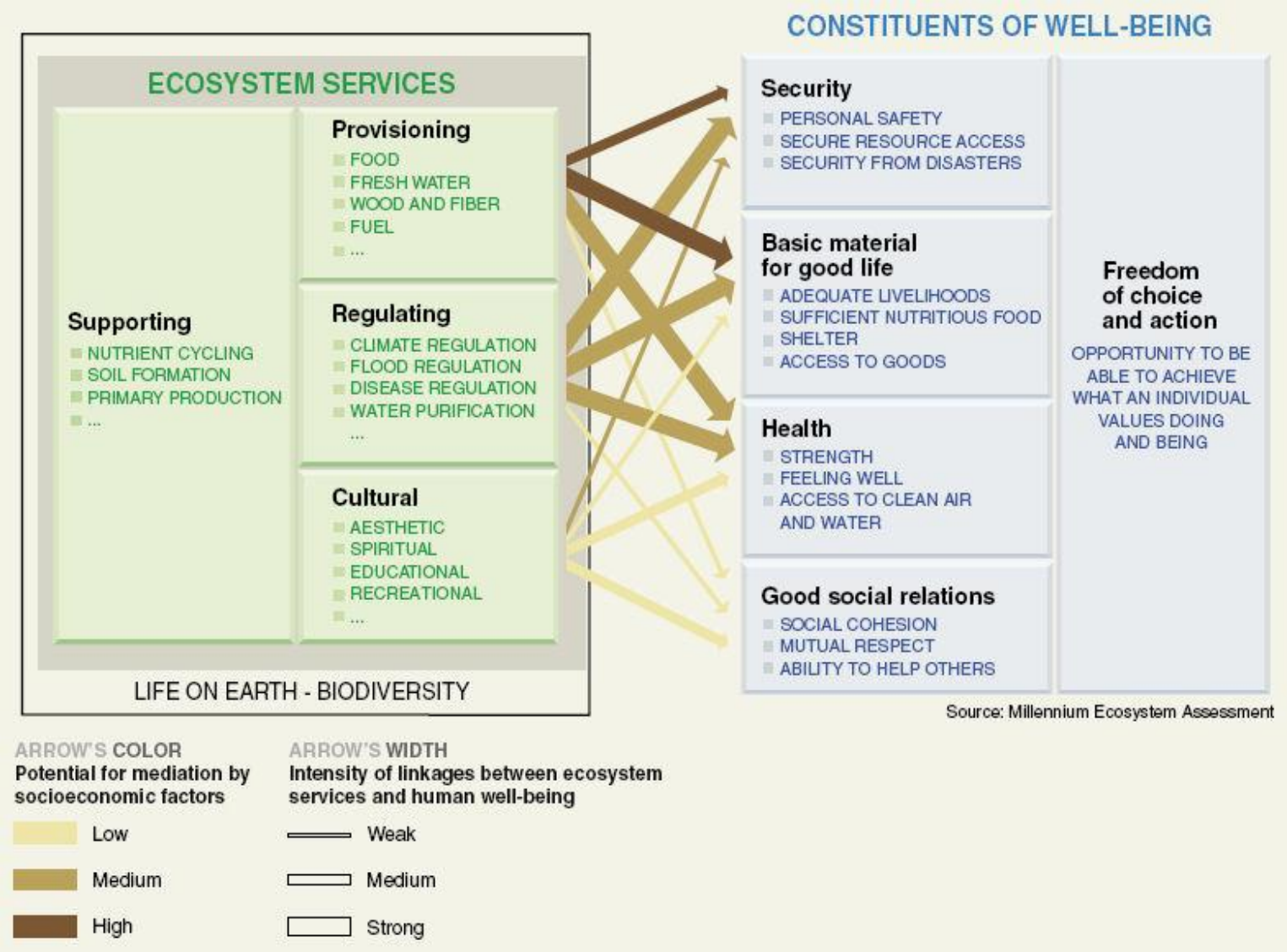
Landcare Research
Manaaki Whenua

Ecosystem services conditions and trends

John Dymond, Anne-Gaelle Ausseil
and Alex Herzig

Concept


ECOSYSTEM SERVICES
Supporting
NUTRIENT CYCLING
SOIL FORMATION
PRIMARY PRODUCTION
...
Provisioning
FOOD
FRESH WATER
WOOD AND FIBER
FUEL
...
Regulating
CLIMATE REGULATION
FLOOD REGULATION
DISEASE REGULATION
WATER PURIFICATION
...
Cultural
AESTHETIC
SPIRITUAL
EDUCATIONAL
RECREATIONAL
...
LIFE ON EARTH - BIODIVERSITY
CONSTITUENTS OF WELL-BEING
Security
PERSONAL SAFETY
SECURE RESOURCE ACCESS
SECURITY FROM DISASTERS
Basic material for good life
ADEQUATE LIVELIHOODS
SUFFICIENT NUTRITIOUS FOOD
SHELTER
ACCESS TO GOODS
Health
STRENGTH
FEELING WELL
ACCESS TO CLEAN AIR AND WATER
Good social relations
SOCIAL COHESION
MUTUAL RESPECT
ABILITY TO HELP OTHERS
Freedom of choice and action
OPPORTUNITY TO BE ABLE TO ACHIEVE WHAT AN INDIVIDUAL VALUES DOING AND BEING
Source: Millennium Ecosystem Assessment
ARROW'S COLOR
Potential for mediation by socioeconomic factors
Low
Medium
High
ARROW'S WIDTH
Intensity of linkages between ecosystem services and human well-being
Weak
Medium
Strong

Ecosystem Services Classification

Provisioning Services *Products obtained from ecosystems*	Regulating Services *Benefits from regulation of ecosystem processes*	Cultural Services *Non-material benefits obtained from ecosystems*
• Food & fibre • Fuel • Genetic resources • Biochemical, natural medicines & pharmaceuticals • Ornamental resources • Freshwater	• Air quality maintenance • Climate regulation • Water regulation • Erosion control • Water purification & waste treatment • Human disease regulation • Biological control • Pollination • Storm protection	• Cultural diversity • Spiritual & religious values • Knowledge systems • Educational values • Inspiration • Aesthetic values • Social relations • Sense of place • Cultural heritage values • Recreation & ecotourism

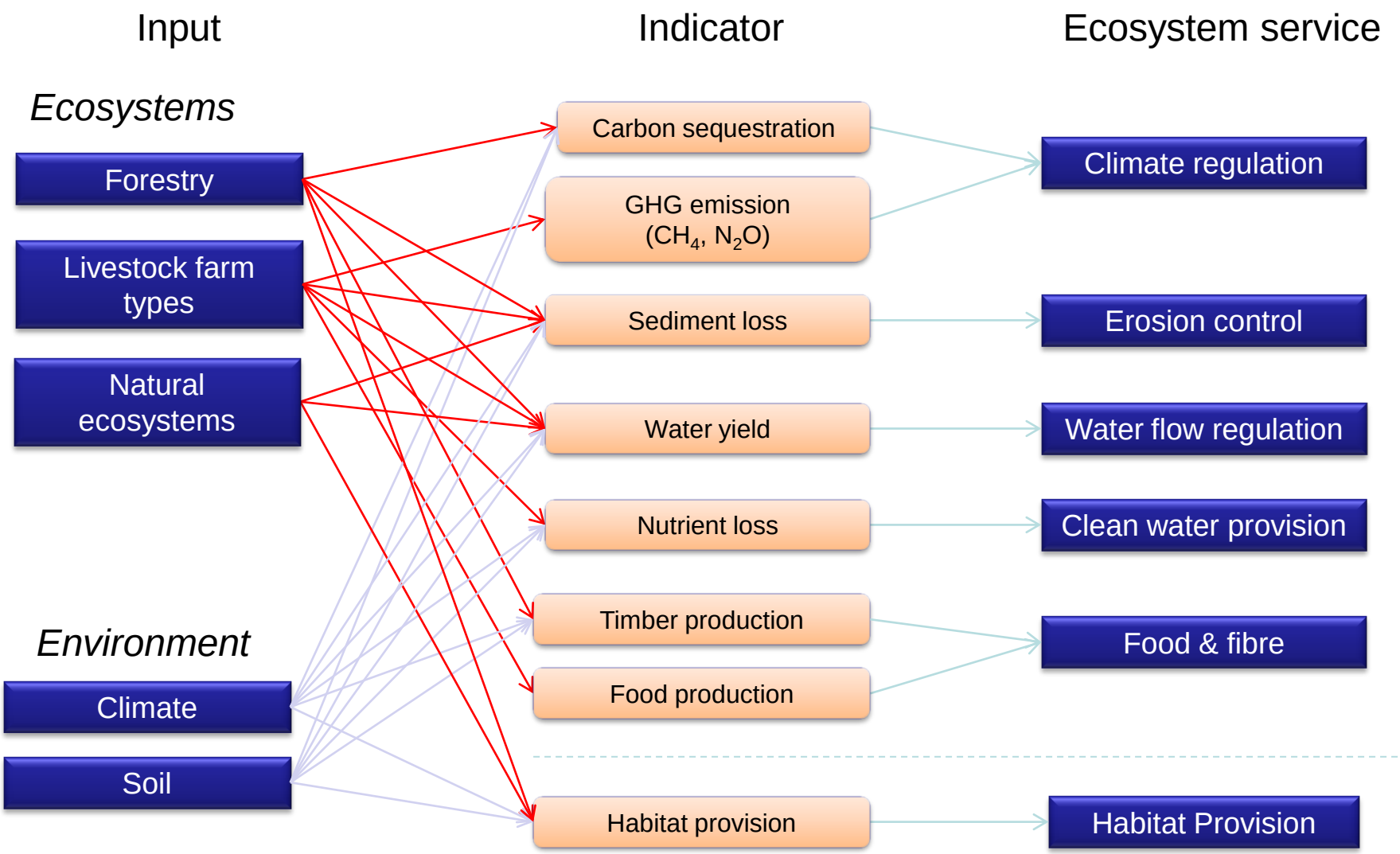
Supporting Services

Services necessary for the production of all other ecosystem services

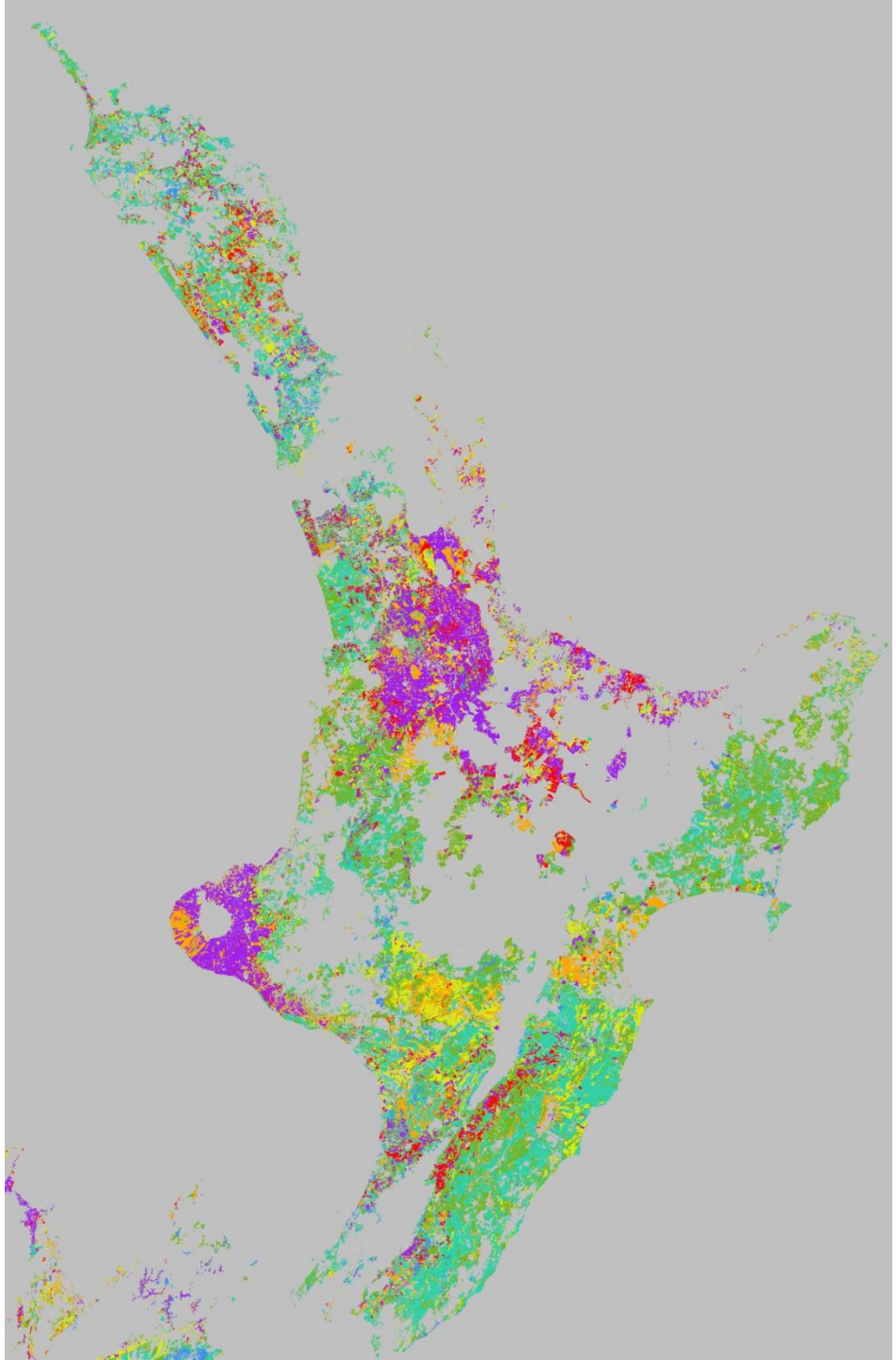
- Soil formation & retention
- Nutrient & water cycling
- Primary production
- Production of atmospheric oxygen
- Provisioning of habitat

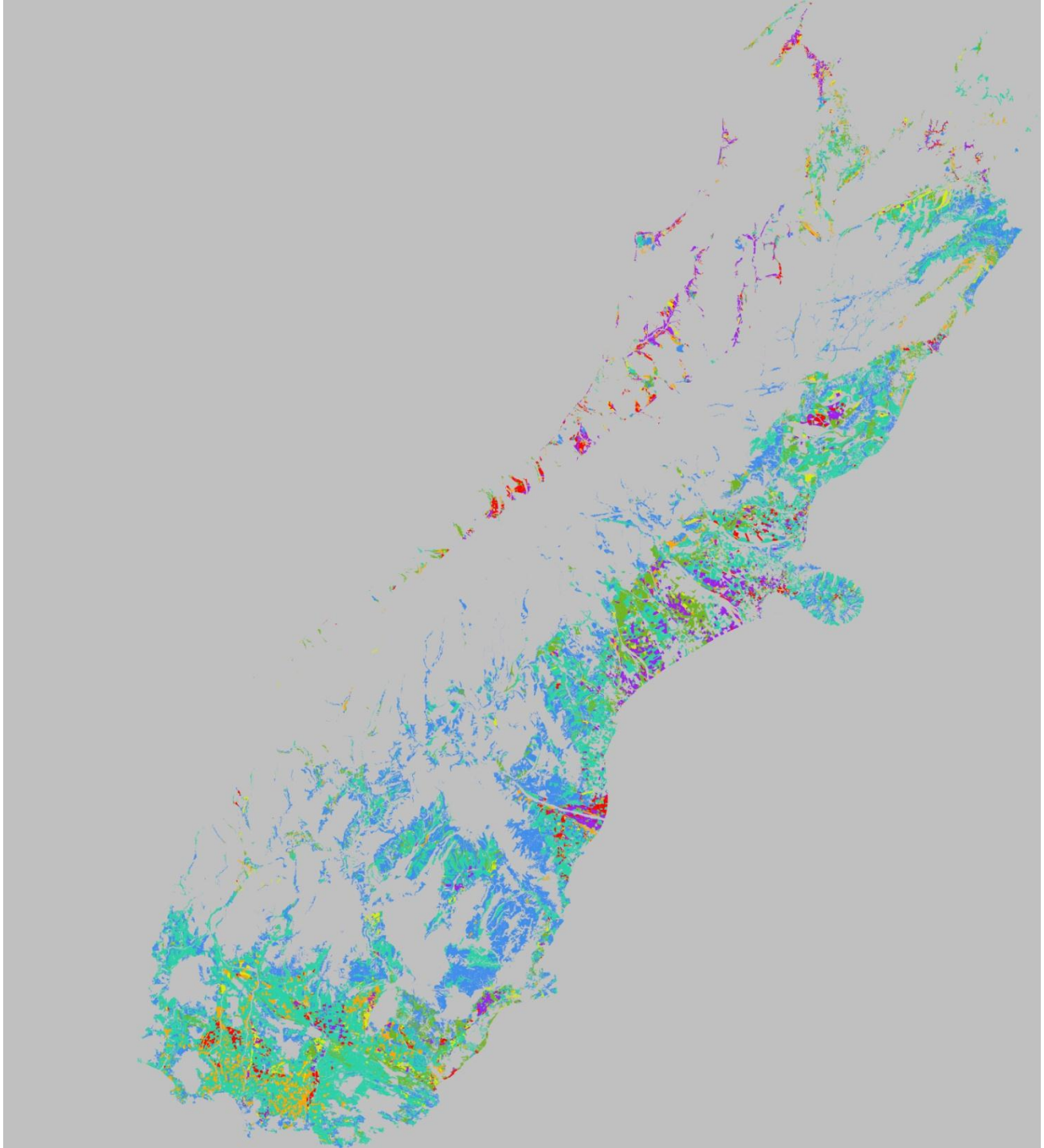
Based on Millennium Ecosystem Assessment (2005)

