Land suitable for new planted forests in North-East NSW

A technical report on the modelling method and results

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North East NSW Forestry Hub

2rog

DOCUMENT CONTROL

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EXECUTIVE SUMMARY

Overview

This project was commissioned by the North East NSW Regional Forestry Hub to identify the general location and extent of cleared land that may be suitable for the establishment of new planted forests under the Commonwealth Government's One Billion Trees Program.

Approach

A suite of environmental and socio-economic factors was modelled to identify suitable land for new planted forests. These factors included:

- Current land use
- Mean annual rainfall
- Slope
- Elevation
- Soils
- Proximity to infrastructure including dwellings and powerlines
- Proximity to riparian zones and wetlands
- Bushfire prone land
- Distance to nearest existing plantations
- Distance to nearest biomass processing plant
- Landscape-scale vegetation cover (for environmental plantings only)
- Property size

Combinations of these metrics were used in the model to determine suitability for five discrete planted forest types, namely:

- Commercial hardwood (eucalypt) plantations
- Commercial southern pine plantations
- Commercial radiata pine plantations
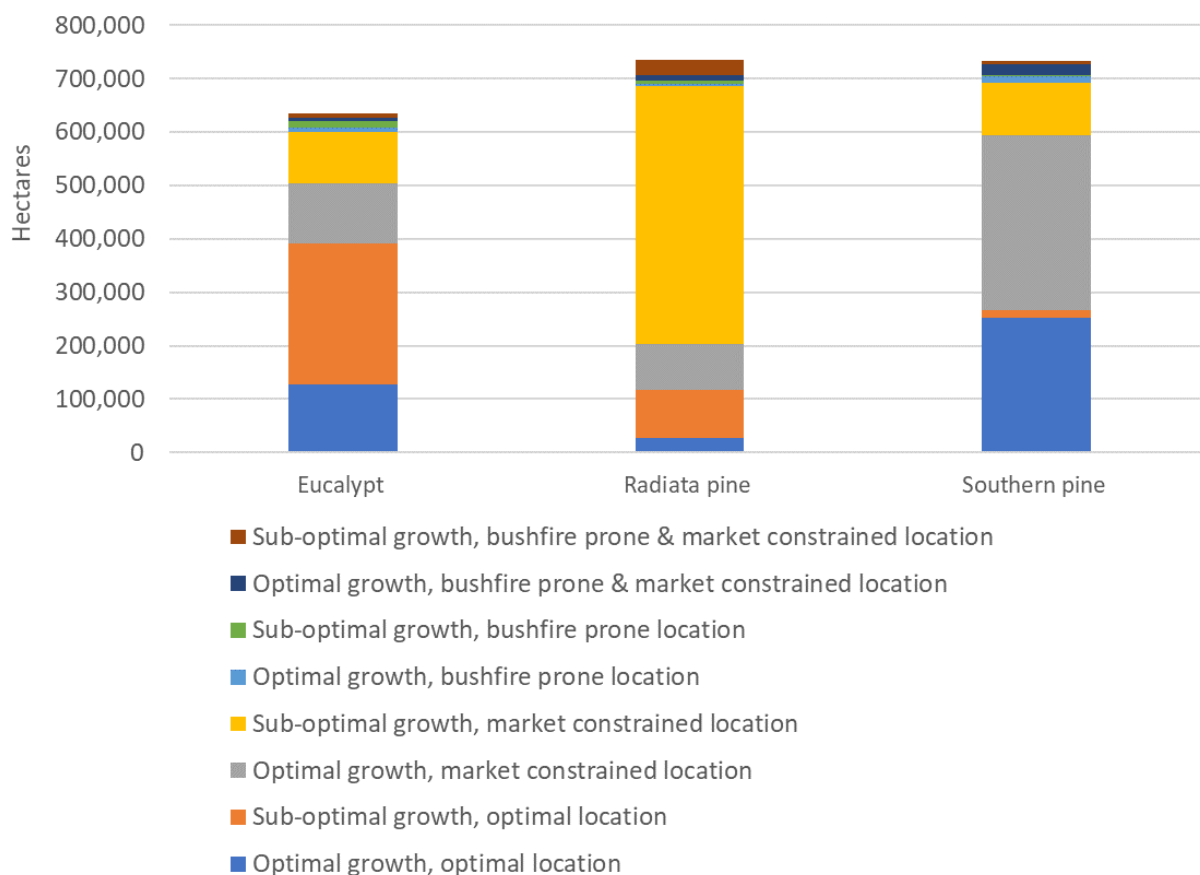- Farm forestry plantings
- Environmental plantings

Outputs

Mapping and analyses found 6,300 km^2 (630,000 hectares) of cleared land suitable for hardwood plantations (chiefly eucalypts), 7,300 km^2 (730,000 ha) of cleared land suitable for southern pine plantation and 7,400 km^2 (740,000 ha) suitable for radiata pine plantation.

When parameters were applied to distinguish between optimal and sub-optimal land the extent of suitable land was much reduced (see chart below).

There were fewer hardwood areas market-constrained compared with pines, with more areas 'market-constrained' for radiata pine than southern pine. Coastal areas suitable for hardwood and southern pine plantations were found to largely overlap.

Area of cleared land suitable for commercial plantation in north east NSW

Legend:
- ■ Sub-optimal growth, bushfire prone & market constrained location
- ■ Optimal growth, bushfire prone & market constrained location
- ■ Sub-optimal growth, bushfire prone location
- ■ Optimal growth, bushfire prone location
- ■ Sub-optimal growth, market constrained location
- ■ Optimal growth, market constrained location
- ■ Sub-optimal growth, optimal location
- ■ Optimal growth, optimal location

There are fewer geographic constraints to establishing farm forestry plantings and environmental plantings compared with commercial plantations, with 15,200 km^2 (1.52 million ha) found to be available for farm forestry plantings and 35,200 km^2 (3.52 million ha) available for environmental plantings. While there are more areas available for establishing environmental plantings, preferred planting areas were located within Mitchell landscapes that have been heavily cleared of native vegetation in the past. Preferred landscapes included the Tweed and Clarence Valleys, the Upper Manning and the Upper Hunter Valleys, and much of southern parts of the New England Tableland. In total these areas cover 10,379 km^2 (1.04 million ha).

Optimum coastal locations for new eucalypt plantations include higher rainfall zones in the Tweed and Richmond valleys, as well as coastal areas around Coffs Harbour, between Taree and Wauchope, and in the Dungog-Gloucester region of the northern Hunter catchment. In contrast, optimum coastal locations for new southern pine plantations are around the Richmond Range region in the north where most existing plantations exist, although there is also an area north of Newcastle in which a large southern pine plantation is also established.

Optimum locations for new radiata pine plantations are around the Dungowan-Nowendoc-Nundle areas of the southern high-rainfall part of New England where large plantations are already established and hauled to Werris Creek railway for processing further afield.

Limitations and caveats

The spatial mapping and analyses undertaken for this project provides useful strategic insights into different zones in the Hub region in which different commercial plantations and other plantings could feasibly be established (and where they cannot). However, the analyses rely on broad spatially datasets (e.g. rainfall, soils, land use) that could be inaccurate at fine scales (e.g. individual paddocks). For this reason, it is likely that some areas that are currently mapped as 'unsuitable' could be suitable for establishing plantations or plantings, and *vis versa*. It follows that this product will be useful for identifying broad regions in which plantations are likely to be viable or not, but at the local scale site inspection will be required to gauge paddock-scale suitability.

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ABBREVIATIONS

Abbreviation	Description
DPI	NSW Department of Primary Industries
GIS	Geographic Information System
NE NSW	North East New South Wales
RFA	Regional Forest Agreement

01 INTRODUCTION

01.1 Project context

In September 2018 the Commonwealth Government launched the National Forests Industries Plan[1] which provides a vision to plant 1 billion trees within timber plantations by 2030 to support Australian forestry industries. To date 11 Regional Forestry Hubs have been established under the Plan. These include the North East NSW (NE NSW) Regional Forestry Hub which commenced operations in April 2019. Each Regional Forestry Hub is responsible for:

- Working with landholders and other stakeholder to identify new plantation opportunities
- Adding value to existing infrastructure and processing capability
- Creating growth and jobs in the forestry sector
- Ensuring the right trees are planted in the right places
- Undertaking an inventory of existing farm forestry resources on private land

A key priority of the NE NSW Regional Forestry Hub is to promote establishment of new plantations in the region. 2rog Consulting was engaged by the NE NSW Regional Forestry Hub to undertake a spatial assessment to identify viable areas in the NE NSW landscape in which to future timber (eucalypt and pine) could be established. This report provides a methodology and a summary of outcomes (including maps).

01.2 Region of study

The region administered by the North East NSW Forestry Hub is the same as the region covered by the North East Regional Forest Agreement (RFA). It extends from the NSW Central Coast just north of Sydney to the NSW-Queensland border, and inland to escarpment and tablelands (Figure 01-1). The region covers a total area of 97,183 km^2. This includes:

- 60,024 km^2 of forest/woodland
- 37,159 km^2 of non-forest (mainly agricultural land)

It also includes:

- 62,166 km^2 of freehold land
- 9,158 km^2 of state forest
- 20,600 km^2 of national park and other reserve
- 5,259 km^2 of other crown land

The region currently supports 1,071 km^2 of existing commercial plantations, including 809 km^2 of hardwood plantation (chiefly *eucalypt* and *corymbia*), 156 km^2 of southern pine plantation, and 106 km^2 of radiata pine plantation. Given 16,771 km^2 of agricultural freehold land across the region has been cleared of native vegetation, much of this area may also be suitable for establishment of commercial eucalypt or pine plantations, or farm forestry or environmental plantings.

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[1] DAWR (2018). *Growing a better Australia – A billion trees for jobs and growth.* Department of Agriculture and Water Resources Canberra. Available at: https://www.agriculture.gov.au/forestry/publications/growing-better-australia
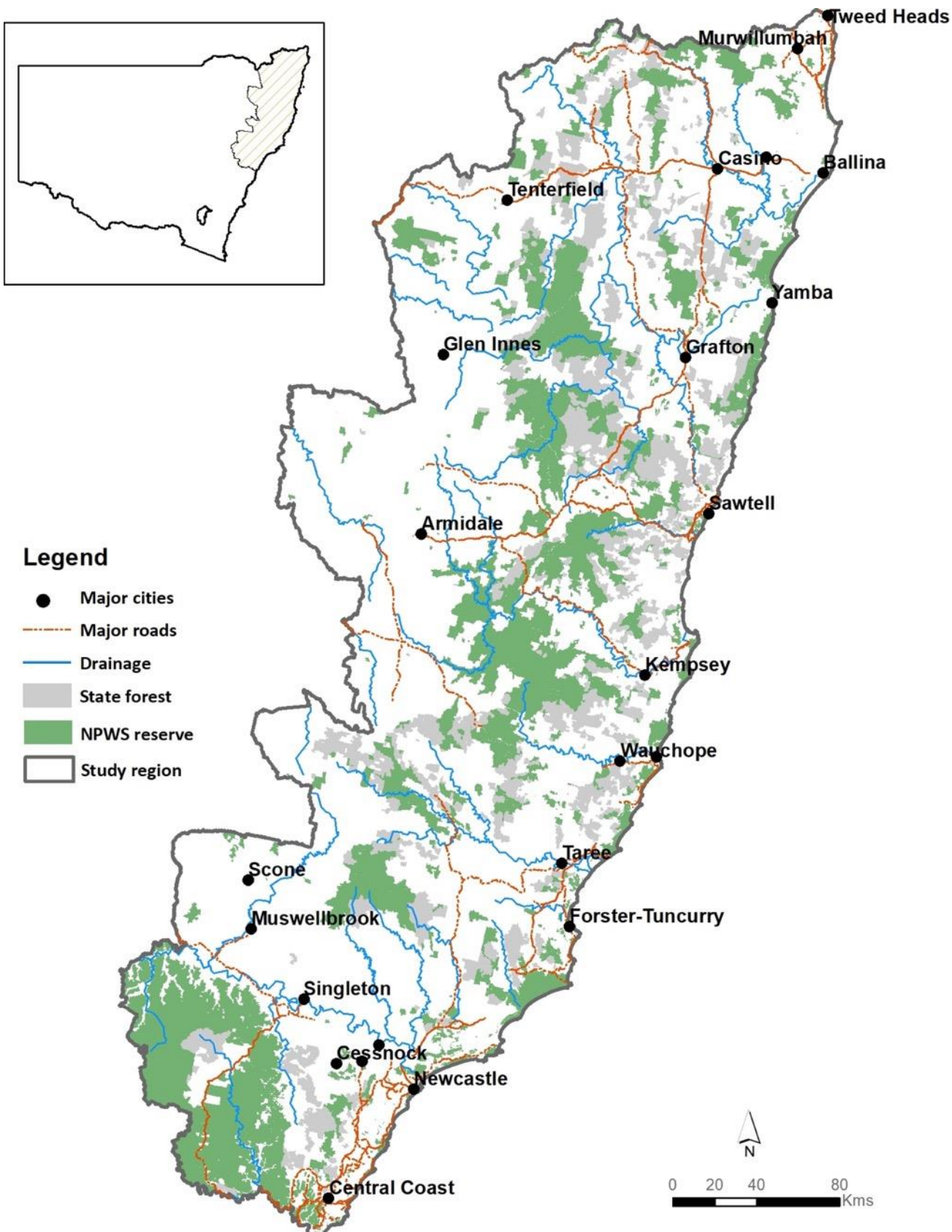
Figure 01-1. NE NSW Forestry Hub region

01.3 Plantation viability

The viability of planted forests is dependent on factors that can be controlled by the grower (deterministic factors) and factors that cannot (stochastic factors). Deterministic factors include species and provenance selection, site selection, site preparation and management, and location. Stochastic factors include climatic events (fires, droughts, floods, storms), pests and diseases, and market conditions at the time of sale. While stochastic factors cannot be controlled, their impact can be moderated through good quality planning.

