University of Southern Queensland

Faculty of Health, Engineering and Sciences

Examining the Hansen Global Forest Change (2000 - 2014) Dataset within an Australian Local Government Area

A dissertation submitted by

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ENG4111 and ENG4112 Research Project

towards the degree of

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Abstract

Human activities have long changed the state of land cover on the surface of the earth. However, since the Industrial Revolution that rate of change has reached such proportions that the very biogeochemical systems that sustain the biosphere of the planet have been impacted. Forests are an essential component in the biogeochemical processes that maintain a balanced geosphere.

This project provides a GIS based spatial analysis of forest cover and forest loss in the region covered by the Sunshine Coast Council. The analysis was performed against various datasets which were relevant to forest cover. The Hansen global forest change dataset was utilized as it provides a time-series analysis of high (30m) spatial resolution Landsat images aimed at capturing the global forest extent and change from the years 2000 to 2014.

The aim was to test the hypothesis that "Forests are lost when land use is converted to another use" and to reveal which land use changes contribute to forest loss. An analysis over remnant vegetation areas was also performed in an attempt to give an indication of the effectiveness of conservation efforts.

The ArcGIS tabulate area tool was used to analyse the areas of the Hansen dataset against a set of "zones" defined by the datasets of interest.

The analysis has provided key insights into land use change within the study area. In particular, 95% of forest gain was outside of land use change areas. 21% of land use change areas, with change Nature Conservation removed, experienced forest loss. Only 3% forest loss was experienced in areas with no change, giving strength to the hypothesis outlined above.

The study confirmed that the Hansen dataset is successful at performing land use analysis at the local government scale, though it does not discriminate types of forest loss i.e. plantation to virgin forest. Errors were encountered in the data affecting the ability to successfully quantify the effectiveness of vegetation management strategies in the study area.

Keywords: *Hansen Global Forest Change, Land Use Change, GIS, ArcMap, Spatial Analysis, Zonal Tools*

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Limitations of Use

Certification of Dissertation

I certify that the ideas, designs and experimental work, results, analyses and inclusions set out in this dissertation are entirely my own effort, except where otherwise indicated and acknowledged.

I further certify that the work is original and has not been previously submitted for assessment in any other course or institution, except where specifically stated.

James Miller

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James Miller

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Chapter 1

Introduction

1.1 Background to the Study

Human activities have long changed the state of land cover, but since the Industrial Revolution that rate of change has reached such proportions to impact the very biogeochemical systems that sustain the biosphere. Changes to these biogeochemical systems can result in indirect changes to land cover, from phenomenon such as land salinization and climate change, in areas not touched by humans. Land-use and land-cover (LU/LC) change is one of the main driving forces of this change (Lambin, Rounsevell, & Geist, 2000) and can have an intense impact on the economy, society and environment, especially in rapidly developing areas (Fan, Wang, & Wang, 2008).

Forests are essential in the biogeochemical process for maintaining a balanced geosphere. Maintaining and improving the remaining forest land cover is essential to restore or reverse the negative impact to the earth's biogeochemical systems. Human induced forest loss is a global concern because of numerous consequences, namely:

- Increased carbon emissions - as forest and forest soils store carbon
- Loss of biodiversity
- Environmental degradation

Forests are generally lost due to natural processes or when the land they occupy is converted to another land use. When the forest is lost due to change in land use an observable pattern in the land use/land cover change can be revealed. Being a product of the natural and socio-economic factors, an understanding of these patterns is essential for planning (which is essentially a land use scheme) an area for sustainable development i.e. balancing environmental, economic and social factors. This understanding can also assist in the monitoring of the changes of land use, and therefore in some circumstances land cover, due to the demands of a rapidly growing population.

1.2 Statement of the Problem

International agreements involve the reporting on the state of forest cover which detail forest loss and forest gain. The results of these reports can greatly influence the economic prosperity of a nation as financial incentives are tied to conserving forests. There is, therefore, a requirement for an internationally recognised and unbiased Forest Cover dataset that can be utilised to produce these reports. By unbiased it is implied that the cover is produced on a purely scientific basis, with no external motives skewing the data. The Hansen dataset matches these criteria, with this study intending to demonstrate its validity by performing an analysis over an Australian local government area.

The Sunshine Coast region has been one of Australia's fastest growing residential and tourist areas for quite some time. It is projected that the population will increase from 290,000 to 380,000 over the next 10 years, an increase of 31% (Sunshine Coast Council, 2016). Early in its history the logging of the forests was one of the drivers of the region's growth which still occurs at a greatly reduced rate. In modern times the main drivers of growth are the attraction of its significant beaches, Pacific coastline, waterways, scenic hinterlands, national parks and bushland, in which the forest ecosystems play a significant role. There are several distinct forest ecosystems in the region, from coastal dunes to sub-tropical rainforests. These all need protection from the effects of land use change (except to that of conservation) that an increasing population demands. A study into the spatial pattern of these changes is useful in quantifying the effects on forest loss and gain.

Various mandates for the protection of forest ecosystems have been formed from the international level and have flowed down the various levels of national and state governments in which the region is located. The most significant of these is managed through the Queensland's Vegetation Management Act 1994, to manage/protect the natural environment and the Sustainable Planning Act 1999 to manage the socio economic growth. An analysis of areas protected by the

Vegetation Management Act against forest loss as well as planned land use areas in the Sustainable Planning Act may reveal the effectiveness of these regulations.

1.3 Justification for the Study

There is a need for a global forest cover dataset for use by various organisations and various levels of governments throughout the world, especially in nations that do not have the skills or budget to produce their own. This is used mainly for reporting forest cover to international bodies to include in their reports, for example the FAO state of forest reports. This study aims at demonstrating the effectiveness of using the Hansen Dataset in providing a generic unbiased forest cover for use in spatial analysis throughout the world.

To demonstrate the practical use of this dataset it was decided to analyse the data against a familiar area, namely, the Sunshine Coast Council in Queensland, Australia. Queensland does produce its own land use and land cover datasets to perform analysis for planning and other activities. Performing analysis of Land Use, Land Use Changes, protected areas, planning schemes etc. against an independently generated Forest Cover dataset revealed land uses and land use changes resulting in forest loss. This type of analysis is critical in forming development strategies that minimize impact on forests.

1.4 Aims and Objectives

1.4.1 Aims

The aim of this research project is to use ArcGIS to evaluate the changes in vegetation resulting from the investigation of the Hansen forest loss/gain datasets against various datasets published by the Queensland State Government. The study concentrated on the region covered by the Sunshine Coast Council. The regulated vegetation management areas, via the Remnant Regional Ecosystems dataset, will also be analysed against the Hansen forest loss/gain dataset to identify losses and gains occurring in these protected areas.

This study also aimed to demonstrate the value of using the Hansen Dataset to analyse forest loss in a relatively small study area.

1.4.2 Objectives

In order to achieve the above aim, the following objectives have been set

- Identifying areas of forest loss where change of land use has occurred
- Identifying forest loss/gain in Remnant Regional Ecosystems
- Demonstrate the value of using the Hansen Dataset to analyze forest cover in a relatively small study area

1.5 Scope and Limitations of the Study

The scope of this study is limited to what can be performed on a home PC with freely available data and software (with the exception of ArcGis Home Edition). The limitations of time, data storage, CPU processing power and skills limit the scope to a handful of datasets to be analysed. It was therefore necessary to limit the study to a small study area, namely, the area of Sunshine Coast Council.

Whilst there are abundant datasets available to analyse against, it was decided to limit the amount used that would satisfy the Aims and Objectives of the study.

1.6 The Organisation of the Dissertation

This dissertation is structured to tell a story of the research performed. This chapter, the introduction, introduces the project and gives a brief outline including justification for the study whilst presenting the aims and objectives. Chapter 2 is the review of literature and background study for the project helping to identify the gap in knowledge that is being fulfilled by this research. Chapter 3 introduces the study area and outlines the methods used to acquire and process data and perform the analysis. Chapter 4 presents the results culminating from the methods outlined in Chapter 3.

Chapter 5 provides a discussion of the results with conclusion being drawn in Chapter 6. Recommendations for future improvements and studies are provided in Chapter 7.

Ancillary material used in the production of this dissertation is also included as appendices, a list of tables and a list of figures.

Chapter 2

Literature Review

2.1 Introduction

A review of the literature revealed many spatial studies performed on Land Use Land Cover (LULC), along with many international, national, state and local regulations, treaties and guidelines in managing LULC at the various levels of administration.

Does the proportion of change in forest correlate well with population densities? A literature review was undertaken to further develop the idea towards a research project. The purpose of the review was to gather relevant information about:

- The Study Area
- History of Land-Use Land-Cover studies
- Forest Land Cover
- Choosing a Land Use Dataset
- Hansen Global Forest Change Dataset
- Obligations/Mandates under International Law
- Australia Legislative Response
- Queensland Legislative Response

2.2 History of Land Use Land Cover Change studies

Research on human induced global environmental change generally falls into two overlapping categories, industrial metabolism (flow of materials and energy in modern industrial society) and LU/LC change (the alteration of the land surface and its biotic cover) (Meyer & Turner II, 1992) The latter is to be investigated in this study. The category of LU/LC change is a hybrid category comprising of land use (how humans utilize the land), studied by social scientists and land cover (the physical and biotic character of the land surface), studied by natural scientists

(Meyer & Turner II, 1992). Integrating the two creates a category, LU/LC, with analysis of the changes revealing an understanding of how human activities affect the natural environment (Iqbal & Khan, 2014).

The antiquity of land cover change is reflected in the early writings on environmental science of the 19th century (Meyer & Turner II, 1992). The 20th century saw a proliferation in the study of global LU/LC change with the advent of satellite imagery at the end of the century making relatively quick and accurate assessments possible. Currently, well and truly into the 21st century, freely available satellite imagery from a significant period of time is available. This imagery, along with freely available software to process and analyse them, has resulted in LU/LC change being studied by individuals up to the international body level.

Study of LU/LC is extremely valuable in supporting the planning and utilization of natural resources, with GIS providing the ideal platform to handle the multidisciplinary datasets required to perform the study (Mallupattu & Sreenivasula Reddy, 2013). When integrated with Remote Sensing (RS) data the GIS provides the platform for spatial analysis of the classified (RS) data, thus being the principal tool for detecting LU/LC change (Fan, Wang, & Wang, 2008).

Currently, LU/LC change studies are performed at universities, by local, state and federal governments, and by international organizations, with each producing their own datasets and reports.

2.3 Forests

Forests are a particular type of Land Cover which are critical in maintaining the biogeochemical systems that sustain the biosphere of the Earth. Of particular interest is the role forests play in the carbon cycle (Figure 2-1) that contributes to Climate Change where they store substantial amounts of carbon, sequester carbon during growth, and release carbon when burning or decaying(Australian Government, 2013).

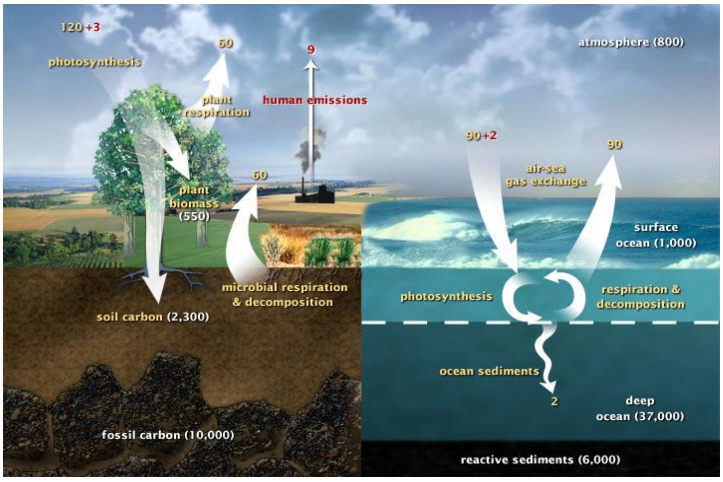


Figure 2-1: Fast Carbon Cycle; the movement of carbon between land, atmosphere, and oceans. Source: (Riebeek, 2011)

Forests have four major roles in climate change:

1. They currently contribute about one-sixth of global carbon emissions when cleared, overused or degraded
2. They react sensitively to a changing climate
3. When managed sustainably, they produce woodfuels as a benign alternative to fossil fuels
4. They have the potential to absorb about one-tenth of global carbon emissions projected for the first half of this century into their biomass, soils and products and store them - in principle in perpetuity.

(FAO, 2012)

Forests are also essential in maintaining other social, environmental and economic factors that make up the human and natural environment. Most importantly:

- Economic
    - Wood production and industry development
    - Plantations
    - Tourism
    - Employment
- Environmental
    - Conservation
    - Biodiversity
    - Water supply and catchment management
- Social
    - Open Space
    - Recreation
    - Research and development
    - Private native forest

(Australian Government, 2013)

Defining what constitutes a forest is essential when performing analysis, for example Achard, et al., (2016) used the Hansen dataset to compare the results of their own study and noted that a source of discrepancies was in the differences in the definitions of forest. Therefore specifying what constitutes a forest is essential before starting any study. This is easier said than done as forest types (Figure 2-2) can differ considerably depending on the latitude, temperature, rainfall patterns, soil composition and human activity (UNEP, 2009). The point of view of a person comes from, and the motives for a study, will determine the definition of forest. In fact, a study by Lund (2014 rev) revealed over 800 different definitions of forest from around the world. For the purposes of this study international and national legal definitions will be pursued.

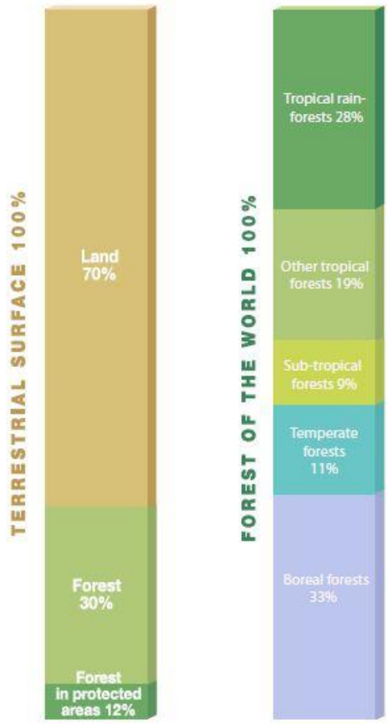


Figure 2-2: Global Forest Types
Source: (UNEP, 2009)

The Australian Government produces two major reports on forest cover to fulfil international mandates. The first is the "State of the Forest" report (SOFR). This report is produced every five years and is supplied to the Food and Agricultural Organisation of the United Nations (FAO) to compile its Global Forest Resource Assessment. It also provides a comprehensive national forestry assessment to be used by Government departments, industry and educational institutions throughout the country and the world (Australian Government, 2016). In the SOFR forests are defined as

> *"An area, incorporating all living and non-living components, that is dominated by trees having usually a single stem and a mature or potentially mature stand height exceeding 2 metres and with existing or potential crown cover of overstorey strata about equal to or greater than 20 per cent. This includes Australia's diverse native forests and plantations, regardless of age. It is also sufficiently broad to encompass areas of trees that are sometimes described as woodlands."*
>
> (Australian Government, 2013)

The SOFR further breaks down forests into:

- **Closed Forest:-** 80% Tree Canopy Cover
- **Open Forest:-** 50 - 80% Tree Canopy Cover
- **Woodland:-** 20 - 50% Tree Canopy Cover
- **Other Woody Vegetation:-** Areas with tree canopy < 20% are not classified as forests.

(Australian Government, 2013)

The FAO defines forest as

> *"Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use."*
>
> (FAO, 2015)

It is interesting to note that the FAO's Forest Resource Assessment (FRA) Australian country report contains the FAO definition for forest whilst stating that the data within is sourced from the SOFR provided by the Australian government, i.e. with a different definition of forest (FAO, 2014). This discrepancy further outlines the importance of clearly defining "forest" when conducting analysis. The following questions and answers from the FRA guide to country reporting may answer why there is a discrepancy.

> *"Q:How does the FRA definition of forest correspond with the definition of forest in other international reporting processes?*
>
> *A:The definition of forest used for reporting to FRA is generally accepted and used by other reporting processes. However, in the specific case of the UNFCCC, the IPCC guidelines for country reporting on greenhouse gas emissions allow for certain flexibility in the national definition of forest, stating that the country can choose the thresholds of the following parameters, allowed interval within parenthesis:*
>
> - *minimum area (0.05 - 1.0 hectares)*
> - *tree crown cover (10 - 30 %)*
> - *tree height (2 - 5 meters)*

The thresholds should be selected by the country at the first national communication and must then be kept the same for subsequent national communications"

(FAO, 2015)

As can be seen the definition used in the Australian SOFR assessment falls within the allowable criteria outlined by the IPCC

The second international reporting obligation, in regards to forests is the Australia's National Inventory Report and Revised Kyoto Protocol National Inventory Report submitted under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. The reports are used to quantify Australia's carbon emissions in which, as previously discussed, forests form a part. Forests are included in the Land, Land Use change and Forestry (LULUCF) section of the report. The definition of forest in this report (below) is consistent with the definition used in the SOFR, with the addition of a minimum area.

"Parties are required to select single minimum values for land area, tree crown cover and tree height. Australia uses a criteria of 20\% tree crown cover, 2 metre minimum tree height, and a minimum of 0.2 hectares in land area for inclusion. These minimum criteria are within the ranges outlined in the Marrakech Accord." (Australian Government, 2016)

2.4 Choosing a Land Use Dataset

How humans use the land greatly impacts the Earth's natural resources, environment and agricultural production. Land Use mapping is an attempt to capture how land is used and temporal capture of land use over time will reveal changes. Study of land use and land use change against other datasets, such as a particular land cover, can reveal patterns that were not previously apparent. Land

Use data is used for various applications such as agricultural land auditing, regional planning and land degradation (Queensland Government, 2016).

There is currently no global high resolution land use dataset derived (data mined) from the Landsat Archive that would mirror the work carried out by Hansen, et al. (2013), whose efforts created a global forest cover and forest cover change dataset. It was therefore necessary to select a Land Cover dataset that is compatible with the scale and detail of the Hansen dataset. Whilst there are many land use datasets available for the study area, choosing one at the appropriate scale and sufficient diversity in classification for the study was essential. Land use datasets are created at scales relevant to the study area they have been created to support. For example, the USGS produces MODIS-based Global Land Cover Climatology dataset has a 0.5km pixel size and 17 different classifications, Figure 2-3, which is relevant at global scales (for which it is created), but is too coarse for area being studied.

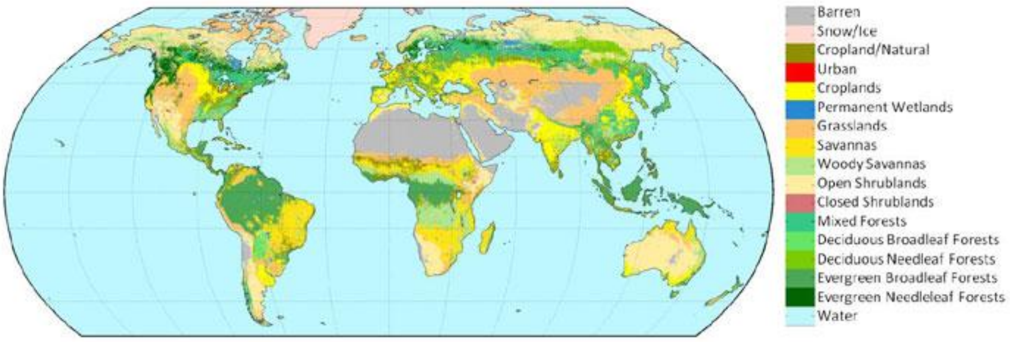


Figure 2-3: 0.5 km MODIS-based Global Land Cover Climatology
Source: (Broxton, Zeng, Sulla-Menashe, & Troch, 2014)

The United Nations Environmental Program (UNEP) via other agencies developed a 5arc minutes (approx 10km) land use dataset to use for global land degradation analysis, Figure 2-4, again this dataset is too coarse for area being studied.

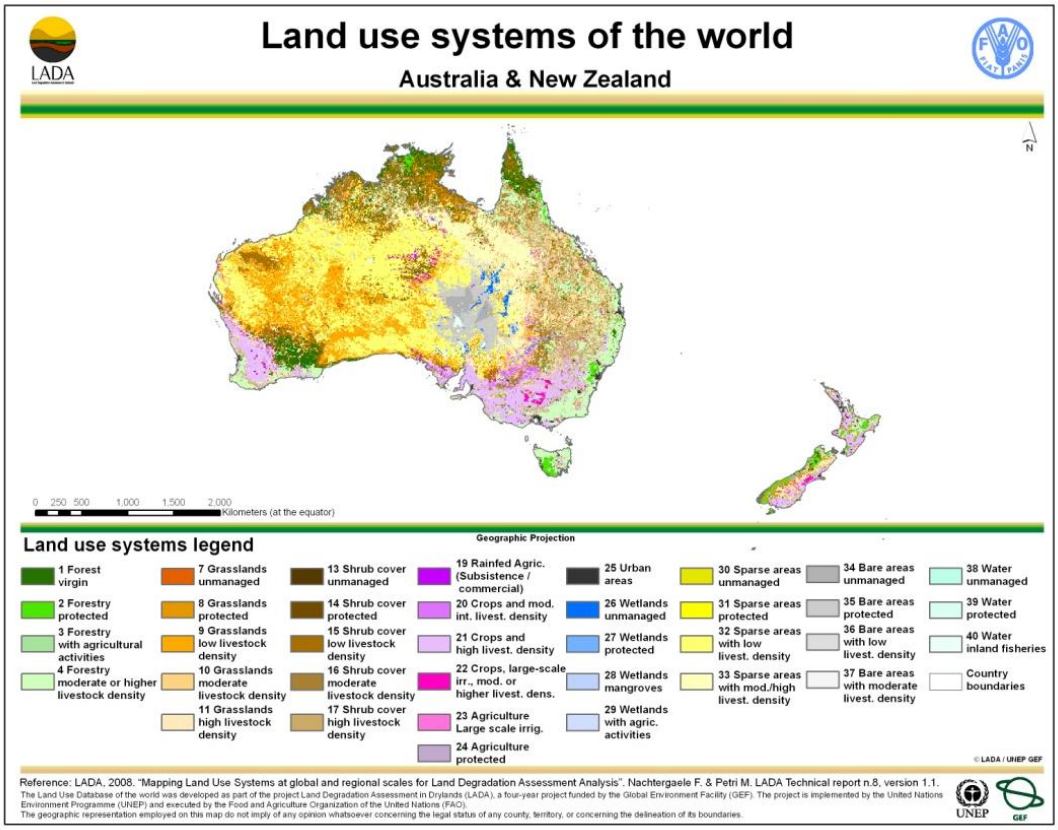


Figure 2-4: Mapping Land Use at global and regional scales for Land Degradation Assessment Analysis. Source: (Nachtergaele & Petri, 2008)

The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) has developed the Australian Collaborative Land Use and Management Program (ACLUMP), which is a consortium of Australian Government with state and territory government partners with a program to promote a "nationally consistent land use and land management practices information for Australia" (Australian Government, 2015). This includes activities such as consistent mapping practices, agreed technical standards (Australian Land Use and Management Classification (ALUM)), a national land use data directory and regional and national reporting of land use and land management practices. The land use mapping projects produced by this program are a 1:2,500,000 national scale map, Figure 2-5, and a regional catchment level scale maps, with a mapping scale relative to the intensity of land use, Figure 2-6.

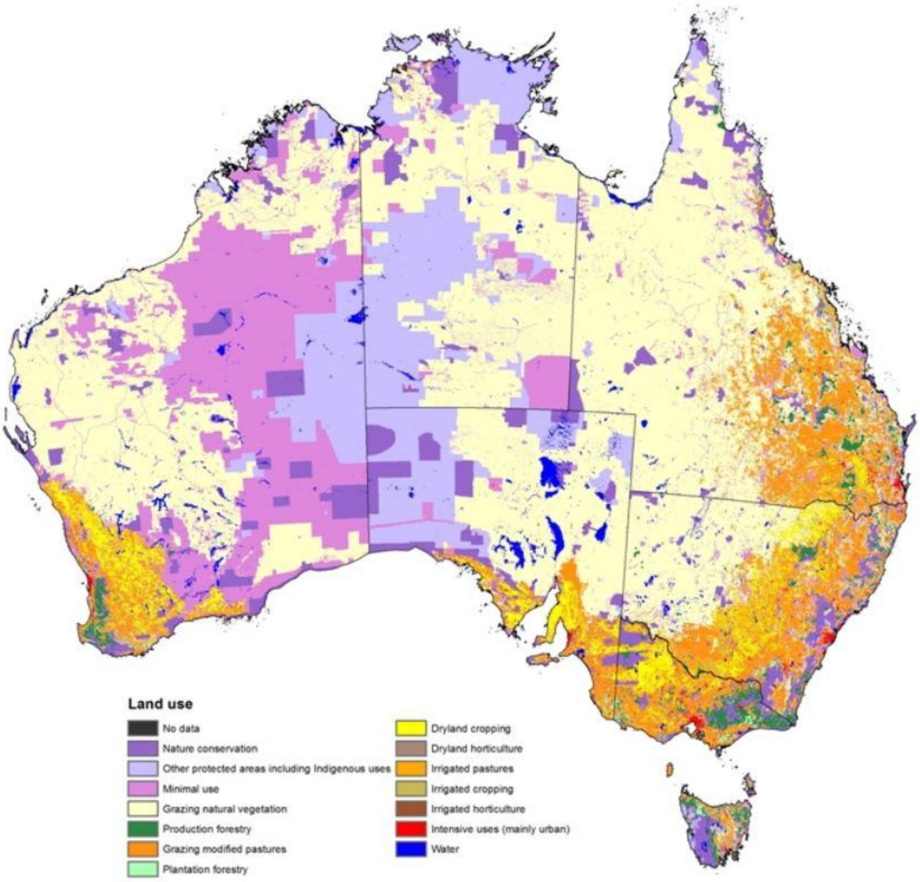


Figure 2-5: National scale land use map developed by ABARES in 2010

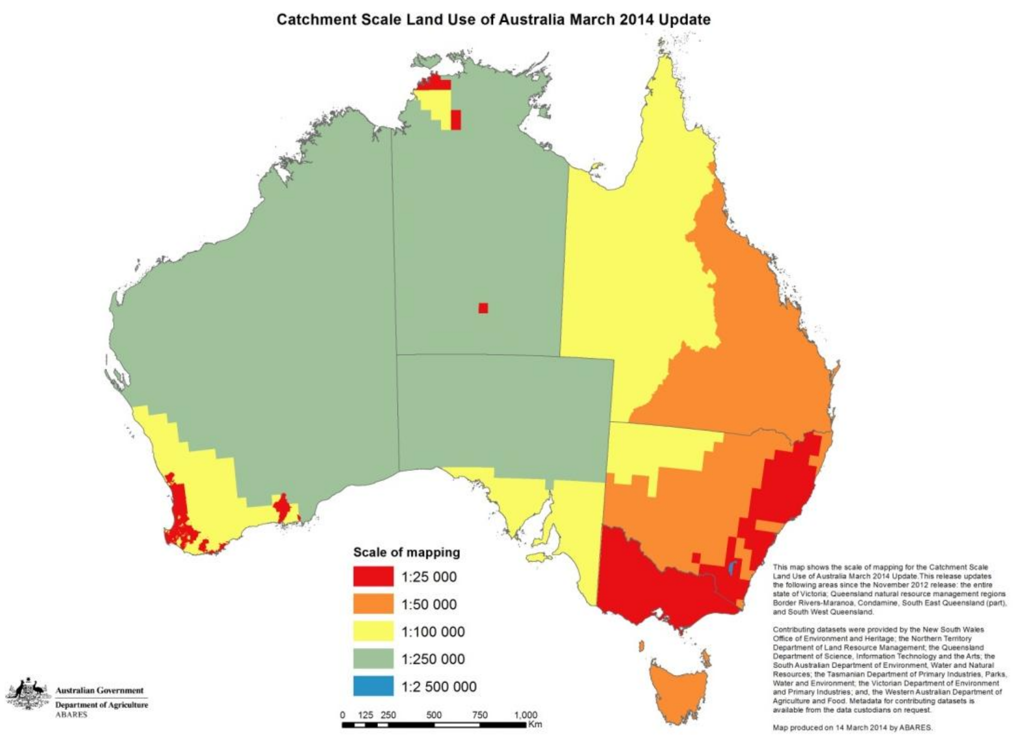


Figure 2-6: National Map showing catchment scale land use mapping scales

The regional catchment level maps of ACLUMP are managed by the State Government that they fall in. In Queensland this is captured in the datasets created by the Queensland Land Use Mapping Program (QLUMP). All regional catchment level land use maps have been completed for 1999, giving a baseline for comparison against subsequent data captures, creating a corresponding land use change dataset. Selected regions are given high priority for recapture due to the high population and level of land use change being experienced. Figure 2-7 outlines the QLUMP dataset currency throughout the state (Queensland Government, 2016).

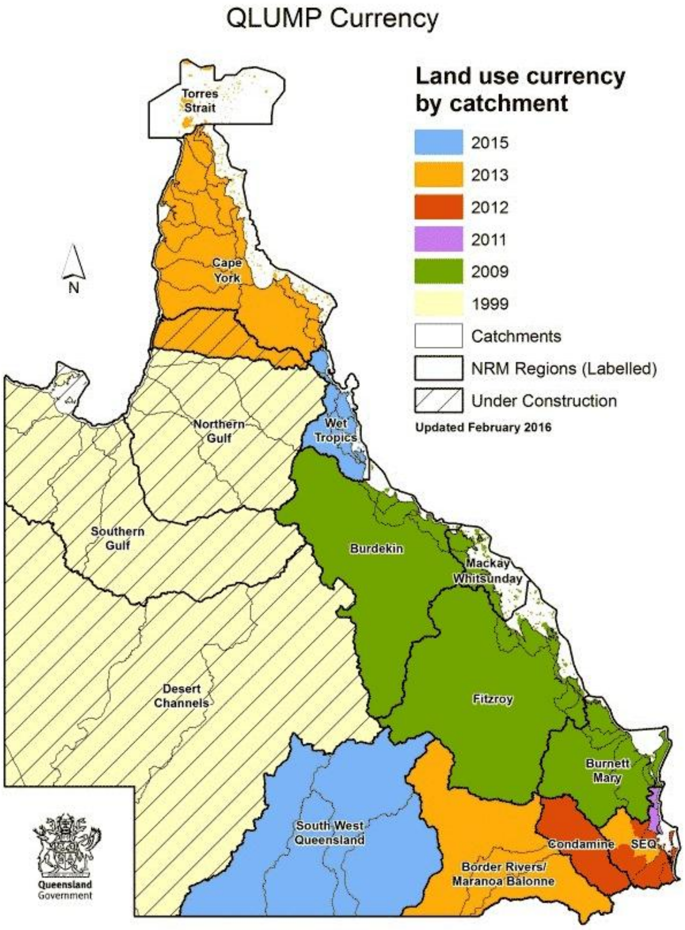


Figure 2-7: Queensland Land Use currency by catchment

The QLUMP regional catchment level maps are at a scale and timeframe that is compatible with the Hansen dataset and relevant to the size of the region being analysed for this project. Three of the regional catchment areas fall within the study area. These are captured independently and at different times (except for the

1999 base year). Some of the analysis may need to be broken into these catchment areas so that it can be performed adequately.

