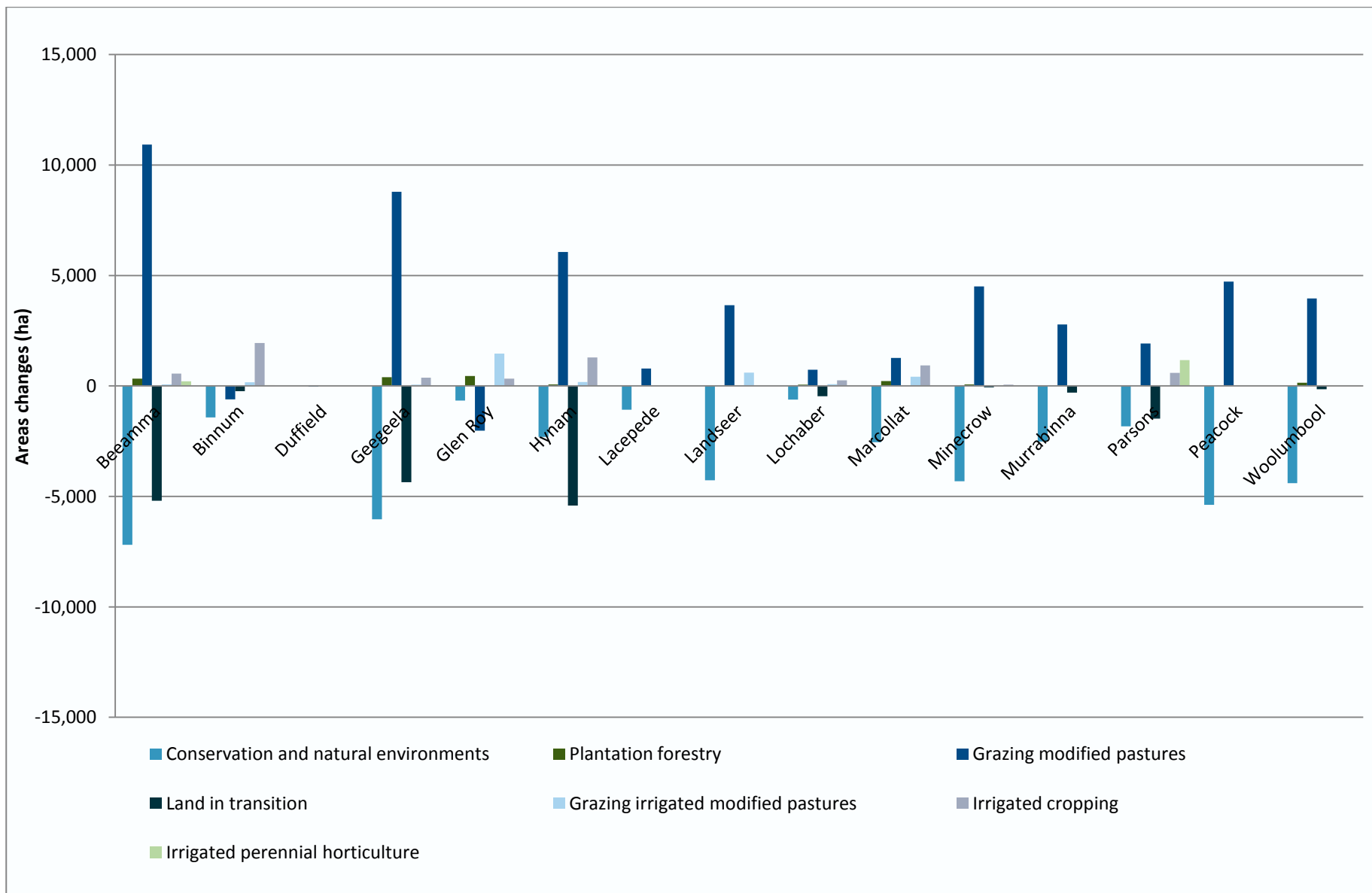


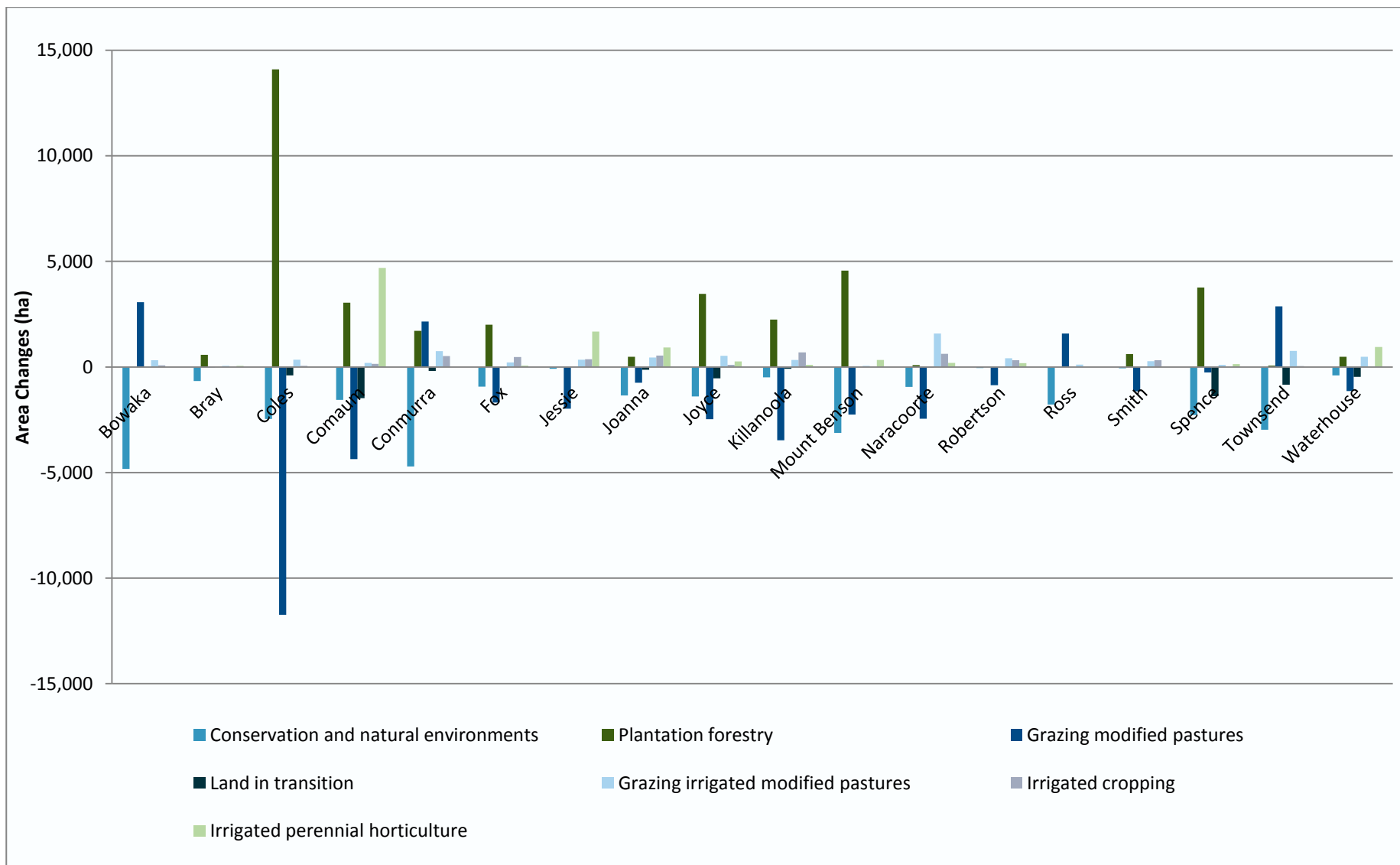
Figure 4.3 Hundreds within the study area.