In collaboration with the Hub, the following deterministic factors were identified with respect to site and commercial viability of new planted forests:

Site viability

- Current land use
- Mean annual rainfall
- Slope
- Elevation
- Soils
- Proximity to infrastructure including dwellings and powerlines
- Proximity to riparian zones and wetlands
- Proximity of bushfire prone land
- Distance to existing plantation
- Distance to pulpwood processing facilities
- Landscape-scale vegetation cover (for environmental plantings only)
- Property size

Commercial viability

- Road distance to hardwood processing plants (access to eucalypt thinning markets)
- Road distance to railway hub (radiata pine only)
- Presence of large established plantations within the local region[2]
- Area of viable land on individual properties.

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[2] There is currently about 107,000 ha of commercial plantations mapped within the North East NSW Regional Forestry Hub region, including 80,882 ha of eucalypt plantations, 10,636 of radiata pine plantations, and 15,250 ha of southern pine plantations.

02 APPROACH

02.1 Overview

A geographic information system (GIS) was used to undertake spatial analyses to assign a rating of either '1' (viable area) or '0' (non-viable area) across several modelling layers and parameters, for five planted forest types:

- commercial plantation (eucalypt)[3]
- commercial plantation (southern pine)
- commercial plantation (radiata pine)
- farm forestry planting
- environmental restoration planting

02.2 GIS data compilation

Various spatial datasets were sourced from the NSW Government portal or Hub data and clipped to the study of region to undertake analyses. These are listed in Table 02-1.

Table 02-1. Spatial datasets used for analysis

Name	Description
NE Forestry Hub region	Area administered by the Hub, including Upper North East and Lower North East regional forest agreement (RFA) regions
Land portions	Cadastre layer including all administrative land parcels and properties (amalgams of portions)
Existing plantations	Location of all existing plantations (Forestry Corporation of NSW and NSW Department of Primary Industries)
Tenure	Broad tenure classes – NPWS-managed lands, state forest, Crown reserves, private land)
Dwellings	Point later of dwellings, including all buildings.
Processing plants	Point layer of wood processing plants
Roads	Line layer of all major and minor public roads
Rivers and streams	Hydro-line layer of all rivers and streams
Wetlands	Wetland layer
Vegetation types - extant	Current extant of plant community types in the region
Land use	Land use layer, including agricultural, urban, commercial and industrial land uses
Digital elevation model (DEM)	Used to generate slope and elevation layers
NSW soil regolith	Major soil types
Acid sulphate soils	Heavy floodplain soils subject to inundation and acid sulphate pollution
Hydrological soil groups	Contains mapping of heavy clay soils
NSW rainfall	Mean annual rainfall
Bushfire prone land	Classes of bushfire proneness (mapped by Rural Fire Service)
Local government areas (LGAs)	Council shires in the Hub region
Mitchell landscapes	Mitchell landscapes that occur in the Hub region

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[3] Includes 'Corymbia spp. such as C. maculata – Spotted Gum)

02.3 Development of individual viability layers

02.3.1 Overview

A total 27 'viability' layers were developed for this project. Each was developed as a 30 m raster surface that contained two zones: 'viable' (value = 1); and 'non-viable' (value = 0). The gross area of each zone within each layer was calculated.

02.3.2 Commercial plantations

A total of 21 individual viability layers were developed (Table 02-2). Of these, 15 layers were relevant to commercial hardwood plantations and radiata pine plantations and 14 layers were relevant to southern pine plantations. A total 11 viability layers were relevant to all commercial types (hardwood, southern pine, radiata pine), one (1) viability layer was relevant to the two commercial pine types, and the remaining nine (9) viability layers were each relevant to a single commercial plantation type (Table 02-2).

02.3.3 Farm forestry plantings and environmental plantings

There are fewer constraints when establishing farm forestry plantings and environmental plantings, as the achievement of superior growth and stem form is not as important. For example, non-commercial plantings can be established at any elevation and within any rainfall zone, and none of the economic factors considered for commercial eucalypt and pine plantations come into play.

A total of eight (8) individual layers were developed for farm forestry plantings and environmental plantings (Table 02-3). Of these, four (4) layers were relevant to both types of planting, two (2) layers were relevant to farm forestry plantings, and two (2) layers were relevant to environmental plantings (one of which prioritises sites in Mitchell landscapes that have been heavily cleared in the past).

02.4 Development of composite viability layers

A composite viability layer was developed for each of the three commercial types (eucalypt plantation, radiata pine plantation, southern pine plantation) using the "COMBINE" command in ArcGIS. This command enables integration of multiple layers into a single aggregated layer. For this project the aggregated layer contained a single code-string for each 30 m pixel that represents a unique combination of 1,0 values, to which a final viability category was assigned.

02.5 Assignment of final viability category

One of ten categories was assigned to commercial plantation types based on the unique combination of viable/non-viable values in the code-string of the composite layer (Table 02-4).

Eight of these categories were associated with viable areas, and contained information about:

- growth (optimum or sub-optimum)
- location (optimum, or bushfire prone and/or market constrained)

The other two categories were:

- 'land unsuitable for plantation' in which the site was associated with one or more biophysical constraints (e.g. erosive soils, poor soils, low rainfall, near powerlines)
- 'existing plantation'.

Farm forestry plantings and environmental plantings were each separated into 'suitable' and 'unsuitable', with suitable lands for environmental plantings being split further into high priority or not based on whether they occurred within an 'over-cleared' Mitchell landscape (Table 02-4).

02.6 Map production

Each of the viability categories was mapped across the Hub region to show the location of areas for which commercial plantations could be established in the future.

Table 02-2. Description of datasets used to assemble viability maps for commercial plantations

Dataset	Non-viable area (value = '0')	Viable area (value = '1')	Commercial plantation type		
			Eucalypt	Southern pine	Radiata pine
Existing woody vegetation	Woody vegetation	Non-woody vegetation	✓	✓	✓
Land use #	High value agricultural lands, urban, residential, industrial	Mainly grazing lands, including grazing native forests	✓	✓	✓
Land tenure	NPWS managed land, state forest, Crown land	Private or leasehold land	✓	✓	✓
Slope	$\geq 30°$ + other combinations of slope/regolith/erosivity (Attachment 01)	$\leq 5°$ + other combinations of slope/regolith/erosivity (Attachment 01)	✓	✓	✓
Soil regolith					
Rainfall erosivity					
Acid sulphate and heavy clay soils	Acid sulphate and heavy clay soils	All other soils	✓	✓	✓
Elevation	> 650 m above sea level	0 – 650 m above sea level	✓		
Elevation	> 500 m above sea level	0 – 500 m above sea level		✓	
Elevation	< 650 m above sea level	≥ 650 m above sea level			✓
Mean annual rainfall	< 1,000 mm/yr	$\geq 1,200$ mm/yr ##	✓		
	< 800 mm/yr	$\geq 1,000$ mm/yr ###		✓	✓
Powerlines	Within 6 m of powerlines up to 11 kV Within 12.5 m of powerlines 12 – 33 kV Within 15 m of powerlines 34 – 66 kV Within 22.5 m of powerlines 67 – 132 kV Within 30 m of powerlines 133 – 330 kV Within 35 m of powerlines > 330 kV	Outside powerline setback zones	✓	✓	✓
Buildings	Within 70 m of a building	> 70 m from any building (habitable dwelling)	✓	✓	✓
Hydro-line network	Within 20 m of river or major stream Within 10 m of an ephemeral watercourse	Outside riparian setback zones	✓	✓	✓
Wetlands	Within 20 m of wetland > 0.1 ha	Outside wetland setback zone	✓	✓	✓
Water	Mapped water storages and estuaries	Non water bodies	✓	✓	✓

Dataset	Economically constrained area (value = '0')	Economically viable area (value = '1')	Commercial plantation type		
			Eucalypt	Southern pine	Radiata pine
Bushfire prone land	Within 100 m of any patch of 'woody vegetation' > 100 ha, in Category 1 bushfire prone land	All other areas	✔	✔	✔
Hardwood thinning plants	Land that is > 200 km (by road) from Newcastle, Brisbane, Condong, Harwood, Broadwater (hardwood thinning markets)	Within 200 km travel distance from hardwood thinning plant	✔		
Werris Creek railway hub	Land that is > 100 km direct line distance to Werris Creek railway hub, from which radiata pine can be transported via train	Within 100 km of Werris Creek railway hub			✔
Existing hardwood plantations	Greater than 50 km from a group of existing hardwood plantations#### that total > 500 ha in area	Within an area containing > 500 ha of hardwood plantations	✔		
Existing southern pine plantations	Greater than 50 km from a group of existing southern pine plantations#### that total > 1,000 ha in area	Within an area containing > 1,000 ha of southern pine plantations		✔	
Existing radiata pine plantations	Greater than 50 km from a group of existing radiata pine plantations#### > 1,000 ha in area	Within an area containing > 1,000 ha of radiata pine plantations			✔

\# Refer to **Attachment 2** for viable and non-viable land use codes

\#\# Areas receiving 1,000 - 1,200 mm/yr classed as 'sub-optimal' for hardwood plantations (value = '0.5')

\#\#\# Areas receiving 800 - 1,000 mm/yr classed as 'sub-optimal' for pine plantations (value = '0.5')

\#\#\#\# Group of plantations within 10 km of each other

Table 02-3. Description of datasets used to assemble viability maps for farm forestry enterprises and environmental plantings

Dataset	Non-viable area (value = '0')	Viable area (value = '1')	Type of non-commercial planting	
			Farm forestry	Environmental planting
Land tenure	NPWS managed land, state forest, Crown land	Private or leasehold land	✓	✓
Land use #	High value agricultural lands, urban, residential, industrial, forested lands	Other agricultural lands including some cropping areas and all cleared grazing lands	✓	
	All non-agricultural lands and forested lands	Most cleared agricultural lands		✓
Powerlines	Within 6 m of powerlines up to 11 kV Within 12.5 m of powerlines 12 – 33 kV Within 15 m of powerlines 34 – 66 kV Within 22.5 m of powerlines 67 – 132 kV Within 30 m of powerlines 133 – 330 kV Within 35 m of powerlines > 330 kV	Outside powerline setback zones	✓	✓
Buildings	Within 70 m of a building	> 70 m from any building (habitable dwelling)	✓	✓
Acid sulphate and heavy clay soils	Acid sulphate and heavy clay soils	All other soils	✓	
Water	Mapped water storages and estuaries	Non water bodies	✓	✓

Dataset	Above-target sub-region (value = '0')	Viable area (value = '1')	Type of non-commercial planting	
			Farm forestry	Environmental planting
Mitchell landscape clearing status	Less than 70% of the area of the landscape has been cleared of native vegetation	≥ 70% of landscape historically cleared of native vegetation		✓

Refer to **Attachment 2** for viable and non-viable land use codes

Table 02-4. Viability descriptors based on viability code-string

Eucalypt plantations and radiata pine plantations

Site constraints											Market constraints			Bushfire prone land	Viability category
Non-forest	Land use	Tenure	Erosivity	Power-lines	Buildings	Riparian	Water bodies	Soils	Rainfall	Elevation	Property	Existing plantations	Distance to market		
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	Optimal growth, optimal location
1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	Optimal growth, bushfire prone location
1	1	1	1	1	1	1	1	1	1	1	At least one of these = 0			1	Optimal growth, market constrained location
1	1	1	1	1	1	1	1	1	1	1	At least one of these = 0			0	Optimal growth, bushfire prone & market constrained location
1	1	1	1	1	1	1	1	1	0.5	1	1	1	1	1	Sub-optimal growth, optimal location
1	1	1	1	1	1	1	1	1	0.5	1	1	1	1	0	Sub-optimal growth, bushfire prone location
1	1	1	1	1	1	1	1	1	0.5	1	At least one of these = 0			1	Sub-optimal growth, market constrained location
1	1	1	1	1	1	1	1	1	0.5	1	At least one of these = 0			0	Sub-optimal growth, bushfire prone & market constrained location
At least one of these = 0											0 or 1	0 or 1	0 or 1	0 or 1	Land unsuitable for plantation
															Existing plantations

Southern pine plantations

Site constraints											Market constraints		Bushfire prone land	Viability category
Non-forest	Land use	Tenure	Erosivity	Power-lines	Buildings	Riparian	Water bodies	Soils	Rainfall	Elevation	Property	Existing plantations		
1	1	1	1	1	1	1	1	1	1	1	1	1	1	Optimal growth, optimal location
1	1	1	1	1	1	1	1	1	1	1	1	1	0	Optimal growth, bushfire prone location
1	1	1	1	1	1	1	1	1	1	1	At least one of these = 0		1	Optimal growth, market constrained location
1	1	1	1	1	1	1	1	1	1	1	At least one of these = 0		0	Optimal growth, bushfire prone & market constrained location
1	1	1	1	1	1	1	1	1	0.5	1	1	1	1	Sub-optimal growth, optimal location
1	1	1	1	1	1	1	1	1	0.5	1	1	1	0	Sub-optimal growth, bushfire prone location
1	1	1	1	1	1	1	1	1	0.5	1	At least one of these = 0		1	Sub-optimal growth, market constrained location
1	1	1	1	1	1	1	1	1	0.5	1	At least one of these = 0		0	Sub-optimal growth, bushfire prone & market constrained location
At least one of these = 0											0 or 1	0 or 1	0 or 1	Land unsuitable for plantation
														Existing plantations

Farm forestry plantings

Site constraints					Viability category
Land use	Tenure	Power-lines	Buildings	Soils	
1	1	1	1	1	Land suitable for farm forestry planting
At least one of these = 0					Land unsuitable for farm forestry planting

Environmental plantings

Site constraints				Site located within an over-cleared Mitchell landscape	Viability category
Land use	Tenure	Power-lines	Buildings		
1	1	1	1	1	Land suitable for environmental planting – high priority
1	1	1	1	0	Land suitable for environmental planting
At least one of these = 0				0 or 1	Land unsuitable for environmental planting

03 OUTPUTS

03.1 Individual viability layers

A total 27 viability layers were generated for this project. A summary is provided in Table 03-1 and each is mapped in Attachment 01. Proximity to significant areas of established plantations is a significant market constraint for all three commercial plantation types, while distance to Werris Creek railway hub is a major market constraint for radiata pine plantations. Rainfall, tenure, elevation and existing native vegetation discounts a large area of the region for commercial plantations.