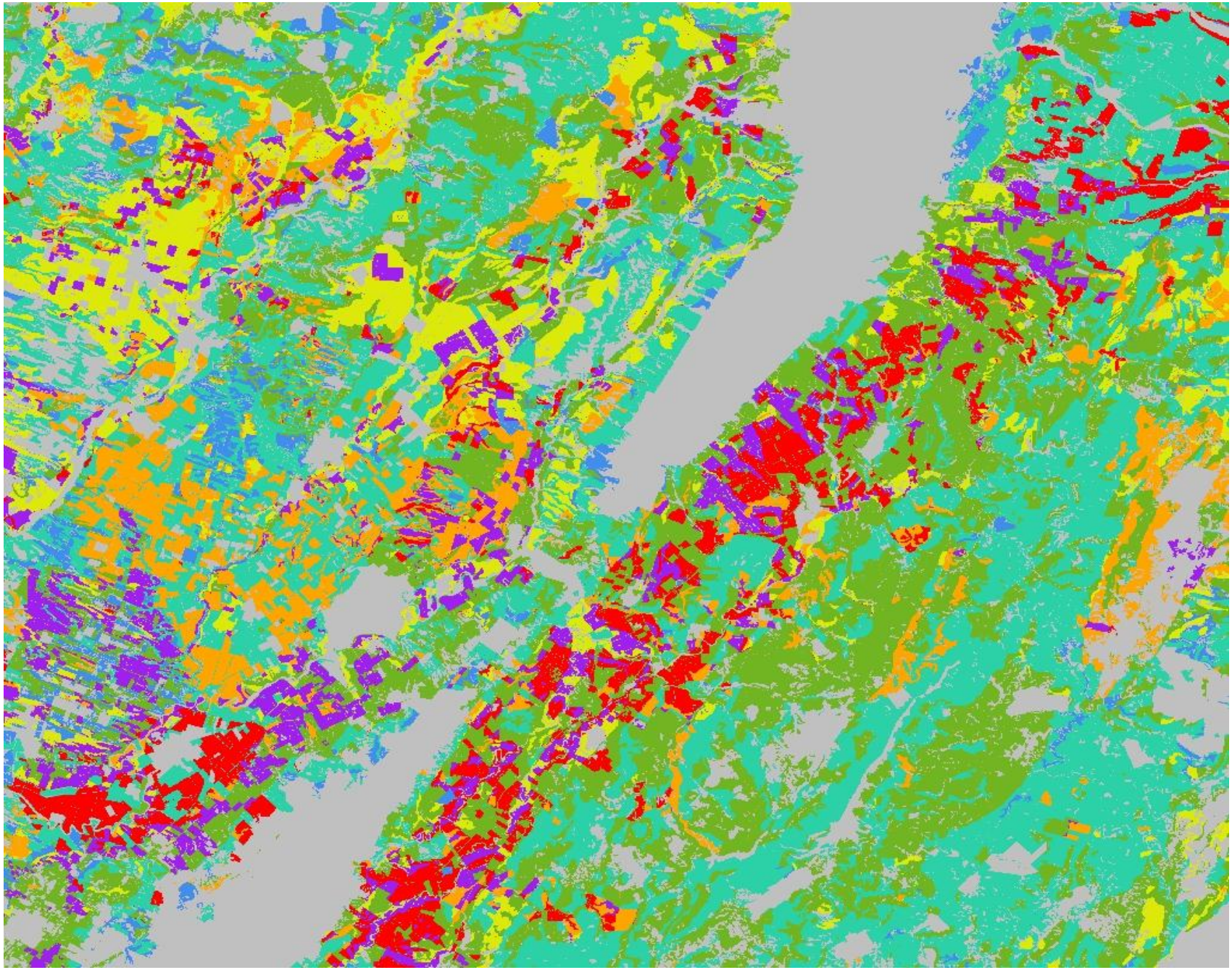
GIS framework



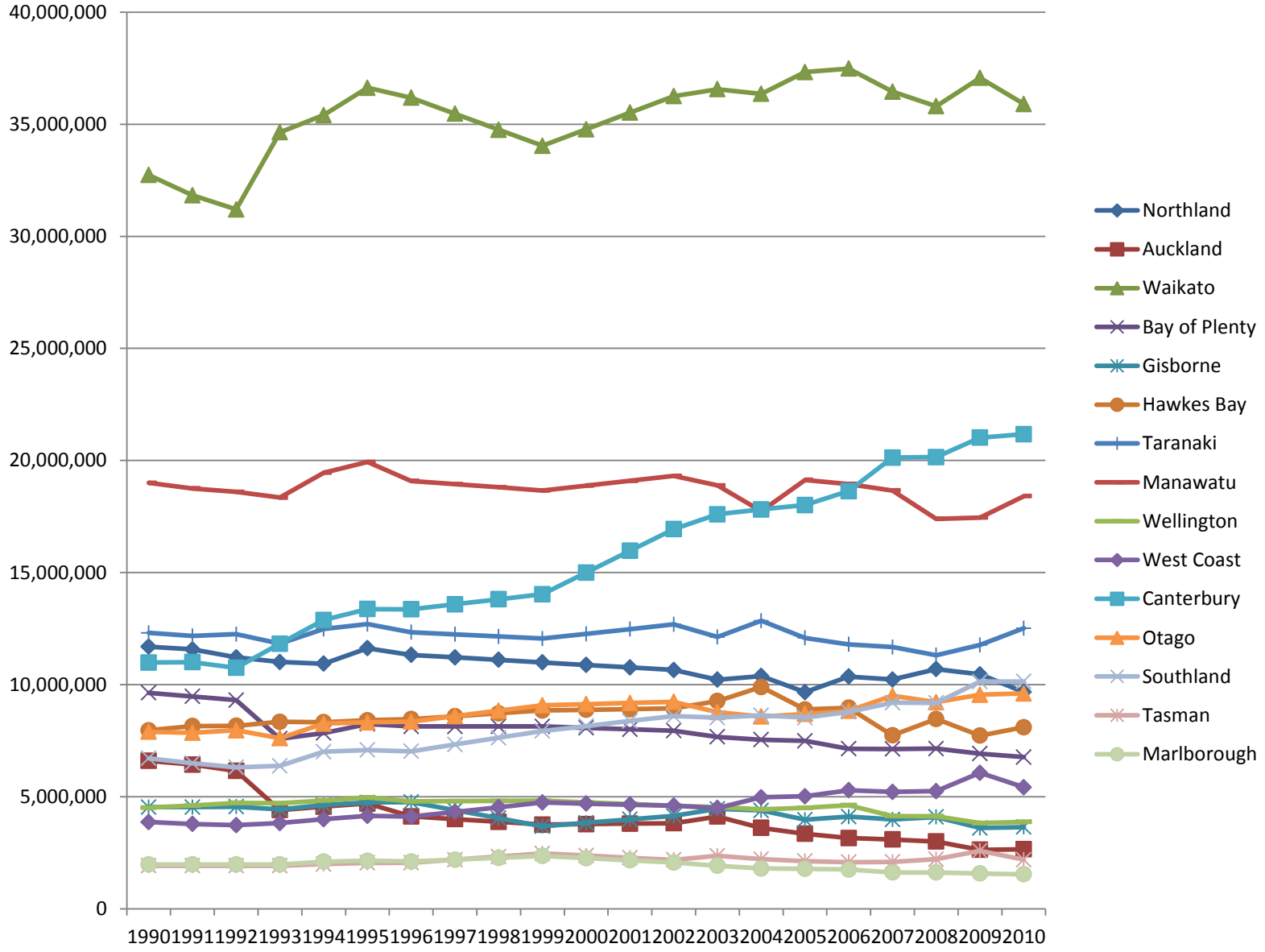

Provision of fresh water



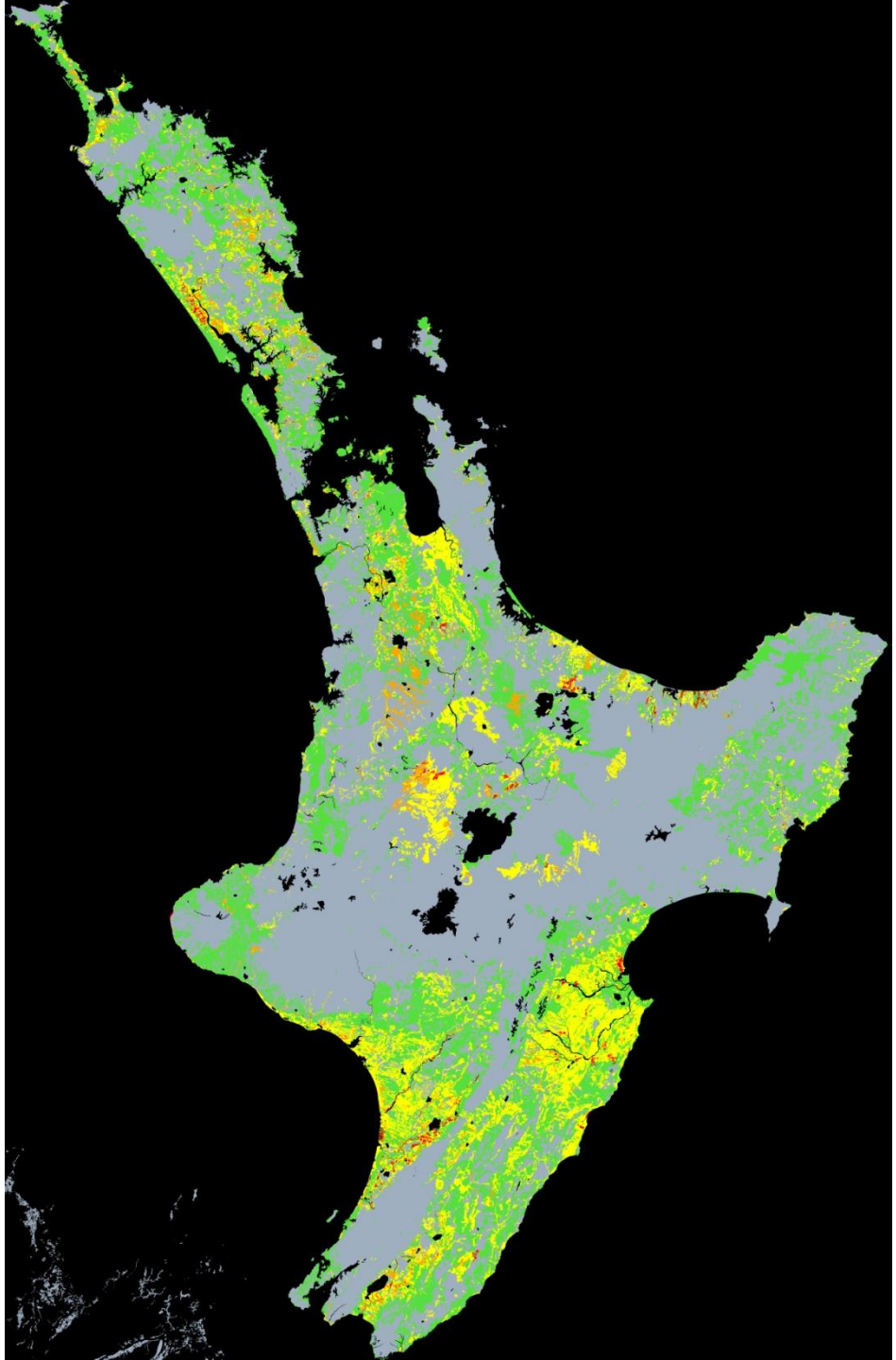




Total Nitrate N leached (kgs)



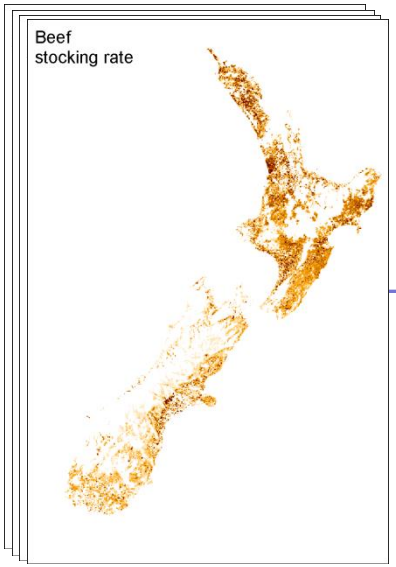
Dissolved reactive phosphorus (mg/litre)




