ENVIRONMENT & SOCIAL TECHNICAL NOTE

Number: ESTN-013
Date: April 2010

Positioning Future Forests: Identifying areas that could benefit from the establishment of functional forests

Summary

In the future the value of forests will be based on their ability to provide benefits and services such as carbon sequestration, bioenergy, biodiversity, erosion and flood mitigation, improved water quality and recreational resources in addition to a range of timber values. Central to the concept of functional forests is the notion that specific future forests provide the best economic and environmental outcomes for a given location. These outcomes are important for overseas markets and forest certification programmes. Advanced GIS tools were used to delineate areas suitable for future forests. The New Zealand total area available for afforestation is ~2.5 million ha. Potential carbon forests increase this area by 45,802 ha. Another 65,000 ha is potentially available for the establishment of riparian forests across NZ dairy farms. These map results can be used by forest owners, industry stakeholders and policy managers to visualise, quantify and plan for the future distribution of New Zealand forests.

Authors: David Palmer, Barbara Höck, Haydon Jones, Peter Clinton, Tim Payn

Introduction

Forests have an important role to play, especially in situations where land is considered to be marginal or borderline for profitable livestock production. Forests can improve water quality, reduce soil erosion and flood risk, while increasing biodiversity, sequestering carbon, and providing recreational and aesthetic values.

Potential future forests in New Zealand are dictated by current land use, climate, geography, vegetation cover and current ownership. This study maps these areas using national GIS datasets.

These map results can be used by forest owners, industry stakeholders and policy managers to visualise the future distribution of New Zealand forests. Individual land managers could decide future land use accounting for factors such as soil erosion commercial timber potential and carbon sequestration.

The aim of this research is to increase the utility of forests by providing non timber values in addition to current timber values, thereby increasing the sustainability and global competitiveness of the New Zealand forestry sector.

This research will determine the most suitable locations for future forests by: (1) identifying land suitable for future forests using nationally available spatial datasets, (2) provide maps that delineate the locations of future forests, and (3) report on the areas available.

Methods

Identification of potential future forests

The potential distribution of new future forests was mapped using the GIS platform ArcGIS™ together with a variety of GIS spatial datasets (Table 1).

AgriBase™ Land Cover Database 2 (LCDB2) data (AsureQuality, 2009) was used to identify land cover classes. Using the Agribase™ classes, beef (BEF), deer (DEE), grazing (GRA), not farmed (NOF), sheep (SHP), mixed sheep & beef (SNB), and unspecified (UNS), were selected from both low producing grassland, depleted grassland and high-producing exotic grassland. The BEF class was excluded from the analysis for the high-producing exotic grassland. All classes for gorse and or broom and mixed exotic shrubland were selected regardless of farm type.

Table 1. Spatial datasets and criteria used to determine potential land available for plantation and bioenergy forests or for carbon forests. The additional criteria used to determine land available for carbon forests are shown in **[bold]**

Spatial dataset	Unit	Criterion
Temperature	^{0}C	> 7.9
Slope	Degree	7 to 40 **[no upper limit]**
Land cover database 2 (LCDB2) in association with Agribase farm type	-	High producing grassland (DEE, GRA, NOF, SHP, SNB, UNS) Low producing grassland (BEF, DEE, GRA, NOF, SHP, SNB, UNS) Depleted grassland (BEF, DEE, GRA, NOF, SHP, SNB, UNS) Gorse and broom (regardless of Agribase class) Mixed exotic shrubland (regardless of Agribase class)
Land use capability (LUC)	-	5, 6, 7 **[8]**
Department of Conservation estate (DoC)	-	No
Potential predicted vegetation	-	21, 23, 24, 25 (non-forest classes excluded)

Land Use Capability (LUC) classes (Figure 1b) were used to identify areas suitable for afforestation. For production and bioenergy forests we selected classes 5 to 7, and extended this to include class 8 for carbon forests. Land Use Capability was derived from the LRI spatial data.