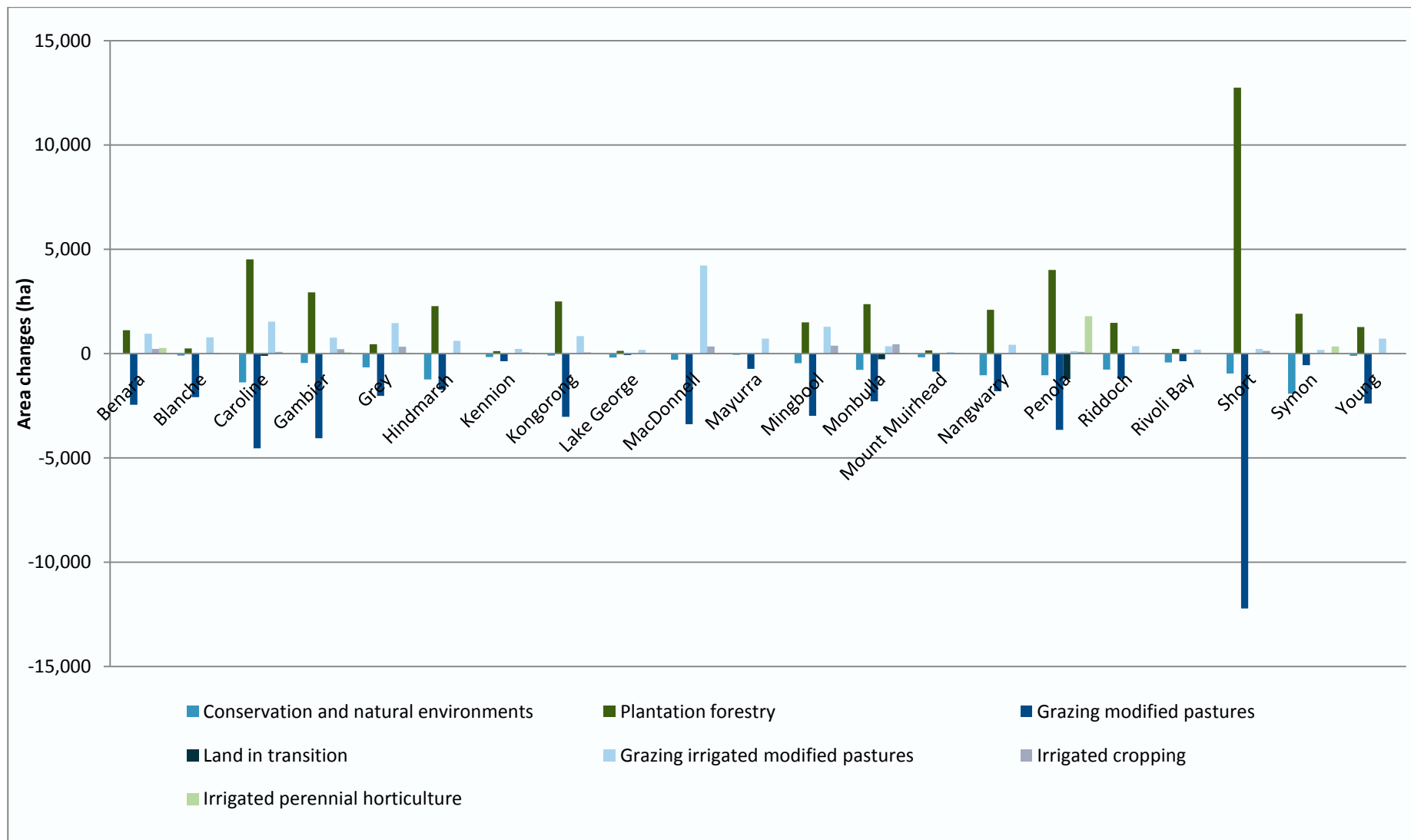
(a)



(b)



(c)



(d)

Figure 4.4 Changes in areas (ha) under each major land use class for each hundred in counties (a) Buckingham, (b) Macdonnell, (c) Robe and (d) Grey.

## 5 Conclusions and Further Work

A preliminary historical land use map for 1969 has been constructed through visual interpretation of black and white aerial photographs and, in the case of irrigated land uses, an assessment of irrigation bore construction records. The basis for this was the 2008 land use map. The 2008 map was modified where a change was suggested by the aerial photographs or locations of irrigation bores present in 1969. This 1969 land use map is considered to be a “first pass” attempt at constructing a land use map for 1969, for the purposes of historical modelling of groundwater recharge, and there are many ways in which it can be improved through future work, for example:

- Obtaining and analysing aerial photos outside the area covered by photos used in this study (e.g. Victoria). It is unlikely that aerial photographs exist for the northern part of the study area, however this has not been investigated exhaustively.
- Questioning local residents who may have a memory of historical land use and land coverage, e.g. when particular areas were cleared of native vegetation. This may be useful in the northern part of the study area, however, it is believed that the majority of clearing of native vegetation occurred in the 1960s.
- A more rigorous investigation into historical irrigation practices and statistics, particularly for vineyard areas where good historical records may exist.

An “intermediate” land use map has been constructed to approximately represent the period 1983-1990, focusing on areas affected by the 1983 bushfires and on the effects of vineyard expansion in the late 1970s and early 1980s. This land use map is considered to be more useful in modelling of rainfall recharge to groundwater for the region than using an existing electronic land use map, e.g. 1998 or the new 1969 land use map. However, refinement of this map using aerial photos, extraction bore drilling records, anecdotal evidence and information from the forestry and viticulture industries would be of great benefit to future applications, including recharge modelling.

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## Appendix A Table of major historical events related to land cover and land use in the South East

DATE(S)	EVENT(S)
1839	First settlement in the South East.
1864	First drains constructed around Millicent.
Second half of 1800s	John Riddoch developed land in the Coonawarra area. 140 ha of vines planted by 1890 – Shiraz, Cabernet Sauvignon, Pinot Noir and Malbec (Davidson, 1982).
1870s	Concerns raised in SA Parliament about over-harvesting of the colony's native forests. Government encourages replanting.
By 1881	Woods and Forests Dept establishes first plantations at Mount Burr and Leg of Mutton Lake (Mount Gambier) due to lack of timber in the region.
1908	Penola plantation established.
1908-onward	Pulses of large-scale forestry established.
1914–1918	World War I
1926	Auspine – Gunns (Newforest) developments established.
1931	Mount Burr sawmill established.
1934	Survey of forests by Swain Royal Commission.
1938	Blue gum plantation established at Tantanoola.
1939	Veneer mill built at Mt Gambier.
1941	First pulp mill in SA opens near Millicent.
1939–1945	World War II – resulting in slowed development of forestry.
1942	Approximately 4,000 acres of scrubland (mainly tea tree and swamp bush) cleared at Eight Mile Creek.
1951	Nangwarry sawmill established.
1957	Mount Gambier sawmill established – then the largest in the southern hemisphere.
late-1950s	Softwood plantations established.
1960s	Expansion of forestry industry financed by Commercial Afforestation Funds, resulting in native vegetation clearance.
1960s	Area between Kingston and Salt Creek cleared of the last of the native vegetation (George Mackenzie, pers. comm., July 2014).
1960s	First broadacre irrigation in Padthaway area (from Padthaway WAP).
1964	Trial vineyard planted at Padthaway and proven successful. (Previous land use was restricted to native vegetation and some improved pasture.) Significant viticultural expansion in Padthaway region followed.
1966	Coonawarra had been established.