2.5 Hansen Global Forest Change Dataset

The Hansen global forest change dataset is a time-series analysis of high (30m) spatial resolution Landsat (Remotely Sensed) images aimed at capturing the global forest extent and change from the years 2000 to 2012. This study was the first attempt at data mining the entire Landsat archive in order to quantify global forest cover change (Hansen, et al., 2013). In order to quantify the accuracy of the data produced, the results of the mapping exercise went through an independent validation process. The validation was performed at the Global and biome levels and revealed a global accuracy of 99.6% for forest loss and 99.7% for forest gain. The accuracy for the sub-tropical biome, in which the study area of this report falls, is 99.7% for forest loss and 99.7% for forest gain (Hansen, et al., 2013).

In their study Hansen, et al. (2013) define forest loss as “a stand-replacement disturbance or the complete removal of tree cover canopy at the Landsat pixel scale. Forest gain was defined as the inverse of loss, or the establishment of tree canopy from a nonforest state.” and use the term “forest” to refer to tree cover and not the land use. This is important to note as land uses such as fruit tree plantations are grown under tree cover and are not considered to be of the forest land use and, inversely, areas under the forest land use may be in the early stages of growth and not have any actual tree cover (FAO 2012, Hansen, et al. 2013). As a result of this distinction it would be expected that the forest areas acquired from the Hanson dataset will vary from “forests” derived from other national and international Land Cover studies. This is crucial to understand when comparing results derived from this dataset with results derived from analysis of other “forest” datasets.

The Hansen global forest change dataset provides a transparent, open and consistent platform on which to quantify critical issues related to forest cover change. These qualities of the dataset have opened up research into forest cover related studies in the scientific community. For example, Achard, et al. (2014) use the Hansen dataset to compare the results of their own study and conclude that a source of discrepancies is the differences in the definitions of forest. Whilst (Apan, Suarez, Maraseni, & Castillo, 2016) uses the dataset to analyse forest cover loss in the protected tropical forests of the Philippines.

The first year in the series (2000) was used as the base year and is recorded in a raster dataset treecover2000. This dataset captures the canopy closure for all vegetation taller than 5m with each grid cell recording the percentage of canopy closure i.e. a value of 0 - 100(Hansen, et al., 2013). Figure 2-8 demonstrates the tree cover dataset in the study area.

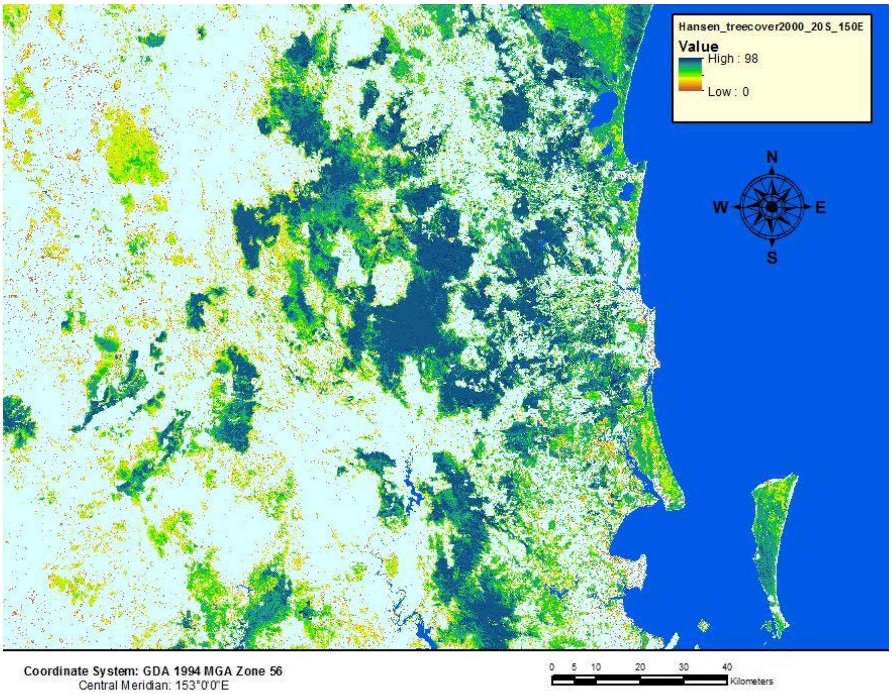


Figure 2-8: Hansen Base Tree Cover (2000) in the Study Area

The rest of the Hansen dataset is made of several raster images denoting changes in the forest cover in reference to the base year (2000). The Global forest cover loss 2000-2014 (loss) raster identifies forest cover loss over the entire period, with each cell encoded as either 1 (loss) or 0 (no loss). Whilst the year of gross forest cover loss event (lossyear) raster contains a disaggregation of total forest loss to annual time scales, with each cell encoded as either 0 (no loss) or else a value in the range 1-14, representing loss detected primarily in the year 2001-2014, respectively. Forest gain for the period 2000-2012 is captured in the Global forest cover gain 2000-2012 (gain) raster, with each cell encoded as either 1 (gain) or 0 (no gain) (Hansen, et al., 2013). Figure 2-9 demonstrates the disaggregated loss per year raster for a sample area.

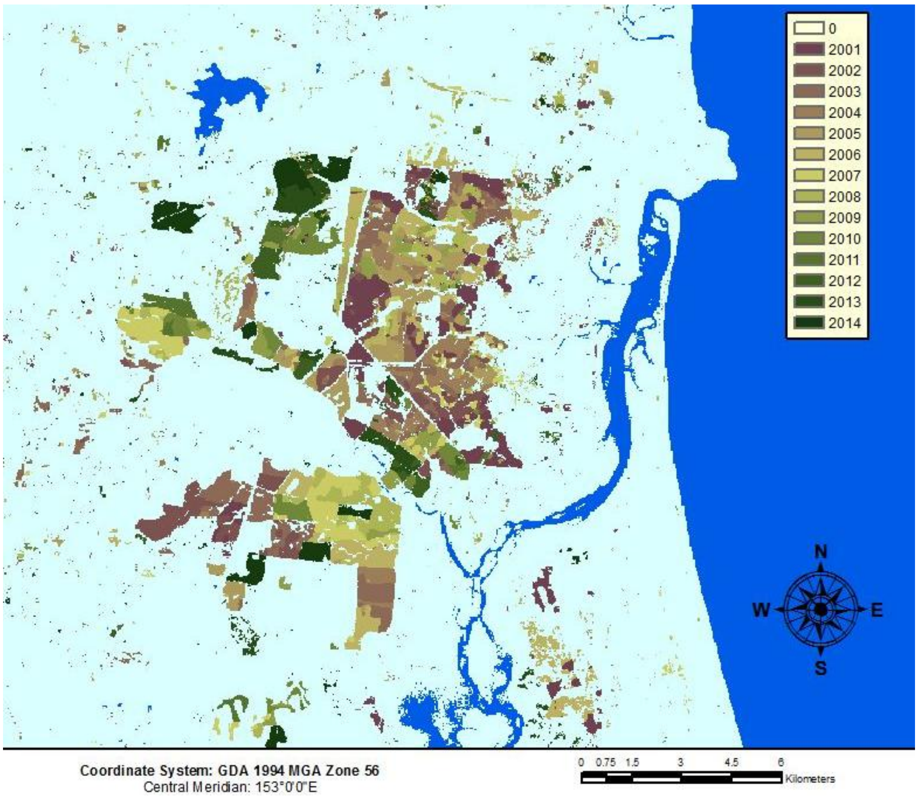


Figure 2-9: Hansen Tree cover Loss by Year in a Sample of the Study Area

2.6 Obligations/Mandates under International Law

Some environmental problems (e.g. ozone layer depletion and greenhouse gas emissions) are global in scale and require an international approach. To tackle these global issues, various international treaties and laws have been put into place. These can be traced back to the declaration made during United Nations Conference on the Human Environment in 1972 held in Stockholm, Sweden, often referred to as the Stockholm Declaration.

> *"The natural resources of the earth, including air, water, land flora, and fauna and especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management as appropriate.*
>
> *(Principle 2 – Stockholm Declaration 1972)"*

International laws, unlike the municipal or domestic laws within a nation, have no parliament or court enforcing their jurisdiction. Therefore, they have an ambiguous method of introduction, adjudication and enforcement. It is entirely up to each nation whether they are prepared to be bound by a particular international law (McNamara, 2015).

Australia as a signatory and Annex I party to the Kyoto Protocol under the United Nations Framework Convention on Climate Change (UNFCCC) has numerous obligations to limited greenhouse gas emissions. Article 2 of the Kyoto Protocol outlines the ultimate objective of the convention and it is guided be Article 3 of the convention. This is provided below with key points relating to forests emboldened.

"Article 2

1. Each Party included in Annex I, in achieving its quantified emission limitation and reduction commitments under Article 3, in order to promote sustainable development, shall:

(a) Implement and/or further elaborate policies and measures in accordance with its national circumstances, such as:

(ii) Protection and enhancement of ***sinks and reservoirs of greenhouse gases*** *not controlled by the Montreal Protocol, taking into account its commitments under relevant international environmental agreements; promotion of* ***sustainable forest management practices, afforestation and reforestation****;*

Article 3

3. The net changes in greenhouse gas emissions by sources and removals by sinks resulting from ***direct human-induced land-use change and forestry activities, limited to afforestation, reforestation and deforestation since 1990****, measured as verifiable changes in carbon stocks in each commitment period, shall be used to meet the commitments under this Article of each Party included in Annex I. ....*

4. Prior to the first session of the Conference of the Parties serving as the meeting of the Parties to this Protocol, each Party included in Annex I shall

> *provide, for consideration by the Subsidiary Body for Scientific and Technological Advice, **data to establish its level of carbon stocks in 1990 and to enable an estimate to be made of its changes in carbon stocks in subsequent years**. ...."*
>
> (United Nations, 1997)

Whilst the Kyoto protocol is one of the most coherent and strongest agreements there are other international instruments involving forest protection (McDermott, O'Carroll, & Wood, 2007). Namely:

- The RAMSAR Convention on Wetlands of International Importance
- The Convention on Biodiversity.
- World Heritage Convention
- Convention on International Trade in Endangered Species (CITES)

As such there is generally two separate responses to international treaties; one to report on carbon sinks and the other to address biodiversity.

2.7 Australia Legislative Response

Under Section 51 of the Australian Constitution the Australian Government has legislative powers in regards to international treaties. To fulfil its international obligations for the preservation of carbon sinks and protection endangered ecological communities, *The Environment Protection and Biodiversity Conservation Act 1999 (C'wlth.)* (EPBCA) was implemented.

Australia produces the State of Forest Report addressing biodiversity and the National Inventory Report to address reporting on carbon sinks.

The forest area data to support the SOFR was produced using a "Multiple Lines of Evidence" approach, integrating data sourced from multiple sources (Australian Government, 2013).

The Sunshine Coast consists of several areas that potentially contain ecological communities listed under the EPBCA. Special attention was paid to these areas in the study.

2.8 Queensland Legislative Response

Regulation in Queensland includes the *Nature Conservation Act 1992* and the *Vegetation Management Act 1999* (VMA). Both play a key role in the protection of terrestrial ecosystems including forests, with VMA mainly concentrating on the preservation of remnant vegetation. Since the introduction of the VMA state-wide clearing of remnant vegetation has decreased considerably i.e. from 645 000ha in 1999-200 to 53 000ha/year in the 2006-2009 period, demonstrating considerable effectiveness of the legislation (Department of Environment and Heritage Protection, 2012).

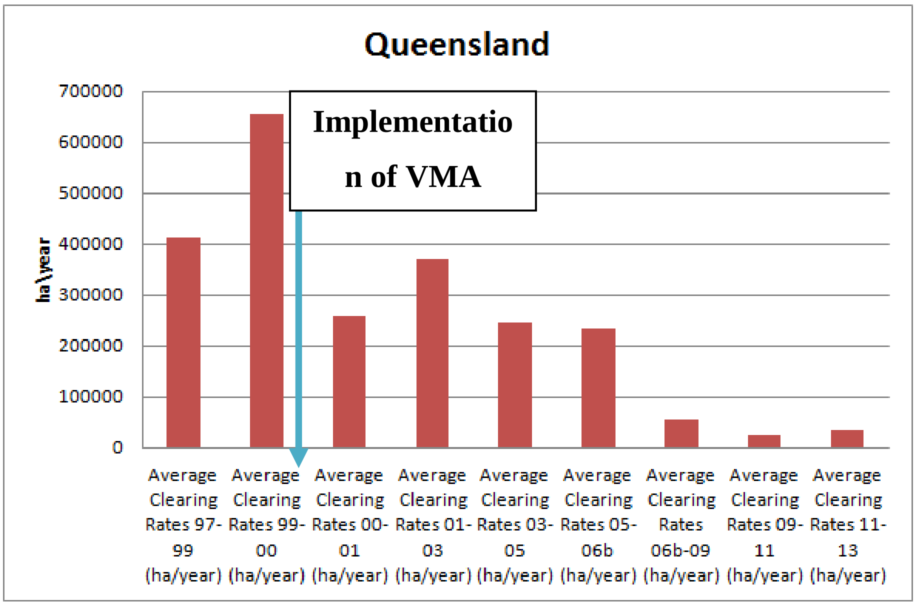


Figure 2-10: Queensland Average Annual Clearing Rates for Remnant Vegetation 1997 to 2013
Source: (Department of Environment and Heritage Protection, 2012)

The Queensland Government produces the Statewide Landcover and Trees Study (SLATS) dataset in order to investigate the overall cover of woody vegetation and its change for greenhouse gas inventory, i.e. carbon sinks and vegetation management (Queensland Goverment, 2016).

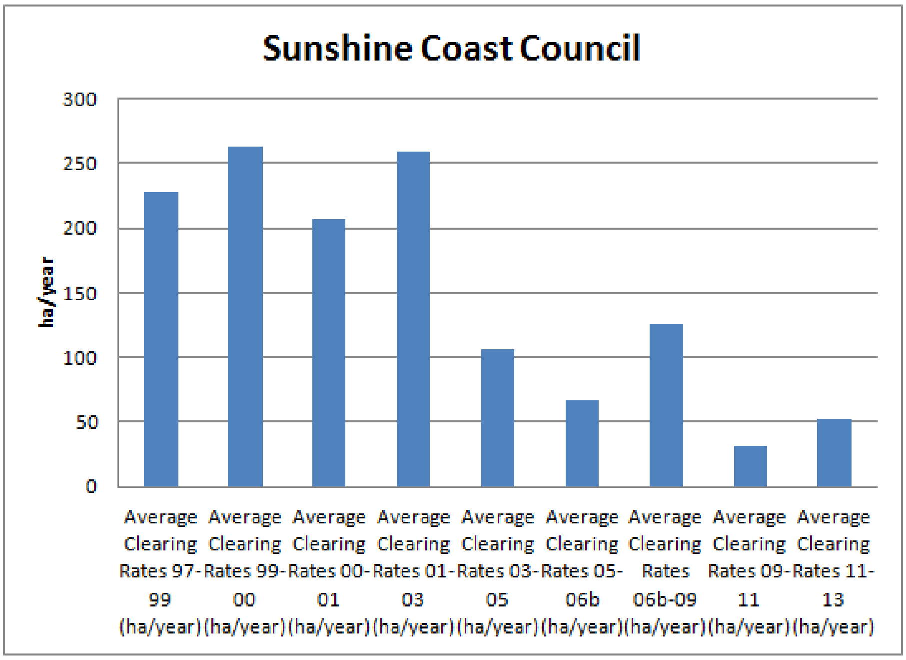


Figure 2-11: SCC Average Annual Clearing Rates for Remnant Vegetation 1997 to 2009
Source: (Department of Environment and Heritage Protection, 2012)

2.8.1 Regional Ecosystems

The Queensland government has developed a “Regional Ecosystem” (RE) classification system in order to categorize and map native vegetation communities throughout Queensland. This dataset is used to determine the remnant regional ecosystem extent and change for biodiversity assessment and vegetation management (Queensland Goverment, 2016).

The vegetation communities are grouped according to the native vegetation occurring in particular Land Zone (a combination of geology, soil and landform) in a specific bioregion (Figure 2-12) in Queensland. The RE classification is supported by a three part code depicting Bioregion, Land Zone and Vegetation type. Maps have been produced along with an accommodating Regional Ecosystem Description Database (REDD) to maintain detailed descriptions. RE’s have been mapped at 1:100 000 in most of Queensland and reflect the remaining Remnant Vegetation (RV). Remnant Vegetation refers to any patches of native trees, shrubs or grasses still remaining (Queensland Government, 2014).

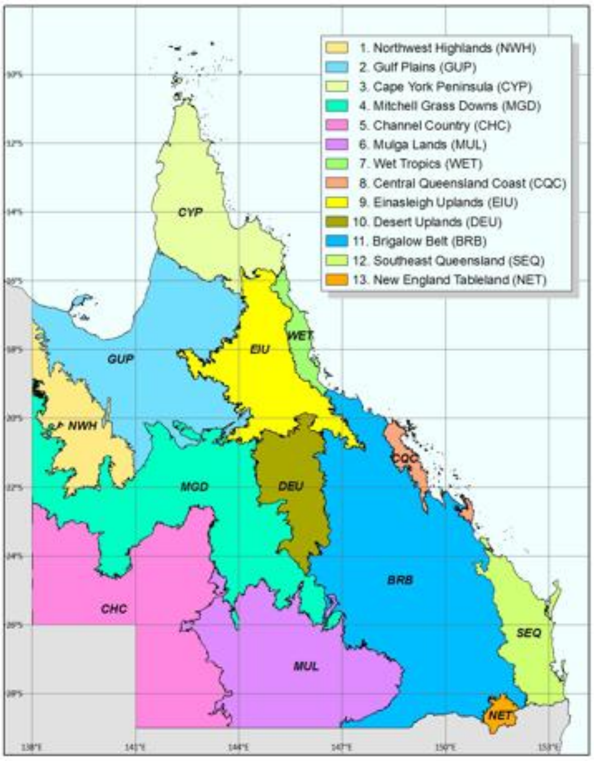


Figure 2-12: Queensland Bioregions. Source: (Queensland Government, 2014)

Regional ecosystems are granted different protection status (RE Status) under the VMA. This status is based on an assessment on the condition of the remnant vegetation. The RE Status is broken into three levels, which are:

1. **Endangered**

   A regional ecosystem is listed as ‘endangered’ under the Act if:

   - remnant vegetation is less than 10% of its pre-clearing extent across the bioregion; or
   - 10–30% of its pre-clearing extent remains and the remnant vegetation is less than 10,000ha.

   In addition to the criteria listed for an ‘endangered’ regional ecosystem under the Act, for biodiversity planning purposes a regional ecosystem is listed with a biodiversity status of ‘endangered’ if:

   - less than 10% of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss; or

- 10–30% of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and the remnant vegetation is less than 10,000ha; or
- it is a rare regional ecosystem subject to a threatening process.

2. Of concern

A regional ecosystem is listed as ‘of concern’ under the Act if:

- remnant vegetation is 10–30% of its pre-clearing extent across the bioregion; or
- more than 30% of its pre-clearing extent remains and the remnant extent is less than 10,000ha.

In addition to the criteria listed for an ‘of concern’ regional ecosystems under the Act, for biodiversity planning purposes a regional ecosystem is listed with a biodiversity status ‘of concern’ if:

- 10–30% of its pre-clearing extent remains unaffected by moderate degradation and/or biodiversity loss.

3. No concern at present/Least concern

A regional ecosystem is listed as ‘least concern’ under the Act if:

- remnant vegetation is over 30% of its pre-clearing extent across the bioregion, and the remnant area is greater than 10,000ha.

In addition to the criteria listed for ‘least concern’ regional ecosystems under the Act, for biodiversity planning purposes a regional ecosystem is listed with a biodiversity status of ‘no concern at present’ if:

- the degradation criteria listed above for ‘endangered’ or ‘of concern’ regional ecosystems are not met.

2.8.2 Broad Vegetation Groups (BVG)

The BVGs are a high level ecological grouping of vegetation communities and regional ecosystems defined by the Queensland Herbarium and provided by the Queensland Government via the Queensland Spatial Catalogue (Neldner, Niehus, Wilson, McDonald, & Ford, 2015). As they provide an overview of ecological patterns at the state and bioregion level they are a useful addition to the RE framework. As such the remnant BVG areas are also included in the RE dataset (Figure 2-14). A standalone pre-clearing BVG dataset (Figure 2-13) is also available providing an estimated of the original BVG coverage.

There are 3 levels of BVGs, each of which was designed to reflect the size and scale of a particular type of study area:

- 1:5,000,000 (national)
- 1:2,000,000 (state)
- 1:1,000,000 (regional)

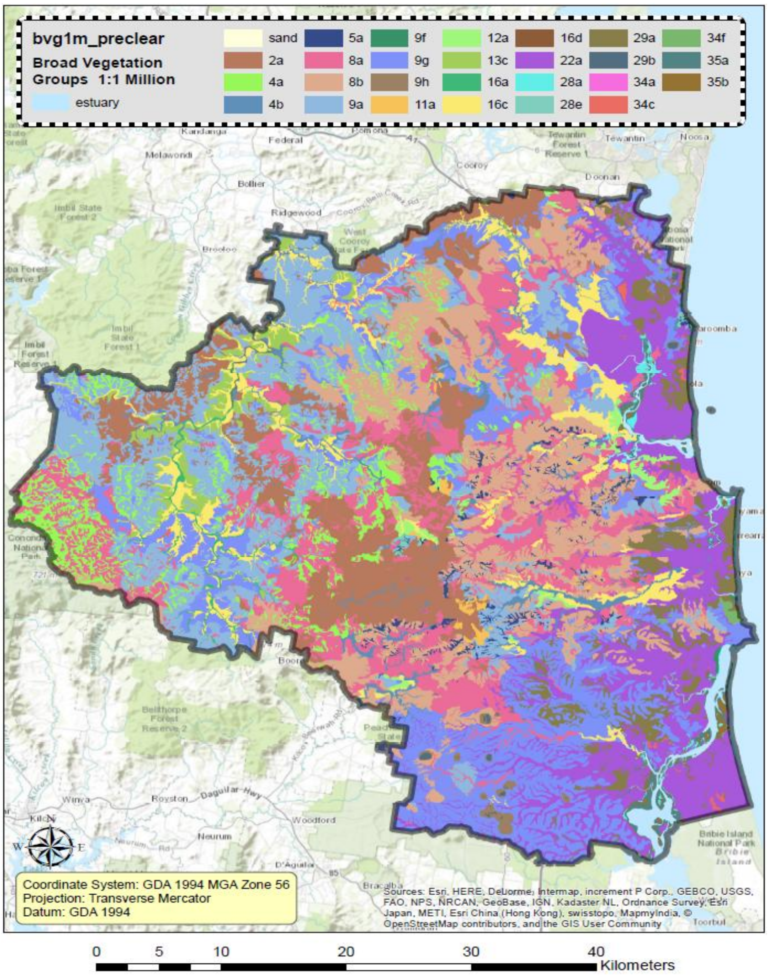


Figure 2-13: Pre-clearing BVG's in the SCC

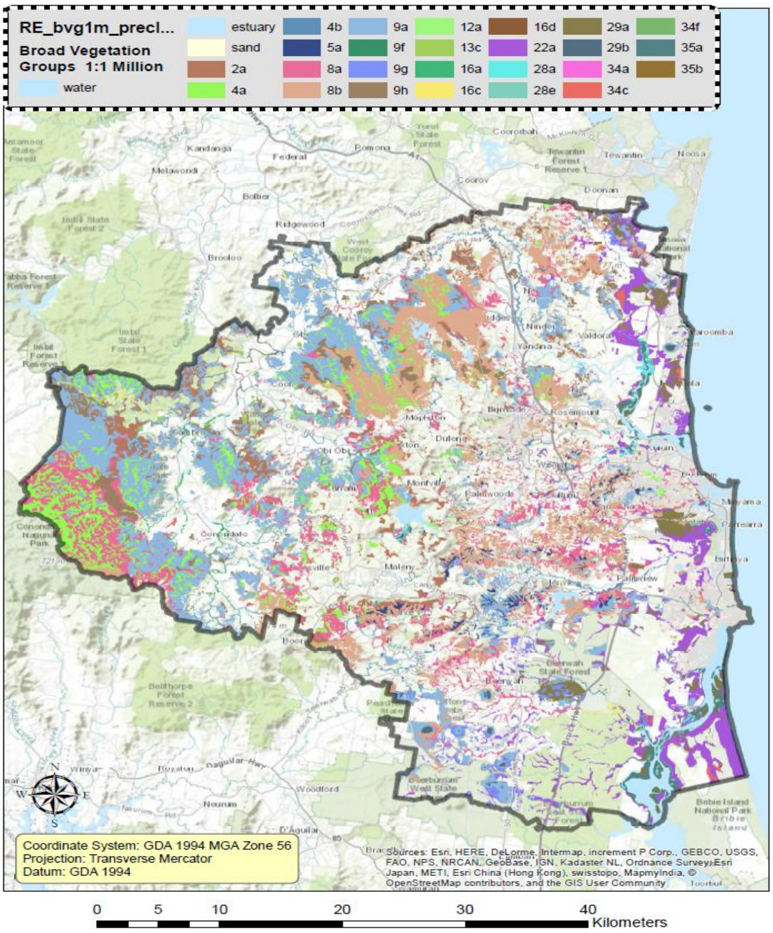


Figure 2-14: Remnant BVG's in the SCC

2.9 Summary

The Hansen global forest change dataset provides a transparent, open and consistent platform on which to quantify critical issues related to forest cover change. The SOFR and NIR produced by the Australian Government provide a sufficient definition of forest to use for the study. The study area is of sufficient size and contains enough diversity of land uses and forest cover to provide a relevant analysis.

The literature review revealed no specific Local Government Area studies of Land Use Change against Forest Loss which could reveal insightful information on forest loss at the local government areas.

Chapter 3

Research Methods

3.1 Introduction

The procedure adopted in this research forms the basis for setting up a GIS analysis project and the subsequent analysis. Figure 3-1 provides a basic outline of the procedure used in completing this project.

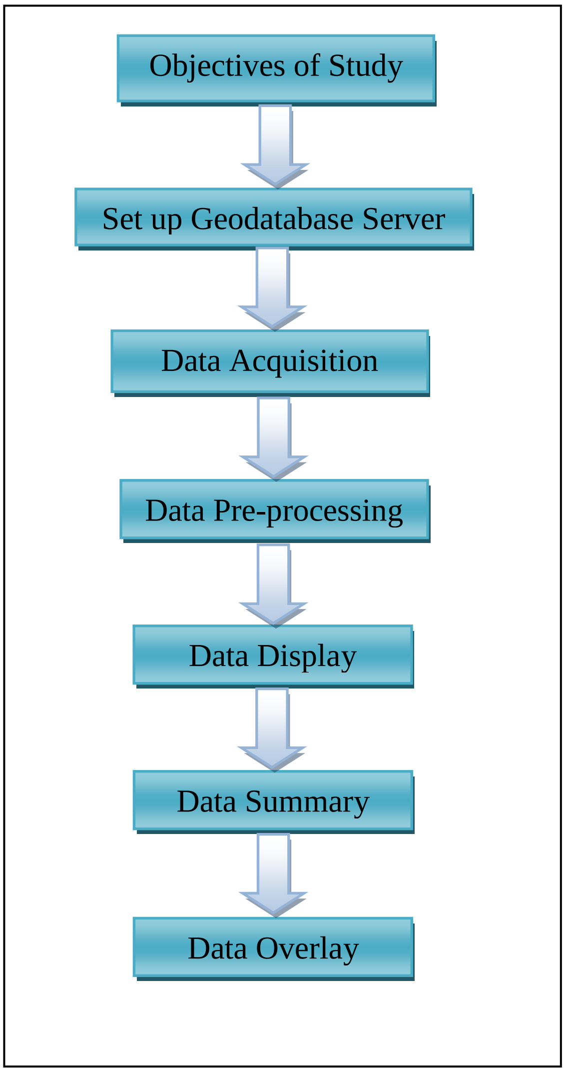


Figure 3-1: Overview of Methodology

All GIS work was performed in ESRI's Arc MAP 10.3.1.

3.2 The Study Area: Sunshine Coast Council

The study area comprises of the area administered by the Sunshine Coast Council in Queensland, Australia. Figure 3-2 identifies the area in context of the Australian continent and Figure 3-3 shows the area and the neighboring councils. The council has a perimeter of 289.5 kilometers and covers an area of 2,284.8 square kilometers. The area is in the subtropical humid forest global ecological zone as outlined by the FAO, but does have drier winter and autumn months (July - November), Figure 3-4. The climate is ideal for human habitation experiencing an average of 7 hours sunshine a day, hence the name of Sunshine Coast. On average, temperatures do not get either extremely hot or extremely cold, remaining fairly consistent throughout the year, Figure 3-4.

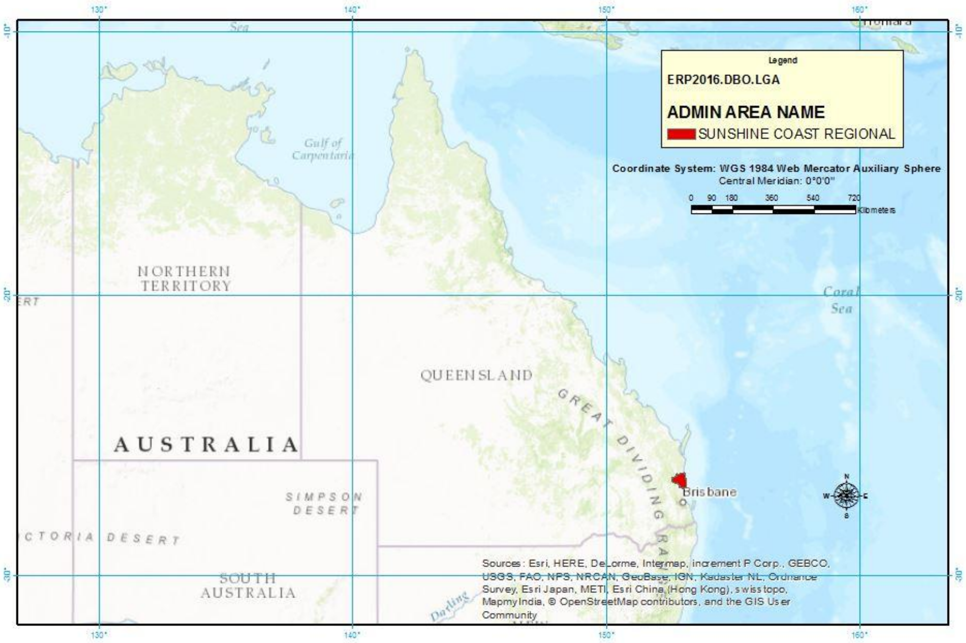


Figure 3-2: Sunshine Coast Council Study Area

The Sunshine Coast Council currently has a population of 290,000 people making it fifth largest in the state (Queensland Government, 2016). The area has been one of Australia’s fastest growing residential and tourist areas for quite some time with the population projected to increase from 290,000 to 380,000 over the next 10 years, an increase of 31% (Sunshine Coast Council, 2016).

Early in its history, the logging of the forests was one of the drivers of the growth, which is still occurring at a decreased rate. In modern times the main drivers of growth is the attraction of its climate, significant beaches, Pacific coastline, waterways, scenic hinterlands, national parks and bushland, in which the forest ecosystems form a significant part.