Table 03-1. Summary of viability layers

Layer	Type	Area (km²)		
		Optimal	Sub-optimal	Unviable
Mean annual rainfall	Eucalypt plantation	30,035	25,764	41,384
	Radiata pine plantation	55,799	23,335	18,049
	Southern pine plantation			

Layer	Type	Viable	Unviable
Elevation	Eucalypt plantation	63,245	33,938
	Radiata pine plantation	33,217	63,966
	Southern pine plantation	56,008	41,175
Non-woody vegetation	All plantations	39,827	57,356
Riparian setbacks	All plantations	94,594	2,589
Waterbodies	All plantations and plantings	96,268	915
Land use	All plantations	43,012	54,171
	Farm forestry plantings	21,761	75,422
	Environmental plantings	39,590	57,593
Tenure	All plantations and plantings	65,661	31,522
Erosivity	All plantations	89,484	7,699
Soils	All plantations and farm forestry plantings	82,145	15,038
Buildings	All plantations and plantings	96,484	599
Powerlines	All plantations and plantings	96,929	254

Layer	Type	Not highly bushfire prone	Highly bushfire prone
Bushfire prone land	All plantations	92,854	4,329

Layer	Type	Not market constrained	Market constrained
Large area of existing plantations established in the region	Eucalypt plantation	67,532	29,651
	Radiata pine plantation	12,098	85,085
	Southern pine plantation	24,018	73,165
Properties	Eucalypt plantation	17,587	79,596
	Radiata pine plantation	14,921	82,262
	Southern pine plantation	19,495	77,688
Road distance to processing plant	Eucalypt plantation	58,542	38,641
Distance to Werris Creek railway	Radiata plantation	8,399	88,784

Layer	Type	High priority	Other
Mitchell landscape cover	Environmental planting	19,823	77,360

03.2 Composite layers

For each of the three commercial plantation types, a summary of the total area of each viability category is provided in Table 03-2.

The total area of land that is suitable for establishing radiata pine plantations on the tablelands and escarpment is almost the same as that for establishing southern pine plantations along the coast, at about 7,300 km². However, much higher proportion of land in the Hub region would provide optimum growth (in contrast to sub-optimum growth) for southern pine than for radiata pine, and a higher proportion of area suitable for radiata pine is market-constrained (related chiefly to the distance from Werris Creek railway hub).

The total area in the Hub region suitable for establishing new eucalypt plantations is estimated at about 6,300 km², slightly less than for either of the pines. However a much lower proportion of areas suitable for growing hardwoods are market-constrained and/or bushfire prone compared with suitable areas for pines (only 38% of suitable areas for eucalypt plantations are market constrained or bushfire prone, compared with 84% for radiata pine and 64% for southern pine).

Table 03-2. Area of different viability categories for commercial plantations within the NE NSW Hub region

Viability category	Area (km²)		
	Eucalypt	Radiata pine	Southern pine
Optimal growth, optimal location	1,266	264	2,517
Sub-optimal growth, optimal location	2,658	912	147
Optimal growth, market constrained location	1,122	862	3,275
Sub-optimal growth, market constrained location	956	4,821	980
Optimal growth, bushfire prone location	73	47	123
Sub-optimal growth, bushfire prone location	135	53	33
Optimal growth, bushfire prone & market constrained location	64	105	191
Sub-optimal growth, bushfire prone & market constrained location	72	288	72
Sub-total	*6,346*	*7,352*	*7,338*
Existing plantations (established)	809	106	156
Land unsuitable for plantations	90,658	89,725	89,739
Total	**97,183**	**97,183**	**97,183**

There are fewer geographic constraints to establishing farm forestry plantings and environmental plantings compared with commercial plantations, with 15,200 km² available for farm forestry plantings and 35,200 km² for environmental plantings (Table 03-3). A considerably larger area is suitable for environmental plantings (compared with farm forestry plantings) as fewer spatial constraints were imposed on these plantings. For example, acid sulphate soils and heavy clay soils and most agricultural land use categories were permitted for environmental plantings.

Table 03-3. Area of different viability categories for non-commercial plantings in the NE NSW Hub region

Viability category	Area (km²)	
	Farm forestry planting	Environmental planting
Suitable land – high priority	na	10,379
Suitable land	15,182	24,825
Unsuitable land	82,001	61,979
Total	**97,183**	**97,183**

The following maps show the distribution of each viability category across the Hub region:

- Eucalypt plantation (Figure 03-1)
- Radiata pine plantations (Figure 03-2)
- Southern pine plantations (Figure 03-3)
- Farm forestry plantings (Figure 03-4)
- Environmental plantings (Figure 03-5)

Optimum locations for new eucalypt plantations include higher rainfall zones in the Tweed and Richmond valleys, as well as coastal areas around Coffs Harbour, between Taree and Wauchope, and in the Dungog-Gloucester region of the northern Hunter catchment (Figure 03-1).

Optimum locations for new radiata pine plantations are around the Dungowan-Nowendoc-Nundle areas where large plantations are already established and hauled to Werris Creek railway for processing further afield (Figure 03-2).

Optimum locations for new southern pine plantations are around the Richmond Range region in the north where most existing plantations exist, although there is also an area north of Newcastle in which a large southern pine plantation is also established (Figure 03-3).

Areas for growing radiata pine are spatially separated from areas for growing southern pine and eucalypts (i.e. no overlap in elevation), however suitable areas for southern pine and eucalypts overlap considerably, with 6,237 km^2 in the coastal region suitable for both types. It follows that the total area of the Hub region in which some type of commercial eucalypt or pine plantation could be established is around 14,800 km^2 or about 15% of the total area of the Hub region.

In contrast to commercial plantations, there are fewer geographic impediments to establishing farm forestry plantings and environmental plantings, with all parts of the Hub region containing suitable landscapes for these enterprises (Figure 03-4, Figure 03-5). There are more areas available for establishing environmental plantings, however the preferred areas for environmental plantings are within Mitchell landscapes that have been heavily cleared of native vegetation in the past. Preferred landscapes include the Tweed and Clarence Valleys, the Upper Manning and the Upper Hunter Valleys, and much of southern parts of the New England Tableland (Figure 03-5).

03.3 Limitations and caveats

The spatial mapping and analyses undertaken for this project provides useful strategic insights into different zones in the Hub region in which different commercial plantations and other plantings could feasibly be established (and where they cannot). However, the analyses rely on broad spatially datasets (e.g. rainfall, soils, land use) that could be inaccurate at fine scales (e.g. individual paddocks). For this reason, it is likely that some areas that are currently mapped as 'unsuitable' could be suitable for establishing plantations or plantings, and *vis versa*. It follows that this product will be useful for identifying broad regions in which plantations are likely to be viable or not, but at the local scale site inspection will be required to gauge paddock-scale suitability.