DATE(S)	EVENT(S)
1976	Padthaway Prescribed Wells Area proclaimed due to concerns over rising groundwater salinities. Water resource was fully allocated at time of prescription.
1978	Aphid infestations ruined lucerne crops.
1978/79	<p>Areas of different types of irrigation in each Local Government area and areas of different types of irrigated crop and pasture provided in Till (1982). Pastures and Lucerne accounted for 74% of the irrigated area in the SE. The irrigation methods were flood and spray in approx. equal amounts. Wild irrigation of pastures was common – flood irrigation with little control (simple spreading of water over paddocks) – cheap and easy to set up, very inefficient.</p> <p>Total area under spray irrigation had not changed greatly over the previous 10 years, but had increased in the Coonapyn Downs LGA and decreased in the Mount Gambier LGA.</p> <p>The area under vineyards had increased in past years but was now relatively stable. There were very small amounts of drip irrigation on vineyards.</p> <p>For potatoes, hand shift lines and travelling guns (spray irrigation) were most common.</p> <p>Travelling guns (spray) used in Lower South East on dairy farms.</p> <p>In more northerly areas, travelling guns and centre pivots were used on pasture.</p>
1980s	<p>Significant viticultural expansion in Coonawarra region. Vineyards were rain-fed prior to installation of overhead spray and then drip irrigation.</p> <p>In 1982 there was almost 1,500 ha of vineyards (Davidson, 1982).</p> <p>At 1982, the two main forms of irrigation in Coonawarra were set sprinklers (also used for frost protection) and water winches (Davidson, 1982).</p>
At 1982	Water from Sheepwash Swamp, downstream of Bakers Range gauging station used to flood irrigate approx. 3,500 ha of land (Davidson, 1982).
At 1982	Recent expansion of Adelaide metro area had forced many market gardeners to move to the South East (Till, 1982).
1983	Ash Wednesday bushfires burn vast areas of forests. Replanting is complete by the early 1990s.
1984	Tatiara Prescribed Wells Area proclaimed due to concerns over deteriorating groundwater quality. Prior to prescription, some irrigated areas were increasing in size by 20% per year.
1985	<i>Groundwater (Border Agreement) Act</i> proclaimed.
1986	Naracoorte and Comaum Caroline Prescribed Wells Areas proclaimed.
1987–1988	First blue gum ( <i>Eucalyptus globulus</i> ) plantations established.
1990–1995/96	Significant expansion of blue gum forestry plantations financed by taxation concessions and involving organisations such as Apsil, Timbercorp, APT, Great Southern, and Elders.
1992–2002	Significant plantation forestry development in Border Designated Area Zones 1B, 2B and 3B, replaced pasture land.
1992	Establishment of large centre pivots irrigation, particularly in the area south of Mount Gambier. (Previously irrigation was undertaken by flooding and/or travellers (travelling sprinklers)). Expansion of centre pivot irrigation was motivated by local availability of the first mud rotary drill rig, which enabled well completion in the Camelback Formation within 2–3 days. In addition, milk companies were paid premium prices if dairy farmers could supply milk all year-round.

DATE(S)	EVENT(S)
1993	Naracoorte Ranges Prescribed Wells Area expanded to include the Naracoorte Plains area following a two year moratorium.
1997	Lacepede-Kongorong Prescribed Wells Area proclaimed with the intention of introducing structured resource management before problems of over-allocation emerged.
1997–present	Significant development of groundwater resources in the southern part of Border Designated Area Zone 1A.
1997–1998	First report published summarising water allocation and use for an irrigation season following the formation of the South East Water Catchment Management Board.
2003	Prescription of Tintinara-Coonalpyn Prescribed Wells Area completed.
2003–2004	First public reporting of actual groundwater extraction volumes. (Previously, extraction estimates were based on crop water use estimates).
2009	Revised WAP for Padthaway – first rigorous assessment of acceptable extraction limits for groundwater recognising all stakeholders’ values.
2011	Completion of REFLOWS floodways, the final engineering stage of the Upper South East Dryland Salinity and Flood Management Program.

## Apendix B.

No	New Classification	Beeamma			Benara			Binnum			Blanche			
		1969	2008	Changes	1969	2008	Changes	1969	2008	Changes	1969	2008	Changes	
1	Conservation and natural environments	13,071	5,877	-7,193	1,747	1,743	-4	3,956	2,531	-1,425	511	419	-92	
2	Grazing natural vegetation	0	0	0	0	0	0	0	0	0	0	0	0	
3	Production forestry	0	0	0	0	0	0	0	0	0	0	0	0	
4	Production from dryland agriculture and plantations	0	0	0	0	0	0	0	6	6	0	0	0	
5	Plantation forestry	173	506	333	3,154	4,277	1,123	12	22	10	3,417	3,670	253	
6	Grazing modified pastures	16,733	27,665	10,932	19,111	16,664	-2,447	23,651	23,040	-611	18,412	16,324	-2,089	
7	Dryland cropping	379	590	211	601	396	-205	10,193	9,946	-247	634	616	-19	
8	Perennial horticulture	0	0	0	0	0	0	0	0	0	23	0	-23	
9	Seasonal horticulture	0	0	0	0	0	0	0	0	0	0	0	0	
10	Land in transition	5,405	210	-5,195	7	7	0	341	104	-236	0	0	0	
11	Grazing irrigated modified pastures	19	92	73	0	957	957	82	252	170	23	801	778	
12	Irrigated cropping	32	587	555	0	229	229	117	2,060	1,943	19	60	41	
13	Irrigated perennial horticulture	0	217	216	0	273	273	2	33	31	0	13	13	
14	Irrigated seasonal horticulture	0	34	34	0	0	0	0	303	303	0	17	17	
15	Irrigated land in transition	0	0	0	0	0	0	61	0	-61	0	0	0	
16	Intensive horticulture	0	0	0	0	0	0	0	0	0	0	12	12	
17	Intensive animal husbandry	0	0	0	16	16	0	0	67	66	25	13	-12	
18	Intensive uses	374	405	32	272	332	60	766	812	46	2,703	3,798	1,095	
19	Mining and Waste	0	0	0	2	2	0	0	0	0	136	151	16	
20	Water	4	5	1	4,818	4,833	16	80	84	4	144	152	7	
<b>Total</b>		<b>36,189</b>	<b>36,189</b>	<b>0</b>	<b>29,727</b>	<b>29,728</b>	<b>1</b>	<b>39,261</b>	<b>39,261</b>	<b>0</b>	<b>26,047</b>	<b>26,046</b>	<b>-1</b>	