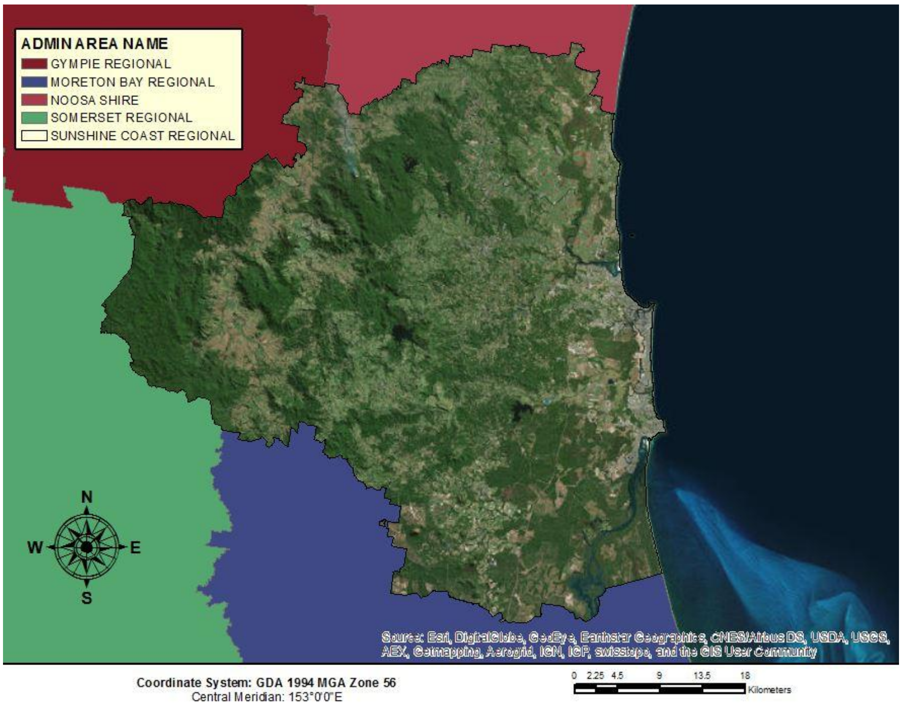


Figure 3-3: Sunshine Coast Council and Surrounding LGA's

There are several distinct ecosystems in the region, namely:

- Coastal Dunes
- Mangroves and saltmarshes
- Seagrass communities
- Heathland and paperbarks
- Dry sclerophyll and open forest/woodland
- Wet sclerophyll
- Sub-tropical Rainforest
- Rocky/montane heath

(Sunshine Coast Council, 2016)

Not all of them are forest ecosystems but they all need protection from the effects of land use change (except to that of conservation) that an increasing population demands.

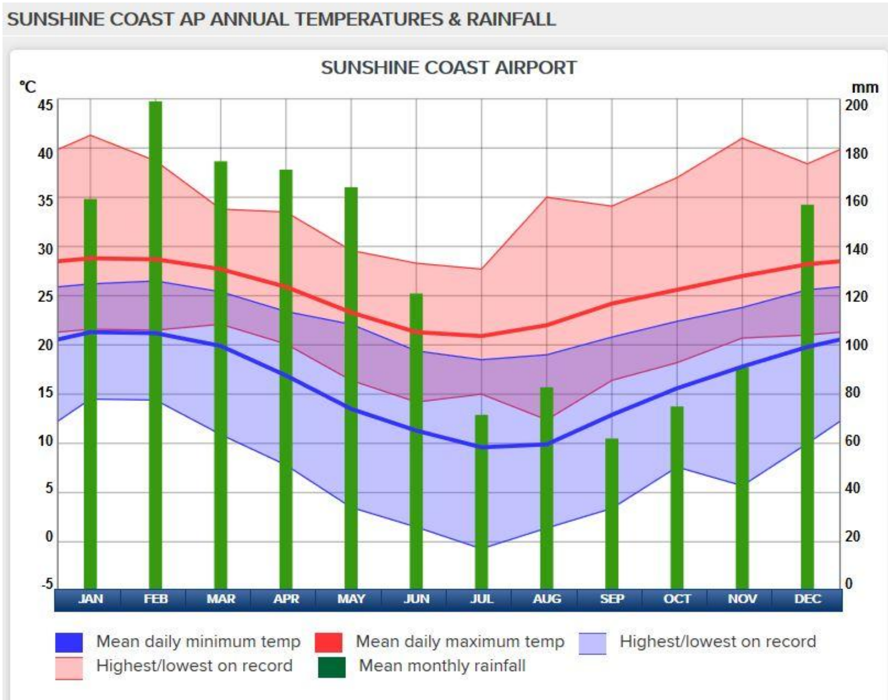


Figure 3-4: Sunshine Coast Annual Averages and Extremes

3.3 Setup Geodatabase

A geodatabase was created to store and manage the geospatial data for the project. The decision to use a geodatabase was made as they offer structural, performance and data management advantages over a personal database or a collection of shapefiles (Childs, 2009). SQL Server was installed to carry out the management of the Geodatabase.

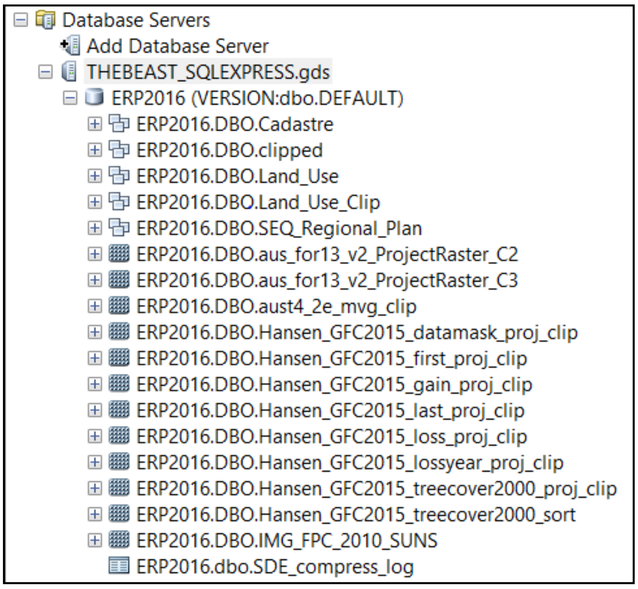


Figure 3-5: Geodatabase Structure

3.4 Data Acquisition

The data was acquired from various open data sources. During the literature review various data sources, that reflect forests or could have an impact on forested areas e.g. land use, were revealed. The process of acquiring those sources of data is outlined in this section.

3.4.1 Hansen Global Forest Change Dataset

This dataset contains the earth observation derived forest cover/forest change data which forms the core of this study. The development of the Hansen Global Forest Change Dataset was discussed in the literature review. This section will discuss how the dataset is published, how it was acquired and the layers that it is made up off.

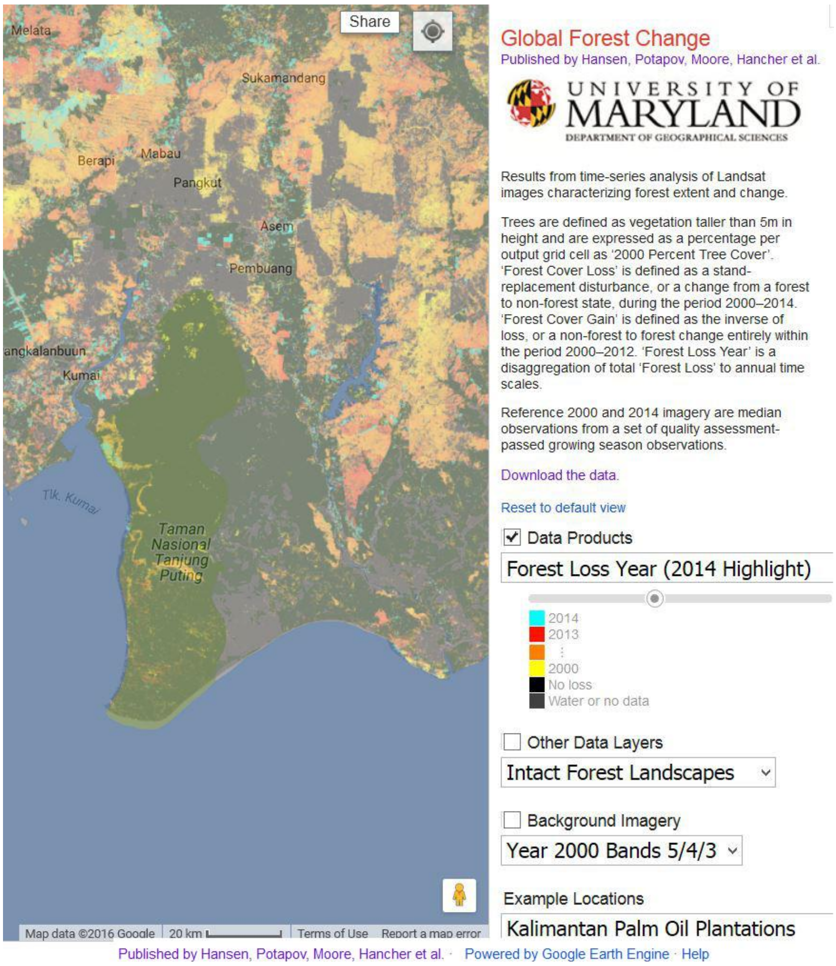


Figure 3-6: Example from Hansen source Website: Kalimantan Palm Oil Plantations

The Department of Geographical Sciences at the University of Maryland publishes the Hansen dataset via the Google Earth Engine. The dataset has a dedicated asset ID (*UMD/hansen/global_forest_change_2015*) allowing direct analysis of the results in the Google Earth Engine. A dedicated web page displaying the data (view only, no analysis) has also been published via the Google Earth Engine. Figure 3-6 shows a predefined sample area on the web page demonstration the data. Analysis of the data directly in the Google Earth Engine can only be performed against other datasets published on the platform and relies on a dependable Internet connection; neither of these criteria is met for this study.

The data is also available for downloaded in a compilation of seven tiff raster images divided into a series of 10 x 10 degree tiles covering the globe, see Figure 3-7. Downloading of the data allows the displaying and analysis of the data to be performed on a personal computer, such as the requirement for this study. The study area falls entirely within one of the tiles making for simpler acquisition of the data i.e. only one series to be managed.

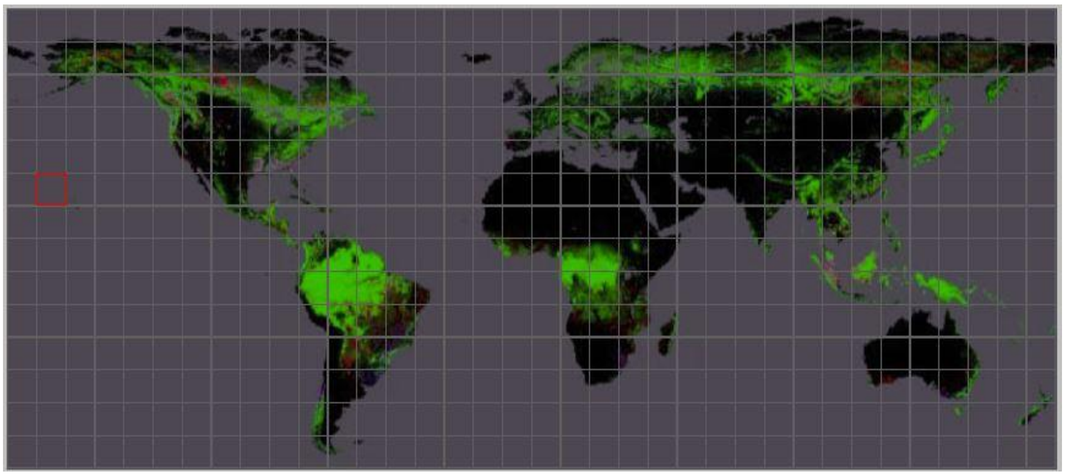


Figure 3-7: Hansen 10 x 10 Degree Granuals of Data

The seven Tiff files that make up the dataset are outlined as follows:

1. **Tree canopy cover for year 2000 (treecover2000)**: This layer provides the base tree cover for the year 2000. Each grid cell represents the percentage of canopy closure for all vegetation taller than 5m in height i.e. in the range 0-100.
2. **Global forest cover loss 2000--2014 (loss):** Forest loss during the period 2000-2014. Encoded as either 1 (loss) or 0 (no loss).
3. **Global forest cover gain 2000--2012 (gain)**: Forest gain during the period 2000-2012. Encoded as either 1 (gain) or 0 (no gain).
4. **Year of gross forest cover loss event (lossyear):** A disaggregation of total forest loss to annual time scales. Encoded as either 0 (no loss) or else a value in the range 1-13, representing loss detected primarily in the year 2001-2014, respectively.
5. **Circa year 2000 Landsat 7 cloud-free image composite (first)**: Reference multispectral imagery from the first available year, typically 2000.
6. **Circa year 2014 Landsat cloud-free image composite (last):** Reference multispectral imagery from the last available year, typically 2014.
7. **Mask:** Represents areas of no data, mapped land surface and water bodies.

(Hansen, et al., 2013)

Reclassifying Tree Canopy Data

The data in the treecover2000 dataset was reclassified to correspond to the Australian forest definitions as outlined in chapter 2.3Forests. This was performed by

1. Making a copy of the dataset
2. Adding a new field for cover
3. Using a simple python script in the *Field Calculator* function, Figure 3-8, to reclassify the data into 5 categories.

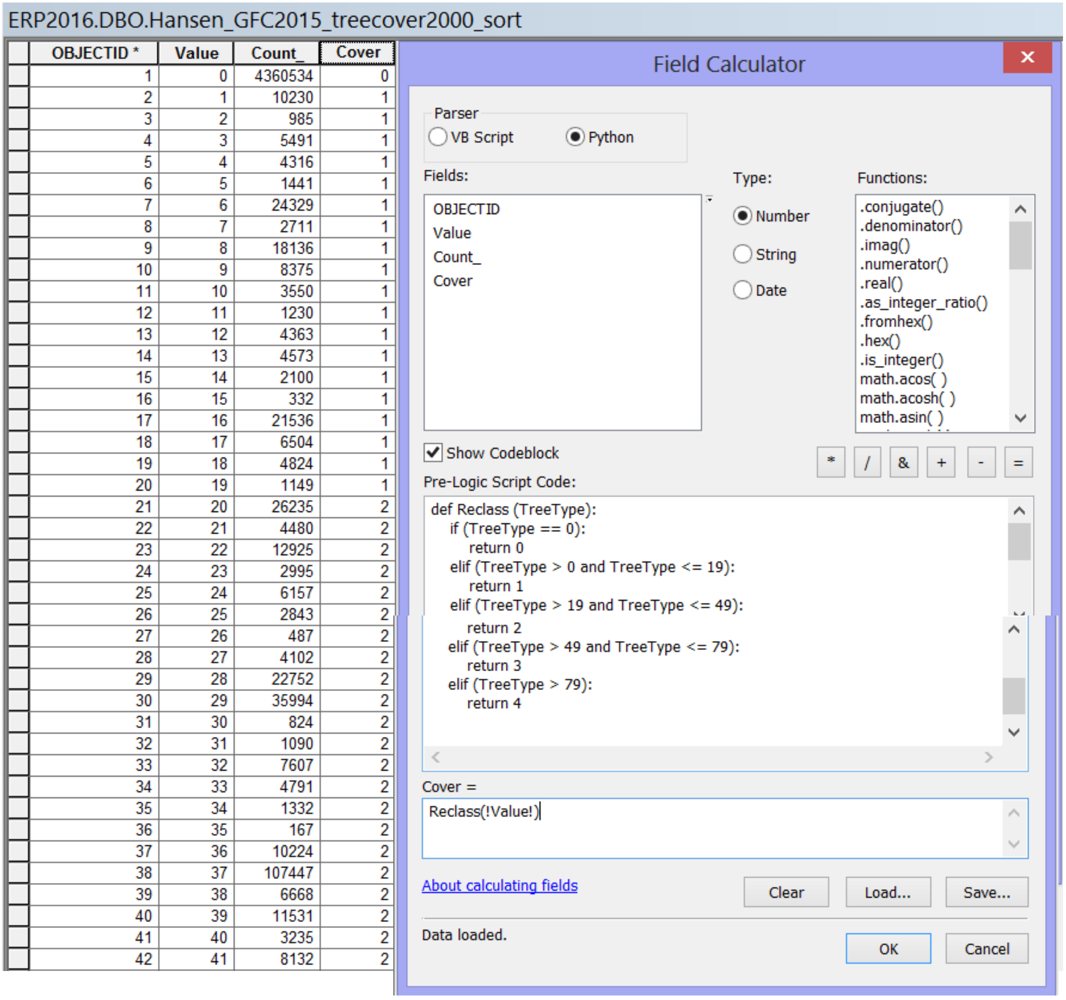


Figure 3-8: Reclasifying Treecover2000

Creating Forest Cover Gain, Loss and Loss/Gain Cover

To create a coverage combining Forest and Forest Gain the "*Raster Algebra"* function was used, Figure 3-9. The Logic behind the calculation is contained in Table 3-1: Raster Algebtra Logic Table

Table 3-1: Raster Algebtra Logic Table

	Loss	Gain *2	Loss + 2Gain	Result
Values	0	0	0	No Loss Gain
	1	0	1	Forest Loss
	0	2	2	Forest Gain
	1	2	3	Forest Loss and Gain

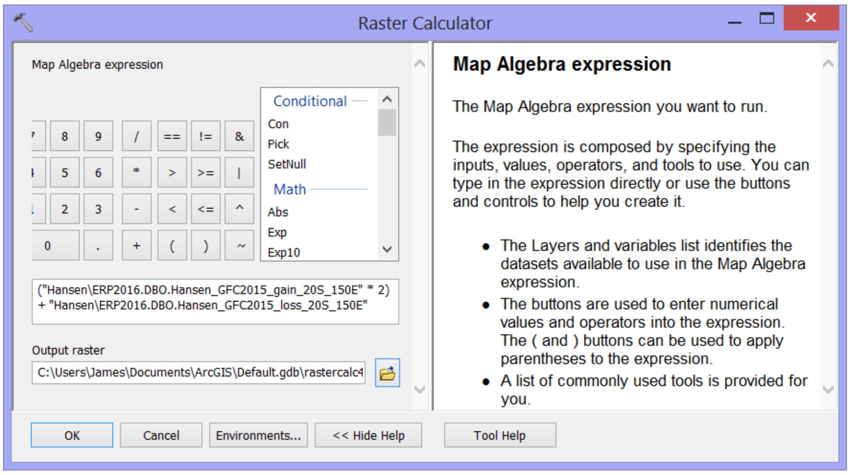


Figure 3-9: Raster Algebra to Create Forest Loss/Gain Layer

3.4.2 Queensland Land Use Management Program (QLUMP)

Studies assessing patterns of land use and land use change to create the QLUMP data are performed at catchment levels across the State. In some areas several smaller catchments are combined into a larger study area. QLUMP datasets are provided in their study areas and are also merged together to form Natural Resource Management (NRM) regional and state level datasets. All of the QLUMP datasets covering the SCC were acquired, projected and clipped. The datasets were then analyzed to determine the most appropriate QLUMP dataset/s for this study.

The SCC is sits within three catchment study areas; the Maroochy/Noosa, the Burnett/Mary and the Stanley River Systems. The SCC is also covered by the Queensland state dataset and is within the Burnett/Mary, and SEQ NRM regions, Figure 3-10.

At the 1:50,000 mapping scale the QLUMP data has a minimum mapping unit of two hectares and a minimum width of 50 metres for linear features. Areas that are within these criteria are amalgamated into the surrounding Land Use areas (Queensland Government, 2014). To match the QLUMP minimum mapping units, all results revealing areas < 2 hectares are omitted.

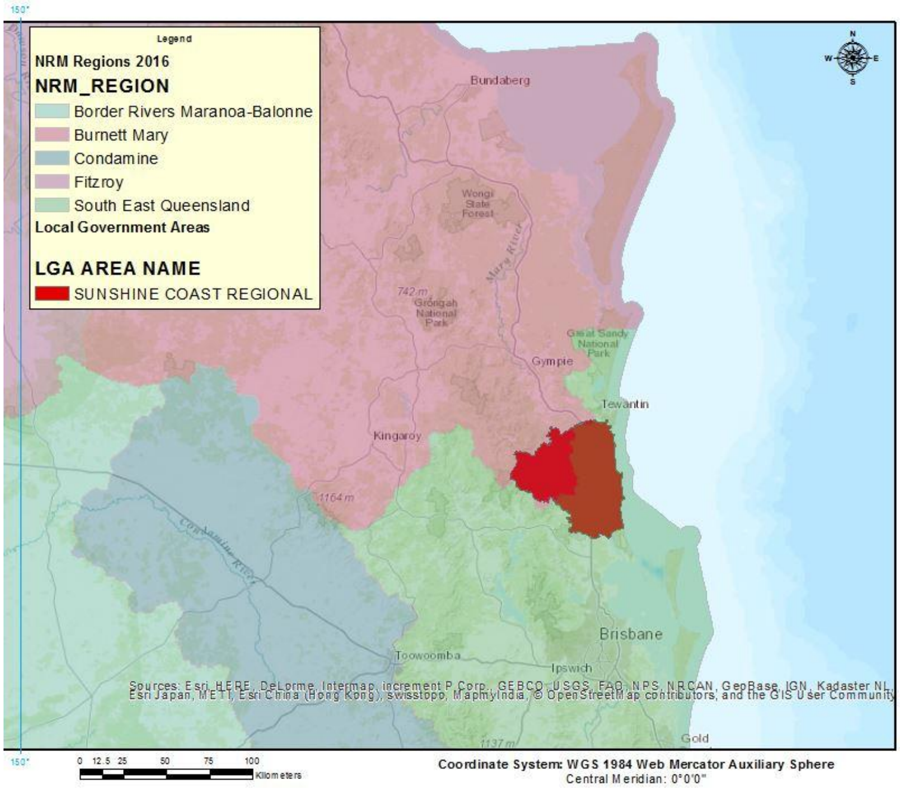


Figure 3-10: NRM Regional Context

Table 3-2 outlines the QLUMP datasets available over the study area and the years the data was captured.

The catchment area datasets contain every Land Use layer available for the area i.e. a layer for every year the data was captured. A land use change layer for every period is also provided. The catchment level datasets are appropriate for this study.

The NRM regional dataset comprise of layers representing the reference land use cover (start date), the current land use and the Land Use change. The SEQ NRM region is comprised of both the Maroochy/Noosa and the Stanley River areas, which have different study epochs (Table 3-2). This was dealt with by labelling the latest dataset “Update”. The NRM regional layers are appropriate to this study.

Table 3-2: QLUMP Datasets Available over Study Area

Catchment Area	Year						Change	Notes
	1999	2006	2009	2011	2012	Latest Year		
QLD						y	Contains no change data	Contains the latest Land Use data for the State
SEQ	y					y	Change data for base against latest LU	Does not cover entire study area
Burnett Mary	y	y		y			1999 - 2009	
Maroochy Noosa	y		y				1999 - 2006 1999 - 2011 2006- 2011	
Stanley	y	y			y		1999 - 2006 1999 - 2012 2006 - 2012	

The Queensland state-wide dataset is comprised of only one dataset representing the current land use, not providing a reference year or, consequentially, a Land Use change dataset. This renders the QLD QLUMP dataset inappropriate for this study.

Both the Catchment and NRM regional datasets are appropriate for this study, with the catchment level data containing intermediate data not required for the study. The NRM regional datasets were adopted for the study.

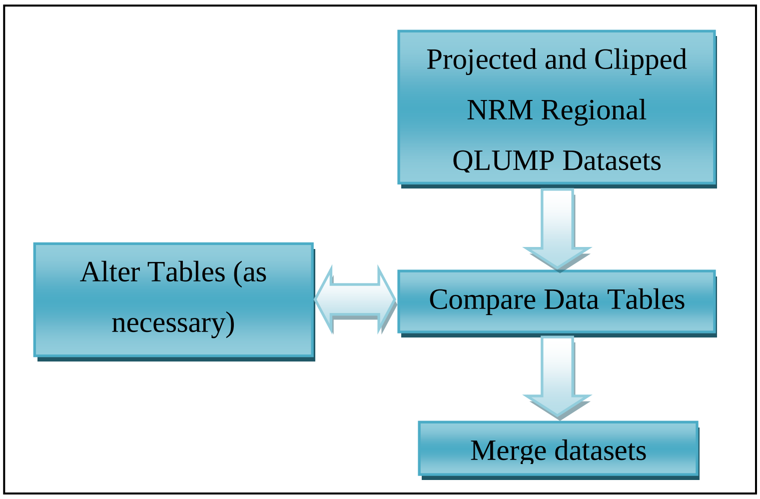


Figure 3-11: Merging Method

To create a single Land Use study area the clipped QLUMP NRM regional layers were merged together. Before merging them together the data model was analysed to ensure the attributes of each table being merged was identically labelled Figure 3-11.

It was found that:

The 1999 layer had an identical field (RuleID) with different types of data (integer and text) and an additional field (RuleID_1) containing text data matching RuleID values from the adjoining layer. To align the two tables, in the table with the additional field, RuleID was removed and RuleID_1 was renamed to RuleID.

The Land Use update (latest) layer had an additional "Year" attribute with some attributes labelled slightly differently. The Burnett/Mary LU 2009 table had year attribute added (populated with 2009) and the attribute headings modified to match the SEQ Update layer.

The Land Use change layer had an additional "LU_Change_Era" attribute with some attributes labeled slightly differently. The Burnett/Mary LU Change 2009 table had "LU_Change_Era" attribute added (populated with 1999-2009) and the attribute headings modified to match the SEQ Update layer.

3.4.3 Broad Vegetation Groups (BVG) Pre-clearing

This study utilized the regional scale BVG dataset to provide information on the vegetation types that forest loss is occurring. After acquisition of this dataset from the Queensland Spatial Catalogue, it became apparent that it provided the pre-clearing data only, making it useful only as a baseline for comparing the remnant BVG areas against. It was found that the Regional Ecosystems dataset provided remnant BVG areas within in, which was more useful to this study. The pre-clearing dataset did come with preset Arcmap visualisation layers that were useful for displaying the RE BVG data.

Performance issues were encountered when attempting to clip this dataset, the process would not complete even after left running for a couple of hours. It was initially thought that, as the dataset encompassed the entire state, the size of the dataset was the issue. On further analysis it was found that the data was provided in a multipart structure, i.e. polygons of the same type were all one object. The data had to be converted to single part in order to break the polygons up. The ArcMap *Multipart to Singlepart* tool accomplished this. Once the data was reduced to singlepart the clip process was successfully completed within a couple of minutes.

3.4.4 Regional Ecosystems and Remnant Vegetation

The history of the regional ecosystem classification is discussed in the Literature Review. The RE is a vector polygon dataset supplied via the Queensland Spatial Catalogue. The table for this dataset contains 36 fields supplying extensive information on RE's, RV status, regulated vegetation and BVG's. Three sets of data were extracted from this dataset:

- **VM Poly** attributes conveying the Vegetation Management status of the polygons
- **DBVG1M** attribute conveying the dominant BVG for the polygons
- **RE** attribute conveying the regional ecosystem of the polygons

Each of the key attributes are contained over several fields, containing information such as the percentage coverage and secondary ecosystem types within the polygons.

3.4.5 Cadastre

The cadastral information is supplied in the Digital Cadastral Database (DCDB) hosted on the Queensland Spatial Catalogue. Whilst the DCDB is not the Department or Natural Resources and Mines point of truth for property boundaries, property descriptions, or tenure information it is sufficiently accurate for a study of this scale.

3.4.6 Other Background Information

South East Queensland (SEQ) Regional Plan

This data was downloaded but analysis was not performed.

Regulated Vegetation Management Map

This data coincided with the RE data and was found to be duplicating information.

Major Vegetation Groups (MVG)

This data was observed to be to coarse for the study.

3.5 Data Pre-processing

Several steps were performed to standardize the datasets to projections and area.

3.5.1 Projection

Due to the location and the size of the study area it was decided to project all datasets to MGA94 Zone 56. The central meridian of Zone 56 (153°) runs through the centre of the SCC area with the entire area falling within the zone.

3.5.2 Clipping

Each dataset was clipped to the study area. This was performed to reduce the size of the datasets and to minimize the processing time.

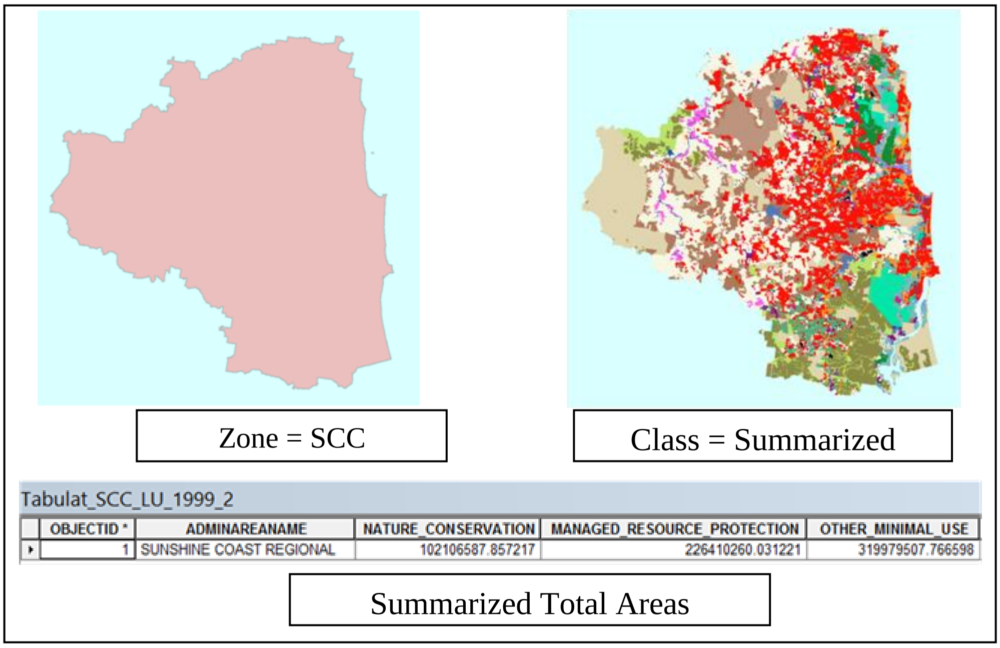
3.6 Tabulate Area

3.6.1 Summary Statistics

The Tabulate Area function was used to summarize each of the datasets against a zone dataset Figure 3-12. To summarize the data a dataset containing the polygon representing the SCC was used for the zone. The result is a table with areas summarized against each value of the chosen attribute.

The Tabulate Area function "Calculates cross-tabulated areas between two datasets and outputs a table." and is found under Zonal toolset of the Spatial Analyst Tools.

Table to Excel was used to export the data into excel so the summary statistics and analysis and could be performed.

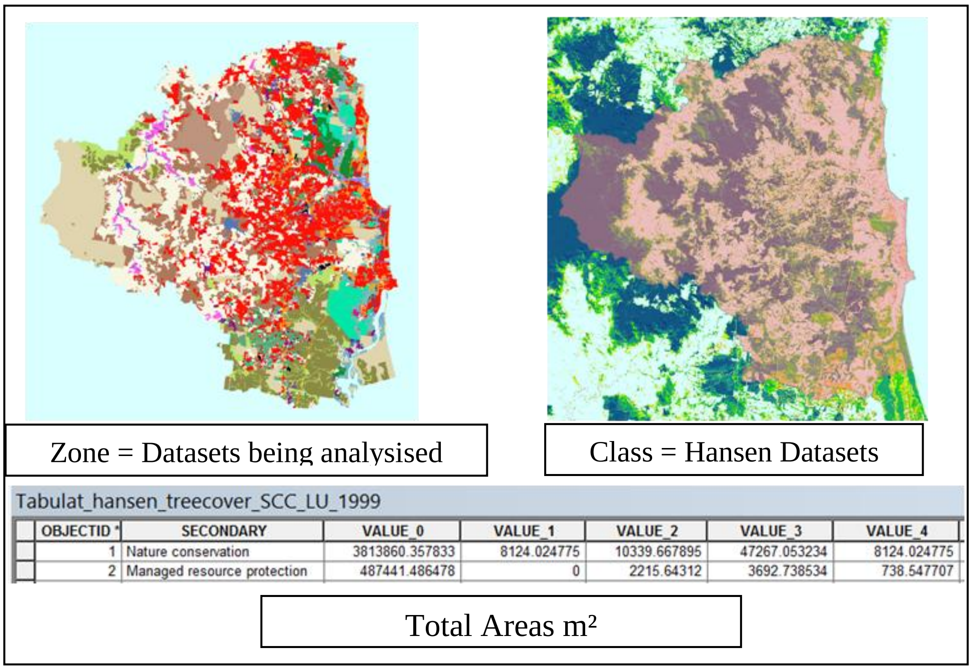


OBJECTID *	ADMINAREANAME	NATURE_CONSERVATION	MANAGED_RESOURCE_PROTECTION	OTHER_MINIMAL_USE
1	SUNSHINE COAST REGIONAL	102106587.857217	226410260.031221	319979507.766598

Figure 3-12: Summarizing Areas Using the Tabulate Area Tool

3.6.2 Hansen Overlay

Again the Tabulate Area function was used to overlay the Hansen data against the study data. In this process the Study data was used as the Zone with the Hansen data used as a Class, Figure 3-13.



