LAND CAPABILITY HANDBOOK

Guidelines for the Classification of Agricultural Land in Tasmania

Second Edition

Edited by
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Department of Primary Industries, Water and Environment
Prospect Offices
1999

First Edition K E Noble 1992

DEPARTMENT *of* PRIMARY INDUSTRIES, WATER *and* ENVIRONMENT
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Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Contents

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

ACKNOWLEDGEMENTS

This revised edition of the Land Capability Handbook has been put together over a lengthy period of time. It has been developed in response to an increasing demand for land capability information and a greater desire by non practitioners to understand the land capability classification process. Also, with greater numbers of DPIWE staff involved with land evaluation, it has been necessary to produce a document that will help to maintain consistency of approach between the various surveyors.

Much of this second edition has been taken straight from the original publication by Kathy Noble and her input is gratefully acknowledged. Other DPIWE personnel who have contributed significantly include Greg Pinkard, Rob Moreton, Bill Cotching, John Loy (DNR, Queensland), Peter Zund, Rob Musk and Ron DeRose.

Many farmers, land owners and property managers have provided information for this document through general discussion and conversation and there knowledge, even when only anecdotal, has been invaluable.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

1. INTRODUCTION

The Department of Primary Industries, Water and Environment (DPIWE, formerly Department of Primary Industry and Fisheries) has, for some years, been involved with a land capability mapping program for the agricultural areas of Tasmania. To date this work has covered six 1:100 000 scale map sheets in the northern part of the State, with additional sheets underway in both northern and southern areas and plans to continue mapping throughout the major agricultural areas.

The last year or so has seen not only an increase in the demand for land capability information but also an increase in the number of practitioners involved in undertaking land capability classification. It was clear that a revised edition of the Land Capability Handbook, following on from the original work by Noble (1992), would greatly facilitate the task of ensuring consistency between surveyors across the State, as well as providing additional information for those people outside the Department who may be teaching or using the Tasmanian Land Capability Classification System. This edition of the Handbook goes a step further than the original by attempting to provide a selection of guidelines for the evaluation of individual soil and land characteristics for land capability classification.

As well, the system itself has evolved somewhat since it's early development and this handbook sets out to explain these changes. One of the more obvious changes is the upper limit for slope steepness for Class 4 land. Initially set at 30% in older reports, this limit increased to 32% in some reports before the current limit of 28% was adopted. While this is recognised as an inconsistency in the mapping approach the changes are not considered to have any significant impact on areas or class boundaries of previously classified land.

In Tasmania, the land capability system in general, and the guidelines in particular, have been developed in consultation with a wide range of land owners, growers, managers, industry and DPIWE personnel. The guidelines draw heavily upon similar guidelines from around Australia, New Zealand and the UK and the various classes and categories of land have been adjusted, after considerable consultation with those involved in the agri industry, to suit Tasmanian conditions.

Despite the inherent subjectivity in the methodology, land capability remains an internationally accepted form of land evaluation. In Tasmania it should be an essential input to all planning decisions in order to ensure that the long-term sustainability and correct management of agricultural land is achieved. This principal applies at the State and regional level, down to planning at the farm scale.

In the context of this work *Land Capability* may be defined as a ranking of the ability of land to sustain a range of agricultural land uses without degradation of the land resource. Until now it has been an interpretive, and somewhat subjective, assessment based on the physical limitations and hazards of the land, potential cropping and pastoral productivity, and the versatility of the land to produce a range of agricultural goods without damage to the land resource.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

The 1:100 000 scale land capability mapping program currently being undertaken by DPIWE personnel assesses only private Freehold and leased or unallocated Crown land. It does not include designated State Forests, National Parks, State Reserves, Crown Reserves, HEC or other similar areas or reserves. It should be noted that land capability is the result of an evaluation of a variety of other land resource information. It is an end product and does not in itself contain basic resource information. It is therefore difficult to derive other products, such as land suitability for various enterprises, from land capability maps.

The aim of this handbook is two fold. Firstly, it sets out to explain land capability to potential users and the public in general. Secondly, it presents a series of guidelines for the quantitative assessment of land capability in Tasmania and seeks to address some of the practical survey problems that have been encountered over the past five years in the hope that this will enable a more consistent approach to land capability evaluation in the State. It is emphasised that the class limits defined for a variety of land characteristics and qualities later in this text are **not** rules but guidelines and that some degree of flexibility must be allowed for. There is a lack of specific, quantifiable knowledge relating to the management and use of the State's land resources and there remains the need to physically check the accuracy of class limits through research, observation and practical experience under conditions specific to Tasmania.

Despite the limitations of the system and the lack of scientific rigour resulting from limited data availability, land capability classification is still a valuable tool for all those involved in evaluating the capability of the land. The value of land capability classification in Tasmania has been recognised by the State Policy on the Protection of Agricultural Land which now requires councils to consider the capability of the land in the development of strategic plans. The guidelines presented in this report should enable people from a range of backgrounds to better understand the value of the system and allow others to make consistent interpretations of land capability when presented with the same resource information. Hopefully, with increasing research and knowledge, the guidelines can be improved and class limits tightened.

The applications of land capability information are very varied and depend on the mapping scale and the level of detail of information collected. At the 1:100 000 scale, the main aim is to identify and map the distribution and extent of different classes of agricultural land in order to provide a more effective base for land use planning. As well, the intention is to ensure that the long-term productivity of Tasmania's agricultural resources is maintained, through the promotion of compatible land uses and management practices.

Figure 1 outlines the completed, current and prospective mapping program until 2001, within the State.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

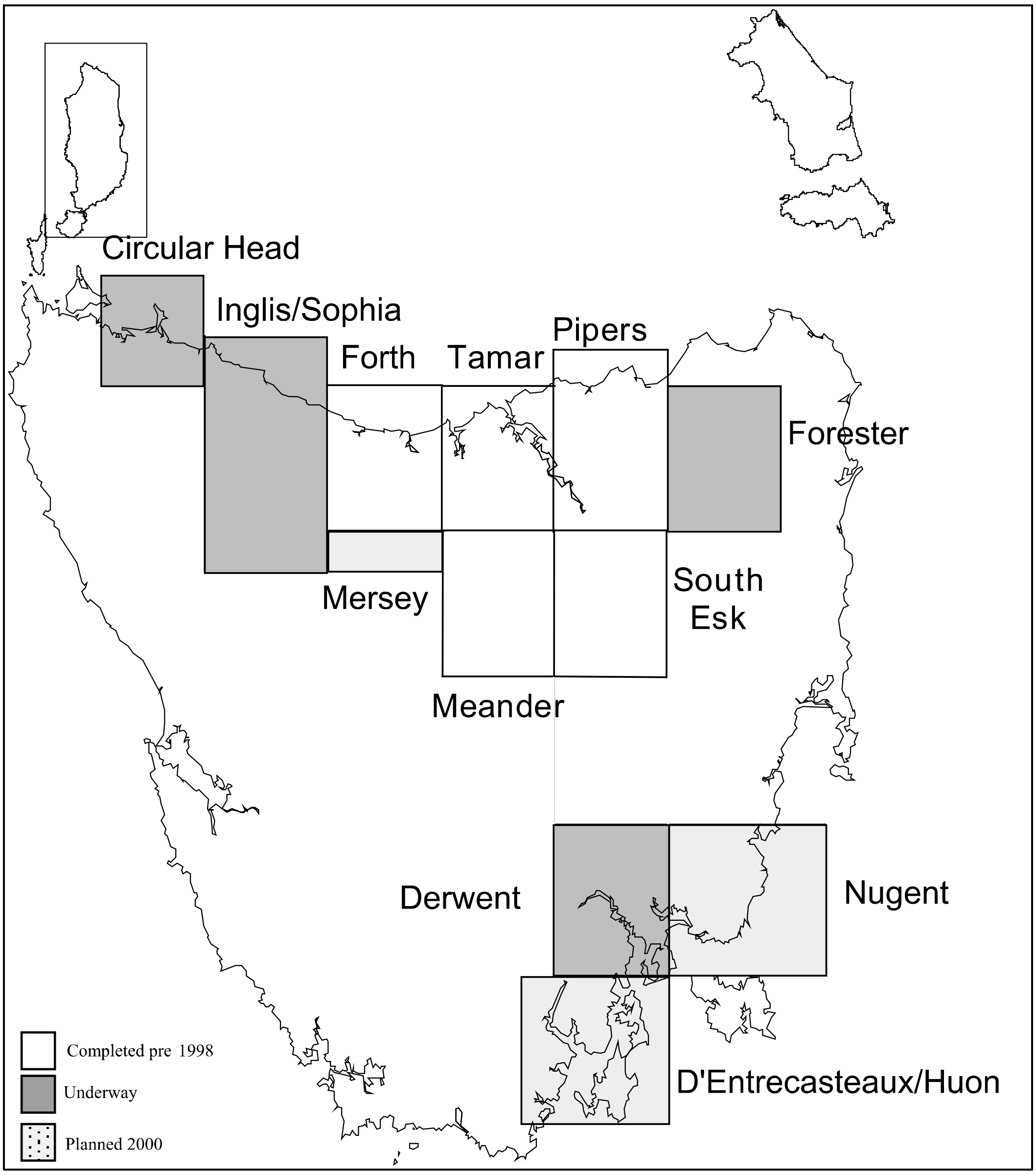


Figure 1. Land Capability Maps Completed, Underway and Planned

2. LAND CAPABILITY CLASSIFICATION

Land capability classification is an internationally recognised means of land classification, used to evaluate the capability of land to support a range of land uses, on a long-term sustainable basis.

For the Tasmanian classification, agricultural land uses only are covered, and are defined as broadscale grazing and cropping uses. Land capability ratings for specific land uses are not evaluated, nor is the capability of land for forestry use incorporated into the classification system.

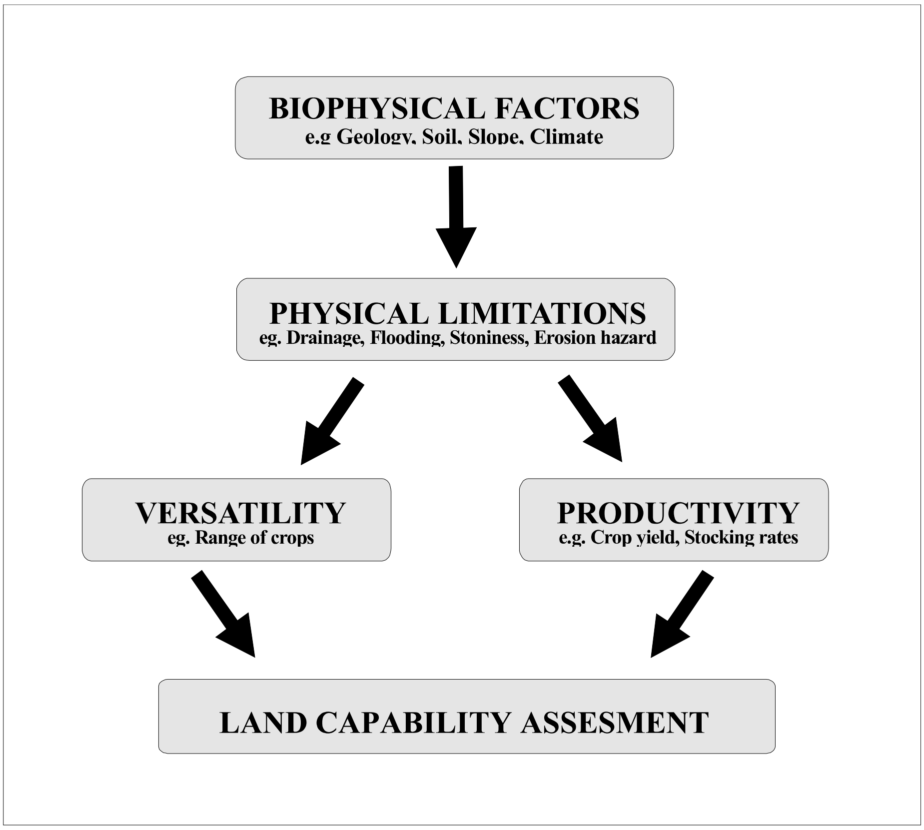


Figure 2. Factors in land capability assessment.

Land capability assessment takes into account the physical nature of the land (eg. geology, soils, slope) plus other factors (eg. climate, erosion hazard, land management practices) which determine how that land can be used without destroying its long-term potential for sustainable agricultural production. It also takes into account limitations that might affect agricultural use, eg. stoniness, drainage, salinity or flooding. Land capability assessment is therefore based on the permanent biophysical features of the land (including climate), and does not take into account the economics of agricultural production, distance from markets, social or political factors.

Land capability assessment should not be confused with land suitability assessment which, in addition to the biophysical features, does take into account economic, social and/or political factors in evaluating the 'best' use of a particular area of land. Land capability classification gives a grading of land for broadscale agricultural uses, whereas land suitability is applied to more specific, clearly defined land uses, such as land 'suitable' for carrots.

Land suitability also requires much more detailed collection of land resource information, pertinent to the particular land use eg. soil nutrient status. This level of detail is outside the scope and resources of the 1:100 000 scale series.

The land capability classification system for Tasmania gives an indication of the inherent capability of the land for general agricultural production and does not attempt to portray specific land uses, or rank the value of any particular agricultural land use above another. Neither does it attempt to give an indication of land values.

The system of land capability classifies land into a number of classes according to the land's capability to produce agricultural goods (based on broadscale grazing and cropping uses). The system for Tasmania is based on the USDA (United States Department of Agriculture) approach to land capability, as opposed to the FAO (Food and Agricultural Organisation) system which emphasises land suitability.

There are generally three levels to the land capability classification:

- The land capability **class** - which gives an indication of the general degree of limitation to use;
- **subclass -** which identifies the nature of the dominant limitation;
- and the **unit -** which group together similar types of land requiring the same kind of management, the same kind and intensity of conservation treatments, and which occur on soils which are adapted to the same kinds of crops, with similar potential yields.

At the 1:100 000 scale of mapping it is only possible to record and map land at the class level. However, for more recent maps, subclass information has been recorded for many map polygons and this information is stored on the DPIWE's Geographical Information System (GIS) database and is available to the public on request. The information is recorded simply as a limitation code for each limitation identified within the map polygon and no attempt has been made to identify the extent or boundaries of individual subclasses.

The system can also be used and applied at more detailed scales by mapping to the subclass and unit level, depending on the purpose of the survey. A scale of 1:50 000 is considered the minimum for subclass mapping and 1:25 000 for mapping to unit level. The levels of the land capability classification system are shown in Figure 3. A more detailed description of the land capability classes, subclasses and units, are found in Section 3. DPIWE staff are currently undertaking mapping programs at 1:100 000 scale for regional planning and 1:25 000 scale for more detailed local area planning.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

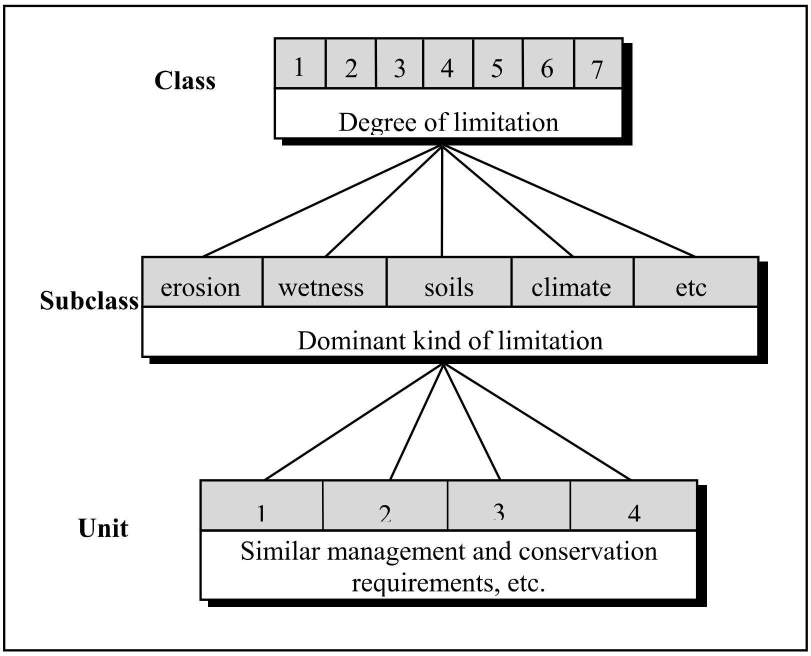


Figure 3. Levels of the land capability classification system.
(Adapted from: National Water and Soil Conservation Organisation, 1979, Our Land Resources. (NWASCO), Wellington, New Zealand.)

In Tasmania land capability evaluation is undertaken primarily through field observation although various modelling and computer techniques, such as the use of digital elevation models are being increasingly used to supplement fieldwork.

Photo 1. Checking capability boundaries in the field.

3. FEATURES OF THE TASMANIAN LAND CAPABILITY CLASSIFICATION SYSTEM

3.1 Introduction

The classification system in Tasmania is based primarily upon three permanent *biophysical* features of the landscape - soil, slope and climate, and their interactions. These three factors have a major influence in determining the capability of the land to support various levels of agricultural production. Other factors which must be taken into account are rock type, erosion hazard, range of crops that can be grown, management practices, soil conservation treatment, risk of flooding and past land use history.

The system assess the versatility of the land to produce a range of agricultural goods that are considered typical for Tasmania, and not just those that are specific or suited to localised areas. Nor does the system take into account forest productivity. It is based on cultivation of the land for cropping purposes and not other land use systems which can sustain 'crops' on steeper land with longer rotations, and less risk of erosion (eg perennial horticulture, tree crops, orchards). The range of crops that can be grown on classes 1 and 2 land would be wider than the range of crops grown on classes 3 and 4 land and would include a wide range of vegetables and allied crops, cereals, essential oils and forage crops.

The system is hierarchical and comprises seven classes, ranked in order of increasing degree of limitations to use, and in decreasing order of versatility. Class 1 land can produce a wider variety of crops and pastures at higher levels of production with lower costs, or with less risk of damage to the land, than any of the other classes of land. Class 2 land is similarly superior to classes 3 to 7, and so on. Class 4 land is considered the limit for cropping. It is restricted by severe hazards or limitations to production such that cropping can only occur one or two years out of ten without leading to degradation of the soil resource or is limited to only one or two crop types which require low inputs and management but which allow more frequent cropping. The capability class is therefore an indicator of the degree of versatility, level of productivity and risk of degradation for a particular area of land.

The second level of classification, indicated by the subclass code, identifies the nature of the risk or the type of hazard or limitation present. Limitations may be defined as physical factors or constraints which affect the range of crops that can be grown or limit the frequency of cultivation. This information is usually only presented on maps of scale 1:50 000 or greater although limited subclass information is available for some of the more recently published maps. The subclass code is indicated by a letter following the class code. Initially the system identified four major limitation groups - erosion, wetness, soils and climate. However, this approach is considered to provide only limited information to potential users and that subclass information could be made more valuable by increasing the range of limitations identified. The identification of a wider range of limitations is a new approach to mapping adopted for maps published from 1999 onwards.

The third level of classification is the unit level, identified by a number following the subclass code. Unit level mapping is usually appropriate to 1:25 000 scale mapping or

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

larger. The unit level takes into account the levels of production, management strategies and soil conservation requirements that the land may need in order to maintain that level of production without long-term degradation.

The system considers degradation of the soil resource and does not take into account the possible effects of agricultural land use on water quality, aesthetics, wildlife, etc.

3.2 Land Capability Classes

The land capability class is the broadest grouping of the land capability classification and gives an indication of the general degree of limitation to use and the versatility of the land (see Figure 4).

Figure 4. Land uses appropriate to different land classes
(Adapted from: National Water and Soil Conservation Organisation, 1979, Our Land

INCREASING LIMITATIONS TO USE

<table>
<tr><th>CLASS</th><th>CROPPING SUITABILITY</th><th>PASTORAL SUITABILITY</th><th>LAND USE OPTIONS</th></tr>
<tr><td>1</td><td rowspan="2">High</td><td rowspan="4">High</td><td rowspan="4">Many</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td><td>Medium</td></tr>
<tr><td>4</td><td>Low</td></tr>
<tr><td>5</td><td rowspan="3">Unsuitable</td><td>Medium</td><td rowspan="2">Limited</td></tr>
<tr><td>6</td><td>Low</td></tr>
<tr><td>7</td><td>Unsuitable</td><td>Extremely Limited</td></tr>
</table>

DECREASING VERSATILITY

Resources. (NWASCO), Wellington, New Zealand.)

CLASS		LIMITATIONS	CHOICE OF CROPS	CONSERVATION PRACTICES
1	Under cultivation	Very minor	any	Very minor
2		Slight	Slightly reduced	Minor
3		Medium	Reduced	Major
4		Severe	Restricted	Major + careful management
5	Under pastoral use	Slight to moderate	Grazing	
6		Severe	Grazing	
7		Very severe to extreme	No, or very minor agricultural value	

Figure 5. Features of land capability classes.

The cut-offs used to define the classes (and used as class limits within the guidelines defined in section 4) are based primarily on observation, experience and information from other classification systems, and not on experimental results. It is expected that these class limits will be modified as our understanding of our soils, climate and topography, and their interactions, increases. Figure 5 outlines the main features of the capability classes. Classes 1-4 only are considered capable of supporting cropping activities on a sustainable basis; Classes 5 and 6 are suitable for grazing activities only although pasture improvement may be possible on Class 5 land (Class 6 land remaining as native pasture); Class 7 land is unsuitable for any form of sustainable agricultural activity.

Class Definitions

Land capability class definitions are as follows:

CLASS 1

Land well suited to a wide range of intensive cropping and grazing activities. It occurs on flat land with deep, well drained soils, and in a climate that favours a wide variety of crops. While there are virtually no limitations to agricultural usage, reasonable management inputs need to be maintained to prevent degradation of the resource. Such inputs might include very minor soil conservation treatments, fertiliser inputs or occasional pasture phases. Class 1 land is highly productive and capable of being cropped eight to nine years out of ten in a rotation with pasture or equivalent without risk of damage to the soil resource or loss of production, during periods of average climatic conditions.

CLASS 2

Land suitable for a wide range of intensive cropping and grazing activities. Limitations to use are slight, and these can be readily overcome by management and minor conservation practices. However the level of inputs is greater, and the variety and/or number of crops that can be grown is marginally more restricted, than for Class 1 land.

This land is highly productive but there is an increased risk of damage to the soil resource or of yield loss. The land can be cropped five to eight years out of ten in a rotation with pasture or equivalent during 'normal' years, if reasonable management inputs are maintained.

CLASS 3

Land suitable for cropping and intensive grazing. Moderate levels of limitation restrict the choice of crops or reduce productivity in relation to Class 1 or Class 2 land. Soil conservation practices and sound management are needed to overcome the moderate limitations to cropping use.

Land is moderately productive, requiring a higher level of inputs than Classes 1 and 2. Limitations either restrict the range of crops that can be grown or the risk of damage to the soil resource is such that cropping should be confined to three to five years out of ten in a rotation with pasture or equivalent during normal years.

CLASS 4

Land primarily suitable for grazing but which may be used for occasional cropping. Severe limitations restrict the length of cropping phase and/or severely restrict the range of crops that could be grown. Major conservation treatments and/or careful management is required to minimise degradation.

Cropping rotations should be restricted to one to two years out of ten in a rotation with pasture or equivalent, during ‘normal’ years to avoid damage to the soil resource. In

Photo 2. Class 1 (foreground) and Class 2 land (middle distance) on basalt rock at Table Cape in north west Tasmania.

Photo 3. Class 4 land on alluvial sediments with Class 5 land on basalt on hillslopes in background.

Photo 4. Class 4 land is also suitable for occasional cropping.

Photo 5. Class 5 land, suitable only for grazing and occasional fodder crops, with Class 6 land in the background**.**

some areas longer cropping phases may be possible but the versatility of the land is very limited. (NB some parts of Tasmania are currently able to crop more frequently on Class 4 land than suggested above. This is due to the climate being drier than 'normal'. However, there is a high risk of crop or soil damage if 'normal' conditions return.)

CLASS 5

This land is unsuitable for cropping, although some areas on easier slopes may be cultivated for pasture establishment or renewal and occasional fodder crops may be possible. The land may have slight to moderate limitations for pastoral use. The effects of limitations on the grazing potential may be reduced by applying appropriate soil conservation measures and land management practices.

CLASS 6

Land marginally suitable for grazing because of severe limitations. This land has low productivity, high risk of erosion, low natural fertility or other limitations that severely restrict agricultural use. This land should be retained under its natural vegetation cover.

CLASS 7

Land with very severe to extreme limitations which make it unsuitable for agricultural use.

E - Exclusion Areas

Land that is not private freehold or leased crown land and has not therefore been considered during the evaluation. Also included in this classification are urban centres and other obviously non-agricultural areas.

<u>Note on Class Definitions</u>

The length of cropping phase given for Classes 1-4 is intended as a general guide only. Past experience has shown that there is some confusion and concern regarding the figures given. While some land will just not support production beyond the intensity recommended (due to the risk of erosion or soil structure decline, for example), other areas are limited by the risk of loss occasioned by such factors as adverse climatic conditions or flooding.

For example, some parts of a survey area may be subject to a significant flood risk. Due to rainfall patterns in recent years it might be possible to cultivate these areas more intensively than might 'normally' be achieved. By cultivating these areas farmers are accepting a high risk of failure or damage to crops from flooding and whether or not a crop is planted in any particular year is dependent, in part, on just how much risk an individual farmer is prepared to accept. In other areas the soils are such that significant periods of cultivation without a break can lead to severe structure decline, hindering germination, water infiltration, soil aeration and increasing the likelihood of erosion.

Also, the classification system takes into account the *variety* of crops that can be grown. Thus Class 4 land might incorporate areas where a relatively wide range of crops could be grown but the risk of damage to the resource is such that cropping should **only** be undertaken one or two years out of ten. Conversely, other areas may support a more limited range of crops but production may be sustainable over a longer period.

It should be noted that capability classes have not been defined on the basis of productivity. This is partly due to problems in comparing the relative value of different agricultural practices and partly due to the lack of data regarding just what is sustainable for each land class. As well, within any particular land class, there is likely to exist a range of land and, at a more detailed level of mapping, it may be possible to distinguish, for example, between good Class 4 land and poor Class 4 land.

3.3 Land Capability Subclasses

Subclass codes provide information relating to the nature of the limitation or hazard for a particular area. Twelve different limitations and hazards are identified and grouped under four main categories. Other limitations do exist but are not defined and are recorded by the main category subclass code under which they occur (ie poor nutrient status is a soils or ‘s’ limitation). Subclass codes are not normally presented on published 1:100 000 scale maps as the detailed fieldwork necessary to identify subclass map unit boundaries has not been done. However, subclass codes have been recorded for some more recent map sheets and are stored in the digital versions of the maps on the Department’s GIS. Subclass codes appear on all maps of 1:25 000 scale or larger.

The decision as to whether a subclass should be recorded at the general level (e, w, s, c) or at a more specific level is dependent on the ease with which specific limitations can be identified. Thus, only if it is clear that erosion has been caused by wind would the code *a* be used. If the cause of erosion is uncertain then the general code *e* should be used.

The assessment of the degree of risk or level of limitation imposed by many of the following criteria remains a subjective assessment on the part of the surveyor. The guidelines set out in Section 4 attempt to provide some objectivity to the classification system and further discussion and definition of these limitations is provided there.

- **e** (erosion). Unspecified erosion limitation (both current and potential).
  - **a** (aeolian). Erosion caused by the effects of strong wind. Usually affects sandy or poorly aggregated soils and can occur on slopes of very low gradient.
  - **h** (water). Erosion resulting from the affects of rainfall, either directly through raindrop impact or through secondary affects of overland flow and surface runoff (including stream bank erosion).
  - **m** (mass movement). Landslip, slumping, soil creep and other forms of mass movement.

- **w** (wetness). Unspecified wetness limitation.
  - **f** (flooding). Limitations created through the surface accumulation of water either from overbank flow from rivers and streams, run-on from upslope areas or because the area lies in a topographic depression.
  - **d** (drainage). Limitations resulting from the occurrence of a ground watertable, or restricted or impeded permeability within the soil profile, leading to the development of anaerobic conditions.
- **s** (soils). Unspecified soil limitations.
  - **g** (coarse fragments). Limitations caused by excess amounts of coarse fragments (particles of rock 2 - 600mm in size), including gravel, pebbles and stones, which impact on machinery, damage crops or limit growth. Coarse fragments may occur on the soil surface or throughout the profile.
  - **r** (rockiness). Limitations caused by boulders or outcrops of bedrock material greater than 600mm in size (cf coarse fragments, above).
  - **k** (conductivity). Land at risk from salinity (as indicated by high electrical conductivity readings of a 1:5 ratio soil:water paste).
  - **l** (limiting layer). Rooting depth or depth to some limiting layer.
- **c** (climate). Unspecified climatic limitations.
  - **p** (precipitation). Limitations resulting from insufficient or uneven distribution of rainfall.
  - **t** (temperature). Limitations caused by frost risk or by reduced length of growing season due to low temperatures.
- **x** (complex topogrpahy). Limitations caused by irregular, uneven or dissected topography which limit ease of management or divide land into parcels difficult to manage individually at the paddock scale.

In practice it may be possible to identify more than one limitation that restricts the use of an area of land. Every attempt should be made to record the dominant limitation although it may occasionally be necessary to record a maximum of two subclass codes. If more than two limitations are evident they should be grouped according to the broad limitation code under which they fall (e, w, s, or c).

At 1:100 000 scale mapping subclass codes are included on the digital map version only. These codes are intended to provide further information for potential users as to the nature of limitations that might occur within a particular map polygon. However, as individual subclass boundaries are not identified at this level of mapping several subclass codes may be needed to identify the nature of limitations in different parts of the polygon. The dominant limitation for a polygon should always be recorded. Other limitations are at the discretion of individual surveyors and are dependent on additional limitations being observed. For example, an area of land may be classified 5r on the basis of significant rock outcrop. However, one part of the polygon mapped was observed to have a drainage limitation. A subclass code of 'd' could then also be recorded for this polygon although the actual area limited by poor drainage would not be identified. This approach allows for the identification of several limitations without the necessity of trying to identify individual subclass boundaries.

3.4 Land Capability Units

Land capability units are the third level of capability evaluation appropriate to 1:25 000 scale mapping or larger.

Land capability units identify areas of land of similar land class and subclass and which require similar management and conservation measures, which have similar potential productivity and are able to support the same range of crops. Such areas are likely to have similar soils, geology, slope range, and climatic range. Where any individual factor changes sufficiently to alter the management requirements, use or productivity of the land, a new capability unit should be recorded.

For example, an area of sloping land on krasnozem soils on basalt on the North West Coast may be classified as Class 4, with a dominant limitation of erosion under cultivation, Class 4e. To distinguish this type of land from Class 4 land on grey podzolic soils on quartzite rock (also Class 4e), a *unit* code is used:

eg 4e1 may represent sloping land on basalt soils
4e2 may represent sloping land on quartzite soils

To extend the example, similar land on basalt soils is identified elsewhere which, while still dominated by high erosion hazard, also has an additional climatic limitation which significantly affects the range of crops that can be grown and the level of productivity compared to unit 4e1. This land would be classified as 4e3 at the land capability unit level. Similar subdivisions of all other subclasses can be made on the basis of some additional characteristic which affects management or productivity.

Land capability information presented at the unit level enables much more detailed planning to be carried out. At the same time it requires much more detailed information to be collected about the land, which is out of the scope of the Land Capability Survey at the 1:100 000 scale. The availability of detailed soil information (maps and reports) together with a range of other land resource data greatly facilitates the identification of land capability units.

It should be noted that unit level map codes are not consistent across the State but only across a survey. That is, Class 4e1 in one survey area is unlikely to be the same as 4e1 within another survey area. The unit numbers can vary depending on the number of different land capability units identified within the survey area. Unit numbers conventionally are ranked in order from best to worse within a particular capability class (i.e. land with higher productivity and fewer limitations would be given a higher land capability unit ranking than land with lower productivity and more severe limitations - thus 4e1 is better than 4e2 etc.).

3.5 Complexes

Complex map units are recorded when two land capability classes are identified in an area and occur in such a pattern that it is not possible to separate them at the scale of mapping being undertaken. For a complex map unit to be mapped each land class must occupy at least 40% of the map unit. In such cases the dominant land class is recorded first, followed by the subdominant land class - ie Class 3+2. Complex units are identified on the map with striped shading with the dominant land class having the broader stripe.

Some simple rules apply to the use and identification of complex map units. Firstly, complexes are not to be used in instances where it is difficult to decide whether an area of land falls in one class or another. A decision must be made. Secondly, there must be at least 40% of each land class within the mapped polygon. Thirdly, the size of individual units of a single class must be too small to map individually or the pattern must be too complex to separate at the scale of mapping. Fourthly, it must be feasible to manage each land class as a separate unit. For example, a complex mapped as Class 4+5 may be limited by rock outcrop. The pattern of rock outcrop should be such that it is feasible to manage the areas of Class 4 land as separate areas, even though they cannot be mapped individually. If the pattern of rock outcrop is distributed evenly across the area, making it unrealistic to crop any of the land, then the area should be classified as Class 5.