## Appendix B.

No	New Classification	Bowaka			Bray			Caroline			Coles			
		1969	2008	Changes	1969	2008	Changes	1969	2008	Changes	1969	2008	Changes	
1	Conservation and natural environments	7,737	2,912	-4,825	2,287	1,619	-668	3,544	2,166	-1,377	5,203	2,739	-2,463	
2	Grazing natural vegetation	0	0	0	0	0	0	0	0	0	0	0	0	
3	Production forestry	0	0	0	0	0	0	0	0	0	0	0	0	
4	Production from dryland agriculture and plantations	0	0	0	0	0	0	0	0	0	0	0	0	
5	Plantation forestry	23	26	3	95	674	578	6,963	11,479	4,517	320	14,416	14,096	
6	Grazing modified pastures	15,300	18,364	3,064	18,967	18,956	-11	13,487	8,949	-4,538	19,544	7,806	-11,738	
7	Dryland cropping	811	797	-14	472	474	2	306	41	-265	19	19	1	
8	Perennial horticulture	0	0	0	50	0	-50	7	0	-7	0	0	0	
9	Seasonal horticulture	0	0	0	0	0	0	0	0	0	0	0	0	
10	Land in transition	0	0	0	0	0	0	107	0	-107	401	0	-401	
11	Grazing irrigated modified pastures	332	655	323	0	49	49	48	1,576	1,528	0	341	341	
12	Irrigated cropping	0	70	70	0	0	0	0	89	89	0	56	56	
13	Irrigated perennial horticulture	0	3	3	0	51	51	0	13	13	0	0	0	
14	Irrigated seasonal horticulture	0	0	0	0	0	0	0	0	0	0	14	14	
15	Irrigated land in transition	0	0	0	0	0	0	56	0	-56	0	21	21	
16	Intensive horticulture	0	5	5	0	0	0	0	0	0	0	0	0	
17	Intensive animal husbandry	0	0	0	0	0	0	0	0	0	0	0	0	
18	Intensive uses	529	568	38	299	342	43	467	621	154	395	425	30	
19	Mining and Waste	0	0	0	7	7	0	0	32	31	0	0	0	
20	Water	188	1,503	1,315	3,744	3,749	5	436	457	21	993	1,034	41	
<b>Total</b>		<b>24,920</b>	<b>24,902</b>	<b>-18</b>	<b>25,921</b>	<b>25,921</b>	<b>0</b>	<b>25,420</b>	<b>25,424</b>	<b>4</b>	<b>26,874</b>	<b>26,873</b>	<b>-1</b>	

## Appendix B.

No	New Classification	Comaum			Conmurra			Duffield			Fox			
		1969	2008	Changes	1969	2008	Changes	1969	2008	Changes	1969	2008	Changes	
1	Conservation and natural environments	4,014	2,451	-1,563	8,329	3,613	-4,716	4,860	4,886	27	4,129	3,197	-932	
2	Grazing natural vegetation	0	0	0	0	0	0	0	0	0	0	0	0	
3	Production forestry	0	0	0	0	0	0	0	0	0	0	0	0	
4	Production from dryland agriculture and plantations	0	2	2	0	0	0	0	0	0	0	0	0	
5	Plantation forestry	2,358	5,404	3,045	200	1,910	1,710	8	8	0	10	2,014	2,004	
6	Grazing modified pastures	14,764	10,398	-4,366	25,519	27,668	2,148	18,222	18,189	-33	19,556	17,873	-1,683	
7	Dryland cropping	1,628	1,378	-250	3,722	3,448	-275	634	629	-5	1,328	1,097	-231	
8	Perennial horticulture	541	0	-541	0	0	0	0	0	0	0	0	0	
9	Seasonal horticulture	0	0	0	0	0	0	0	0	0	0	0	0	
10	Land in transition	1,481	0	-1,481	193	0	-193	0	0	0	45	0	-45	
11	Grazing irrigated modified pastures	0	186	186	2	754	752	0	0	0	0	220	220	
12	Irrigated cropping	5	153	148	0	513	513	0	0	0	0	464	464	
13	Irrigated perennial horticulture	54	4,743	4,689	0	0	0	0	0	0	0	63	63	
14	Irrigated seasonal horticulture	0	97	97	0	0	0	0	0	0	0	89	89	
15	Irrigated land in transition	33	0	-33	0	0	0	0	0	0	0	0	0	
16	Intensive horticulture	0	0	0	0	0	0	0	0	0	0	0	0	
17	Intensive animal husbandry	0	0	0	0	0	0	0	0	0	0	0	0	
18	Intensive uses	413	494	81	486	532	46	505	513	7	383	423	39	
19	Mining and Waste	8	8	0	0	0	0	0	0	0	0	0	0	
20	Water	296	321	25	453	464	11	2,860	2,869	9	517	558	41	
<b>Total</b>		<b>25,594</b>	<b>25,636</b>	<b>42</b>	<b>38,904</b>	<b>38,902</b>	<b>-2</b>	<b>27,089</b>	<b>27,094</b>	<b>5</b>	<b>25,968</b>	<b>25,997</b>	<b>29</b>	

## Appendix B.

No	New Classification	Gambier			Geegeela			Glen Roy			Grey			
		1969	2008	Changes	1969	2008	Changes	1969	2008	Changes	1969	2008	Changes	
1	Conservation and natural environments	625	183	-442	13,113	7,077	-6,036	3,734	1,780	-1,954	1,476	811	-664	
2	Grazing natural vegetation	0	0	0	0	0	0	0	0	0	0	0	0	
3	Production forestry	0	0	0	0	0	0	0	0	0	0	0	0	
4	Production from dryland agriculture and plantations	0	1	1	0	19	19	0	0	0	0	0	0	
5	Plantation forestry	7,518	10,454	2,936	299	696	398	26	204	178	2,989	3,439	450	
6	Grazing modified pastures	14,325	10,268	-4,057	15,881	24,668	8,787	19,234	18,379	-855	18,956	16,929	-2,027	
7	Dryland cropping	811	623	-188	967	1,695	728	1,720	1,736	16	1,097	900	-197	
8	Perennial horticulture	87	0	-87	0	0	0	1,473	0	-1,473	66	0	-66	
9	Seasonal horticulture	0	0	0	0	0	0	0	0	0	0	4	4	
10	Land in transition	0	0	0	4,525	163	-4,361	517	32	-484	0	0	0	
11	Grazing irrigated modified pastures	172	935	763	0	61	61	0	251	251	87	1,553	1,466	
12	Irrigated cropping	0	218	218	0	373	373	207	818	611	45	381	336	
13	Irrigated perennial horticulture	13	74	61	0	0	0	121	3,725	3,604	183	214	31	
14	Irrigated seasonal horticulture	0	67	67	0	0	0	0	60	60	0	510	510	
15	Irrigated land in transition	104	0	-104	0	0	0	0	0	0	0	11	11	
16	Intensive horticulture	0	0	0	0	0	0	0	0	0	0	0	0	
17	Intensive animal husbandry	4	4	0	0	9	9	0	0	0	6	6	0	
18	Intensive uses	1,218	2,151	933	782	803	21	353	381	28	498	574	75	
19	Mining and Waste	4	29	25	0	0	0	0	0	0	0	0	0	
20	Water	133	147	13	16	17	2	125	144	19	655	723	68	
<b>Total</b>		<b>25,016</b>	<b>25,154</b>	<b>138</b>	<b>35,582</b>	<b>35,582</b>	<b>0</b>	<b>27,511</b>	<b>27,511</b>	<b>0</b>	<b>26,059</b>	<b>26,056</b>	<b>-3</b>	