Figure 03-1. Viability mapping for commercial eucalypt plantations in the North East NSW Regional Forestry Hub region
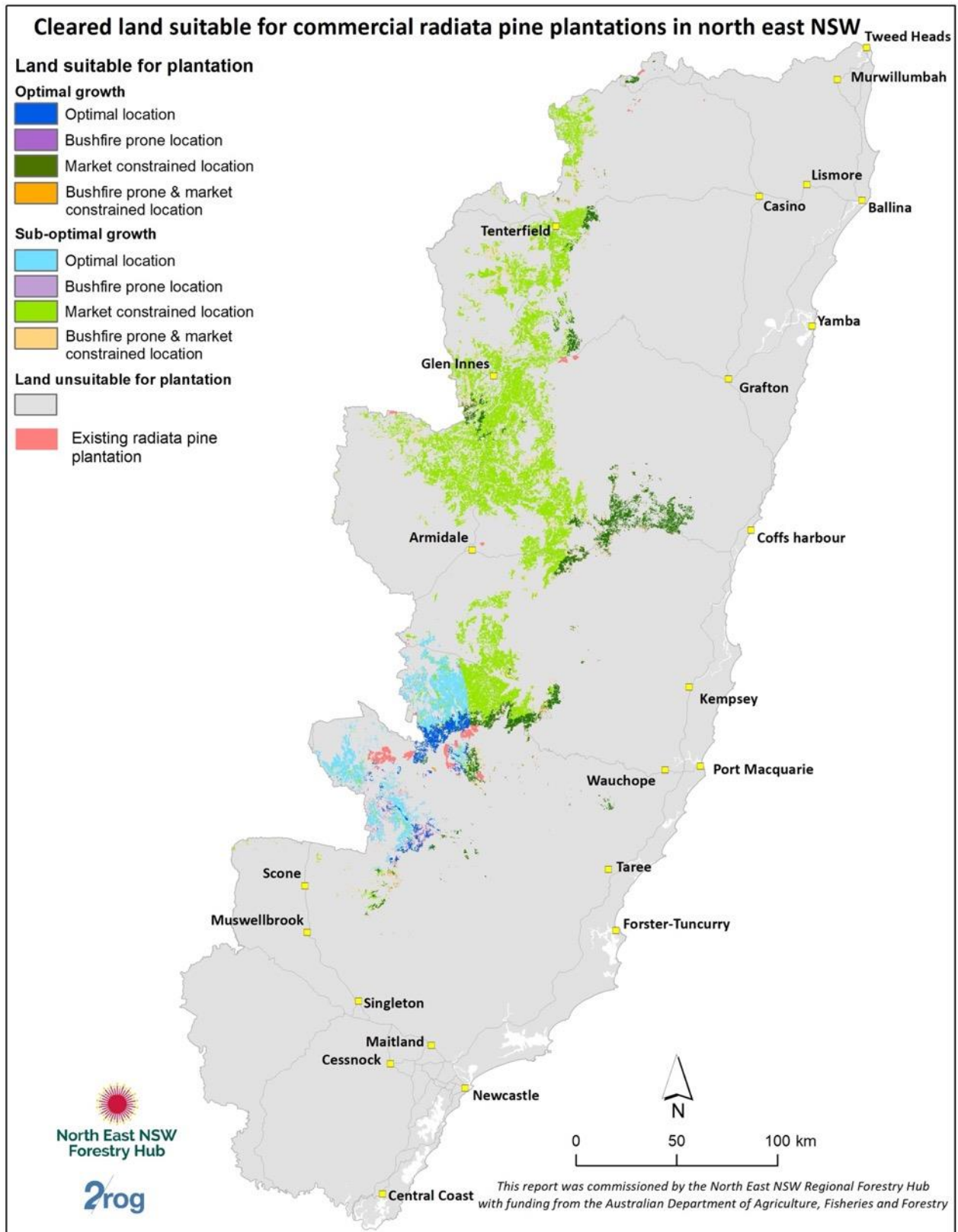
Figure 03-2. Viability mapping for commercial radiata pine plantations in the North East NSW Regional Forestry Hub region
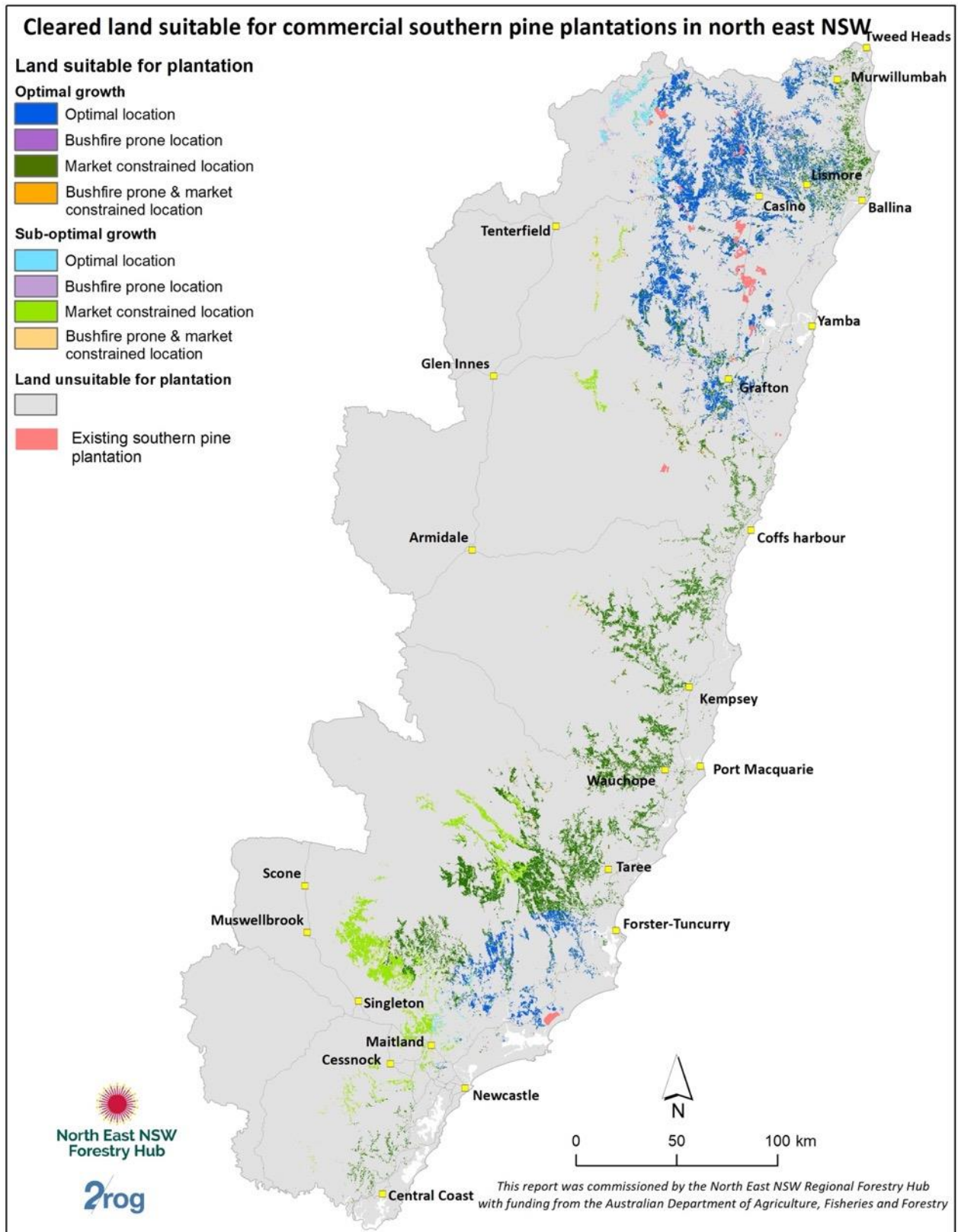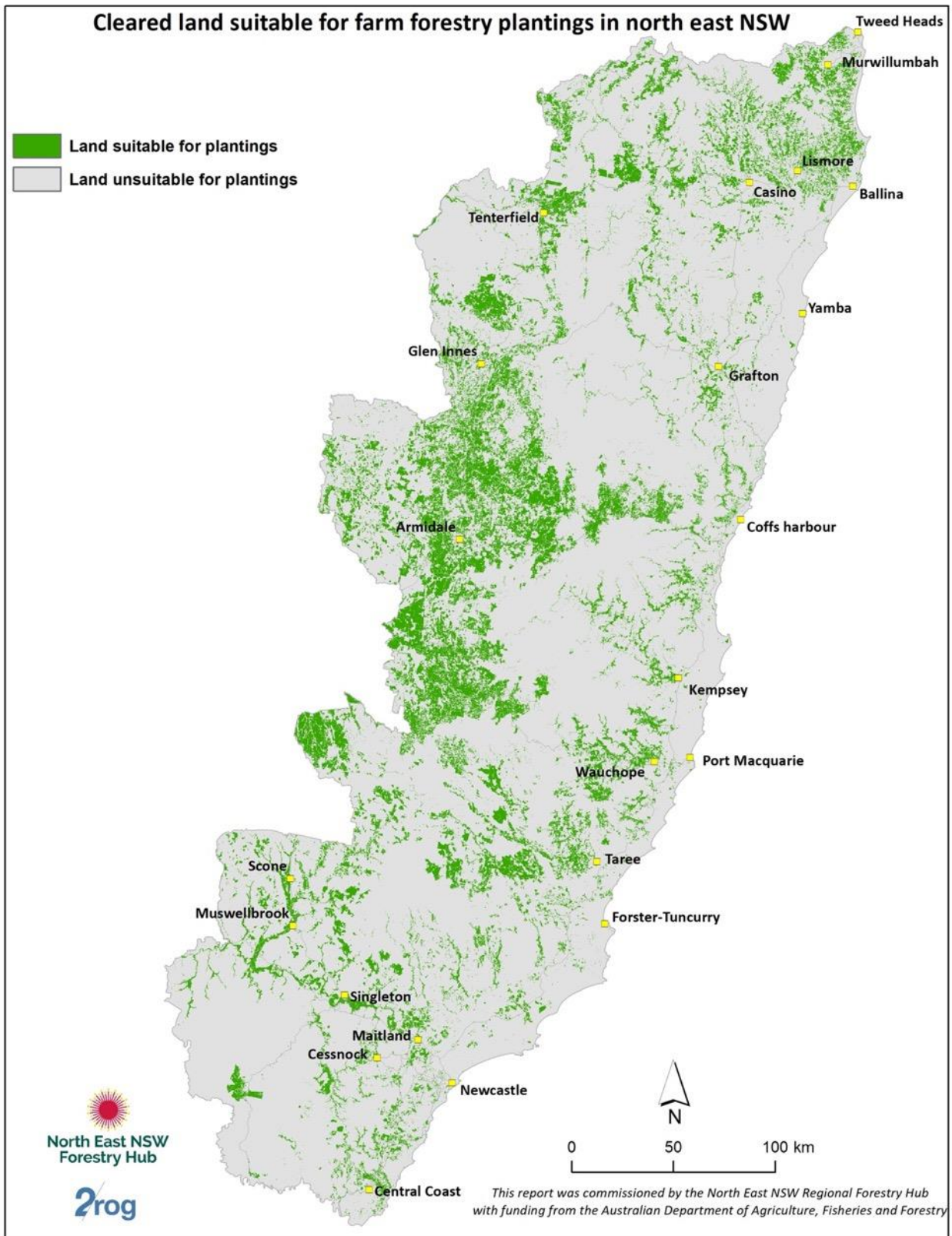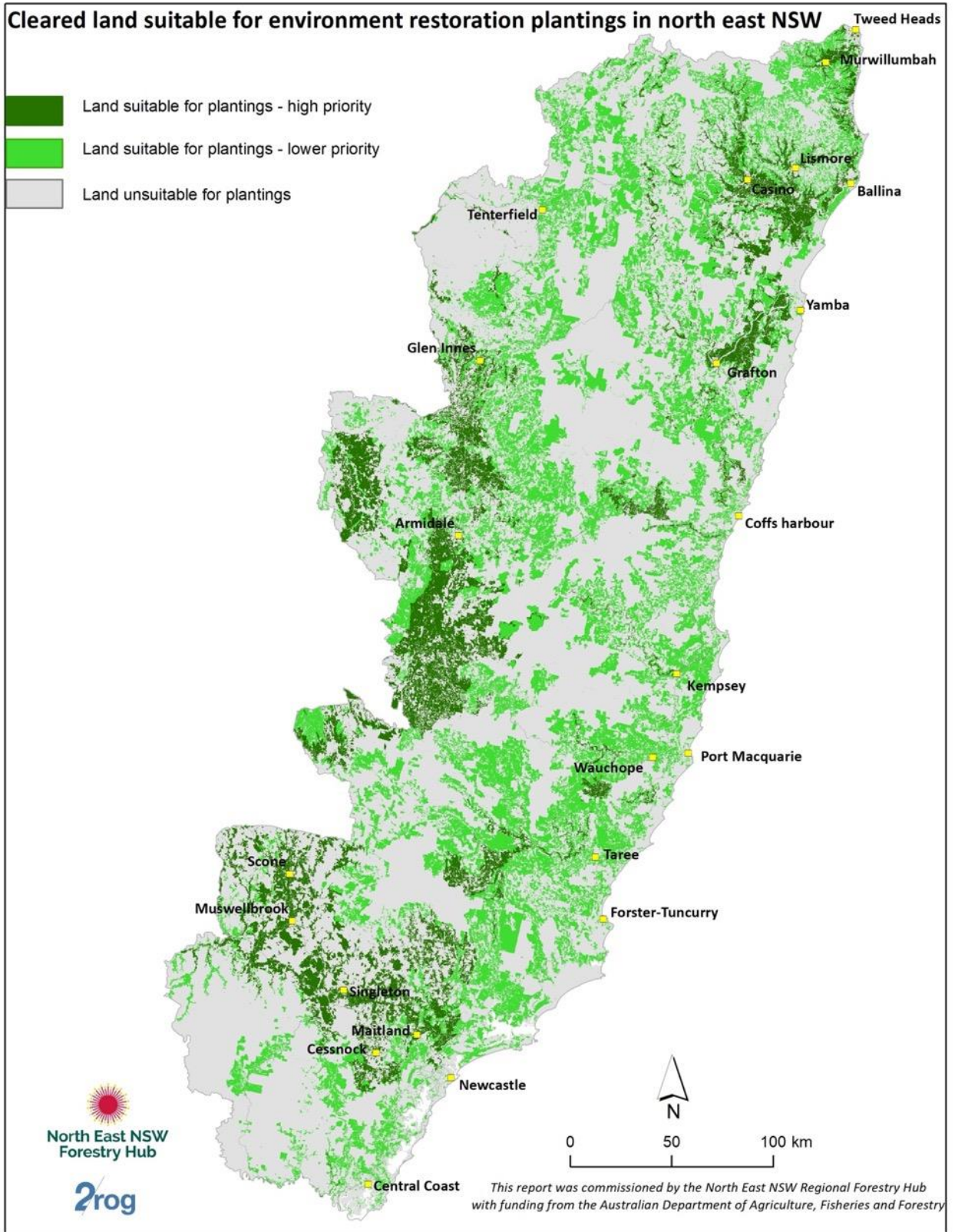
Figure 03-3. Viability mapping for commercial southern pine plantations in the North East NSW Regional Forestry Hub region

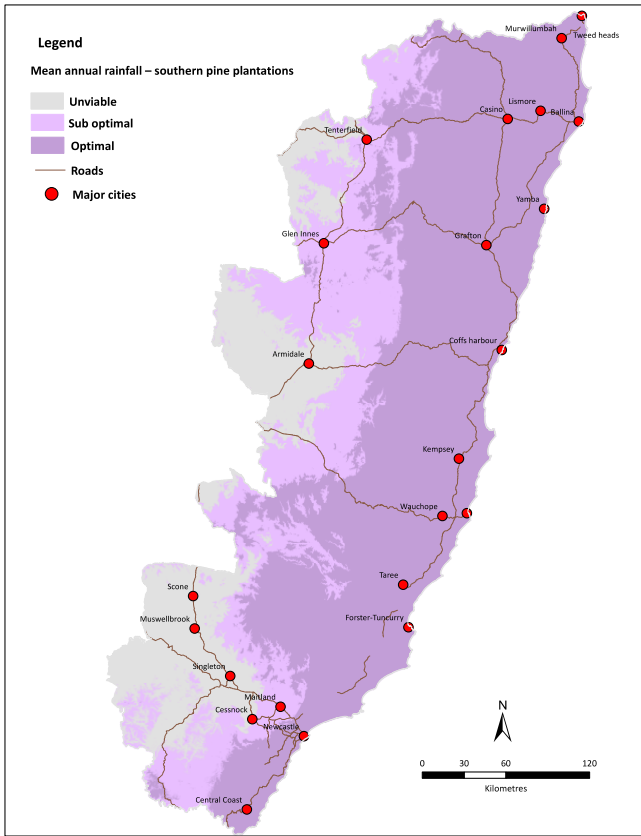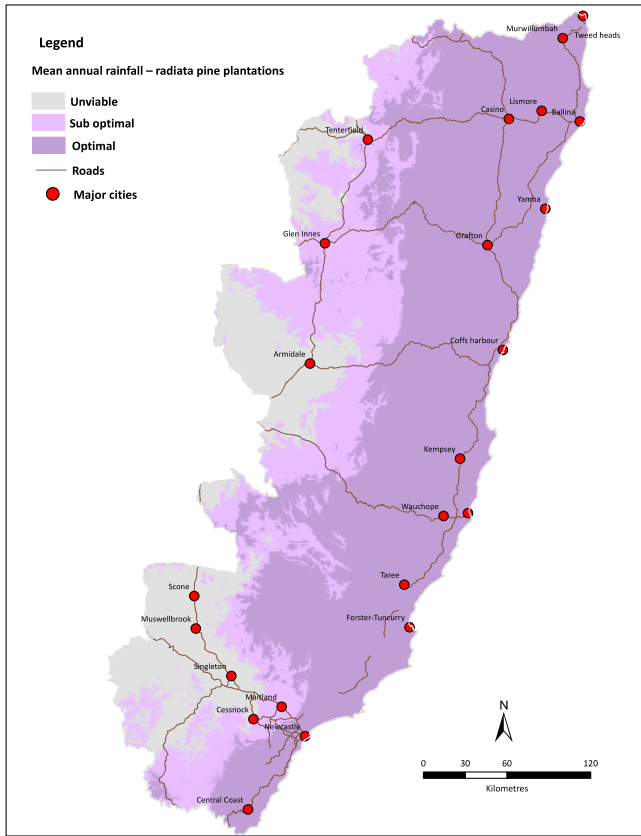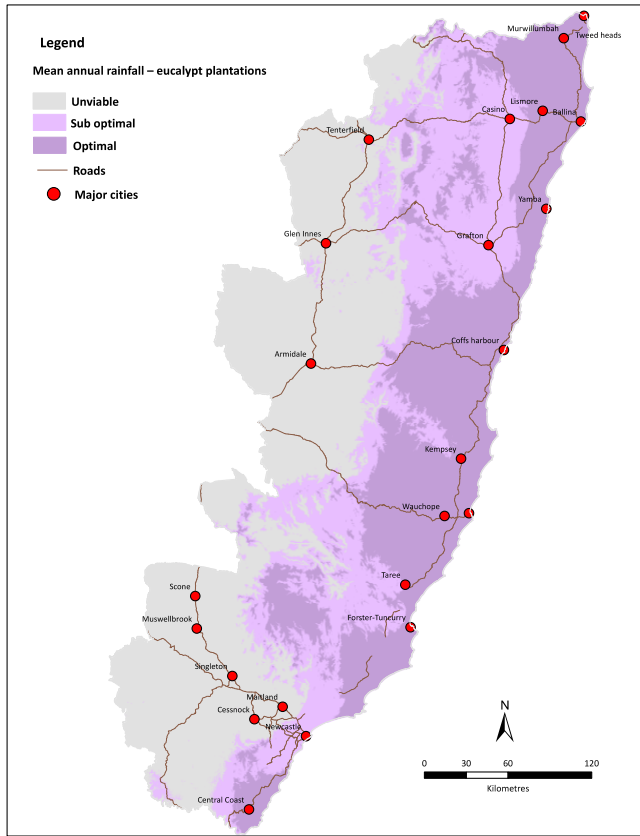**Figure 03-4. Viability mapping for farm forestry plantings in the North East NSW Regional Forestry Hub region**