OBJECTID *	SECONDARY	VALUE_0	VALUE_1	VALUE_2	VALUE_3	VALUE_4
1	Nature conservation	3813860.357833	8124.024775	10339.667895	47267.053234	8124.024775
2	Managed resource protection	487441.486478	0	2215.64312	3692.738534	738.547707

Figure 3-13: Analyzing Areas Using the Tabulate Area Tool

3.7 Data Analysis

Once the areas where tabulated the data was exported into Microsoft Excel for data analysis and the creation of graphs. This was performed due to the ability to easily modify and graph the data as required.

3.8 Summary

This chapter went through the process of acquiring, accessing, preprocessing and displaying techniques used to prepare the data for analysis and display. The technique used to overlay the data to summarize and produce area analysis the areas was also discussed. The next chapter presents the results ready for analysis.

Chapter 4

Results

4.1 Introduction

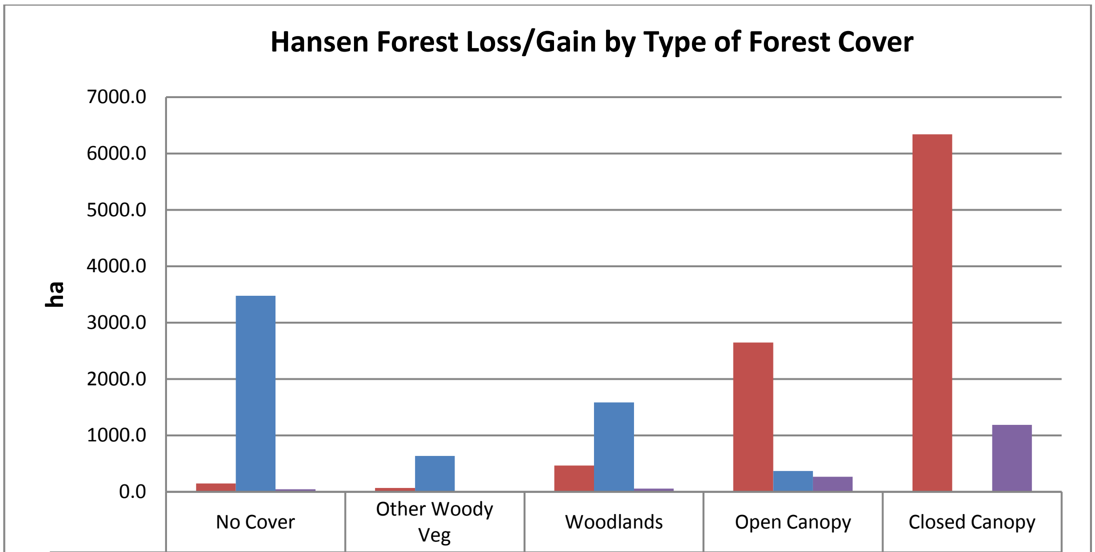
Performing the outlined methodology from the last chapter resulted in set clipped datasets covering the Sunshine Coast Council, a set of tables summarizing the datasets and a set of tables resulting from the Hansen Forest Cover overlays. This chapter presents these results in a series of Maps, Tables and Graphs.

4.2 Dataset Summary

This section presents the relevant summary statistics for each of the datasets studied.

4.2.1 Hansen Dataset

Figure 4-2, Figure 4-3 and Figure 4-4 present the base forest cover, forest gain/loss and forest loss by year, respectively, covering the Sunshine Coast Council area. Figure 4-1 outlines the Forest Loss/Gain against the Forest Cover.



	No Cover	Other Woody Veg	Woodlands	Open Canopy	Closed Canopy
Loss	144.2	67.4	462.2	2643.5	6341.1
Gain	3476.9	633.7	1586.1	367.6	9.1
Loss/Gain	42.1	7.5	52.4	266.5	1183.8

Figure 4-1: Hansen Forest Loss/Gain by Forest Type Cover

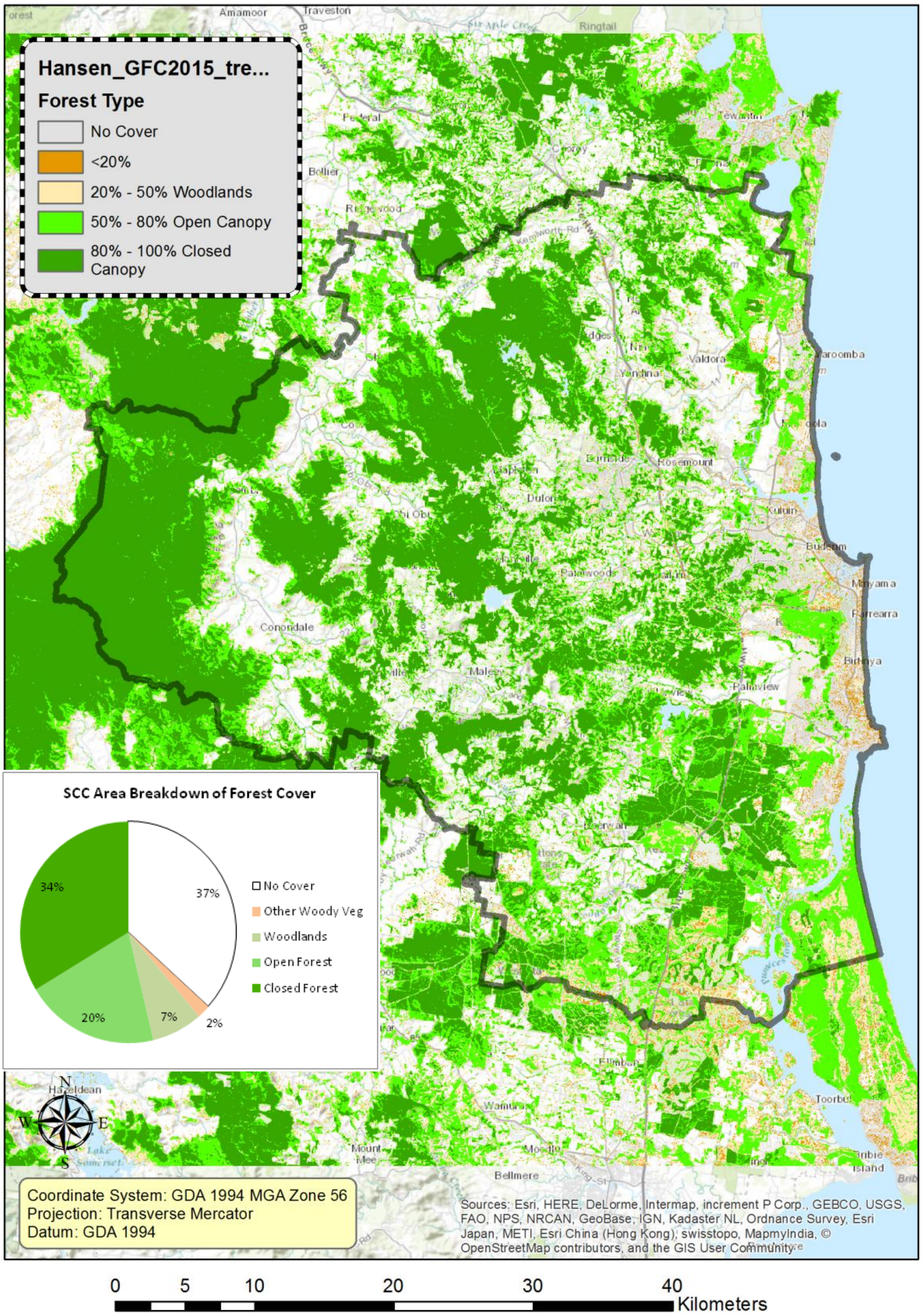


Figure 4-2: Hansen Forest Cover 2000

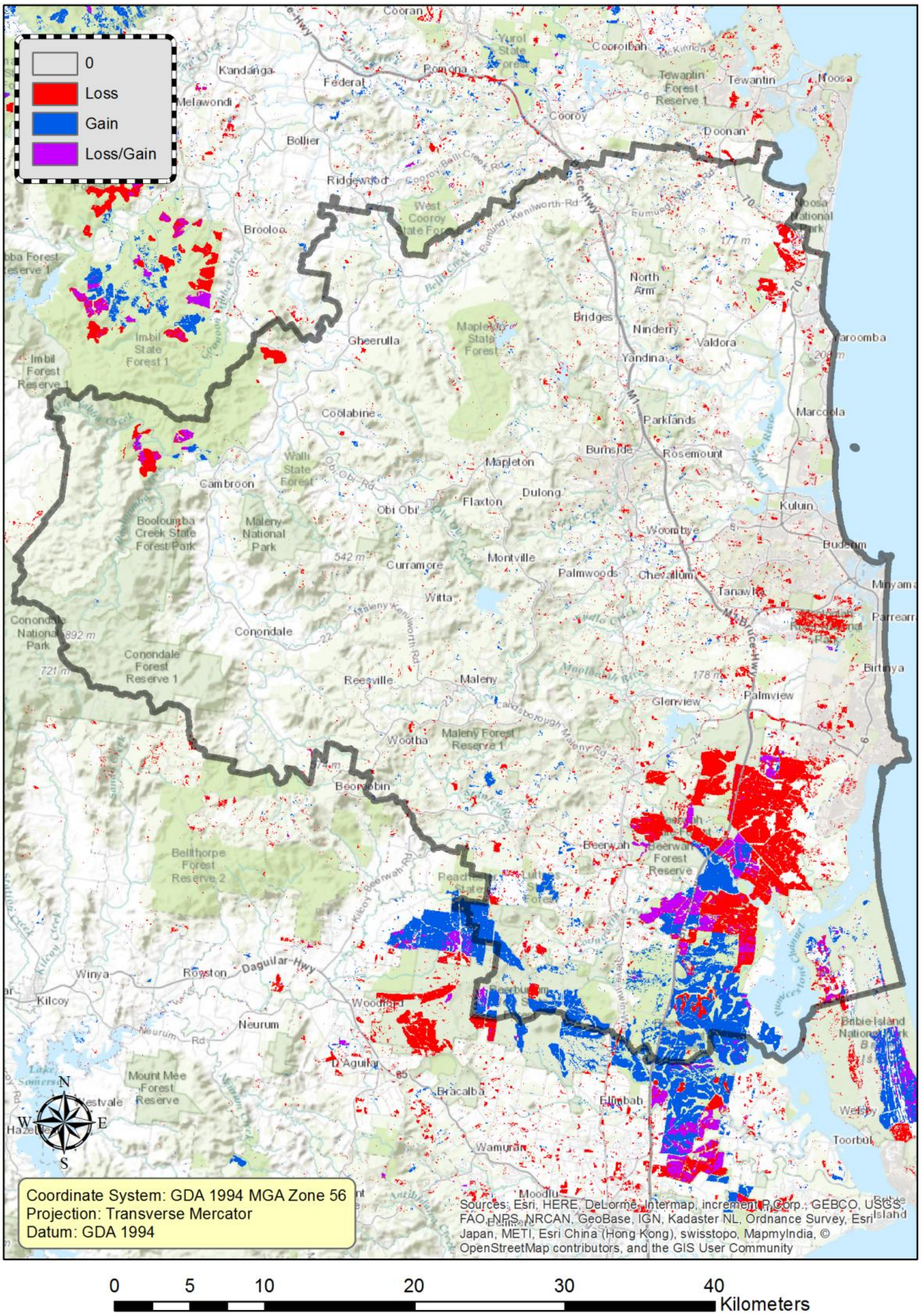


Figure 4-3: Hansen Forest Gain/Loss

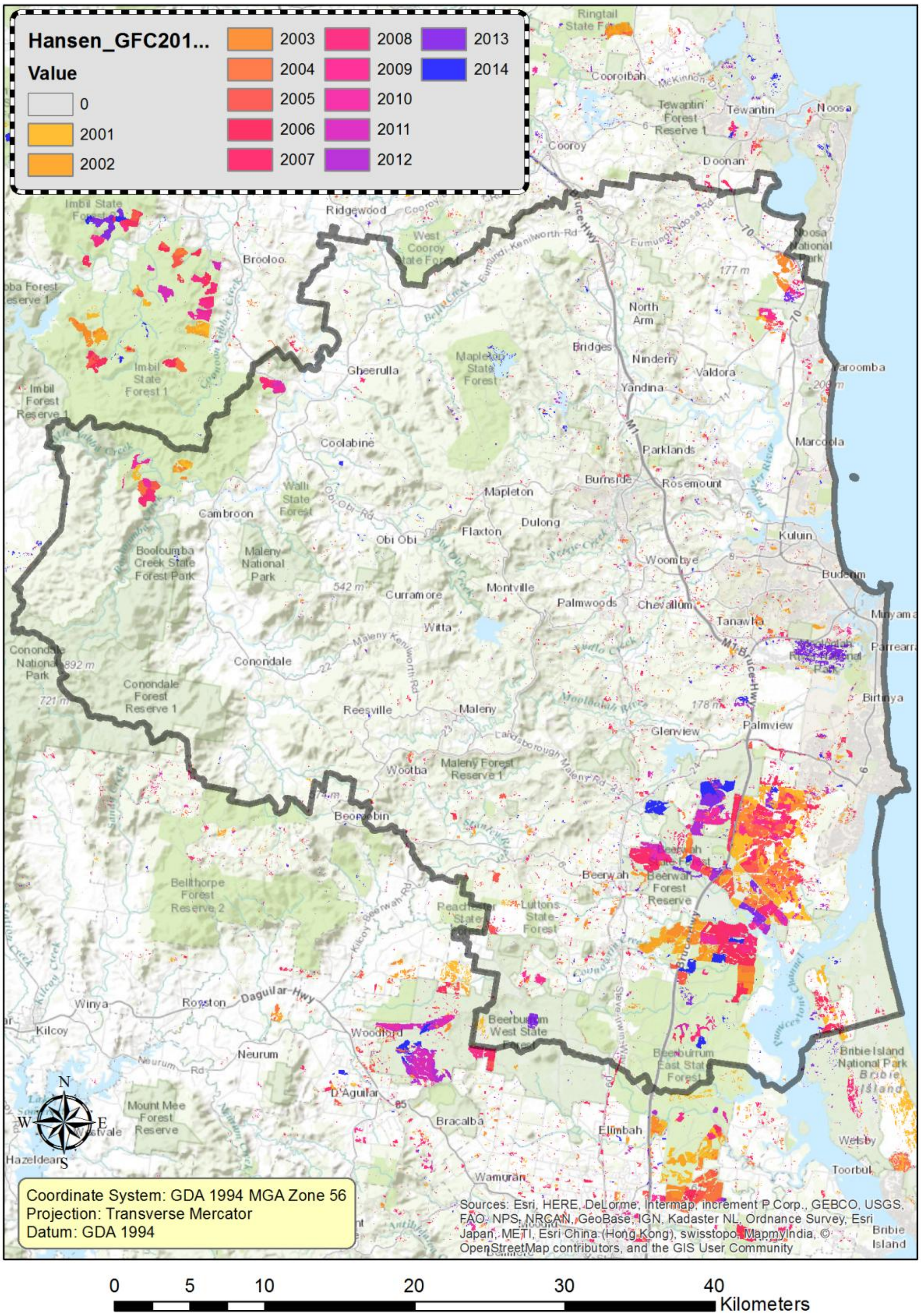


Figure 4-4: Hansen Forest Loss by Year 2000 – 2014

4.2.2 QLUMP

Land Use

Figure 4-5 and Figure 4-6 show the 1999 (base) and update (latest) QLUMP datasets for the Sunshine Coast Council. The maps are presented at the secondary ALUM classification.

Table 4-1 and Table 4-2 tabulate the summary statistics for each of the areas (in hectares). The red lines indicated the primary percentage of the total area, whilst the blue lines represent the percentage of secondary level against the primary.

Table 4-1: Summary Statistics of Land Use (1999) in the Sunshine Coast Council

Land Use Code	Land Use Class	Area (ha)	Area %
1	Conservation and Natural Environments	64849.6	28.6%
1.1	Nature Conservation	10210.7	4.5%
1.2	Managed Resource Protection	22641.0	10.0%
1.3	Other Minimal Use	31998.0	14.1%
2	Production from relatively natural environments	63404.0	28.0%
2.1	Grazing native vegetation	50700.4	22.4%
2.2.0	Production forestry	12703.6	5.6%
3	Production from dryland agriculture and plantations	36266.6	16.0%
3.1	Plantation forestry	20216.4	8.9%
3.2	Grazing modified pastures	28.5	0.0%
3.3	Cropping	10233.4	4.5%
3.4	Perennial horticulture	5037.0	2.2%
3.5	Seasonal horticulture	11.4	0.0%
3.6	Land in transition	739.9	0.3%
4	Production from irrigated agriculture and plantations	4411.0	1.9%
4.2	Irrigated modified pastures	2196.9	1.0%
4.3	Irrigated cropping	455.3	0.2%
4.4	Irrigated perennial horticulture	1434.3	0.6%
4.5	Irrigated seasonal horticulture	324.4	0.1%
5	Intensive uses	45242.2	20.0%
5.1	Intensive horticulture	165.1	0.1%
5.2	Intensive animal production	296.0	0.1%
5.3	Manufacturing and industrial	728.5	0.3%
5.4	Residential	38275.7	16.9%
5.5	Services	3437.7	1.5%
5.6	Utilities	22.8	0.0%
5.7	Transport and communication	1627.8	0.7%
5.8	Mining	506.5	0.2%
5.9	Waste treatment and disposal	182.1	0.1%
6	Water	12259.6	5.4%
6.1	Lake	85.4	0.0%
6.2	Reservoir/dam	1730.2	0.8%
6.3	River	825.3	0.4%
6.5	Marsh/wetland	8548.7	3.8%
6.6	Estuary/coastal waters	1070.0	0.5%
	Grand Total	226433.0	100.0%

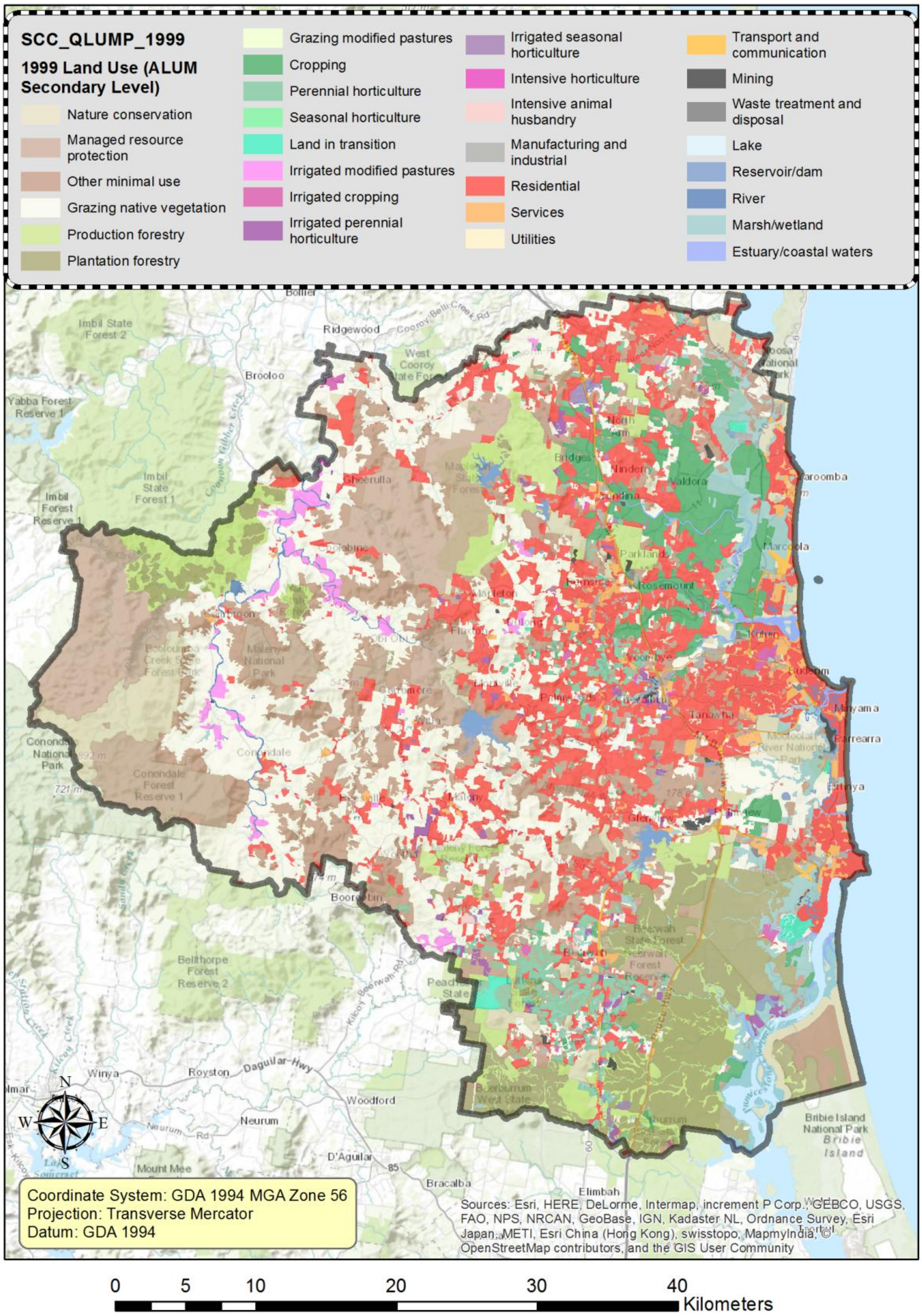


Figure 4-5: 1999 Land Use Map for the Sunshine Coast Council

Table 4-2: Summary Statistics of Land Use (Update) in the Sunshine Coast Council

Land Use Code	Land Use Class	Area (ha)	Area %
1	Conservation and Natural Environments	70143.8	31.0%
1.1	Nature Conservation	34395.2	15.2%
1.2	Managed Resource Protection	7816.7	3.5%
1.3	Other Minimal Use	27931.9	12.3%
2	Production from relatively natural environments	57865.1	25.6%
2.1	Grazing native vegetation	50357.5	22.2%
2.2.0	Production forestry	7507.5	3.3%
3	Production from dryland agriculture and plantations	31358.8	13.8%
3.1	Plantation forestry	16248.4	7.2%
3.2	Grazing modified pastures	28.0	0.0%
3.3	Cropping	4132.6	1.8%
3.4	Perennial horticulture	4219.9	1.9%
3.5	Seasonal horticulture	3.3	0.0%
3.6	Land in transition	6726.7	3.0%
4	Production from irrigated agriculture and plantations	4896.0	2.2%
4.2	Irrigated modified pastures	2183.7	1.0%
4.3	Irrigated cropping	235.5	0.1%
4.4	Irrigated perennial horticulture	1943.6	0.9%
4.5	Irrigated seasonal horticulture	530.5	0.2%
4.6	Irrigated land in transition	2.7	0.0%
5	Intensive uses	51096.1	22.6%
5.1	Intensive horticulture	325.5	0.1%
5.2	Intensive animal production	697.0	0.3%
5.3	Manufacturing and industrial	790.6	0.3%
5.4	Residential	43027.5	19.0%
5.5	Services	4008.8	1.8%
5.6	Utilities	26.1	0.0%
5.7	Transport and communication	1595.8	0.7%
5.8	Mining	442.2	0.2%
5.9	Waste treatment and disposal	182.8	0.1%
6	Water	11078.2	4.9%
6.1	Lake	107.8	0.0%
6.2	Reservoir/dam	1785.6	0.8%
6.3	River	994.1	0.4%
6.5	Marsh/wetland	7084.8	3.1%
6.6	Estuary/coastal waters	1105.9	0.5%
	Grand Total	226438.1	100.0%

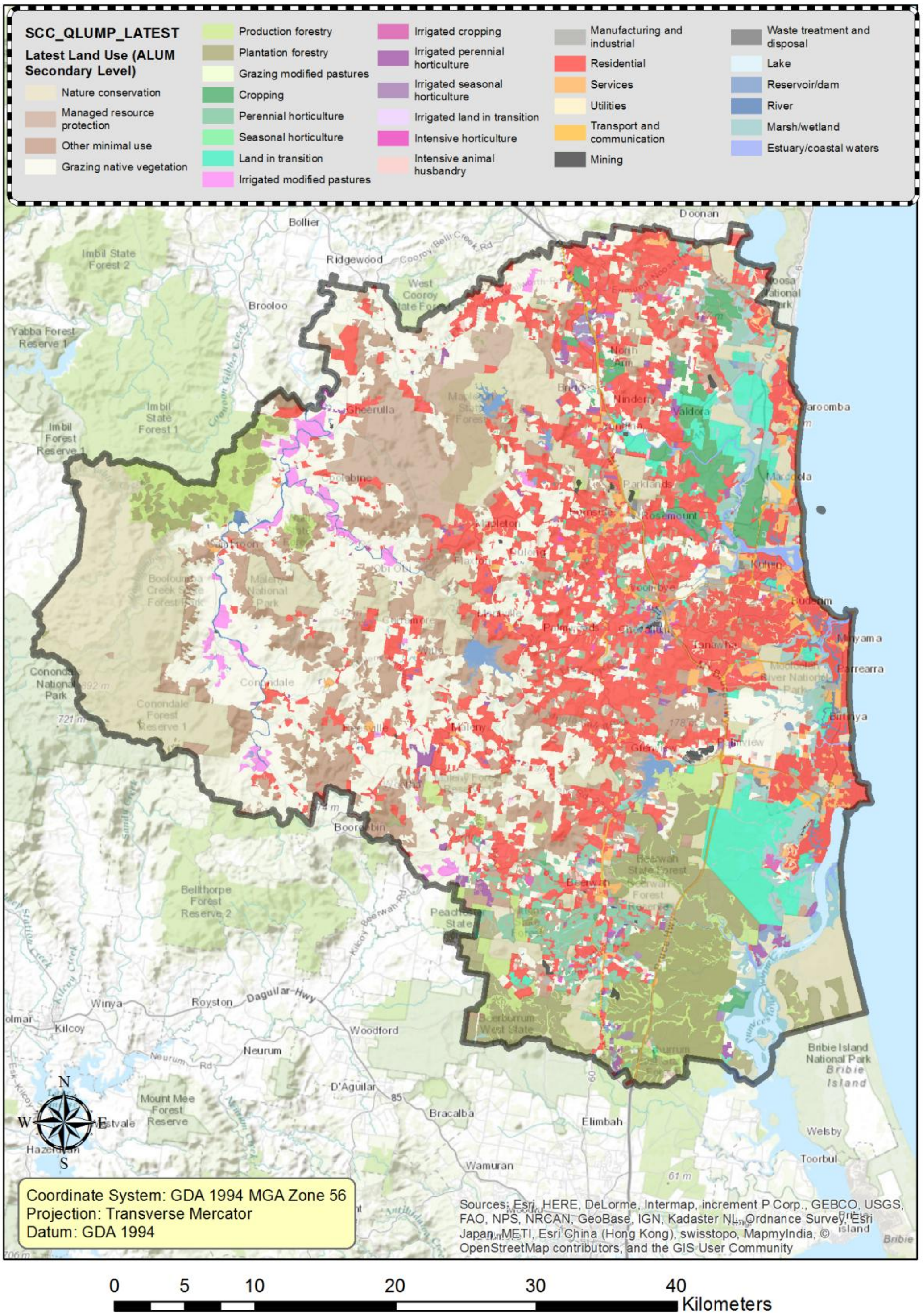


Figure 4-6: Latest Land Use Map for the Sunshine Coast Council

Land Use Change

Figure 4-7 displays the LU change areas totaling more than 1000ha from 1999 to the current data. Table 4-3 summarizes the Land Use changes for 1999 to current for areas greater than 150ha. Table 4-4 outlines a land use change matrix for the same period

Table 4-3: Summary Statistics for Land Use Change 1999- Current (Areas > 150ha)

Land Use Class (Secondary) Change from 1999 to 2011	Area (ha)	Area Change (%)	Total Change (%)
Managed resource protection to Nature conservation	15504	6.85%	37.96%
Production forestry to Nature conservation	5223	2.31%	12.79%
Plantation forestry to Land in transition	3637	1.61%	8.90%
Cropping - Sugar to Grazing native vegetation	2338	1.03%	5.72%
Cropping - Sugar to Land in transition	2184	0.96%	5.35%
Grazing native vegetation to Residential	1883	0.83%	4.61%
Other minimal use to Nature conservation	1774	0.78%	4.34%
Other minimal use to Residential	1520	0.67%	3.72%
Marsh/wetland to Nature conservation	1514	0.67%	3.71%
Perennial horticulture to Grazing native vegetation	794	0.35%	1.95%
Perennial horticulture to Residential	545	0.24%	1.33%
Cropping - Sugar to Cropping	498	0.22%	1.22%
Grazing native vegetation to Land in transition	482	0.21%	1.18%
Grazing native vegetation to Perennial horticulture	378	0.17%	0.93%
Cropping - Sugar to Residential	378	0.17%	0.92%
Other minimal use to Managed resource protection	360	0.16%	0.88%
Other minimal use to Grazing native vegetation	287	0.13%	0.70%
Grazing native vegetation to Services	254	0.11%	0.62%
Livestock grazing to Managed resource protection	234	0.10%	0.57%
Cropping - Sugar to Irrigated perennial horticulture	234	0.10%	0.57%
Cropping - Sugar to Irrigated seasonal horticulture	200	0.09%	0.49%
Land in transition to Plantation forestry	171	0.08%	0.42%
Livestock grazing to Irrigated perennial horticulture	151	0.07%	0.37%
Grazing native vegetation to Intensive animal production	149	0.07%	0.36%
Land in transition to Residential	147	0.06%	0.36%
Total	40840	18.03%	100.00%

Table 4-4: SCC Change in Land Use (Primary) Matrix

Change in Primary Land Use SCC from 1999 to 2011 (ha)	Conservation and natural environments	Intensive uses	Production from dryland agriculture and plantations	Production from irrigated agriculture and plantations	Production from relatively natural environments	Water	Total
Conservation and natural environments	62677.7	1674.0	184.9	47.1	340.6	16.6	64940.9
Intensive uses	23.2	45095.2	67.7	33.2	30.4	8.5	45258.2
Production from dryland agriculture and plantations	336.6	1645.7	30121.3	645.1	3364.1	27.0	36139.8
Production from irrigated agriculture and plantations	28.2	184.0	55.6	3642.0	482.0	21.9	4413.8
Production from relatively natural environments	5565.4	2462.7	924.4	528.6	53659.0	50.2	63190.3
Water	1514.3	58.7	13.9	0.0	0.0	10953.9	12540.8
Total	70145.4	51120.3	31367.8	4896.0	57876.2	11078.2	226483.9

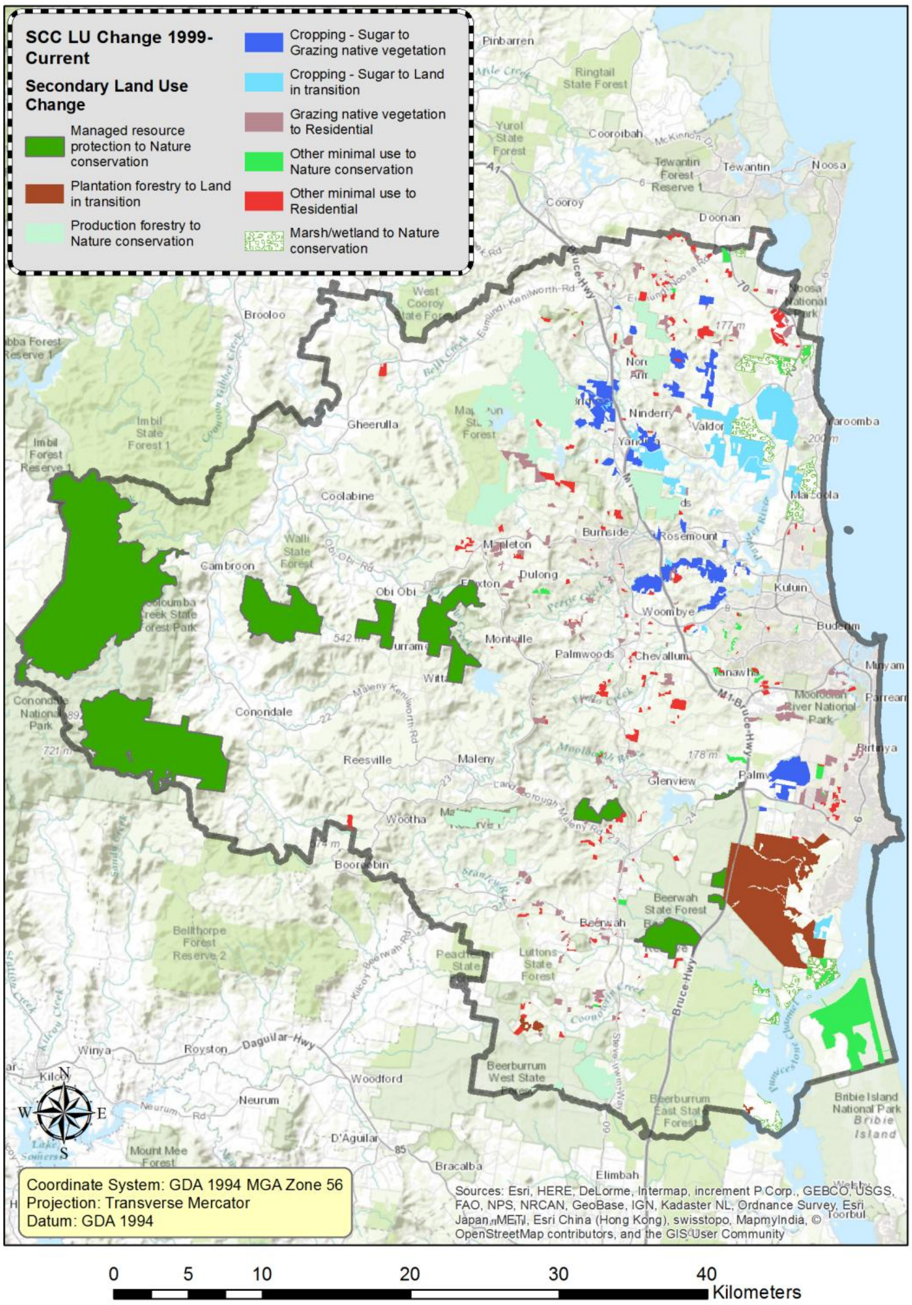


Figure 4-7: Land Use Change Map for the Sunshine Coast Council (Areas > 1000ha)

4.2.3 Regional Ecosystems and Remnant Vegetation Summary

Figure 4-8 presents the latest Regional Ecosystem map, categorized by the VMPoly attribute, for the Sunshine Coast Council Area. Table 4-5 tabulates the summary statistics for the area (in hectares).