The use of complex map units should be kept to an absolute minimum wherever possible.

3.6 Permanent and Non-Permanent Limitations

Physical limitations can be classified as either permanent, or able to be removed or modified (non-permanent). Permanent limitations include slope and effects of climate. Removable or modifiable limitations include flooding, poor drainage, and the presence of stones. The feasibility of the removal of a limitation depends largely on the severity of the limitation, and also on economics.

While economics is not a factor in the assessment of land capability is it significant in considering whether or not an area of land can be improved through the removal of non permanent limitations. The improvement of land has to be considered as a) a reasonable option; b) technologically feasible and c) economically viable. Limitations that are assumed to be removable using existing technology on an individual farm basis include poor drainage, stoniness, and low fertility. Where the necessary technology for land improvement is not available, or is beyond the capability of an individual farmer and requires a catchment or community scheme, the land is classified according to the nature of its present limitations. If in time such schemes become operative, the land can be reclassified (if appropriate) into a higher land capability class.

3.7 Land Capability and Irrigation

While land capability evaluation does not consider the potential for irrigation it does recognise the importance that irrigation plays in modern farming systems in parts of the State. Where irrigation is considered normal farming practice, using on farm storage,

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

land capability is assessed on the basis that irrigation is used. This position conflicts slightly with some reports which indicate that where land lies within a designated irrigation zone the potential for irrigation has been taken into account in the classification of that land. It is unlikely that, for the two map sheets completed taking this earlier approach, using the revised approach to irrigation potential would have resulted in a change in land capability. The rationale behind this approach is explained below.

Many areas of land have the potential to attain an improved land capability ranking through the application of irrigation. However the extent of the beneficial effects of irrigation on land capability will vary considerably, depending upon such factors as water availability and quality, soil suitability and irrigation management. These factors require individual assessment on a property basis. For the 1:100 000 scale land capability survey series such a detailed assessment of irrigation potential is obviously impossible. A number of regional irrigation schemes have been identified around the State (such as Cressy/Longford, Winnaleah and Coal River) but the irrigation scheme boundary is a somewhat arbitrary line. Consequently there are areas within the scheme that could not be economically irrigated and areas outside the boundary which could easily be provided with irrigation. To avoid this arbitrary assessment of irrigation potential land capability is assessed assuming no irrigation potential.

Thus, where crop production is limited by water availability rather than for any other reason, and the land is not within an irrigation scheme nor has ready access to irrigation water (assessed on the basis of whether or not irrigation is considered normal practice in the area) then the land capability is assessed on the basis that irrigation is unavailable. However, the potential for improvement would be identified by the use of a ‘c’ (climatic) or ‘p’ (precipitation) subclass code to indicate that the area is too dry under normal climatic conditions to support a higher capability classification.

For example, consider an area of well drained, well structured alluvial soil which lies in an area where rainfall is less than 750mm each year. Assuming that rainfall is the only limiting factor, this land would be classified Class 4p as the lack of rainfall severely limits the productivity and range of potential crops. Were irrigation water to become available, the area would be reclassified class 3, or 2 with a new limiting factor. Conversely, a similar soil which contained a high proportion of stones classified as 4g would remain class 4g even if irrigation was available, as the stoniness of the soil remains the dominant limiting factor.

While irrigation potential is not considered at the 1:100 000 mapping scale it could be included at a more detailed level of mapping. If irrigation potential is included in the evaluation of land capability a number of other issues require consideration. For example, consideration should be given to the off-site impacts of irrigation and how this might affect land capability.

Consider an area of gently inclined basalt soils overlying Permian sediments. Without irrigation these soils might be considered to be Class 3c or 3p. With irrigation they might be reasonably expected to be Class 2 land. However, percolation of irrigation water through the basalt and subsequent surface seeps at the interface between the basalt and the Permian rocks is likely to lead to slumping and landslip at the juncture of the two rock types. Also, the surplus irrigation water draining through the ground may pick up salt from the Permian rocks, contaminate and/or recharge existing groundwater and give rise to the development of saline scalds on valley flats. While the degradation might be occurring on Permian soils and valley flats the source of the degradation is the irrigation on the basalt soils. Unless appropriate and reasonable management practices can be implemented to offset this degradation the basalt country should remain Class 3.

Where available irrigation water is of poor quality the capability of the land to support irrigated agricultural production may be reduced if such water is used compared to water of good quality. For the purposes of land capability classification the use of water of currently available quality is assumed, together with the adoption of appropriate drainage and irrigation management. Such an approach may lead to the classification of land at a class below that at which it is currently being used. However, this approach recognises the long term detrimental impact poor quality water usage has on sustainable land use management. Guidelines for irrigation water quality and land capability are presented at Section 4.2.6 in this report.

3.8 Land Capability and Drainage

Similar issues relate to the evaluation of land capability in areas requiring soil drainage. Where soil drainage is required and remains a feasible and realistic option open to individual farmers then the land will be evaluated on the assumption that improvements have been carried out. Elsewhere, where drainage requirements are at a catchment or regional level and are obviously beyond the scope of individuals then land is evaluated in its current state. The land capability of areas that fall within existing Drainage Trust Schemes (eg. Dairy Plains, King Island, Flinders Island, Mowbray Swamp and Circular Head) has been assessed according to the present condition of the land.

3.9 Summary

As with most land classification systems certain assumptions are necessary. For the Tasmanian system these include:

(a) The land capability classification is an interpretive classification based on the permanent biophysical characteristics of the land.

(b) A better than average level of management is being applied to the land.

(c) Appropriate soil conservation measures have been applied.

(d) Where it is reasonable and feasible for an individual farmer to remove or modify physical limitations (eg high water tables, stoniness, low fertility) the land is assessed assuming the improvements have been made.

(e) Land capability assessments of an area can be changed by major schemes that permanently change the nature and extent of the limitations (eg drainage or flood control schemes).

(f) The land capability classification is not a productivity rating for specific crops, although the ratio of inputs to outputs may help to determine the land capability class.

(g) Land capability does not take into account economic, social or political factors and is not influenced by such factors as location, distance from markets, land ownership, or skill of individual farmers.

(h) Present and past uses of the land (or similar land elsewhere) are guides to potential, in that they can indicate the limits of the capability of the land. Present land use and vegetation cover are not always good indicators of land capability class. The system of land capability is aimed at assessing the potential sustainable productivity of land rather than current productivity.

(i) Irrigation, or the feasibility of irrigation, is not considered when evaluating land capability except where it is considered to be part of general agricultural practice or the area forms part of a recognised irrigation scheme.

(j) Assessments are based on the capability of the land for sustained agricultural productivity, since use of the land beyond its capability can lead to land degradation and permanent damage.

Photo 6. Class 6 and 7 land, Middlesex Plains

Photo 7. Fragile organosols and Button Grass are classified as Class 7.

4. GUIDELINES FOR AGRICULTURAL LAND CAPABILITY CLASSIFICATION

4.1 Introduction

The guidelines set out in the following paragraphs are just that, *Guidelines*, not hard and fast rules to be used without exception. The guidelines attempt to give some objectivity to a system hitherto considered by many to be too subjective. It is hoped that these guidelines will bring a greater degree of consistency of mapping between those involved in fieldwork and provide a more reliable and understandable product for potential users of the information.

The following paragraphs present a summary of land characteristics and qualities for each land capability class. More detailed tables identifying class limits for many of the limitations described in Section 3 are presented in Section 4.2. Due to a lack of reliable data it has not been possible to identify class limits for all those limitations discussed in section 3. Where class limits are undefined the assessment of capability must remain subjective.

Class 1 land has most or all of the following features :

- land is level or very gently inclined with slopes less than 5%,
- soils are deep, stone free, well drained and have good water holding capacity,
- surface drainage is good, surface water ponding only occurs after heavy downpours,
- soils can be maintained in good tilth and productivity,
- productivity is high for a wide range of crops,
- erosion hazard is nil to slight, and virtually no special soil conservation techniques are required,
- soils are able to withstand frequent cultivation and irrigation without serious damage under sound, average management,
- soil physical and chemical deficiencies can be corrected economically,
- extremes of climate do not seriously affect productivity, and several crops per year are possible,
- soils do not have high sand or clay contents.

Class 2 land has most or all of the following features:

- slopes may range up to 12%,

- soils are deep, contain few stones, are well drained and have good water holding capacity,
- soils have a moderate to high capacity to withstand frequent cultivation without serious damage under sound, average management,
- minor conservation measures may be required,
- soils can be maintained in good tilth and productivity,
- productivity is high to moderately high for a range of crops, and two crops are possible each productive year,
- adverse soil characteristics can be improved economically,
- the risk of flooding is low.

Class 3 land has most or all of the following features:

- slopes may range up to 18%,
- high to moderately high levels of productivity under improved pasture species and crops,
- the range of crops is generally more restricted than on Class 1 or 2 land,
- soil depth and drainage can be variable,
- conservation measures are necessary under cropping,
- soil physical features and/or slope restrict the amount of cultivation the land will tolerate between pasture phases,
- adverse climatic conditions affect range of cropping options and/or productivity levels.

In addition they may have a range of limitations from among the following:

- erosion hazard,
- soil physical handicaps (e.g. stoniness, internal drainage, soil structure, nutrient deficiencies),
- salinity hazard,
- periodic flooding.

Class 4 land has a similar set of limitations to those described above for Class 3 but the limitations are more severe so that only occasional cropping is possible. Slopes may range up to 28%. Major soil conservation practices and careful management may be necessary under cropping.

Class 5 land has many of the following features:

- slopes can range up to around 56%,
- land may be broken by gullies and surface irregularities,
- the degree of stoniness, wetness or other physical limitations prevents the cultivation of the soil for cropping,
- erosion hazard may be moderate to severe,
- nutrient deficiency, acidity or salinity may depress but not prevent plant growth.

Class 6 land is often very steep, rocky or wetlands.

The land may have either a single very severe limitation or a combination of several severe limitations. These limitations make this class of land unsuitable to be cleared for grazing and steeper areas should be left under a vegetative cover, because of the potential erosion hazard and low productivity. Conservation measures including revegetation or retention of existing vegetation cover should be adopted. Class 6 land usually remains under native pasture or other natural vegetation cover and is generally impractical to traverse by a wheeled vehicle due to steep slopes, excessive topographic variability, stoniness or wetness

Class 7 land has a similar set of limitations to those described for Class 6 but the limitations are very severe to extreme, making this land unsuitable for any form of agricultural use.

Note:

1. Slope ranges given are the maximum slopes for the most stable soils in Tasmania (ie soils on basalt). Other less stable soils will have slope ranges lower than these for each capability class.

2. The cropping rotations indicated are a guide to ensure that soil structure is maintained or improved, thereby preventing degradation of the soil resource under cropping regimes. This applies particularly to sloping land that has the potential to be cultivated and where erosion of structurally degraded soils is a particular hazard.

4.2 Guidelines for Assessing Soil, Land and Climate Characteristics

The following sections set out to provide guidelines for assessing land capability against a number of soil, land and climate characteristics, limitations and hazards. Wherever possible, attempts have been made to provide quantified guidelines rather than entirely subjective notes. The class limits have been determined using information from alternative systems from around the country and modified following local experience and discussions with farmers and land managers in the north of the State.

It is not the intention of these guidelines to enable anyone to evaluate land capability. By its very nature the land capability classification system will always retain a certain amount of subjectivity which requires years of experience to be able to judge. It is not possible to show within this document how interactions between individual limitations might affect the overall capability classification. Salinity and waterlogging, for example, where they occur together, might result in a down grading of classification over areas where only one occurs. The significance of interacts between limitations is left to the expertise of individual surveyors to determine.

Further modification of these guidelines may, in time, become necessary as our understanding of the soils and climate, and the environmental processes that go on around us, grows and develops, and as we gain additional experience from other parts of the State. Meanwhile, this information is presented as an interim measure to ensure consistency between surveyors and information to potential users. Constructive criticism of class limits is encouraged and I welcome hearing the views of practitioners within the Department, agriculture and associated industries, and of private consultants.

4.2.1 Climatic Limitations (c)

Climate is one of the major permanent limitations that restrict the agricultural versatility of the land around Tasmania. While the climate generally is considered to be temperate maritime but the extensive mountain ranges, rising to over 1600m, that cover much of the State severely restrict those areas that can be considered suitable for agriculture to more coastal districts (particularly for cropping).

For land capability classification at the 1:100 000 scale, only generalised statements and boundaries relating to climate can be made. At more detailed scales of mapping, climatic boundaries (as they affect land capability) can be more clearly defined. However, other than rainfall information, some broadscale wind and temperature data and limited evapotranspiration information, there is limited information that is available which is appropriate to anything other than small scale land capability mapping. Even at 1:100 000 scale, assessment of climate is made on a map sheet by map sheet basis. Considerable emphasis is placed on the experience of farmers and surrogate measures, such as elevation for temperature, are often used. At more detailed levels of mapping it is possible to take into account the more localised effects of aspect, elevation, topography and seasonallity.

Some of the major climatic constraints to agricultural use of land in Tasmania are:

- Uneven rainfall distribution (associated with topography, altitude and time of year)
- Unreliable rainfall in certain areas
- Increasing frost hazard and shorter growing seasons in areas away from the coastal maritime influence
- Effect of wind in exposed areas.

Providing guidelines for the affect of climate on land capability class is not straight forward. Latitude, longitude, distance from sea and altitude, together with local topographic effects all exert some control on how climate can influence land capability.

In other States around Australia and overseas a range of factors have been used in attempts to determine climatic classes. In the UK three climatic groups have been identified and defined using average rainfall, average potential evapotranspiration and long term average of mean daily maximum temperature (Bibby and Mackney 1977). In

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

1988 revised agricultural land classification (ALC) guidelines defined capability classes according to average annual rainfall (AAR) and accumulated temperature (ATO) during the major part of the growing season (ATO is the excess of daily air temps. above a threshold of O^0C). Consideration is also given to the assessment of droughtiness. For the ALC system this is calculated using crop-adjusted available water capacity (AP) for the soil profile and moisture deficit (MD) data to estimate a moisture balance (MB) for the reference crops, winter wheat and maincrop potatoes A brief summary of this technique is presented in Appendix 1.

Temperature (t)

Temperature can impact on the ability of land to support a range of agricultural practices in a variety of ways. It can affect the moisture balance, discussed above, by controlling potential evapotranspiration rates and crop moisture demands. Low temperatures and frosts impact on the length of growing season which inturn restricts the range of crops that can be grown in an area. Lower temperatures and high risk of frost also limit the production of crops that require warmer temperatures or are frost sensitive.

As there is no growing season data available for Tasmania, and temperature information is limited to a few recording stations, it has been necessary to use surrogate information. After consultation with growers, land managers and consultants, generally in the north of the State elevation was identified as a suitable surrogate. The class intervals used have been identified following discussions with farmers, industry personnel and colleagues within DPIF. They are, however, untested and tentative and do not take into account local topographic affects caused by varying slopes, landforms or aspects. Also, no consideration is given to varying latitude or longitude or proximity to the coast, except where clear anecdotal evidence is supplied by farmers or industry.

Land Class	Altitude Range	Potential Activities
1	<180m	Full range of crops and livestock
2	180-260m	Full range but higher risk for frost sensitive crops
3	260-380m	Not sweet-corn or other frost sensitive crops
4	380-500m	Very restricted range of crop, eg cereals, seed potatoes, dairy
5	500-600m	Dairy, improved pasture, occasional fodder crops
6	600-900m*	Low intensity grazing, often on native pastures only
7	>900m	Nil

* Limits for Class 6 land are very tentative.

Rainfall (p)

Tasmania experiences a winter dominated rainfall pattern and in many areas the application of irrigation water during the drier summer season is essential to the economic productivity of the land. However, the Tasmanian Land Capability Classification System does not generally take into account the possibilities for irrigation except where land falls within a designated irrigation scheme, or irrigation of crops is standard practice amongst most farmers. The rainfall classes defined below are tentative and are for rain fed agricultural practices only. Interactions between rainfall and soil available water holding capacity (SAWHC) have not been considered, nor has the interaction between rainfall, soil texture and topographic gradient (erosion risk, see later section). Rainfall classes have been identified from experience and from discussions with farmers and land managers. As will be seen from the table below, some capability classes have an upper and lower rainfall range appropriate to that class. For example, average annual rainfall in range 700-850mm or 1500-1700mm is considered limiting at Class 3 level.

Land Class	Average Annual Rainfall (mm)*	
1	850-1300	
2	1300-1500	
3	700-850;	1500-1700
4	550 -700;	1700-1850
5	<550;	1850-2000
6	2000-2500	
7	>2500	

* Does not take account of rainfall seasonallity.

4.2.2 Soil Limitations (s)

A whole range of soil limitations exist which affect the ability of land to support agricultural enterprises on a sustainable basis. These guidelines discuss those major limitations which have been identified in Tasmania and which are commonly used in the classification of agricultural land.

Soil Depth (l)

For the purpose of these guidelines, soil depth is considered to be the depth of soil material, including both A and B horizons, overlying some limiting layer which severely impedes or restricts the development of plant roots. This limiting layer may be bed rock, ground water, iron pan or other cemented layer, heavy, massive subsoils (including some texture contrast B horizons) or some other similar type of barrier. Limiting layers restrict the volume of soil available from which plant roots can extract air, moisture and nutrients essential for the healthy development of the plant. While different plants clearly have different requirements in terms of soil depth, shallower soils invariably limit the range of crops that can be grown.

Land Class	Soil Depth (cm)
1	>90
2	65-90
3	50-65
4	35-50
5	20-35
6	10-20
7	<10

Salinity (k)

Salinity as a limitation to sustainable agriculture, is not widespread in Tasmania, and where it has been identified it is often of limited extent. Issues relating to the occurrence of salinity have been identified in the north Midlands and, more recently, in the Coal River Valley where it is beginning to impact on horticultural productivity where the land is being irrigated.

In Tasmania, salinity is usually associated with saline seeps and scalds and, in some areas, with the use of poor quality irrigation water. Soil salinity affects plant growth and productivity and the impact of salinity is heightened if the land is also subject to impeded soil drainage. Different crops have different levels of sensitivity to salt and increasing levels of salt in the ground will consequently limit the range of crops that can be grown to those that are increasingly tolerant.

For the purposes of land capability classification, the severity of the salinity hazard is assessed partly from the electrical conductivity (EC) of a 1:5 soil:water mixture and partly from the level of risk of salinity development as indicated by position in the landscape, ground water and irrigation water quality etc. While the measurement of current salinity levels is quantitative, the risk of future salinisation remains a somewhat subjective assessment. The units of measurement for salinity are decisiemens per metre (dS/m) although various other units have been used (conversion table for more commonly used units is presented in the Appendix 2). Care needs to be taken with the interpretation of salinity results to ensure that the units are clearly understood. Also, soil conductivity can be determined on a saturation extract. This is more difficult to achieve but is considered to give better results as it considers the relationship between plant, soil texture and salinity. There is no precise conversion from EC to ECe although the following conversions are in general usage in Tasmania.

Sands	ECe=ECx14
Sandy loams to clay loams	ECe=ECx9.5
Clays	ECe=ECx6.5

Class limits for salinity are presented using saturated extract conductivities and all EC measurements will therefore require converting.

Land Class	ECe (dS/m)	Crop indicators
1 and 2	0-2	Only sensitive crops affected.
3	2-4	Wide range of horticultural crops affected and productivity reduced.
4	4-8	Most crops affected; halophytic species evident. Occasional patches of bare ground.
5	8-16	Common halophytic species evident; pasture productivity reduced. Patches of bare ground common
6	16-32	Land dominated by halophytic plants but will support productive species such as tall wheat grass and puccinellia.
7	>32	Bare salt and salt pans.

For the purposes of land capability classification in Tasmania, consideration is given to the maximum ECe in the top 50cm of soil. Consideration is also given to the *risk* of salinity development in this zone. For example, current ECe levels might be only 3dS/m (Class 3 land). However, due to the position in the landscape of the area of interest, there is considerable risk of a rising saline groundwater table if the land is cropped on a regular basis. It is therefore considered that there is a high risk of ECe levels rising above 4dS/m in the top 50cm of soil and the land is evaluated as Class 4.

Coarse Fragments (g) and Rock Outcrop (r)

The assessment of the degree of limitation caused by the presence of coarse rock fragments and rock outcrop is a topic that has created much discussion. Land capability is limited not only by the abundance of rocks and stones but also by their size and distribution throughout the soil profile. Fewer large rocks can be more limiting than more smaller rocks. Also, the distribution of rocks and stones is also important, both two dimensionally across the land surface and three dimensionally within the soil profile. Stones scattered evenly across an area are likely to be more limiting than the same percentage of stones occurring in isolated pockets and surrounded by relatively stone free land. It is difficult to provide reliable and useable guidelines relating to the distribution of coarse fragments and the impact on land capability remains the subjective judgement of individual surveyors.

The terms rock, stones, and boulders have very specific meanings for soil surveyors, based on the definitions that occur in the *Australian Soil and Land Survey Handbook* (McDonald *et al*, 1990). These terms have been generally misused in everyday discussion and even within this report the term *stones* has often been used to mean all coarse fragment size groups. For land capability purposes the *g* limitation is intended for use where coarse fragments are of a size from 2mm to 600mm. This range includes gravel, cobbles and stones. The use of the *r* limitation is intended for coarse fragments greater than 600mm in size (boulders) and bedrock outcrop.

Some general comments may be of value. There has been considerable discussion as to whether the figures in the table below represent surface stone or profile stone content as each can affect land capability in different ways and to different degrees. Surface stone can impact on cultivation, seedling emergence, harvesting and trafficability while

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

profile stone content tends to affect cultivation, root development, nutrient and water availability. Broadly speaking, a given percentage coarse fragments is likely to have a greater impact on the surface than the same content distributed throughout a soil profile. As a general rule, the figures presented below should be considered to be profile stone content. If similar amounts of stone are found on the surface then land capability may be reduced by a half to a full capability class.

In considering the amount of surface coarse fragments attention should be given to the way such fragments are distributed. Is it fairly even over the area of the unit concerned or are stones, cobbles and rock outcrops concentrated in reefs allowing cultivation around them? What is the proportion and size of these reefs in relation to the overall area concerned? The impact of these issues on land capability has to be determined by individual surveyors using experience and common sense.

The use of the g or r limitation in land capability is intended to reflect the physical limitation on crop production imposed by coarse fragments and rock outcrop. Impacts on erosion and plant available water should be addressed under the appropriate alternative limitation.

	Coarse Fragment size			
Abundance (%)	2-60mm (gravel)	60-200mm (cobbles)	200-600mm (stones)	>600mm (boulders and rock outcrop)
<2	1	1	2	2
2-10	2	2	2	3
10-20	2	3	3	4
20-35	3	4	4	5
35-50	4	5	5	5
50-70	5	5	6	6
70-90	6	6	6	6
>90	7	7	7	7

Land capability classes for various coarse fragments sizes and abundance.

An alternative, and more subjective, evaluation of coarse fragments is presented in the following table:

Capability Class	Definition
1	Nil or very few coarse fragments on the surface or within the profile.
2	Sufficient coarse fragments to interfere with tillage operations but for most land uses stone picking is not necessary.
3	Sufficient coarse fragments to necessitate picking, and limits range of potential crops.
4	Coarse fragments severely impact on cultivation and harvesting and severely limit the range of potential crops.
5	Too many coarse fragments to consider picking but pasture improvement possible using conventional machinery.
6	Too many coarse fragments for improvement with conventional machinery; pasture improvement only possible through aerial application.
7	Rock pavements, scree slopes and cliff faces.

4.2.3 Wetness limitations (w)

Two types of wetness limitation are defined although it is acknowledged that the identification of the nature of soil wetness is not always clear. Wetness resulting from restricted internal soil drainage and from flooding are defined below, but issues relating to run-on from off-site areas, inundation resulting from heavy rain or run-on, or low surface infiltration are not discussed and remain subjective.

Soil Drainage (d)

Soil drainage defines the internal drainage status of the soil which has a significant impact on workability, trafficability and poaching risk as well as crop physiological effects. Soil drainage is a complex soil property defined according to a range of soil and climatic characteristics including rainfall (amount and distribution), soil permeability (itself dependent on texture and structure) and depth to ground water. Each of these factors can influence the degree to which a soil becomes waterlogged. Waterlogging causes a deficiency of oxygen within the crop rooting zone which retards root development and consequently affects crop health and productivity.

Land Class	Drainage Status	Mottle Depth (cm)	Mottle Severity	Approx. Permeability	Comment
1	Well	>90	Few/feint	250-500mm/day	
2	Well	>90	Few/feint	250-500mm/day	
	Rapidly	Nil	Nil	>500mm/day	Sandy soils
3	Moderately well	50-90	Few/distinct	50-250mm/day	
4	Imperfectly	20-50	Common/ feint	25-50mm/day	May have few rusty root mottles to surface; possible seasonal water table below 50cm
5	Poorly	10-20	Common/ distinct	5-25mm/day	May be rusty root mottles from surface; may have shallow seasonal groundwater table
6	Very Poorly	Surface	Many/ prominent	5mm/day	May be saturated for long periods or have shallow groundwater table
7	Swamp		Many/ gleyed		Permanently Saturated

In Tasmania, the assessment of soil drainage remains a somewhat subjective procedure and some experience is necessary for consistent and reliable results. Drainage status is defined according to the depth and degree of mottling and care needs to be taken to ensure that the mottles are truly redox mottles (not a weathering product of rocks and stones within the profile, or mixing of material from adjacent horizons) and that they are a contemporary feature, not relict. In some soils, particularly ferrosols and vertosols (krasnozems and Canola soils) identification of mottles may be difficult.

The following guidelines for soil drainage may also be useful and are adapted from McDonald *et al*.

Drainage Status	**Definition**	**Capability Class**
Rapidly drained	Soils are usually coarse-textured; no horizon is normally wet for more than several hours after water addition.	1 or 2
Well drained	Soils often of medium texture; some horizons may remain wet for several days after water addition.	1 or 2
Moderately well drained	Soils are usually medium to fine textured: some horizons may remain wet for as long as a week after water addition.	3
Imperfectly drained	Soil have a wide range of texture: some horizons may remain wet for periods of several months.	4
Poorly drained	Soil have a wide range of texture: all horizons may remain wet for periods of several weeks.	5
Very poorly drained	Soil have a wide range of texture: strong gleying and surface accumulation of organic matter are typical.	6

Flood Risk (f)

The assessment of flood risk is very subjective and is often based on local knowledge although flood risk maps and detailed information do exist for some major rivers. The significance of flooding for land capability assessment depends on a range of factors including flood depth and duration. Shallow floods are frequently less damaging than deep floods; similarly floods lasting more than a day or so are more significant than those that occur only for a few hours. Timing of a flood event is also important as different crops are more or less sensitive to inundation depending on their stage of development. The following generalisations are made for the Tasmanian system:

Land Class	**Flood Risk**
1 and 2	Negligible
3	Winter floods of 1-2 days; rare summer floods of <1 day
4	Severe flooding 1 year in 5 for periods of >2 days; Occasional summer flooding.
5	Severe flooding 1 year in 3; common summer flooding.
6	Damaging floods in most years; significant risk of stock losses.

4.2.4 Erosion Hazard (e)

Erosion of the land surface is a natural geomorphic process which operates under varying soil, geomorphic and climatic conditions. In the agricultural context we are concerned mainly with accelerated erosion, or that aspect of erosion resulting directly from the activities of man through various land use and management activities. Three elements of erosion are considered for land capability purposes; erosion by wind, erosion by water and mass movement. The first two of these, erosion by wind and water, are widespread throughout the agricultural areas of Tasmania, while mass movement, mainly in the form of landslip, is locally important.

Erosion is considered to be a limitation when it leads to losses in productivity, interferes with cropping flexibility or requires additional costs or management to prevent deterioration. Susceptibility to erosion is dependant on a variety of factors including rainfall amount and intensity, soil texture and structure stability and slope steepness. The tables below provide only a rough guide and consideration should be given to any local effects or knowledge. The system uses soil texture, structure grade, topsoil depth and dispersibility related to gradient to determine a susceptibility rating for erosion by water.

Water Erosion (h)

Erosion by water can take many forms from simple rain drop impact to sheet, rill and gully erosion. Even landslips may be triggered by a build-up of hydraulic pressure within the soil mantle.

For land capability, it is the risk of sheet, rill and gully erosion with which we are most concerned. The following tables assess the erosion hazard on the basis of soil texture, structure and dispersion characteristics as influenced by topographic gradient. It is acknowledged that rainfall amount and intensity also contribute to erosion risk but these climatic effects are not specifically considered in this evaluation.

To assess erosion risk by using the following tables it is necessary to know soil texture, structure and dispersion characteristics. Erosion risk can then be assessed against a range of slope classes. The first table is used to assess the erodibility of the soil and the second table takes this result and uses it to determine the level of erosion risk with respect to topographic gradient. The level of erosion risk determines capability class.

To use the tables first identify the appropriate texture, structure and dispersion categories for the soil of interest. This provides an indicator of the *erodibility* of that soil. Thus structured sandy clay loams with no dispersion have a low erodibility.

From the second table, identify the appropriate slope category and erodibility class to determine the erosion risk for that soil. Continuing with the above example, a soil with low erodibility on a 12-18% slope has a moderate erosion risk. From the third table, land with a moderate erosion risk comes out as Class 4 land.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Key to estimation of soil erodibility

Texture	Structure	Dispersion		
		None	**Slight**	**Dispersive**
Sands	Loose	V high	V high	Extreme
Loamy sands		High	High	V High
Sandy loams	Apedal	High	High	V high
	Weak	High	High	V High
	Moderate	Moderate	Moderate	High
Loams,	Apedal	Moderate	High	V High
Silt Loams,	Structured	low	Moderate	High
Sandy clay loams				
Clay Loams,	Apedal	low	Moderate	High
Light Clays	Structured	V low	low	Moderate
Medium to heavy clays	Apedal	Low	Moderate	Moderate
	Structured	Low	Low	Moderate

Key to estimation of soil erosion risk

Slope	Erodibility					
(%)	**V Low**	**Low**	**Moderate**	**High**	**V High**	**Extreme**
0-5	Nil	V low	Low	Moderate	Moderate	Moderate
5-12	V low	V low	Low	Moderate	Moderate	High
12-18	Low	Moderate	Moderate	High	Very High	Very High
18-28	Moderate	High	High	Very High	Very High	Very High
28-56	High	High	Very High	Very High	Very High	Extreme
>56	High	High	V High	V High	Extreme	Extreme

Erosion Risk	Land Class
Nil	1
Very Low	2
Low	3
Moderate	4
High	5
V High	6
Extreme	7

Wind Erosion (a)

The susceptibility of soil to wind erosion is partly dependent on the size and degree of aggregation of individual soil particles. The risks of wind erosion can be reduced by maintaining a good vegetative ground cover to protect the soil surface and by minimising tillage operations which reduce soil structural aggregates to individual soil particles.

Only general guidelines are available for the assessment of wind erosion risk in Tasmania:

Class 1 and 2: Well structured or massive loams, clay loams and clays generally have low erodibility and low erosion risk;

Class 3: Structured sandy loams and sandy clay loams with good organic matter content.

Class 4: Loose sandy loams, and loamy sands with some structure and reasonable organic matter content;

Class 5: Loose loamy sands

Class 6 and 7: Loose sands with little or no organic matter (beach dunes).

Mass Movement (m)

Mass movement, particularly landslip, is of local significance in Tasmania. Landslips frequently occur where soil developed on reasonably permeable materials overlie less permeable materials. Rainwater percolating through the more permeable upper layers of soil and rock is held up at the interface of the two rock types and lubricates the intervening surface. If the overlying material is well fractured, or becomes saturated, slippage can easily occur along this surface. The risk of landslip for land capability is assessed from evidence of previous landslips within the area and on similar rock types. Care needs to be given in assessing whether existing landslip evidence is contemporary or relict, and what the affect of further vegetation clearance or irrigation (if relevant) may have on sub-surface hydraulic characteristics.

Generally speaking, capability classes 1-3 are not at risk from land slip. Class 4 land has some risk but this is negligible if the land remains under pasture or is cropped only occasionally. Class 5 land shows occasional active slips and grazing needs to be controlled to maintain a good vegetative ground cover. Class 6 land has common active landslips and has very limited potential for agricultural activities. If this land occurs under a natural vegetation cover that cover should be maintained and no land clearing should be undertaken.

4.2.5 Complex Topography (x)

Experience over the last few years has suggested that occasionally there is a need for a topographic limitation which reflects the general unevenness or irregularity of the terrain, and where it is this unevenness which is the major limiting factor to the agricultural use of the land rather than some alternative factor (eg drainage, erosion risk). Such uneven ground may be the result of strong gilgai microrelief or hummocky landscape resulting from numerous land slips.