Climate regulation

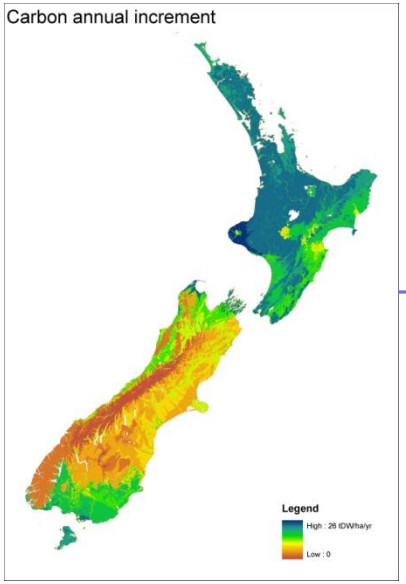
Anthropogenic fluxes of GHG

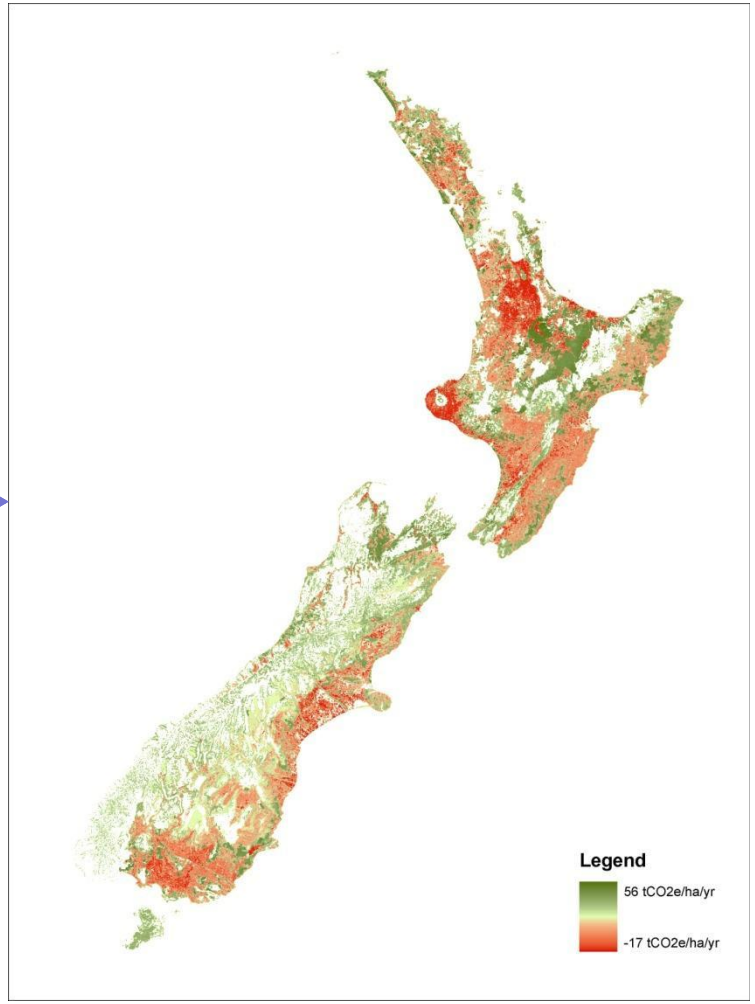
Animal numbers



x EF

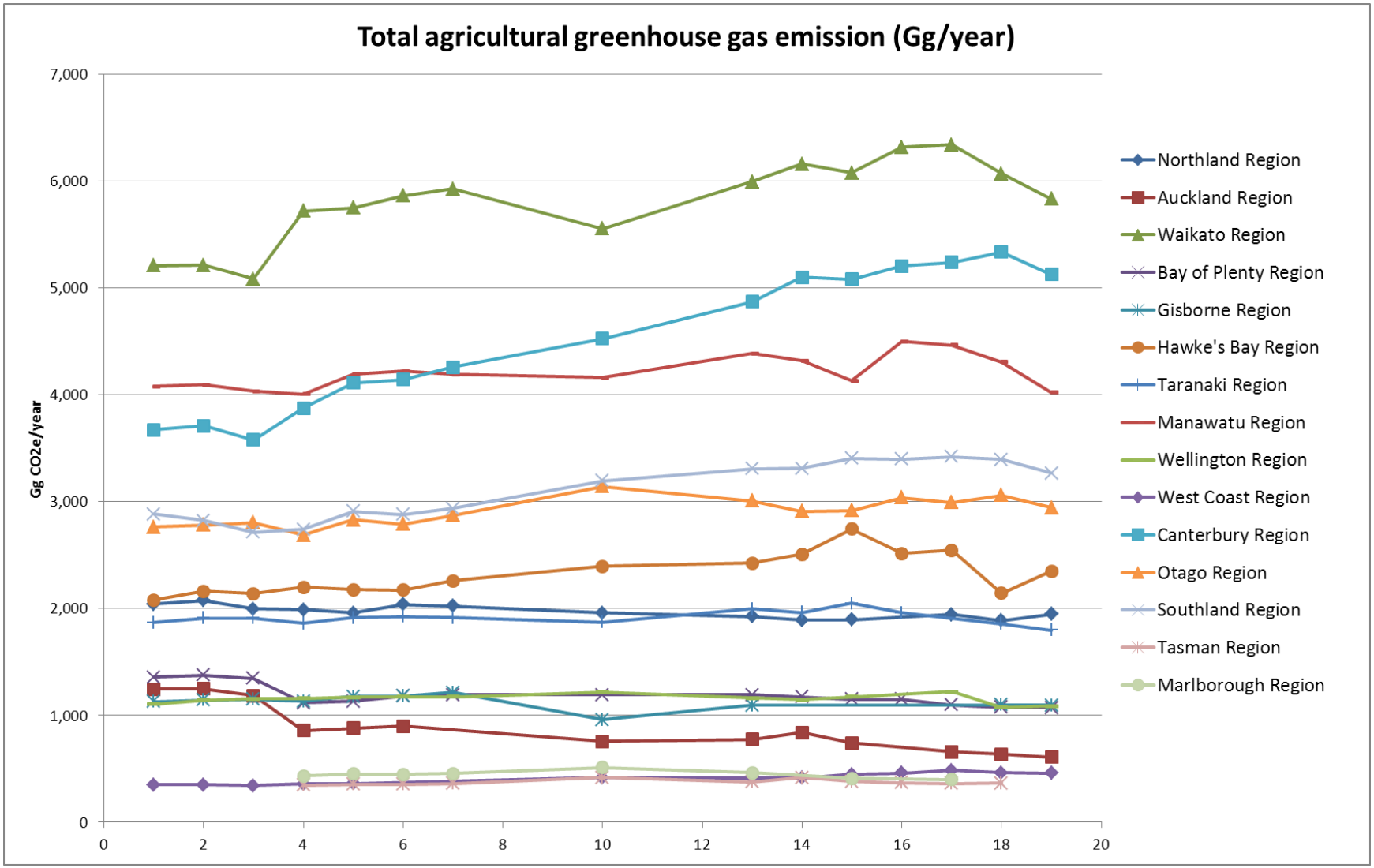
CenW



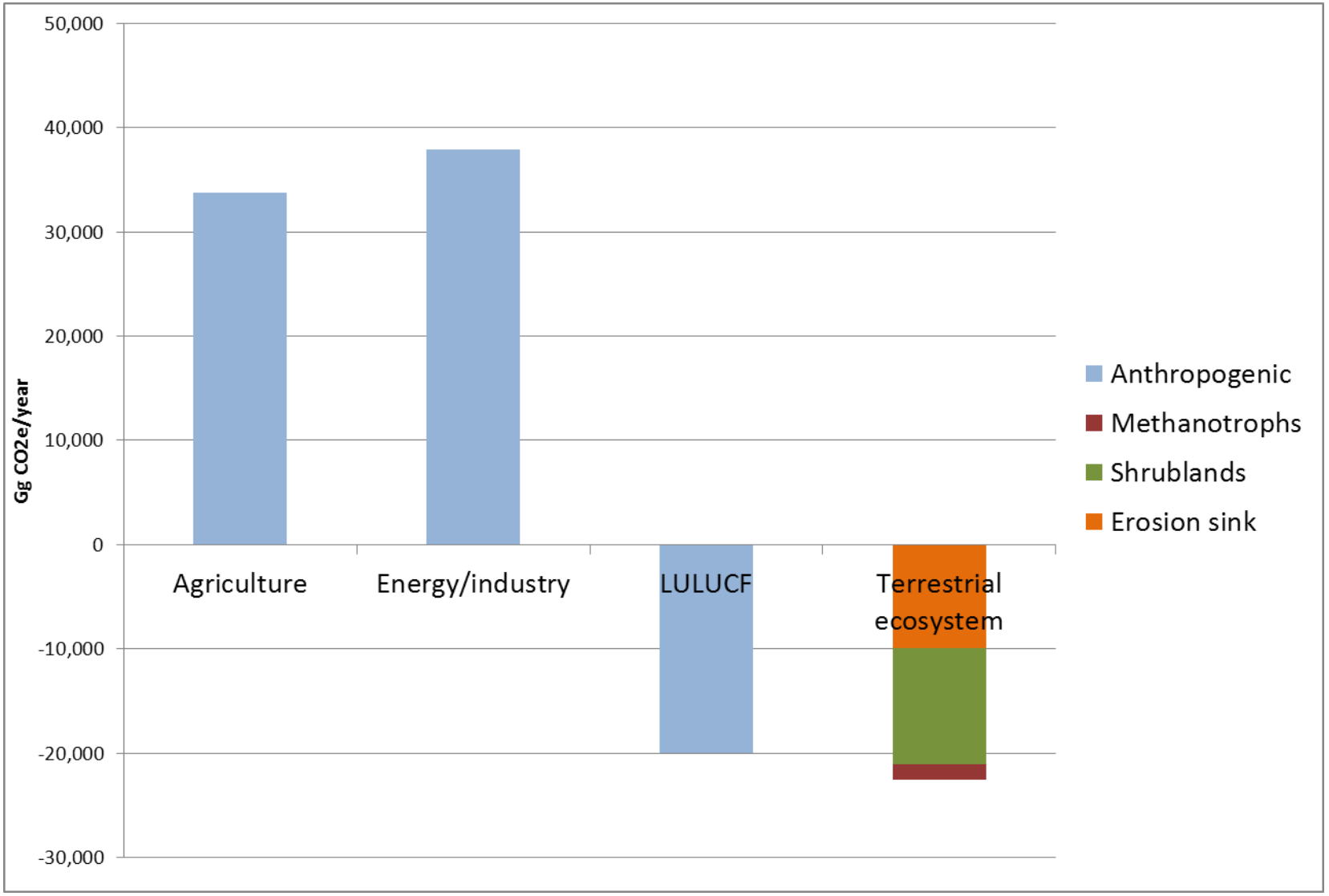


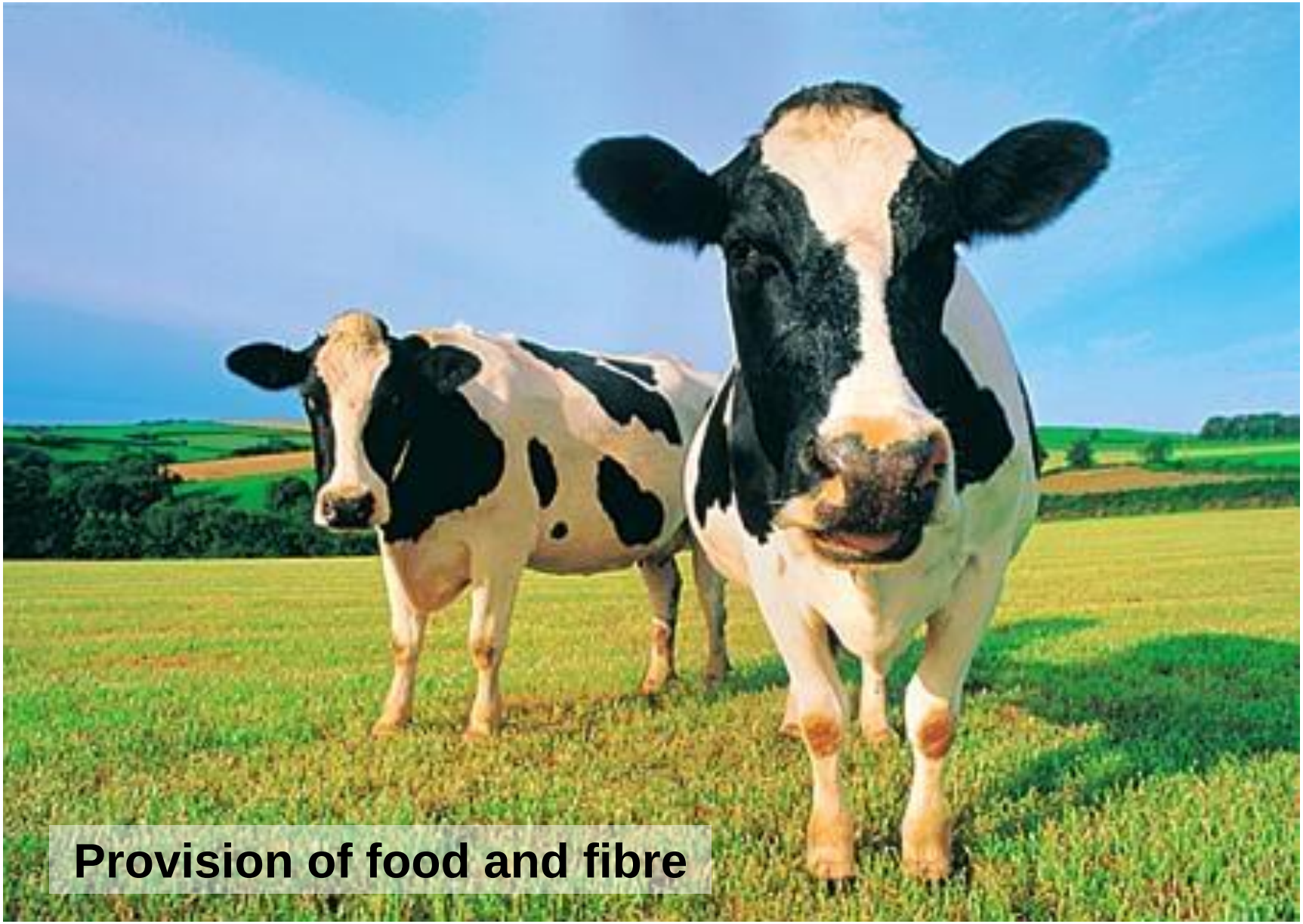
Sources and sinks

Trend analysis (e.g. GHG)

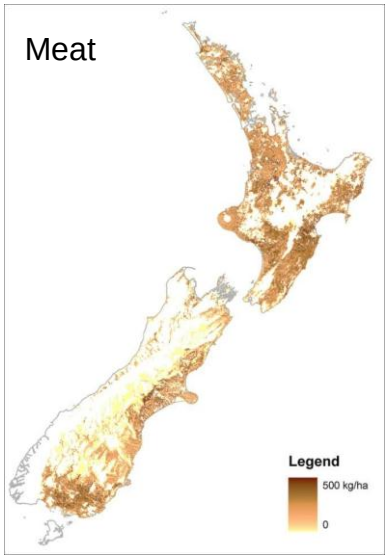


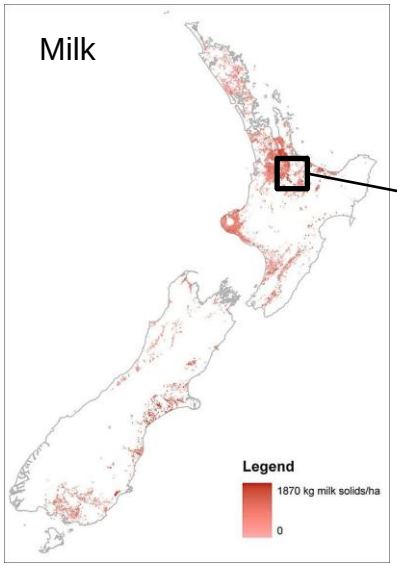
Anthropogenic vs natural ecosystems

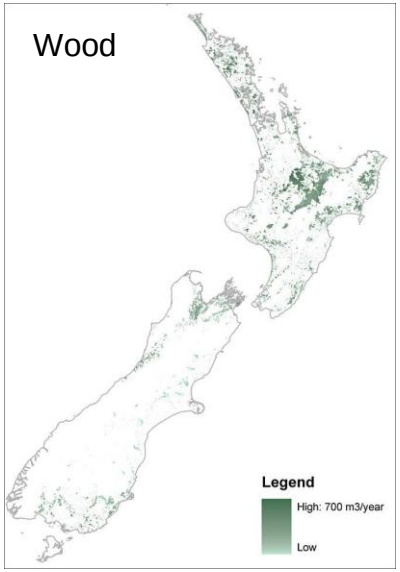


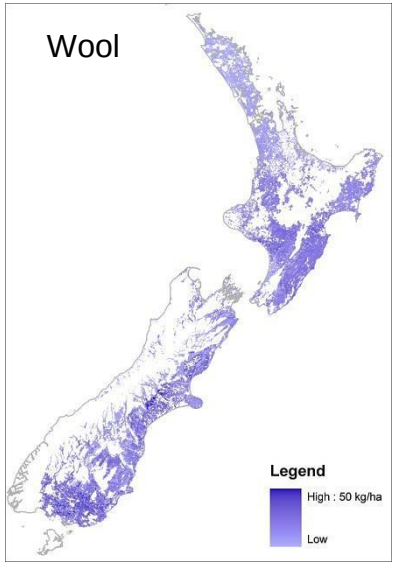

Provision of food and fibre

Food and fibre

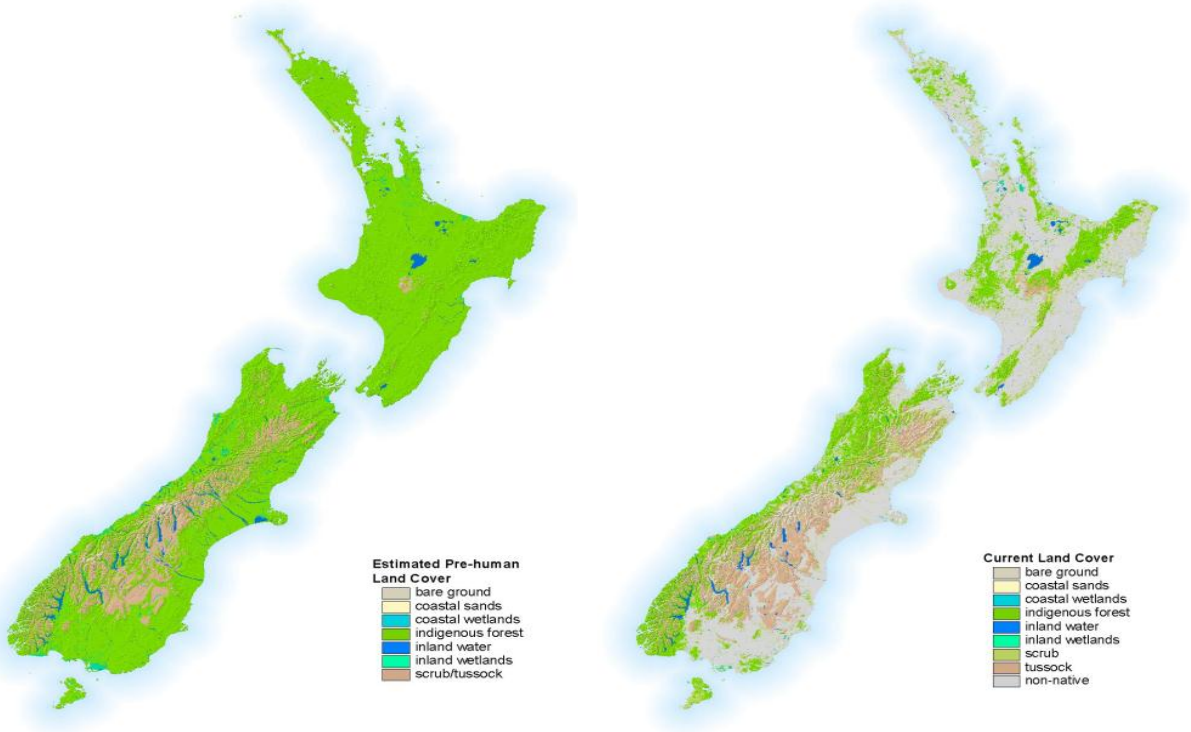




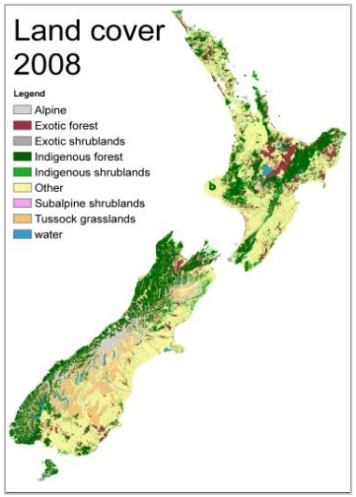


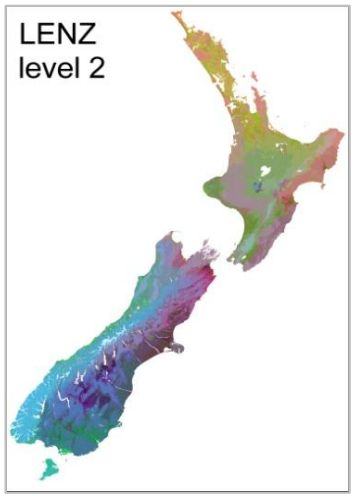


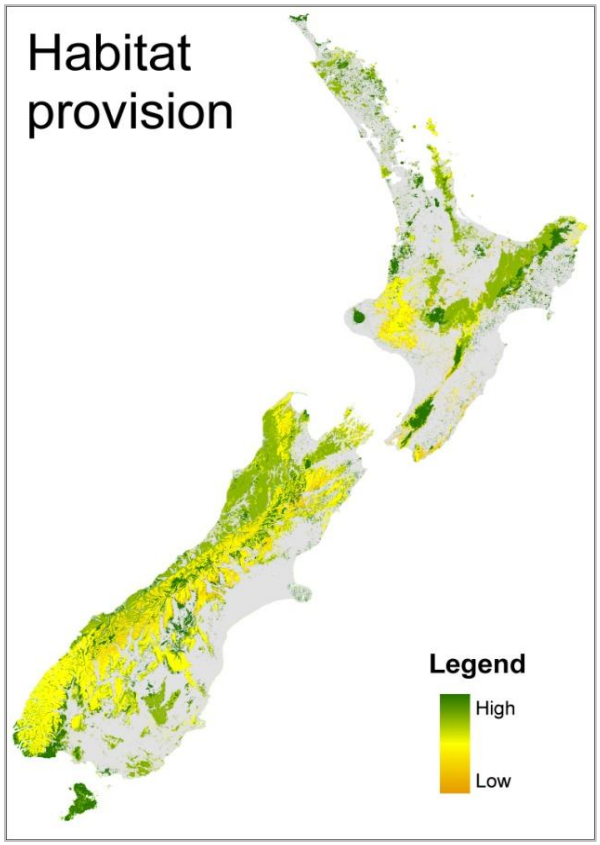

Provision of natural habitat
Rob Suisted



	Historic area (Mha)	Current area (Mha)	Area lost between 1990-2008 (ha)	% remaining
Indigenous forest	23.2	6.5	51,000	28%
Tussock grasslands	8.2	3.5	71,000	43%
Freshwater wetland	2.4	0.2	?	10%


Land cover
2008
Legend
Alpine
Exotic forest
Exotic shrublands
Indigenous forest
Indigenous shrublands
Other
Subalpine shrublands
Tussock grasslands
water