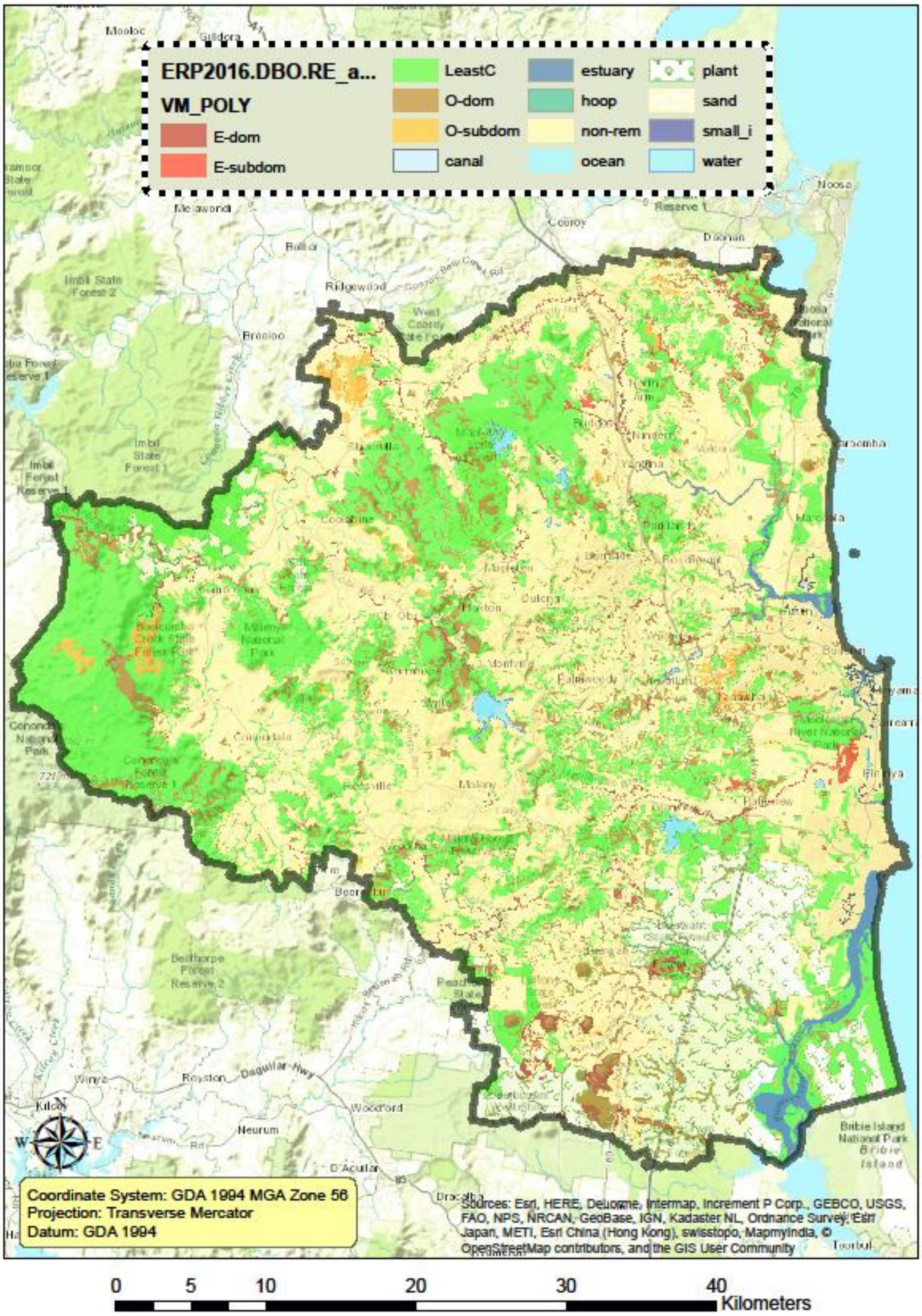


Figure 4-8: Remnant Vegetation Map for the Sunshine Coast Council

Table 4-5: Summary Statistics of RE in the Sunshine Coast Council

VM_POLY	Area (ha)	Percentage of Area
E_DOM	3398.300044	1.5%
O_SUBDOM	2567.224991	1.1%
LEASTC	69064.61379	30.2%
O_DOM	16951.65416	7.4%
NON_REM	110982.6733	48.6%
PLANT	20486.56928	9.0%
ESTUARY	2959.993338	1.3%
WATER	1092.920617	0.5%
SMALL_I	5.692294881	0.0%
CANAL	284.6147441	0.1%
E_SUBDOM	654.6139113	0.3%
OCEAN	22.76917952	0.0%
HOOP	5.692294881	0.0%
Grand Total	228477.3319	100%

4.2.4 BVG Pre-clearing Summary

Figure 4-9 presents the national scale (1:5,000,000) BVG Pre-clearing map for the Sunshine Coast Council area. The colours in Table 4-6 are aligned in order to distinguish the broad areas. Figure 4-10 presents the regional scale (1:1,000,000) BVG Pre-clearing map for the Sunshine Coast Council Area; this level of data is relevant to this study.

Table 4-6 tabulates the summary statistics for the area (in hectares) and provides a comparison against the remnant vegetation in the SCC.

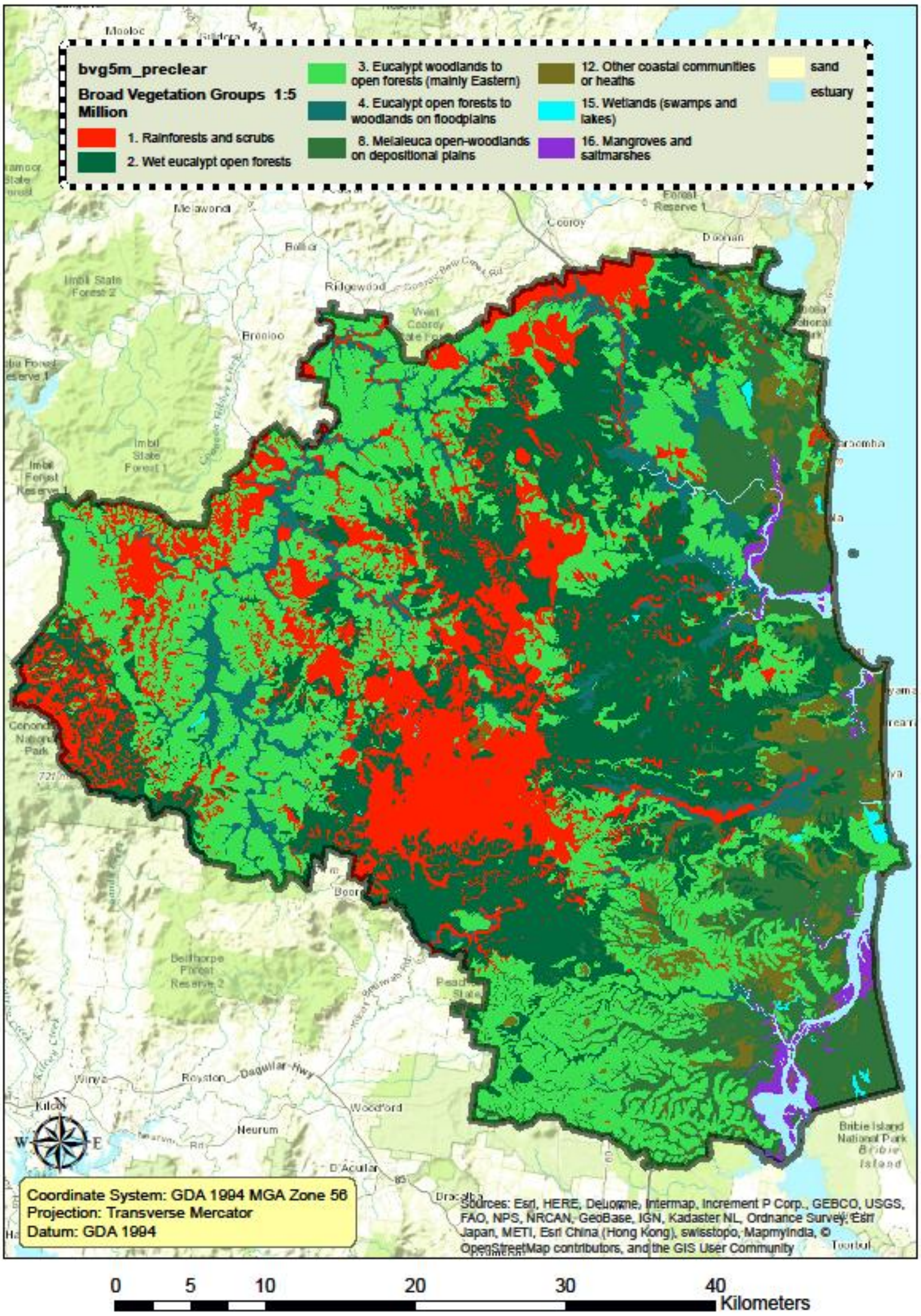


Figure 4-9: 1:5,000,000 BVG Map for the Sunshine Coast Council

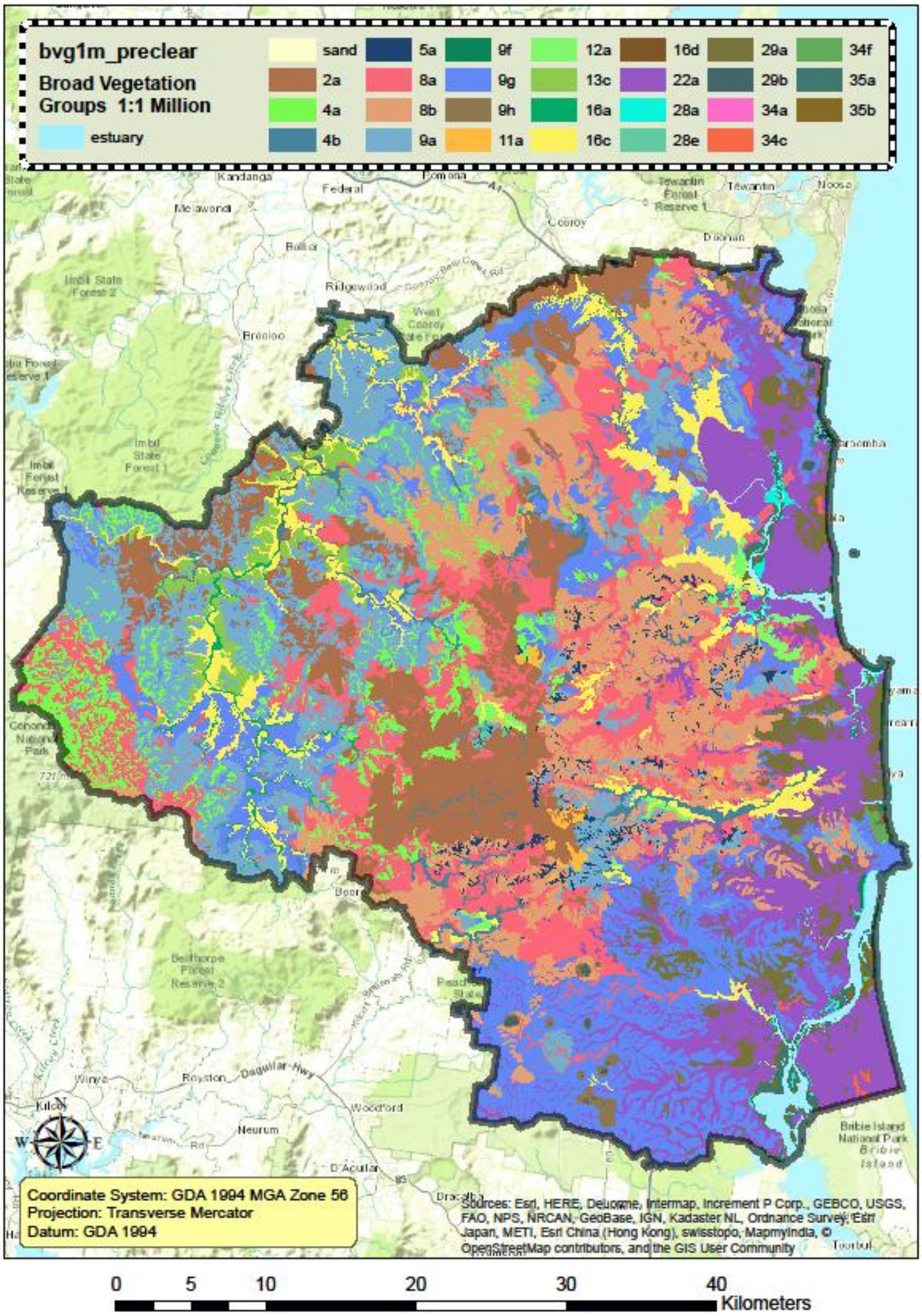


Figure 4-10: 1:1,000,000 BVG Map for the Sunshine Coast Council

Table 4-6: Breakdown of Pre-Clearing and Remnant BVG's in the SCC

Code	Description	Pre-Clear Area (ha)	Pre-Clear Area %	Rem Area (ha)	Rem Area %	% in 2013	QLD % in 2013
2a	Complex evergreen mesophyll-notophyll vine forest frequently with Araucaria cunninghamii (hoop pine) from foothills to ranges.	23053	10.1%	5422	2.4%	23.5%	73%
4a	Notophyll and mesophyll vine forest with feather or fan palms in alluvia and in swampy situations on ranges or within coastal sandmasses.	9867	4.3%	8381	3.7%	84.9%	65%
4b	Evergreen to semi-deciduous mesophyll to notophyll vine forest, frequently with Archontophoenix spp. (palms) fringing streams.	4554	2.0%	1890	0.8%	41.5%	75%
5a	Araucarian notophyll/microphyll and microphyll vine forests of southern coastal bioregions.	1759	0.8%	1193	0.5%	67.8%	26%
8a	Wet tall open forest dominated by species such as Eucalyptus grandis (flooded gum) or E. saligna, E. resinifera (red mahogany), Lophostemon confertus (brush box), Syncarpia glomulifera (turpentine), E. laevopinea (silvertop stringybark). Contains a well developed understorey of rainforest components, including ferns and palms, or the understorey may be dominated by sclerophyll shrubs.	30121	13.2%	13140	5.8%	43.6%	77%
8b	Moist open forests to tall open forests mostly dominated by Eucalyptus pilularis (blackbutt) on coastal sands, sub-coastal sandstones and basalt ranges. Also includes tall open forests dominated by E. montivaga, E. obliqua (messmate stringybark) and E. campanulata (New England ash).	30087	13.2%	16869	7.4%	56.1%	61%
9a	Moist eucalypt open forests to woodlands dominated by a variety of species including Eucalyptus siderophloia (red ironbark), E. propinqua (small-fruited grey gum), E. acmenoides (narrow-leaved white stringybark), E. microcorys (tallowwood), E. carnea (broad-leaved white mahogany), E. tindaliae (Queensland white stringybark), Corymbia intermedia (pink bloodwood), Lophostemon confertus (brush box).	33024	14.5%	24912	10.9%	75.4%	63%
9f	Woodlands dominated by Corymbia spp. e.g.: C. intermedia (pink bloodwood), C. tessellaris (Moreton Bay ash) and/or Eucalyptus spp. such as E. tereticornis (blue gum), frequently with Banksia spp., Acacia spp. and Callitris columellaris (Bribie Island pine) on coastal dunes and beach ridges.	209	0.1%	70	0.0%	33.4%	72%
9g	Moist to dry woodlands to open forest dominated by stringybarks or mahoganies such as Eucalyptus tindaliae (Queensland white stringybark), E. latisinensis (white mahogany), E. acmenoides (narrow-leaved white stringybark); or E. racemosa (scribbly gum) or E. seeana or E. tereticornis (blue gum) and Corymbia intermedia (pink bloodwood).	34552	15.1%	1498	0.7%	4.3%	39%

Code	Description	Pre-Clear Area (ha)	Pre-Clear Area %	Rem Area (ha)	Rem Area %	% in 2013	QLD % in 2013
9h	Dry woodlands dominated by species such as Eucalyptus acmenoides (narrow-leaved white stringybark) (or E. portuensis or E. helidonica), E. tereticornis (blue gum), Angophora leiocarpa (rusty gum), Corymbia trachyphloia (yellow bloodwood) or C. intermedia (pink bloodwood), and often ironbarks including E. crebra (narrow-leaved red ironbark) or E. fibrosa (dusky-leaved ironbark). A heathy shrub layer is frequently present. On undulating to hilly terrain.	722	0.3%	3605	1.6%	499.0%	71%
11a	Moist to dry open forests to woodlands dominated by Eucalyptus orgadophila (mountain coolibah). Some areas dominated by E. tereticornis (blue gum), E. melliodora (yellow box), E. albens (white box), E. crebra (narrow-leaved red ironbark) or E. melanophloia (silver-leaved ironbark).	747	0.3%	0	0.0%	0.0%	57%
12a	Dry woodlands to open woodlands dominated by ironbarks such as Eucalyptus decorticans (gum-topped ironbark), E. fibrosa subsp. nubila (blue-leaved ironbark), or E. crebra (narrow-leaved red ironbark) and/or bloodwoods such as Corymbia trachyphloia (yellow bloodwood), C. leichhardtii (rustyjacket), C. watsoniana (Watson's yellow bloodwood), C. lamprophylla, C. peltata (yellowjacket). Occasionally E. thozetiana (mountain yapunyah), E. cloeziana (Gympie messmate) or E. mediocris are dominant. Mostly on sub-coastal/inland hills with shallow soils.	1636	0.7%	242	0.1%	14.8%	85%
13c	Woodlands of Eucalyptus crebra (sens. lat.) (narrow-leaved red ironbark), E. drepanophylla (grey ironbark), E. fibrosa (dusky-leaved ironbark), E. shirleyi (Shirley's silver-leaved ironbark) on granitic and metamorphic ranges	3642	1.6%	613	0.3%	16.8%	70%
16a	Open forest and woodlands dominated by Eucalyptus camaldulensis (river red gum) (or E. tereticornis (blue gum)) and/or E. coolabah (coolabah) (or E. microtheca (coolabah)) fringing drainage lines. Associated species may include Melaleuca spp., Corymbia tessellaris (carbeen), Angophora spp., Casuarina cunninghamiana (riveroak). Does not include alluvial areas dominated by herb and grasslands or alluvial plains that are not flooded.	1025	0.4%	460	0.2%	44.9%	90.0%
16c	Woodlands and open woodlands dominated by Eucalyptus coolabah (coolabah) or E. microtheca (coolabah) or E. largiflorens (black box) or E. tereticornis (blue gum) or E. chlorophylla on floodplains. Does not include alluvial areas dominated by herb and grasslands or alluvial plains that are not flooded.	11282	4.9%	554	0.2%	4.9%	67.0%
16d	River beds, open water or sand, or rock, frequently unvegetated.	80	0.0%	80	0.0%	99.7%	96.0%
22a	Open forests and woodlands dominated by Melaleuca quinquenervia (swamp paperbark) in seasonally inundated lowland coastal areas and swamps.	27266	11.9%	7895	3.5%	29.0%	47.0%

Code	Description	Pre-Clear Area (ha)	Pre-Clear Area %	Rem Area (ha)	Rem Area %	% in 2013	QLD % in 2013
28a	Complex of open shrubland to closed shrubland, grassland, low woodland and open forest, on strand and foredunes. Includes pure stands of Casuarina equisetifolia (coastal sheoak).	1090	0.5%	711	0.3%	65.2%	96.0%
28e	Low open forest to woodlands dominated by Lophostemon suaveolens (swamp box) (or L. confertus (brush box)) or Syncarpia glomulifera (turpentine) frequently with Allocasuarina spp. on rocky hill slopes.	203	0.1%	140	0.1%	69.1%	89.0%
29a	Open heaths and dwarf open heaths on coastal dunefields, sandplains and headlands.	7270	3.2%	2514	1.1%	34.6%	93.0%
29b	Open shrublands to open heaths on elevated rocky substrates.	213	0.1%	213	0.1%	100.0%	93.0%
34a	Lacustrine wetlands. Lakes, ephemeral to permanent, fresh to brackish; water bodies with ground water connectivity. Includes fringing woodlands and sedgelands.	2	0.0%	2	0.0%	100.1%	99.0%
34c	Palustrine wetlands. Freshwater swamps on coastal floodplains dominated by sedges and grasses such as Oryza spp., Eleocharis spp. (spikerush) or Baloskion spp. (cord rush) / Leptocarpus tenax / Gahnia sieberiana (sword grass) / Lepironia spp.	462	0.2%	367	0.2%	79.3%	94.0%
34f	Palustrine wetlands. Sedgelands/grasslands on seeps and soaks on wet peaks, coastal dunes and other non-floodplain features.	265	0.1%	17	0.0%	6.5%	59.0%
35a	Closed forests and low closed forests dominated by mangroves.	1621	0.7%	1619	0.7%	99.8%	98.0%
35b	Bare saltpans ± areas of Tecticornia spp. (samphire) sparse forbland and/or Xerochloa imberbis or Sporobolus virginicus (sand couch) tussock grassland.	706	0.3%	468	0.2%	66.3%	95.0%
estuary	bare	2948	1.3%	3008	1.3%	102.0%	
ocean	bare	30	0.0%	39	0.0%	131.1%	
sand	bare	40	0.0%	6	0.0%	15.9%	
water	bare	0	0.0%	1401	0.6%	0.0%	
non-rem	Non Remnant areas	0	0.0%	131141	57.4%	0.0%	
	Grand Total	**228478**	**100%**	**228471**	**100%**	**100%**	

4.2.5 Cadastre

Figure 4-11 presents the latest Cadastral map, categorized by the Tenure attribute, covering the Sunshine Coast Council area. Figure 4-12 graphs the summary statistics for the area.

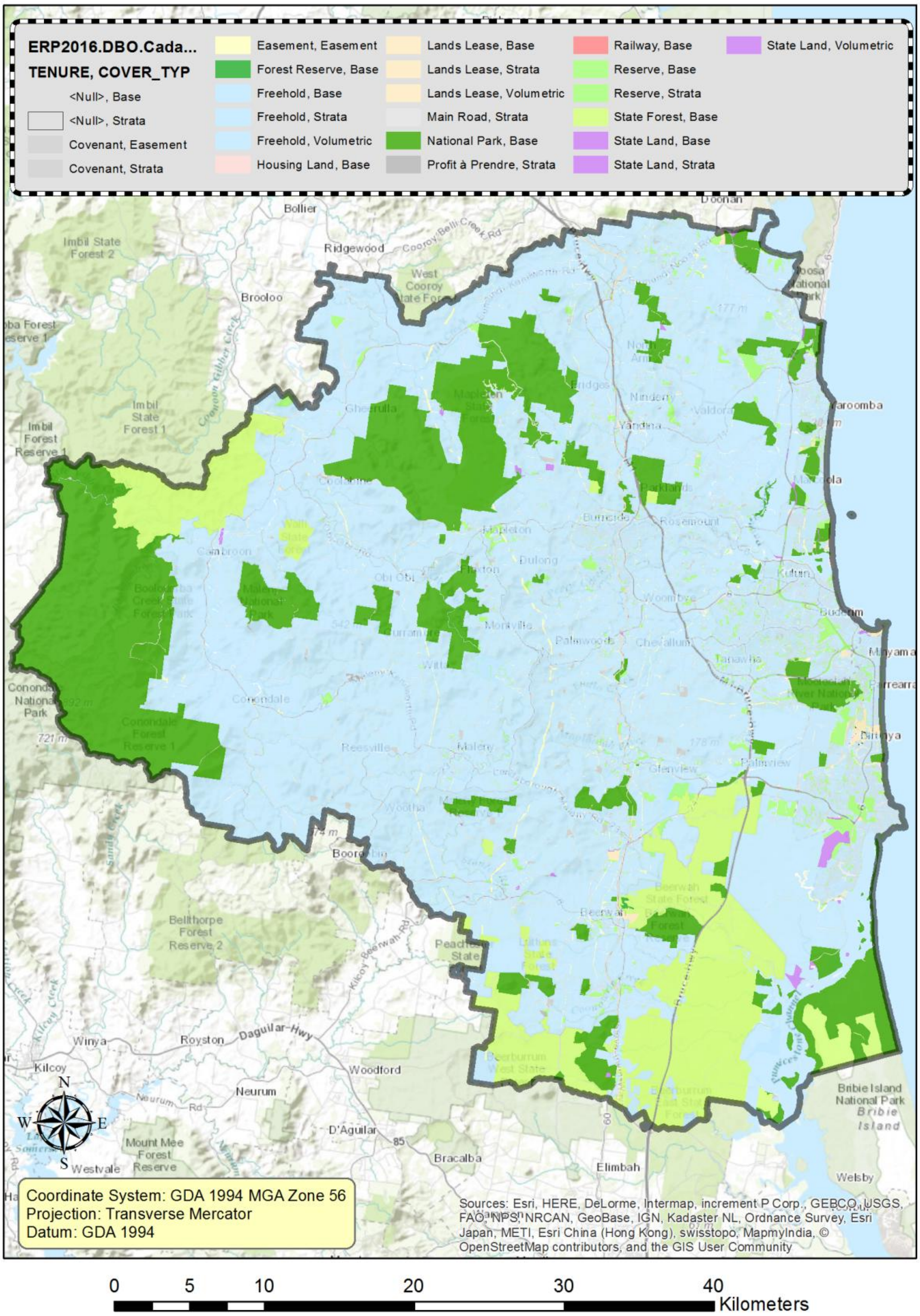


Figure 4-11: SCC by Tenure

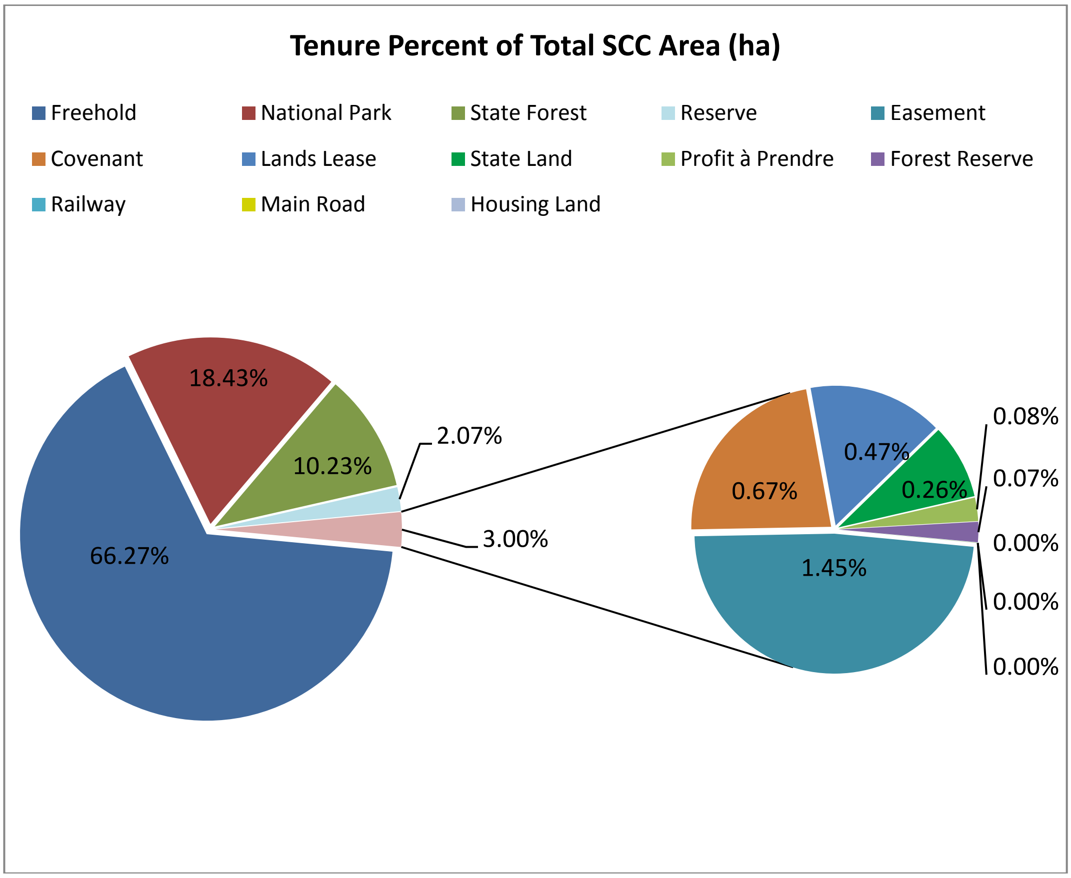


Figure 4-12: Percentage Breakdown of Cadastre in the SCC

4.3 Hansen Overlay

This section presents the Hansen Forest Cover analysis results for each of the datasets studied.