The use of this limitation appears to be confined predominantly to the separation of land classes 3, 4 and 5. The limiting criteria in each case is the ease of access and trafficability of an area. Irregular and uneven ground not only makes vehicular access uncomfortable but affects the efficiency of cultivation, seeding and harvesting machinery. Classification depends on the degree of unevenness:

Class 3 land: minor impediment caused by irregular terrain

Class 4 land: significant impediment such that machinery is constantly digging over-deep or lifting too high above the ground.

Class 5: Generally impractical to cultivate except for occasional pasture improvement.

Summary Table

The following table presents an easy to use summary of the tables that have been presented above. It is not intended as an exhaustive list of soil and land characteristics used to assess land capability but simply a guide to the assessment of some of the more common properties used in Tasmania.

Land Class	Gravel % (22-60mm)	Cobble % (60-200mm)	Stone % (200-600mm)	Boulders and rock outcrop %	Rooting Depth (cm)	Soil Drainage Status	Flood/ Innundation Risk	Erosion Risk	Elevation* (m.a.s.l.)	Rainfall (mm p.a.)	Salinity (ECe dS/m)
1	<2	<2	N/A	N/A	>90	Well	Negligible	Nil	<180	850-1300	0-2
2	2-20	2-10	<10	<2	65-90	Well/ rapidly	Negligible	Very low	180-260	1300-1500	0-2
3	20-35	10-20	10-20	2-10	50-65	Mod Well	Occasional, short winter, rare summer	Low	260-380	700-850; 1500-1700	2-4
4	35-50	20-35	20-35	10-20	35-50	Imperfectly	Occasional severe winter, occasional summer	Moderate	380-500	550 -700; 1700-1850	4-8
5	50-70	35-70	35-50	20-50	20-35	Poorly	Severe winter, common summer	High	500-600	<550; 1850-2000	8-16
6	70-90	70-90	50-90	50-90	10-20	Very Poorly	Damaging floods in most years	Very high	600-900*	2000-2500	16-32
7	>90	>90	>90	>90	<10	Swamp	Swamp	Extreme	>900	>2500	>32

* Limits for Class 6 land are very tentative.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

4.2.6 Irrigation Water Quality and Land Capability

The fact that some land can have an improved land capability under irrigation rather than rainfed agriculture has been discussed earlier in this report (page 19). However, the issue of irrigation water quality has not been adequately addressed. In areas where this issue has previously been identified, such as the Cressy/Longford irrigation scheme, the assumption was made that all irrigation water would be of good quality. At the time this was a reasonably accurate, if simplistic, assumption.

However, since commencing fieldwork within the Derwent map sheet it has become necessary to review the validity of this assumption. Within the Coal River irrigation scheme water of category 2 and 3 quality is currently being used for irrigation of some horticultural crops. In some situations crop losses have been experienced, while in others, little affect has been noticed and improved crop yields have been achieved. It would not be unreasonable to continue to classify this land on the assumption that only good quality irrigation water is used; this evaluation indicating the absolute potential of the land to support agricultural activities. This would not be a true reflection of reality, however, and imposes a further assumption that good quality water can be made available.

Within the Coal River Valley, the use of good quality irrigation water by farmers is currently not uniformly achievable and the improvement of existing water quality standards is considered by many to be beyond the control of individual farmers. It is proposed therefore that, where land capability is limited solely by lack of rainfall and where the land lies within a designated irrigation scheme or irrigation is considered common agricultural practice, land capability is assessed on the basis of currently available irrigation water quality following the guidelines outlined below.

The extent of degradation imposed by poor quality irrigation water depends to some extent on the nature of the irrigated soils, the internal drainage of those soils and irrigation management. The following guidelines assume that suitable management practices are applied.

In using the following guidelines it is important to distinguish between *water quality categories* and *land capability classes*. Firstly, we determine the quality of the irrigation water.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Water Quality Category	EC (µS/cm)	Total dissolved solids (mg/l)	Comment
Class 1	0 - 280	0 - 175	Low salinity water which may be applied to most soils using any method. Some leaching required but salt buildup is unlikely.
Class 2	280 - 800	175 - 500	Medium salinity water which may be applied to well or moderately well drained soils on all but the most salt sensitive crops. Moderate leaching is required
Class 3	800 - 2300	500 - 1500	High salinity water which may be applied only to well drained soils and requires salinity control. May retard growth of salt sensitive crops
Class 4	> 2300	> 1500	Very high salinity water which may only applied to well drained soils if absolutely necessary. Considerable leaching and salt sensitive crops are required.

General guidelines for irrigation water salinity (after ANZECC, 1992).

Secondly, we consider the drainage status of the soils to be irrigated. In the absence of any other limitation, the affect of irrigation on the land capability classification of soils with differing drainage characteristics are given below.

Soil Drainage Status	Water Quality Category			
	1	2	3	4
Well drained	Capability Class 1	Capability Class 3	Capability Class 3	Class 4
Moderately well drained	Capability Class 3	Capability Class 3	Class 4	unsuitable
Imperfectly drained	Class 4	Class 4	unsuitable	unsuitable
Poorly drained	Class 5	unsuitable	unsuitable	unsuitable

General guidelines for land capability assessment of drainage limitations and irrigation.

4.3 Stylised Land Capability/Landform Relationships for Different Rock Types

The following pages represent stylised relationships between land capability, landform and various rock types. They are not intended to cover all eventualities across the State but are simply a guide as to how information on preceding pages can be applied.

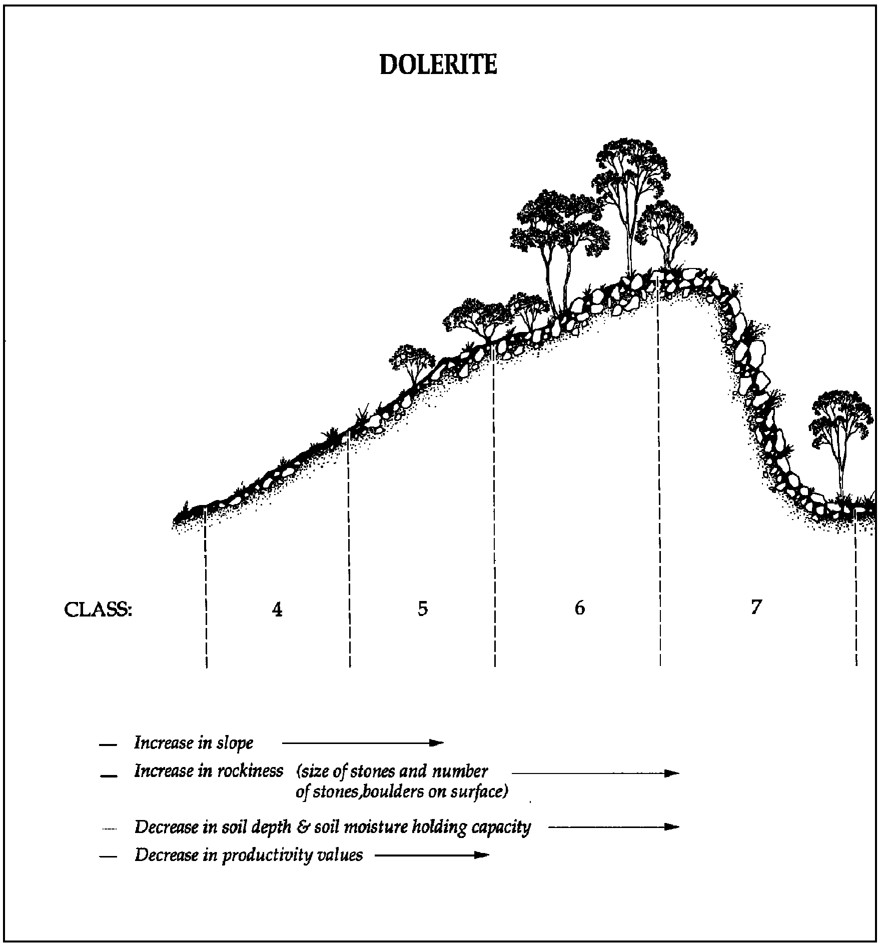


Figure 6. Diagrammatic representation of land capability classes mapped on dolerite

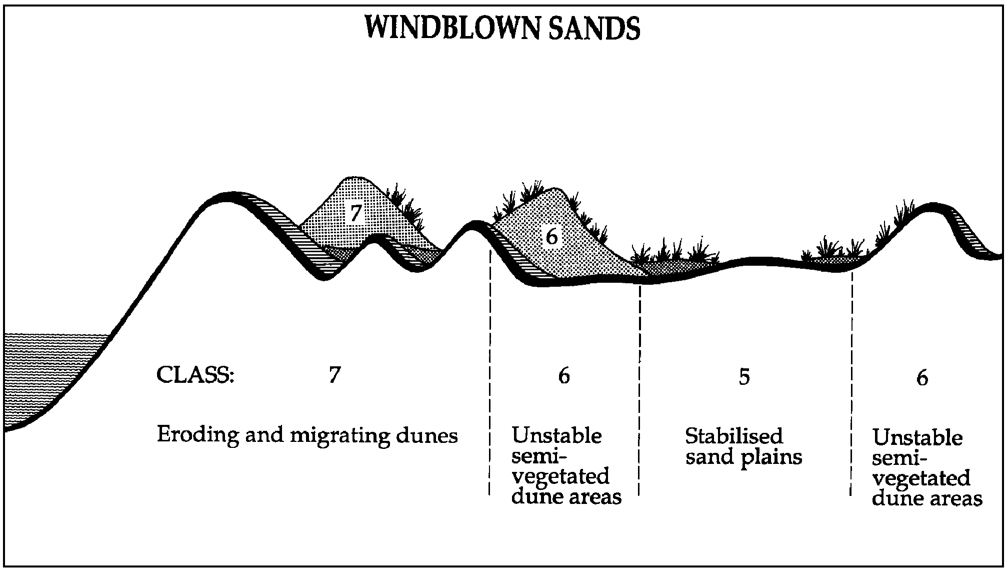


Figure 7. Relationships between land capability classes mapped on windblown sand

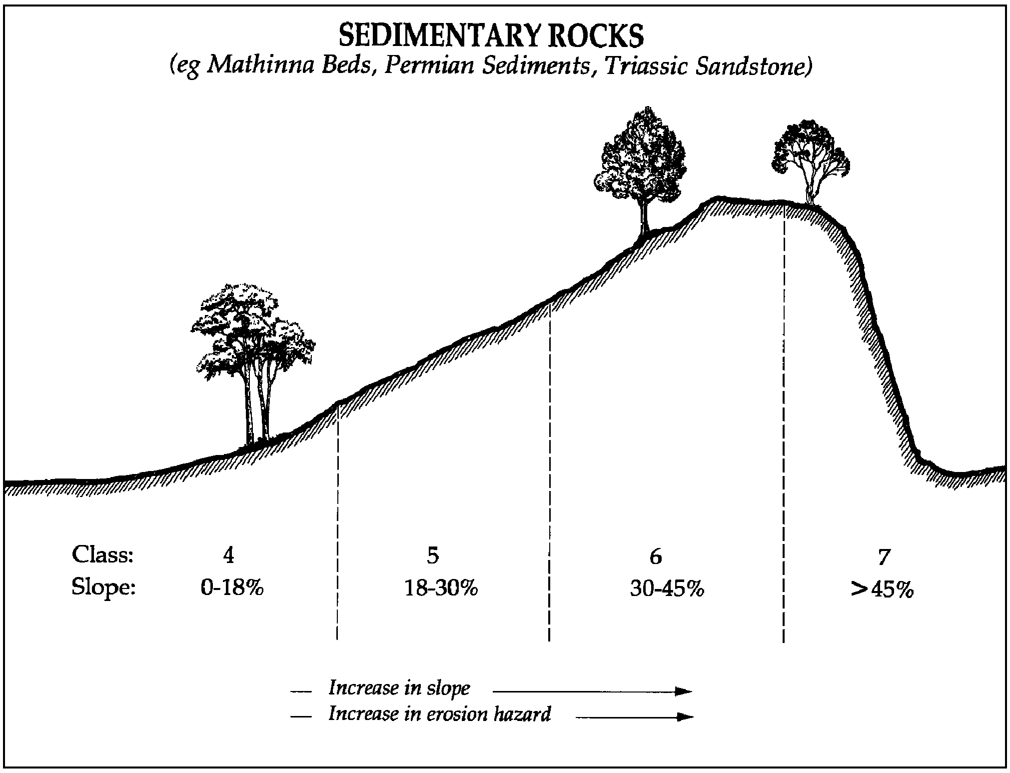
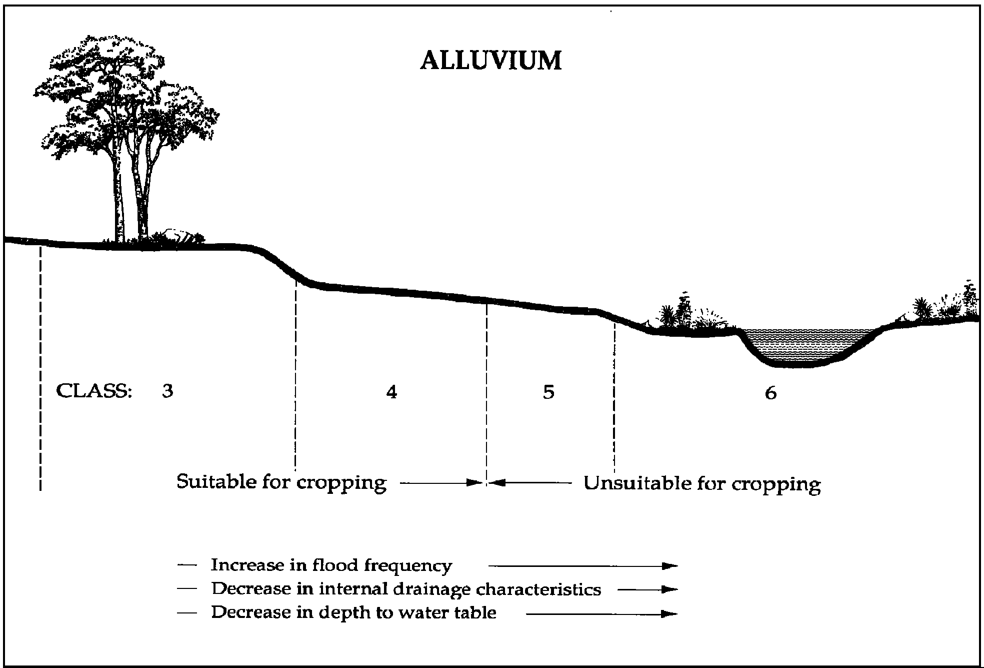
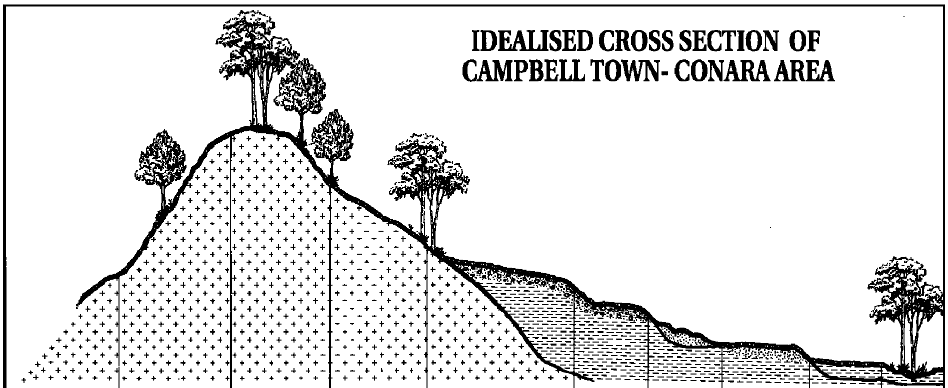


Figure 8. Relationship between land capability classes on sedimentary rock types



Class	**3**	**4**	**5**	**6**
Flooding Frequency	Not flooded	Occasionally flooded	Often flooded	Frequently flooded
Water Table	Fluctuating	Fluctuating; near surface in winter	Surface water in winter	Surface water much of year
Internal Drainage	Well to moderately drained	Moderately well to poorly drained	Poorly to very poorly drained	Very poorly drained

Figure 9. Diagrammatic representation of land capability classes on recent alluvium



Land capability classes	6	5	4	4,5	4	4	4	4	6,5
Geology	dolerite	dolerite	dolerite gravels	sands on clay and ironstone gravels	sandy gravel on clay	windblown sand	sands on clay	silts, clays	river bed gravels
Soil association	Deddington	Eastfield	Eastfield	Woodstock	Brickendon	Panshanger	Brumby	Canola	
Topography	steep hills > 40%	rolling to moderately steep hills < 40%	rolling slopes	flat to undulating terraces	flat to undulating terraces	rolling sand dunes	flat to undulating terraces	flat terraces	flat areas near river beds
Limitations	numerous rock outcrops, shallow soils	rock outcrops	stony soils	low fertility, acid soils susceptible to drought, some areas with much ironstone gravel.	gravelly, more freely drained than Brumby soils.	loose, freely drained soils, subject to wind erosion.	dry in summer, wet in winter	heavy clay soils prone to flooding. fertile soils	frequent flooding, some areas very stony

Figure 10. Stylised cross-section showing geology, soil, landform and land capability relationships from the North Midlands

5. HOW TO USE LAND CAPABILITY MAPS AND REPORTS

As discussed previously, the land capability classification system is applicable to mapping at almost any scale. Within Tasmania the focus is on 1:100 000 scale mapping with some limited 1:25 000 information. It is important that the land capability map be used in conjunction with the accompanying report. The potential uses for land capability information are dependent on the level of classification provided and the scale of mapping. Only capability class information is presented on 1:100 000 scale maps, class and subclass information would be available on 1:50 000 scale publications and class, subclass and unit information would normally be available on maps of 1:25 000 scale or larger.

5.1 Limitations of Scale

Special attention needs to be paid to the "limitations" imposed by the scale of mapping and the following comments relate to the 1:100 000 scale mapping currently being undertaken by the Department.

It is important that maps are used at the scale at which they are published (1:100 000). **The map should not be reproduced at a larger scale (eg. 1:25 000)**. The land capability boundaries found on the maps are reliable only at the published scale of 1:100 000. Errors in interpretation will occur if maps are enlarged or if the information is used at the farm or detailed planning level. If more detail is required, the area of interest should be remapped at a scale more suitable for the end use, rather than enlarging the map.

5.1.1 Minimum map unit size and purity

The accuracy of the land capability class boundaries depends on a number of factors including the complexity of the terrain, soils and geology. Where topography, or other visible features, change abruptly the class boundaries may be well defined. Alternatively, changes may be gradual and more difficult to assess such as with a change in soil depth, some soil types, slope, or extent of rockiness. In these cases the boundary is transitional and therefore can be less precisely plotted on the map.

Gunn *et al* (1988) indicate that, at a scale of 1:100 000, the standard minimum area for a map unit which can be adequately depicted on the map is approximately 64ha. There appears to be little consistency however, as Landon (1991) suggests a wide range of "minimum areas" are currently in use. For the purposes of this work, unit areas of less than 64ha have been mapped where they are identifiable on the basis of clearly visible boundaries (usually topographic). Impurities in map units will occur where land class changes are a result of less obvious changes in land characteristics or qualities.

In any mapping exercise there are always areas which are physically too small to delineate accurately at a given map scale and in such cases these areas are absorbed into surrounding units. The map units shown will therefore often contain more than the one land capability class or sub-class. The map units are assigned the dominant land capability class within them but it should be recognised that some map units may contain up to 40% of another class. In the majority of cases however, a land capability map unit may be deemed to be about 80% pure and, in more uniform areas, up to 90%.

COMPLEX map units (eg 4+5) are identified in some areas where, due to the complexity of soils and landscape, two land classes are identified within a single map unit, each class occupying between 40% and 60% of the unit. However, at the scale of mapping, the individual pockets of each land class are either too small to map independently or the pattern is very complex and separate capability classes cannot easily be identified. Such units are shown as striped units on the map. The first digit of the map unit label represents the dominant land capability class as does the slightly wider of the two coloured stripes on the map. Further information on the use and identification of complexes is presented earlier in this handbook.

5.2 Interpretation of the Land Capability Information

The scope and range of applications of the land capability information depends on the scale at which the surveys are carried out. Large scale maps such as those at 1:5 000 or 1:10 000 contain detailed information and are suitable for whole farm planning purposes, planning farm layouts and identifying appropriate land uses, soil conservation and land management practices. A scale of 1:25 000 is more appropriate for catchment planning, although this is a guide only as the scale used will often be determined by the size of the catchment to be surveyed and the amount of time that is allocated for mapping it. Medium scale surveys, about 1:50 000, contain class and subclass information and are suitable for district planning for route alignment, urban and rural development planning including residential and industrial development planning.

Best use of the 1:100 000scale maps and reports can be made by local government, regional and State land use planning authorities. The information at this scale is **not** intended to be used to make planning decisions at farm level, although the information collected does provide a useful base for more detailed studies. The methodology does however apply to all scales of mapping and can be utilised equally well by local landowners, local, regional or State planning authorities.

Examples of other potential uses of land capability information at 1:100 000 scale are:

- Identifying areas of prime agricultural land (Classes 1 to 3) for retention for agricultural use
- Rational planning of urban and rural subdivisions
- Identifying areas for new crops, enterprises or major developments
- Identifying areas for expansion of particular land uses
- Planning of new routes for highways, railways, transmission lines, etc.
- Identifying areas of land degradation, flooding or areas that may require special conservation treatment
- Identifying areas of potential erosion hazard

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

– Resolving major land use conflicts

Integrated catchment management (depending on catchment size)

Land capability information combined with other resource data can, with the aid of a GIS (Geographic Information System), greatly enhance the accessibility, interpretation and use of this information.

Describing land capability information through reports and accompanying maps is insufficient to ensure the adoption of sustainable land use practices. Change away from unsustainable practices can only occur through increased social awareness and education (a recognition that change is needed) together with the development of an appropriate implementation framework, including legislative and administrative support, responsible for putting land use policies into practice. The protection of high quality agricultural land from non-agricultural use is an issue of particular concern in many areas and the information included in the various maps and reports will help to achieve this and support the proposed State Policy on the Protection of Agricultural Land currently under preparation by DPIWE.

The land capability maps and reports do not purport to have legal standing as documents in their own right, nor should they attempt to stand alone in planning decisions without being supported by other relevant land resource, economic, social or conservation considerations. The information is intended as a guide to planning development and, where more detailed planning is required, for farm planning or route alignment for example, further fieldwork at a more appropriate scale needs to be undertaken.

5.3 Copyright

The maps, reports and digital information stored on the DPIWE databases are copyright, and the data is solely owned by the Department of Primary Industry, Water and Environment, Tasmania. Every encouragement is given to individuals and organisations who wish to use the information contained in this report and accompanying map to assist property management or regional planning activities. However, commercial organisations or individuals wishing to reproduce any of this information, by any means, for purposes other than private use, should first seek the permission of the Secretary, Department of Primary Industries, Water and Environment, Hobart.

5.4 Availability of Other Reports and Maps in this Series

An Index of the land capability maps (based on the TASMAP 1:100 000 Series) is shown on the rear cover of this report. The maps which have been published to date are indicated in Figure 1.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Land capability publications currently available :

Pipers Report and Accompanying Map ($15)

Tamar Report and Accompanying Map ($15)

Meander Report and Accompanying Map ($20)

South Esk Report and Accompanying Map ($30)

Forth Report and Accompanying Map ($30)

Inglis Report and Accompanying Map ($30)

Land Capability Handbook ($10)

Land Capability Classification in Tasmania, Information Leaflet (free**)**

Maps, reports and the handbook are available for purchase by contacting your nearest Department of Primary Industries, Water and Environment Office or direct from:

Department of Primary Industries, Water and Environment
Resource Management and Conservation Division
Land and Water Assessment Branch
GPO Box 46
Kings Meadows, TAS. 7249.

6. LAND CAPABILITY FOR LAND USE PLANNING: REGIONAL AND DISTRICT SCALES

Correct land use planning decisions, at the property, local, regional or State level, can only be made when based on a full and accurate picture of the total land resource and there is no doubt that land resource information (in particular, land capability information) is an essential ingredient in planning to allow informed and reliable decision making.

In carrying out the Land Capability Survey of Tasmania, the Department of Primary Industries, Water and Environment (formerly Department of Primary Industries and Fisheries) recognises that there has been a lack of this type of information available to planners in the past, and that many land use decisions in the State have not been based on land capability principles. Other States that have had land capability information available for some time, have also recognised that the information may not have been adequately incorporated into land use planning decisions. As a result, land capability information is now used extensively as a basis for land use planning decisions in all other States.

However, it is insufficient to provide land capability and other resource information in order to protect our valuable agricultural resources if administrative, legislative and political frameworks are not in place to ensure that this type of information is used in the planning process. Further, land capability information is insufficient to protect the land if there is no legislative framework to ensure that not only is land used within its capability but is also managed according to its capability classification. In recognition of this, the State government proposed the development of a policy on the Protection of Agricultural Land which required the incorporation of land capability principles in the development of regional development strategy plans. This policy was passed in April 1999. Further political developments will be required, however, if the State's valuable agricultural resources are to have a sustainable future.

The value and use of land capability information is largely dependent on the purpose and scale for which the information was gathered. Obviously, the more detailed the information the greater it's value for detailed planning and development. However, with limited resources available for land capability classification and land resource surveys in general, the approach of DPIWE has been to undertake 1:100 000 scale mapping which will provide an overview and relatively quick coverage of the State with the type of information that is useful to planners at district and regional scales.

It is proposed that once the 1:100 000 State survey is completed, areas where more detailed information is required (eg around urban fringes, areas of highly intensive agricultural use) will be remapped at 1:25 000 scale, providing planners and land managers with more detailed information.

Land capability on its own cannot and does not purport to dictate land use planning decisions or policies and should not be regarded as standing alone in any planning decision, without being supported by other relevant land resource, economic, social or conservation considerations that may be pertinent to the decision making process. Only with recognition of all these factors can responsible decisions on land use be made. The land capability information provides a scientific and objective base on which to overlay all other information in order to make wise and rational land use decisions. A broadening of the issues to be considered in this way is more of a suitability evaluation, undertaken in many other states as part of a strategic development plan. In Tasmania it is up to the planners and developers to investigate social and economic factors as the land capability information provides only an assessment of the physical resources of the land.

The decisions that planners make in interpreting the land capability data must take into account:-

a) The physical potentials and limitations of the land, as indicated in the land capability assessment.

b) The land capability information - an understanding of the land capability system, the limitations of the data, and the limitations imposed by the scale of the information presented.

c) Other social, economic, political, infrastructure, and conservation considerations.

d) Regional and State planning strategies and policies, eg protection of prime agricultural land for agricultural use (Classes 1-3).

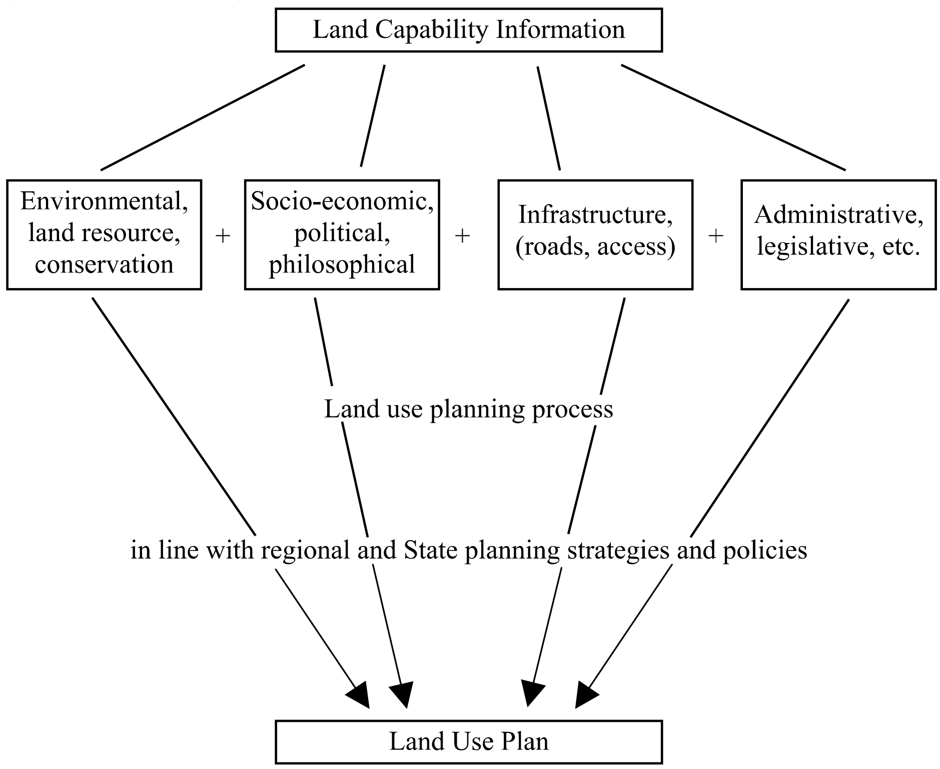


Figure 11. Framework for Land Use Planning

Potential uses of the land capability information at the regional or district scales include identifying areas of prime agricultural land, areas for expansion of particular land uses, new crops or major developments, planning for urban and rural subdivisions, and planning for new routes, highways or transmission lines.

Land capability information can be used to provide a basis for deriving zoning or policy areas for regional and district planning schemes. This has been successfully undertaken for West Tamar and Kentish Councils.

Local authorities can identify areas where development may be safely promoted or should be restricted. Areas can be defined which should be protected from urban intrusion, preserved for agriculture, or used for semi-rural living.

This objective information can be used to allay concerns that decisions about residential developments are made on a piecemeal basis, and fail to recognise the regional or State importance of agriculture.

Outlined below are some examples of applications of land capability at various scales.

1) Regional and State Planning: 1:100 000 (small scale)

At this scale, the land capability information can only be presented at the class level. This information can be used to:

a) Provide an overview of land capability of the region.

b) Identify the nature and extent of the land resource.

c) Identify areas with potential for intensive agricultural use eg prime agricultural land.

d) Assist with regional strategic planning.

e) Identify extent of areas at risk from land degradation.

f) Identify areas for new developments, or urban expansion.

g) Provide a standardised framework on which to base more detailed assessments.

h) Resolving state level land use conflicts.

2) District Planning and Large Catchment: 1:50 000 (medium scale)

Mapping at this scale can be carried out to the class or subclass levels. At this scale information on the time of limitation is necessary for consultants and planners involved in urban and rural development planning.

Provides information for all of those mentioned above in more detail, including more detail about the land resource, for: -

a) Urban and rural development planning, including residential and industrial subdivision

b) Transport, telecommunication and transmission line route alignment

c) Soil conservation planning

d) Location of industries

e) Location of irrigation schemes

f) Locating landfill and effluent disposal sites

Medium scale mapping provides more reliable information on the nature of limitations. It is also able to supply some information relating to soil type and soil characteristics. Land capability classification is not a substitute for soil survey, however, and for reliable soil information soil surveys should be undertaken at a scale appropriate to the proposed development.

3) Catchment Planning; Urban Fringe Areas 1:25 000 (large scale)

a) Specialised agriculture (eg viticulture)

b) Defining management options

c) Hobby farm expansion

d) Urban growth options

e) Providing information for detailed planning and policy development

More detailed plans for urban development may be recommended to ensure that inappropriate developments do not occur on land at risk from flooding, areas with landslip hazard, land with reactive or unstable soils, or on areas that are too steep or too rocky for development. Some other States and New Zealand have developed an Urban Land Capability Classification System which takes into account in detail these types of constraints that affect development of land for urban use.

Figure 12 outlines a possible framework for the application of land capability assessment.