Figure 03-5. Viability mapping for environmental plantings in the North East NSW Regional Forestry Hub region

ATTACHMENT 01 – VIABILITY MAPS

Mean annual rainfall – eucalypt plantations

Optimal > 1,200 mm   (30,035 km² – 31% of Hub region)
Sub-optimal 1,000 – 1,200 mm (25,764 km² – 26% of Hub region)
Unviable < 1,000 ha   (41,384 km² – 43% of Hub region)

Mean annual rainfall – radiata pine plantations

Optimal > 1,000 mm   (55,799 km² – 57% of Hub region)
Sub-optimal 800 – 1,000 mm (23,335 km² – 24% of Hub region)
Unviable < 800 ha   (18,049 km² – 19% of Hub region)

Mean annual rainfall – southern pine plantations

Optimal > 1,000 mm   (55,799 km² – 57% of Hub region)
Sub-optimal 800 – 1,000 mm (23,335 km² – 24% of Hub region)
Unviable < 800 ha   (18,049 km² – 19% of Hub region)
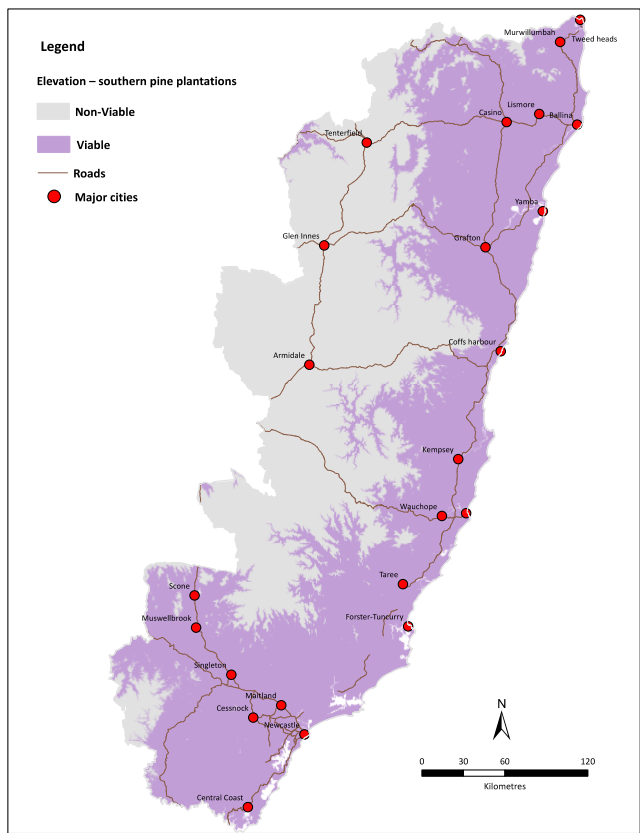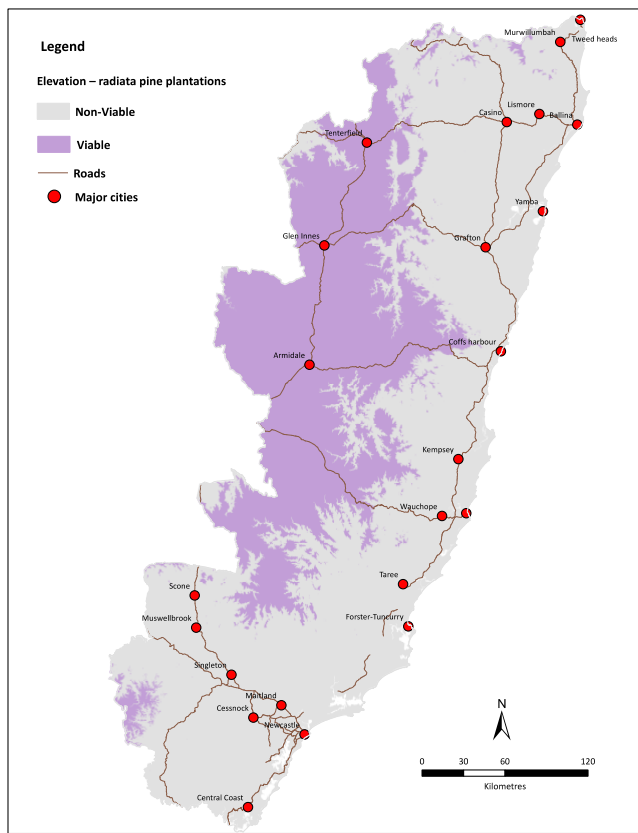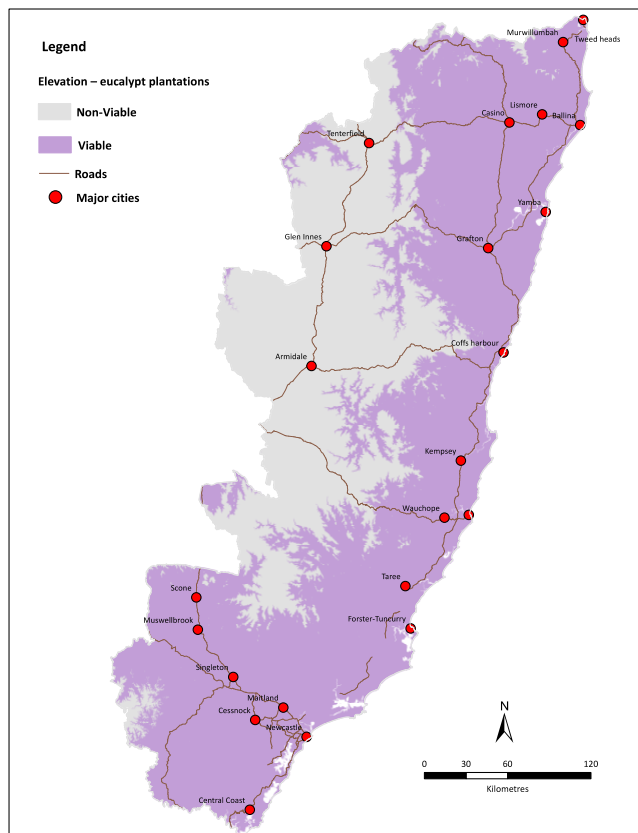
Elevation – eucalypt plantations

Viable ≤ 650 m asl   (63,245 km^2 – 65% of Hub region)
Unviable > 650 m asl   (33,938 km^2 – 35% of Hub region)

Elevation – radiata pine plantations

Viable > 650 m asl   (33,218 km^2 – 34% of Hub region)
Unviable ≤ 650 m asl   (63,966 km^2 – 66% of Hub region)

Elevation – southern pine plantations

Viable ≤ 500 m asl   (56,008 km^2 – 58% of Hub region)
Unviable > 500 m asl   (41,175 km^2 – 42% of Hub region)
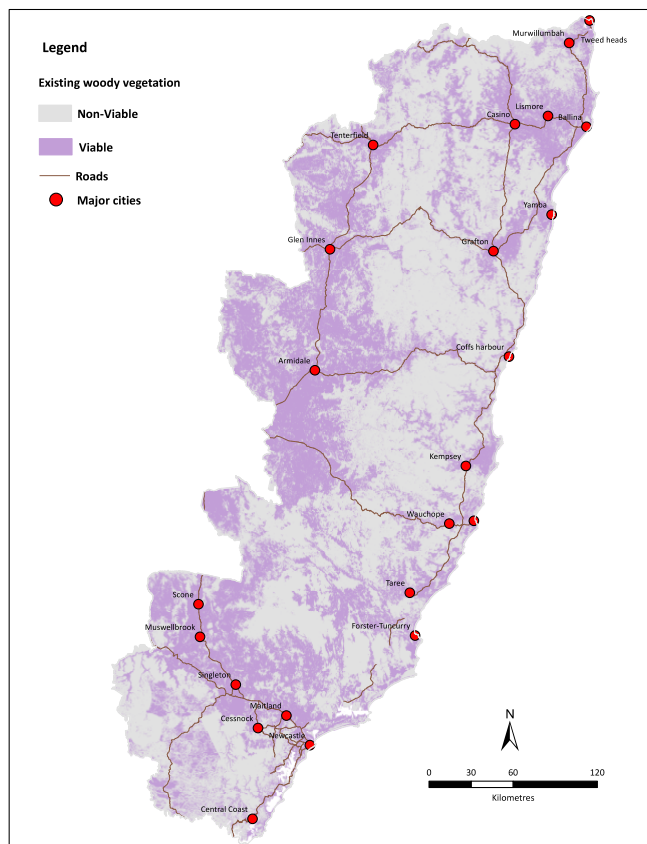
Existing woody vegetation – all commercial plantations

Viable – non-woody   (39,827 km^2 – 41% of Hub region)
Unviable – woody   (57,356 km^2 – 59% of Hub region)
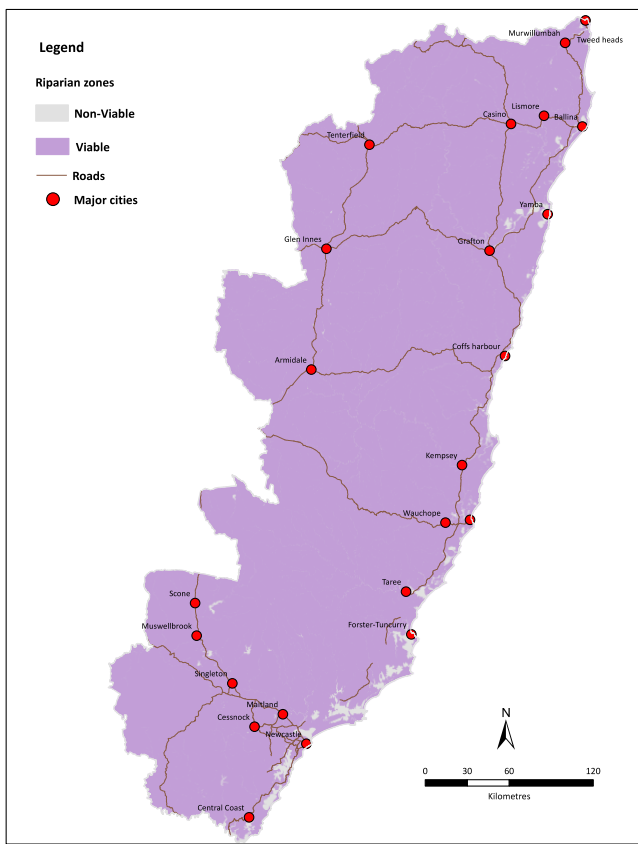
Riparian zones (streams, wetlands and estuaries) –
all commercial plantations

Viable – outside setback zone   (94,594 km^2 – 97% of Hub region)
Unviable – inside setback zone (2,589 km^2 – 3% of Hub region)
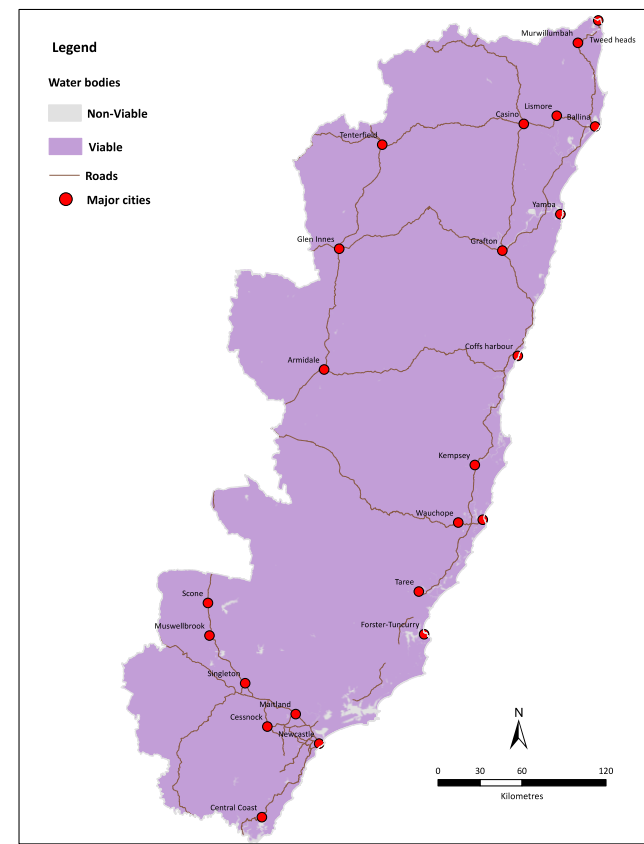
Water bodies (reservoirs, estuaries) – all commercial plantations