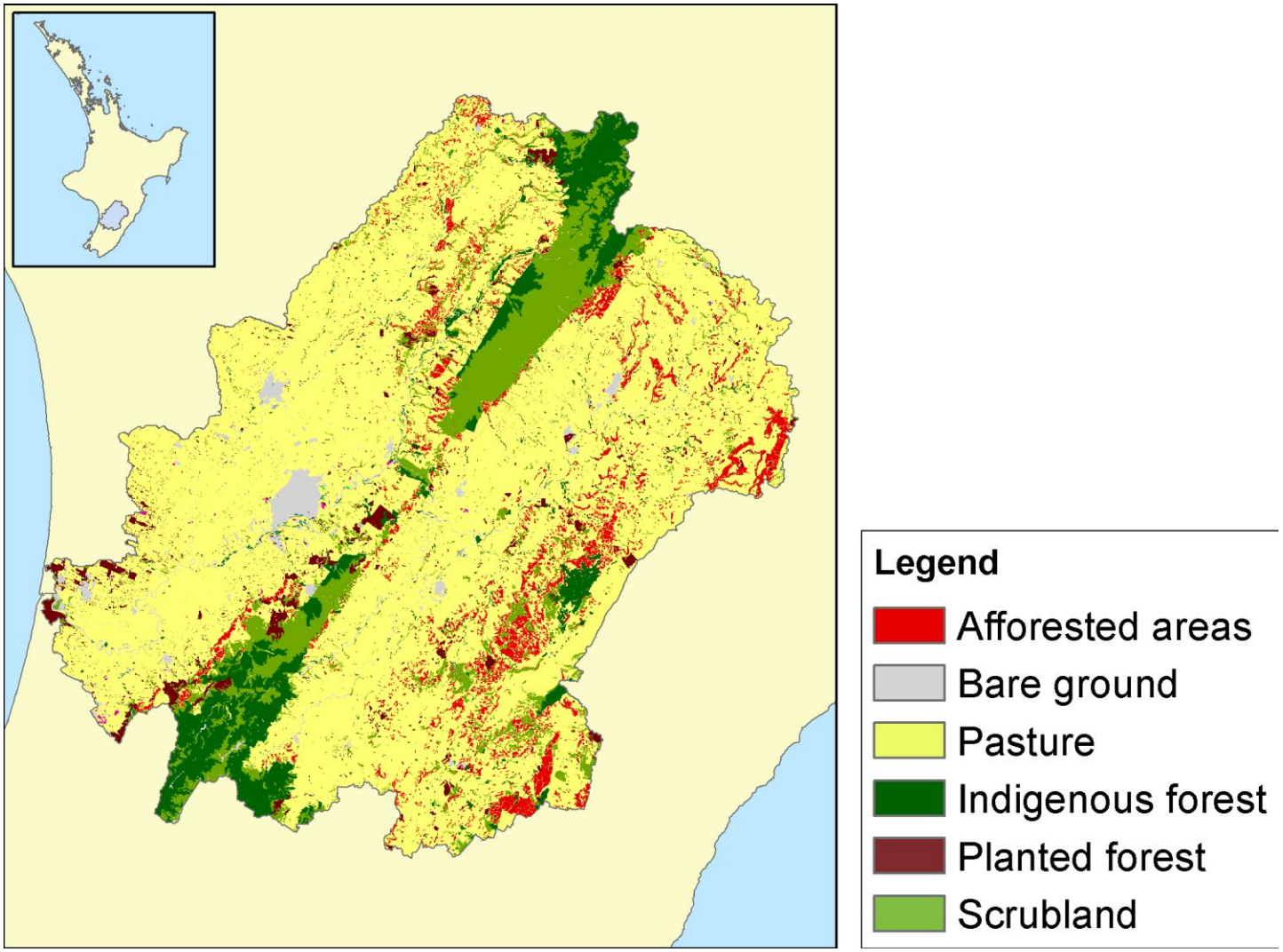

LENZ
level 2


Habitat
provision
Legend
High
Low

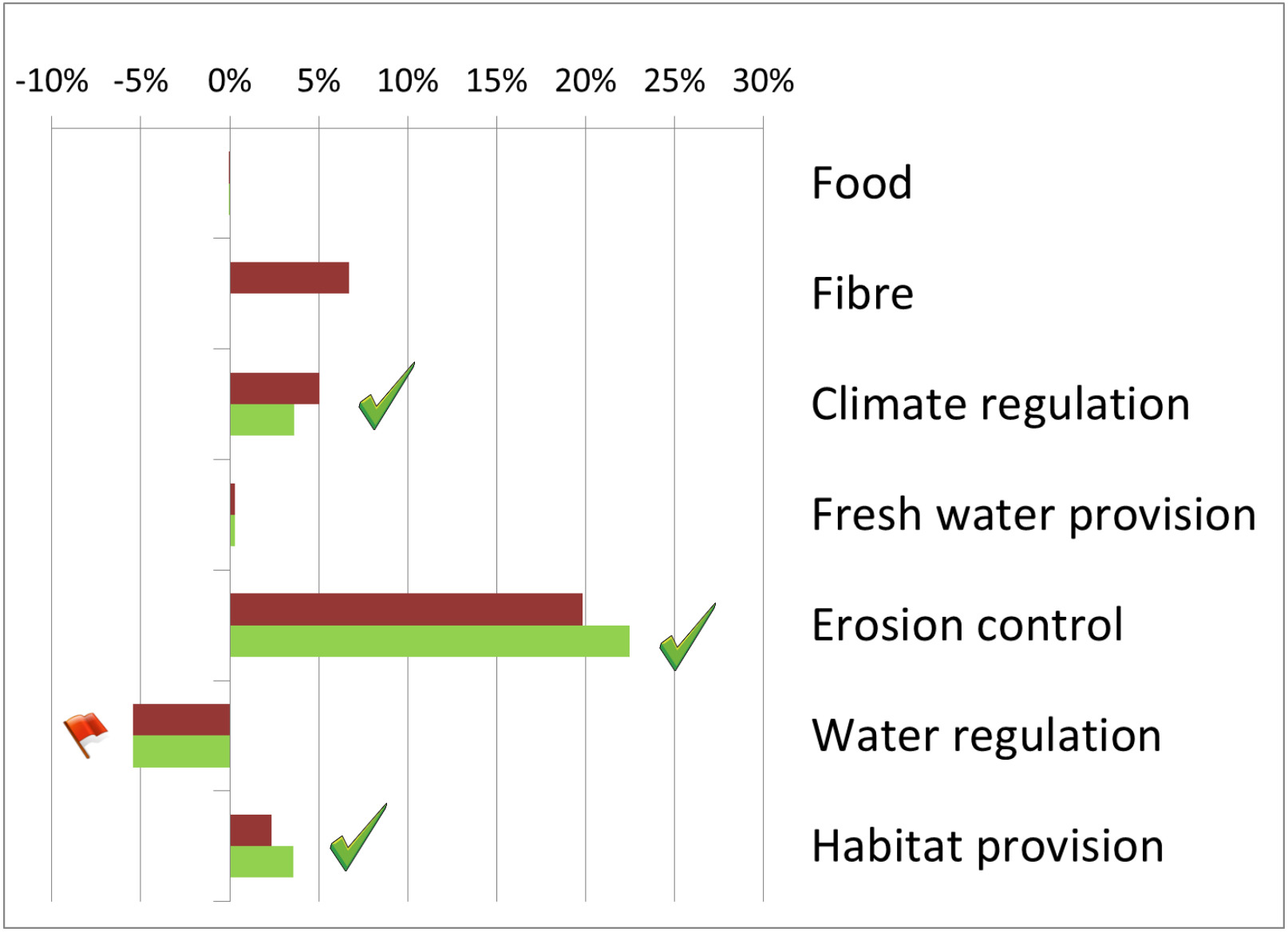
Land-use change and ecosystem services

- Soil conservation planting in hill country
- Soil, water, and carbon tradeoffs with exotic forest
- Opportunities for restoration of indigenous forest
- Lifestyling and urbanisation on high class land

Afforestation scenario

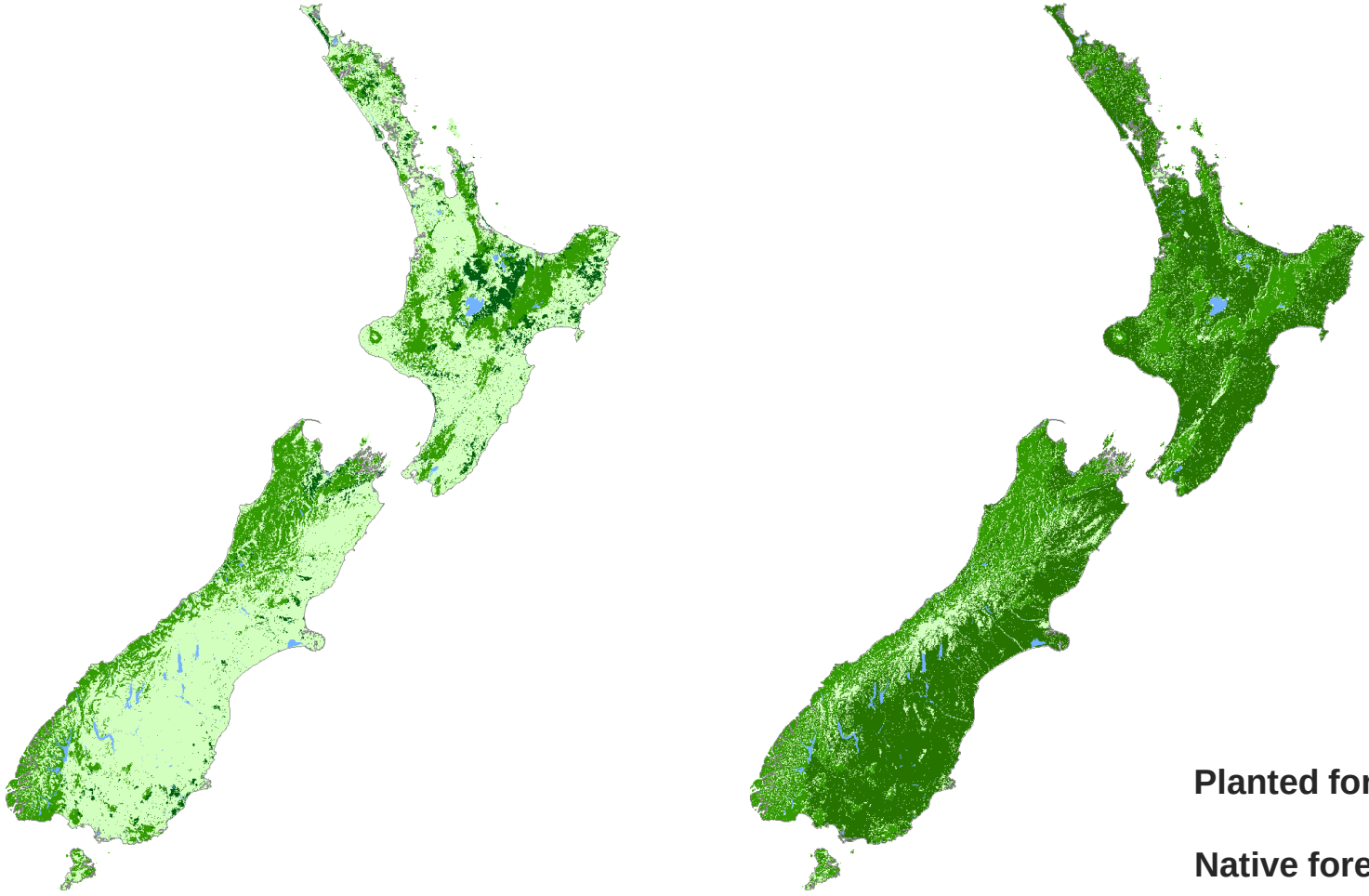


Results

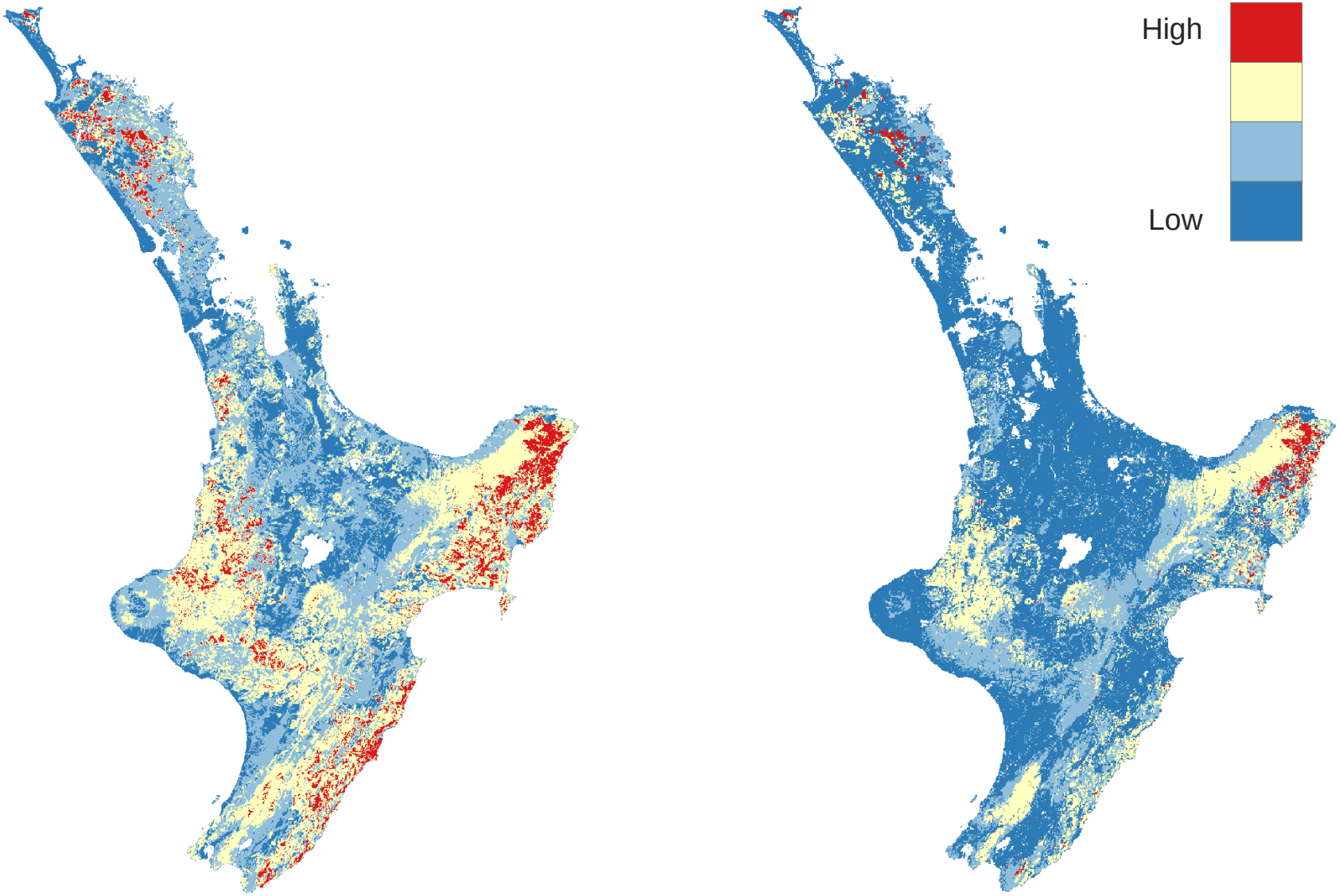

-10%
-5%
0%
5%
10%
15%
20%
25%
30%
Food
Fibre
Climate regulation
Fresh water provision
Erosion control
Water regulation
Habitat provision