All potential future forest selections used a threshold of 7.9 ˚C mean annual temperature (Figure 1c). Below this temperature was considered too cold and unproductive for most forest species establishment. A slope of 7 to 40 degree was applied to plantation and bioenergy forests, whereas the upper slope limit was removed for the purposes of carbon forests (Figure 1d).

Potential predicted vegetation classes of duneland, shrubland, tussock grassland and wetlands and the Department of Conservation (DoC) estate were excluded from all analysis (Figure 1e and 1f).

Identification of Riparian Margins with Potential for Afforestation

The Dairying and Clean Stream Accord of 2003 between the Fonterra Co-operative Group and Government Agencies targets the exclusion of dairy cattle from water bodies and encourages management of farm nutrients to minimise environmental impacts in waterways.

To consider the Dairying and Clean Stream Accord we overlaid AgriBase™ dairy (DAI) farm type with the New Zealand River Environment Classification (REC) to estimate the total length of land available for riparian forestry. Our calculations used a setback of 5m from the waterway or stream with forestry extending another 20m, leaving a total of $40m^2$ for every linear m of waterway or stream. The analysis was further refined with the exclusion of organic and gley soils from the analysis. The impact of removing organic and gley soils from the analysis was a reduction in potential forest area in wet and flood prone areas (wetlands). However, in these areas it would be possible to restore previous flood plain forest cover.

Regional Information

While this is primarily a desktop exercise the greatest benefit from this spatial approach is our ability to now calculate and map the areas involved in the analysis. To provide a meaningful representation of the data an overlay was undertaken with New Zealand political regions.

Results

Areas selected for potential afforestation are given in Figure 2. Note that the AgriBase™ dairy cover class was not included in this graphic because waterway and stream information is not identifiable at a coarse ~1: 5,000,000 scale.