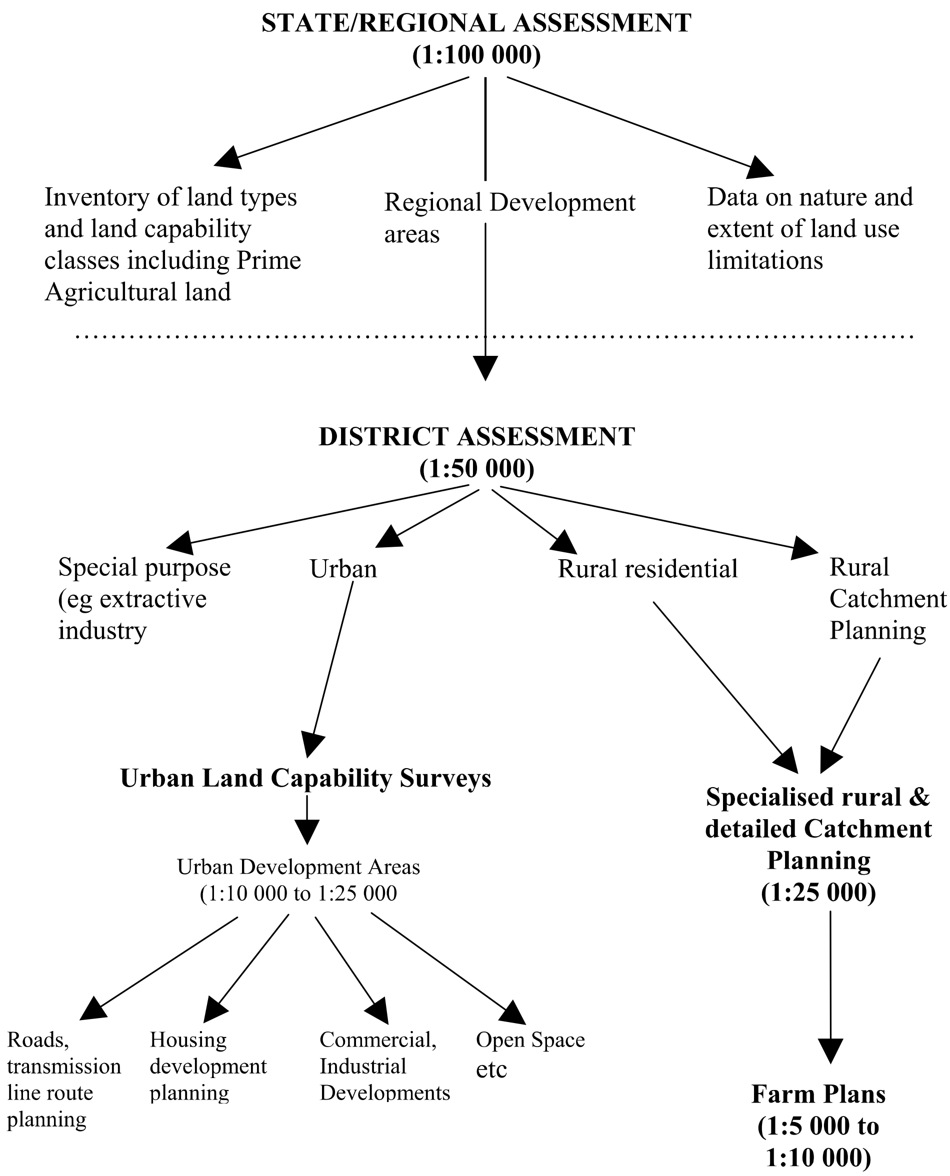


Figure 12. A possible framework for the application of land capability assessments. (Adapted from Dept. of Agriculture, South Australia)

7. LAND CAPABILITY FOR FARM PLANNING

Using land within its capability naturally starts at the farm level. Decisions such as land use, length of cropping phase, stocking rates and management methods develop from an assessment of the land's capability to sustain the proposed level of use.

While most farmers make an assessment of the land's ability to produce and the appropriate methods for management, economic circumstances may lead farmers to look only to the short-term and neglect long-term considerations. Where the land's ability to sustain a particular land use without permanent damage is ignored, the unfortunate, but inevitable result is land degradation: soil compaction, erosion in its various forms, tree decline or soil salting.

Property management decisions should therefore be more consciously based on land capability. Planning farm layout and operation on the basis of the inherent bio-physical characteristics of the land - soil type, slope, drainage and erosion hazard - is a basic principle of Property Planning. Matching the land's capability for production with the required farming practices leads to subdivision of the farm into land capability units (or natural land management units).

For example, fence location and paddock shape and size should be dictated by factors such as topography and soil type.

Of particular importance in cropping areas is the situation where individual paddocks may have more than one soil type present. Usually this results in one soil type being used beyond its capability and therefore suffering permanent damage. Where practical, different soil types should be identified and treated separately.

A similar situation applies with paddocks which may contain only one soil type, but may contain some small steep areas or drainage lines. If the entire paddock including the steep areas or drainage lines are cultivated, these areas may be subject to erosion. The preferred practice is to suit the land use to capability by leaving drainage lines as pasture, and planting steeper areas for wood production. Both options result in less soil disturbance and prevention of long-term damage.

Land capability assessment at the property level involves the same principles as those used for broader scale assessment. However, more detailed information needs to be collected as the result is direct guidelines for land use and soil management practices.

By using the principles of land capability assessment at the property level, the farmer can better plan his farm layout and operations to identify the most appropriate land use for different areas of his property, and thereby ensure the long-term sustainable productivity of the land is not threatened (see Figure 13).

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

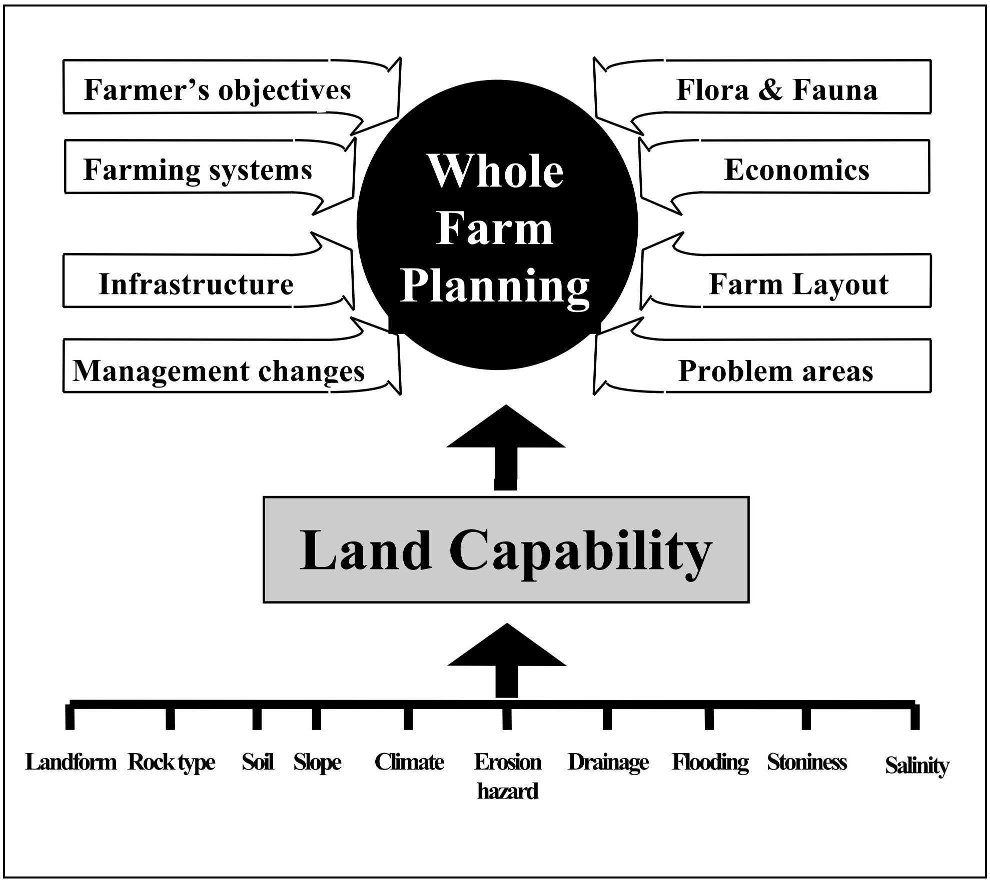


Figure 13. Land capability as a basis for farm planning

7.1 Procedure for Land Capability Mapping at Farm Level

Land capability at the property level is carried out by mapping to the class, subclass and unit level, as described in Section 3.

Before a land capability map can be drawn, it is essential to have an understanding of the physical resources of the property, and their relationships.

A detailed physical resource inventory is required for each area of the farm as this is used as the basis for the land capability assessment. The type of information needed would be rock type, soil type and properties, slope, aspect, altitude, exposure, erosion, hydrology and rainfall, etc. The land capability units based on this physical information are then drawn onto an aerial photograph of the farm and this information then forms the basis for the whole farm plan (Figure 13, above).

As part of a farm plan a series of overlays will be drawn over an aerial photograph of the property. Suitable scales for aerial photographs will depend on the size of the property and on the complexity of the landscape, but should be between 1:1 000 and 1:10 000.

At these scales it is possible to subdivide the landscape into land management units which reflect farm management and soil conservation needs.

In preparation for land capability assessment, overlays will be needed showing:

(a) major landforms

(b) geology

(c) soil types

To derive these overlays, the farmer's detailed knowledge will need to be supplemented by extensive field work over the entire property to determine boundaries and to make records or notes about certain features eg. descriptions of major soil types, slope, erosion features, rockiness, flooding hazard, drainage problems, salinity areas, etc.

The land capability units at the property level will be a subdivision of the landscape into management areas that have similar soil types, geology, slope, erosion hazard, aspect etc. These areas will require similar management and conservation treatments, and will be capable of growing the same kinds of crops, with similar potential yields.

Many of the land capability boundaries will be obvious, but others will require field checking. If the first three overlays are completed in detail, then this will make the land capability overlay much easier to compile. Land capability is an assessment of the potential of the land, so the boundaries should not be influenced by present fence lines, infrastructure, vegetation or land use. The practicality of managing these areas will be dealt with when developing the whole farm plan.

The land capability units identified should then be ranked in order, and described in an accompanying legend. An example is presented in the table below.

LAND CAPABILITY LEGEND - CRESSY RESEARCH STATION

LAND CAPABILITY CLASS	AREA (ha)	DESCRIPTION	ROCK TYPE	SOILS	SLOPE	LAND DEGRADATION HAZARD	LIMITATIONS TO CROPPING USE	SOIL CONSERVATION AND WATER MANAGEMENT MEASURES	COMMENTS
4e1	21	Gently undulating slopes (between Brickendon and Brumby surfaces)	Colluvium on clay.	**Newnham Series (N)** 0-15cm brown fine sandy loam, 15-20cm bleached clayey sand, some gravels, 20cm+ brown friable clay with red and yellow mottles.	0-3%	Rill, sheet erosion. Structural decline.	Suitable for cropping most of the year.	Minor soil conservation works.	Subsoil clays drain more freely than the Brumby series soils.
4e2	62	Flat to gently undulating surfaces of a thin veneer of Panshanger windblown sand, overlying Brumby terrace.	Windblown sand (35-50cm deep) overlying clays and gravels.	**Panshanger over Brumby Series (P/Br)** 0-20cm brown fine sandy loam, 20-40cm bleached yellowish, sand (wet during winter), 40cm+ yellowish, sometimes mottled sandy clay to heavy clay	0-5%	Rill, sheet erosion. Structural decline.	Suitable for spring and autumn cropping.	Windbreaks. Minimum Tillage techniques	Where depth of Panshanger sand is less than 35cm profiles were considered to be more typical of Brumby soil series.
4e3	5	Undulating to rolling slopes and scarps.	Alluvial sands on clay.	**Brumby Series (Br)** 0-20cm grey or brownish grey fine sandy loam, 20-30cm bleached white or pale yellow sandy clay loam or clay, with small quartz and ironstone gravel, 30cm+ yellowish grey (mottled & gleyed) clay.	5-15%	Wind erosion. Structural decline. Waterlogging.	Easier to get machinery on than 4w1 because of better drainage.	Drainage. Minor soil conservation works	Soils are better drained than 4w1.
4e4	73	Flat to rolling surfaces, lunettes and dunes of deep, windblown sands. Includes flat to gently undulating low lying areas within sand dune formations.	Windblown sands (>60cm deep)	**Panshanger Series (P)** 0-20cm dark reddish brown fine sandy loam 20-25cm + loose reddish brown sand **Panshanger Series (Pw)** 0-20cm brownish grey sandy loam 20-35 bleached loose grey/yellowish grey or creamy yellow sand, with manganese concretions, 35cm+ loose grey sand or yellow sandy clay.	0-15%	Wind, rill, sheet erosion. Structural decline.	Good winter cropping (free draining). Soils dry out too rapidly for spring and summer cropping. Cultivation timing critical because of wind erosion hazard.	Windbreaks. Minimum Tillage techniques	Deep uniformly textured and weakly structured sand, with low organic matter content. P soils are very free draining with frequent periods of severe soil moisture deficiencies. Highly susceptible to wind erosion. Includes areas of Wilmore (W) soils which have a higher clay content than P soils. Low lying areas on Pw soils retain moisture for longer periods than Ps soils because of slower drainage. Some Pw profiles are paler with cream/yellowish colours in B, C horizons.
4w1	214	Flat to gently undulating terraces with poorly drained soils.	Alluvial sands on clay.	**Brumby Series (Br)** Similar profiles to 4e3, sometimes with more gravel present.	0-5%	Wind, rill, sheet erosion. Structural decline. Waterlogging.	Suited to spring cropping. Must be careful with irrigation timing and amounts, to give soils time to dry out before winter.	Drainage. Minor soil conservation works	Poorly drained soils with impeded vertical and lateral drainage. The surface soil is normally acid. In summer these soils set hard and with excessive cultivation rapidly lose their surface structure. The fine grained nature of the A2 horizon may result in excessive siltation of mole drains. Topsoil depths and textures may vary due to varying amounts of admixed Panshanger sand.
4w2	45	Flat terraces adjacent to streams. Recent alluvial soils with high clay content and restricted internal drainage.	Alluvial clays.	**Canola Series (Ca)** 0-25cm very dark grey or black organic clay loam or clay with grey or rust mottles, 25cm+ dark grey clay, yellowish grey clay or sandy clay, sometimes gravelly with orange mottles.	0-3%	Streambank erosion, waterlogging, flooding.	Suitable for spring cropping (good barley country). Difficult to get soil in suitable condition for cultivation - sets into hard clods, or is too boggy to work.	Drainage	Profiles are variable due to differences in alluvial parent material, flood frequency and degree of soil development. High water tables, poor internal drainage and surface flooding make these clay soils difficult to manage.
4s1	1	Gently sloping lower level surfaces of the Brickendon Terrace.	Alluvial gravel and sands on clay.	**Brickendon Series (B)** 0-15cm brown/grey silt loam or fine sandy loam, 15-25cm yellow/grey bleached fine sandy loam with quartz and ironstone gravel 25-30cm + heavy orange and red mottled clay.	0-5%	Wind erosion. Structural decline. Waterlogging.	Suitable for cropping most of the year.	Drainage. Minor soil conservation works	Subsoil clays drain more freely than Brumby Series soils. Slightly more erodible than 4e1 because of increased slope. Profiles are not as gravelly as typical Brickendon Series soils.
5e1	0.8	Moderately steep scarps of deep windblown sand.	Windblown sands (>60cm deep)	**Panshanger Series (P)** 0-20cm dark reddish brown fine sandy loam 20-25cm + loose reddish brown sand	30%	Wind, sheet, rill erosion.	Unsuitable for cropping because of slope and erosion hazard.	Windbreaks. Block planting of conservation trees. Maintenace of complete pasture cover.	
5w1	21	Poorly drained, low lying areas in drainage channels subject to frequent surface flooding and waterlogging and salinity concentrations.	Alluvial sands on clay.	**Brumby Series (Br)** Profiles generally shallower than those in 4e3, with clay B horizon at 20-25cm.	0-3%	Flooding, waterlogging. Salinity, gully erosion.	Unsuitable for cropping unless drainage is successful. Avoided for cropping because of wetness problems and associated poor yields.	Drainage Maintenace of waterways and drainage channels.	
6w1	7	Low lying poorly drained areas adjacent to streams and broken by meanders and oxbows.. Soils are subject to flooding and are very difficult to drain successfully.	Alluvial clays	**Canola Series (Ca)** Similar profiles to 4w2	0-3%	Streambank erosion, flooding waterlogging.	Unsuitable for cropping because of difficulty of drainage and flooding hazard.	Flood levees where practical	

Example of Land Capability Legend at Farm Scale

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APPPENDICES

APPENDIX 1

SOIL MOISTURE AND ITS APPLICATION TO LAND CAPABILITY CLASSIFICATION

The following pages provide an introduction to Soil Available Water Capacity and Soil Moisture Deficits and explores how they might be applied in the context of land capability. The information presented is based on an approach adopted by the Ministry of Agriculture Fisheries and Food in England (MAFF, 1988). The methodology is untested here in Tasmania and so has not been included in the main body of this text. Some more uptodate information on moisture retention by different soil textures is also included.

Crop adjusted available water capacity (AP)

AP is a measure of the amount of water retained in the soil profile which can be easily used by a crop. It is widely accepted that there is a direct relationship between water retention and soil texture but the figures seem to vary depending on the author of the data. For the ALC system, available water is calculated for the rooting depth of the crop (wheat or potatoes) and also giving allowance to the differing demands of the crops through different seasons and the degree of development of the root system.

Thus:
AP(wheat) cm = TA_{vt} x LT_t+$\sum$(TA_{vs} x LT_{50})+$\sum$(EA_{vs} x $LT_{50\text{-}120}$)

and:
AP(potatoes) cm = Ta_{vt} x LT_t+$\sum$(TA_{vs} x LT_{70})

where
Ta_{vt} = Total available water (TA_V) for topsoil texture
Ta_{vs} = Total available water for each subsoil layer
Ea_{vs} = Easily available water for each subsoil layer
Lt_t = Thickness (cm) of topsoil layer
LT_{50} = Thickness (cm) of each subsoil layer to 50 cm (depth of well developed wheat root system)
$LT_{50\text{-}120}$ = Thickness (cm) of each subsoil layer between 50 and 120 cm (depth of less well developed wheat root system)
LT_{70} = Thickness (cm) of each subsoil layer to 70 cm (depth of potato root system)

Moisture Deficit

The moisture deficit term used by ALC droughtiness assessment represents the balance between rainfall and potential evapotranspiration calculated over the critical part of the growing season.

Thus:
MD (wheat)= mid-July PSMD-1/3April PSMD

and

MD (potatoes)= August PSMD-1/3June PSMD -1/3 mid-may PSMD

Where
PSMD is Potential soil moisture deficit at various stages of crop growth reflecting differing demands for moisture (ie potatoes have little leaf cover until mid May and full cover not achieved until end of June).

and PSMD = ∑(R-PE)

where (R-PE) is calculated daily and summed over a defined period.
R = rainfall
PE = potential evapotranspiration - the amount of moisture transpired by a short green crop, completely covering the ground and with unrestricted water supply (Penman 1948).

Moisture Balance

Then moisture balance for ALC is therefore

MB(Wheat)= AP(wheat)-MD(wheat)

MB(potatoes)= AP(potatoes)-MD(potatoes)

The reliability and usefulness of these moisture balances are dependent on good rainfall and evaporation data at a substantial number of recording stations. Within Tasmania there is reasonable rainfall information data available but very limited evaporation and temperature data. Calculation of water balance information is thus severely constrained and inappropriate even to 1:100 000 scale mapping.

Available Water Holding Capacity

Soil available water holding Capacity (AWHC) is a measure of the soils ability to retain water under freely drianing conditions. Close correlation has been identified between AWHC and soil texture although actual AWHC may influenced by such factors as soil structure, organic matter content and stone content. In assessing AWHC storage within the rooting zone of potential crops needs to be considered. For most annual field crops this depth is usually about 120 cm, while for potatoes it is only 70 cm. Also, cereals have a less well developed root system below about 50 cm and can only extract readily available moisture (this concept is discussed further under Climate).

In some soils plant roots may not extend to their optimum depth due to some restricting layer within the profile. In Tasmania such layers are often rock or the underlying clayey B horizons within duplex or texture contrast soils. In such instances the rooting zone is the depth to the restricting layer. The following tables indicate total and readily available water in different texture groups and provide a guideline to the assessment of land capability class and soil available water holding capacity.

Texture Group	Water Holding Capacity (mm water/metre soil)	
	Readily available	Total available
Medium to coarser sand	30-50	40-80
Fine sand	40-60	60-100
Loamy sand	50-70	80-120
Sandy loam	40-70	100-140
Light sandy clay loam	60-90	110-170
Loam	80-100	140-200
Sandy clay loam	70-90	150-180
Clay loam	60-90	150-220
Clay	50-70	140-220

After Maschmedt and adapted from Wetherby 1992

The water holding capacity of a soil may be calculated by totalling the capacity for each texture layer within the rooting zone.

Land Class	Rootzone AWHC
1	>100 mm
2	80-100 mm
3	50-80 mm
4	30-50 mm
5	<30 mm

Soils with available storage of less than 30 mm are considered unsuitable for cropping activities and pasture becomes increasingly fragile as AWHC decreases further. Agricultural systems are considered to be rainfed with no application of irrigation water.

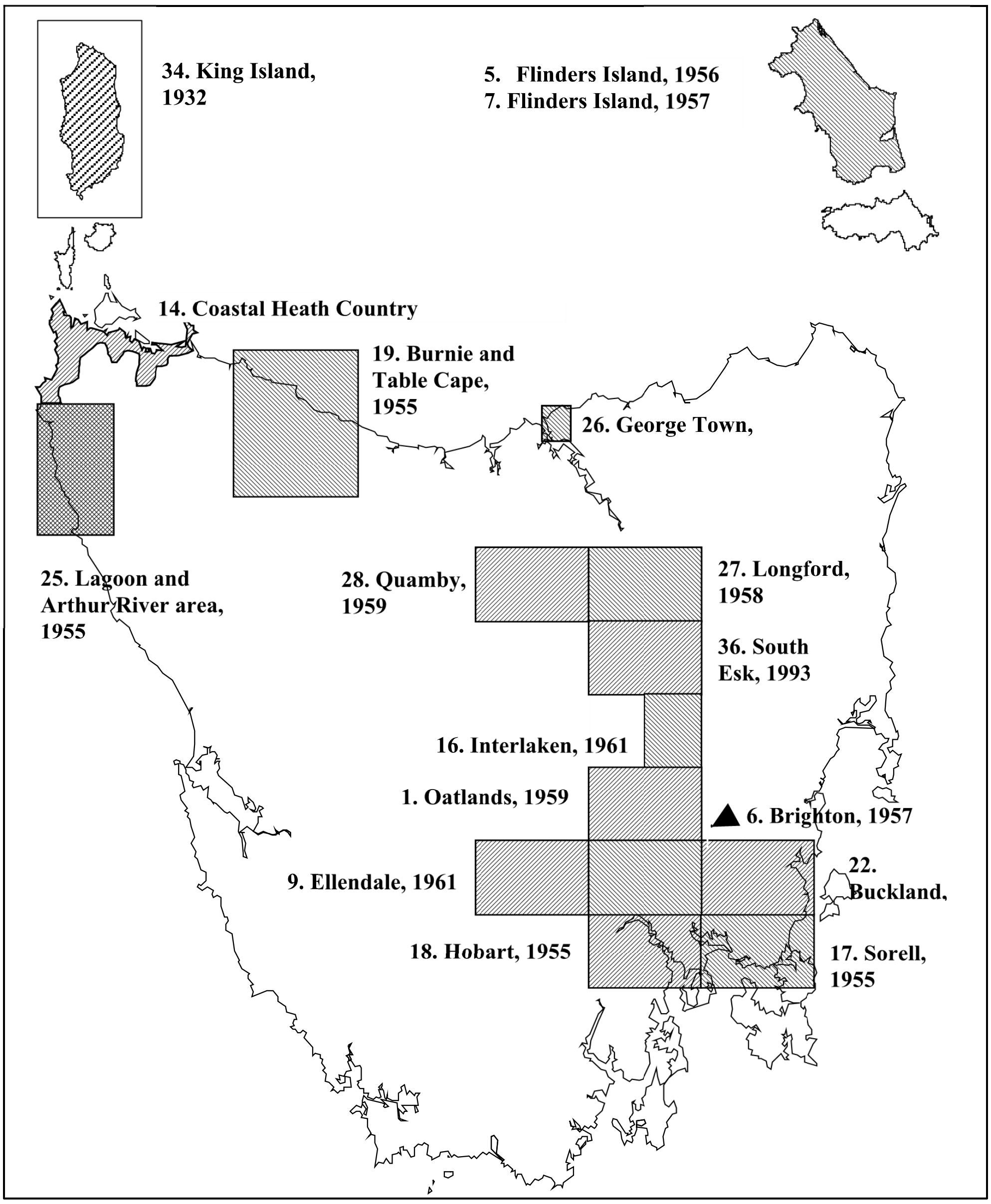
APPENDIX 2

CONVERSIONS FOR COMMON EC AND SALINITY MEASUREMENTS

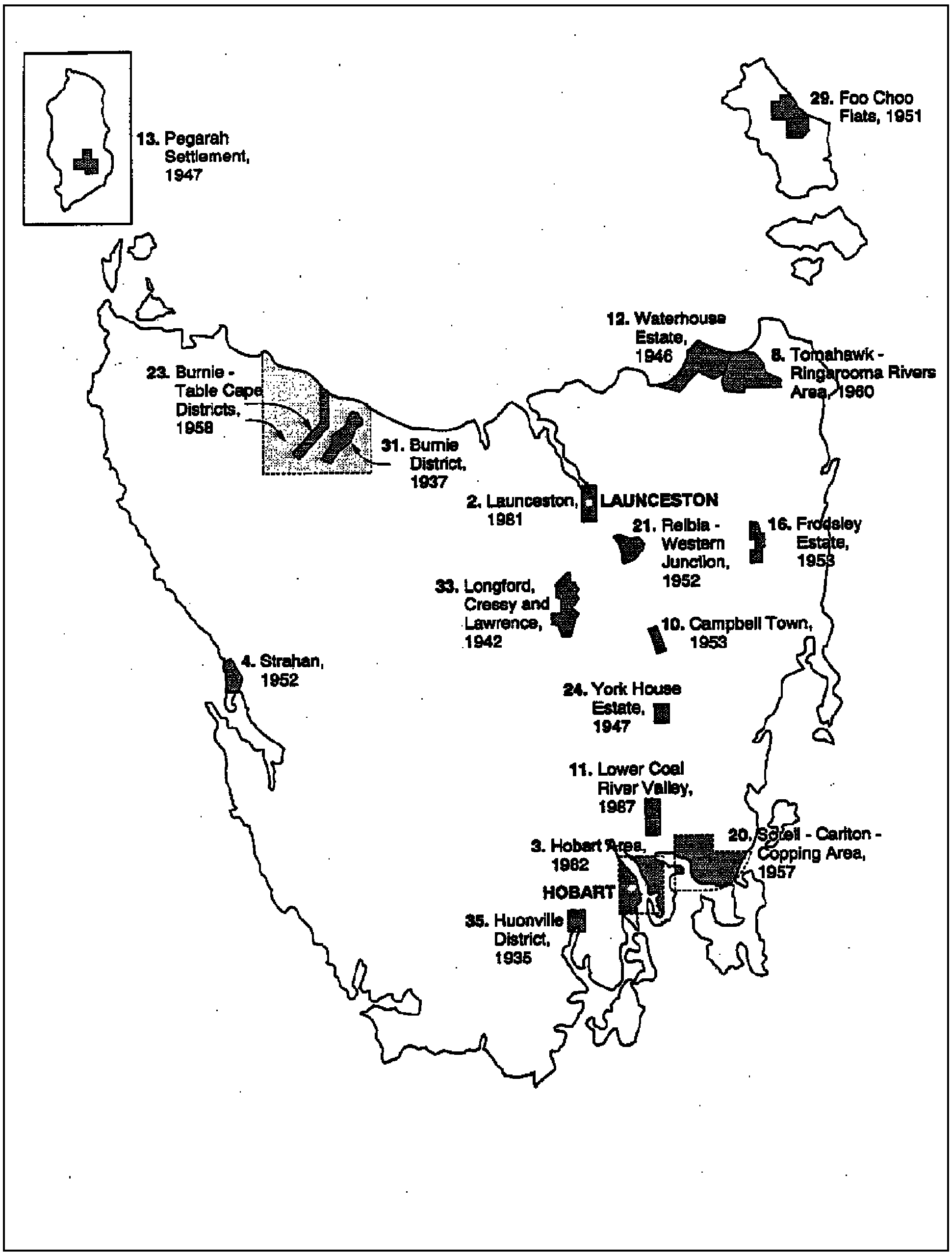
dS/m	μS/cm	mS/cm	mS/m	ppm
0	0	0	0	0
0.5	500	0.5	50	320
1.0	1000	1.0	100	640
1.5	1500	1.5	150	960
2	2000	2	200	1280
2.5	2500	2.5	250	1600
3	3000	3	300	1920
3.5	3500	3.5	350	2240
4	4000	4	400	2560
4.5	4500	4.5	450	2880
5	5000	5	500	3200
6.0	6000	6.0	600	3840
7.0	7000	7.0	700	4480
8.0	8000	8.0	800	5120
9.0	9000	9.0	900	5760
10.0	10000	10.0	1000	6400

APPENDIX 3

SOIL MAPS AND REPORTS AVAILABLE FOR TASMANIA



Published Reconnaissance Soil Maps of Tasmania (as at June 1999)



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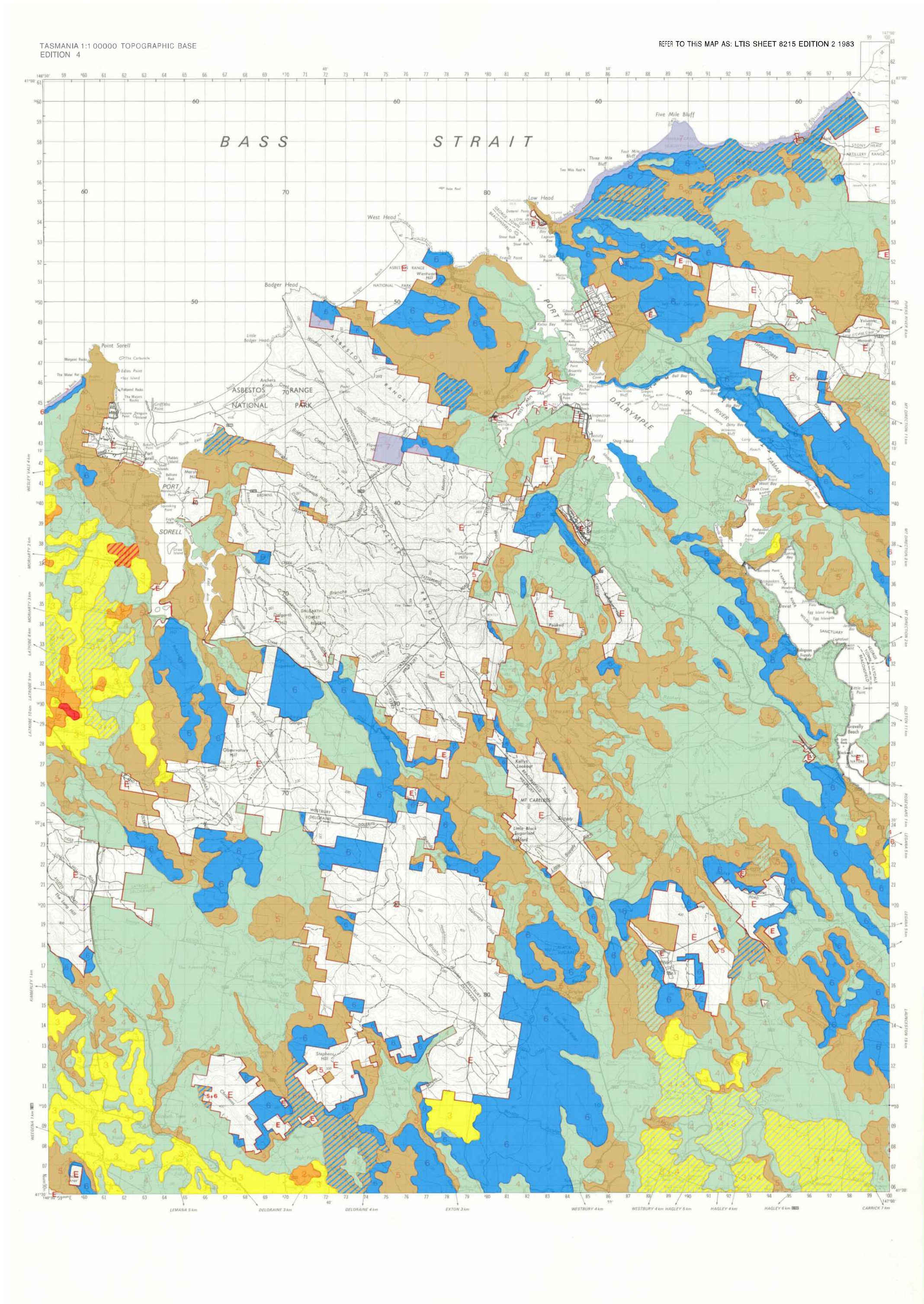
TAMAR



LAND CAPABILITY SURVEY TASMANIA

LAND CAPABILITY CLASSES

(based on the capability of land for long-term sustainable agricultural production)

1 CLASS 1
Multiple use land with virtually no limitations* to intensive cropping and grazing. It occurs on flat land with deep, well drained soils, and in a climate that favours a wide variety of crops. It is capable of being cropped eight to nine years out of ten in a rotation with pasture or equivalent.

2 CLASS 2
Land suitable for intensive cropping and grazing. Limitations to use are slight, and these can be readily overcome by management and minor conservation practices. Limitations reduce the length of the cropping phase to five to eight years out of ten in a rotation with pasture or equivalent.

3 CLASS 3
Land suitable for cropping and intensive grazing. Cultivation for cropping should be limited to two to five successive crops in a rotation with pasture or equivalent. Soil conservation practices and sound management are needed to overcome the moderate limitations to cropping use. The range of crops able to be grown is generally more restricted than on Class 1 or 2 land.