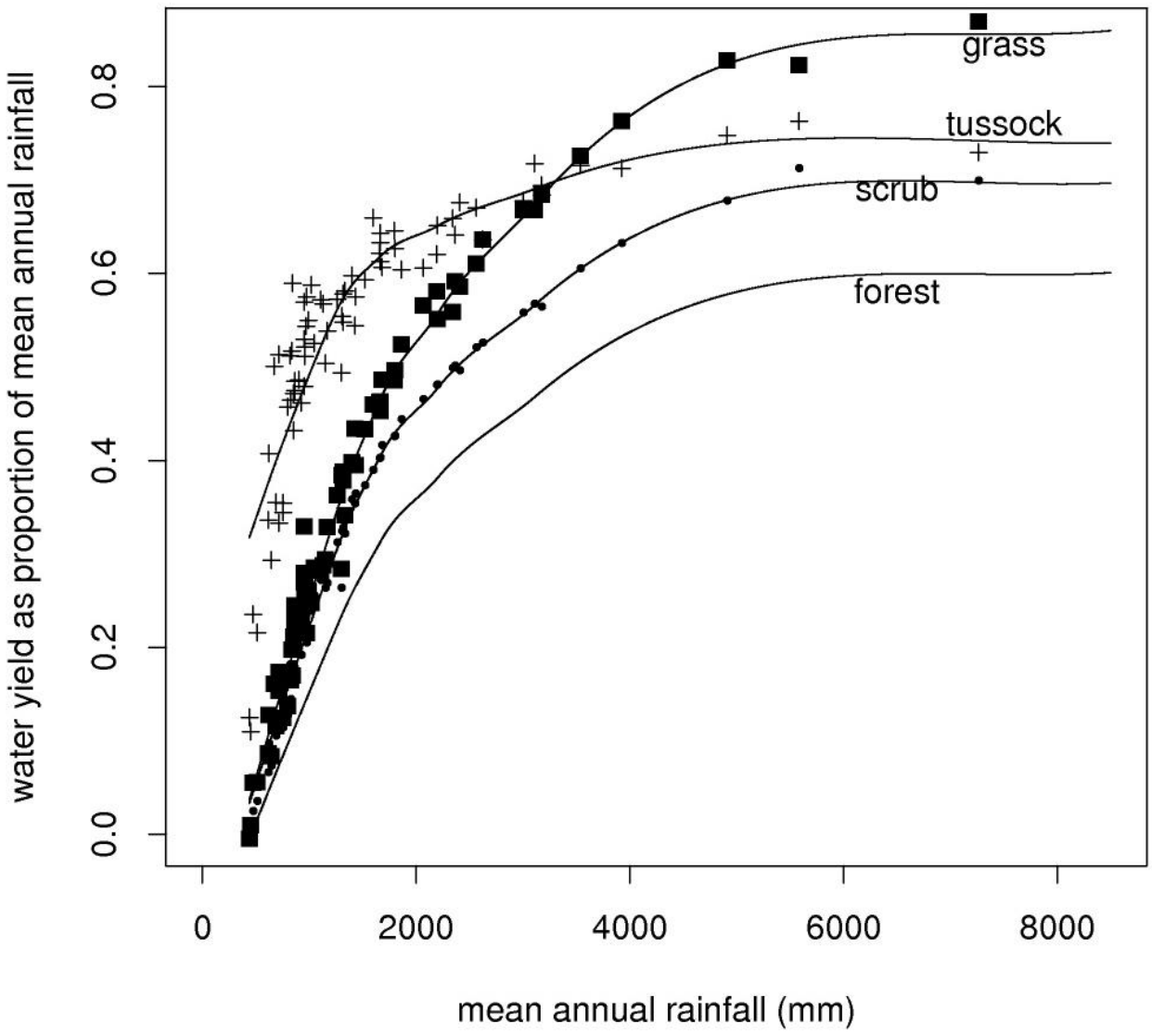
Soil, water, and carbon tradeoffs

Plant exotic forest on grassland

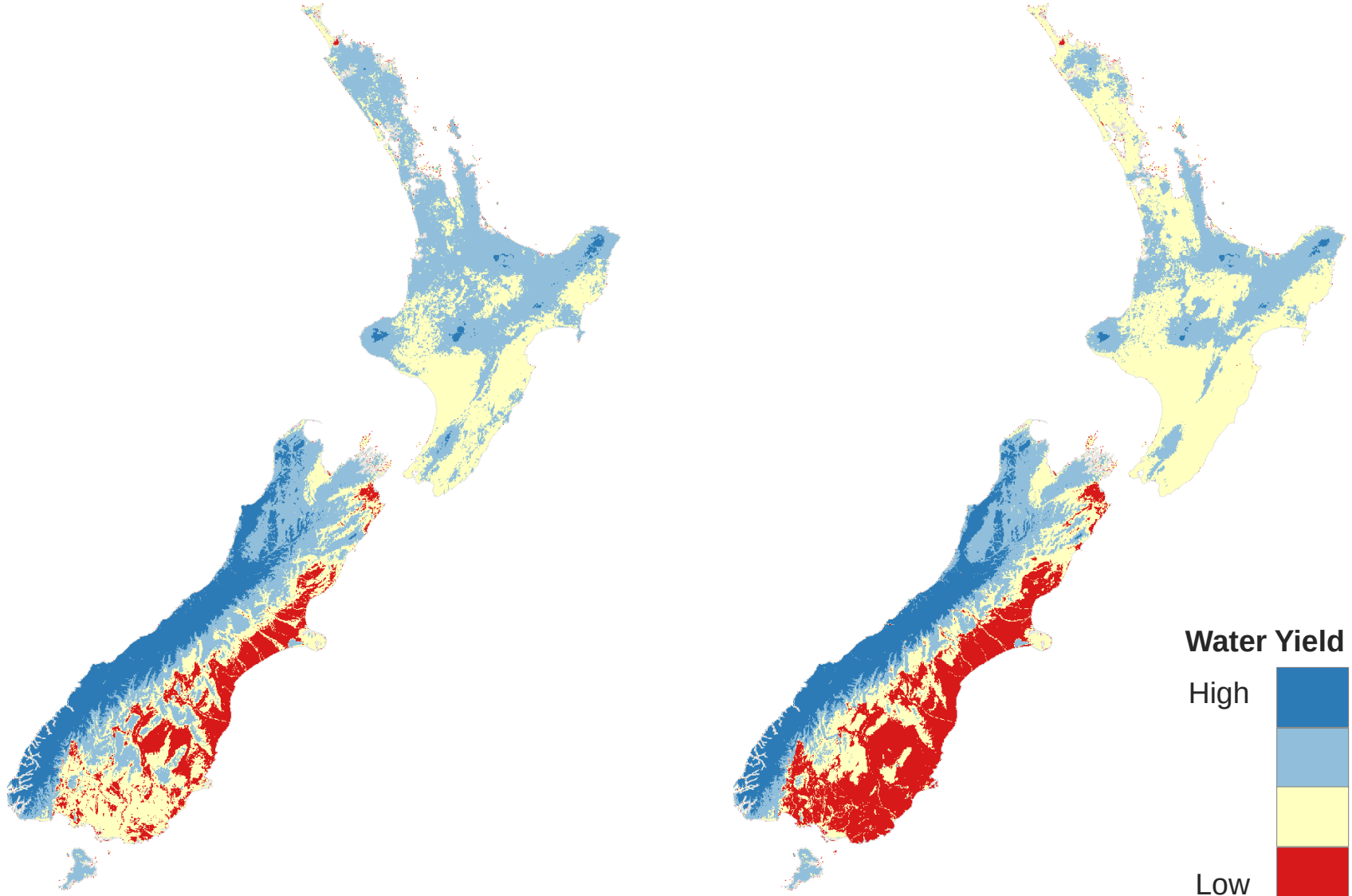


Erosion rates decrease under forest




water yield as proportion of mean annual rainfall
0.0
0.2
0.4
0.6
0.8
0
2000
4000
6000
8000
mean annual rainfall (mm)
grass
tussock
scrub
forest

Water yield decreases under forest

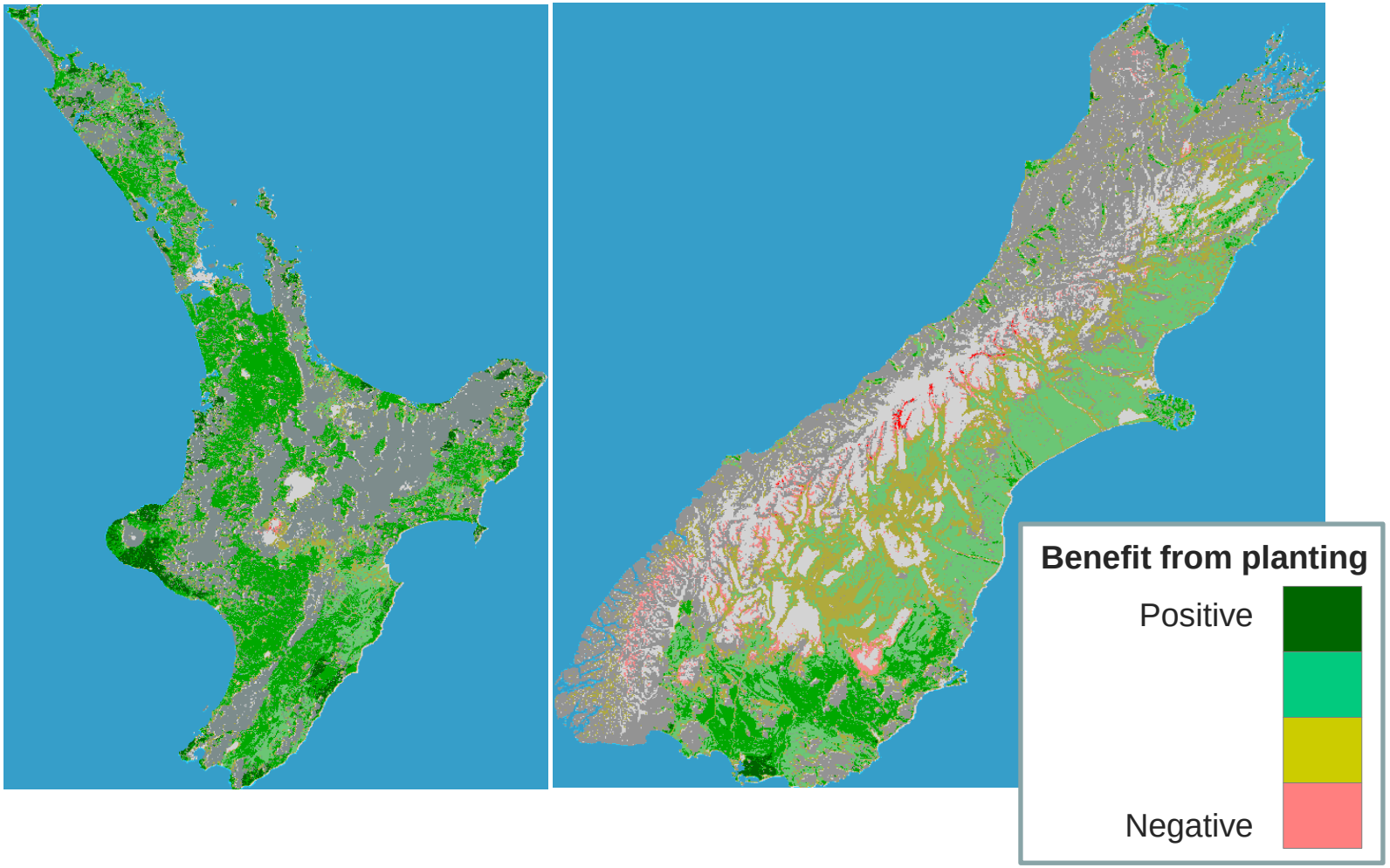


(1) Marginal value of avoided soil erosion = $1 per tonne

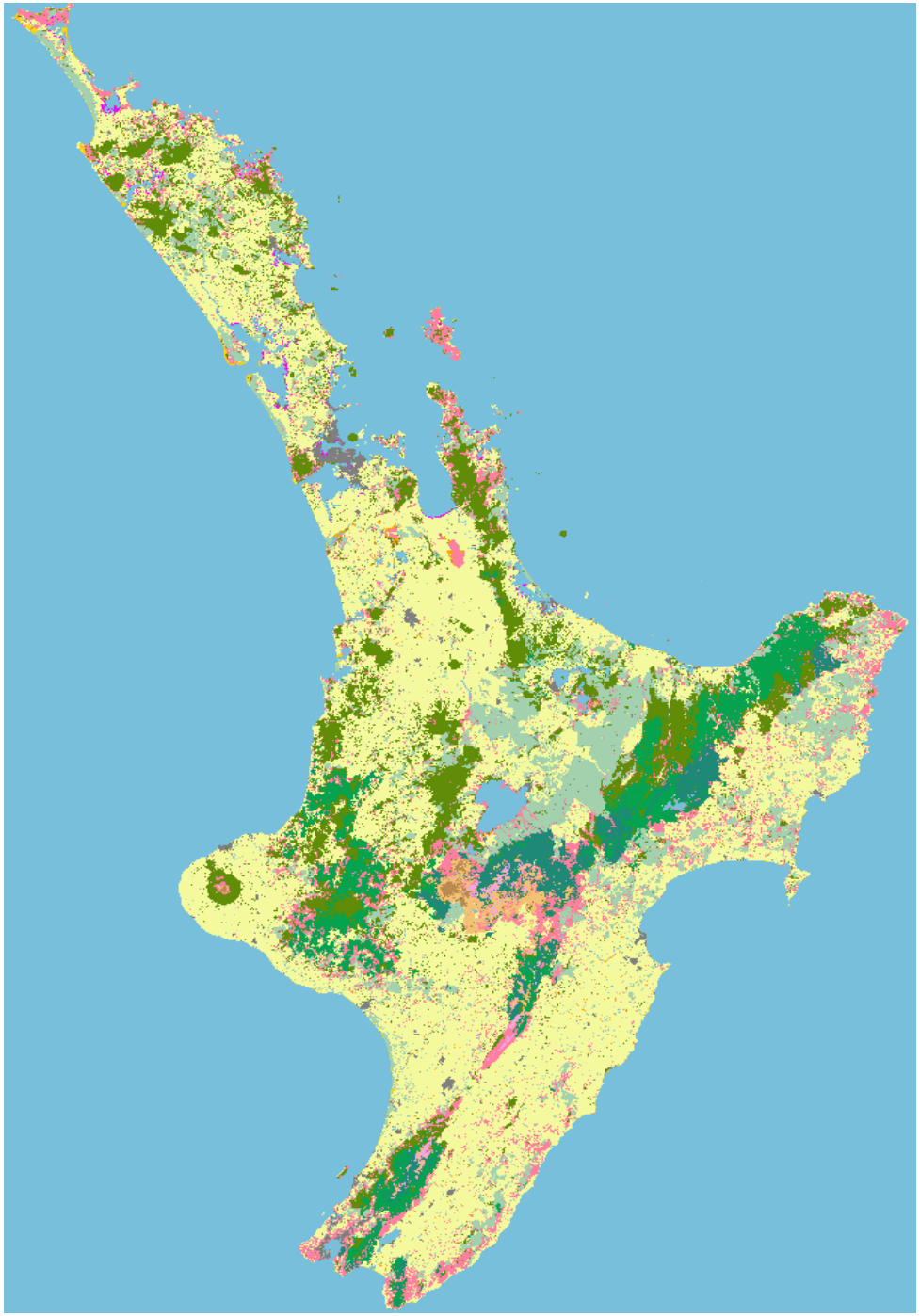
(2) Marginal value of irrigation water = $1 per cubic metre

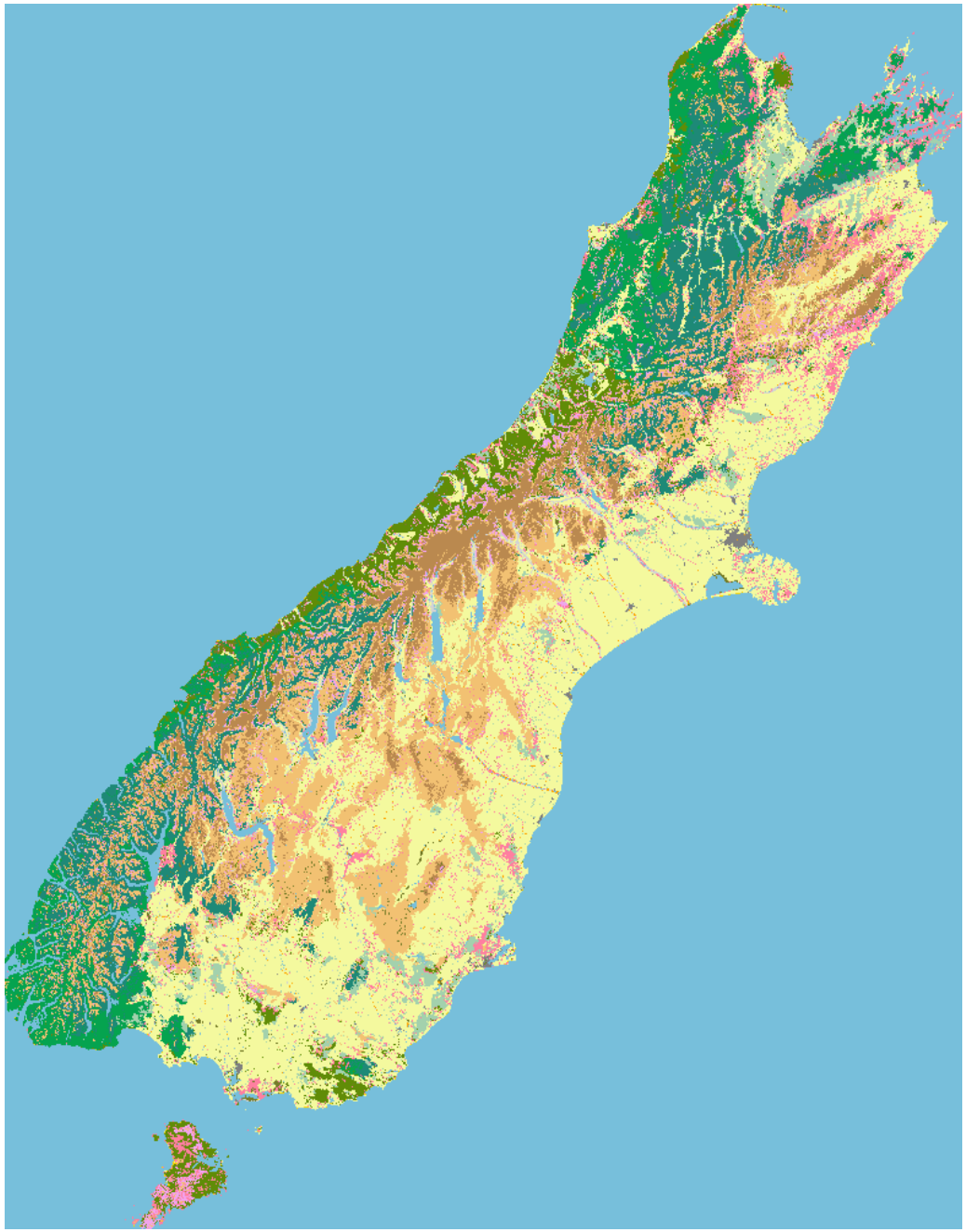
(3) Marginal value of sequestered carbon = $73 per tonne