## Appendix B.

No	New Classification	Hindmarsh				Hynam			Jessie			Joanna		
		1969	2008	Changes		1969	2008	Changes	1969	2008	Changes	1969	2008	Changes
1	Conservation and natural environments	3,402	2,166	-1,236		7,081	4,780	-2,302	311	219	-92	3,804	2,456	-1,348
2	Grazing natural vegetation	0	0	0		0	0	0	0	0	0	0	0	0
3	Production forestry	0	0	0		0	0	0	0	0	0	0	0	0
4	Production from dryland agriculture and plantations	0	0	0		0	0	0	0	9	9	0	10	10
5	Plantation forestry	9,556	11,831	2,275		51	124	72	25	47	22	1,227	1,707	480
6	Grazing modified pastures	10,014	8,277	-1,738		21,237	27,303	6,065	16,728	14,757	-1,971	17,067	16,316	-751
7	Dryland cropping	1,319	1,151	-168		4,198	4,187	-12	6,546	6,161	-385	2,163	1,846	-317
8	Perennial horticulture	7	4	-3		0	0	0	8	8	0	15	0	-15
9	Seasonal horticulture	0	0	0		0	0	0	0	0	0	0	0	0
10	Land in transition	0	0	0		5,415	0	-5,415	0	0	0	138	0	-138
11	Grazing irrigated modified pastures	73	691	618		146	327	181	23	365	343	38	491	452
12	Irrigated cropping	0	19	19		0	1,293	1,293	53	419	366	13	556	544
13	Irrigated perennial horticulture	0	15	15		1	20	19	32	1,713	1,681	78	1,001	924
14	Irrigated seasonal horticulture	0	21	21		0	37	37	0	0	0	0	135	135
15	Irrigated land in transition	0	0	0		0	0	0	19	0	-19	42	0	-42
16	Intensive horticulture	0	60	60		0	0	0	0	0	0	0	0	0
17	Intensive animal husbandry	22	12	-10		7	7	0	0	0	0	0	0	0
18	Intensive uses	784	879	96		384	431	48	428	497	70	263	311	48
19	Mining and Waste	23	23	0		0	0	0	14	15	1	1	1	0
20	Water	576	597	21		51	64	12	177	145	-31	698	717	18
<b>Total</b>		<b>25,776</b>	<b>25,748</b>	<b>-28</b>		<b>38,573</b>	<b>38,573</b>	<b>0</b>	<b>24,363</b>	<b>24,357</b>	<b>-6</b>	<b>25,547</b>	<b>25,546</b>	<b>-1</b>



## Appendix B.

No	New Classification	Joyce				Kennion			Killanoola			Kongorong		
		1969	2008	Changes		1969	2008	Changes	1969	2008	Changes	1969	2008	Changes
1	Conservation and natural environments	4,377	2,981	-1,396		2,399	2,234	-165	2,023	1,530	-493	2,232	2,133	-99
2	Grazing natural vegetation	0	0	0		0	0	0	0	0	0	0	0	0
3	Production forestry	0	0	0		0	0	0	0	0	0	0	0	0
4	Production from dryland agriculture and plantations	0	0	0		0	0	0	0	0	0	0	0	0
5	Plantation forestry	156	3,617	3,462		2,373	2,489	116	15	2,255	2,240	3,858	6,362	2,504
6	Grazing modified pastures	31,123	28,650	-2,473		17,018	16,654	-364	15,521	12,046	-3,475	15,239	12,211	-3,027
7	Dryland cropping	706	653	-53		2,631	2,633	2	6,995	6,802	-193	390	87	-303
8	Perennial horticulture	0	0	0		5	0	-5	3	0	-3	0	0	0
9	Seasonal horticulture	0	0	0		0	5	5	0	0	0	0	0	0
10	Land in transition	540	0	-540		0	0	0	86	0	-86	0	0	0
11	Grazing irrigated modified pastures	3	528	525		0	227	227	0	328	328	42	882	840
12	Irrigated cropping	0	98	98		0	59	59	0	691	691	0	61	61
13	Irrigated perennial horticulture	3	265	262		0	40	40	0	103	102	0	16	16
14	Irrigated seasonal horticulture	0	0	0		0	0	0	0	759	759	0	0	0
15	Irrigated land in transition	0	0	0		0	0	0	0	15	15	58	0	-58
16	Intensive horticulture	0	0	0		0	0	0	0	0	0	0	0	0
17	Intensive animal husbandry	0	0	0		0	4	4	0	0	0	19	19	0
18	Intensive uses	708	823	115		749	792	43	334	393	59	442	501	59
19	Mining and Waste	5	5	0		0	0	0	1	1	0	0	0	0
20	Water	1,232	1,247	16		615	650	35	856	913	57	1,611	1,622	11
<b>Total</b>		<b>38,852</b>	<b>38,868</b>	<b>16</b>		<b>25,790</b>	<b>25,788</b>	<b>-2</b>	<b>25,835</b>	<b>25,835</b>	<b>0</b>	<b>23,891</b>	<b>23,895</b>	<b>4</b>

## Appendix B.

No	New Classification	Lacepede				Lake George			Landseer			Lochaber		
		1969	2008	Changes		1969	2008	Changes	1969	2008	Changes	1969	2008	Changes
1	Conservation and natural environments	4,379	3,303	-1,076		4,715	4,528	-188	9,753	5,487	-4,266	1,569	948	-621
2	Grazing natural vegetation	0	0	0		0	0	0	0	0	0	0	0	0
3	Production forestry	0	0	0		0	0	0	0	0	0	0	0	0
4	Production from dryland agriculture and plantations	0	0	0		0	0	0	0	0	0	0	0	0
5	Plantation forestry	0	0	0		17	153	135	0	0	0	24	77	53
6	Grazing modified pastures	18,675	19,464	789		8,540	8,468	-71	15,101	18,759	3,658	21,222	21,956	734
7	Dryland cropping	255	255	0		106	0	-106	0	0	0	1,524	1,346	-177
8	Perennial horticulture	1	0	-1		0	0	0	0	0	0	0	0	0
9	Seasonal horticulture	0	1	1		0	0	0	0	0	0	0	0	0
10	Land in transition	0	0	0		0	0	0	0	0	0	466	0	-466
11	Grazing irrigated modified pastures	0	16	16		0	180	180	0	600	600	24	108	84
12	Irrigated cropping	1	14	13		0	0	0	0	0	0	67	320	253
13	Irrigated perennial horticulture	0	5	5		0	25	25	0	0	0	0	30	30
14	Irrigated seasonal horticulture	0	0	0		0	0	0	0	0	0	0	0	0
15	Irrigated land in transition	0	0	0		0	0	0	0	0	0	0	0	0
16	Intensive horticulture	0	0	0		0	0	0	0	0	0	0	0	0
17	Intensive animal husbandry	0	5	5		11	12	1	0	0	0	0	0	0
18	Intensive uses	1,139	1,378	240		307	328	21	176	193	17	208	261	53
19	Mining and Waste	4	5	0		0	0	0	0	0	0	0	0	0
20	Water	1,733	1,740	7		8,077	8,080	3	4,774	4,765	-9	852	909	57
<b>Total</b>		<b>26,187</b>	<b>26,186</b>	<b>-1</b>		<b>21,774</b>	<b>21,774</b>	<b>0</b>	<b>29,804</b>	<b>29,804</b>	<b>0</b>	<b>25,956</b>	<b>25,956</b>	<b>0</b>