4 CLASS 4
Land marginally suitable for cropping because of limitations which restrict the range of crops that can be grown, and/or make major conservation treatment and careful management necessary. Cropping rotations should be restricted to one to two years out of ten in a rotation with pasture or equivalent. This land is well suited to intensive grazing.

5 CLASS 5
Land with slight to moderate limitations to pastoral use. This land is unsuitable for cropping, although some areas on easier slopes may be cultivated for pasture establishment or renewal. The effects of limitations on the grazing potential may be reduced by applying appropriate soil conservation measures and land management practices.

6 CLASS 6
Land marginally suitable for grazing because of severe limitations. This land has low levels of production, high risk of erosion, low natural fertility or other limitations that severely restrict agricultural use.

7 CLASS 7
Land with very severe to extreme limitations which make it unsuitable for agricultural use.

E EXCLUSION AREAS
Land other than Private Freehold and Leased Crown land, e.g. State Forests, State Reserves, Conservation Areas, etc.

* LIMITATIONS
In the above descriptions, limitations refer to physical factors or constraints which affect the versatility of the land and determine its capability for long-term sustainable agricultural production.

Different kinds of limitations are erosion hazard, slope, climate, flooding, poor drainage, stoniness, salinity and poor soil structure.

SCALE 1:100000

Kilometres 2 1 0 2 4 6 Kilometres

Contour Intervals : 20 metres with 100 metre index contours

MAP USERS NOTE:
This map provides an appraisal of land capability based on landscape, soils, climate and agronomic factors. The land capability class boundaries have been delineated by field work and aerial photo-interpretation. This map must not be enlarged. It is reliable only at the published scale of 1:100 000, and should not be used at a scale greater than this. This map should only be used in conjunction with the accompanying land capability report, which gives further details on the interpretation and use of this map. Only Private Freehold and Leased Crown land has been mapped. State Forests, State Reserves and Conservation Areas etc, have been excluded.

Field work by K E Noble 1990
Compiled by K E Noble 1990,1991
Drafted by D O'Toole 1991
Printed by Government Printer, Hobart, Tasmania 1992

Refer to this map as:
Noble, K. E. 1992, Land Capability Survey of Tasmania.
Tamar, 1:100 000 map. Department of Primary Industry, Tasmania, Australia.
Accompanies report titled 'Land Capability Survey of Tasmania. Tamar Report' By K E Noble, Department of Primary Industry, Tasmania, 1992.

© Department of Primary Industry, Tasmania, 1992.

Base map supplied by Department of Environment and Planning, Mapping Division, Hobart, Tasmania.

LAND CAPABILITY SURVEY TASMANIA

TAMAR

1:100 000

LAND CAPABILITY SURVEY of TASMANIA

ABOUT THIS MAP
This map depicts an assessment of land capability at a scale of 1:100 000. It is part of a series of Land Capability Maps covering all the Private Freehold and Leased Crown land in Tasmania. The land capability information is shown over a topographic base. The classification system used to generate this map consists of seven classes based on the capability of the land for long-term sustainable agricultural production.

Department of Primary Industry, Tasmania

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Landscape Change in the Meander Valley: A Case Study for Monitoring and Reporting of Land Use Modification, Vegetation Condition and Biodiversity Loss.

Sean Cadman

Bushcare Tasmania
May 2003

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Version: 1, Version Date: 18/06/2024

Disclaimer: The views expressed in this document are those of the Author and are not necessarily shared by any of the partner organisations.

Acknowledgments

I would like to acknowledge the contribution of all the partner organisations in providing inputs into this case study: CSIRO, Jeremy Wallace& Xiaoliang Wu; Environment Australia, Elizabeth Mcdonald; Department of Primary Industries Water and Environment, Mark Brown and Simon Lynch; Meander Valley Council, David Elliott and Stuart Brownlea. Finally Nina Cadman for her work on the vegetation classification.

Special thanks to Kiowa Rieck for helping me overcome MS Word and formatting the document for me.

All the work undertaken for this study was made possible by the Natural Heritage Trust.

Cover Images Clockwise: recently cleared native forest ready for plantations, training site ID 9; heavily gorse infested eucalypt forest, training site ID 1, terrain illumination corrected Landsat TM for 23rd November 2000; Air photo 1998 the Huntsman Valley an area experiencing rapid landscape change and; woody – non woody change Meander Valley 1991 – 2000.

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Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Table of Contents

APPENDICES 1-5 VOLUME II

List of Figures

List of Tables

Summary

Meander Valley Council has been the recipient of a large devolved Natural Heritage Trust grant to implement the recommendations of its Natural Resource Management Strategy. This grant has focused on the maintenance and enhancement of native vegetation and the protection of riparian vegetation and improving water quality. Part of the grant money was set aside to determine if a satellite monitoring system could be put in place to monitor biodiversity outcomes at the landscape scale.

This case study brings together the work of the partner organisations into a single document. The case study is expected to inform the development of a National Vegetation Condition Framework and inform State of Environment reporting in Tasmania.

Four objectives for the study were identified:

1 An assessment of the utility of a multi temporal woody change analysis undertaken by CSIRO (Perth) covering the municipality and subsequent use of this data to determine woody change trends in the municipality and changes by sub-catchment.

2 The determination of the feasibility of attributing woody change using a range of different vegetation data sets including a satellite vegetation classification, with the subsequent determination of biodiversity loss over time.

3 The policy and methodological reform that the results from the analytical work suggest.

4 An additional objective was to undertake a quick comparison between SOE data sets and the data derived for this project. This latter work is not included in the body of the report but is in one of a series of appendices, which include the reports, describing the input data into this report.

The appendices to the report have been produced as a separate volume

- It has been possible to accurately determine woody to non-woody change over a nine-year period and report against this by sub-catchment.
- By pursuing a two-fold approach using; firstly a digital satellite data derived vegetation classification and; secondly the intersection of available vegetation data sets. It has been possible to establish indicative trends in vegetation loss by community. Accurately determine and confirm areas subject to conversion to agriculture or plantation; and areas of native forest harvesting from 1995 - 2000.
- The results from 1995 – 2000 have been mapped and represented as areas of high biodiversity loss (conversion of native vegetation) and moderate biodiversity loss (harvesting)
- In the period 1995 – 2000, 2993 ha of native woody vegetation was lost to plantations, agricultural development or urbanisation in Meander Valley.

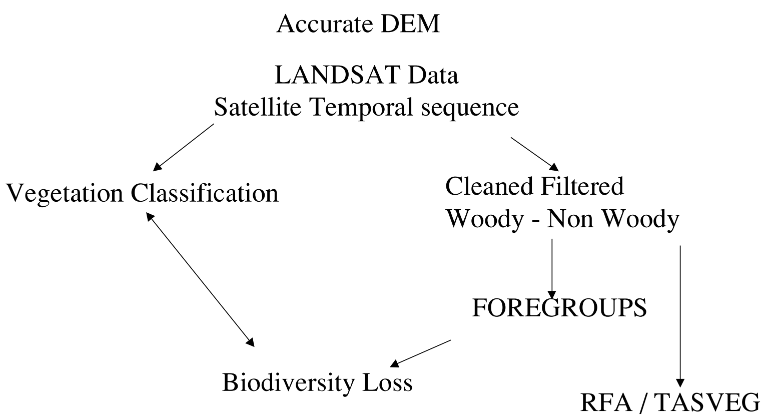
- The indicative trends show that forest communities identified as a priority for protection continued to be cleared in the period 1995 – 2000 including those considered endangered.

- The data showed a strong link between woody – non-woody change and plantation establishment with clearing rates accelerating post 1998.

- It was not possible to determine areas of woody weeds or woody weeds in understoreys. The methodological approach did not allow for the determination of clearance of non-woody native vegetation.

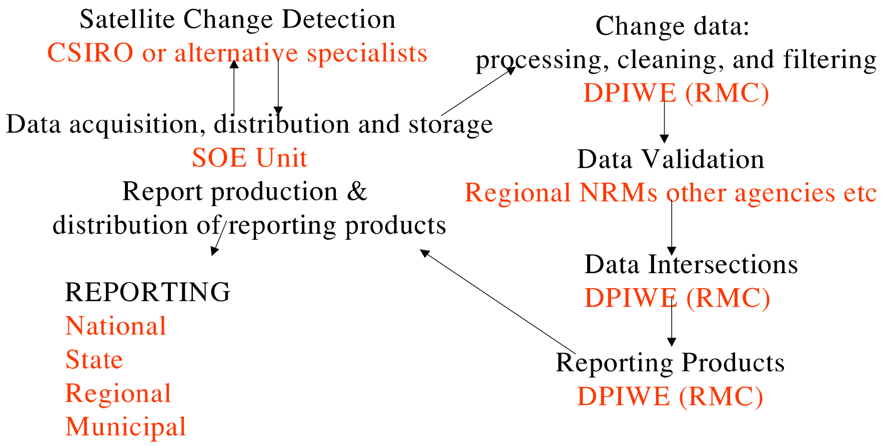
- The need for monitoring and reporting reform in the emerging Natural Resource Management policy environment is demonstrated and analysis and administrative frameworks proposed (below).

Reporting Woody Vegetation Biodiversity Loss



Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Possible Data Administration Framework for reporting vegetation / lanadcover change in Tasmania



The report contains a detailed set of conclusions drawn from the methodologies used and results obtained.

A set of recommendations arising from the study have been made which relate to each component of the study.

The most significant recommendations for implementation are:

- Meander Valley Council should adopt biannual reporting of' biodiversity loss' for the municipality
- State Government agencies should work towards monitoring and reporting reform
- Regional Natural Resource Management processes should establish baselines and monitoring regimes for regional vegetation management outcomes based on a robust spatial approach.

Chapter 1
Introduction

In 1998 Meander Valley Council commenced work on a Natural Resource Management Strategy (Inspiring Places 2000) and decided to seek funding for a devolved funding grant through the Natural Heritage Trust in the 1999 round. Bushcare provided help in drawing up the funding application and together with Meander Valley Council staff recognised that such a large commitment of public funding would require the capacity to demonstrate that positive and or negative environmental outcomes were occurring across the municipality at the landscape rather than project scale. Measures of inputs eg kilometres of fencing per hectare of bush protected provide a measure of relative efficiency of funds delivery but give little information as to whether the investments are providing a solution to broad landscape degradation trends, particularly biodiversity loss.

The grant application was successful including the provision of funding to undertake to determine baseline condition trends for the municipality using multi-temporal LANDSAT TM satellite data.

Bushcare as a participant in the Meander Valley Monitoring Study has worked cooperatively with a number of partners to help determine the feasibility of using satellite data to monitor changing condition in the vegetation of the Meander Valley over time. This report brings together the work of CSIRO Environment Australia Bushcare, Department of Primary Industries Water and Environment staff and Meander Valley Council.

Biodiversity loss is acknowledged widely both in Australia and Globally as one of the most significant environmental threats (Commonwealth of Australia 1996). Recognition of this threat is embodied in the establishment and continued support of the Bushcare and Biodiversity Conservation Programs nationally.

Ultimately the threats to biodiversity at a landscape scale can be distilled into two components loss of habitat and by inference the threatened species they contain or may contain and deterioration in the condition of habitat which if unchecked leads to the first component. Loss of condition is in fact on a continuum with pristine ecosystems at one end and human induced salt pans, concrete and bitumen at the other. Native vegetation loss is often regarded as the best surrogate measure of this – at least for terrestrial ecosystems (Saunders et al 1998).

Recent efforts in Tasmania to protect biodiversity have focussed largely on the creation of a crown reserve system. A federally funded on ground works to stabilise and enhance condition on private land together with a voluntary financial incentive scheme to capture forest communities largely confined to private land within a private forest reserve program. The crown reserve system is not capable of protecting all elements of terrestrial biodiversity and indeed much public debate is currently happening to suggest that the crown reserve system is not adequately protecting all the elements of biodiversity that could be protected.

The need for institutional reform to improve biodiversity outcomes is an explicit deliverable sought in the NHT partnership agreement (Commonwealth of Australia 1998a). This reform is expected to occur at all levels of government. Meander Valley Council through its Natural Resource Management Committee has been at the forefront of these processes.

Given the often unsubstantiated accusations pro and contra land-clearing, and in the context of a large public investment in securing biodiversity outcomes in the Meander Valley the need for accurate clearing data that can be as finely attributed as possible becomes acute. In the absence of a clear, well-documented and substantiated cases of irreparable damage then endless and pointless arguments about information rather than action occupies the body politic. This is as much true at a regional, state and national level as at the local government level.

In addition to these reasons Australia has Greenhouse abatement strategies in place part of which is the collection of accurate information in respect of the loss of woody vegetation in the landscape. There is recognition in Australian and international efforts to slow down the Greenhouse effect that a carbon trading system is a useful component (Commonwealth of Australia 1998b) There is parallel recognition that this should not be environmentally perverse. In order to ensure robustness these accreditation processes for carbon tradeable plantations have focussed on an early establishment date for the plantation and or its establishment on long cleared agricultural land. This is so that the plantation represents a net-positive carbon-sequestration outcome and has not occurred at the expense of biodiversity outcomes. The ability to demonstrate convincingly that a plantation has not been established at the expense of native forest therefore becomes critical.

As efforts focus in all jurisdictions to change Natural Resource Management Planning and funding to regional approaches then accurate agreed baselines, monitoring processes and reporting mechanisms need to be in identified within Regional NRM implementation and investment plans. In this context this report is timely as it proposes a practicable implementable solution for regional- state scale monitoring and reporting that can be further refined to deliver solutions to higher order accreditation requirements such as may well be necessary in carbon trading regimes.

This work is expected to inform the development of the Vegetation Condition Framework a joint initiative of the Environment Australia and the National Land and Water Resource Audit and inform State of Environment reporting in Tasmania

The objectives of the work undertaken for Meander Valley Council by Bushcare fall into four broad categories:

1 An assessment of the utility of a multi temporal woody change analysis undertaken by CSIRO (Perth) covering the municipality and subsequent use of this data to determine woody change trends in the municipality and changes by sub-catchment.

2 The determination of the feasibility of attributing woody change using a range of different vegetation data sets including a satellite vegetation classification, with the subsequent determination of biodiversity loss over time.

3 The policy and methodological reform that the results from the analytical work suggest.

4 An additional objective was to undertake a quick comparison between SOE data sets and the data derived for this project. This latter work is not included in the body of the report but is in one of a series of appendices, which include the reports, describing the input data into this report (Appendix 1).

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Chapter 2

Woody – Non Woody Change detection in the Meander Valley Municipality between 1991 – 2000.

Data Inputs.

CSIRO was engaged to undertake the calibration, rectification and subsequent woody change detection of a temporal sequence of satellite images covering the NW of Tasmania including Meander Valley. The latter task (change detection) was only undertaken for the Meander Valley Municipal area, as this required the use of a high-resolution spot height controlled digital elevation model in order to correct for terrain illumination. The Department of Primary Industries Water and Environment Land Management Branch generated this data for the Project. This data is regarded as critical to the success of the work.

The methodological approaches used and results obtained are fully described in Appendices 2 & 3 (Wallace and Wu 2001 & Wallace 2001).

In summary woody vegetation change detection is complicated in Tasmania because seasonal rainfall patterns are highly variable from year to year and in the agricultural landscape this produces unacceptably high errors of commission of woody vegetation. In order to allow for this a technique described as neighbourhood smoothing was applied. In brief this uses a statistical approach to compare woody / non-woody probabilities of the neighbouring pixels.

Temporal smoothing using an approach known as conditional probability networking (CPN) is first applied which removes many of the errors due to transient cultivation effects. The neighbourhood smoothing is applied in the CPN, which removes many further errors by relabelling isolated spots.

Wallace and Wu reported that this would lead to some relabelling of thin woody or mixed woody pixels as non-woody.

This technique has allowed for the production of series of data products with high intrinsic accuracy, which can then be further, manipulated and corrected based on field knowledge. These resulting derived products can then be used to produce statistical analysis of change.

The most appropriate data for testing the utility of the methodology are:

MVCdisturbancecodes.tif; composite image data containing always-woody data, always non-woody data, and change by date data. This is described in a read me text file provided by CSIRO.

mvc_6date_everwoody.bil is single attribute image coverage, which is the woody mask used to exclude false woody positives. This is described in a read me text file provided by CSIRO.

In addition CSIRO generated single date ER-mapper coverage's eg MVC_code6.xxx for all the post 1995 disturbance data at the request of the author.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

The individual full LANDSAT TM data for each date was used for reference and cross checking purposes.

In order to meet the requirements of Meander Valley Council's Natural Resource Management Project final cleaned and validated woody / non woody change data was required to be analysed by sub-catchment units.

The data, an Arc View coverage Mvcsubcatchment.xxx was derived by Bushcare for use in the development of the Council's Natural Resource Management Strategy (Inspiring Places 2000). This data excludes the small area contained within the South Esk catchment at the eastern end of the Municipality statistics for this area are therefore derived by subtracting totals of all other sub-catchment units from the total for the Municipality.

Map 1 Shows this data intersected with MVCdisturbancecodes.tif

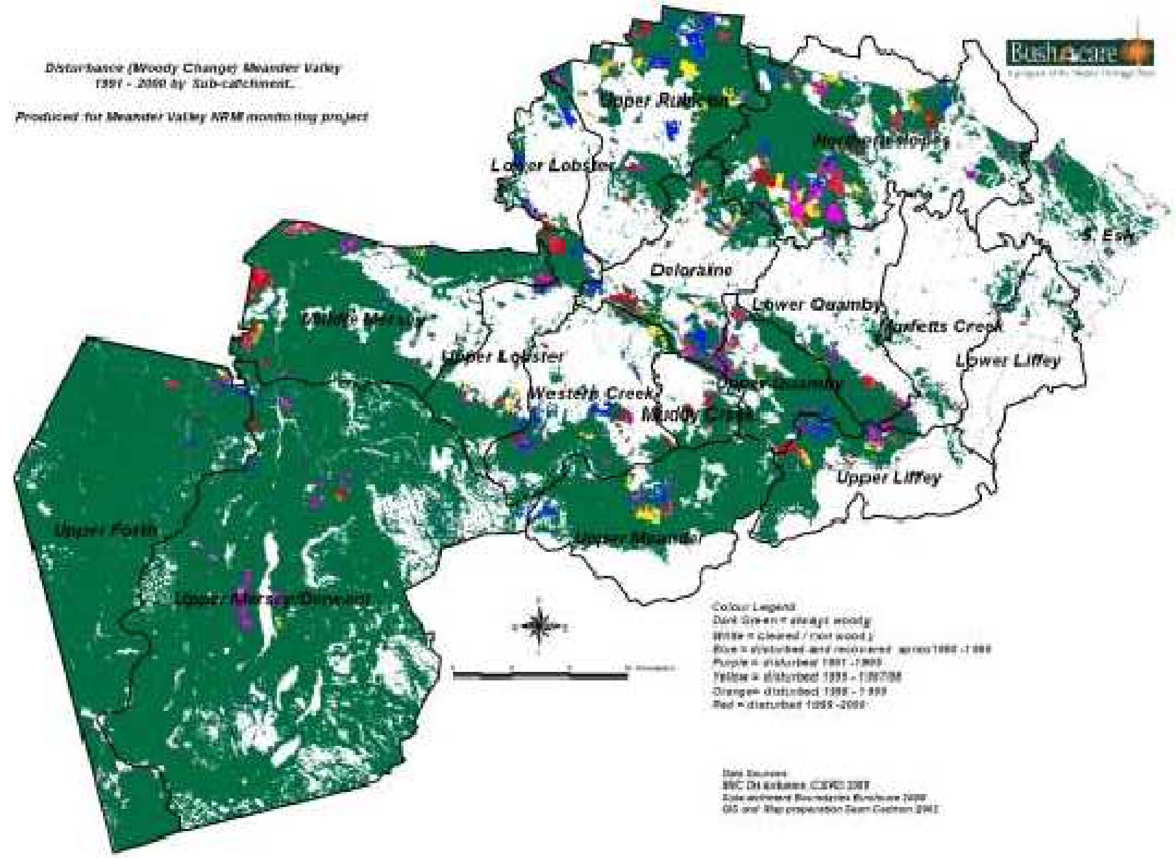


Figure 1. Map1

6

Landscape Change in the Meander Valley: A Case Study for Monitoring and Reporting of Land Use Modification, Vegetation Condition and Biodiversity Loss.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Methodology, Results and Discussion

The coverage MVCdisturbancecodes.tif was exhaustively visually examined to look for obvious errors of omission and commission.

A thorough scrutiny of the woody change data indicated a very high level of accuracy. Three obvious errors were found.

1. Figurers 2 & 3 below show a large patch of apparently cleared land around Mt Ironstone. The Ironstone plateau represents one of the largest areas of High Plateau surface. This is almost entirely free of woody vegetation. Its altitude also means that it can experience heavy snowfalls well into spring and sometimes-early summers. The clearing shown is in fact such a snowfall!

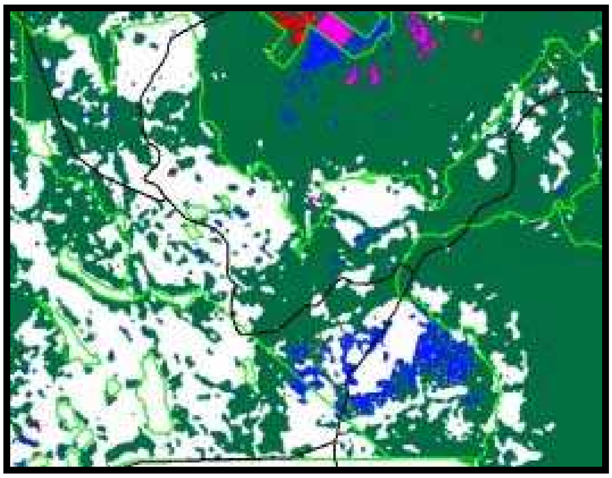


Figure 2. Woody change 91-95

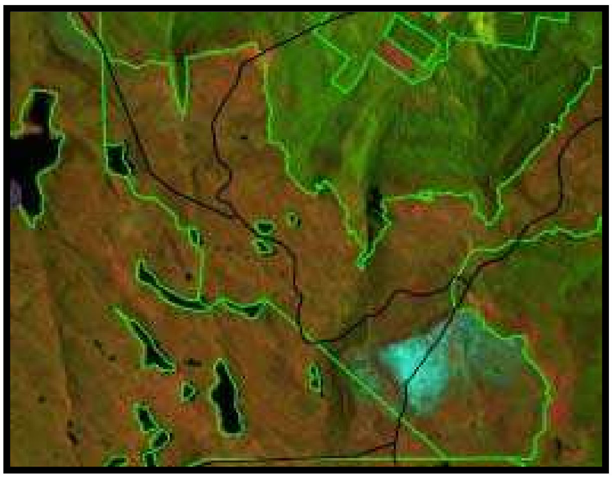


Figure 3. Snow on Mt Ironstone 1995

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

2. There is an anomaly on the very steep ridges of the Gog Range. This area has highly reflective quartz rock in patches and the area was subjected to two fires within the period of analysis. One of these was severe causing considerable rock exposure. Some of this rock exposure is still evident. Most fire effects on woody change recording are either not captured or produce a pattern of small patches that get filtered out. It seems valid to measure an intense fire event as woody change as there is a clear and persistent impact both to the canopy of the vegetation, ground cover and soil. For this reason these areas were included in the analysis. There is unlikely to be a permanent loss of native vegetation. A similar event that occurred on Mt Roland in 1999 was excluded as woody change because no objective assessment of recovery could be made due to the recency of the event. No data is lost so these areas can be manually included in further analysis if woody recovery fails to occur.

3. Small highly scattered patches in areas where change is unlikely to have occurred. These are likely to be due to a range of reasons, some of which will be fire effects, low intensity logging, snow patches at high altitude. One explanation for anomaly's of this nature noticed on the Western Tiers was the coincidence of the dates of the imagery with heavy flowering of Musk (Olearia argophylla) shrubberies! Similar results are found in the highly fragmented agricultural landscapes. These are likely to be real effects relating to loss of condition, including dieback, small scale clearing deciduous woody exotics and fire.

At the request of the Tasmanian State of Environment Reporting unit (SOE) woody change data and a satellite vegetation classification generated for its SOE report were compared with data used in this study (Appendix 1). This strongly reinforced the value of the methodological approach taken by Wallace and Wu (ibid). Some losses of woody vegetation no doubt occurred particularly in the agricultural landscape but the reduction of 'noise' in the data far outweighed these losses.

Before considering an approach to analysing this data it was noted that 1991 data included areas that would have been cleared prior to this date. In addition for the first period of change 1991 – 1995 the data shows area recovered plus the area showing woody to non-woody change at the 1995 date. This is different for1995 – 2000 data that is based on areas of change only and with intermediate date intervals.

On the basis of the above observations a methodology was devised to clean, filter and analyse the data to allow for determination of woody to non-woody vegetation by sub-catchment units for Meander Valley Municipality.

The data provided by CSIRO, MVCdisturbancecodes.tif is in a raster formatting that is divided into pixels approximately $25m^2$. Each pixel contains spectral data, which allows for the kind of sophisticated analysis described in Wallace and Wu (ibid). However in this format it is hard to perform spatial analysis particularly those involving transformations associated with intersections with other vector data. In addition editing of raster data requires specialised tools and knowledge. For this reason MVCdisturbancecodes.tif is categorised using Arc View Image Analysis software. This assigns a class label to each spectral value that can be discriminated by the software. This product is then vectorised by converting to a polygon coverage (Arc view shape file).

Once in this format the data can be subseted, filtered and cleaned easily. Firstly the disturbance classes are extracted from the data to create a new coverage.

All polygons of 1 hectare or less were then deleted, this is approximately equivalent to 15 pixels. This filter was chosen for two reasons:

- Firstly the noise in the data is dramatically reduced, albeit at the cost of small areas that had definitely been cleared together with areas around the edge of larger clearings and recently cleared narrow linear features such as roads and transmission lines;
- Secondly 1 hectare represents the legislative limit above which woody vegetation is deemed to require planning approval from the Forest Practices Board ie a pragmatic threshold.

This threshold can easily be adjusted and the analysis re-run using a lower limit if this is deemed desirable. However a minimum threshold of 4 pixels should be applied.

The data was cut using the World Heritage Area boundary this eliminated large snow patches and anomalies produced by changes in the water levels of some highland lakes. In the absence of any planned disturbance the only significant changes will be caused by medium to large-scale fires. Change of this nature is best captured opportunistically and separately. No events of this type were apparent over the time period of the analysis within the WHA. A fire around Mt Roland was excluded from the analysis due to its recency. IF at the time of the next analysis recovery is poor or absent then this area can be included as woody loss.

Once the disturbance data has been filtered and cleaned it was split into two change periods 1991 – 1995 and 1995 – 2000 using the date classes attribute to produce Arc view shape file coverages (1991-95newclean.xxx and 1995-2000newclean.xxx). There are two reasons that the data was treated this way:
Firstly the data for the first period was derived somewhat differently as described above and; secondly late 1995 represents the point in time at which the Regional Forest Agreement (RFA) data sets started to be compiled. These data are the standard against which performance is being measured for RFA compliance.

The base for the analysis was provided by the woody / cleared mask derived by simply vectorising mvc_6date_everwoody.bil to produce an Arc View Shape file coverage. This is then intersected with the MVC sub-catchments coverage using the Arc View Geoprocessing wizard tools.

The same approach was applied to the disturbance data for the two time periods.

The results were exported into an excel-spreadsheet to complete the analysis, to derive the area statement for the S. Esk sub-catchment and allow for the production of percentage change numbers.

In addition clearance rates for the individual dates for the whole municipality were derived by vectorising filtering and cleaning the individual post 1995 date files eg MVC_code6.xxx. The totals were exported into excel and graphed.

The results are presented below as a series of tables and graphs.

Woody Change in the Meander Valley between 1991 – 2000 by Sub-catchment.

Table 1. Woody Vegetation Present in 1991 as determined from Satellite Data/Sub-Catchment

NAME Sub-catchment	HECTARES 1991 woody
Deloraine	6111
Lower Liffey	647
Lower Lobster	1787
Lower Quamby	3951
Middle Mersey	19531
Muddy Creek	1940
Murfetts Creek	1804
Northern slopes	17513
Upper Forth	39518
Upper Liffey	5227
Upper Lobster	5279
Upper Meander	12362
Upper Mersey/Derwent	67937
Upper Quamby	6283
Upper Rubicon	11646
Western Creek	6670
S. Esk	4102
Meander Valley	**212308**

Table 2. Non Woody Vegetation Present in 1991 as determined from Satellite Data/Sub-catchment

NAME Sub-catchment	HECTARES 1991 non woody
Deloraine	8292
Lower Liffey	5573
Lower Lobster	5336
Lower Quamby	10723
Middle Mersey	6782
Muddy Creek	2871
Murfetts Creek	13497
Northern slopes	9504
Upper Forth	1552
Upper Liffey	1368
Upper Lobster	6384
Upper Meander	1659
Upper Mersey/Derwent	15889
Upper Quamby	1989
Upper Rubicon	10318
Western Creek	10404
S. Esk	7985
Meander Valley	**120126**

Table 3. Cumulative woody/non woody change 1991-2000

NAME Sub-catchment	HECTARES 1991 – 2000 cleared
Deloraine	1000
Lower Liffey	69
Lower Lobster	325
Lower Quamby	317
Middle Mersey	789
Muddy Creek	151
Murfetts Creek	150
Northern slopes	2767
Upper Forth	260
Upper Liffey	608
Upper Lobster	639
Upper Meander	441
Upper Mersey/Derwent	716
Upper Quamby	517
Upper Rubicon	1751
Western Creek	746
S. Esk	232
Meander Valley	**11477**

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Table 4. Cumulative woody/non woody change 1991-1995Table 4 Cumulative woody / non woody change 1991 – 1995

NAME Sub-catchment	HECTARES 1991 -1995
Deloraine	483
Lower Liffey	44
Lower Lobster	258
Lower Quamby	129
Middle Mersey	201
Muddy Creek	23
Murfetts Creek	99
Northern slopes	1241
Upper Forth	147
Upper Liffey	312
Upper Lobster	269
Upper Meander	181
Upper Mersey/Derwent	569
Upper Quamby	202
Upper Rubicon	931
Western Creek	395
S. Esk	174
Meander Valley	**5659**

Table 5. Cumulative woody/non woody change 1995-2000

NAME Sub-catchment	HECTARES 1991 -1995
Deloraine	517
Lower Liffey	25
Lower Lobster	67
Lower Quamby	188
Middle Mersey	588
Muddy Creek	128
Murfetts Creek	52
Northern slopes	1526
Upper Forth	113
Upper Liffey	295
Upper Lobster	370
Upper Meander	260
Upper Mersey/Derwent	147
Upper Quamby	315
Upper Rubicon	819
Western Creek	350
S. Esk	58
Meander Valley	**5818**

Table 6. Cumulative cleared/non woody expressed as % by sub-catchment (rounded figures),

NAME Sub-catchment	% cleared 1991	% cleared 2000	2000% cleared of remaining
Deloraine*	58%	60%	6%
Lower Liffey˜	90%	90%	1%
Lower Lobster˜	75%	76%	4%
Lower Quamby˜	73%	74%	2%
Middle Mersey	26%	28%	3%
Muddy Creek*	60%	61%	3%
Murfetts Creek˜	88%	88%	1%
Northern slopes#	35%	41%	9%
Upper Forth	4%	4%	1%
Upper Liffey	21%	27%	8%
Upper Lobster*	55%	57%	5%
Upper Meander	12%	15%	3%
Upper Mersey/Derwent	19%	20%	1%
Upper Quamby	24%	29%	6%
Upper Rubicon#	47%	51%	7%
Western Creek*	61%	63%	4%
S. Esk*	66%	67%	2%
Meander Valley	36%	38%	3%

~ at or below 30% woody vegetation cover

* at risk of reaching 30% woody vegetation cover

moderately cleared with rapid acceleration in clearing.

Figure 4. Rates of Woody to Non Woody Change between 1991-2000 & 1995-2000 with post 1995 plantation harvesting excluded.