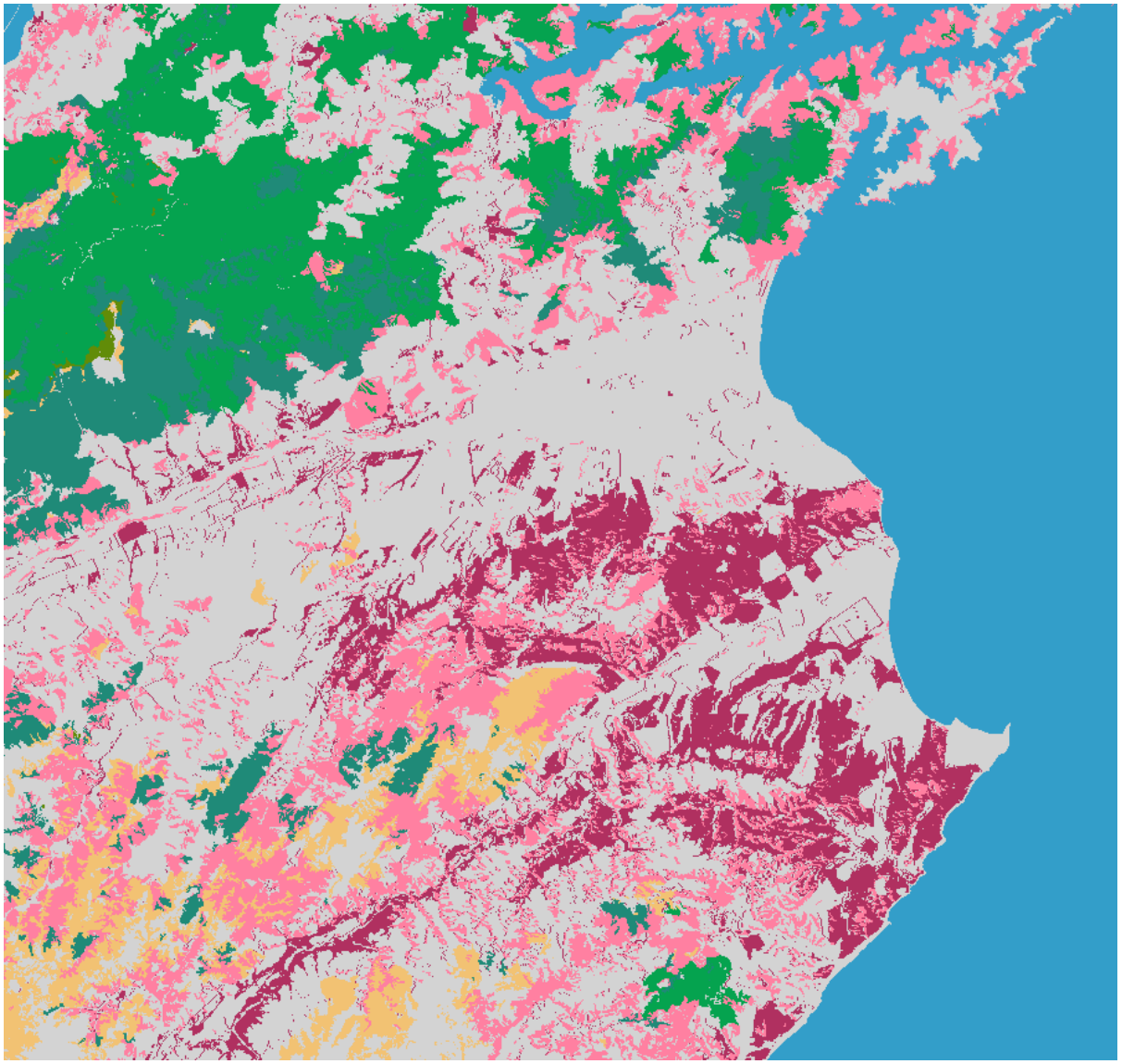
Value of marginal ecosystem services provided by afforestation of pasture

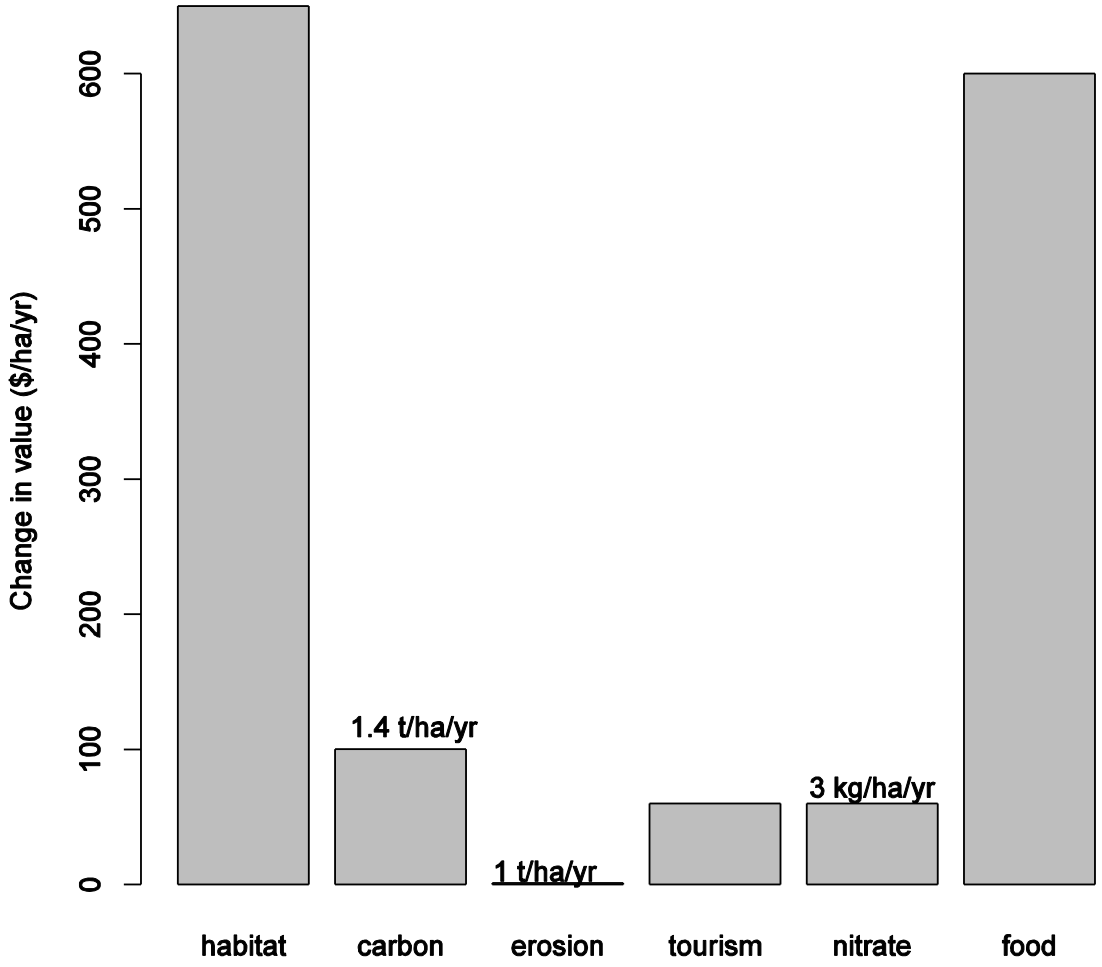


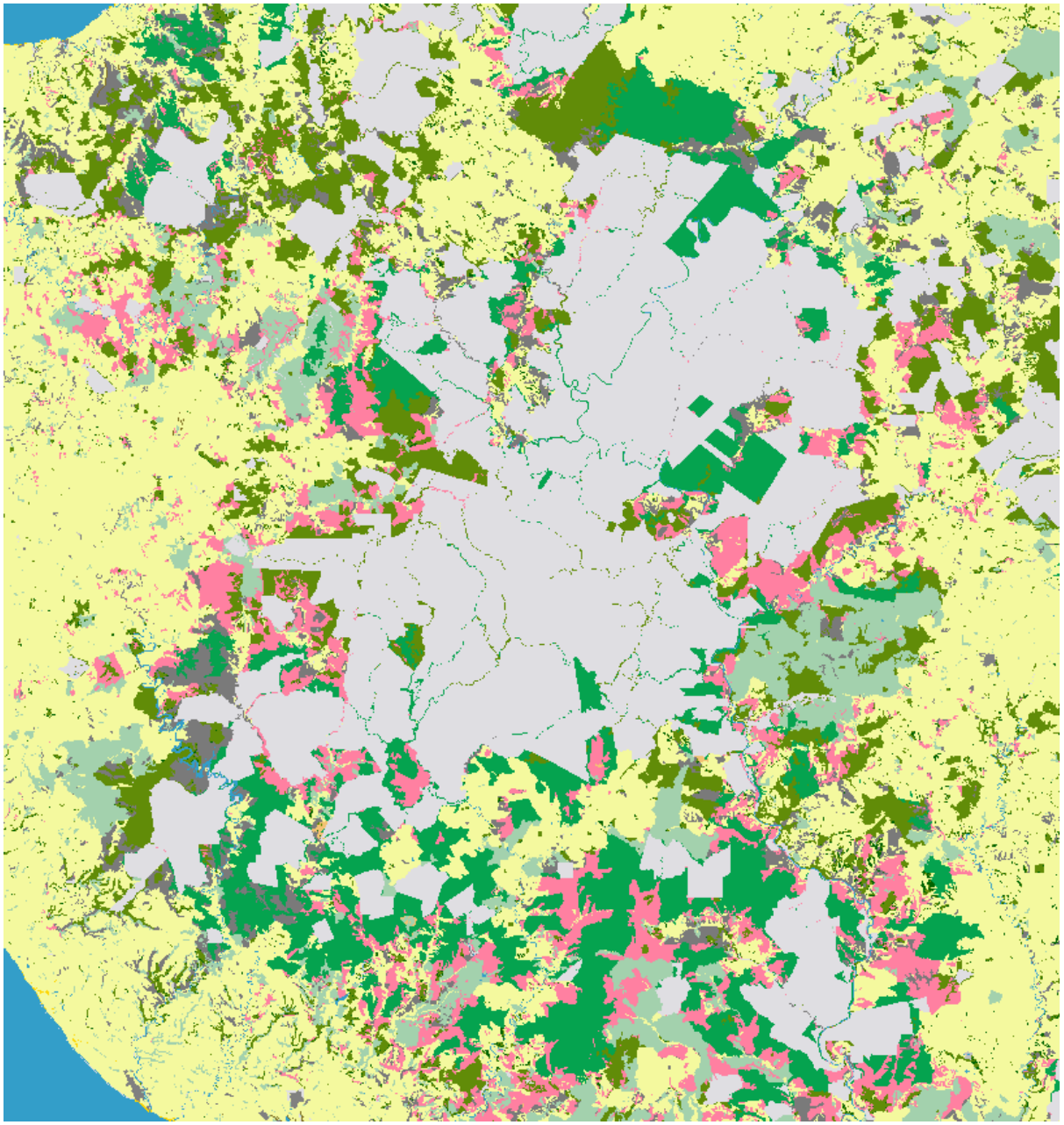
Opportunities for indigenous forest restoration

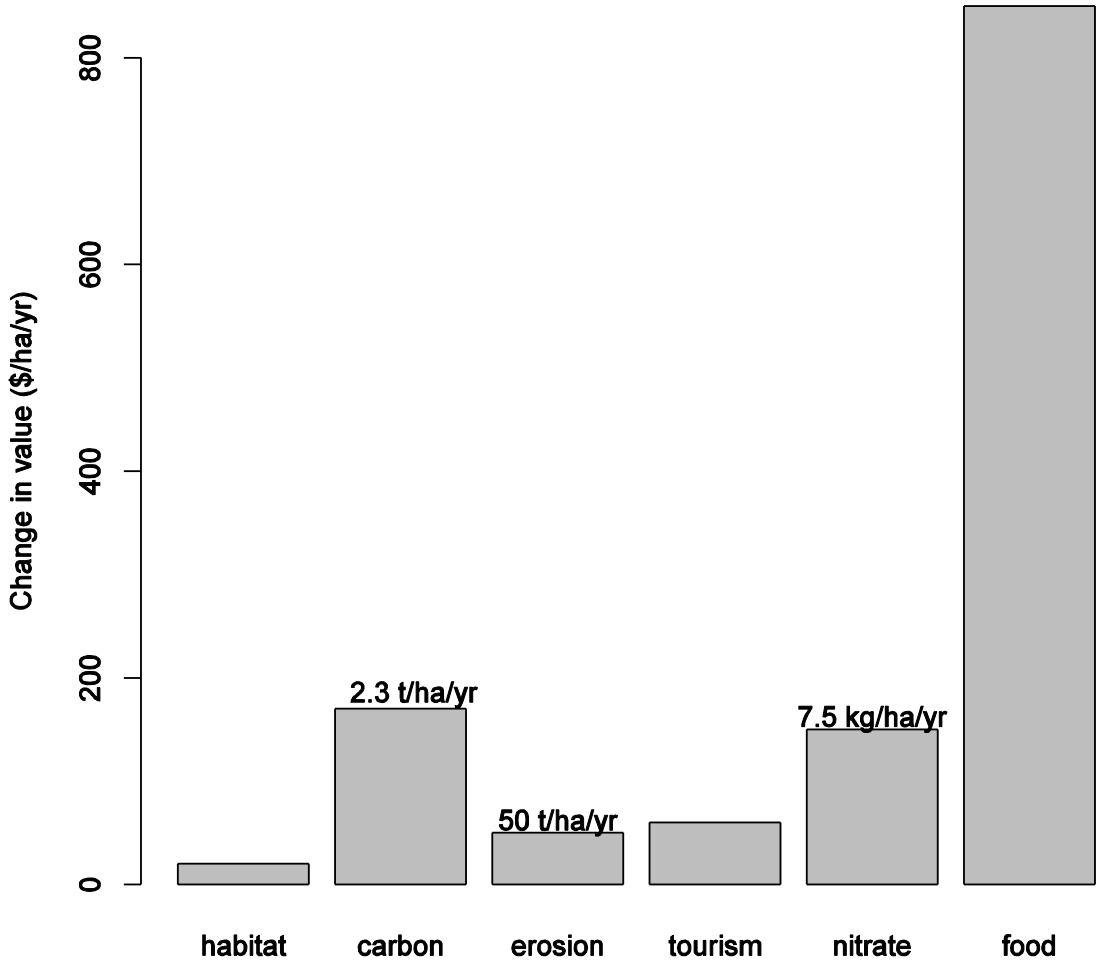




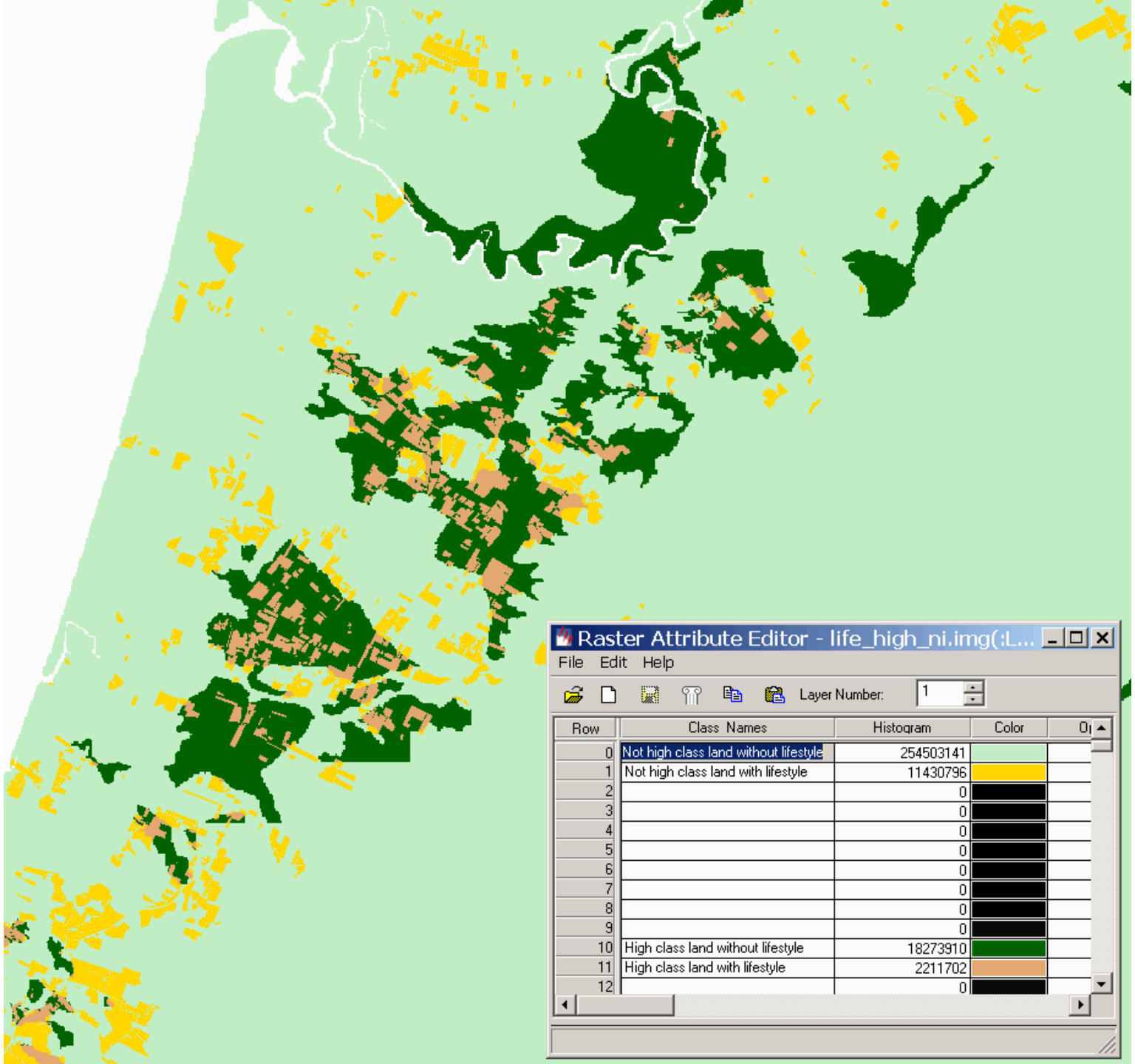



Change in value ($/ha/yr)
0
100
200
300
400
500
600
1.4 t/ha/yr
1 t/ha/yr
3 kg/ha/yr
habitat
carbon
erosion
tourism
nitrate
food




Change in value ($/ha/yr)
0
200
400
600
800
2.3 t/ha/yr
50 t/ha/yr
7.5 kg/ha/yr
habitat
carbon
erosion
tourism
nitrate
food


Maintenance of high quality soil


Raster Attribute Editor - life_high_ni.img(:L...
File Edit Help
Layer Number: 1
Row | Class Names | Histogram | Color
0 | Not high class land without lifestyle | 254503141
1 | Not high class land with lifestyle | 11430796
2 | 0
3 | 0
4 | 0
5 | 0
6 | 0
7 | 0
8 | 0
9 | 0
10 | High class land without lifestyle | 18273910
11 | High class land with lifestyle | 2211702
12 | 0

Urbanisation between 1990 and 2008

Region	high-class land (kha)	high-class land occupied by new urbanisation
Northland	27.8	0%
Auckland	62.9	4%
Waikato	287.0	0%
Bay of Plenty	37.1	1%
Taranaki	87.1	0%
Manawatu/Wanganui	148.2	0%
Gisborne	40.6	0%
Hawkes Bay	92.5	0%
Wellington	36.3	0%
Tasman	16.0	1%
Nelson	0.3	11%
Marlborough	37.7	0%
West Coast	0.3	0%
Canterbury	319.5	1%
Otago	87.8	0%
Southland	183.6	0%
New Zealand	1464.8	0.5%