4.3.1 QLUMP Land Use Change

Figure 4-13 breaks down the forest cover for the current in the current land use. This gives an indication of breakdown only as the forest cover layer is for 2001.

Figure 4-14 outlines the forest loss and forest gain breakdown where land use has changed and where it hasn't changed, giving an indication of the proportions.

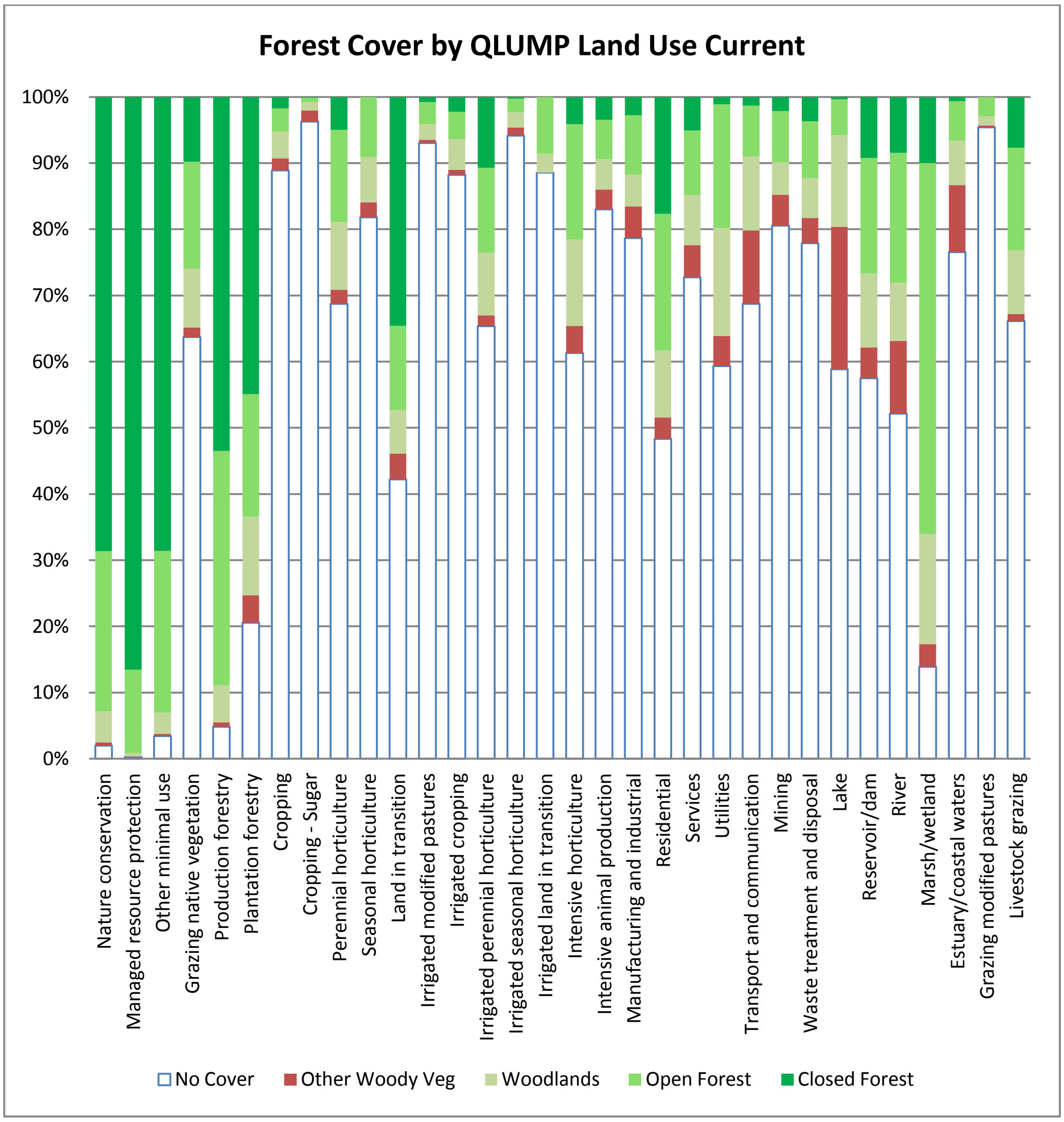


Figure 4-13: Forest Cover by QLUMP Land Use

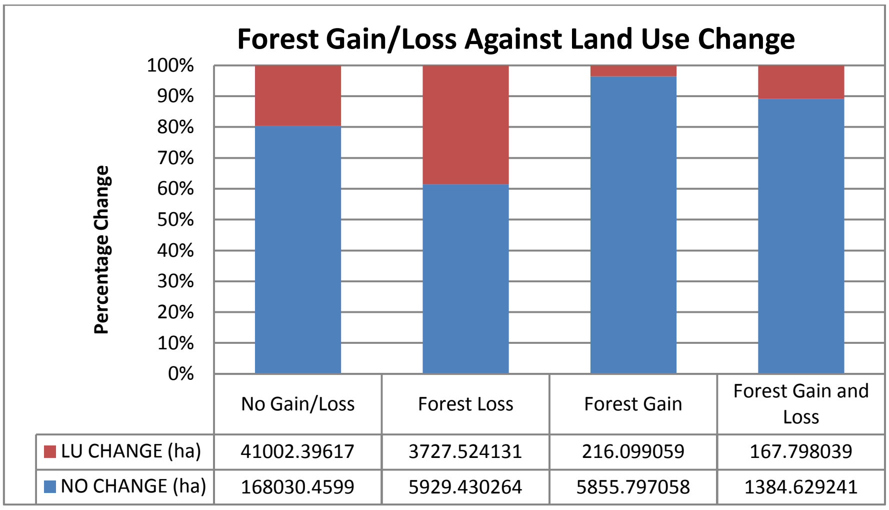
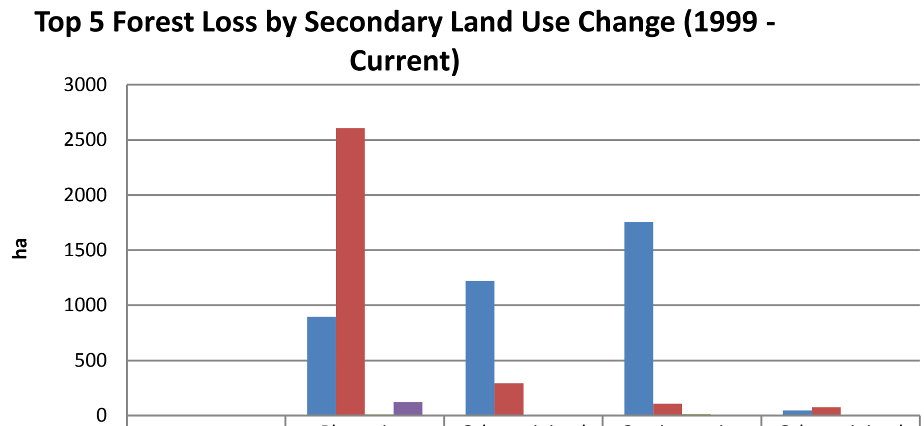


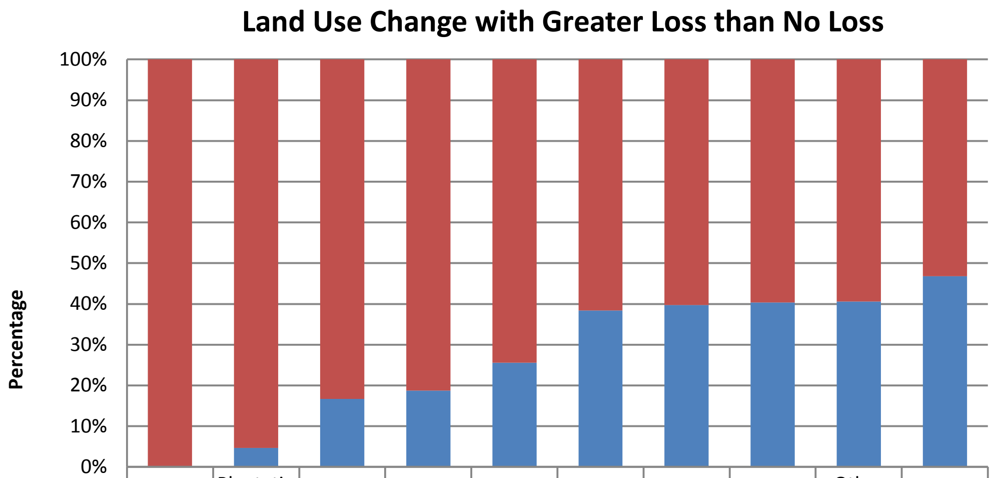
Figure 4-14: Forest Cover Change against Land Use Change

Figure 4-15 reveals the top 5 areas of forest loss occurring in areas of land use change, whilst Figure 4-16 reveals the top land use change areas with the highest proportion of forest loss.



	SECONDARY_JOIN	Plantation forestry to Land in transition	Other minimal use to Residential	Grazing native vegetation to Residential	Other minimal use to Land in transition
■ (blue)	0	895.5629492	1219.637683	1758.112816	48.22716525
■ (red)	0	2605.817874	293.6465682	108.2710938	77.47365444
■ (green)	0	12.11218239	2.437207432	15.21408276	0
■ (purple)	0	122.6727741	5.982236425	1.10782156	0.960112019

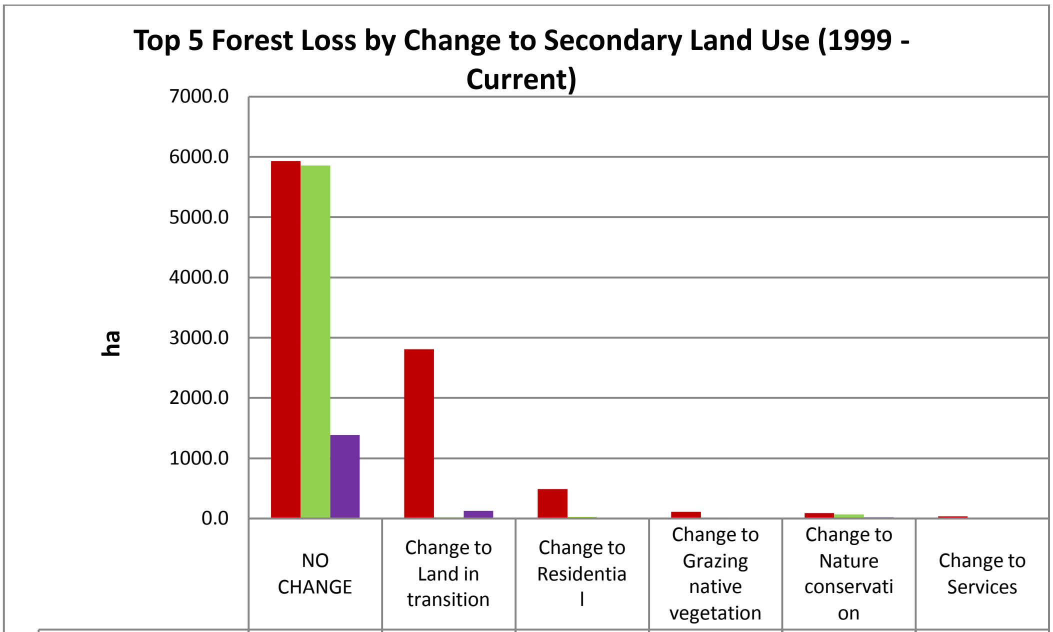
Figure 4-15: Top 5 Forest Loss by Secondary Land Use Change



	Other minimal use to Cropping	Plantation forestry to Perennial horticulture	Nature conservation to Waste treatment and disposal	Reservoir/dam to Land in transition	Plantation forestry to Land in transition	Other minimal use to Land in transition	Other minimal use to Irrigated cropping	Production forestry to Mining	Other minimal use to Irrigated perennial horticulture	Mining to Reservoir/dam
Forest Loss	9.1	4.5	3.0	1.9	2605.8	77.5	3.7	2.3	24.5	2.4
No Gain/Loss	0.0	0.2	0.6	0.4	895.6	48.2	2.4	1.6	16.8	2.1

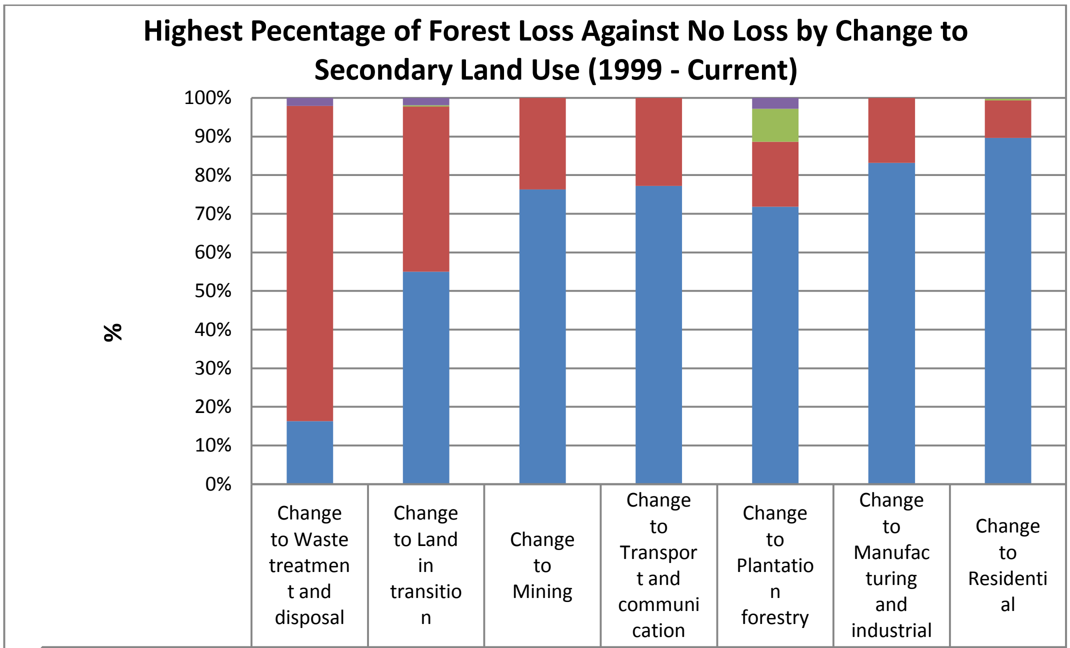
Figure 4-16: Land Use Change with Greater Forest Loss than no Loss

Figure 4-17 reveals the top 5 areas of forest loss occurring in areas of what the land use has been changed to, whilst Figure 4-18 reveals the top land use change to areas with the highest proportion of forest loss.



	NO CHANGE	Change to Land in transition	Change to Residentia l	Change to Grazing native vegetation	Change to Nature conservati on	Change to Services
Forest Loss	5929.4	2807.7	488.2	108.2	88.9	36.6
Forest Gain	5855.8	20.6	25.2	13.9	70.8	1.9
Forest Gain and Loss	1384.6	124.2	7.4	1.0	22.7	0.4

Figure 4-17: Top 5 Forest Loss by Land Use Changed To



	Change to Waste treatment and disposal	Change to Land in transition	Change to Mining	Change to Transport and communication	Change to Plantation forestry	Change to Manufacturing and industrial	Change to Residential
Forest Gain and Loss	0.1	124.2	0.0	0.0	5.5	0.0	7.4
Forest Gain	0.0	20.6	0.0	0.0	17.0	0.0	25.2
Forest Loss	3.0	2807.7	9.2	10.4	33.5	7.2	488.2
No Gain/Loss	0.6	3604.5	29.7	35.3	142.7	35.9	4511.9

Figure 4-18: Highest Percentage of Forest Loss by Secondary Land Use Change

4.3.2 Regional Ecosystems and Remnant Vegetation

Figure 4-19 breaks down the forest cover by remnant vegetation status. This gives an indication of breakdown only as the forest cover layer is for 2001.

Figure 4-20 outlines the forest loss by remnant status.

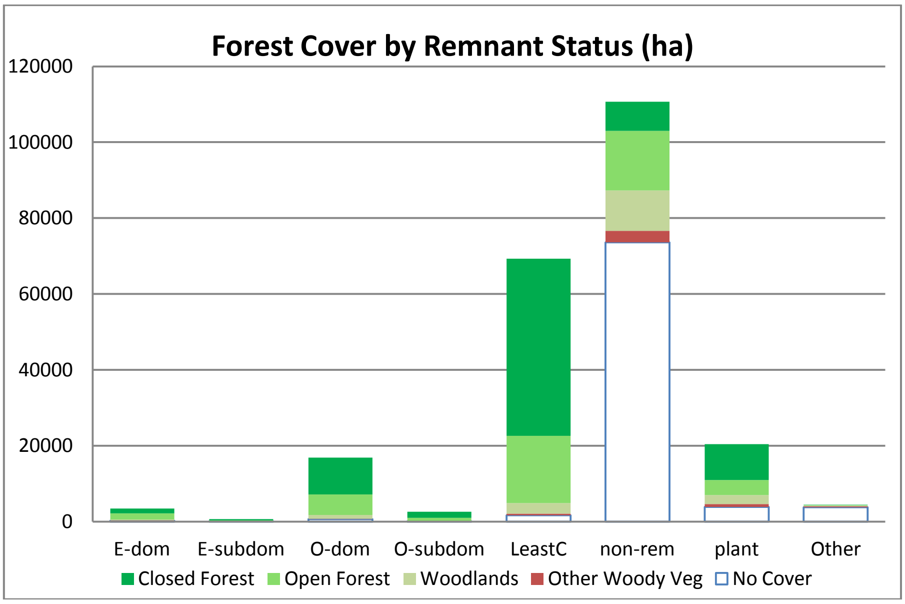


Figure 4-19: Forest Cover by Remnant Vegetation Status

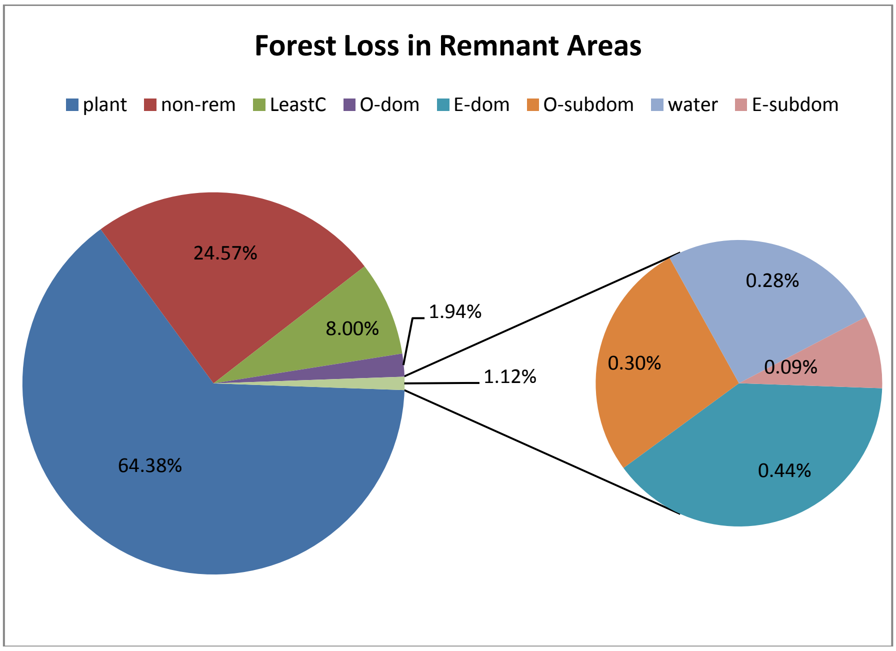


Figure 4-20: Forest Lost in Remnant Vegetation Areas

Figure 4-21 outlines the yearly forest loss by remnant status. This gives an indication only as the remnant areas layer used is the latest version. For example the remnant area polygons for 2003 may be different to the current areas.

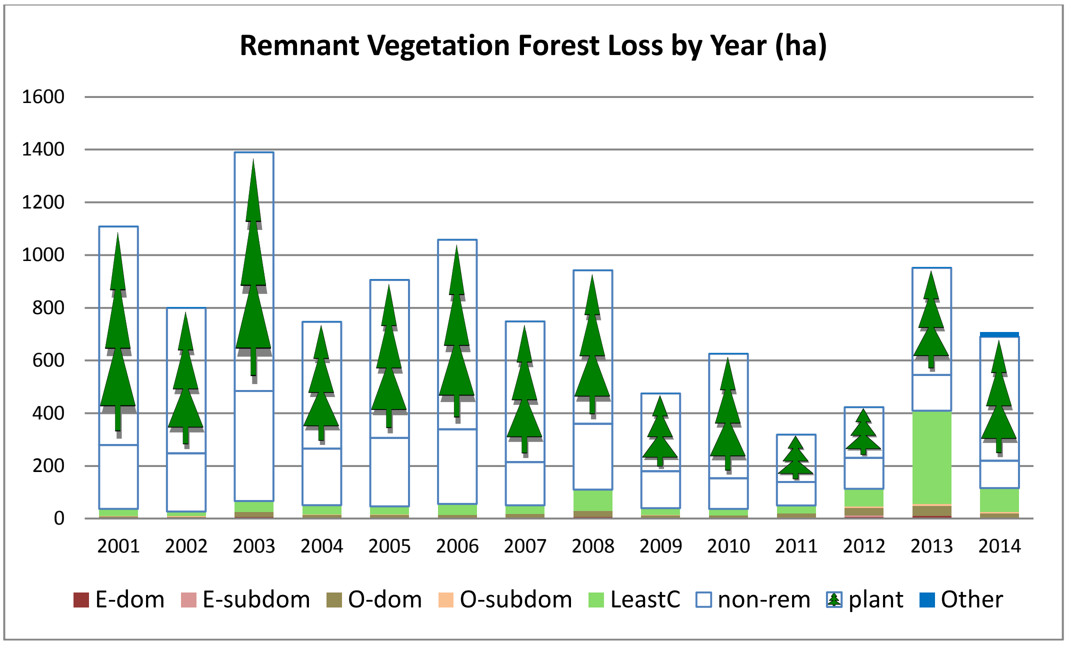
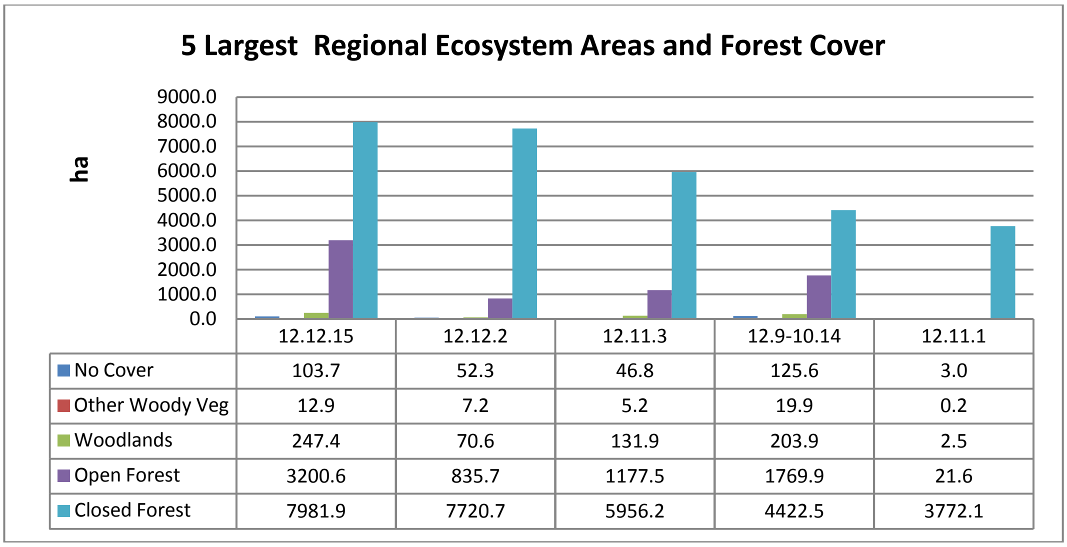


Figure 4-21: Yearly Remnant Vegetation Loss

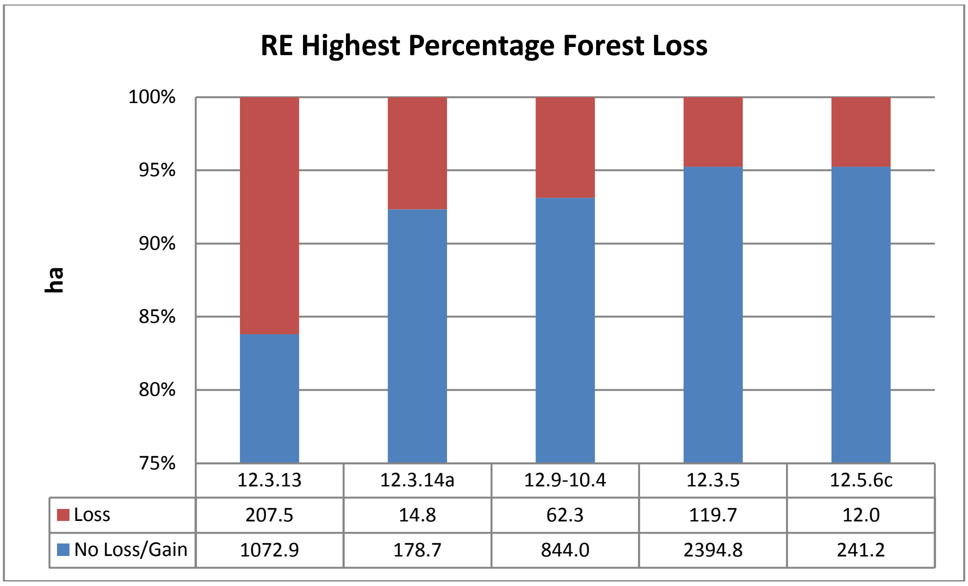
Figure 4-22 shows the 5 RE's covering the largest area, and the forest cover type.



	12.12.15	12.12.2	12.11.3	12.9-10.14	12.11.1
No Cover	103.7	52.3	46.8	125.6	3.0
Other Woody Veg	12.9	7.2	5.2	19.9	0.2
Woodlands	247.4	70.6	131.9	203.9	2.5
Open Forest	3200.6	835.7	1177.5	1769.9	21.6
Closed Forest	7981.9	7720.7	5956.2	4422.5	3772.1

Figure 4-22: Five Largest Regional Ecosystem Areas

Figure 4-23 the 5 RE's experiencing the highest percentage of forest loss.

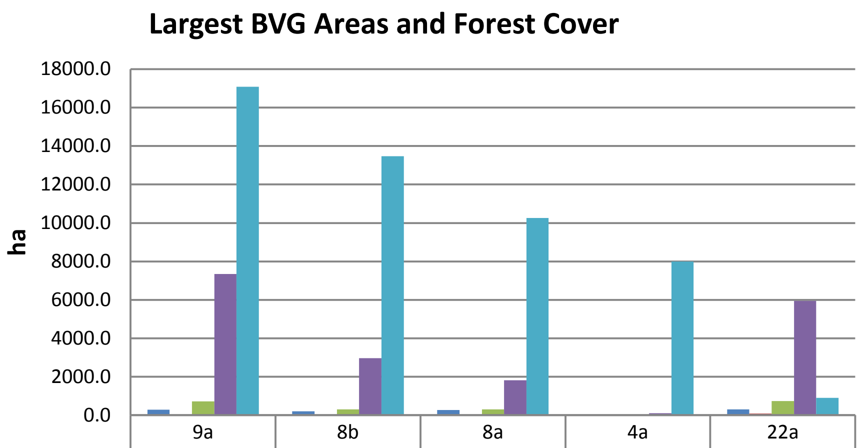


	12.3.13	12.3.14a	12.9-10.4	12.3.5	12.5.6c
Loss	207.5	14.8	62.3	119.7	12.0
No Loss/Gain	1072.9	178.7	844.0	2394.8	241.2

Figure 4-23: Highest Percentage Forest Loss in RE Areas (>150ha)

4.3.3 Remnant BVG areas

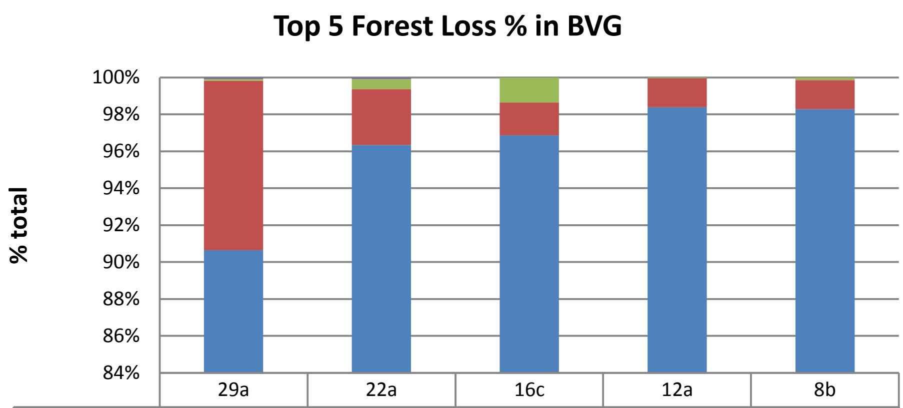
The remnant BVG information is extracted from the same dataset as the RE data. Figure 4-24 outlines the Largest BVG areas and the breakdown of forest cover.



	9a	8b	8a	4a	22a
No Cover	296.7	205.8	278.9	11.9	300.8
Other Woody Veg	42.3	31.3	26.9	1.3	85.5
Woodlands	727.8	311.3	299.4	12.9	735.7
Open Forest	7351.7	2971.8	1825.2	111.7	5947.7
Closed Forest	17090.5	13475.0	10258.2	8003.3	902.6

Figure 4-24: Largest BVG Areas and Forest Cover Breakdown

Figure 4-25 displays the BVG’s with the highest percentage of forest loss.