## Appendix B.

No	New Classification	MacDonnell				Marcollat			Mayurra			Minecrow		
		1969	2008	Changes		1969	2008	Changes	1969	2008	Changes	1969	2008	Changes
1	Conservation and natural environments	1,388	1,098	-291		5,512	2,961	-2,551	5,339	5,276	-63	9,855	5,544	-4,311
2	Grazing natural vegetation	0	0	0		0	0	0	0	0	0	0	0	0
3	Production forestry	0	0	0		0	0	0	0	0	0	0	0	0
4	Production from dryland agriculture and plantations	0	0	0		0	0	0	0	0	0	0	0	0
5	Plantation forestry	32	50	18		7	224	217	31	39	8	95	167	72
6	Grazing modified pastures	23,031	19,644	-3,387		31,064	32,333	1,269	14,047	13,318	-729	22,395	26,904	4,509
7	Dryland cropping	1,552	484	-1,067		964	520	-445	2,349	2,300	-50	493	320	-173
8	Perennial horticulture	18	0	-18		0	0	0	83	0	-83	0	0	0
9	Seasonal horticulture	0	0	0		0	0	0	0	54	54	0	0	0
10	Land in transition	0	0	0		0	0	0	0	0	0	58	0	-58
11	Grazing irrigated modified pastures	57	4,279	4,223		324	737	413	0	719	719	0	0	0
12	Irrigated cropping	0	348	348		12	939	928	2	23	21	0	55	55
13	Irrigated perennial horticulture	0	18	18		0	0	0	0	29	29	0	0	0
14	Irrigated seasonal horticulture	0	67	67		0	11	11	0	13	13	0	0	0
15	Irrigated land in transition	145	0	-145		0	0	0	0	0	0	0	0	0
16	Intensive horticulture	0	0	0		0	0	0	0	0	0	0	0	0
17	Intensive animal husbandry	57	58	1		0	0	0	9	9	0	0	0	0
18	Intensive uses	639	858	220		492	532	40	662	719	57	165	197	32
19	Mining and Waste	82	82	1		2	2	0	30	30	0	0	0	0
20	Water	288	300	12		1,312	1,429	117	3,703	3,728	24	787	657	-129
<b>Total</b>		<b>27,288</b>	<b>27,288</b>	<b>0</b>		<b>39,689</b>	<b>39,689</b>	<b>0</b>	<b>26,256</b>	<b>26,257</b>	<b>1</b>	<b>33,848</b>	<b>33,845</b>	<b>-3</b>

## Appendix B.

No	New Classification	Mingbool				Monbulla			Mount Benson			Mount Muirhead		
		1969	2008	Changes		1969	2008	Changes	1969	2008	Changes	1969	2008	Changes
1	Conservation and natural environments	1,044	580	-464		2,991	2,217	-774	4,279	1,151	-3,128	719	548	-171
2	Grazing natural vegetation	0	0	0		0	0	0	0	0	0	0	0	0
3	Production forestry	0	0	0		0	0	0	0	0	0	0	0	0
4	Production from dryland agriculture and plantations	0	5	5		0	0	0	0	0	0	0	0	0
5	Plantation forestry	2,868	4,364	1,496		36	2,407	2,371	672	5,239	4,567	2,208	2,362	153
6	Grazing modified pastures	18,892	15,904	-2,988		20,331	18,040	-2,291	19,335	17,087	-2,249	14,899	14,035	-864
7	Dryland cropping	841	715	-126		860	869	9	141	135	-6	5,881	5,934	52
8	Perennial horticulture	0	0	0		17	0	-17	0	10	10	158	0	-158
9	Seasonal horticulture	0	0	0		0	0	0	0	0	0	0	158	158
10	Land in transition	0	0	0		273	0	-273	0	0	0	0	0	0
11	Grazing irrigated modified pastures	91	1,379	1,288		0	350	350	0	53	53	0	71	71
12	Irrigated cropping	32	413	381		0	449	449	0	1	1	0	39	39
13	Irrigated perennial horticulture	0	0	0		1	37	36	7	341	334	0	0	0
14	Irrigated seasonal horticulture	0	317	317		0	45	45	0	240	240	0	0	0
15	Irrigated land in transition	0	0	0		0	0	0	10	0	-10	0	0	0
16	Intensive horticulture	0	0	0		0	0	0	0	0	0	0	0	0
17	Intensive animal husbandry	0	0	0		0	0	0	0	0	0	0	0	0
18	Intensive uses	464	517	53		533	600	67	457	633	176	1,674	2,358	684
19	Mining and Waste	0	0	0		5	5	0	0	0	0	9	9	0
20	Water	524	565	41		586	615	29	831	841	9	406	441	35
<b>Total</b>		<b>24,758</b>	<b>24,759</b>	<b>1</b>		<b>25,632</b>	<b>25,636</b>	<b>3</b>	<b>25,733</b>	<b>25,731</b>	<b>-2</b>	<b>25,955</b>	<b>25,953</b>	<b>-2</b>

## Appendix B.

No	New Classification	Murrabinna				Nangwarry			Naracoorte			Parsons		
		1969	2008	Changes		1969	2008	Changes	1969	2008	Changes	1969	2008	Changes
1	Conservation and natural environments	6,669	4,151	-2,518		3,936	2,893	-1,043	1,833	892	-941	5,962	4,139	-1,823
2	Grazing natural vegetation	0	0	0		0	0	0	0	0	0	0	0	0
3	Production forestry	0	0	0		0	0	0	0	0	0	0	0	0
4	Production from dryland agriculture and plantations	0	0	0		0	4	4	0	0	0	0	0	0
5	Plantation forestry	0	0	0		14,499	16,595	2,097	320	406	87	40	50	10
6	Grazing modified pastures	14,418	17,198	2,780		5,656	3,846	-1,809	17,576	15,124	-2,452	15,575	17,500	1,924
7	Dryland cropping	0	0	0		177	177	0	1,092	1,143	52	1,178	689	-490
8	Perennial horticulture	0	0	0		0	0	0	0	0	0	0	0	0
9	Seasonal horticulture	0	0	0		0	0	0	0	0	0	0	0	0
10	Land in transition	298	0	-298		0	0	0	6	6	0	1,511	35	-1,476
11	Grazing irrigated modified pastures	0	14	14		0	426	426	70	1,655	1,585	0	21	21
12	Irrigated cropping	0	0	0		0	0	0	93	715	622	4	596	592
13	Irrigated perennial horticulture	0	4	4		0	11	11	28	218	190	7	1,174	1,167
14	Irrigated seasonal horticulture	0	0	0		0	77	77	0	0	0	0	0	0
15	Irrigated land in transition	0	0	0		0	0	0	0	235	235	0	0	0
16	Intensive horticulture	0	0	0		0	0	0	0	0	0	0	0	0
17	Intensive animal husbandry	0	0	0		0	0	0	2	18	17	0	0	0
18	Intensive uses	322	332	10		376	410	34	2,047	2,617	570	279	352	73
19	Mining and Waste	0	0	0		10	10	0	53	53	0	4	4	0
20	Water	242	246	4		1,028	1,243	215	1,705	1,740	35	82	84	2
<b>Total</b>		<b>21,949</b>	<b>21,945</b>	<b>-4</b>		<b>25,682</b>	<b>25,695</b>	<b>12</b>	<b>24,824</b>	<b>24,823</b>	<b>-1</b>	<b>24,642</b>	<b>24,642</b>	<b>0</b>