Viable – non waterbody   (96,268 km^2 – 99% of Hub region)
Unviable – waterbody   (915 km^2 – 1% of Hub region)
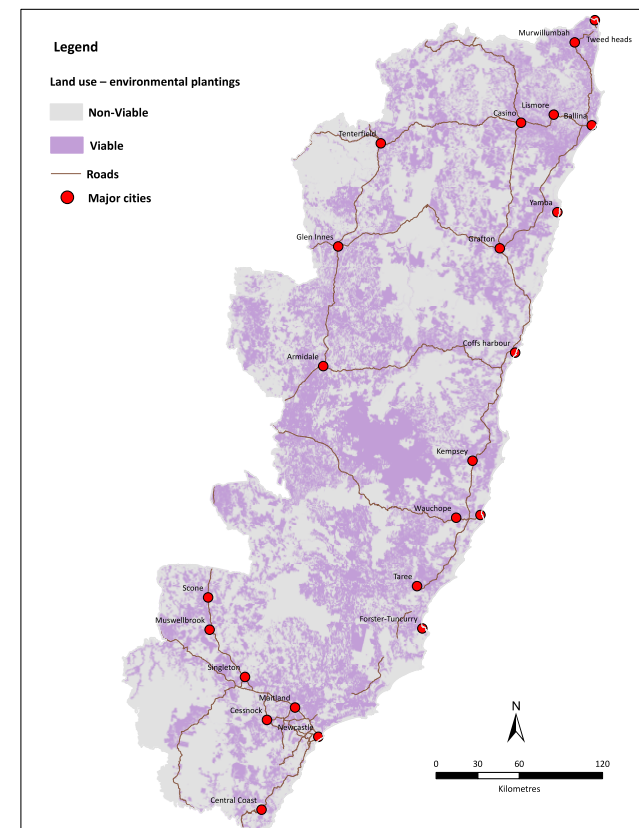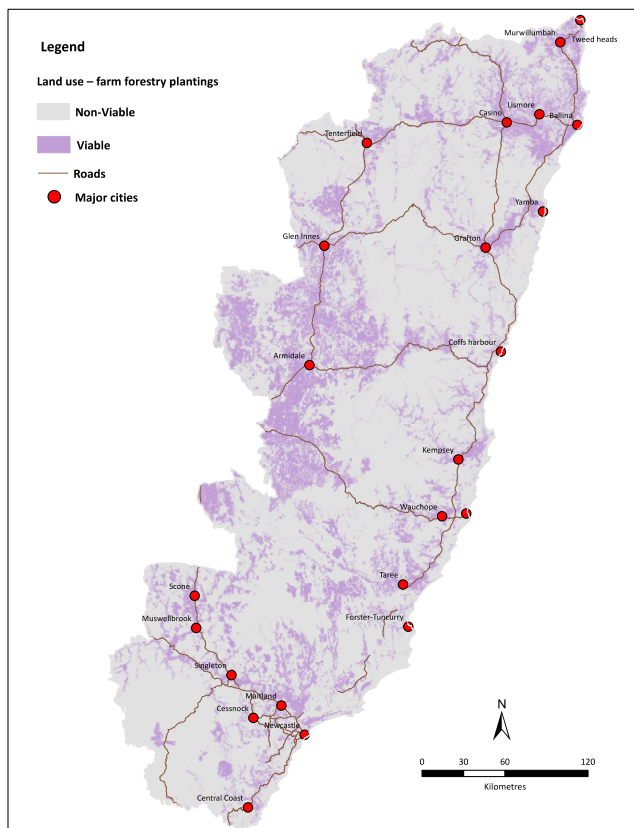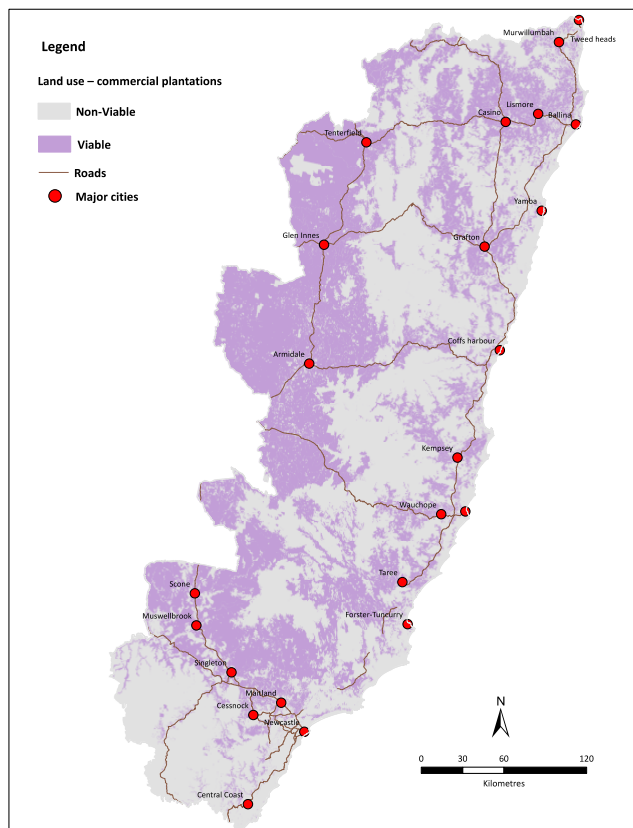
Land use – all commercial plantations

Viable   (43,012 km² – 44% of Hub region)

Unviable (54,172 km² – 56% of Hub region)

Land use – farm forestry plantings

Viable   (21,761 km² – 22% of Hub region)
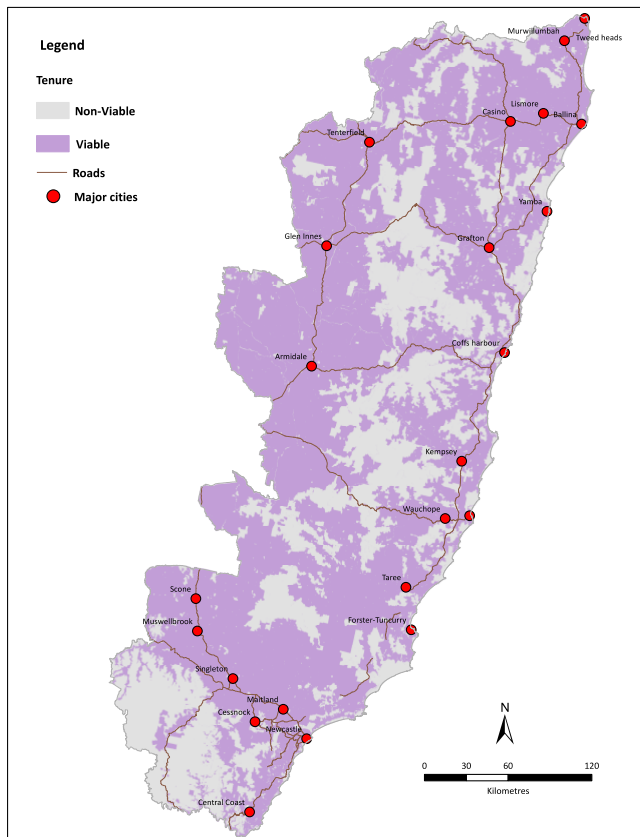
Unviable (75,422 km² – 78% of Hub region)

Land use – environmental plantings

Viable   (39,590 km² – 41% of Hub region)

Unviable (57,593 km² – 59% of Hub region)

Note: 'Grazing native vegetation' was included as 'viable' land use category for commercial plantations in view of the potential to clear semi-vegetated grazing country to establish commercial plantations. However this category was included as 'non-viable' land use for farm forestry plantings and environmental plantings
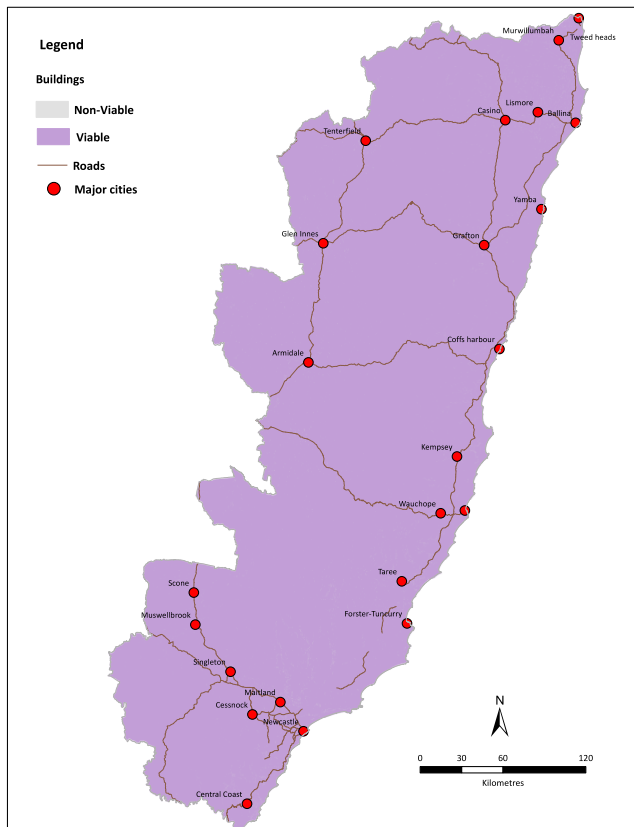
Tenure – all commercial plantations and non-commercial plantings

Viable – private/leasehold land (65,661 km^2 – 68% of Hub region)
Unviable – public land (31,522 km^2 – 32% of Hub region)
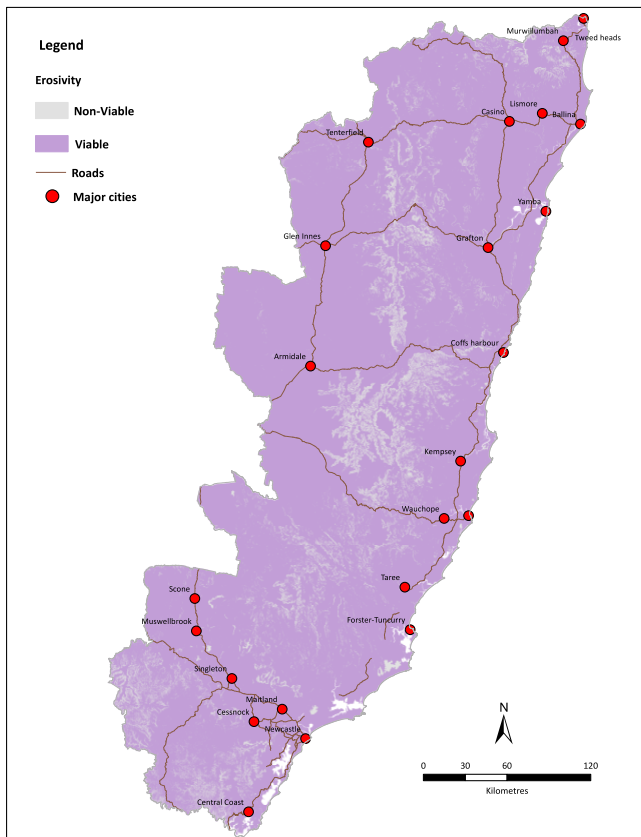
Erosivity – all commercial plantations

Viable (89,484 km^2 – 92% of Hub region)
Unviable (7,699 km^2 – 8% of Hub region)
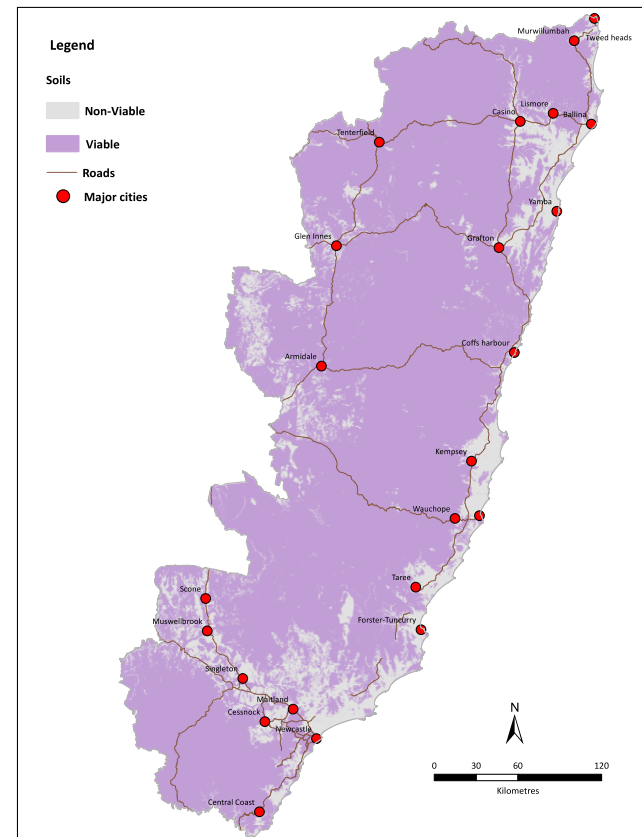
Soils – all commercial plantations and farm forestry plantings

Viable – friable soils (82,145 km^2 – 85% of Hub region)
Unviable – acid soils or heavy clays (15,038 km^2 – 15% of Hub region)

Buildings – all commercial plantations and non-commercial plantings

Viable > 70 m from building   (96,584 km^2 – 99% of Hub region)