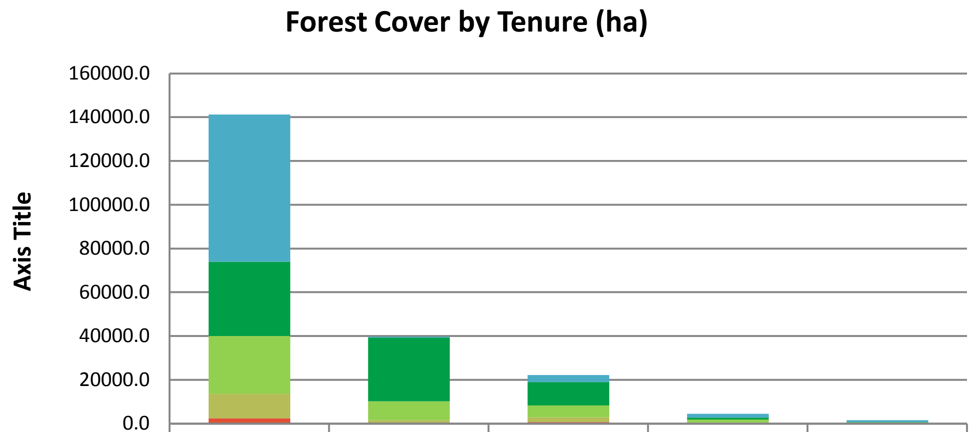


	29a	22a	16c	12a	8b
Loss/Gain	2.3	7.3	0.1	0.0	2.1
Gain	2.1	42.7	7.8	0.1	21.4
Loss	229.3	242.3	10.5	3.6	267.9
No Loss/Gain	2265.7	7680.0	568.4	224.4	16703.9

Figure 4-25: Top 5 percentage Forest Loss for BVG’s

4.3.4 Cadastre

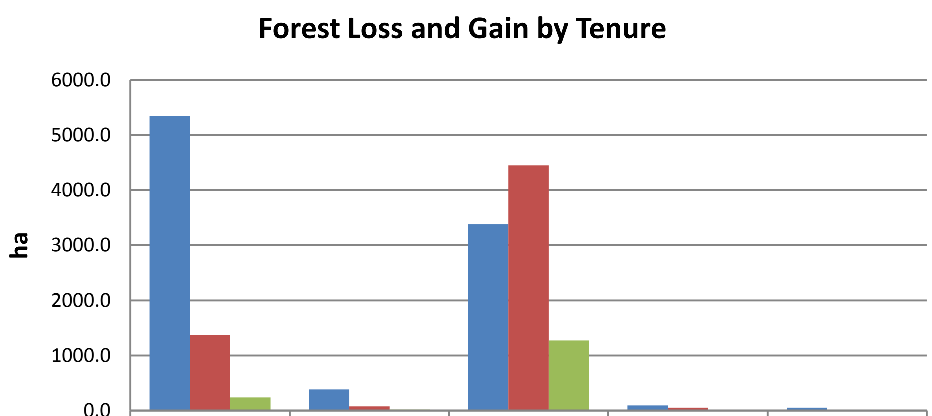
Figure 4-26 breaks down the forest cover by tenure (only the top 5 shown). This gives an indication of breakdown only as the forest cover layer is for 2001.



	FREEHOLD	NATIONAL PARK	STATE FOREST	RESERVE	EASEMENT
No Cover	67280.0	527.3	3208.5	1664.4	799.1
Closed Forest	33893.4	29029.5	10612.5	931.9	195.1
Open Forest	26436.7	8636.4	5453.1	1276.4	333.5
Woodlands	11103.0	1464.0	2226.2	392.0	168.3
Other Woody Veg	2497.0	127.8	666.5	195.1	42.9

Figure 4-26: Forest Cover (2001) by Tenure (2015)

Figure 4-27 outlines the forest loss and gain for the period from 2001to 2014 by tenure.



	Freehold	National Park	State Forest	Reserve	Easement
Loss	5347.9	386.0	3378.0	92.2	51.7
Gain	1368.4	75.4	4450.8	49.7	10.1
Loss/Gain	241.0	18.5	1271.6	3.0	0.5

Figure 4-27: Forest Loss and Gain 2001- 2014 by Tenure

4.4 Summary

The results produced an extensive array of data in the form of maps and graphs. These results are analyzed in Chapter 5.

Chapter 5

Discussion

5.1 Introduction

This chapter provides an interpretation of the summary and overlay results.

5.2 The Hansen Dataset

It was found that the general makeup of forest in the study area is considerably different to the Australian average (Figure 5-1). The SCC has a significantly higher percentage of Closed Forests (34% to 3%) and much lower percentage of woodlands (8% to 67%). This would be expected as the majority of the Australian Continent is dry scrubby land with the study area being sub-tropical. Having the relatively rare closed forest cover in the study area makes it of high conservation value.

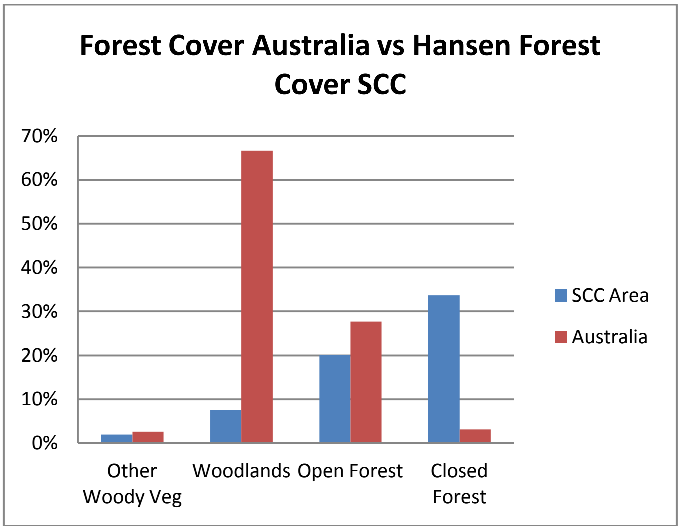


Figure 5-1: Comparison of Forest Cover in the Study Area with Australia Continent

By the Hansen definition of Forest Loss and Forest gain it was not expected to find forest loss in areas of no cover and conversely forest gain in areas with forest cover. Figure 4-1 outlines that this is not the case and can be taken as errors in the data. 1.8% of the area with No Cover was recorded as having forest loss with 2%

of the area with forest cover recorded as having forest gain (areas of loss and gain were not included). This is outside the Hansen stated accuracy of 99.7% for Sub Tropical climate domain.

5.3 Land Use and Land Use Change

The Land Use change was analyzed from the available QLUMP datasets. The Queensland government publishes Land Use summaries for each of the catchment areas but there is no publication summarizing the LGA's. There is also no data analyzing Land Use change against Land Cover. This leaves a gap in the data available to compare the results of this study.

The Land Use change (1999 – current) analysis reveals that 20% of the total study area experienced Land Use change, with three main drivers in that change:

- Change to Nature Conservation with 24,263ha being converted. This results in 54% of all the land use change.
- Change to Residential with 5,041ha being changed. This does not include the Land in transition that is in the process of being converted from plantation forestry to the Caloundra South residential area, an additional 3,637ha. This results in 19% of all the land use changed.
- Change from Cropping –Sugar due to the collapse of the sugar industry in the area. A total of 6,227ha has been changed from Sugar Cropping to other land uses. Most of this change is to grazing and residential.

The Land Use change reflects the population growth, conservation efforts and collapse of the sugar industry on the Sunshine Coast in the last decade.

An overview of the forest loss reveals that 39% of the forest loss occurs in areas of Land Use Change, which is 9% of the total Land Use change area. As previously discussed 54% of land use change is change to Nature Conservation, when this is removed from the overall figure 21% of the total Land Use Change area experienced forest loss. As a large proportion of this area is plantation forests (see RE discussion), the results do not indicated the loss of significant forests. Only 3% of the area experiencing no Land Use change was identified as having forest loss.

There were no significant gains in forest cover in areas of Land Use change. The largest area of forest gain was in the change from "Other minimal use to Nature conservation" resulting in 50ha or 4% of forest gain in the area. The highest percentage of forest gain was 54% of "Livestock grazing" to "Other minimal use" though this was only a total of 8ha of forest gain. An overwhelming 94% of forest gain was experienced in areas experiencing no Land Cover change.

Looking at what the Land Use areas were changed to revealed slightly different results. Change to "Land in transition" resulting in the greatest loss of forest cover of 2807ha or 43% of the change area or 29% of the entire forest loss in the study area. The change to "Waste treatment" resulted in the highest percentage loss of 82% of the area converted experiencing loss in forest cover, though this was a very small (3.6ha) area.

5.4 Regional Ecosystems and Remnant Vegetation

The results identify that a significant proportion (7216ha or 64%) of the forest loss is occurring in areas categorized as "Plantation". This is to be expected as the very nature of plantation forestry is the cycle of growth and harvest (loss). The remainder of the forest loss was broken down into non-remnant areas (25%) and remnant vegetation areas (11%). The remnant vegetation areas are of greater interests as they are areas of significant, protected forests.

The analysis of the annual forest loss for areas of remnant vegetation revealed a spike in forest loss of Least Concern (LC) ecosystem for 2013 (350ha compared to an average of 64ha per year). This potentially indicates illegal clearing activity as clearing of this ecosystem is restricted under the *Vegetation Management Act 1999 (QLD)*. Further analysis was performed to identify this area of forest loss. It was found that a majority of the 2013 LC loss was clustered in on area, Figure 5-2. Investigating the area revealed that it was within the Mooloola River National Park(Figure 5-2), which *"protects valuable remnants of coastal lowland habitat—rainforest, open eucalypt woodlands, melaleuca forests, wallum banksia woodlands, scribbly gum open forests, wallum heath and sedgelands."* (Queensland Government, 2012). Ground truthing using google street view revealed that the area is low vegetation with no significant trees without any evidence of forest loss. The analyses revealed that the area incorrectly categorized this area as forest cover in the 2001 forest cover layer.

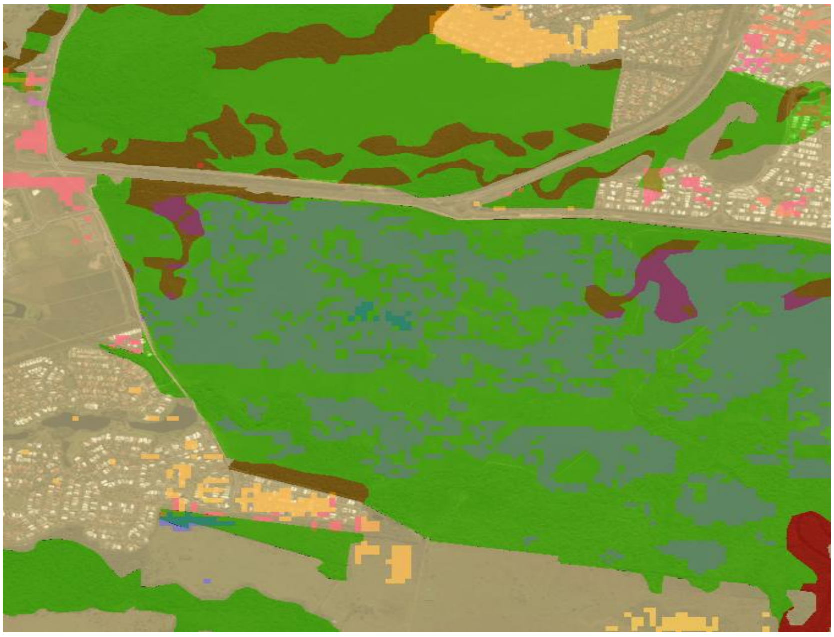


Figure 5-2: Area of 2013 Least Concern Remnant Vegetation Loss

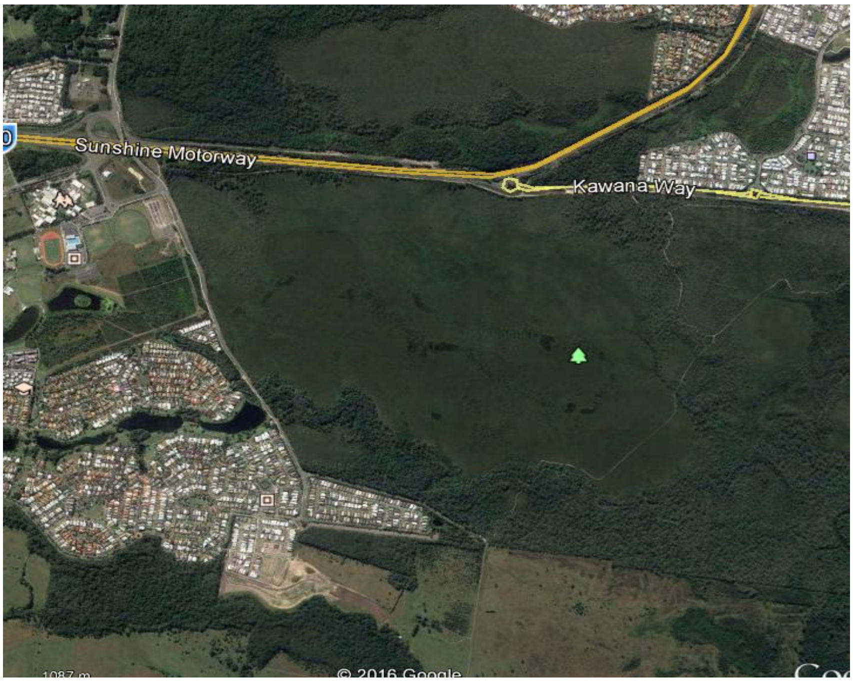


Figure 5-3: Aerial Photograph of Area

Figure 5-4: Google Street View of area of Forest Loss

The RE of this area is 12.3.13 with the short RE description *of "Closed heathland on seasonally waterlogged alluvial plains usually near coast".* The LGA regional ecosystems report revealed no ecosystem loss for this RE. The description of the RE may reveal a source of the Hansen Dataset error i.e. seasonally waterlogged alluvial plains. The fluctuating water content of these areas could have resulted in the incorrect classification. Analysis of areas with same RE category (12.3.13) did not reveal any other incorrect forest classifications.

Analysis of the highest percentage of forest loss for the RE's revealed that the 12.3.13 ecosystem above being the highest. As discussed this is an error, the next highest percentage loss is RE 12.3.14a. Analysis of the 12.3.14a areas experiencing forest loss found that they either adjoin the 12.3.13 habitat or are amongst plantation areas. This suggests that they are also an error in the forest loss data. In fact the entire top 5 percentage forest loss areas were within the same error suggesting that the error has been propagated.

Having identified this entire area as being incorrect the area could be masked of the forest loss theme and the entire analysis performed again, revealed another set of results. Time did not permit this second analysis to be performed.

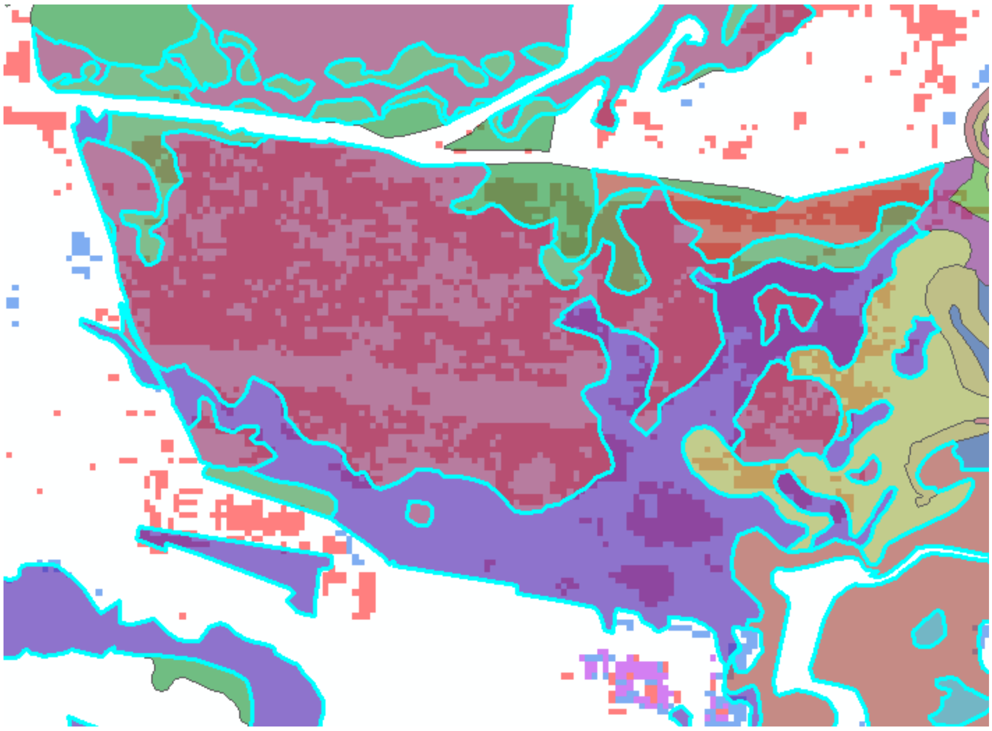


Figure 5-5: Area Containing Forest Loss error, Top Percentage Forest Loss RE's Highlighted

Having identified this entire area as being incorrect the area could be masked of the forest loss theme and the entire analysis performed again, revealed another set of results. Time did not permit this second analysis to be performed.

5.5 Remnant BVG

As the BVG's are a higher level of ecosystem classification the RE's and the data is derived from the same dataset as the RE's it was expected to reveal very similar results to the RE analysis. The two of the largest RE's (12.12.15 and 12.11.3) being part of the largest remnant BVG area (9a) confirms this. What was revealed was that the BVG 22a was mostly open forest matching the percentage canopy cover of 60%, supplied in the SEQ Benchmarks report.

As the classification are closely related, the errors experienced in the RE forest loss analysis also affected the results of the BVG forest loss analysis

5.6 Cadastre

Freehold land consists of 50.5% forest cover, with the majority of National Park (98% cover) and State Forest (82.5% cover) forested.

A majority of the forest loss was observed within the “Freehold” and “State Forest” tenures. As most of the State Forest area is covered by plantation forestry large amounts of forest loss and gain were observed.

The forest loss in the “National Parks” was within the Mooloola National Park which, as discussed previously was an error.

5.7 Summary

A high percentage of plantation and errors in the forest loss data skewed some of the results. The Land Use change analysis did reveal some relevant and insightful results.

Chapter 6

Conclusion and Recommendations

6.1 Introduction

This chapter attempts presents the significance and implications of the results of this study and investigates recommendations for future research.

6.2 Conclusions

This study revealed the significance of understanding the data, how it was created and the intention of its creators before performing any studies using it. In the case of the Hansen Dataset it was essential to comprehend how they defined forests in the creation of their data before commencing this study. The understanding of the forest definition revealed that it was not appropriate for study in areas of low, <5m, trees.

One limitation of using the Hansen dataset was the inability to determine degradation in the forest cover as it only indicates complete forest loss or its inverse. Another limitation is that the Forest Cover layer itself is only for the base year at the start of the study making comparison with current datasets inappropriate. If the Hansen Dataset provided a forest cover for each year it would then be possible to derive forest degradation (i.e. a decrease in canopy cover) over time and provide a current Forest Cover to compare with current datasets e.g. cadastre, Land Use etc. This limitation in the data made any summary statistics regarding forest cover misaligned as current datasets were used but summarized against the Hansen 2001 base forest cover.

Regional Ecosystems are not necessarily forested areas with some consisting of low vegetative swamps and other scrublands. A more in depth analysis would require the identification and removal/masking of non “forest” RE’s from the analysis to provide a more accurate result.

This significant amount of plantation forestry in the SCC area significantly watered down the results. If this study was to be performed again or over another area the plantation areas should be masked out of the analysis to reveal only the significant areas of forest loss.

One particular region produced a significant amount of Hansen forest cover errors, contaminating the results of the RE analysis. This was due to the scale of the study but would of had limited impact at a state, national or global scale study as it would be a small percentage of the larger study area. Consequentially, performing the study at the LGA level did help in identifying errors that would have been missed in a larger scale study. These errors are within only a small sample of the entire Hansen Global Dataset and are not indicative of the entire dataset. It does, however, open the avenue for further investigation into classification of forests in the type of ecosystems where the error occurred.

The analysis of Land Use change yielded the most successful results, revealing a significantly larger amount of forest loss in areas of Land Use change (21% with change to Nature Conservation removed) as opposed to areas not experiencing land use change (3%). This gives considerable weight to the hypothesis “Forests are lost when land use is converted to another use”.

6.3 Recommendations for Practical Applications

It is recommended that the Hansen dataset be used by entities required to report on the state of forests in their regions. This dataset could form a significant part of a Multiple Lines of Evidence study, like those performed by the Australian Government to produce their State of Forests Reports.

Analyzing the datasets independently was not the best method with a more holistic approach using aspects of each of the datasets to complement each being a preferred method for future research. For example, using the “Plantation” area from the RE dataset to create a mask for the forest data would of improved the results.

6.4 Recommendations for Future Research

Analyse of the Hansen data against other datasets that could have an impact of forest such as:

- Analyse forest loss against natural topography e.g. slope, aspect etc.
- Distance from roads
- River network
- Population density
- Changing Coastlines

Perform cluster and fragmentation analysis of forest loss to reveal cluster and hotspots of forest loss and to identify areas of reduced forest cover.

Performing an analysis against the Queensland Governments SLATS data could also be beneficial in validating the Hansen data.

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APPENDIX A: Project Specification

For:	James Miller
Title:	Examining the Hansen Global Forest Change 2000 - 2014 dataset within an Australian Local Government Area
Major:	Geographic Information Systems
Supervisors:	Dr. Armando A. Apan
Enrolment:	ENG4111 – EXT S1, 2016 ENG4112 – EXT S2, 2016
Project Aim:	The objective of this research project is to investigate the forest loss/gain against the change in land use in the region covered by the Sunshine Coast Council. The research is aimed at:

- Identifying any correlation between change of land use and forest loss.
- Identifying forest loss/gain in Remnant Regional Ecosystems.
- Demonstrate the value of using the Hansen Dataset to analyse forest cover in a relatively small study area.

Programme: Version 3.00, 30th September 2016

1. Search for existing studies into forest loss and forest gain against land use change.
2. Acquire background datasets for use. Summarize metadata to be included as an appendix.
3. Determine relevant percentage tree canopy cover for forest cover in the region.
4. Acquire the Hansen Global Forest Change Datasets and review related literature.
5. Select and acquire relevant Land Use datasets and review related literature.
6. Determine relevant percentage tree canopy cover for forest cover in the region.
7. Pre-process and load all data into ArcGIS and set up visualization.
8. Review functionality available within the GIS (ArcMap) and access the best tools to utilise for the study.
9. Tabulate spatial temporal summary of forest areas and land use areas i.e. percentage breakdown of land cover/use by timeframe, rate of forest loss/gain.
10. Analyse
    a. Forest loss (2 period difference i.e. 2000-2014)
    b. Forest gain (2 period difference i.e. 2000-2012)
    c. Yearly Forest Cover loss (2001 -2014)

    Against

    a. Land Use change
    b. Remnant Regional Ecosystems

If time and resources permit:

11. South east Queensland regional plan (The Sustainable Planning Act 2009).
12. Cadastre (Land Tenure)

APPENDIX B: ALUM Land Use ClassificationV7

Revision as at 19 May 2010

1 Conservation and Natural Environments

1.1.0	**Nature conservation**
1.1.1	Strict nature reserves
1.1.2	Wilderness area
1.1.3	National park
1.1.4	Natural feature protection
1.1.5	Habitat/species management area
1.1.6	Protected landscape
1.1.7	Other conserved area

1.2.0	**Managed resource protection**
1.2.1	Biodiversity
1.2.2	Surface water supply
1.2.3	Groundwater
1.2.4	Landscape
1.2.5	Traditional indigenous uses

1.3.0	**Other minimal use**
1.3.1	Defence land - natural areas
1.3.2	Stock route
1.3.3	Residual native cover
1.3.4	Rehabilitation

2 Production from Relatively Natural Environments

2.1.0	**Grazing native vegetation**

2.2.0	**Production forestry**
2.2.1	Wood production
2.2.2	Other forest production

3 Production from Dryland Agriculture and Plantations

3.1.0	**Plantation forestry**
3.1.1	Hardwood plantation
3.1.2	Softwood plantation
3.1.3	Other forest plantation
3.1.4	Environmental forest plantation

3.2.0	**Grazing modified pastures**
3.2.1	Native/exotic pasture mosaic
3.2.2	Woody fodder plants
3.2.3	Pasture legumes
3.2.4	Pasture legume/grass mixtures
3.2.5	Sown grasses

3.3.0	**Cropping**
3.3.1	Cereals
3.3.2	Beverage and spice crops
3.3.3	Hay and silage
3.3.4	Oil seeds
3.3.5	Sugar
3.3.6	Cotton
3.3.7	Alkaloid poppies
3.3.8	Pulses

3.4.0	**Perennial horticulture**
3.4.1	Tree fruits
3.4.2	Oleaginous fruits
3.4.3	Tree nuts
3.4.4	Vine fruits
3.4.5	Shrub nuts, fruits and berries
3.4.6	Perennial flowers and bulbs
3.4.7	Perennial vegetables and herbs
3.4.8	Citrus
3.4.9	Grapes

3.5.0	**Seasonal horticulture**
3.5.1	Seasonal fruits
3.5.2	Seasonal nuts
3.5.3	Seasonal flowers and bulbs
3.5.4	Seasonal vegetables and herbs

3.6.0	**Land in transition**
3.6.1	Degraded land
3.6.2	Abandoned land
3.6.3	Land under rehabilitation
3.6.4	No defined use
3.6.5	Abandoned perennial horticulture

4 Production from Irrigated Agriculture and Plantations

4.1.0	**Irrigated plantation forestry**
4.1.1	Irrigated hardwood plantation
4.1.2	Irrigated softwood plantation
4.1.3	Irrigated other forest plantation
4.1.4	Irrigated environmental forest plantation

4.2.0	**Grazing irrigated modified pastures**
4.2.1	Irrigated woody fodder plants
4.2.2	Irrigated pasture legumes
4.2.3	Irrigated legume/grass mixtures
4.2.4	Irrigated sown grasses

4.3.0	**Irrigated cropping**
4.3.1	Irrigated cereals
4.3.2	Irrigated beverage and spice crops
4.3.3	Irrigated hay and silage
4.3.4	Irrigated oil seeds
4.3.5	Irrigated sugar
4.3.6	Irrigated cotton
4.3.7	Irrigated alkaloid poppies
4.3.8	Irrigated pulses
4.3.9	Irrigated rice

4.4.0	**Irrigated perennial horticulture**
4.4.1	Irrigated tree fruits
4.4.2	Irrigated oleaginous fruits
4.4.3	Irrigated tree nuts
4.4.4	Irrigated vine fruits
4.4.5	Irrigated shrub nuts, fruits and berries
4.4.6	Irrigated perennial flowers and bulbs
4.4.7	Irrigated perennial vegetables and herbs
4.4.8	Irrigated citrus
4.4.9	Irrigated grapes

4.5.0	**Irrigated seasonal horticulture**
4.5.1	Irrigated seasonal fruits
4.5.2	Irrigated seasonal nuts
4.5.3	Irrigated seasonal flowers and bulbs
4.5.4	Irrigated seasonal vegetables and herbs
4.5.5	Irrigated turf farming

4.6.0	**Irrigated land in transition**
4.6.1	Degraded irrigated land
4.6.2	Abandoned irrigated land
4.6.3	Irrigated land under rehabilitation
4.6.4	No defined use (irrigation)
4.6.5	Abandoned irrigated perennial horticulture

5 Intensive Uses

5.1.0	**Intensive horticulture**
5.1.1	Shadehouses
5.1.2	Glasshouses
5.1.3	Glasshouses (hydroponic)
5.1.4	Abandoned intensive horticulture

5.2.0	**Intensive animal husbandry**
5.2.1	Dairy sheds and yards
5.2.2	Cattle feedlots
5.2.3	Sheep feedlots
5.2.4	Poultry farms
5.2.5	Piggeries
5.2.6	Aquaculture
5.2.7	Horse studs
5.2.8	Stockyards/saleyards
5.2.9	Abandoned intensive animal husbandry

5.3.0	**Manufacturing and industrial**
5.3.1	General purpose factory
5.3.2	Food processing factory
5.3.3	Major industrial complex
5.3.4	Bulk grain storage
5.3.5	Abattoirs
5.3.6	Oil refinery
5.3.7	Sawmill
5.3.8	Abandoned manufacturing and industrial

5.4.0	**Residential and farm infrastructure**
5.4.1	Urban residential
5.4.2	Rural residential with agriculture
5.4.3	Rural residential without agriculture
5.4.4	Remote communities
5.4.5	Farm buildings/infrastructure

5 Intensive Uses

5.5.0	**Services**
5.5.1	Commercial services
5.5.2	Public services
5.5.3	Recreation and culture
5.5.4	Defence facilities - urban
5.5.5	Research facilities

5.6.0	**Utilities**
5.6.1	Fuel powered electricity generation
5.6.2	Hydro electricity generation
5.6.3	Wind farm electricity generation
5.6.4	Electricity substations and transmission
5.6.5	Gas treatment, storage and transmission
5.6.6	Water extraction and transmission

5.7.0	**Transport and communication**
5.7.1	Airports/aerodromes
5.7.2	Roads
5.7.3	Railways
5.7.4	Ports and water transport
5.7.5	Navigation and communication

5.8.0	**Mining**
5.8.1	Mines
5.8.2	Quarries
5.8.3	Tailings
5.8.4	Extractive industry not in use

5.9.0	**Waste treatment and disposal**
5.9.1	Effluent pond
5.9.2	Landfill
5.9.3	Solid garbage
5.9.4	Incinerators
5.9.5	Sewage/sewerage

6 Water

6.1.0	**Lake**
6.1.1	Lake - conservation
6.1.2	Lake - production
6.1.3	Lake - intensive use
6.1.4	Lake - saline

6.2.0	**Reservoir/dam**
6.2.1	Reservoir
6.2.2	Water storage - intensive use/farm dams
6.2.3	Evaporation basin

6.3.0	**River**
6.3.1	River - conservation
6.3.2	River - production
6.3.3	River - intensive use

6.4.0	**Channel/aqueduct**
6.4.1	Supply channel/aqueduct
6.4.2	Drainage channel/aqueduct
6.4.3	Stormwater

6.5.0	**Marsh/wetland**
6.5.1	Marsh/wetland - conservation
6.5.2	Marsh/wetland - production
6.5.3	Marsh/wetland - intensive use
6.5.4	Marsh/wetland - saline