## Appendix B.

No	New Classification	Peacock				Pendleton			Penola			Riddoch		
		1969	2008	Changes		1969	2008	Changes	1969	2008	Changes	1969	2008	Changes
1	Conservation and natural environments	9,832	4,454	-5,377		157	167	10	2,026	986	-1,040	1,945	1,182	-764
2	Grazing natural vegetation	0	0	0		0	0	0	0	0	0	0	0	0
3	Production forestry	0	0	0		0	0	0	0	0	0	0	0	0
4	Production from dryland agriculture and plantations	0	0	0		0	0	0	0	0	0	0	0	0
5	Plantation forestry	4	5	0		2	2	0	3,731	7,746	4,015	6,298	7,776	1,478
6	Grazing modified pastures	24,739	29,464	4,725		3,608	3,342	-267	15,299	11,641	-3,658	15,519	14,316	-1,203
7	Dryland cropping	0	0	0		334	332	-2	1,223	1,175	-48	939	942	3
8	Perennial horticulture	0	0	0		0	0	0	265	0	-265	0	0	0
9	Seasonal horticulture	0	0	0		0	0	0	0	0	0	0	0	0
10	Land in transition	0	0	0		0	0	0	1,228	0	-1,228	0	0	0
11	Grazing irrigated modified pastures	0	0	0		0	0	0	23	143	120	160	520	359
12	Irrigated cropping	0	0	0		201	452	251	0	80	80	0	0	0
13	Irrigated perennial horticulture	0	0	0		0	0	0	46	1,841	1,795	0	0	0
14	Irrigated seasonal horticulture	0	0	0		0	0	0	0	2	2	0	0	0
15	Irrigated land in transition	0	0	0		0	0	0	0	0	0	0	0	0
16	Intensive horticulture	0	0	0		0	0	0	0	0	0	0	0	0
17	Intensive animal husbandry	0	0	0		0	0	0	0	0	0	0	0	0
18	Intensive uses	380	427	48		55	61	5	734	833	99	557	647	90
19	Mining and Waste	0	0	0		0	0	0	7	7	0	0	0	0
20	Water	1,978	2,581	603		0	0	0	567	671	104	649	690	40
<b>Total</b>		<b>36,933</b>	<b>36,932</b>	<b>-1</b>		<b>4,358</b>	<b>4,355</b>	<b>-3</b>	<b>25,148</b>	<b>25,126</b>	<b>-23</b>	<b>26,068</b>	<b>26,072</b>	<b>4</b>

## Appendix B.

No	New Classification	Rivoli Bay				Robertson			Ross			Short		
		1969	2008	Changes		1969	2008	Changes	1969	2008	Changes	1969	2008	Changes
1	Conservation and natural environments	4,870	4,449	-421		1,168	1,122	-46	3,581	1,806	-1,775	3,962	3,007	-955
2	Grazing natural vegetation	0	0	0		0	0	0	0	0	0	0	0	0
3	Production forestry	0	0	0		0	0	0	0	0	0	0	0	0
4	Production from dryland agriculture and plantations	0	0	0		0	0	0	0	0	0	0	0	0
5	Plantation forestry	23	246	223		44	49	5	0	0	0	76	12,820	12,744
6	Grazing modified pastures	10,251	9,882	-369		14,977	14,116	-861	19,173	20,757	1,585	21,007	8,795	-12,211
7	Dryland cropping	1,698	1,821	123		4,627	4,547	-80	262	205	-57	20	20	0
8	Perennial horticulture	106	0	-106		0	0	0	30	0	-30	0	0	0
9	Seasonal horticulture	0	107	107		0	0	0	0	0	0	0	0	0
10	Land in transition	0	0	0		0	0	0	0	0	0	0	0	0
11	Grazing irrigated modified pastures	0	191	191		0	413	413	0	116	116	0	223	223
12	Irrigated cropping	0	0	0		0	315	315	0	23	23	0	127	127
13	Irrigated perennial horticulture	0	0	0		0	181	181	0	31	31	0	0	0
14	Irrigated seasonal horticulture	0	0	0		0	1	1	0	0	0	0	0	0
15	Irrigated land in transition	0	0	0		0	0	0	0	0	0	0	0	0
16	Intensive horticulture	0	0	0		0	0	0	0	0	0	0	0	0
17	Intensive animal husbandry	0	0	0		0	0	0	0	54	54	0	0	0
18	Intensive uses	862	891	30		331	364	33	222	268	46	402	421	19
19	Mining and Waste	0	0	0		0	0	0	691	690	-1	0	0	0
20	Water	2,281	2,503	223		4,648	4,688	40	1,623	1,628	5	519	572	53
<b>Total</b>		<b>20,090</b>	<b>20,090</b>	<b>0</b>		<b>25,795</b>	<b>25,796</b>	<b>0</b>	<b>25,582</b>	<b>25,578</b>	<b>-4</b>	<b>25,986</b>	<b>25,986</b>	<b>0</b>

## Appendix B.

No	New Classification	Smith				Spence			Stirling			Symon		
		1969	2008	Changes		1969	2008	Changes	1969	2008	Changes	1969	2008	Changes
1	Conservation and natural environments	3,337	3,275	-62		5,745	3,468	-2,277	261	265	4	4,260	2,341	-1,919
2	Grazing natural vegetation	0	0	0		0	0	0	0	0	0	0	0	0
3	Production forestry	0	0	0		0	0	0	0	0	0	0	0	0
4	Production from dryland agriculture and plantations	0	0	0		0	0	0	0	0	0	0	0	0
5	Plantation forestry	2	606	604		71	3,833	3,762	0	0	0	76	1,986	1,910
6	Grazing modified pastures	17,031	15,878	-1,152		26,556	26,292	-264	6,135	4,830	-1,304	15,967	15,414	-553
7	Dryland cropping	1,558	1,515	-43		444	317	-127	2,374	2,366	-8	3,900	3,901	1
8	Perennial horticulture	0	0	0		0	0	0	0	0	0	0	0	0
9	Seasonal horticulture	0	0	0		0	0	0	0	0	0	0	0	0
10	Land in transition	0	0	0		1,383	0	-1,383	0	0	0	0	0	0
11	Grazing irrigated modified pastures	56	324	268		0	94	94	0	0	0	0	174	174
12	Irrigated cropping	0	317	317		0	18	18	1,116	2,405	1,289	0	0	0
13	Irrigated perennial horticulture	0	0	0		0	128	128	0	0	0	0	348	348
14	Irrigated seasonal horticulture	0	0	0		0	0	0	0	0	0	0	0	0
15	Irrigated land in transition	0	0	0		0	0	0	0	0	0	0	0	0
16	Intensive horticulture	0	0	0		0	0	0	0	0	0	0	0	0
17	Intensive animal husbandry	0	0	0		2	2	0	0	0	0	0	0	0
18	Intensive uses	507	525	18		502	539	37	185	197	11	621	648	27
19	Mining and Waste	0	0	0		0	0	0	0	0	0	0	0	0
20	Water	343	360	17		2,988	3,003	15	18	21	3	565	576	11
<b>Total</b>		<b>22,833</b>	<b>22,801</b>	<b>-32</b>		<b>37,691</b>	<b>37,695</b>	<b>3</b>	<b>10,089</b>	<b>10,084</b>	<b>-5</b>	<b>25,389</b>	<b>25,389</b>	<b>0</b>