Unviable ≤ 70 m from building (599 km^2 – 1% of Hub region)
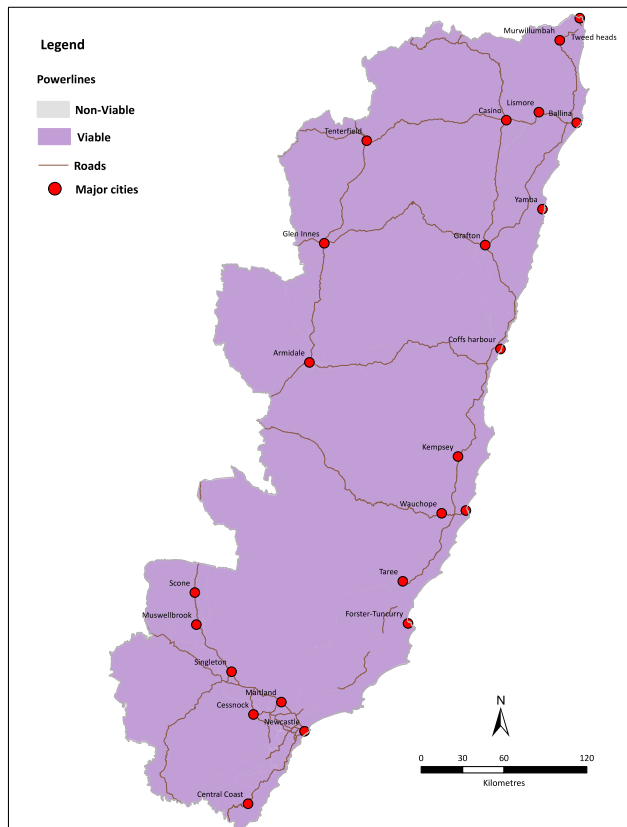
Powerlines – all commercial plantations and non-commercial plantings

Viable – outside setback zone   (96,929 km^2 – 99.7% of Hub region)

Unviable – inside setback zone (254 km^2 – 0.3% of Hub region)
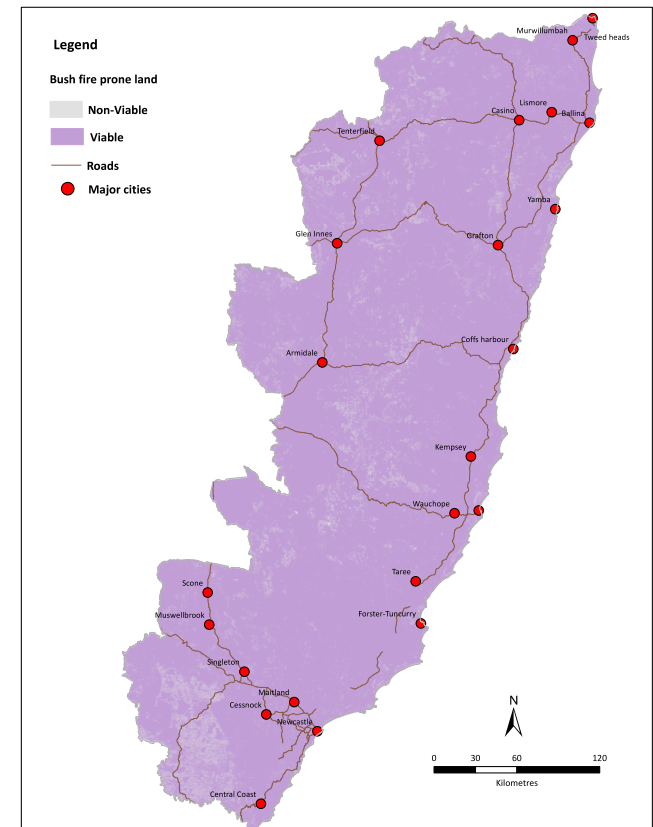
Bushfire prone land – all commercial plantations

Highly bushfire prone   (92,854 km^2 – 96% of Hub region)

Other   (4,329 km^2 – 4% of Hub region)
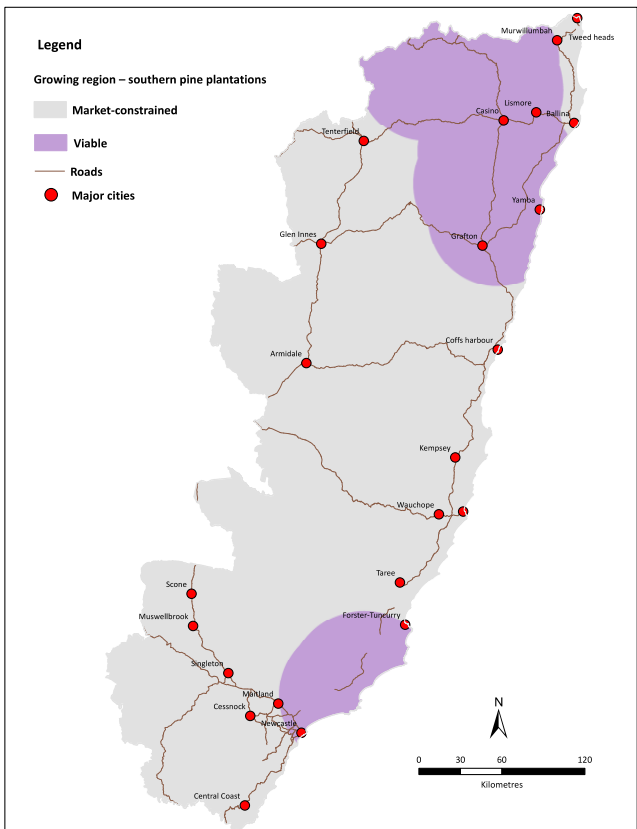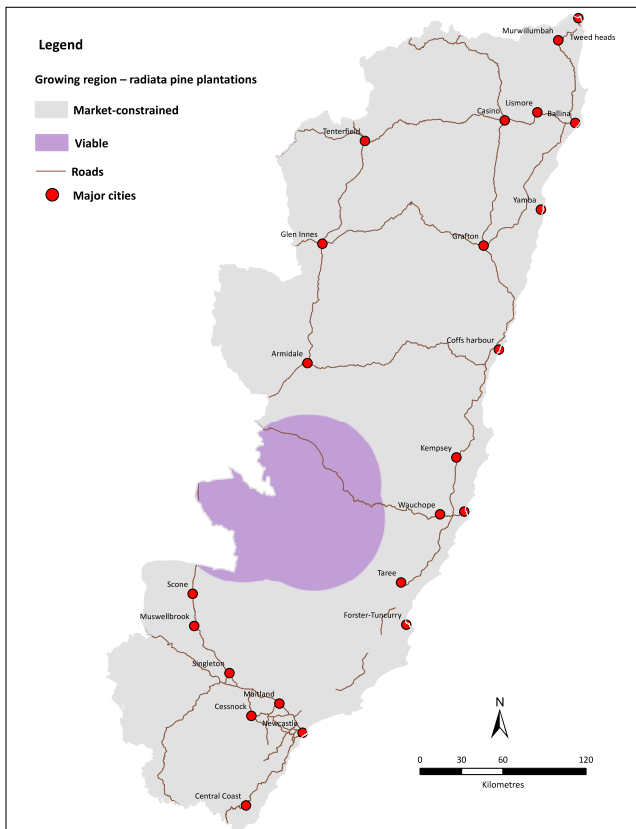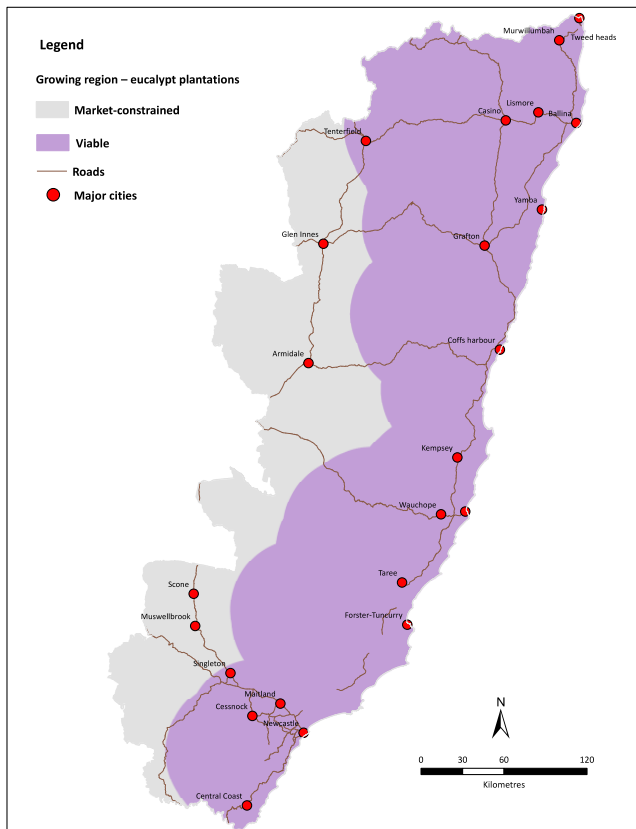
Eucalypt plantation region (> 500 ha of plantations)

Within 50 km of plantation/s (67,532 km^2 – 69% of Hub region)

Outside growing region – market constrained
(29,651 km^2 – 31% of Hub region)

Radiata pine region (> 1000 ha of plantations)

Within 50 km of plantation/s (12,098 km^2 – 12% of Hub region)

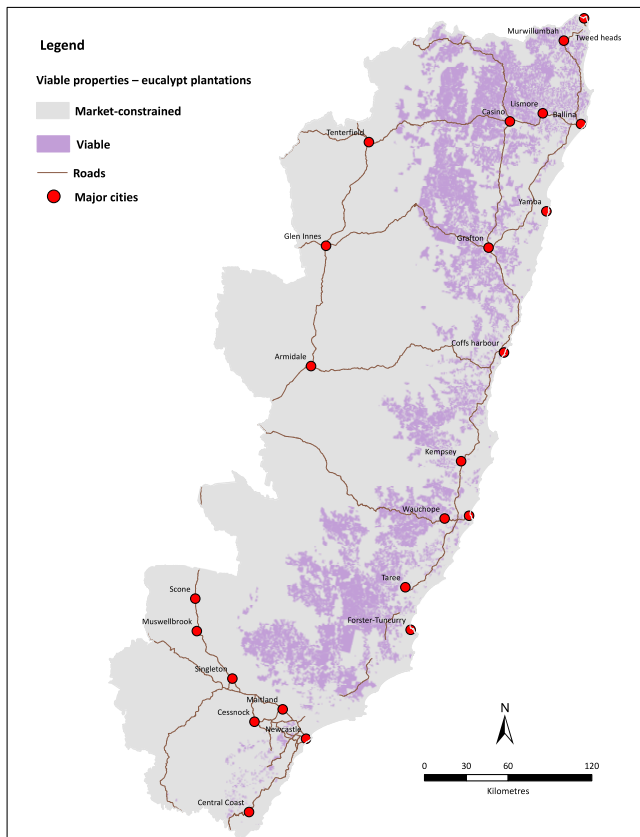Outside growing region – market constrained
(85,085 km^2 – 88% of Hub region)

Southern pine region (> 1000 ha of plantations)

Within 50 km of plantation/s (24,018 km^2 – 25% of Hub region)

Outside growing region – market constrained
(73,165 km^2 – 75% of Hub region)

Viable properties – eucalypt plantations

≥ 30 ha available for planting (17,857 km² – 18% of Hub region)

< 30 ha available for planting – market constrained

(79,596 km² – 82% of Hub region)
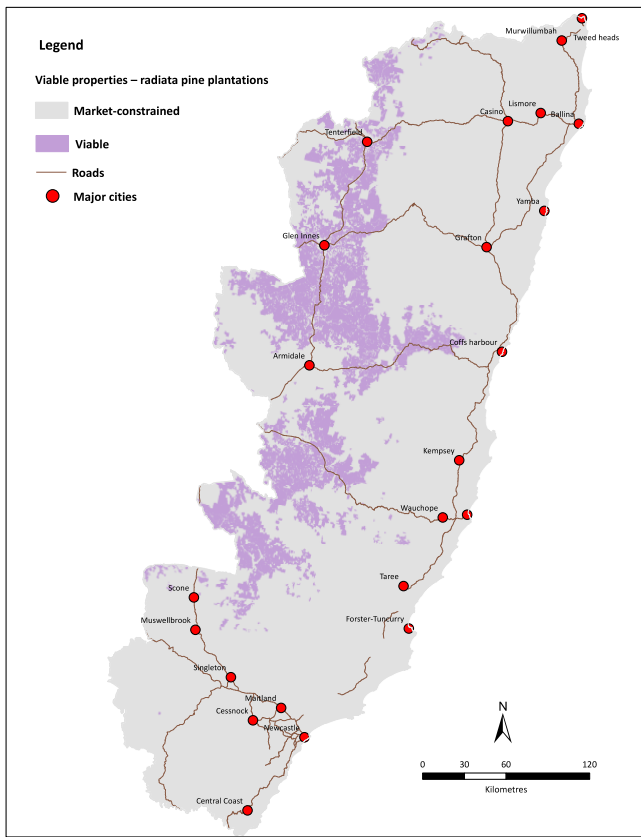
Viable properties – radiata pine plantations

≥ 30 ha available for planting (14,921 km² – 15% of Hub region)