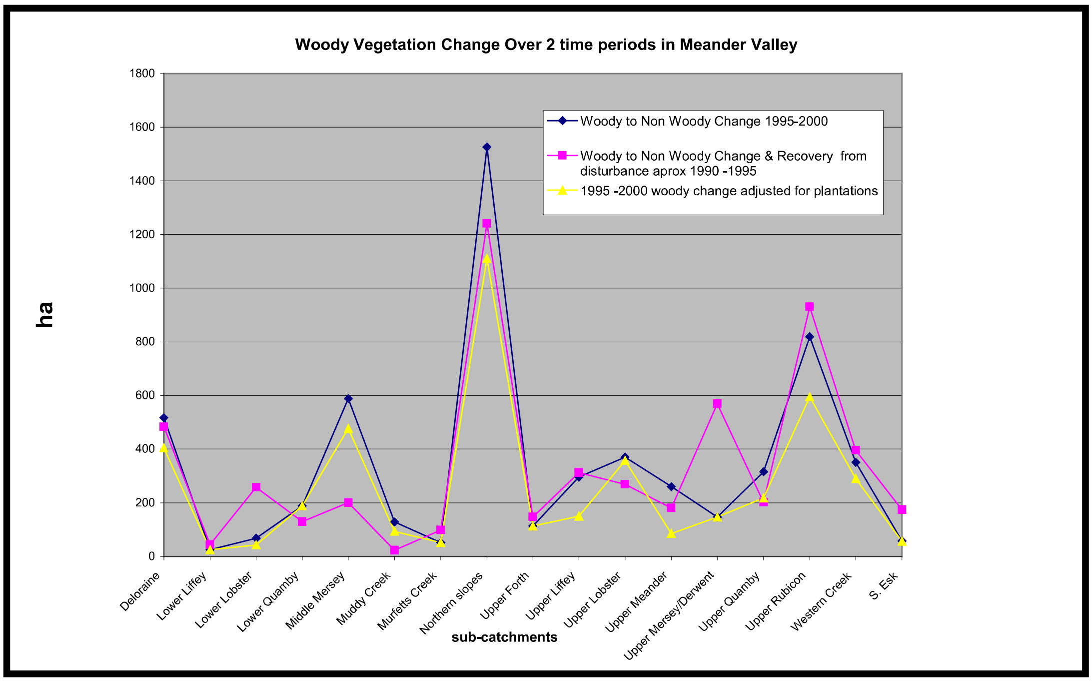
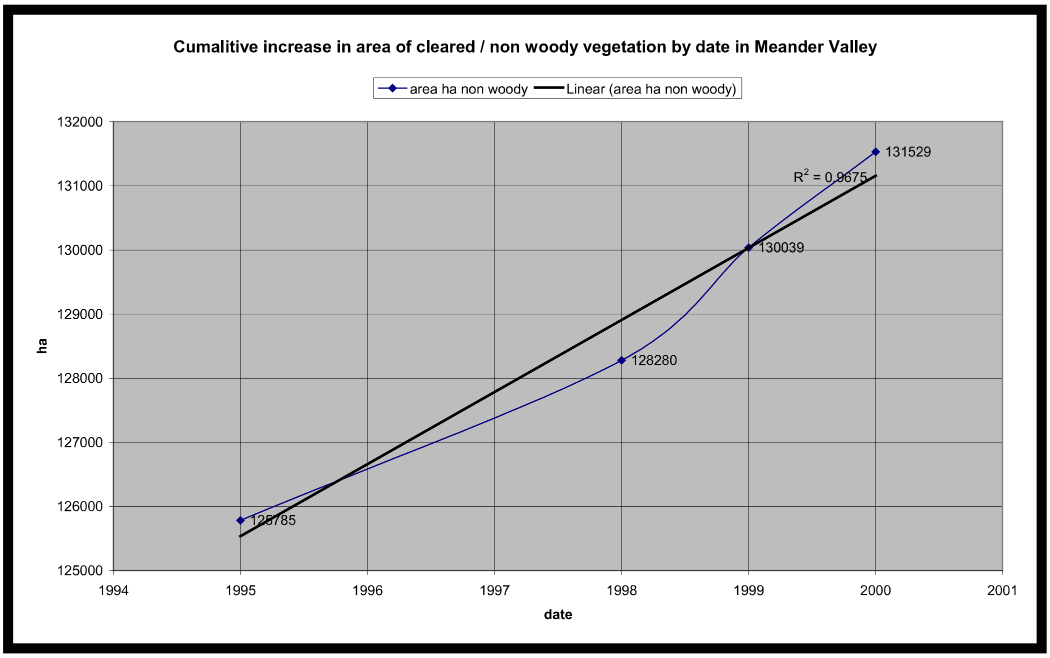


Figure 5. Clearing Trends 1995 -2000 in Meander



In addition to the quantifiable results there are some obvious patterns of concern in terms of the location of recent woody to non-woody change. In this regard the link between The Great Western Tiers and the North Coast of Tasmania through Long Ridge and Pumice Stone ridge has been very heavily impacted. The landscape as a whole is also continuing to be fragmented.

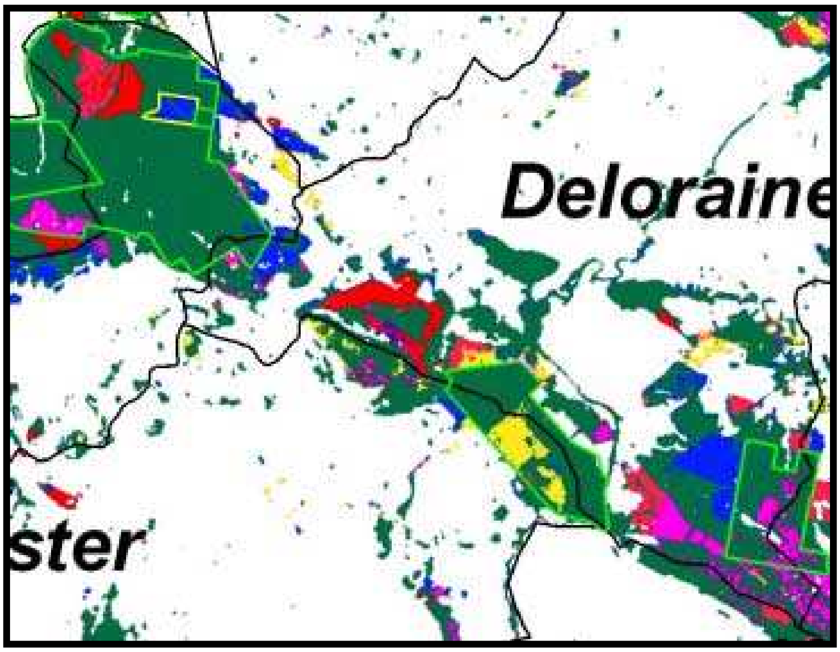


Figure 6. Landscape linkage showing significant levels of woody to non-woody change.

Conclusions

The methodological approach adopted has allowed for a robust and repeatable determination of woody to non-woody change in the Meander Valley.

a) It has been possible to identify accurately woody land cover change land over a nine year period by date and relate this change to landscape units identified in the Meander Valley NRM strategy.
b) Four sub-catchments (maked~) within the overall landscape are at or below the critical thresholds of woody vegetation and by inference native vegetation cover of 30% (Williams, J. 2000) native vegetation cover . A further 4 sub-catchments marked* are at significant risk of reaching this threshold and the trend of clearance over the time sequence of the study for Northern Slopes and Rubicon sub-catchments are cause for some concern.
c) The distribution of woody change in the landscape is highly asymmetric
d) The rates of woody change are roughly equal between the two time periods but a marked acceleration occurs between 1998 and 1999.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

e) The Meander Valley landscape is experiencing increasing fragmentation in terms of woody to non-woody change.
f) It is unnecessary and complex to analyse change within the world heritage area, other than opportunistically where a major natural disturbance has occurred eg fire.

Recommendations

1. That Meander Valley Council adopts the methodological approach detailed in the report to report against woody change by sub-catchment.

2. That the methodological approach adopted for woody change detection (including the use of high resolution DEMs) be extended to other NRM regions and State reporting processes to allow for a consistent approach to data collection.

Chapter 3

Attributing woody to non-woody change in Meander Valley and determining the impacts of clearing on biodiversity.

Data Inputs

The work described in Chapter 2 provides a robust and repeatable methodology for determining woody to non-woody change in Meander Valley. This in turn is very useful for providing an indication of trends of woody vegetation decline. Without any additional attribution this could be used to make estimates of woody biomass and provide indications as to likely catchment degradation associated with saline ground water systems. By inference woody vegetation loss is also providing a strong indication of negative impacts through biodiversity loss.

Bushcare was asked to determine, as part of its contribution to the project whether biodiversity loss could be attributed and quantified in Meander Valley. The critical tasks in establishing changes in vegetation condition in Meander Valley require an understanding of the level of conversion from native vegetation to cleared agricultural land, the level of conversion of native vegetation to exotic plantation and the extent of woody weeds within native vegetation. Finally could non-woody native vegetation types, wetlands and grasslands be determined from satellite data reliably.

The determination of agricultural clearance in landscapes where forestry is not an issue is relatively easily undertaken by temporal differencing of woody non woody vegetation by either manual or automated interpretation of image data (satellite or air photos). A manual approach was implemented recently for King Island (Cadman 2002).

Forestry makes the determination of trends quite difficult as 2 very distinct silvicultural systems are used in Tasmania. Native forest silvicultural systems where logging of varying intensities is applied followed up by natural or supplemented seeded regeneration. These systems have a negative impact on biodiversity, particularly on old-growth dependant elements but at a relatively low level compared to the second system where native forest is converted to exotic species monoculture. In order to establish a landscape scale monitoring system of biodiversity health in an area with a complex pattern of land-use it is vital to be able to attribute that landscape change. Woody change attribution is further complicated because plantation harvesting is also occurring.

A two-fold approach was used to determine the feasibility of attributing biodiversity loss in Meander Valley. The date inputs for the approaches are briefly described and reviewed below. In addition to these inputs were the final cleaned and filtered woody change data described in Chapter 2 (1991-95newclean.xxx and 1995-2000newclean.xxx)

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Digital Vegetation Classification using satellite data.

The primary input data was rectified, calibrated; terrain illumination corrected multi-spectral LANDSAT TM data from 23 November 2000. This data was provided by CSIRO in an ER mapper format, MVC2000_tcorr.ers.

Ground truthed training sites contemporaneous with the satellite data focussing on the desired attributes to be determined by the classification were derived. This data was provided as an Arc view shape file coverage, training sites.xxx. The data is attributed by TASVEG code, age class, and x y coordinates, with a short description and a digital photograph for most but not all sites.

Using these data a digital vegetation classification was derived for Meander Valley municipality excluding the World Heritage Area. The methodology and resulting data products are fully described in Cadman & Cadman 2002 Appendix 4.

The final product from the classification was a filtered ER mapper coverage using neighbour hood smoothing which was reclassed to combine some classes eg all the agricultural and urban classes. MVC2000_classification3_ reclass2(.ers). This data was then subjected to further analysis and filtering using the methodology described below.

The intersection of final woody to non-woody change data products for 1991 – 1995 and 1995 –2000 with a range of the available polygon vegetation coverages for the Meander Valley Municipality.

Three vegetation coverages are available to potentially use for attribution of biodiversity loss.

Regional Forest Agreement (RFA) Forest vegetation coverage. This is a state-wide coverage, which was prepared for use in the Comprehensive Regional Assessment (CRA). The data was compiled between 1995 – 1996. A subset of the data was prepared using Arc view Geo-processing tools covering the Meander Valley Municipality. This Arc view shape file coverage, Muniveg.xxx was used in the analysis described below. An Arc view shape file coverage of a subset of the RFA coverage of all the Plantation polygons in Meander Valley was also derived, Rfavegplantations.xxx

Meander Valley Natural Resource Management Strategy Vegetation coverage. This represents an update of the RFA coverage provided by DPIWE Nature Conservation Branch and the TASVEG 2000 project and uses TASVEG vegetation codes including non-forest communities. It is NOT a full coverage of the municipality. This data was processed using Arc view Geo-processing tools to produce Arc view shape file coverage Nrmsveg.xxx that was used for further analysis with Mvcsubcatchment.xxx.

FORESTGROUP is a state-wide coverage. The following is an extract from the meta-data statement for the data.

'*The dataset is a digital polygon coverage of Tasmania, (captured at 1:25 000 scale), detailing seven broad categories (groups) of forest vegetation, which have been* *aggregated from photo-interpreted forest types (PI-types) derived from varying scales of colour aerial photography.*

Photo-interpreted forest types (PI-types) are coded descriptions of forest vegetation. They classify forest into broad species groups as well as descriptions of stand structure. Full detail of PI-typing is described in Stone 1998).'

Two iterations of this dataset are available The first iteration is for 1999 (data collated 1998). A subset of this was extracted using Arc view geo-processing tools to provide and Arc view shape file coverage of all plantations in Meander Valley for this date. Meander plantations 1998.xxx. A second iteration provided as a state-wide Arc view shape file coverage FORGROUP.xxx is current to June 30 2002.

Review of available vegetation data

All three sets of data sets have been briefly reviewed for their utility in subsequent analysis.

The interpretation of trends in the vegetation data is intrinsically problematic for a number of reasons.

a) The only complete vegetation coverage for the Meander Valley Municipality is the RFA data. This does not identify any of the non-woody vegetation beyond a basic absence field nor does it identify significant components of the woody vegetation eg heaths and woodlands. The data has proved to be very coarse and is particularly deficient in delineating the rare and threatened forest communities.
b) The NRM vegetation data uses TASVEG mapping pathways and has updated some but not all of the RFA forest coverage. This data is not a complete coverage but missed very little of the areas identified as woody to non-woody change. There are still considerable problems with the accuracy of the attribution of this data.
c) Vegetation polygons have been assembled from air photo interpretation. A coverage may consist of a range of dates of photography in addition interpretation is usually by a number of individuals and further a complete coverage has to be built from pieces often resulting in errors at map or photo edges.

The figures below demonstrate the nature of some of the problems with vegetation data.

Example 1.An area of woody change (woody to non woody) from the satellite analysis that was identified when intersected with the NRM vegetation data as Fi or improved pasture was selected at random to demonstrate the point

Figure 7. Vegetation patch 1991

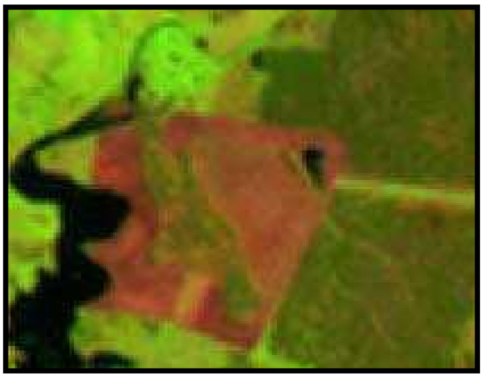


Figure 8. Vegetation Patch 1995

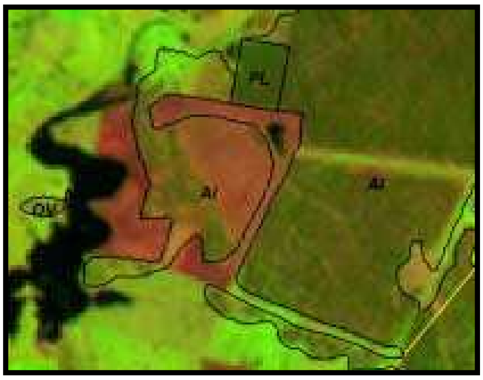


Figure 9. RFA mapping codes

Figure 10. NRM (TASVEG) mapping codes

Figure 11. Satellite post 1995 change

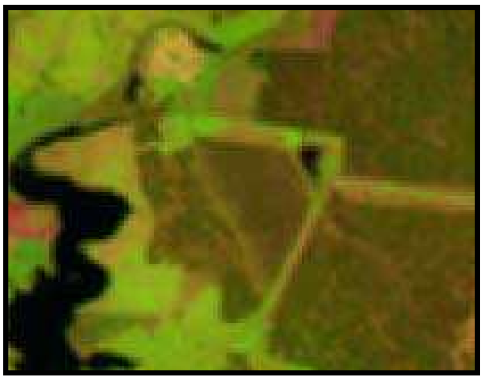


Figure 12. TASVEG code 1999 even aged regrowth very obvious

The small patch was never improved pasture or cropping but when an intersection is made with the woody change data the mapping error becomes obvious. In fact the site is a conversion to plantation.

Example 2 Work undertaken by Bushcare over the last 4 years and recent re-mapping undertaken for the Tamar NRM project (Blake et al 2003) have indicated that the vegetation in the Central North has both high heterogeneity and small patch size. High plant community richness (beta-diversity) has been recognised for part of the region notably the low to high altitude sequences between Quamby and Drys Bluffs (PLUC 1997). However fieldwork over the last 4 years and very recent work (Blake et al 2003) indicate that this is probably the case within much of the region.

Set out below are 3 Figures showing RFA mapping, NRM mapping and ground-truthed property scale mapping for the area between Quamby and Projection Bluffs. The property scale mapping is not a complete coverage. This data demonstrates the problems associated with current vegetation coverages for the region. Three features stand out. Firstly there is significant over and under representation of communities within the area. The rare community OV (Eucalyptus ovata shrubby forest) was unrecognised from the RFA, after a quick look for the NRM mapping the community is identified as present following detailed surveying the community is in fact a major feature of the valley floor. Silver wattle SI is massively over-represented, probably due to age of photography used to generate RFA polygons. Secondly the complexity and diversity of the vegetation only becomes apparent when ground truthed. Thirdly almost all the original polygons (RFA mapping) are either incorrectly attributed or required splitting.

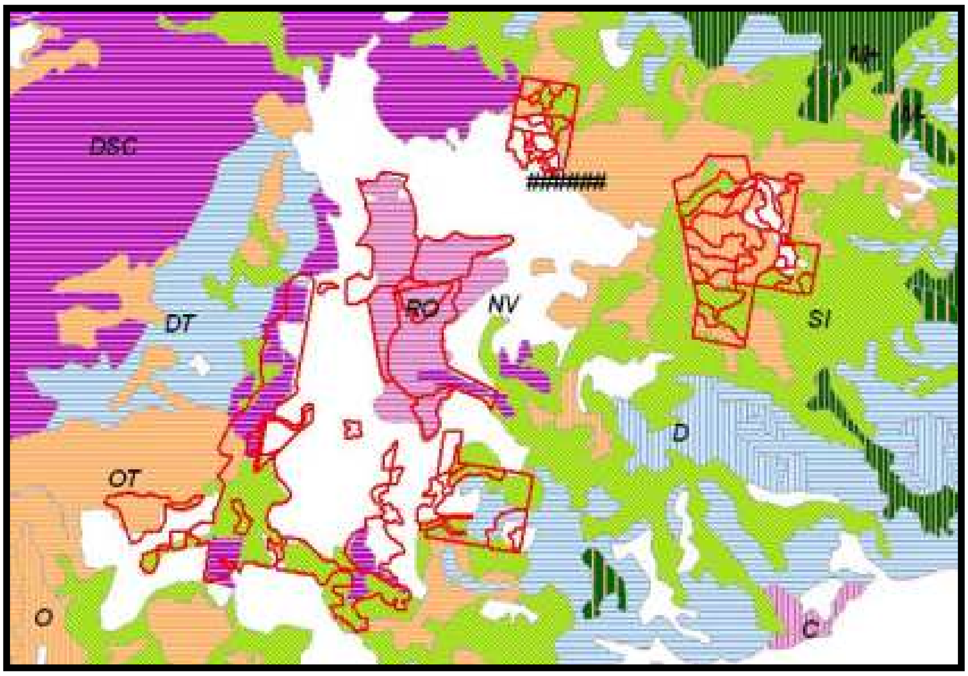
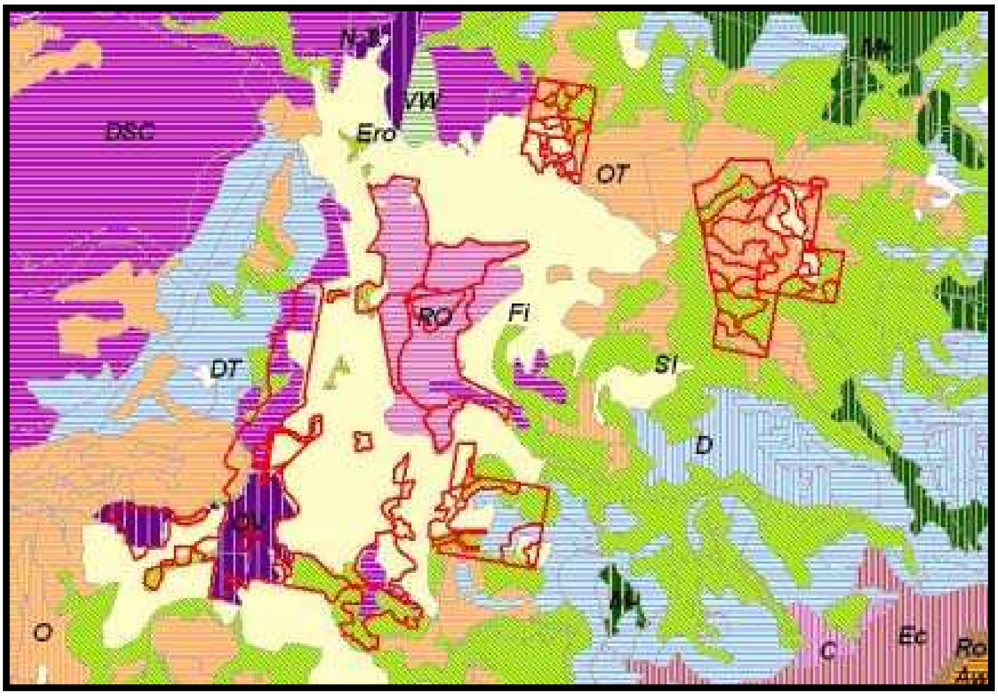


Figure 13. RFA mapping with ground truthed air photo derived polygons on top

Figure 14. NRM mapping minor corrections presence of E. ovata recognised



Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

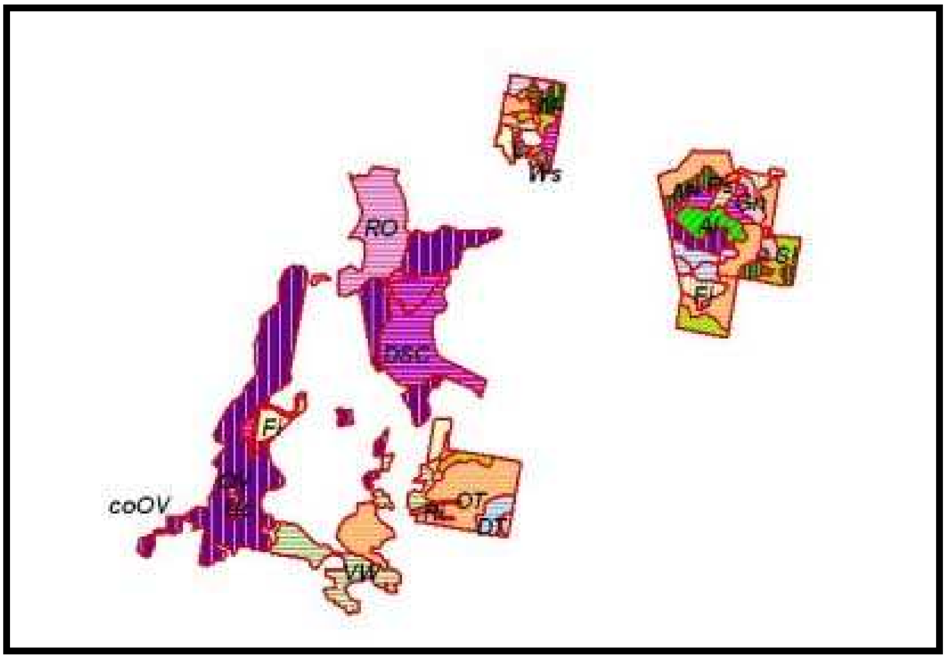


Figure 15. Ground truthed and attributed polygons mapped within the area

There are significant consequences for reporting associated with the error types described above.

Area statements for losses associated with particular vegetation communities are going to be wrong. Therefore interpretation of this data can only be made on broad and obvious trends. In addition any use of the polygon data to ‘train’ analysis of satellite data is likely to produce large compounded errors.

Most but not all of the disturbance data in the FORGROUP dataset is more recent than the last date in the satellite sequence. This is very useful, as a positive attribution of the cleared areas in the 2000 satellite data can be made. As with other photographically derived data there are a number of problems that need to be taken into account when using this data. Non forest woody vegetation is reported as non forest, some area of forest are reported as non forest and the other forest class is significantly overstated on the Gt Western Tiers, presumably due to over interpretation of silver wattle, Figure 13. Recently cleared forest that has not been regenerated is classed as non forest although this does not appear to be a significant issue for most of the analysis as these areas have mostly been cleared post the last satellite date so are not captured. In future it would be highly useful if this latter class could be separately identified as cleared or cut-over, eg crPSW as has been done with recent TASVEG mapping.

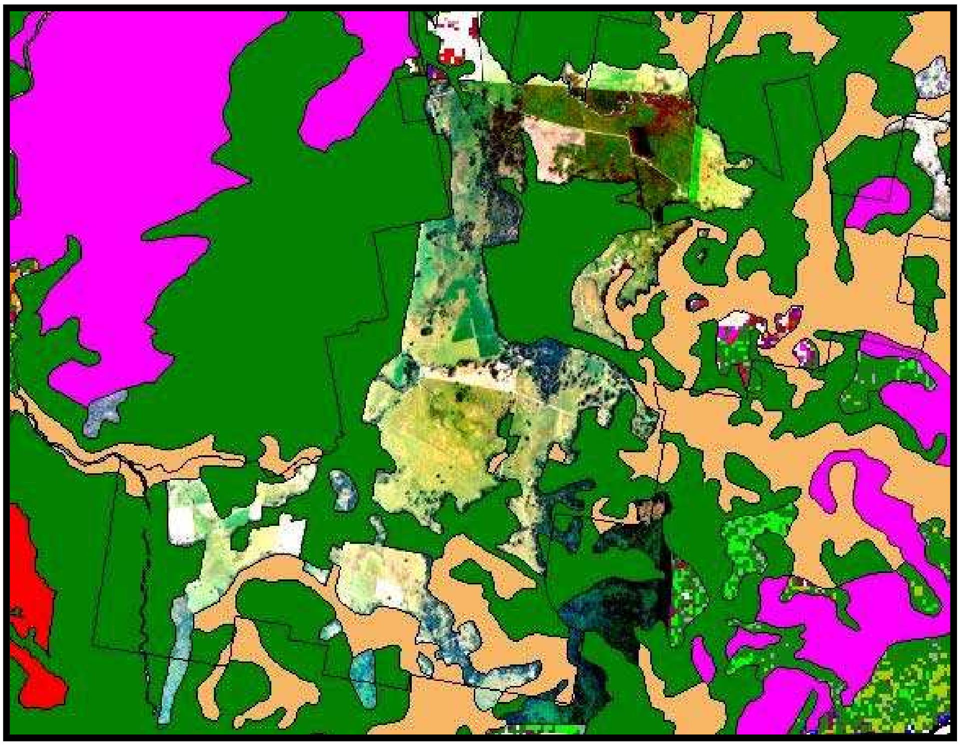


Figure 16. FORGROUP (2002) overlaying air photo Jackeys Marsh

Recognition of the errors illustrated above where the cleared class (shown as transparent) is clearly wrong can be explained by the age of the photography used to capture the 'background data' that is where no logging or plantation conversion has occurred recently. This is in part explained within the meta-data for the data set:

'*The currency of the FORESTGROUP data varies by tenure. Data for public land, (particularly State forest), is current as at June 2002 with regard to the latest landclearing, regeneration, selective logging, and planting information. The information for other native forest is current to the date of the photography from which it was interpreted; the state is covered by a 20 year remapping cycle. For private land, adjustments for land clearing, regeneration, logging and planting are as advised by major forestry companies to Private Forests Tasmania at various times to December 2001; recent changes which are not forestry-related or not associated with the activities of major companies may not be reflected in the data.*'

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Methodology, Results and Discussion

Digital Vegetation Classification using satellite data and subsequent attribution of woody change in Meander Valley

The generation of a digital vegetation classification Figure 20 was based on the use of ground truthed data (Appendix 5) and on ground knowledge to derive an accurate set of training sites. This is described in Cadman & Cadman 2002 (Appendix 4). The plantation and other vegetation attribute training sites were aged to allow for the opportunity to identify age dependant spectral signatures, if possible. Not all of these were used in the classification and further training areas were identified as required during the classification based on ground knowledge.

The attribution of woody weeds within the Meander Valley was unsuccessful. This is almost certainly due to the small patch sizes. Gorse understoreys provide a different spectral signature to the signature of the grassy facies of the Inland E. amygdalina community however this mimics native shrubby forest classes so is not particularly useful. One small native grassland class was derived from the classification but separating out native grasslands from agricultural classes is impossible in part because the patch sizes useful for training are simply not big enough.

The analysis was driven to try and segregate both eucalypt and softwood plantations. A classification class, hardwood plantations was identified as being plantations established on cleared land specifically. Although minor occurrences of other plantation classes are represented on cleared land. The hardwood plantation class has produced a lot of polygons, which are artefacts of agricultural classes, moisture related, and probably crop specific related signatures. This demonstrates the value of establishing a woody / non woody mask and provides an indication of the likely source of the very high false positive woody vegetation signatures in the SOE data sets. As this class was not envisaged in the original design it was not included in the filtering process but is discussed in the conclusions below.

In order to make the data produced from the vegetation classification amenable to further analysis it was vectorised using Arc view Image analysis and filtered using a 2 ha filter. This was a little ruthless but removed almost all the residual noise in the softwood plantation class. The resultant data was then further filtered using rule sets to remove obvious false positives. The rule sets were:

a) Areas below 800 mm rainfall Isohyet, there are some small scale plantings undertaken at or below this figure but not at an industrial scale.
b) Altitude 650 m for pine and 750 m for eucalypt. There are some older plantings that fall outside this but there is no active commercial pursuit of sites above these altitudes (Arthur Lyons pers com).
c) Obvious linear features eg transmission lines roadsides etc.
d) Obvious geological classes eg steep quartzite soils on Gog Range.

The resultant coverage was intersected with the most recent plantation vector data (FORESTGROUP 2002) This has been mapped (Figures 21,22 & 23 maps 2a,b&c)

Figures 17,18,19 demonstrate some additional uses to which the satellite data can be put.

Unfiltered satellite pines shown in mauve overlain by softwood plantations (yellow) and hardwood plantations (red). Plantations between points 1 & 2 show very close correlation between data sets. Errors of over-reporting and under reporting favour the satellite data within and adjacent to the

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

vector data from FORGROUPS 2002 (Figure 17). This is further illustrated below in figure 18where1995 imagery which has not been terrain corrected shows very clearly obvious visual differences between pine and native forest / hardwood plantations. Point 4 clearly stands out on the image and has been interpreted as pine by the classification shown in 17. Areas cleared in the 2000 satellite image are obviously not reported as pine by the analysis. Point 3a in figure 17 is shown as pine plantation by the vector data although visually this is unconvincing. In figure 19 this regeneration (point 3b)is shown strongly as hardwood plantation classes (solid orange).

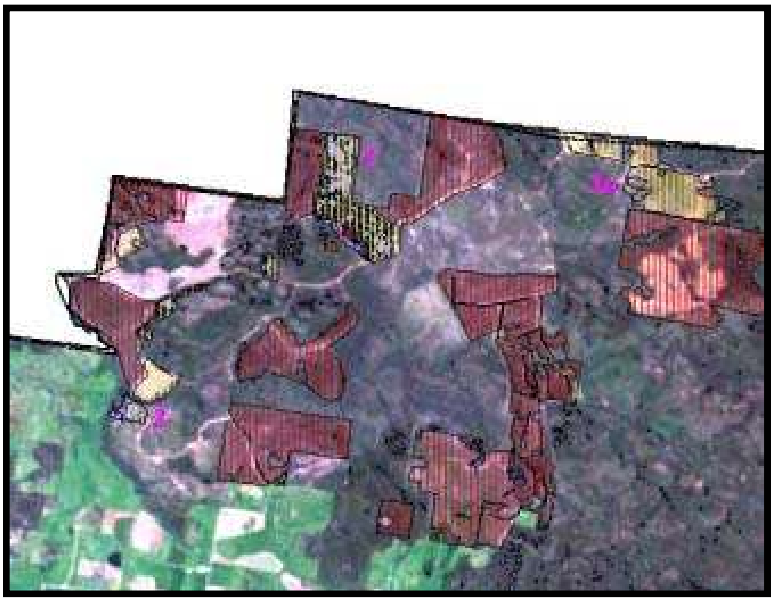


Figure 17 Using satellite classification for error detection.

Figure 18 Using satellite classification for error detection.

Figure 19 Using satellite classification for error detection.