Lifestyle blocks

Region	high-class land (kha)	high-class land occupied by lifestyle blocks
Northland	27.8	28%
Auckland	62.9	35%
Waikato	287.0	11%
Bay of Plenty	37.1	16%
Taranaki	87.2	3%
Manawatu/Wanganui	148.2	5%
Gisborne	40.6	9%
Hawkes Bay	92.5	4%
Wellington	36.3	12%
Tasman	16.0	24%
Nelson	0.3	12%
Marlborough	37.7	10%
West Coast	0.3	0%
Canterbury	319.5	11%
Otago	87.8	10%
Southland	183.6	4%
New Zealand	1464.8	10%

From the UK National Ecosystem assessment

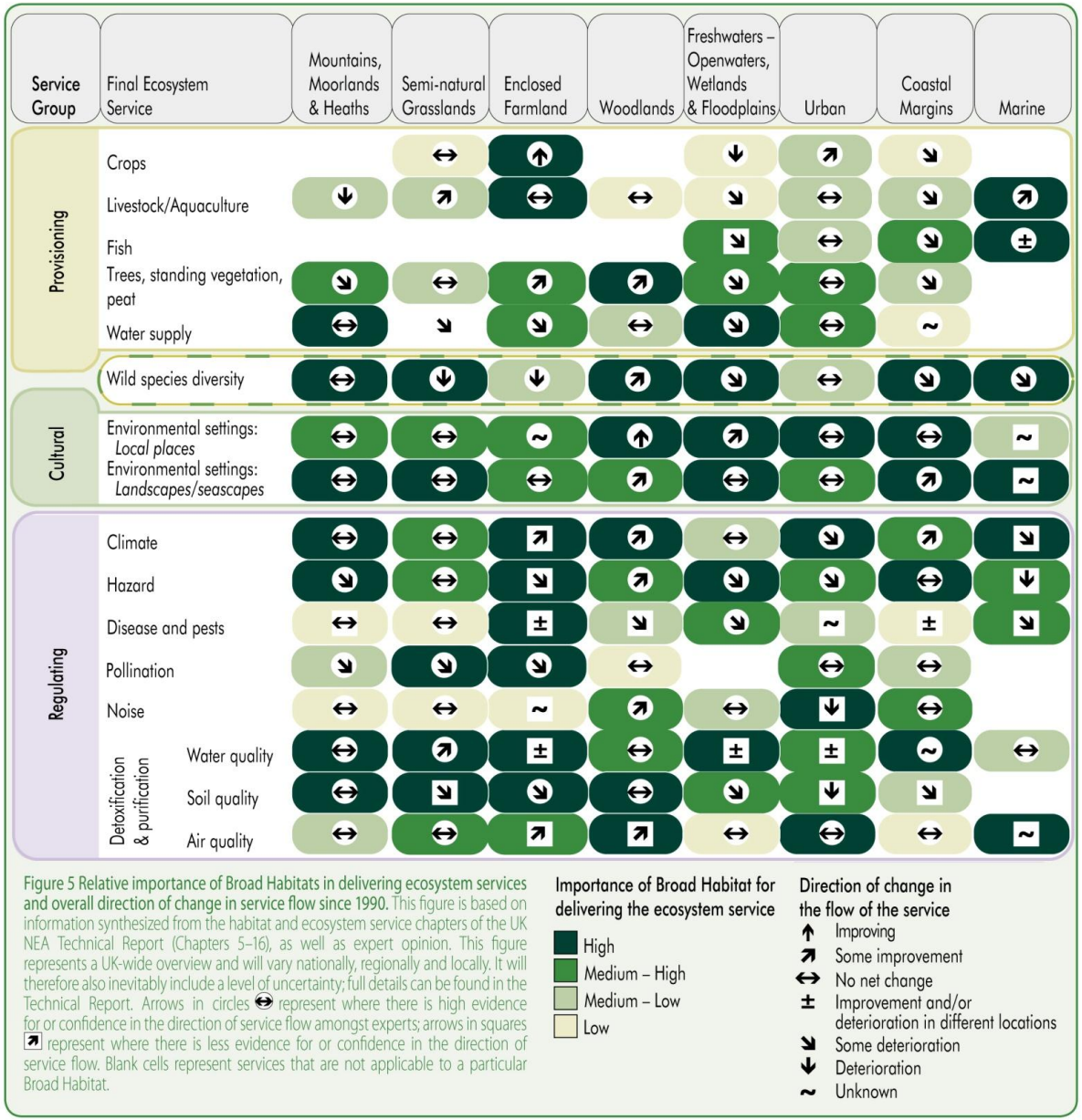
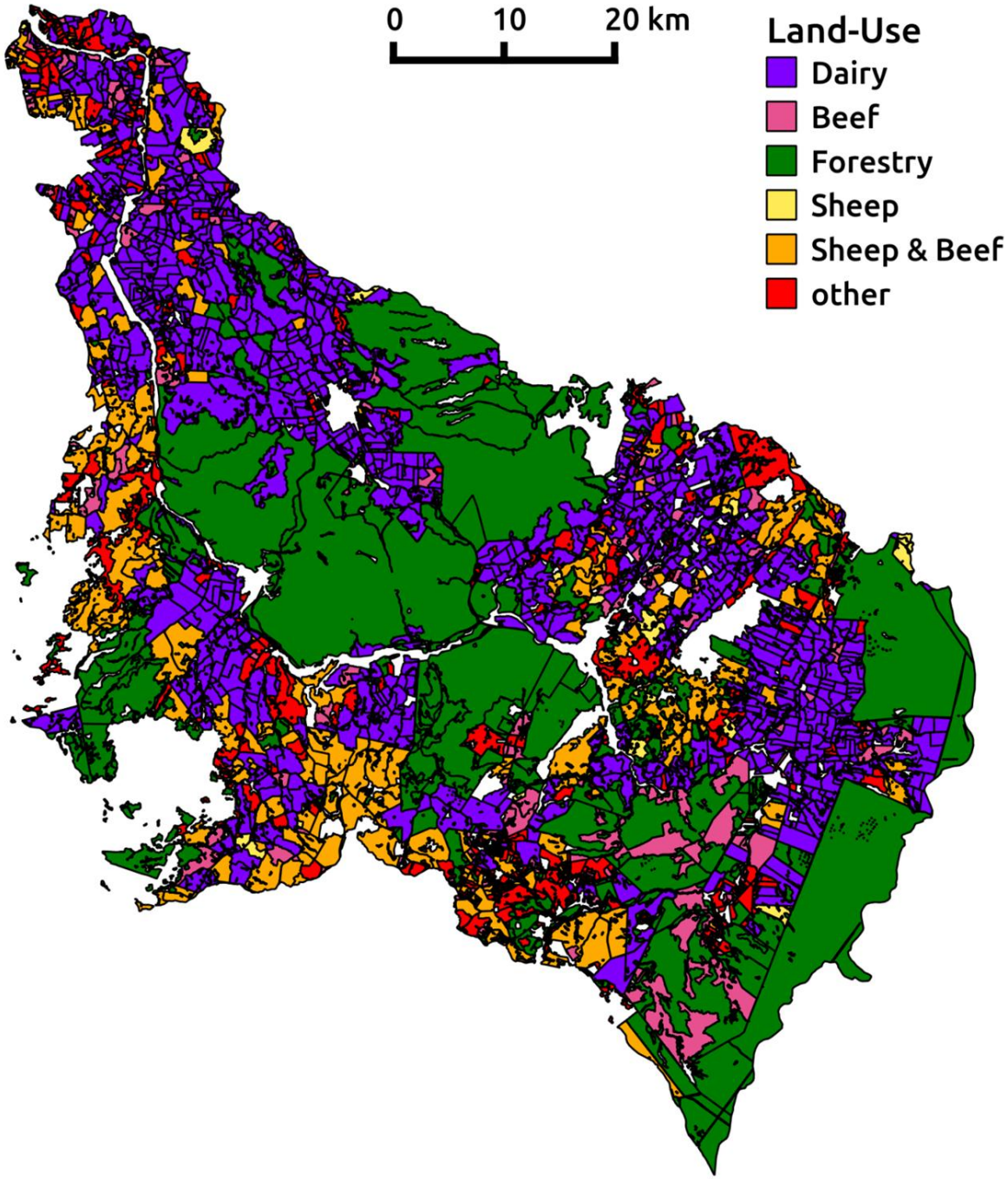
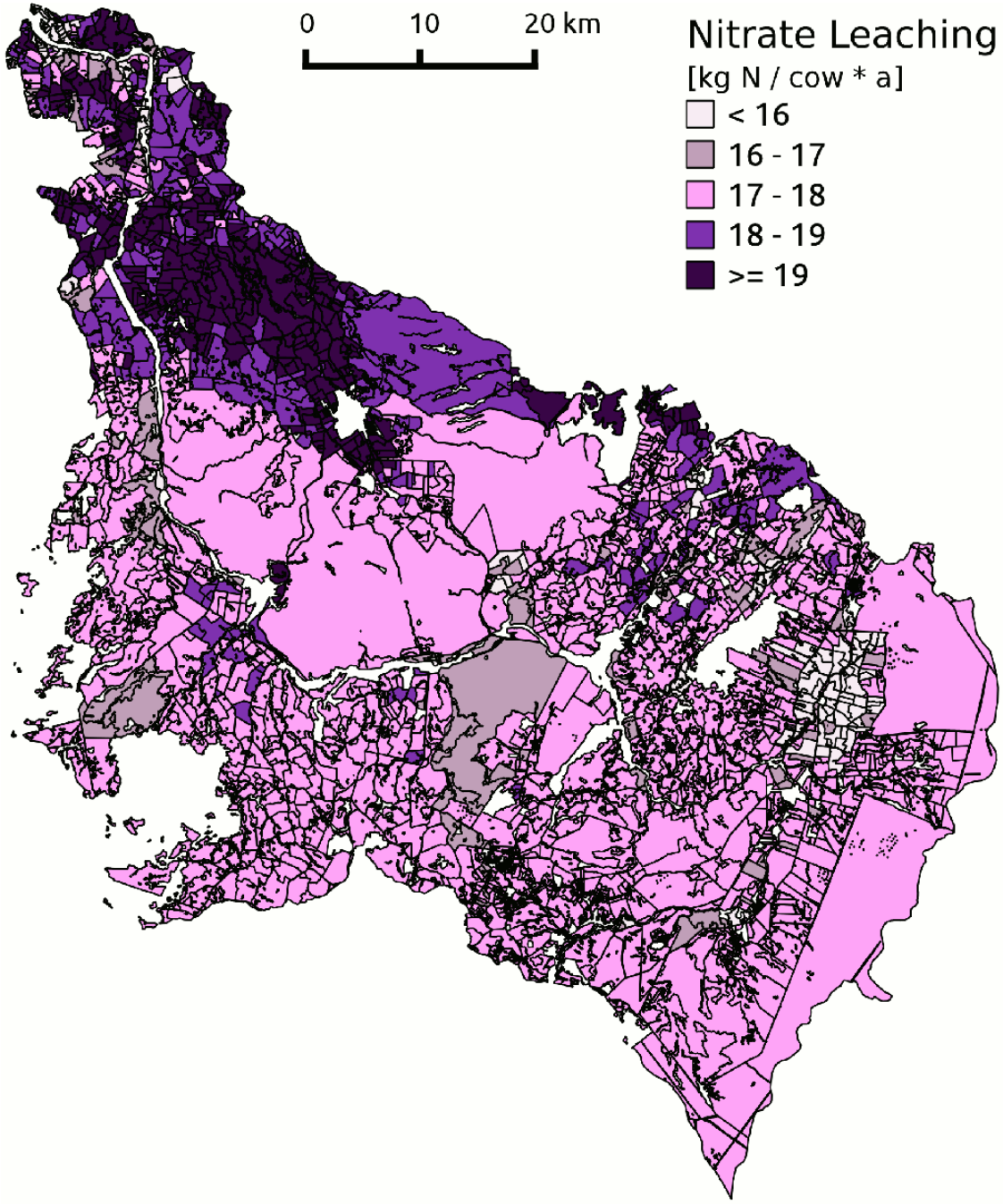


Figure 5 Relative importance of Broad Habitats in delivering ecosystem services and overall direction of change in service flow since 1990. This figure is based on information synthesized from the habitat and ecosystem service chapters of the UK NEA Technical Report (Chapters 5–16), as well as expert opinion. This figure represents a UK-wide overview and will vary nationally, regionally and locally. It will therefore also inevitably include a level of uncertainty; full details can be found in the Technical Report. Arrows in circles ↔ represent where there is high evidence for or confidence in the direction of service flow amongst experts; arrows in squares ↗ represent where there is less evidence for or confidence in the direction of service flow. Blank cells represent services that are not applicable to a particular Broad Habitat.

Optimising ecosystem services


0
10
20 km
Land-Use
Dairy
Beef
Forestry
Sheep
Sheep & Beef
other


0
10
20 km
Nitrate Leaching
[kg N / cow * a]
< 16
16 - 17
17 - 18
18 - 19
>= 19

Maximising Ecosystem Services – Central North Island

***Reconfigure* land-use pattern such that …**

… **nitrate leaching** is **minimised**

Constraint:

- Agricultural output as at 2008

… **erosion** is **minimised**

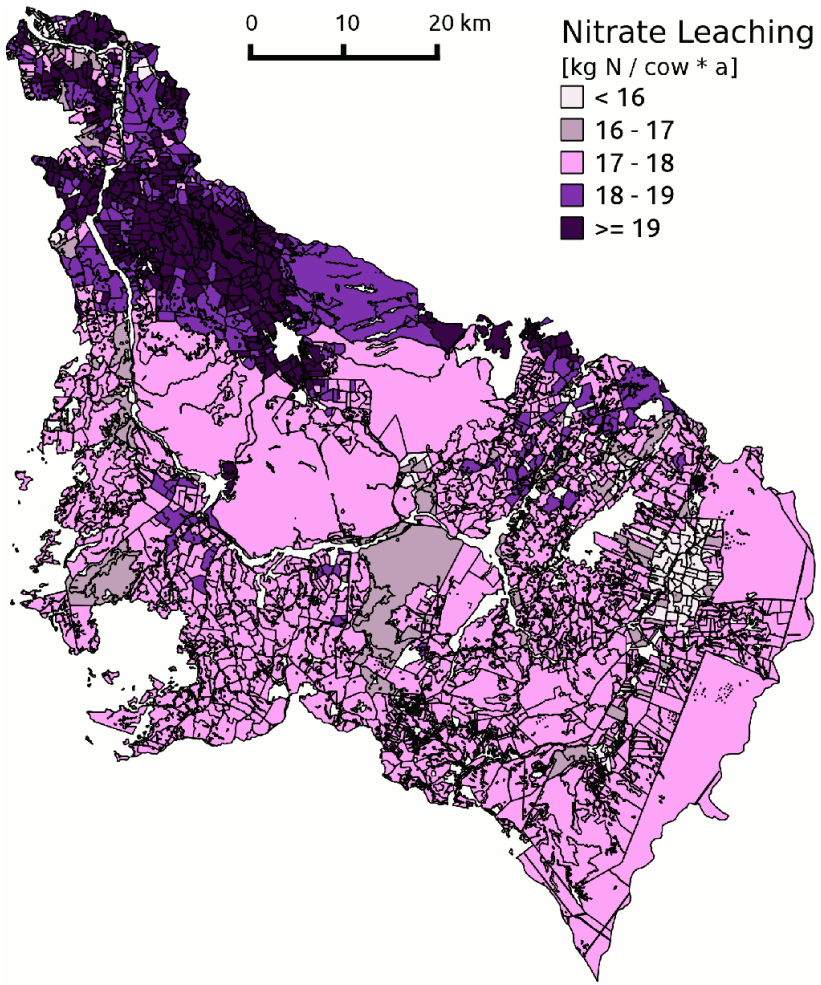
Constraint:

- Agricultural output as at 2008

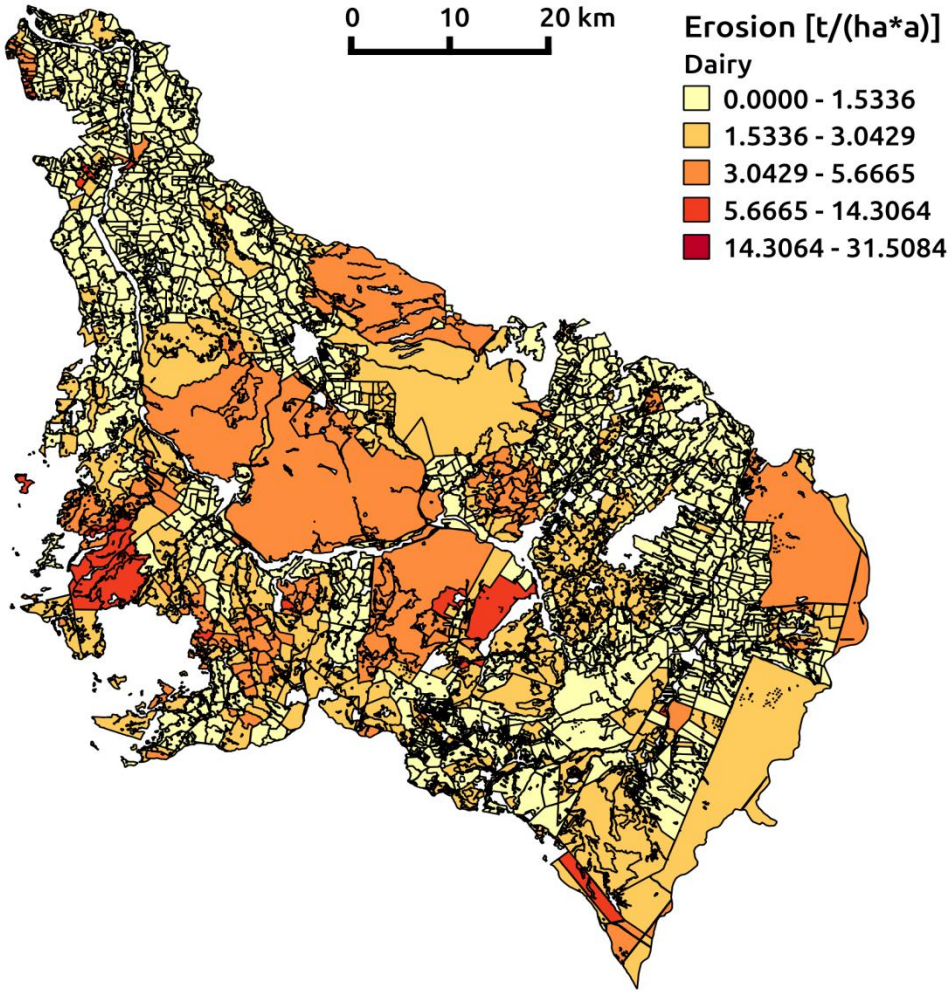
… **nitrate leaching AND erosion** are **minimised**