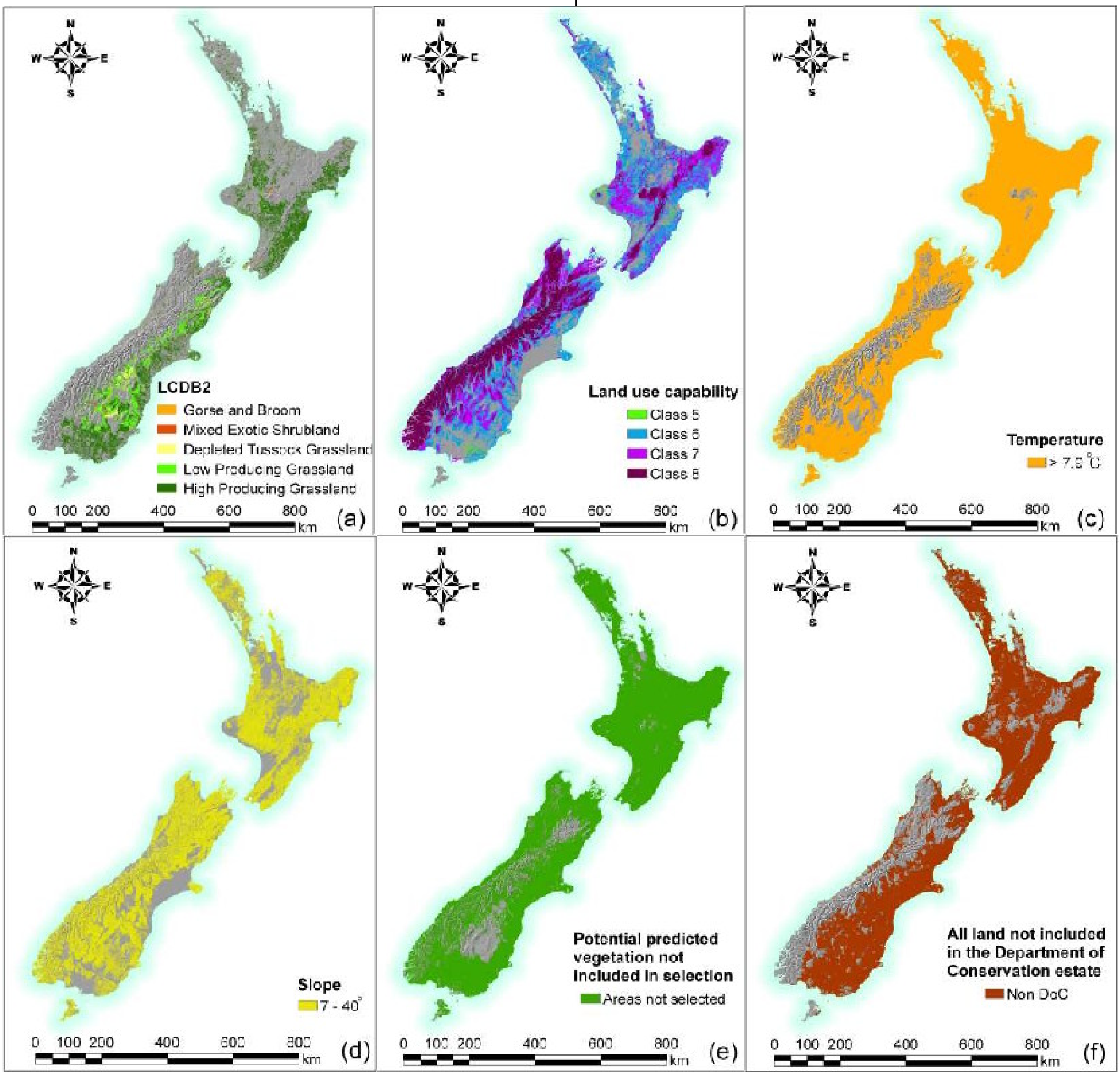

Figure 1. Land use, climate, and vegetation maps showing location of potential future forests. Potential future forests are derived from areas where layers intersect.
(a) Land cover database from which the Agribase^{TM} farm types in Table 1 were derived
(b) Land use capability classes (classes 5 to 7 - plantation and bioenergy, class 8 – carbon only)
(c) Regions with mean annual temperatures above 7.9 ˚C
(d) Slopes representing 7 to 40 degree
(e) Potential predicted vegetation classes not in the selection criterion
(f) All land not included in the Department of Conservation estate

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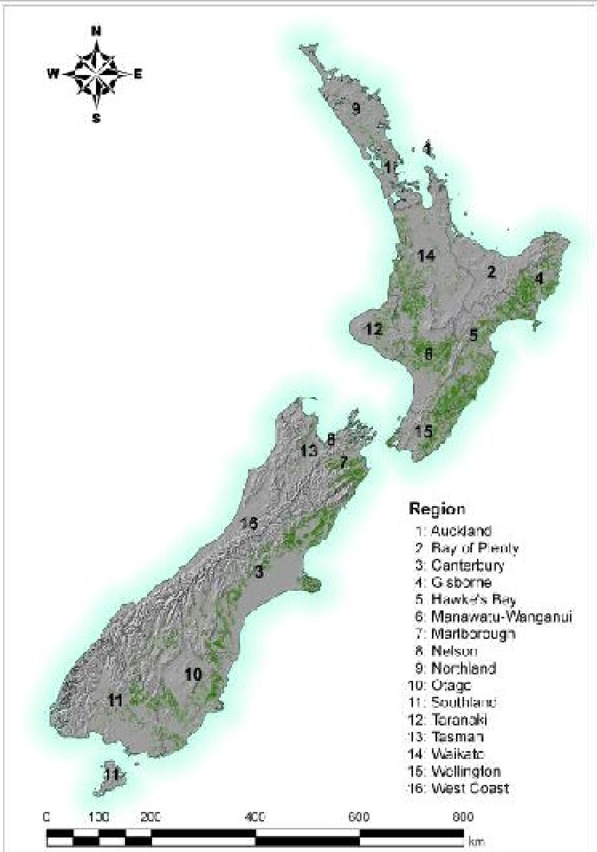

Figure 2: Areas that could benefit from forest cover (riparian forests not included).