Results

See maps below

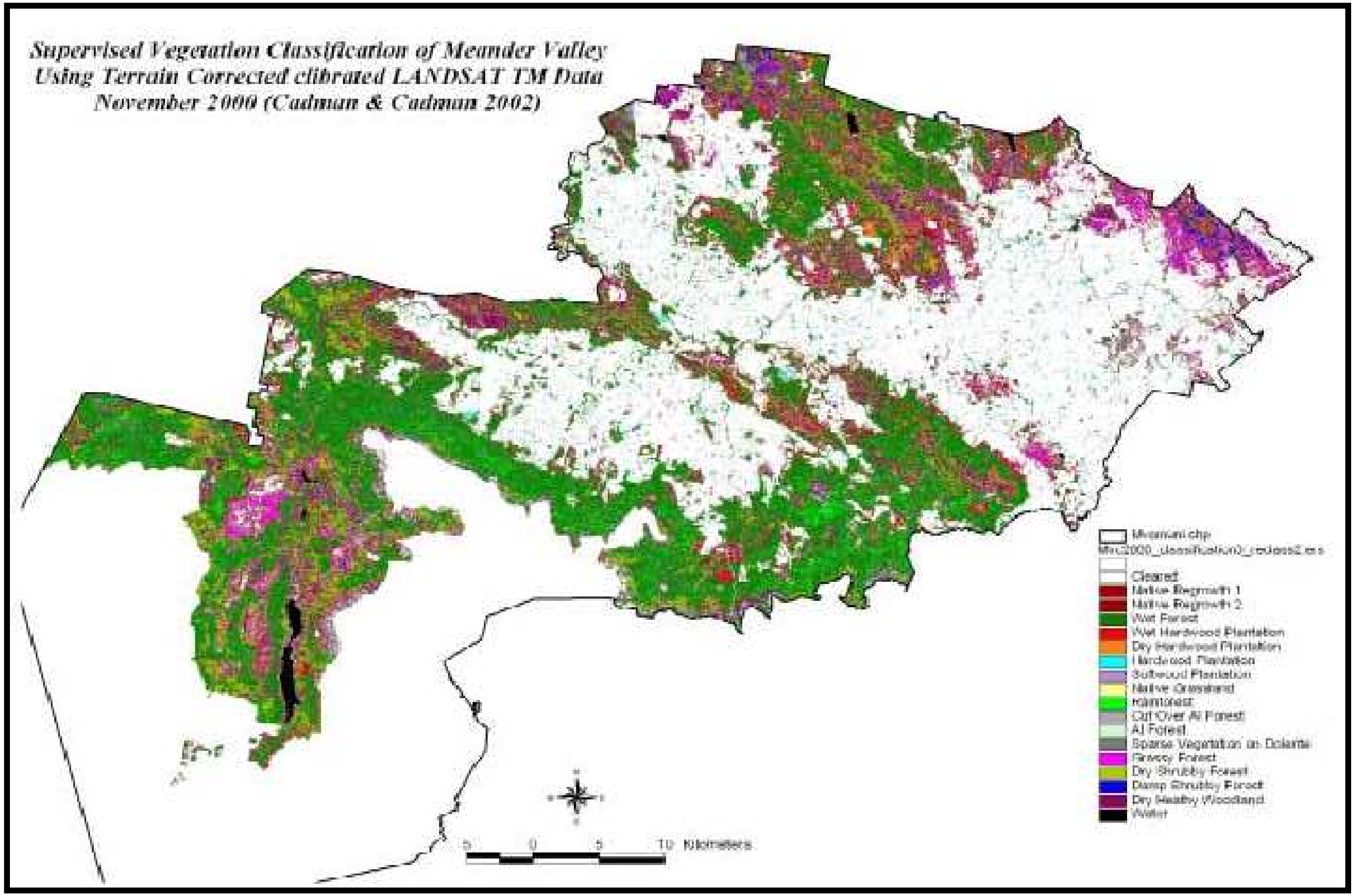


Figure 20. Map 2. Digital Vegetation Classification of Meander Valley minus WHA for November 2000.

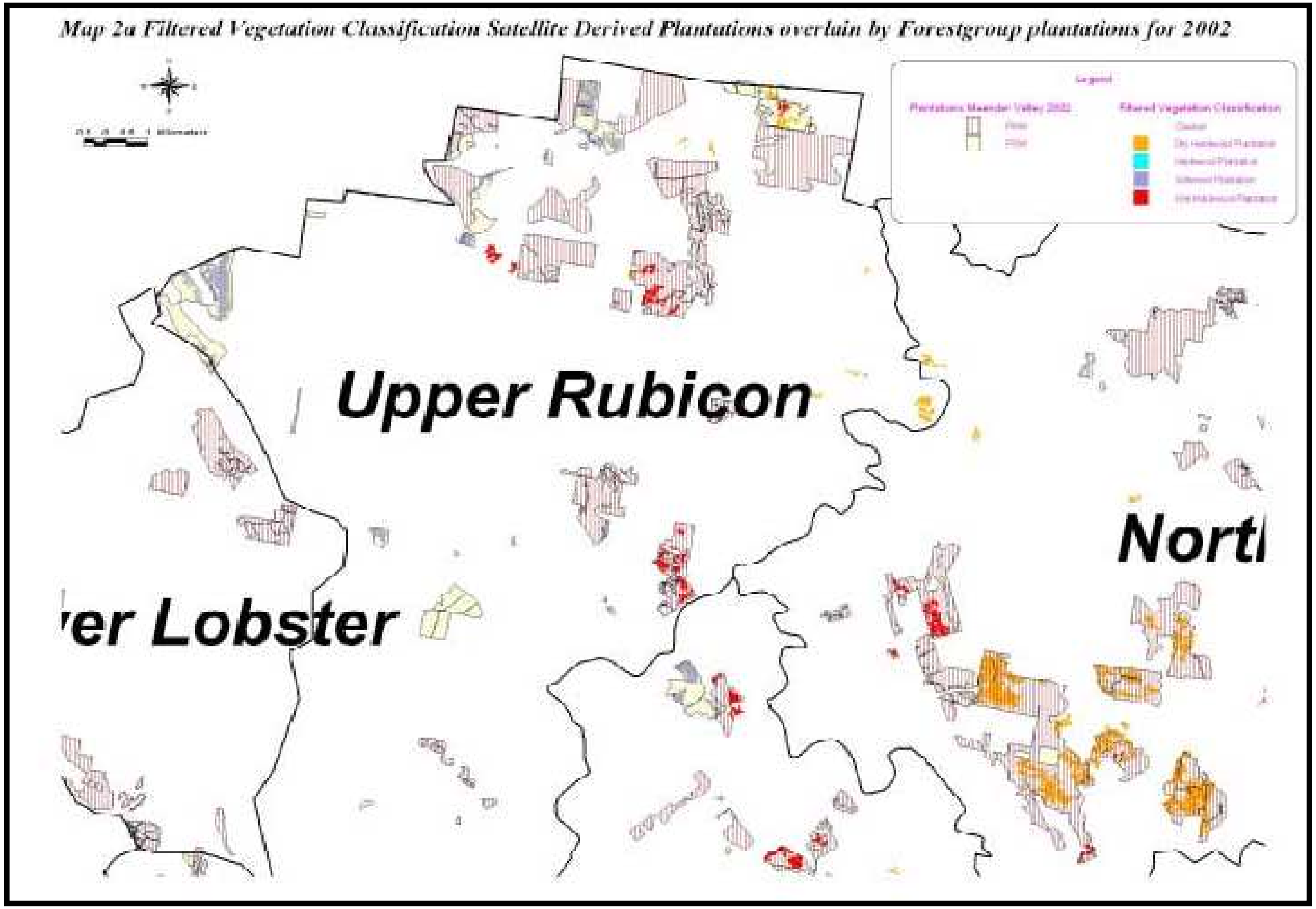


Figure 21. Map 2a Vegetation classification derived plantations overlaying FORGROUP (2002) plantations

27

Landscape Change in the Meander Valley: A Case Study for Monitoring and Reporting of Land Use Modification, Vegetation Condition and Biodiversity Loss.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

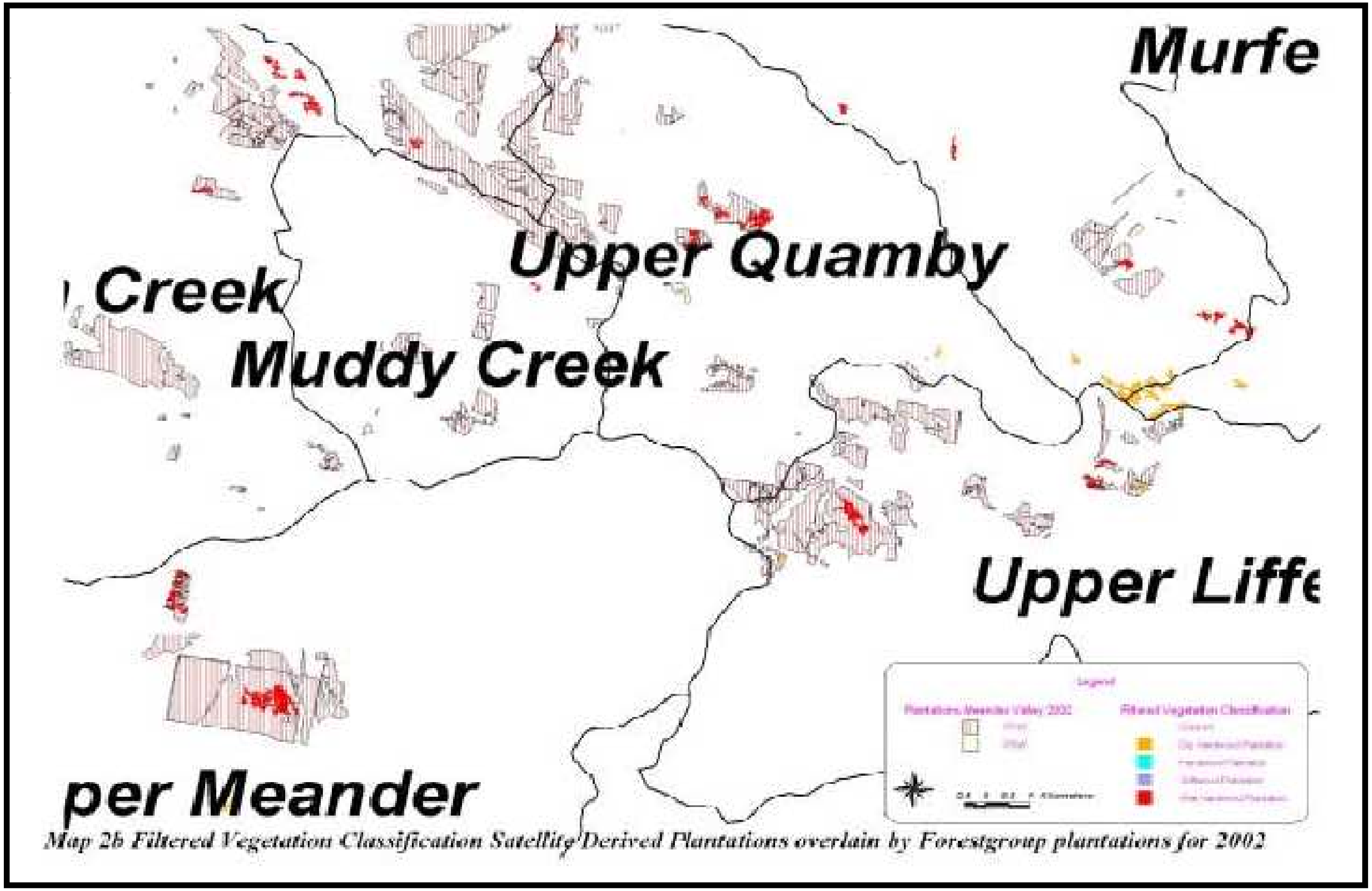


Figure 22. Map 2b Vegetation Classification derived plantations overlaying FORGROUP (2002) plantations

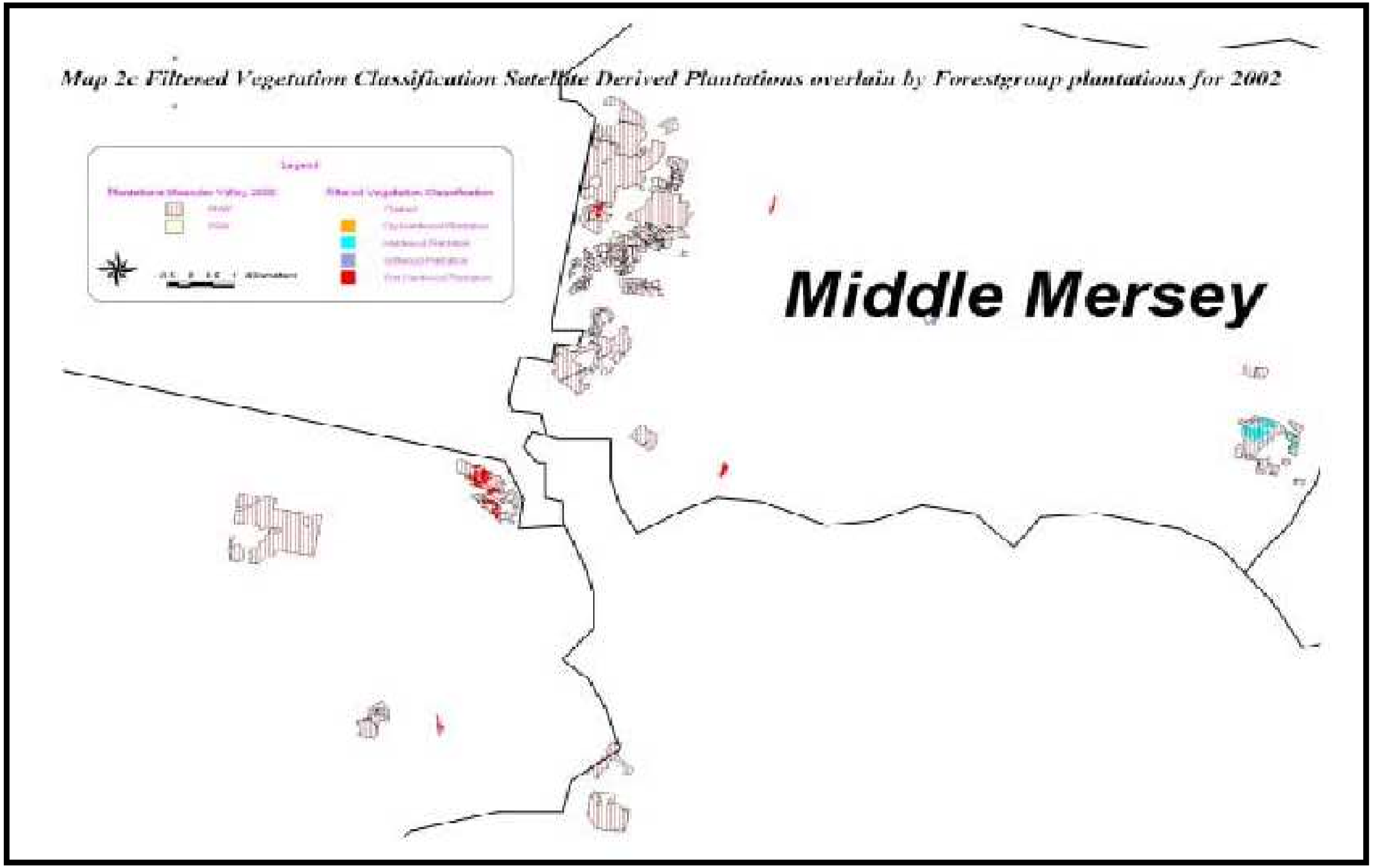


Figure 23. Map 2c. Vegetation classification derived plantations overlaying FORGROUP (2002) plantation

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

The attribution of biodiversity loss by the intersection of woody change data with vegetation polygons.

The review of the vegetation data (above) available for Meander Valley highlighted inherent problems with these data. Despite these problems NRM vegetation data (Nrmveg.xxx) and RFA vegetation (Muniveg.xxx) were intersected with the post 1995 cleaned filtered woody change data (1995-2000newclean.xxx) using Arc view geo-processing tools. The NRM Vegetation woody change data was further processed using the Arc view coverage, Mvcsubcatchment.xxx. Area statements of woody change by TASVEG community were derived, the S. Esk sub catchment were derived by subtracting the total area in the sub-catchment coverage from the total area in the Municipality. In addition plantation data from the three available data sets (RFA, FORGROUP 1999 and FORGROUP 2002) was extracted for Meander Valley as an indication of establishment trends between 1994 and 2001.

The FORGROUP (2002) data is the most intrinsically useable for the accurate attribution of woody change because the disturbance information is kept current. However when performing any intersections an allowance needs to be made for plantation harvesting.

The FORGROUP (2002) data is intersected with the woody change Arc view coverages 1991-95newclean.xxx and 1995-2000newclean.xxx using Arc view geo-processing tools. It is possible to discount for plantation harvesting in the post 1995 period by extracting areas of plantation identified as established in the RFA plantation coverage (Rfavegplantations.xxx) by a series of data transformations using Arc view geo-processing tools. This is not possible for the 1991 – 1995 period so an explicit assumption has been made. This assumption, to adjust the woody change figure downwards by 15% almost certainly leads to under-reporting of native vegetation clearing between 1991 1995 because of the uncertainty as to the attribution of areas of plantations cleared between 1991 and 1995. Figures 24,25,26,27, & 28 show three of the largest woody change polygons. These are all large plantations established between 1990 and 1992. This tends to suggest that most of the woody change detected between 1991 and 1995 was due to clearance of native vegetation. Plantation softwoods shown as cleared are all assumed to be second rotation and subtracted.

Figures 24,25,26,27, & 28 large woody change areas for 1991 -1995

Figure 24. The recently cleared area near the Lake Hwy turn off is shown as RFA plantation in 1995 but was established between 1990-1992

Figure 25. The largest area of clearing shown for 1995 Windows obvious

Figure 26. Very recently cleared native forest

Figure 27. Plantation landcape 1991

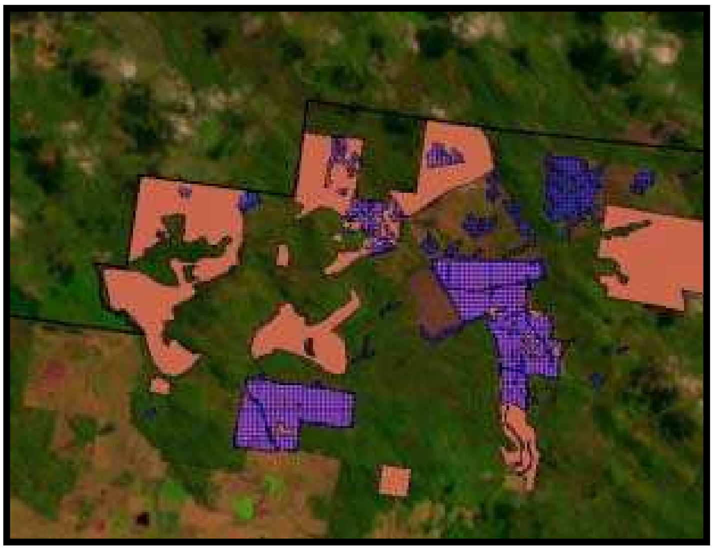


Figure 28.Areas recorded as plantation in the RFA are brown, clearing 1991-1995 Blue Hatch

If a reasonable assumption is made that areas of non forest from the FORGROUP data recorded as woody non woody change represent conversion to pasture or cropping then a figure for effectively irreversible biodiversity loss can be derived for Meander Valley. This can be accurately spatially represented for the period 1995 – 2000 by adding a biodiversity loss attribute field to the adjusted and transformed woody change FORGROUP (2002) data. And be estimated for the 1991 – 1995 period by correcting the data as described above.

The Vegetation Classification data allows for some testing of the least reliable component of the FORGROUP 2002 data. That is the attribution of private land showing woody change but not recorded as plantation or non-forest. By extracting 'Cleared' post 1995 woody change polygons from the vectorised Vegetation classification and then unioning these with the FORGROUP 2002 data using Arc view geo-processing tools its possible to determine the area of these polygons. An area of approximately 200 ha on private land was found in this category. This represents about 4% of the total area of woody change for the period. This is important as it puts a reasonable error bound on the data. Conversely at least one large polygon recorded as non-forest in FORGROUP 2002 was cleared between 1998 and 1999 and scored as high biodiversity loss is unambiguously reporting as native regrowth on the 2000 vegetation classification. It is probable that the 2002 data hasn't been updated to record the regrowth with an outside possibility that the area has been re-cleared post 2000. No attempt has been made to correct the data as it might compromise the spatial accuracy of the results. Possible solutions for refining the methodological approach are discussed below under Conclusions.

Change in the extent of native vegetation in Meander Valley 1995 - 2000

Table 7. Post 1995 woody change attributed with TASVEG vegetation codes (NRM veg).

TAG	HECTARES
AC	74.747
AD	408.893
AI	129.263
AS	5.18
C	0.579
D	60.442
DSC	1154.65
DT	418.877
Ed	0.889
Fi	554.51
Fw	3.196
Gl	0.019
Hg	6.841
M+	0.063
M-	11.765
N	3.359
N.T.	18.699
O	371.627
OT	432.01
OV	162.14
PL	1213.014
RO	15.312
Ri	2.751
Ro	0.09
SI	65.284
Tw	4.309
Uc	0.287
V	65.849
VW	14.666
W	2.483
Wh	18.498
coAD	56.679
coAI	5.735
coD	33.26
coDSC	176.056
coDT	31.503
coEa	0.038
coOT	30.372
coSI	5.914
crDSC	0.259
TOTAL	**5560.108**

Table 8. Post 1995 woody change attributed with RFA vegetation codes

VEGCOMM	HECTARES
######	10.457
AC	235.143
AD	579.853
AI	42.29
AS	1.469
C	0.579
D	81.694
DSC	1653.66
DT	341.234
M+	0.063
M-	22.525
N	9.756
NV	674.866
O	260.453
OT	609.148
OV	37.466
PL	877.3
SI	194.711
V	36.916
VW	148.583
TOTAL	**5818.166**

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Table 9. Woody change from 1995-2000 attributed with mapped NRM vegetation by Sub-catchment

WESTERN CREEK

NAME	TAG	HECTARES
Western Creek	AC	45.3
Western Creek	D	6.2
Western Creek	DSC	95.9
Western Creek	DT	64.6
Western Creek	O	9.1
Western Creek	OT	26.5
Western Creek	OV	2.1
Western Creek	coDSC	1.2
	TOTAL	250.8

UPPER RUBICON

NAME	TAG	HECTARES
Upper Rubicon	AD	8.931
Upper Rubicon	AI	60.622
Upper Rubicon	DSC	304.899
Upper Rubicon	O	11.546
Upper Rubicon	OT	40.97
Upper Rubicon	OV	6.669
Upper Rubicon	V	0.322
Upper Rubicon	VW	0.958
Upper Rubicon	coAI	1.155
Upper Rubicon	coDSC	23.183
	TOTAL	459.3

UPPER LOBSTER

NAME	TAG	HECTARES
Upper Lobster	AC	0.692
Upper Lobster	DSC	37.915
Upper Lobster	DT	22.103
Upper Lobster	O	130.508
Upper Lobster	OT	33.649
Upper Lobster	OV	0.103
Upper Lobster	V	2.578
Upper Lobster	VW	0.71
Upper Lobster	coDSC	1.196
	TOTAL	229.5

UPPER QUAMBY

NAME	TAG	HECTARES
Upper Quamby	AD	0.36
Upper Quamby	D	5.168
Upper Quamby	DSC	41.379
Upper Quamby	DT	24.94
Upper Quamby	O	9.512
Upper Quamby	OT	30.089
Upper Quamby	OV	4.352
Upper Quamby	SI	19.731
Upper Quamby	V	33.468
Upper Quamby	coDSC	90.646
	TOTAL	259.6

UPPER MEANDER

NAME	TAG	HECTARES
Upper Meander	DT	1.995
Upper Meander	M+	0.063
Upper Meander	M-	0.766
Upper Meander	O	2.032
Upper Meander	OT	30.073
Upper Meander	SI	0.837
	TOTAL	35.8

LOWER LIFFEY

NAME	TAG	HECTARES
Lower Liffey	AI	12.273
Lower Liffey	coAI	4.58
	TOTAL	16.9

UPPER LIFFEY

NAME	TAG	HECTARES
Upper Liffey	AI	1.028
Upper Liffey	D	2.532
Upper Liffey	DT	48.651
Upper Liffey	O	7.082
Upper Liffey	OT	30.323
Upper Liffey	SI	5.517
Upper Liffey	VW	6.829
Upper Liffey	coD	0.602
Upper Liffey	coDT	21.251
Upper Liffey	coOT	1.491
	TOTAL	125.3

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

UPPER FORTH

NAME	TAG	HECTARES
Upper Forth	AC	2.849
Upper Forth	D	0.018
Upper Forth	DT	0.309
Upper Forth	O	3.242
Upper Forth	OT	48.571
Upper Forth	SI	1.553
Upper Forth	VW	0.431
Upper Forth	Wh	18.498
Upper Forth	coD	2.53
	TOTAL	78.0

UPPER MERSEY/DERWENT

NAME	TAG	HECTARES
Upper Mersey/Derwent	C	0.579
Upper Mersey/Derwent	D	24.652
Upper Mersey/Derwent	DT	88.794
Upper Mersey/Derwent	Ed	0.889
Upper Mersey/Derwent	M-	0.622
Upper Mersey/Derwent	coD	30.128
	TOTAL	145.7

NORTHERN SLOPES

NAME	TAG	HECTARES
Northern slopes	AD	354.881
Northern slopes	AI	10.075
Northern slopes	DSC	360.919
Northern slopes	N	0.784
Northern slopes	O	42.712
Northern slopes	OT	46.26
Northern slopes	OV	142.945
Northern slopes	Ri	1.98
Northern slopes	SI	2.204
Northern slopes	V	1.268
Northern slopes	coAD	56.679
Northern slopes	coDSC	20.045
Northern slopes	coEa	0.038
Northern slopes	coOT	28.881
Northern slopes	coSI	5.839
Northern slopes	crDSC	0.259
	TOTAL	1075.8

MURFETTS CREEK

NAME	TAG	HECTARES
Murfetts Creek	AD	4.9
Murfetts Creek	AI	22.324
Murfetts Creek	D	0.007
Murfetts Creek	DT	0.981
Murfetts Creek	Gl	0.011
Murfetts Creek	O	2.781
Murfetts Creek	OT	7.241
	TOTAL	38.2

MUDDY CREEK

NAME	TAG	HECTARES
Muddy Creek	DSC	41.803
Muddy Creek	OT	36.208
Muddy Creek	SI	5.569
	TOTAL	83.6

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

MIDDLE MERSEY

NAME	TAG	HECTARES
Middle Mersey	AC	23.358
Middle Mersey	AS	5.18
Middle Mersey	DSC	19.963
Middle Mersey	DT	161.16
Middle Mersey	Hg	6.841
Middle Mersey	M-	10.377
Middle Mersey	N	2.576
Middle Mersey	O	31.804
Middle Mersey	OT	1.864
Middle Mersey	SI	17.746
Middle Mersey	VW	3.782
Middle Mersey	coDT	10.252
	TOTAL	294.9

LOWER QUAMBY

NAME	TAG	HECTARES
Lower Quamby	AD	18.224
Lower Quamby	AI	1.219
Lower Quamby	D	21.898
Lower Quamby	DT	3.192
Lower Quamby	O	69.31
Lower Quamby	OT	17.499
Lower Quamby	Ri	0.772
Lower Quamby	Tw	4.309
Lower Quamby	coDSC	39.806
	TOTAL	176.2

LOWER LOBSTER

NAME	TAG	HECTARES
Lower Lobster	AC	1.217
Lower Lobster	DSC	0.157
Lower Lobster	O	2.726
Lower Lobster	OT	14.553
Lower Lobster	OV	0.322
Lower Lobster	SI	1.204
	TOTAL	20.2

DELORAINE

NAME	TAG	HECTARES
Deloraine	AC	1.368
Deloraine	AD	4.197
Deloraine	AI	8.688
Deloraine	DSC	251.702
Deloraine	DT	1.512
Deloraine	O	49.295
Deloraine	OT	68.239
Deloraine	OV	5.663
Deloraine	RO	15.312
Deloraine	SI	10.923
Deloraine	V	19.256
Deloraine	VW	1.955
	TOTAL	438.1

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Figure 29. Plantation Establishment trends in Meander Valley

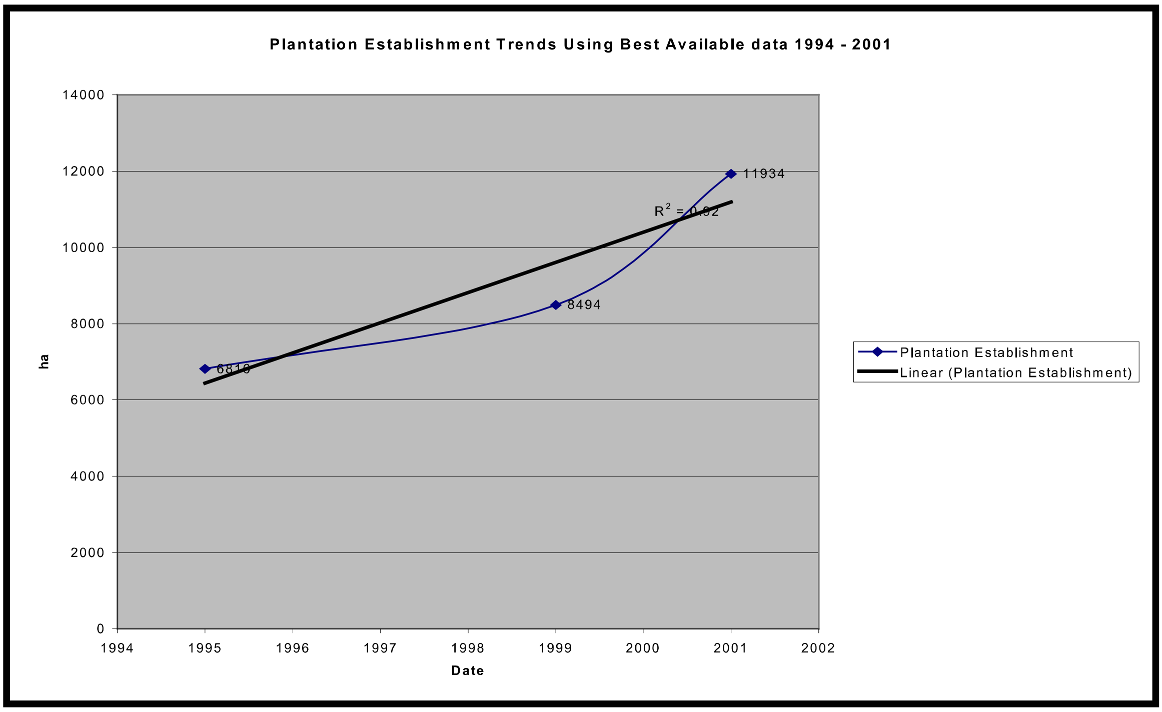


Table 10. Woody to Non Woody Change by Forest Group 1991 -2000

91 - 95			95-2000		
FORGROUP	Hectares	Biodiversity Loss	FORGROUP	Hectares	Biodiversity Loss
ELF	760	moderate	ELF	815	moderate
ETF	1121	moderate	ETF	1053	moderate
NON	665	high	NON	840	high
ONF	66	moderate	ONF	68	moderate
PHW	2798	high	PHW	2023	high
PSW	146	high	PSW	131	high
RFT	4	moderate	RFT	12	moderate
UN	6				

3090	Adjusted Total 1991-1995 High Biodiversity Loss
1952	Total 1991 - 1995 Moderate Biodiversity Loss
2993	Total 1995 2000 High Biodiversity Loss
1948	Total 1995 2000 Moderate Biodiversity Loss
6083	Total High Biodiversity Loss 1991 -2000
3900	Total Moderate Biodiversity Loss 1991 -2000
9983	Total Assignable Biodiversity Loss 1991 - 2000
1494	Estimated Plantation Harvesting 1991 - 2000

ELF = Eucalypt low forest

ETF = Eucalypt tall forest

NON = non forest

PHW = Plantation hardwood

PSW =Plantation softwood

RFT = Rainforest

ONF = Other native forest

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

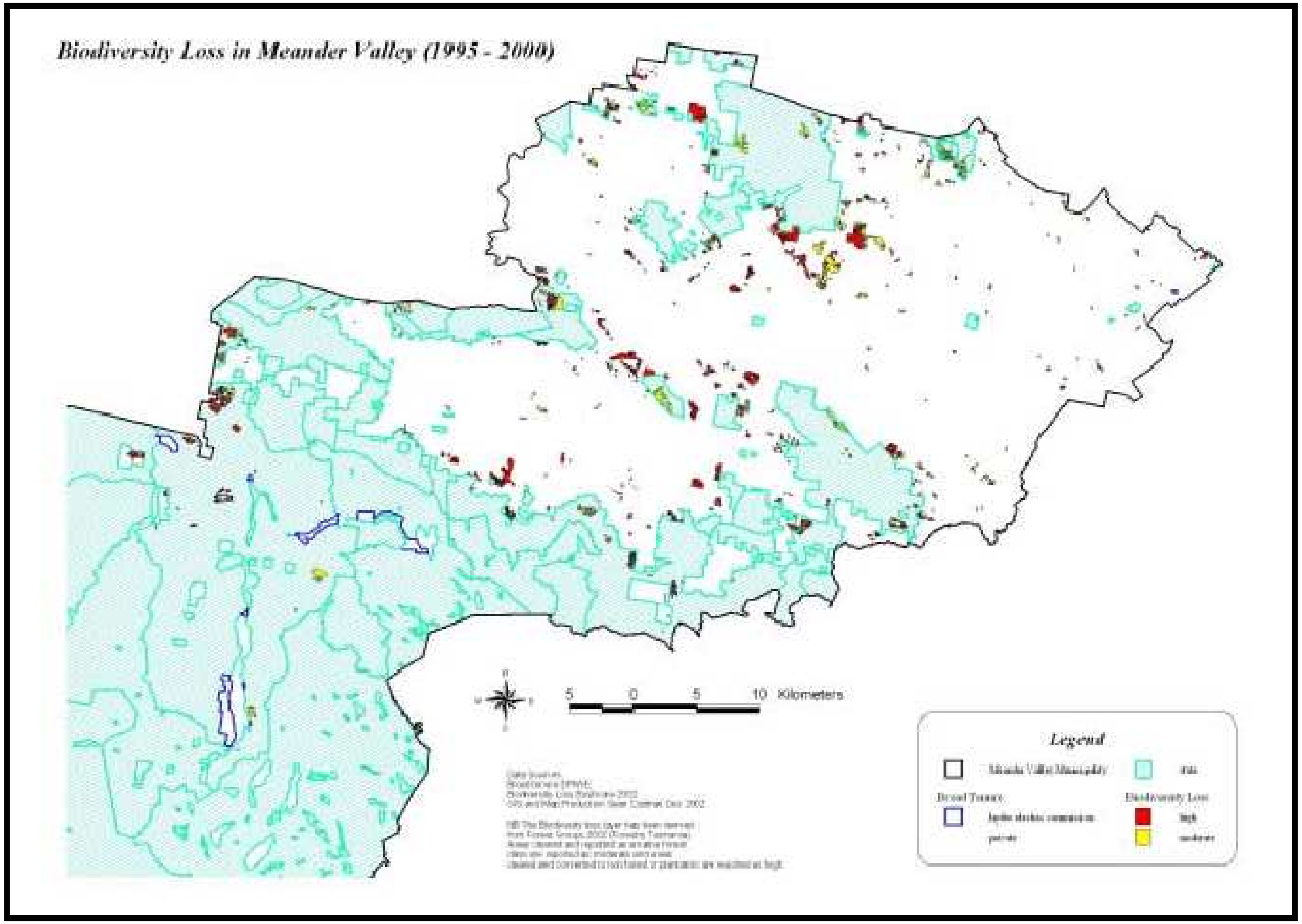


Figure 30. Mapped Biodiversity Loss Meander Valley 1995-2000

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Conclusions

General Comments

The results from the analysis undertaken provide some very useful insights into change occurring in the vegetation of the Meander Valley.