6.6.0	**Estuary/coastal waters**
6.6.1	Estuary/coastal waters - conservation
6.6.2	Estuary/coastal waters - production
6.6.3	Estuary/coastal waters - intensive use

minimum level of attribution

APPENDIX C: Regional Ecosystems of the Sunshine Coast

RE	Description	Regional Status
12.1.1	*Casuarina glauca* ± *Melaleuca quinquenervia* ± mangroves open-forest. Occurs on margins of Quaternary estuarine deposits.	Of Concern
12.1.2	Saltpan vegetation comprising *Sporobolus virginicus* grassland and samphire herbland. Grasses including *Zoysia micrantha* sometimes present in upper portions of tidal flats. Includes saline or brackish sedgelands. Occurs on Quaternary estuarine deposits. Marine plains/tidal flats.	Not of Concern
12.1.3	Mangrove shrubland to low closed forest. Occurs on Quaternary estuarine deposits	Not of Concern
12.2.1	Notophyll rainforest on parabolic high dunes.	Of Concern
12.2.3	Araucarian rainforest on parabolic high dunes.	Of Concern
12.2.5	Open-forest to low closed forest. Species can include *Corymbia intermedia*, *C. tessellaris*, *Banksia integrifolia var. integrifolia*, *Acacia spp*., *Lophostemon confertus*, *Callitris columellaris*, *Livistona spp.* and *Endiandra sieberi*. *Melaleuca quinquenervia* in swales. Understorey generally shrubby and can include vine forest species. Occurs of Quaternary coastal dunes and beaches and sandy banks of coastal streams.	Not of Concern
12.2.5a	Open-forest to low closed forest. Species can include *Corymbia intermedia*, *C. tessellaris*, *Banksia integrifolia var. integrifolia*, *Acacia spp*., *Lophostemon confertus*, *Callitris columellaris*, *Livistona spp*. and *Endiandra sieberi*. *Melaleuca quinquenervia* in swales. Understorey generally shrubby and can include vine forest species. Occurs on Quaternary coastal dunes and beaches and sandy banks of coastal streams.	Not of Concern
12.2.6	*Eucalyptus racemosa*, *Corymbia intermedia*, *C. gummifera*, *Angophora leiocarpa* and *E. pilularis* shrubby or grassy woodland to open-forest. Occurs on Quaternary coastal dunes and beaches. Dunes with deeply leached soils	Not of Concern
12.2.7	*Melaleuca quinquenervia* open-forest to woodland. Other species include *Eucalyptus bancroftii*, *E. latisinensis*, *E. robusta*, *E. tereticornis*, *Corymbia intermedia* and *Lophostemon suaveolens*. Understorey of ferns and sedges. *Banksia robur* sometimes forms a dense shrub layer. Occurs on Quaternary coastal dunes and seasonally waterlogged sand plains.	Not of Concern
12.2.7a	*Melaleuca quinquenervia* low woodland with *Gahnia sieberiana* shrub layer. Occurs on Quaternary coastal sand dunes fringing swamps.	N/A
12.2.7c	*Melaleuca quinquenervia, Eucalyptus robusta, Melicope elleryana* open forest with understorey of *Todea barbara*. Occurs along watercourses on Quaternary coastal dunes and beaches and seasonally waterlogged sand plains.	N/A
12.2.8	*Eucalyptus pilularis* open forest on parabolic high dunes.	Not of Concern
12.2.9	*Banksia aemula* low shrubby woodland. Mallee eucalypts sometimes present, e.g. *Eucalyptus latisinensis*. Occurs on Quaternary coastal dunes and sand plains with deeply leached soils.	Not of Concern

RE	Description	Regional Status
12.2.11	*Woodland to open forest on Quaternary coastal dunes and beaches.*	Not of Concern
12.2.12	*Closed or wet heath ± stunted emergent shrubs/low trees. Characteristic shrubs include Banksia spp. (especially B. robur) Boronia falcifolia, Epacris spp., Baeckea frutescens, Schoenus brevifolius, Leptospermum spp., Hakea actites, Melaleuca thymifolia, Xanthorrhoea fulva with Baloskion spp. and Sporadanthus spp. in ground layer. Occurs on poorly drained Quaternary coastal dunes and sand plains. Low part of sand mass coastal landscapes where water collects from both overland flow and infiltration from adjoining sand dunes.*	Not of Concern
12.2.13	*Open heath on sand plains and dunes (dry heath).*	Of Concern
12.2.14	*Strand and fore dune complex comprising Spinifex sericeus grassland Allocasuarina equisetifolia woodland/open-forest and with Acacia leiocalyx, A. aulacocarpa, Banksia integrifolia var. integrifolia, Pandanus tectorius, Corymbia tessellaris, Cupaniopsis anacardioides, Acronychia imperforata. Occurs mostly on frontal dunes and beaches but can occur on exposed parts of dunes further inland.*	Not of Concern
12.2.15	*Coastal sedgeland with Baumea spp., Juncus spp., Lepironia articulata, Gahnia spp. and Eleocharis spp. and associated water bodies. Occurs on Quaternary coastal dunes and beaches. Low part of coastal landscape where water collects from both overland flow and infiltration from adjoining sand dunes.*	Not of Concern
12.2.15a	*Coastal sedgeland with Baumea spp., Juncus spp., Lepironia articulata, Gahnia spp. and Eleocharis spp. and associated water bodies. Occurs on Quaternary coastal dunes and beaches. Low part of coastal landscape where water collects from both overland flow and infiltration from adjoining sand dunes. Major vegetation communities include: 12.2.15a: Associated permanent water bodies. Occurs on Quaternary coastal dunes and beaches. Low part of coastal landscape where water collects from both overland flow and infiltration from adjoining sand dunes.*	Not of Concern
12.3.1	*Complex to simple notophyll vine forest. Waterhousea floribunda is predominant fringing stream channels. Other species can include Cryptocarya hypospodia, C. obovata, C. triplinervis, Argyrodendron trifoliolatum, Ficus coronata, F. fraseri, F. macrophylla, Aphananthe philippinensis, Elaeocarpus grandis, Grevillea robusta, Castanospermum australe and Syzygium francisii. Ficus racemosa and Nauclea orientalis in north of bioregion. Eucalyptus emergents (e.g. E. grandis) and Araucaria cunninghamii; less commonly Agathis robusta may also be present. Occurs on Quaternary alluvial plains and channels.*	Endangered
12.3.2	*Eucalyptus grandis ± E. microcorys, Lophostemon confertus tall open-forest with vine forest understorey ('wet sclerophyll'). Patches of Eucalyptus pilularis sometimes present especially in vicinity of sedimentary rocks (e.g. around Palmwoods). Fringing streams and in narrow gullies in high rainfall areas.*	Of Concern
12.3.4	*Open-forest to woodland of Melaleuca quinquenervia and Eucalyptus robusta. Occurs in drainage lines in coastal areas.*	Of Concern

RE	Description	Regional Status
12.3.5	*Melaleuca quinquenervia open-forest to woodland. Understorey depends upon duration of water logging; sedges and ferns, especially Blechnum indicum, in wetter microhabitats and grasses and shrubs in drier microhabitats. Other tree species that may be present as scattered individuals or clumps include Lophostemon suaveolens, Eucalyptus robusta, E. tereticornis, E. bancroftii, E. latisinensis, Corymbia intermedia, Callistemon salignus, Livistona australis, Casuarina glauca, Endiandra sieberi. Melastoma malabathricum subsp. malabathricum, Glochidion sumatranum and Melicope elleryana are often in understorey. Occurs on Quaternary alluvial plains in coastal areas.*	Not of Concern
12.3.5a	*Melaleuca quinquenervia open-forest to woodland. Understorey depends upon duration of water logging; sedges and ferns, especially Blechnum indicum, in wetter microhabitats and grasses and shrubs in drier microhabitats. Other tree species that may be present as scattered individuals or clumps include Lophostemon suaveolens, Eucalyptus robusta, E. tereticornis, E. bancroftii, E. latisinensis, Corymbia intermedia, Callistemon salignus, Livistona australis, Casuarina glauca, Endiandra sieberi. Melastoma malabathricum subsp. malabathricum, Glochidion sumatranum and Melicope elleryana are often in understorey. Occurs on Quaternary alluvial plains in coastal areas.*	Of Concern
12.3.6	*Melaleuca quinquenervia, Eucalyptus tereticornis, Lophostemon suaveolens woodland. Occurs on Quaternary alluvial plains and drainage lines in coastal areas.*	Not of Concern
12.3.7	*Narrow fringing community of Eucalyptus tereticornis, Callistemon viminalis, Casuarina cunninghamiana ± Waterhousea floribunda. Other species associated with this RE include Melaleuca bracteata, M. trichostachya and M. fluviatilis in north of bioregion. Lomandra hystrix often present in stream beds. Occurs on Quaternary alluvial plains along watercourses.*	Not of Concern
12.3.8	*Characteristic species include Cyperus spp., Schoenoplectus spp., Philydrum lanuginosum, Eleocharis spp., Leersia hexandra, Triglochin procerum, Nymphaea spp., Nymphoides indica, Persicaria spp., Typha spp., and Pennisetum alopecuroides. Occurs in freshwater swamps associated with floodplains.*	Of Concern
12.3.11	*Open-forest to woodland of Eucalyptus tereticornis, E. siderophloia and Corymbia intermedia. Corymbia tessellaris, Lophostemon suaveolens and Melaleuca quinquenervia frequently occur and often form a low tree layer. Other species present in scattered patches or low densities include Angophora leiocarpa, E. exserta, E. grandis, C. trachyphloia, C. citriodora, E. latisinensis, E. tindaliae, E. racemosa, Melaleuca sieberi and M. viridiflora. E. seeana may be present south of Landsborough. Occurs on Quaternary alluvial plains and drainage lines along coastal lowlands.*	Of Concern
12.3.13	*Closed or wet heathland. Characteristic species include Melaleuca thymifolia, Banksia robur, Xanthorrhoea fulva, Hakea actites, Leptospermum spp. and Baeckea frutescens. Occurs on seasonally waterlogged Quaternary alluvial plains along coastal lowlands.*	Of Concern
12.3.14	*Woodland of Banksia aemula ± mallee eucalypt low woodland to shrubland and/or E. racemosa woodland to open-forest. Occurs on Quaternary alluvial plains along coastal lowlands.*	Of Concern

RE	Description	Regional Status
12.5.2	*Eucalyptus tereticornis, Corymbia intermedia grassy woodland to open-forest. Other species can include Lophostemon suaveolens, Angophora leiocarpa, Eucalyptus acmenoides or E. portuensis, E. siderophloia or E. crebra, Corymbia tessellaris and Melaleuca quinquenervia (lower slopes). Occurs on complex of remnant Tertiary surfaces ± Cainozoic to Proterozoic sediments. Usually deep red soils.*	Endangered
12.5.3	*Eucalyptus tindaliae and/or E. racemosa open-forest with Corymbia intermedia, E. siderophloia ± E. resinifera, E. pilularis, E. microcorys, Angophora leiocarpa on complex of remnant Tertiary surfaces ± Cainozoic to Proterozoic sediments. Melaleuca quinquenervia often a prominent feature of lower slopes. Minor patches (<1ha) dominated by Corymbia citriodora can sometimes occur. Occurs on complex of remnant Tertiary surfaces ± Cainozoic to Proterozoic sediments.*	Endangered
12.5.4	*Eucalyptus-Corymbia-Melaleuca shrubby or grassy woodland. Characteristic species include Angophora leiocarpa, Eucalyptus latisinensis, E. siderophloia, E. exserta, Corymbia intermedia, C. trachyphloia, Lophostemon suaveolens, Melaleuca viridiflora, M. quinquenervia, M. nodosa and Grevillea banksii. Patches of Allocasuarina luehmannii or Banksia robur present locally and Xanthorrhoea johnsonii common in ground layer. Occurs on complex of remnant Tertiary surfaces and Tertiary sedimentary rocks.*	Not of Concern
12.5.6	*Eucalyptus siderophloia, E. propinqua and/or E. pilularis open-forest ± Corymbia intermedia, E. microcorys, E. acmenoides, E. tereticornis, E. biturbinata, Lophostemon confertus with E. saligna, E. montivaga at higher altitudes. Occurs on remnant Tertiary surfaces. Usually deep red soils.*	Endangered
12.5.9	*Closed sedgeland to heathland. Characteristic species include Schoenus brevifolius and/or Baumea juncea and/or Banksia robur and/or Melaleuca nodosa. Occurs on complex of remnant Tertiary surfaces and Tertiary sedimentary rocks. Lower slopes subject to periodic flooding.*	Of Concern
12.5.10	*Banksia aemula ± E. latisinensis low shrubby open-woodland. Diverse understorey of heath species. Occurs on complex of remnant Tertiary surfaces and Tertiary sedimentary rocks.*	Not of Concern
12.8.3	*Complex notophyll vine forest. Characteristic species include Argyrodendron trifoliolatum, Argyrodendron sp. (Kin Kin W.D. Francis AQ 81198), Olea paniculata, Castanospermum australe, Cryptocarya obovata, Ficus macrophylla, Syzygium francisii, Diploglottis cunninghamii, Pseudoweinmannia lachnocarpa, Podocarpus elatus, Beilschmiedia obtusifolia, Neolitsea dealbata and Archontophoenix cunninghamiana. Occurs on Cainozoic igneous rocks, especially basalt and laterised basalt usually <600m altitude.*	Not of Concern
12.8.8	*Eucalyptus saligna or E. grandis tall open-forest often with vine forest understorey ('wet sclerophyll'). Other species include Eucalyptus microcorys, E. acmenoides, Lophostemon confertus, Syncarpia glomulifera. Occurs on Cainozoic igneous rocks and areas subject to local enrichment from Cainozoic igneous rocks.*	Of Concern

RE	Description	Regional Status
12.8.8a	*Eucalyptus siderophloia, E. microcorys, E. propinqua, and Corymbia intermedia ± Eucalyptus carnea open forest on Cainozoic igneous rocks. Occurs on Cainozoic igneous rocks and areas subject to local enrichment from Cainozoic igneous rocks.*	N/A
12.8.9	*Lophostemon confertus tall open forest to open forest on Cainozoic igneous rocks.*	Of Concern
12.8.13	*Microphyll and microphyll/notophyll vine forest ± Araucaria cunninghamii. Characteristic species include Araucaria cunninghamii, A. bidwillii, Cupaniopsis parvifolia, Dendrocnide photinophylla, Rhodosphaera rhodanthema, Flindersia australis, F. schottiana, F. xanthoxyla, Drypetes deplanchei, Olea paniculata, Diospyros geminata, Austromyrtus bidwillii, Excoecaria dallachyana, Pleiogynium timorense (north of bioregion) and Vitex lignum-vitae. Argyrodendron trifoliolatum sometimes present especially in sub-region 6. Occurs on Cainozoic igneous rocks, especially basalt and laterised basalt.*	Of Concern
12.8.14	*Eucalyptus eugenioides, E. tereticornis, E. melliodora, E. biturbinata, Allocasuarina torulosa ± E. moluccana grassy open-forest. Occurs on Cainozoic igneous rocks, especially basalt.*	Not of Concern
12.8.19	*Montane heath and rock pavement with scattered shrubs or open-woodland. Occurs on Cainozoic igneous rocks especially rhyolite and trachyte.*	Not of Concern
12.8.20	*Low shrubby woodland to open-woodland complex. Canopy trees include Eucalyptus racemosa, E. dura, Corymbia trachyphloia, E. carnea, Allocasuarina littoralis, Acacia spp. and Lophostemon confertus. Occurs on Cainozoic igneous rocks, especially rhyolite.*	Of Concern
12.8.24	*Corymbia citriodora, Eucalyptus crebra open forest on Cainozoic igneous rocks.*	Endangered
12.8.25	*Eucalyptus acmenoides, Eucalyptus crebra, Eucaltyptus propinqua, Corymbia intermedia, Lophostemon confertus open forest on Cainozoic igneous rocks.*	Of Concern
12.9-10.1	*Shrubby open-forest. Canopy species include Eucalyptus resinifera, E. grandis, E. robusta, Corymbia intermedia ± E. microcorys, Melaleuca quinquenervia, Syncarpia glomulifera and Lophostemon confertus. Occurs on Cainozoic to Proterozoic sediments.*	Of Concern
12.9-10.4	*Open-forest to woodland with Eucalyptus racemosa locally prominent. Other species can include Angophora leiocarpa, Eucalyptus seeana, E. siderophloia, Corymbia intermedia, E. tindaliae with Lophostemon suaveolens, Melaleuca quinquenervia, E. tereticornis on lower slopes. Occurs on Cainozoic to Proterozoic sediments ± remnant Tertiary surfaces.*	Not of Concern
12.9-10.7	*Eucalyptus crebra, Eucalyptus tereticornis ± Corymbia tesselaris, Angophora spp. Woodland on sedimentary rocks.*	Of Concern
12.9-10.7a	*Eucalyptus crebra, E. tereticornis ± Corymbia tessellaris, Angophora spp., E. melanophloia woodland. Occurs on Cainozoic to Proterozoic sediments. Major vegetation communities include:*	Of Concern

RE	Description	Regional Status
12.9-10.14	*Eucalyptus pilularis tall open-forest with shrubby understorey. Other species include Syncarpia glomulifera, S. verecunda, Corymbia intermedia, Angophora woodsiana and Eucalyptus microcorys in coastal areas and species of RE 12.9/10.5 in drier sub coastal areas. Eucalyptus pilularis sometimes extends onto colluvial lower slopes. Occurs on Cainozoic to Proterozoic sediments especially sandstone.*	Not of Concern
10.14a	*Eucalyptus pilularis tall open-forest with shrubby understorey. Other species include Syncarpia glomulifera, S. verecunda, Corymbia intermedia, Angophora woodsiana and Eucalyptus microcorys in coastal areas and species of RE 12.9/10.5 in drier sub coastal areas. Eucalyptus pilularis sometimes extends onto colluvial lower slopes. Occurs on Cainozoic to Proterozoic sediments especially sandstone.*	Not of Concern
12.9-10.16	*Microphyll to notophyll vine forest ± Araucaria cunninghamii. Characteristic species include Argyrodendron sp. (Kin Kin W.D. Francis AQ 81198), Araucaria cunninghamii, Agathis robusta, Backhousia myrtifolia, Cupaniopsis parvifolia, Dendrocnide photinophylla, Rhodosphaera rhodanthema, Flindersia australis, F. xanthoxyla, Drypetes deplanchei, Olea paniculata, Diospyros geminata, Austromyrtus bidwillii, Excoecaria dallachyana and Vitex lignum-vitae. Occurs on Cainozoic to Proterozoic sediments.*	Of Concern
12.9-10.16x1	*Araucarian microphyll to notophyll vine forest on weathered material.*	Endangered*
12.9-10.17	*Open-forest complex generally with a variety of stringybarks, grey gums, ironbarks and in some areas spotted gum. Canopy trees include Eucalyptus siderophloia, E. propinqua or E. major, E. acmenoides or E. portuensis, E. carnea and/or E. microcorys and/or Corymbia citriodora. Other species that may be present locally include Corymbia intermedia, C. trachyphloia, Eucalyptus tereticornis, E. biturbinata, E. moluccana, E. longirostrata, E. fibrosa subsp. fibrosa and Angophora leiocarpa. Lophostemon confertus or Whipstick Lophostemon (supplejack) often present in gullies and as a sub canopy or understorey tree. Mixed understorey of grasses, shrubs and ferns. Hills and ranges of Cainozoic to Proterozoic sediments.*	Not of Concern
12.9-10.17a	*Lophostemon confertus dominated open-forest. Occurs in gullies and and southern slopes on Cainozoic and Mesozoic sediments*	Not of Concern
12.9-10.17d	*Open-forest with Eucalyptus siderophloia, E. propinqua, Corymbia intermedia +/- E. microcorys, E. acmenoides, E tereticornis, Angophera subvelutina and occasional vine forest species. Other species that may be present locally include Corymbia trachyphloia, E. fibrosa and A. leiocarpa. Hills and ranges on Cainozoic and Mesozoic sediments.*	Not of Concern
12.9-10.22	*Closed sedgeland to heathland with emergent trees. Lower slopes subject to periodic water logging. Characteristic species include Schoenus brevifolius and/or Baumea juncea and/or Banksia robur and/or Melaleuca nodosa. Sometimes grading into Banksia aemula woodland on rises. Occurs on Cainozoic to Proterozoic sediments.*	Of Concern

RE	Description	Regional Status
12.11.1	*Evergreen notophyll vine forest and/or Lophostemon confertus closed forest. Archontophoenix cunninghamiana often present in gully floors. The plant families Lauraceae, Myrtaceae and Elaeocarpaceae are characteristic of the type. Occurs in gullies on Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments and interbedded volcanics.*	Not of Concern
12.11.2	*Tall open-forest with vine forest understorey ('wet sclerophyll'). Canopy species include Eucalyptus saligna or E. grandis, E. microcorys, E. acmenoides and Lophostemon confertus. Characteristic understorey species include Caldcluvia paniculosa, Pittosporum undulatum, Synoum glandulosum and Cryptocarya glaucescens. Occurs on Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments and interbedded volcanics.*	Not of Concern
12.11.3	*Open-forest generally with Eucalyptus siderophloia and E. propinqua ± E. microcorys, Lophostemon confertus, Corymbia intermedia, E. biturbinata, E. acmenoides, E. tereticornis, E. moluccana, Angophora leiocarpa, Syncarpia verecunda with vine forest species and E. grandis or E. saligna in gullies. Eucalyptus pilularis and E. tindaliae sometimes present e.g. mid D'Aguilar Range, Conondale Range. Occurs predominantly on hills and ranges of Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments and interbedded volcanics.*	Not of Concern
12.11.3a	*Open-forest generally with Eucalyptus siderophloia and E. propinqua ± E. microcorys, Lophostemon confertus, Corymbia intermedia, E. biturbinata, E. acmenoides, E. tereticornis, E. moluccana, Angophora leiocarpa, Syncarpia verecunda with vine forest species and E. grandis or E. saligna in gullies. Eucalyptus pilularis and E. tindaliae sometimes present.*	Not of Concern
12.11.3b	*Open forest of Eucalyptus pilularis. Frequent species are E. microcorys, E. siderophloia, E. eugenioides, Corymbia intermedia. Occasionally present are Syncarpia verecunda, E. saligna. Occurs on higher altitude (>300m) subcoastal hills and ranges of Palaeozoic and older moderately to strongly deformed and metamorphosed sediments and interbedded volcanics.*	N/A
12.11.5	*Mixed tall open forest with Corymbia citriodora, Eucalyptus siderophloia, Eucalyptus major on metaphorphics ± interbedded volcanics.*	Not of Concern
12.11.5j	*Open-forest complex in which spotted gum is a relatively common species. Canopy trees include Corymbia citriodora, Eucalyptus siderophloia or E. crebra (sub coastal ranges), E. major and/or E. longirostrata and E. acmenoides or E. portuensis and/or E. carnea and/or E. eugenioides. Other species that may be present and abundant locally include Corymbia henryi, C. intermedia, C. trachyphloia, Eucalyptus tereticornis, E. propinqua, E. biturbinata, E. moluccana, E. melliodora, E. fibrosa subsp. fibrosa and Angophora leiocarpa. Lophostemon confertus often present in gullies and as a sub canopy or understorey tree. Mixed understorey of grasses, shrubs and ferns. Occurs on hills and ranges of Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments and interbedded volcanics.*	Not of Concern

RE	Description	Regional Status
12.11.9	*Open-forest to woodlands with Eucalyptus tereticornis. Other canopy species include Eucalyptus biturbinata, E. melliodora, Corymbia intermedia, E. longirostrata, E. eugenioides, Allocasuarina torulosa, E. moluccana, E. saligna and Angophora subvelutina. Occurs on ridges and upper slopes especially at higher altitudes on Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments and interbedded volcanics. These occurrences are often associated with small areas of intermediate and basic volcanic rocks.*	Of Concern
12.11.10	*Notophyll and notophyll/microphyll vine forest ± Araucaria cunninghamii. Characteristic species include Argyrodendron trifoliolatum, Argyrodendron sp. (Kin Kin W.D. Francis AQ 81198), Choricarpia subargentea, Dissiliaria baloghioides, Brachychiton discolor, Beilschmiedia obtusifolia, Diospyros pentamera, Grevillea robusta, Gmelina leichhardtii and Ficus macrophylla. Occurs on Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments and interbedded volcanics.*	Not of Concern
12.11.14	*Eucalyptus crebra, E. tereticornis grassy woodland. Other species including Eucalyptus melanophloia, Corymbia clarksoniana, C. erythrophloia, C. tessellaris, Angophora spp. may be present in low densities or in patches. Mid-layer generally sparse but can include low trees such as Acacia bidwillii, Capparis spp., Dodonaea triquetra, Alphitonia excelsa and Xanthorrhoea spp. Occurs on mid and lower slopes on Mesozoic to Proterozoic moderately to strongly deformed and metamorphosed sediments and interbedded volcanics.*	Of Concern
12.11.16	*Mixed tall open forest with Eucalyptus cloeziana on metaphorphics ± interbedded volcanics*	Endangered
12.11.16 x1	*Mixed tall open forest with Eucalyptus cloeziana on sedimentary rocks.*	Endangered*
12.12.1	*Notophyll and notophyll/microphyll vine forest, sometimes with Archontophoenix cunninghamiana and/or Lophostemon confertus closed forest. The plant families Lauraceae, Myrtaceae and Elaeocarpaceae are diagnostic of the type and Pouteria queenslandica is common in the northern half of the bioregion. Araucaria cunninghamii is often present on margins. Occurs in gullies on Mesozoic to Proterozoic igneous rocks especially granite and rhyolite.*	Of Concern
12.12.2	*Eucalyptus pilularis tall open-forest with shrubby understorey. Other canopy species include Syncarpia verecunda, Angophora woodsiana, Eucalyptus microcorys, E. resinifera, E. tindaliae, E. propinqua and E. saligna. Occurs on Mesozoic to Proterozoic igneous rocks.*	Not of Concern
12.12.2a	*Open forest to tall open forest of Eucalyptus grandis, with Eucalyptus microcorys, Lophostemon confertus, Syncarpia glomulifera, Archonophoenix cunninghamiana, Eucalyptus resinifera, Corymbia intermedia and Allocasuarina torulosa on soils derived from basalt.*	Not of Concern
12.12.3	*Mixed tall open forest with Corymbia citriodora on Mesozoic to Proterozoic igneous rocks.*	Not of Concern
12.12.6	*Eucalyptus montivaga open-forest to woodland. Other canopy species can include Corymbia trachyphloia, E. acmenoides, Syncarpia glomulifera and C. intermedia. Occurs on Mesozoic*	Of Concern

	to Proterozoic igneous rocks. Altitude >500 m.	

RE	Description	Regional Status
12.12.10	*Shrubland (montane heath). Associated with rocky soils derived from Mesozoic to Proterozoic igneous rocks.*	Of Concern
12.12.12	*Eucalyptus tereticornis, E. crebra (sometimes E. siderophloia) woodland. Other species present can include Eucalyptus melanophloia, Corymbia tessellaris, Angophora subvelutina, A. leiocarpa, C. clarksoniana (central and northern parts) and E. siderophloia, C. intermedia with Melaleuca quinquenervia, Lophostemon suaveolens near drainage lines in moister areas. Occurs on Mesozoic to Proterozoic igneous rocks, especially granite lowlands and basins.*	Of Concern
12.12.14	*Shrubby woodland. Canopy species include Eucalyptus racemosa, Corymbia trachyphloia, E. carnea, E. tindaliae, E. exserta, Angophora woodsiana, E. resinifera and E. microcorys. Occurs on Mesozoic to Proterozoic igneous rocks.*	Of Concern
12.12.15	*Open-forest with Eucalyptus propinqua, Corymbia intermedia, E siderophloia ± E. microcorys, E. acmenoides, Lophostemon confertus, E. moluccana, Angophora subvelutina and occasional vine forest species. Patches of Eucalyptus pilularis sometimes present. Occurs on Mesozoic to Proterozoic igneous rocks.*	Not of Concern
12.12.15 a	*Open-forest with Eucalyptus grandis ± E. propinqua, E siderophloia, E. microcorys, E. acmenoides, Corymbia intermedia, Lophostemon confertus and occasional vine forest species. Patches of Eucalyptus pilularis sometimes present. Occurs in wet gullies on Mesozoic to Proterozoic igneous rocks.*	Not of Concern
12.12.15 b	*Open-forest with Lophosteman confertus ± Eucalyptus propinqua, E siderophloia, E. microcorys, E. acmenoides and Corymbia intermedia. Vine forest species are often present in understorey. Patches of Eucalyptus pilularis sometimes present. Occurs on Mesozoic to Proterozoic igneous rocks often amongst vine forest.*	Not of Concern
12.12.16	*Notophyll vine forest. Characteristic species include Araucaria bidwillii, A. cunninghamii, Argyrodendron trifoliolatum, Argyrodendron sp. (Kin Kin W.D. Francis AQ 81198), Choricarpia subargentea, Brachychiton discolor, Beilschmiedia obtusifolia, Diospyros pentamera, Grevillea robusta, Gmelina leichhardtii, Ficus macrophylla and Sloanea woollsii. Eucalyptus spp. especially E. siderophloia, E. propinqua and E. grandis may be present as emergents. Occurs on Mesozoic to Proterozoic igneous rocks.*	Not of Concern
12.12.19	*Vegetation complex of exposed rocky headlands. Vegetation types include Themeda triandra grassland and wind-sheared shrubland and woodland. Occurs on Mesozoic to Proterozoic igneous headlands.*	Of Concern
12.12.23	*Woodland to open-forest generally with Eucalyptus tereticornis ± E. eugenioides. Other species present, vary from place to place but commonly include Corymbia intermedia, Eucalyptus acmenoides ± E. biturbinata, E. longirostrata, E. melliodora, Corymbia trachyphloia, Lophostemon confertus, whipstick Lophostemon (supplejack), Angophora subvelutina, E. crebra and Allocasuarina torulosa. Occurs at higher altitudes on granite hills and ranges.*	Not of Concern

APPENDIX D: Data Sources

Data	Version	Published Date	Format	Size (Mb)	Source	Pre-processing	Coord Ref
Vegetation management regional ecosystem and remnant map	8.0	7-Mar-16	Geodatabase	758	Qspatial	Proj & Clip	EPSG:4283
Vegetation management - regulated vegetation management map	1.27	7-Mar-16	Geodatabase	253	Qspatial	Proj & Clip	EPSG:4283
Local government area boundaries - Queensland		18-Feb-16	Geodatabase	2	Qspatial	Proj	EPSG:4938
Sunshine Coast Council Boundary		n/a	Feature Class		LGA bnd	extract	
Development areas - South East Queensland Regional Plan 2009-2031		11-Jun-10	Geodatabase	0.4	Qspatial	Proj & Clip	EPSG:4938
Regional land use categories - South East Queensland Regional Plan 2009-2031		11-Jun-10	Geodatabase	1.63	Qspatial	Proj & Clip	EPSG:4938
Regional land use categories - South East Queensland Regional Plan 2005-2026 - Amendment 1		31-Oct-06	Geodatabase	1.34	Qspatial	Proj & Clip	EPSG:4938
Regional land use categories - South East Queensland Regional Plan 2005-2026		30-Jun-05	Geodatabase	1.33	Qspatial	Proj & Clip	EPSG:4938
Cadastral data - Queensland - by area of interest		20-Mar-16	Geodatabase	345	Qspatial	Proj & Clip	EPSG:4283
Regional planning area boundaries - Department of Infrastructure, Local Government and Planning		15-Aug-14	Shape File	3.4	Qspatial	Proj	EPSG:4938
Biogeographic sub regions - Queensland		20-Aug-10	Geodatabase	14	Qspatial	Proj & Clip	EPSG:4283
Hansen Data	1.2	24-Feb-16	Geotiff	2600	Hansen	Proj & Clip	WGS84
Land use mapping - Queensland current		9-May-16	Geodatabase	138	Qspatial	Proj & Clip	EPSG:3577
Land use mapping - South East Queensland NRM region		4-Jun-14	Geodatabase	60	Qspatial	Proj & Clip	EPSG:4283
Land use mapping - Maroochy Noosa catchment 2011		17-Dec-13	Geodatabase	20	Qspatial	Proj/clip/merge	EPSG:4283
Land use mapping - Burnett-Mary NRM region 2009		24-Dec-11	Geodatabase	22.3	Qspatial	Proj/clip/merge	EPSG:4283
Land use mapping - Stanley River sub-catchment 2012		26-May-14	Geodatabase	15	Qspatial	Proj/clip/merge	EPSG:4283
Pre-clearing Broad Vegetation Groups of Queensland	2	8-May-15	Shape File	794	Qspatial	Proj & Clip	EPSG:4283
Statewide landcover and trees study 2012 to 2013 Queensland		12-Nov-15	Shape File	9	Qspatial	Proj & Clip	EPSG:3577
Australia - Present Major Vegetation Groups - NVIS	4.2	28-Jan-16	Geodatabase	65	Aus Gov	Proj & Clip	EPSG:3577
Forests of Australia (2013)		12-Feb-16		91	Aus Gov	Proj & Clip	EPSG:3577