## Appendix B.

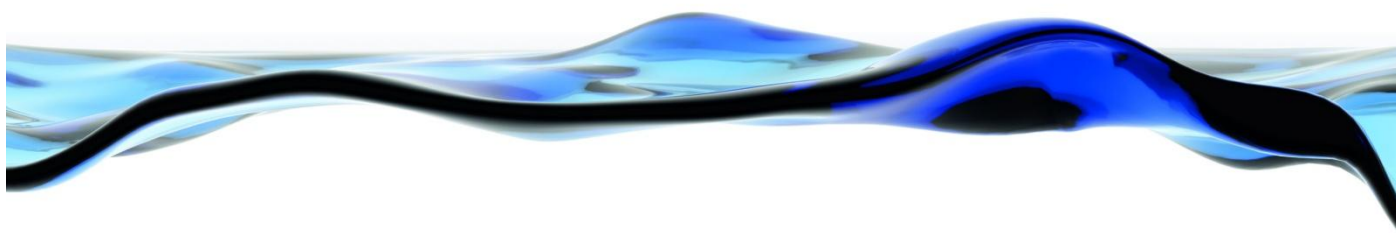
No	New Classification	Tatiara				Townsend			Waterhouse			Willalooka		
		1969	2008	Changes		1969	2008	Changes	1969	2008	Changes	1969	2008	Changes
1	Conservation and natural environments	1,007	1,052	45		6,270	3,302	-2,968	7,010	6,613	-397	1,538	1,583	45
2	Grazing natural vegetation	0	0	0		0	0	0	0	0	0	0	0	0
3	Production forestry	0	0	0		0	0	0	0	0	0	0	0	0
4	Production from dryland agriculture and plantations	0	5	5		0	0	0	0	0	0	0	0	0
5	Plantation forestry	23	18	-5		47	113	66	8	490	482	18	19	1
6	Grazing modified pastures	9,629	9,335	-294		21,706	24,572	2,866	17,131	15,985	-1,145	34,037	33,039	-998
7	Dryland cropping	23,418	22,987	-431		1,360	1,361	0	980	933	-47	1,772	1,774	2
8	Perennial horticulture	13	13	0		0	0	0	164	0	-164	0	0	0
9	Seasonal horticulture	0	0	0		0	0	0	0	0	0	0	0	0
10	Land in transition	1,101	1,104	3		836	0	-836	472	0	-472	0	0	0
11	Grazing irrigated modified pastures	113	432	319		60	824	765	0	477	477	0	91	91
12	Irrigated cropping	61	355	294		0	45	45	0	0	0	125	901	776
13	Irrigated perennial horticulture	0	0	0		0	0	0	47	997	950	0	24	24
14	Irrigated seasonal horticulture	0	0	0		0	0	0	0	160	160	0	0	0
15	Irrigated land in transition	0	0	0		0	0	0	0	0	0	0	0	0
16	Intensive horticulture	0	0	0		0	0	0	0	0	0	0	0	0
17	Intensive animal husbandry	7	7	0		19	19	0	48	47	0	0	0	0
18	Intensive uses	1,554	1,604	50		561	597	36	729	900	171	464	512	48
19	Mining and Waste	35	34	0		0	0	0	4	5	1	0	0	0
20	Water	163	166	3		343	365	22	7,804	7,811	7	56	66	10
<b>Total</b>		<b>37,123</b>	<b>37,113</b>	<b>-10</b>		<b>31,203</b>	<b>31,197</b>	<b>-6</b>	<b>34,397</b>	<b>34,419</b>	<b>22</b>	<b>38,010</b>	<b>38,010</b>	<b>0</b>

## Appendix B.

No	New Classification	Wirrega				Woolumbool			Young			Glen Roy		
		1969	2008	Changes		1969	2008	Changes	1969	2008	Changes	1969	2008	Changes
1	Conservation and natural environments	3,896	3,972	76		8,821	4,425	-4,395	2,472	2,371	-101	3,734	1,780	-1,954
2	Grazing natural vegetation	0	0	0		0	0	0	0	0	0	0	0	0
3	Production forestry	0	0	0		0	0	0	0	0	0	0	0	0
4	Production from dryland agriculture and plantations	0	0	0		0	0	0	0	0	0	0	0	0
5	Plantation forestry	33	34	1		194	342	148	5,175	6,446	1,271	26	204	178
6	Grazing modified pastures	32,628	31,451	-1,177		26,064	30,023	3,958	15,078	12,680	-2,399	19,234	18,379	-855
7	Dryland cropping	17,159	14,466	-2,692		122	121	-1	1,234	1,249	15	1,720	1,736	16
8	Perennial horticulture	9	10	1		0	0	0	3	0	-3	1,473	0	-1,473
9	Seasonal horticulture	0	0	0		0	0	0	0	0	0	0	0	0
10	Land in transition	661	661	0		184	37	-147	0	0	0	517	32	-484
11	Grazing irrigated modified pastures	159	237	78		0	0	0	78	798	720	0	251	251
12	Irrigated cropping	819	3,041	2,221		0	20	20	0	0	0	207	818	611
13	Irrigated perennial horticulture	198	1,424	1,226		0	0	0	0	3	3	121	3,725	3,604
14	Irrigated seasonal horticulture	0	179	179		0	0	0	0	0	0	0	60	60
15	Irrigated land in transition	0	0	0		0	0	0	0	0	0	0	0	0
16	Intensive horticulture	0	0	0		0	0	0	0	0	0	0	0	0
17	Intensive animal husbandry	22	21	0		0	0	0	0	0	0	0	0	0
18	Intensive uses	1,165	1,239	74		262	281	19	556	963	407	353	381	28
19	Mining and Waste	37	37	0		0	0	0	1	1	0	0	0	0
20	Water	134	138	4		608	1,006	398	1,061	1,150	88	125	144	19
<b>Total</b>		<b>56,919</b>	<b>56,910</b>	<b>-9</b>		<b>36,255</b>	<b>36,255</b>	<b>0</b>	<b>25,658</b>	<b>25,660</b>	<b>1</b>	<b>27,511</b>	<b>27,511</b>	<b>0</b>

## Appendix B.

No	New Classification	Total		
		1969	2008	Changes
1	Conservation and natural environments	246,063	158,059	-88,004
2	Grazing natural vegetation	0	0	0
3	Production forestry	0	0	0
4	Production from dryland agriculture and plantations	0	61	61
5	Plantation forestry	81,499	162,293	80,794
6	Grazing modified pastures	1,062,902	1,029,746	-33,156
7	Dryland cropping	131,108	122,824	-8,284
8	Perennial horticulture	3,152	45	-3,107
9	Seasonal horticulture	0	328	328
10	Land in transition	27,678	2,361	-25,317
11	Grazing irrigated modified pastures	2,307	28,190	25,884
12	Irrigated cropping	3,025	21,281	18,256
13	Irrigated perennial horticulture	819	19,466	18,647
14	Irrigated seasonal horticulture	0	3,257	3,257
15	Irrigated land in transition	526	283	-244
16	Intensive horticulture	0	77	77
17	Intensive animal husbandry	274	411	137
18	Intensive uses	35,123	42,003	6,880
19	Mining and Waste	1,175	1,252	76
20	Water	74,558	78,392	3,834
<b>Total</b>		<b>1,670,210</b>	<b>1,670,331</b>	<b>121</b>



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