A word picture of what has occurred in Meander Valley over the last decade is to say that processes to convert forest to hardwood plantation that started in the late 1970's accelerated through the nineties. The conversions of native forest that have occurred are increasingly onto lowland and high priority forest communities largely on private land in the parts of the landscape that have already experienced significant loss of native vegetation. Parallel to this has been a process of native forest harvesting concentrated on State Forest and a smaller but significant alienation of forest to cropping and pastures. Harvesting of first rotation hardwood plantations has started and harvesting of pine is continuing but at a relatively low level.

All the data used in the analysis has limitations. However by confining expectations of what it is possible to deliver then a useful way forward for data collection and monitoring and evaluation of trends in biodiversity condition in Meander Valley can be derived. This is based on a separation of biodiversity loss into two components. Firstly areas that are lost as native vegetation systems (conversion) and secondly as native vegetation systems subject to clearance but actively or passively allowed to return to native vegetation (harvesting).

Any additional work undertaken should probably use 1995 as the base year for analysis because of the availability of the first state-wide plantation layer.

A proposed pathway (Figures 31 & 32) for ongoing monitoring biodiversity condition based on this work in Meander Valley and beyond is elucidated and discussed in Chapter 4.

The losses of biodiversity identified in this report provide powerful argument that Meander Valley Council should implement the Vegetation Strategy undertaken for the Meander Valley Natural Resource Management Committee and further that performance based vegetation management measures need to be incorporated within the new planning scheme.

Specific conclusions based on the components of the analysis are outlined below.

The uses of a digital satellite vegetation classification in attributing vegetation cover and condition.

a) is possible using and then filtering a vegetation classification to segregate pine and young eucalypt plantations for a given date allowing for a robust attribution of a minimum plantation establishment date for a plantation polygon.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

- Pine plantations, once canopy closure occurs tend to have a persistent and predictable signature. After filtering noise levels are very low
- Eucalypt plantations on wet sites have a strong signature, which only persists for 2 or 3 years. Noise levels are low however partial logging regeneration appears to be a small but significant false positive
- Eucalypt plantations on dry sites have a strong signature, which persists for 2 –6 years. Noise levels are higher than for wet sites.
- Hardwood plantations established on cleared land were established as a class that during the classification process became almost self-defining. The true positives provide a very strong signature. This is demonstrated on Figure 23 (map 2c) where the cleared land mask was turned off. However this class even after filtering produces some spectacular false positives! These are moisture related crop signatures. This error has significant implications for woody change analysis in Tasmanian conditions and strongly reinforces the value of establishing a mask for cleared land.

b) Some features from the analysis were further interpreted (figures 17,18 & 19). This indicates that the satellite analysis can predict probable errors in vector data attribution with strong signatures indicating hardwood rather that pine establishment.

c) Satellite analysis to attribute woody change produces very useful indicative results but with the possible exception of pine plantations is unlikely to provide useable quantitative data because signatures are temporally ephemeral. However in combination with vector data sets derived from photogrammetry such analysis can provide an important corroborative function. This suggests that future-reporting processes will require the maintenance of an accurate plantation mask. The ideal combination would be to run a classification at a date 2-3 years after the woody change data has been captured. Such an analysis would provide corroborative support for assumptions that have had to be made in the absence of reliable historical vector data.
d) It was not possible to distinguish most native grassland classes, woody weeds or woody weeds in forest understoreys.
e) Spatially accurate training sites using broad structurally based vegetation classes (eg NVIS type classes) together with accurate disturbance classes produced a useable vegetation classification for woody vegetation classes
f) TASVEG data is unlikely to be useful in training a vegetation classification.

Woody vegetation loss trends by vegetation community.

a) The intrinsic problems of accuracy with vegetation community data mean that results are indicative of trends rather than definitive area statements.
b) The higher the level of attribution(ie NVIS type) the higher probability of accuracy.
c) Most sub catchments show priority vegetation being cleared notably E. ovata shrubby forest (table 9).

d) The damp sclerophyll forest community, which had already been significantly cleared, is being disproportionably targeted for further clearance (table 9).
e) The Northern Slopes, Deloraine and Rubicon sub-catchments are suffering from very high levels of disturbance (figure 4).
f) Priority vegetation is still being cleared in sub-catchments at or below critical thresholds of vegetation cover of 30% (Williams 2000) (table 9).
g) Most of the conversion is occurring on private land in the lowlands in landscapes where native vegetation loss is already high.
h) There is close parallel in the data between the acceleration in plantation establishment and clearing (figures 5 & 29).

Biodiversity Loss

a) FORGROUP data when used together with RFA plantation data can allow for the generation of spatially accurate woody change biodiversity loss data post 1995 (figure 30) and a conservative estimate for the period 1991-1995 (table 10).
b) This work could be extended to allow for a determination of Biodiversity loss by sub-catchment.
c) The total loss figure for 1995 – 2000 is spatially accurate however the attribution is likely to be conservative with respect to figures for high biodiversity loss because of intrinsic problems with the attribution of non forestry related disturbance on private land within the FORGROUP data.
d) A possible solution to limit this error would be to perform an additional analysis with the original satellite data to record woody vegetation recovery. Then reassign the FOREGROUP polygons manually.
e) Alternative solutions need to be urgently developed to accurately capture conversion and harvesting of rare and threatened communities and non forest communities, particularly native grasslands and non woody wetlands.

Recommendations

3. That Meander Valley Council reports against biodiversity loss using the methods described.

4. That data custodian's meet with data users to determine ways to improve access to and utility of vegetation data.

5. That broad vegetation classes (NVIS) be used to monitor landscape vegetation condition and consideration should be given to basing this on satellite based digital classification.

6. That the approach described for attributing biodiversity loss in Meander Valley be extended to other NRM regions to establish baselines for landscape condition and as as a primary monitoring tool to measure progress against targets.

7. That consideration be given to collection of landscape condition data for Local, State and National reporting purposes be based on smaller landscape units and

exclude areas managed as 'Wilderness' National Parks where changes in condition could be monitored opportunistically based on specific disturbance events.

Chapter 4
Biodiversity Monitoring Policy and Reporting Reform

Background

Systematic national whole of environment reporting began with the release of the first National State of the Environment Report in 1996. A specific set of National Biodiversity Indicators was identified in 1998 (Saunders et al 1998). These were refined and a Nationally agreed set of core Biodiversity Indicators were released for use in 2000 (ANZEC 2000). SOE reporting in Tasmania has broadly followed the national approach and uses the same set of core indicators.

The forestry sector nationally and in Tasmania has developed its own set of Biodiversity Criteria and Indicators these have been used to monitor the implementation of the RFA (RPDC 2002). In Tasmania reporting has continued to be done by IBRA Bio-regionalisation 4 by this sector. All other reporting and monitoring is being done against the most current bio-regionalisation, IBRA 5.

A role for local government monitoring of biodiversity is identified in the National Local Government Biodiversity Strategy (Berwick & Thorman 1999). This suggests that data collection should be built on existing work, specifically national SOE reporting (Saunders et al 1998).

The National Land and Water Resources Audit is conducting a systematic audit of biodiversity condition across Australia this work loosely relates to state of environment reporting in that there are an agreed and defined set of reporting links.

In Tasmania the Forest Practices Board (FPB) has the responsibility for monitoring the status of the permanent native forest estate (RPDC 2002).

Finally work is currently under-way to finalise a monitoring policy for the next phase of the Natural Heritage Trust and the National Action Plan for Salinity.

The application of the results to current monitoring and reporting criteria.

The work for this report was in part undertaken to help inform the development of a National Vegetation Framework. The results of the study provides an insight into the implementation and applicability of a number of Biodiversity monitoring indicators:

Rate of clearing, in hectares per annum, of terrestrial native vegetation types, by clearing activity. (Saunders et al);

The methodological approach undertaken for this study is directly applicable to reporting against this indicator, at least for Tasmanian woody vegetation. More intensive aerial survey work is likely to be required to monitor non-woody vegetation clearing rates OR an alternative satellite monitoring pathway. Measures of loss due to urbanisation were not undertaken but this could be easily remedied either manually or using a vegetation classification.

The area and condition of native vegetation by type. In the absence of other measures, vegetation assemblages are used as surrogates for ecological communities and ecosystem diversity.

The methodological approach used is not applicable for measuring condition but is applicable to measuring extent in terms of woody vegetation. This study has demonstrated the unreliability of currently available vegetation data. While errors are likely to be less when TASVEG communities are assigned to NVIS classes problems still remain in terms of woody / non woody boundaries. The vegetation classification work undertaken is roughly comparable to NVIS classes and with further work could provide a robust set of comparable classes.

Area of vegetation burnt, by frequency and intensity of burning and type of vegetation. (Saunders et al);

No attempt was made to explicitly examine fire effects as part of this project. However remote-sensing products used to generate the results could easily be used to establish burning frequency if not intensity.

National Land and Water Resources Audit Vegetation and Biodiversity report Native vegetation is assessed against four indicators:

1. **current extent;**
2. **degree of connectivity;**
3. **condition; and**
4. **use.**

Reporting for the Audit is by bioregion (IBRA 5). Indicators 1 and 2 are relevant to this report.

Current extent. The methodological approach undertaken for this study is directly applicable to reporting against this indicator, at least for Tasmanian woody vegetation. More intensive aerial survey work is likely to be required to monitor non-woody vegetation clearing rates OR an alternative satellite-monitoring pathway.

Degree of Connectivity.

The data products generated for this study are of a type that would be amenable to further analysis for reporting against this criteria. The outputs have been used to reach qualitative conclusions about recent fragmentation.

Extent of area of forest types (Montreal / RFA implementation);

This was an explicit out put from the study. However there are significant problems with the data. This indicator is currently the responsibility of Forestry Tasmania reporting is against very broad classes that have been aggregated from RFA forest types.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Maintenance of the permanent native forest estate;

These data are collected by compiling figures for conversion of forest areas to plantation or agriculture that are reported on the front page of a forest practices plan.

The methodological approach adopted and results in this report highlights the inaccuracy of the approach currently used for reporting the maintenance of the permanent native forest estate. The large discrepancy between the gross state figures figures using the FPB reporting format, 62,831 ha and the Montreal approach above, 38,100 is hard to reconcile with the explanation provided (RPDC 2002).

Table 11. The results for loss of E. ovata from this study have been compared with the results from the 2 forest reporting processes

MAINTENANCE OF THE PERMANENT FOREST ESTATE (FPB Annual Reports)							
RFA Forest Community[2]	**1996**	**97/98**	**98/99**	**99/00**	**00/01**	**TOTAL**	**%1996**
Woolnorth Shrubby *E. ovata* forest	3034	2	22	8	27	55	1.8
Ben Lomand						75	17.1
Midlands						37	1.4
TOTAL Shrubby *E. ovata* forest cleared 1996-2001						167	
RFA Review Indicators (RPDC 2002)							
Total Shrubby *E. ovata* forest cleared 1996-2001						92	1.3
Meander Valley Nov 1995- Nov 2000							
Total Shrubby *E. ovata* forest cleared 1995-2000	**RFA Veg**					37	
Total Shrubby *E. ovata* forest cleared 1995-2000	**NRM Veg**					162	

The limitations of the vegetation data have been discussed at length in this report. However the discrepancies are highly significant. The periods are comparable because the Meander Valley data is post December 1995 and November 2000. The Meander Valley data is intersected with RFA data as is RFA review data. It seems highly unlikely that 40% of the clearing of E. ovata has occurred in the lowlands of Meander Valley suggesting that because E. ovata is largely confined to private land the discrepancy represents significant under reporting of clearing of this endangered community.

On the other hand Forest Practices Plans are meant to reflect what is actually present on the site and should therefore be more accurate. If the assumption is made that the NRM vegetation data is an improvement on the RFA data and therefore more accurate then there would still appear to be significant under-reporting of the clearance of this community.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Land-clearing Reporting Reform.

In Tasmania there are incongruities between input data, bioregional units used and assessment methodologies used for monitoring the State of Biodiversity in Tasmania. The most serious of these incongruities relates to the use of the IBRA 4 bio-regionalisation of Tasmania for forestry reporting and the IBRA 5 bio-regionalisation is used for all other reporting requirements. These incongruities are surmountable.

A more fundamental problem is that there is no reporting organisation providing accurate woody change data. If there was no policy or legislative requirement based upon protection targets of vegetation communities this would be annoying for those charged with undertaking audits and environment reporting. Given that there is currently policy and soon to be legislative commitments in respect of vegetation clearance the current reporting systems are simply inadequate to the task.

There are two possible pathways identified below to get at least an accurate estimate of progress against native vegetation retention targets.

Model 1

The first of these would be to identify a single authority, at the State level responsible for reporting against targets, that is capable of delivering a robust spatially based monitoring regime. Then using the kind of remote sensing and GIS approach outlined in this report apply it across the State.

A prerequisite would be the completion of a state-wide spot height controlled DEM.

1. Complete Statewide spot height controlled DEM.

2. Divide the State up into pragmatic analysis units in order to be able to obtain sufficient cloud free data. Meander Valley Municipality gives a good indicator of appropriate size.

3. Exclude the WHA and mountain top National Parks from the analysis.

4. Establish using multi-temporal sequencing of satellite data woody change baselines from 1995 using the techniques described (Wallace and Wu 2001). Clean and filter these products.

5. Determine an agreed vegetation data set to intersect clearance data with, for policy reasons this may have to be the RFA data for forest vegetation.

6. Extend the spatial capture of disturbance data currently undertaken for the FOREGROUP mapping process to all harvesting and clearing activity irrespective of ownership class.

7. Intersect FOREGROUP data with clearance data allowing a 12 month lag to report accurately on biodiversity loss. This will also allow an estimate of impact on rare and endangered communities not protected by reserves.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

8. Construct an accurate well-trained satellite vegetation classification for each analysis unit to help provide error bounds for analysis.

9. Pre logging / clearing on ground audits of a % of all plans need to be instituted to ensure that fully protected entities are not being included in areas to be cleared and that plans accurately reflect the values present on the sites
.

10. Institute an on ground monitoring system to ensure that rare and threatened communities that have been disturbed by permitted harvesting activities are recovering condition.

11. Monitor WHA and National parks on an as needs basis eg after major disturbance events.

12. Urgently establish a monitoring regime for non woody vegetation particularly grassland and wetlands. This will probably have to be based on annual aerial surveys. IF current vegetation mapping of these classes is accurate enough then a remote sensing based approach would be possible to design.

Model 2

The second approach requires all the same steps to be undertaken but would regionalise the data analysis.

1. Complete Statewide spot height controlled DEM.

2. The 3 NRM regions identify pragmatic analysis units for their regions

3. Exclude the WHA and mountaintop National Parks from the analysis.

4. Cooperatively purchase the raw satellite data to allow for processing. Process this data using best practice consultants eg CSIRO.

5. Clean and filter the data using local expert knowledge for each analysis unit.

6. Construct an accurate well-trained satellite vegetation classification for each analysis unit to help provide error bounds for analysis using local knowledge to ensure that training sites are well defined.

7. Provide the data for Statewide reporting processes and use to monitor against agreed regional benchmarks for vegetation management.

A regionalised approach has the advantage of ensuring ownership of the results and is likely to lead to significantly more accuracy in cleaning data. This will require the establishment of GIS capacity in each region.

A top down approach has significant potential advantages in terms of consistency however lack of local knowledge may well inhibit accuracy. This approach will only work if the entity managing the reporting is sufficiently well resourced.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Both approaches require a cooperative approach from data-custodians and the recognition that reporting reform is absolutely essential.

Figure 31. Process outline for reporting woody vegetation biodiversity loss

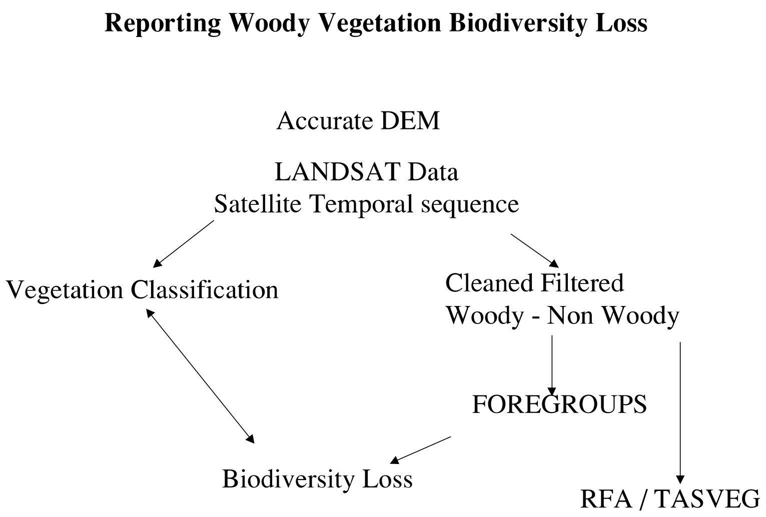
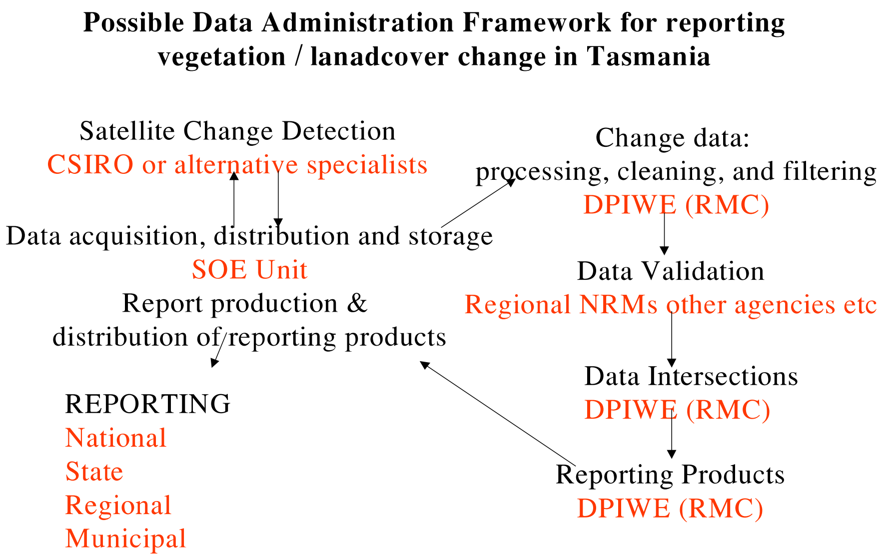


Figure 32. Possible administration structure for spatial land cover change reporting



Conclusions

The need for all levels of government to reform reporting processes and undertake robust measures of biodiversity loss is urgent. For Meander Valley Council there is a great opportunity to continue the work initiated as part of its devolved grant scheme of monitoring biodiversity loss by sub-catchment.

Current State level monitoring processes and methodologies are inadequate to deliver the products being sought by agreed policies and reporting frameworks. The technical approach identified in this report offers a potential solution to deliver spatially robust products to report against biodiversity loss and land-cover change and provide estimates of vegetation loss by community type.

With goodwill the sort of reporting and administrative framework outlined, could deliver the reporting reform necessary to ensure robust vegetation management outcomes can be seen to be coming from institutional change and new regional investment strategies.

Recommendations

8. Meander Valley Council should adopt biannual reporting of' biodiversity loss' for the municipality

9. State Government agencies should work towards monitoring and reporting reform

10. Regional Natural Resource Management processes should establish baselines and monitoring regimes for regional vegetation management outcomes based on a robust spatial approach.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

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Model PAL Provisions Planning Assessment Checklist

Provision	Check	Comment
Table of Use 18.2.1		
Categorising Use	*Which category of defined use or uses does the proposal fit within?*	Uses that are integral to (ie a necessary part of) agriculture are categorised as Resource Development.
Use status	*Is the use permitted, discretionary or prohibited?*	If prohibited the proposal cannot proceed without a planning scheme amendment.
Qualifications	*Is the proposed use or development to be sited on prime agricultural land or land identified in the planning scheme as significant agricultural land?*	The site is on prime land if it is on Class 1, 2 or 3 land as shown in LIST unless it can be shown by a detailed soil survey to be in another class. Significant land is mapped in detail as part of the planning scheme.
Use Standards 18.3.1		
Objective: *To ensure that non-agricultural uses do not fetter agricultural use.*	*Is the proposal for a sensitive use[1]?*	If the use is a sensitive one, it could fetter the use of agricultural land, and Acceptable Solution A1 or Performance Criteria P2 must be met.
Acceptable Solution A1	*Will the sensitive use be separated from all existing or potential agricultural activities by at least 100m measured from the boundary of the lot containing the sensitive use, or 200m measured from the curtilage of the sensitive use?*	If not met, Performance Criteria P1 applies.
Performance Criteria P1	*Will the proposal unreasonably constrain existing or potential agricultural use of any agricultural land through land use conflicts taking into consideration such factors as:* *(a) the potential for noise, light, odour, dust, spray drift and the like from agriculture and the possible hours of operation;* *(b) the topography of the land;* *(c) prevailing wind directions and microclimate effects;* *(d) the potential for introduction of domestic animals and plants into farming areas; and* *(e) buffers or barriers created by vegetation, drainage lines or other natural or man-made features?*	If the proposal would be likely to constrain existing or potential agricultural use it must be considered whether this can be ameliorated and whether the degree of conflict would be reasonable taking account of any advice or representations received and the necessity and desirability of the proposal in relation to the purpose of the zone and the objectives of the planning scheme and of LUPAA.

[1] Sensitive Use is defined as *residential uses or uses involving the presence of people for extended periods such as in childcare centres, schools, hospitals and caravan parks, except in the course of their employment* (to be included in clause 3.1.3 in the Planning Scheme Template introduced by Planning Directive No1).

Provision	Check	Comment
Development Standards 18.4.1		
Objective: *To ensure that development including subdivision does not result in fragmentation or alienation of agricultural land.*	*Does the proposal involve subdivision or strata subdivision?* *Will development including subdivision be on prime agricultural land or land identified in the planning scheme as significant agricultural land?*	Subdivision could fragment agricultural land. Small lots could alienate prime or significant agricultural land from agricultural use.
Acceptable Solution A1	*(a) Will All new lots be at least 50ha in area with a minimum dimension of 200m, (excluding access strips), and have frontage of at least 12m; and* *(b) Will access strips on prime agricultural land to rear lots be no wider than 12m?*	50ha is considered to be a size at which agricultural value would normally exceed residential value. If not met, Performance Criteria P1 applies.
Performance Criteria P1	*Will subdivision or strata subdivision of agricultural land:* *(a) maintain or improve the productive agricultural capacity of the land in accordance with a farm plan prepared by a suitably qualified person; or* *(b) be for the excision of an existing or approved non-agricultural use provided that, except in the case of utilities, the balance lot is not less than 50ha or is adhered to adjoining agricultural land in the same ownership?*	Subclause (a) provides for a case where less than 50ha can support viable agricultural use. Subclause (b) recognises that large lots are not necessary for all uses that are allowable in the Rural Resource zone, and that smaller lots may assist in reducing impacts on agricultural land.
Acceptable Solution A2	*Will development on prime agricultural land, or land identified in the planning scheme as significant agricultural land be only for:* *(a) farm sheds, storage areas, barns and the like, water storage areas and dairies that are necessary part of the agricultural use of the land;* *(b) residential accommodation for a farm manager or a farm worker required as a necessary part of the agricultural use of the land as certified by a suitably qualified person;* *(c) buildings for controlled environment agriculture with a total area of no more than 200m^2; or* *(d) an extension of an existing non-agricultural building of not more than 30% up to a maximum of 100m^2?*	If not met, Performance Criteria P2 applies. Even where the acceptable solution is met, conditions can be applied to minimise alienation.

Performance Criteria 2	*Will:* *(a) development including subdivision on prime agricultural land, or significant agricultural land be designed and located to avoid or minimise the area of existing or potentially productive land adversely affected; and* *(b) Utilities or controlled environment agriculture on prime agricultural land or land identified in this planning scheme as significant agricultural land require the specific location for its operation and is no suitable alternative site available?*	The Council must consider whether the alienation of prime or significant land from agricultural use is justified taking account of the alternatives available, any advice or representations received and the necessity and desirability of the proposal in relation to the purpose of the zone, and the objectives of the planning scheme and LUPAA.
Outcome		
Permitted Application (s.58 LUPAA)	*Is the proposal a permitted use and does it satisfy all relevant acceptable solutions?*	If yes, the proposal must be approved without giving public notice unless there are any contrary provisions in the scheme.
Discretionary Application (s.57 LUPAA)	*If the proposal is a discretionary use or does not satisfy all relevant acceptable solutions. If so does it meet all performance criteria in those cases?*	If yes, the proposal must be given publicly notice and can be approved or refused unless prohibited by any other provision in the planning scheme.
Prohibited	*If the proposal cannot be approved is there justification for amending the planning scheme?*	If yes, the proposal can only be progressed through a planning scheme amendment.

State Policy on the Protection of Agricultural Land 2009

Tasmania
Explore the possibilities

Document Set ID: 1943177
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1. PURPOSE

To conserve and protect agricultural land so that it remains available for the sustainable development of agriculture, recognising the particular importance of prime agricultural land.

2. OBJECTIVES

To enable the sustainable development of agriculture by minimising:

(a) conflict with or interference from other land uses; and

(b) non-agricultural use or development on agricultural land that precludes the return of that land to agricultural use.

3. PRINCIPLES

The following Principles will be implemented through planning schemes and other relevant planning instruments. No one Principle should be read in isolation from the others to imply a particular action or consequence.

1. Agricultural land is a valuable resource and its use for the sustainable development of agriculture should not be unreasonably confined or restrained by non-agricultural use or development.

2. Use or development of prime agricultural land should not result in unnecessary conversion to non-agricultural use or agricultural use not dependent on the soil as the growth medium.

3. Use or development, other than residential, of prime agricultural land that is directly associated with, and a subservient part of, an agricultural use of that land is consistent with this Policy.

4. The development of utilities, extractive industries and controlled environment agriculture on prime agricultural land may be allowed, having regard to criteria, including the following:

   (a) minimising the amount of land alienated;

   (b) minimising negative impacts on the surrounding environment; and

   (c) ensuring the particular location is reasonably required for operational efficiency.

5. Residential use of agricultural land is consistent with this Policy where it is required as part of an agricultural use or where it does not unreasonably convert agricultural land and does not confine or restrain agricultural use on or in the vicinity of that land.

6. Proposals of significant benefit to a region that may cause prime agricultural land to be converted to non-agricultural use or agricultural use not dependent on the soil as a growth medium, and which are not covered by Principles 3, 4 or 5, will need to demonstrate significant benefits to the region based on an assessment of the social, environmental and economic costs and benefits.

7. The protection of non-prime agricultural land from conversion to non-agricultural use will be determined through consideration of the local and regional significance of that land for agricultural use.

8. Provision must be made for the appropriate protection of agricultural land within irrigation districts proclaimed under Part 9 of the *Water Management Act 1999* and may be made for the protection of other areas that may benefit from broad-scale irrigation development.

9. Planning schemes must not prohibit or require a discretionary permit for an agricultural use on land zoned for rural purposes where that use depends on the soil as the growth medium, except as prescribed in Principles 10 and 11.

10. New plantation forestry must not be established on prime agricultural land unless a planning scheme reviewed in accordance with this Policy provides otherwise. Planning scheme provisions must take into account the operational practicalities of plantation management, the size of the areas of prime agricultural land, their location in relation to areas of non-prime agricultural land and existing plantation forestry, and any comprehensive management plans for the land.

11. Planning schemes may require a discretionary permit for plantation forestry where it is necessary to protect, maintain and develop existing agricultural uses that are the recognised fundamental and critical components of the economy of the entire municipal area, and are essential to maintaining the sustainability of that economy.

4. GUIDELINES

The Resource Planning and Development Commission may, with the approval of the Minister, issue guidelines consistent with the terms of this Policy and confined to assisting planning authorities in dealing with the implementation of the Policy.

5. AUTHORITY

This State Policy is prepared pursuant to the *State Policies and Projects Act 1993*.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

6. APPLICATION

This Policy applies to all agricultural land in Tasmania.

A decision made in accordance with the provisions of a planning scheme;

(a) approved under the *Land Use Planning and Approvals Act 1993*, as being in accordance with this Policy, or

(b) amended in accordance with section 13 of the *State Policies and Projects Act 1993*,

is taken to have been made in accordance with the Policy.

7. DEFINITIONS

In this Policy, unless the contrary intention appears:

Agricultural land

"Agricultural land" means all land that is in agricultural use or has the potential for agricultural use, that has not been zoned or developed for another use or would not be unduly restricted for agricultural use by its size, shape and proximity to adjoining non-agricultural uses.

Agricultural use

"Agricultural use" means use of the land for propagating, cultivating or harvesting plants or for keeping and breeding of animals, excluding domestic animals and pets. It includes the handling, packing or storing of produce for dispatch to processors. It includes controlled environment agriculture and plantation forestry.

Controlled environment agriculture

"Controlled environment agriculture" means an agricultural use carried out within some form of built structure, whether temporary or permanent, which mitigates the effect of the natural environment and climate. These include production techniques that may or may not use imported growth mediums. Examples of controlled environment agriculture structures include greenhouses, polythene covered structures, and hydroponic facilities.

Extractive industry

"Extractive industry" means use of land for extracting and removing material from the ground for commercial use, construction, roadwork or manufacturing works. Included is the treatment or processing of these resources by crushing, grinding, milling or screening on, or adjoining the land from which it is extracted. Examples are, mining, quarrying, sand mining and turf extraction.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024

Land

"Land" means land as defined in the *Land Use Planning and Approvals Act 1993*.

Planning scheme

"Planning scheme" means any planning scheme in force under section 29 of the *Land Use Planning and Approvals Act 1993*.

Plantation forestry

"Plantation forestry" means the use of land for planting, management and harvesting of trees predominantly for commercial wood production, including the preparation of land for planting but does not include the milling or processing of timber, or the planting or management of areas of land for shelter belts, woodlots, erosion or salinity control or other environmental management purposes, or other activity directly associated with and subservient to another form of agricultural use.

Prime agricultural land

"Prime agricultural land" means agricultural land classified as Class 1, 2 or 3 land based on the class definitions and methodology from the Land Capability Handbook, Second Edition, C J Grose, 1999, Department of Primary Industries, Water and Environment, Tasmania.

Utilities

"Utilities" means use of land for:

(a) telecommunications; or
(b) transmitting or distributing gas, petroleum products, or electricity; or
(c) transport networks; or
(d) collecting, treating, transmitting, storing or distributing water; or
(e) collecting, treating, or disposing of storm or floodwater, sewage, or sullage

Examples are a gas, water or sewerage main; electrical substation; power line; pumping station; retarding basin; road; railway line; sewage treatment plant; water storage dam; storm or flood water drain and weir.

Document Set ID: 1943177
Version: 1, Version Date: 18/06/2024