< 30 ha available for planting – market constrained

(82,262 km² – 85% of Hub region)
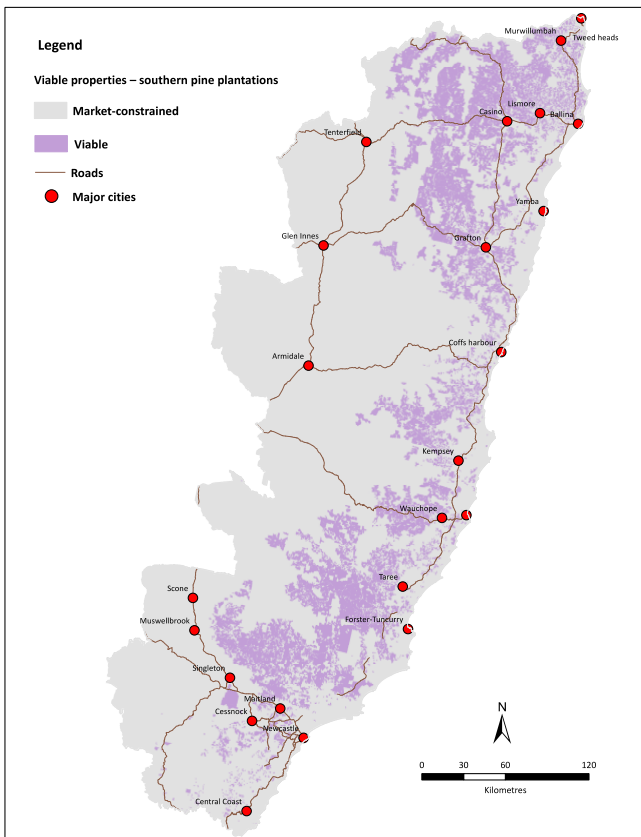
Viable properties – southern pine plantations

≥ 30 ha available for planting (19,495 km² – 20% of Hub region)

< 30 ha available for planting – market constrained

(77,688 km² – 80% of Hub region)
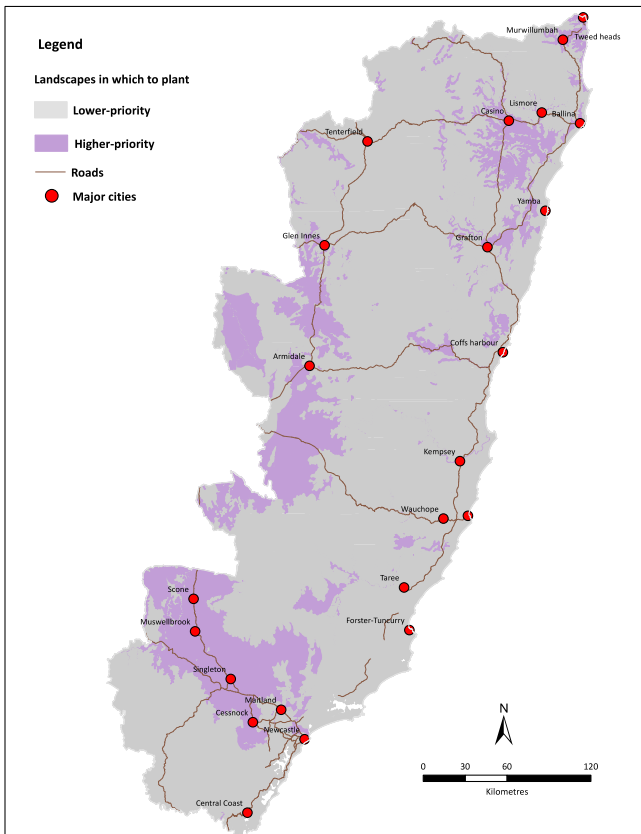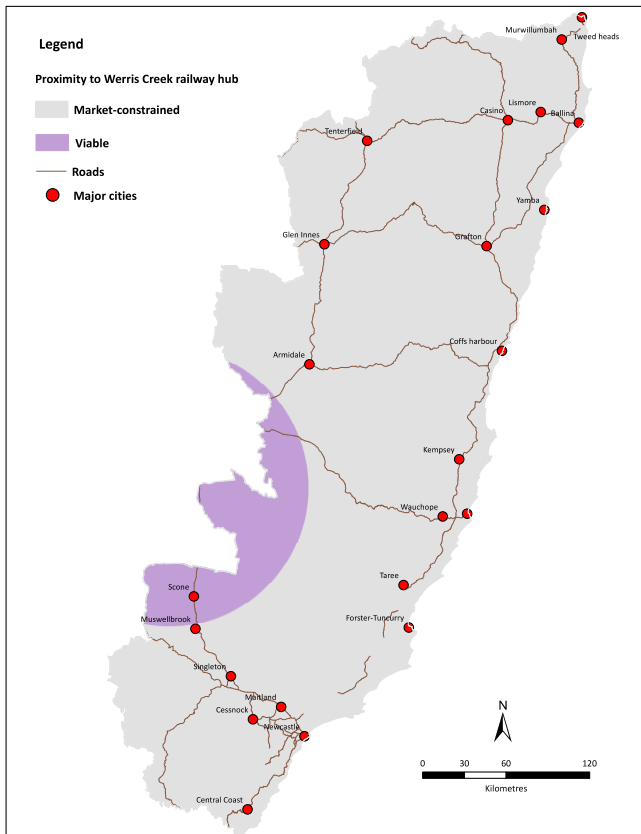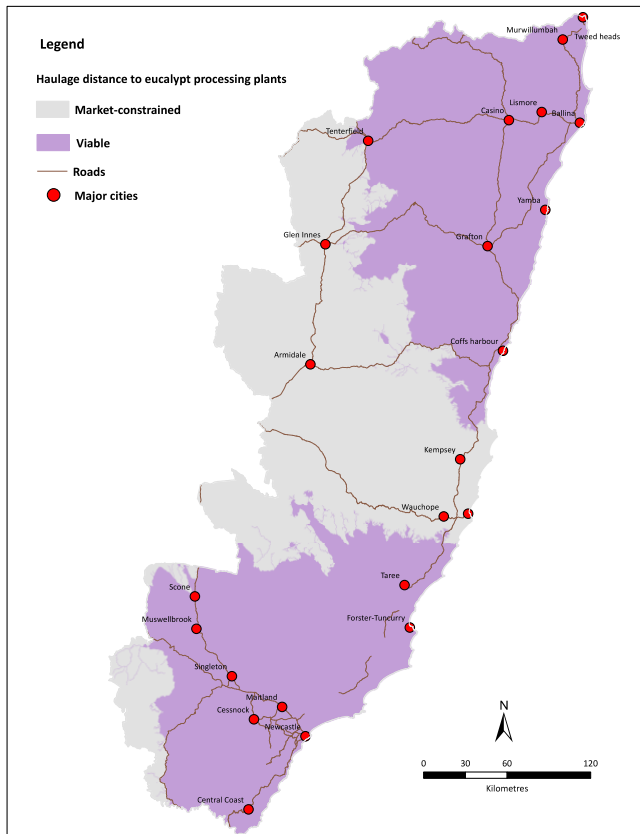
Road distance to nearest processing plant – eucalypt plantations

≤ 200 km from nearest plant (58,542 km² – 60% of Hub region)
> 200 km from nearest plant – market constrained
(38,641 km² – 40% of Hub region)

Distance to Werris Creek railway hub – radiata pine plantations

≤ 100 km from railway hub (8,399 km² – 9% of Hub region)
> 100 km from railway hub – market constrained
(88,784 km² – 91% of Hub region)

Mitchell Landscape status – environmental plantings

≥ 70% cleared – high priority for plantings
(19,823 km² – 20% of Hub region)
< 70% cleared – lower priority for plantings
(77,360 km² – 80% of Hub region)

ATTACHMENT 02 – VIABLE LAND USE CATEGORIES

Land use	Viable = yes		
	Commercial pine or eucalypt plantation	Farm forestry planting	Environmental planting
1.1.0 Nature conservation			
1.1.1 Strict nature reserves			
1.1.3 Nature park			
1.1.6 Protected landscape			
1.1.7 Other conserved area			
1.2.0 Managed resource protection			
1.2.1 Biodiversity			
1.2.2 Surface water supply			yes
1.2.4 Landscape		yes	yes
1.3.0 Other minimal use		yes	yes
1.3.2 Stock route			
1.3.3 Residual native cover			yes
1.3.4 Rehabilitation			yes
2.1.0 Grazing native vegetation	yes		
2.2.0 Production native forests			
3.1.0 Plantation forests			
3.1.1 Hardwood plantation forestry			
3.1.2 Softwood plantation forestry			
3.1.3 Other forest plantation			
3.1.4 Environmental forest plantation			yes
3.2.0 Grazing modified pastures	yes	yes	yes
3.2.1 Native/exotic pasture mosaic	yes	yes	yes
3.2.2 Woody fodder plants	yes		yes
3.2.3 Pasture legumes	yes	yes	yes
3.2.5 Sown grasses	yes	yes	yes
3.3.0 Cropping		yes	yes
3.3.1 Cereals		yes	yes
3.3.2 Beverage & spice crops		yes	
3.3.3 Hay and silage		yes	yes
3.3.4 Oilseeds		yes	
3.3.5 Sugar		yes	yes
3.4.0 Perennial horticulture			yes
3.4.1 Tree fruits			
3.4.2 Olives			
3.4.3 Tree nuts			
3.4.4 Vine fruits			
3.4.5 Shrub berries and fruits			
3.4.6 Perennial flowers and bulbs			

Land use	Viable = yes		
	Commercial pine or eucalypt plantation	Farm forestry planting	Environmental planting
3.4.7 Perennial vegetables and herbs			
3.4.8 Citrus			
3.4.9 Grapes			
3.5.0 Seasonal horticulture		yes	yes
3.5.2 Seasonal flowers and bulbs			
3.5.3 Seasonal vegetables and herbs			
3.6.0 Land in transition		yes	yes
3.6.2 Abandoned land	yes	yes	yes
3.6.3 Land under rehabilitation		yes	yes
3.6.4 No defined use	yes	yes	yes
3.6.5 Abandoned perennial horticulture		yes	yes
4.1.1 Irrigated hardwood plantation forestry			
4.1.3 Irrigated other forest plantation			
4.2.0 Grazing irrigated modified pastures		yes	yes
4.2.4 Irrigated sown grasses		yes	yes
4.3.0 Irrigated cropping		yes	yes
4.3.3 Irrigated hay and silage		yes	yes
4.3.4 Irrigated oilseeds		yes	
4.4.0 Irrigated perennial horticulture			yes
4.4.1 Irrigated tree fruits			
4.4.2 Irrigated olives			
4.4.3 Irrigated tree nuts			
4.4.4 Irrigated vine fruits			
4.4.7 Irrigated perennial vegetables and herbs			yes
4.4.9 Irrigated grapes			
4.5.0 Irrigated seasonal horticulture			yes
4.5.3 Irrigated seasonal vegetables and herbs			yes
4.5.4 Irrigated turf farming			
4.6.5 Abandoned irrigated perennial horticulture		yes	yes
5.1.0 Intensive horticulture			
5.1.1 Production nurseries			
5.1.2 Shade houses			
5.1.3 Glasshouses			
5.1.4 Glasshouses - hydroponic			
5.1.5 Abandoned intensive horticulture		yes	yes
5.2.0 Intensive animal production			
5.2.1 Dairy sheds and yards			
5.2.2 Feedlots			
5.2.3 Poultry farms			
5.2.4 Piggeries			
5.2.5 Aquaculture			
5.2.6 Horse studs		yes	yes

Land use	Viable = yes		
	Commercial pine or eucalypt plantation	Farm forestry planting	Environmental planting
5.2.7 Saleyards/stockyards			
5.2.8 Abandoned intensive animal production		yes	yes
5.3.0 Manufacturing and industrial			
5.3.1 General purpose factory			
5.3.2 Food processing factory			
5.3.3 Major industrial complex			
5.3.5 Abattoirs			
5.3.7 Sawmill			
5.3.8 Abandoned manufacturing and industrial			
5.4.0 Residential and farm infrastructure			
5.4.1 Urban residential			
5.4.2 Rural residential with agriculture		yes	yes
5.4.3 Rural residential without agriculture		yes	yes
5.4.4 Remote communities		yes	yes
5.4.5 Farm buildings/infrastructure			
5.5.0 Services			
5.5.1 Commercial services			
5.5.2 Public services			
5.5.3 Recreation and culture		yes	yes
5.5.4 Defence facilities - urban			
5.5.5 Research facilities			yes
5.6.0 Utilities			
5.6.1 Fuel powered electricity generation			
5.6.3 Wind electricity generation			
5.6.4 Solar electricity generation			
5.6.5 Electricity substations and transmission			
5.6.6 Gas treatment, storage and transmission			
5.6.7 Water extraction and transmission			
5.7.0 Transport and communication			
5.7.1 Airports/aerodromes			
5.7.2 Roads			
5.7.3 Railways			
5.7.4 Ports and water transport			
5.7.5 Navigation and communication			
5.8.0 Mining			yes
5.8.1 Mines			yes
5.8.2 Quarries			yes
5.8.3 Tailings			yes
5.8.4 Extractive industry not in use		yes	yes
5.9.0 Waste treatment and disposal			
5.9.1 Effluent pond			
5.9.2 Landfill			

Land use	Viable = yes		
	Commercial pine or eucalypt plantation	Farm forestry planting	Environmental planting
5.9.3 Solid garbage			
5.9.5 Sewage/sewerage			
6.1.0 Lake			
6.2.0 Reservoir/dam			
6.2.1 Reservoir			
6.2.2 Water storage - intensive use/farm dams			
6.2.3 Evaporation basin			
6.3.0 River		yes	yes
6.3.1 River - conservation		yes	yes
6.3.3 River - intensive use		yes	yes
6.4.0 Channel/aqueduct			
6.4.1 Supply channel/aqueduct			
6.4.2 Drainage channel/aqueduct			
6.4.3 Stormwater			
6.5.0 Marsh/wetland			yes
6.5.1 Marsh/wetland - conservation			yes
6.5.4 Marsh/wetland - saline			yes
6.6.0 Estuary/coastal waters			yes
6.6.3 Estuary/coastal waters - intensive use			yes

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