The New Zealand total area available for afforestation is ~2.5 million ha (excluding riparian forests). Potential carbon forests increase this area by 45,802 ha over the plantation and bioenergy forest option (Table 2).

The Manawatu-Wanganui, Canterbury, Otago, and Hawke's Bay regions have the greatest areas available for afforestation.

Table 3 identifies 65,000 ha as potentially available for some type of riparian forestry across New Zealand dairy farms. Regions with the greatest area available for forestry are the Waikato and Taranaki with 24,000 and 14,000 ha, respectively. Assuming forestry is not suitable for organic peat soils or anaerobic gley soils, the forestable riparian areas shrank the forested area by approximately 22,000 ha.

Table 2. Potential areas available for afforestation separated into regions for (a) plantation and bioenergy and (b) carbon forest options.

Region	(A) Production and bioenergy (ha)	(B) Carbon (ha)
Auckland	19,230	19,315
Bay of Plenty	16,378	16,864
Canterbury	475,814	487,771
Gisborne	212,768	215,927
Hawke's Bay	288,419	294,006
Manawatu-Wanganui	504,707	511,419
Marlborough	122,714	127,271
Nelson	3,204	3,317
Northland	45,153	45,485
Otago	293,501	298,779
Southland	126,609	127,251
Taranaki	65,318	66,619
Tasman	28,387	29,526
Waikato	183,394	185,576
Wellington	155,754	157,857
West Coast	1,880	2,049
New Zealand	2,543,229	2,589,031

Table 3: Potential area available for riparian afforestation across New Zealand dairy farms (a) all classes, and (b) all classes with the exclusion of organic and gley soils.

Region	Area (ha)	
	All Classes	Exclusion of organic & gley soils
Auckland	2,506	1,869
Bay of Plenty	4,344	3,183
Gisborne	64	49
Hawke's Bay	802	728
Manawatu-Wanganui	7,673	4,796
Northland	9,081	6,567
Taranaki	14,501	13,721
Waikato	23,810	14,353
Wellington	2,201	1,182
North Island	64,982	46,446
Canterbury	6,852	5,927
Marlborough	849	765
Nelson	27	1
Otago	3,547	2,916
Southland	5,599	4,491
Tasman	1,775	1,756
West Coast	3,729	3,134
South Island	22,378	18,989
New Zealand	87,360	65,435

Future Forests Research Ltd, PO Box 1127, Rotorua. Ph: 07 921 1883 Email: info@ffr.co.nz Web: www.ffr.co.nz

Conclusions

The total area available for afforestation under our selection criteria is ~2.5 million ha, with a further ~65,500 ha potentially available along riparian plantings within dairying areas. This total area would increase by another 45,802 ha under the carbon forest scenario. Carbon forests were deemed suitable for class 8 land which is predominantly steep mountainous areas or situations and on very steep, erosion-prone land in high rainfall areas.

The area available using these spatial data sets can vary substantially depending on the criteria chosen. Consultation was widely sought to define these thresholds and criteria. We also used knowledge and experience gained through past projects, including the bioenergy options project.

These research results can be used by forest owners, industry stakeholders and policy managers to visualise, quantify and plan for the future distribution of New Zealand forests and to assess potential new values from functional forests.

Future work will include assessing the selected areas for erosion, biodiversity, recreation, water quality and for flood protection purposes. The next stages will take the areas identified here as having potential for afforestation and identify sites most suited to specific forest functions or a combination of these (e.g. forests for carbon, bioenergy, erosion control, timber production or biodiversity conservation).

This research underpins the ability to realise the potential of new services and benefits from forests including timber and non timber values, thereby increasing the sustainability and global competitiveness of the New Zealand forestry sector.

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