Constraint:

- Agricultural output as at 2008



Nitrate Leaching



Soil Erosion

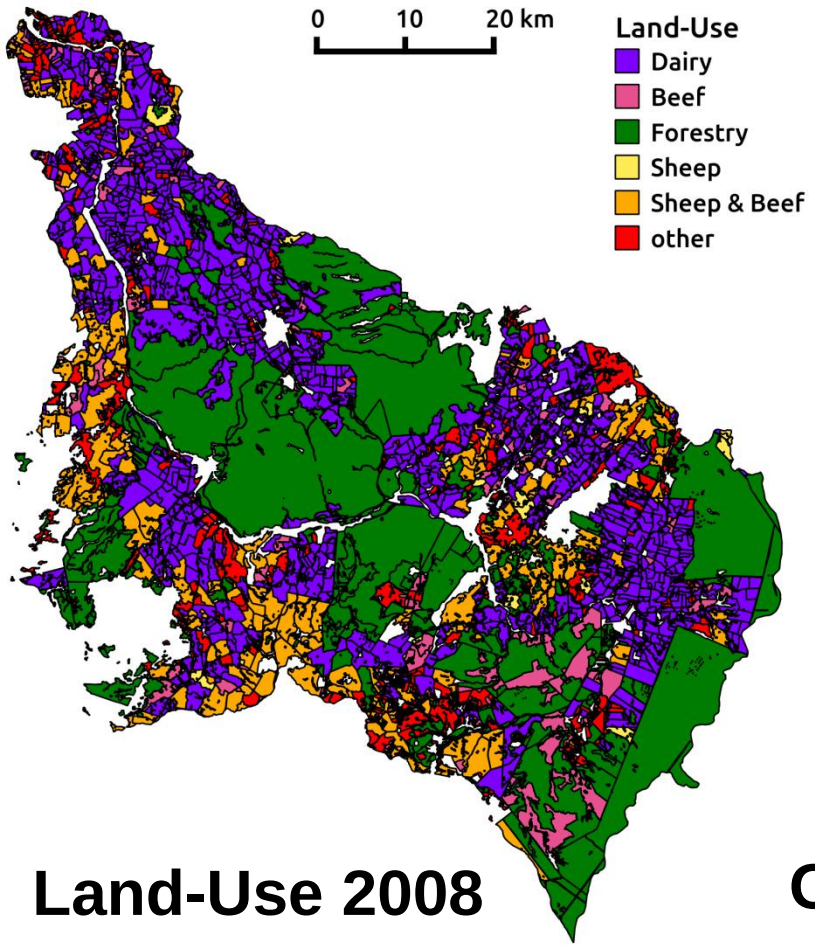
Objective: **min soil erosion**

min nitrate leaching

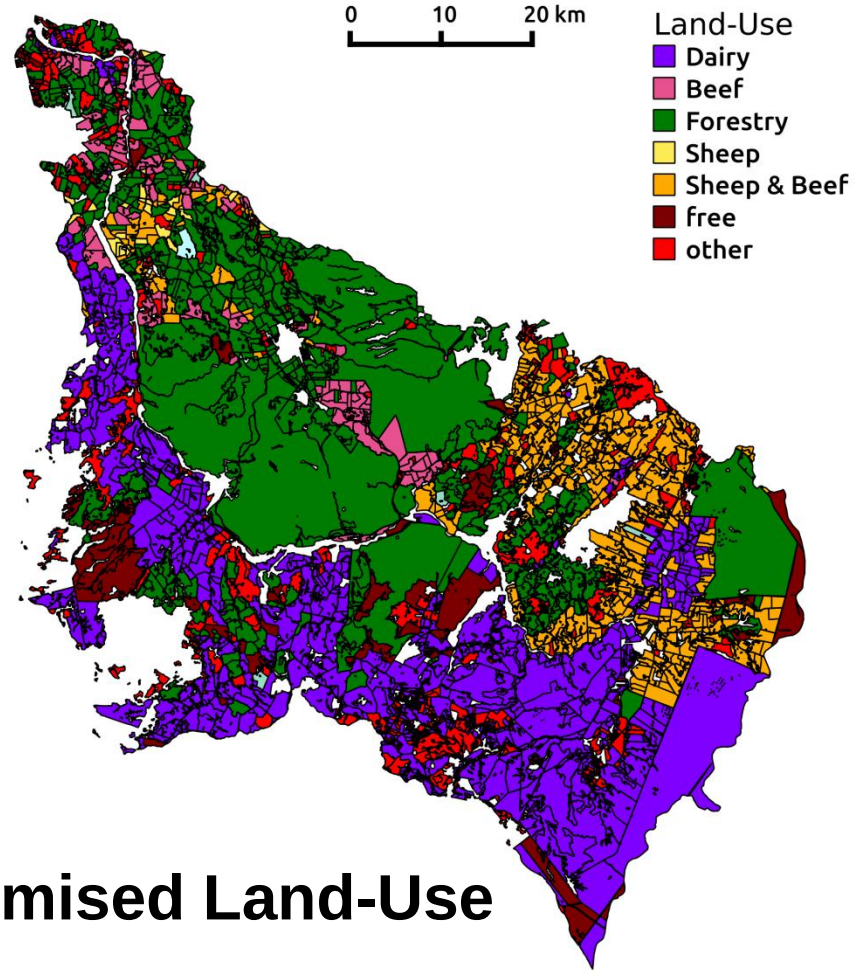
Constraints: **$$ = $$ (2008)**

n. l.<= 6573809 [kg/a]

Land-Use	Area	Nitrate Leaching	Erosion	Milk Solids	Wood	Meat	Wool
Total	-7	-8	-14	0	0	0	0

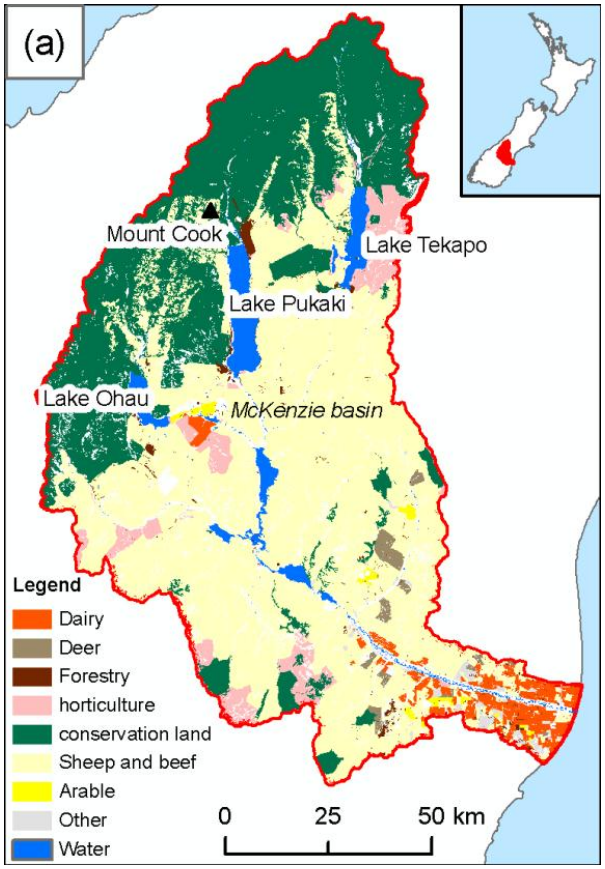


Land-Use 2008

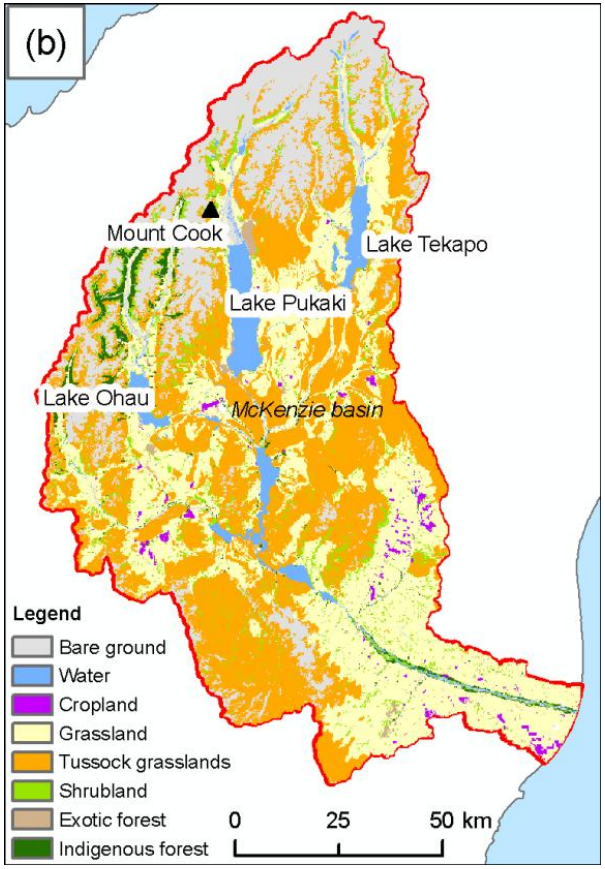


Optimised Land-Use

Waitaki catchment



Land use

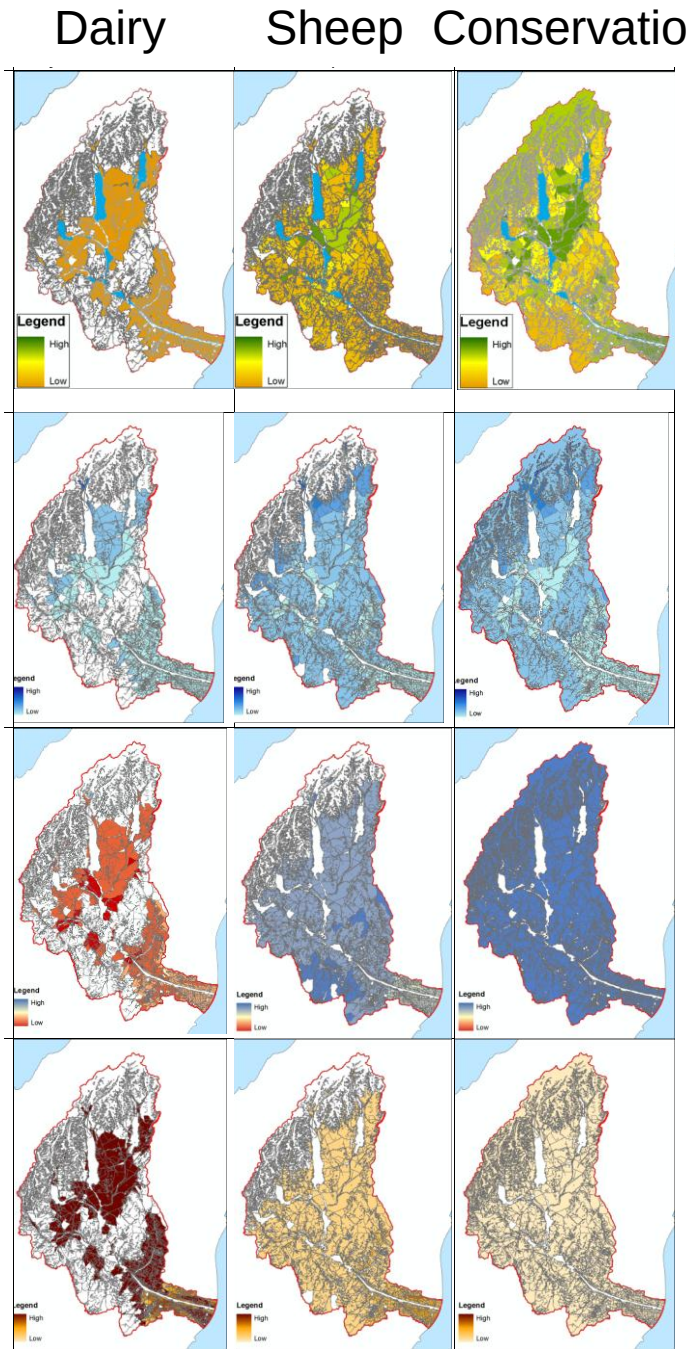


Land cover

Scenarios

	Scenario 1	Scenario 2	Scenario 3
Land use options	Dairy, sheep & beef, conservation land		
Objective	Maximise clean water provision	Maximise habitat provision	Maximise water regulation
Criteria constraint	Maintain current food production levels from dairy and sheep & beef		
Spatial constraint	Dairy and sheep & beef in suitable areas		

Potential ES



Habitat provision (no unit)

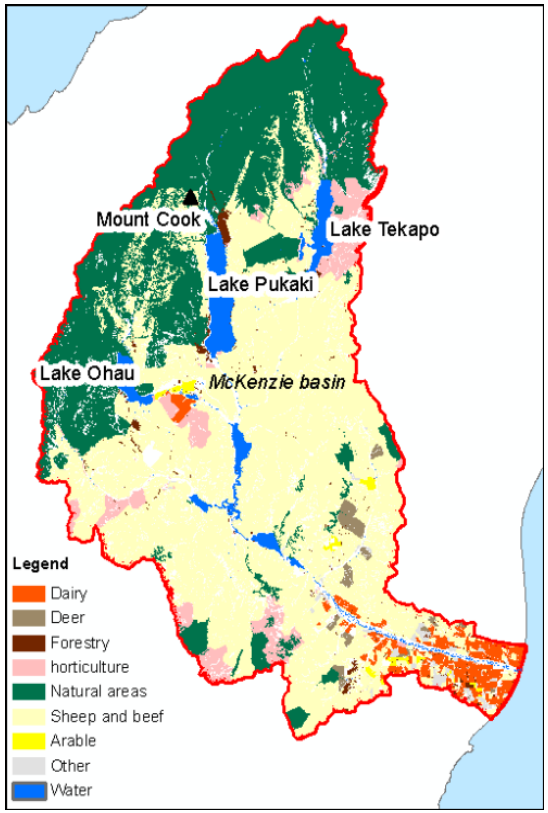
Water yield (mm/yr)

Nitrate leaching (kg N/ha/yr)

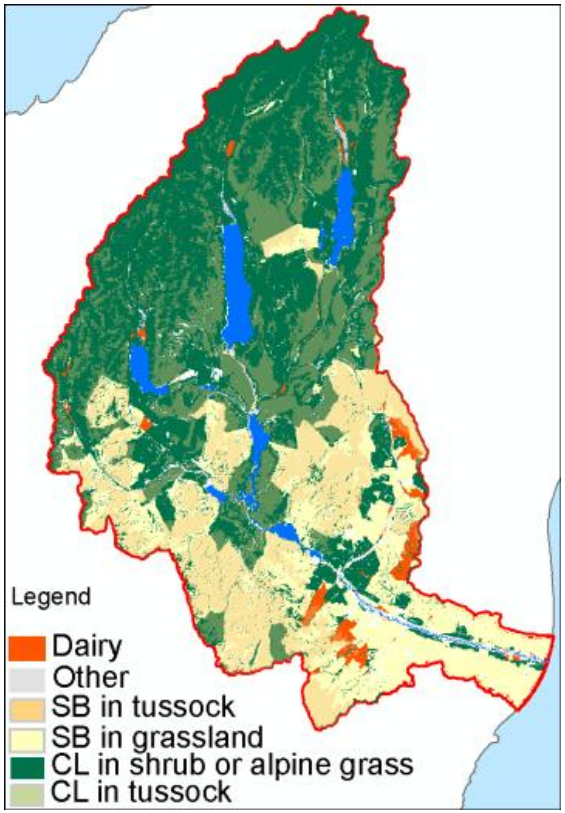
Food production ($/ha)

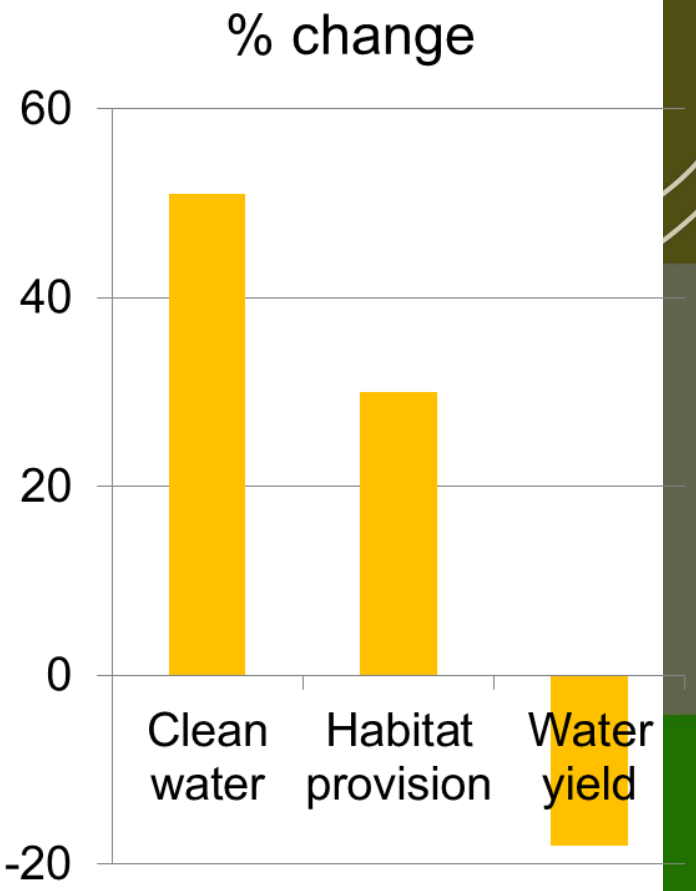
Results: clean water

Current land use



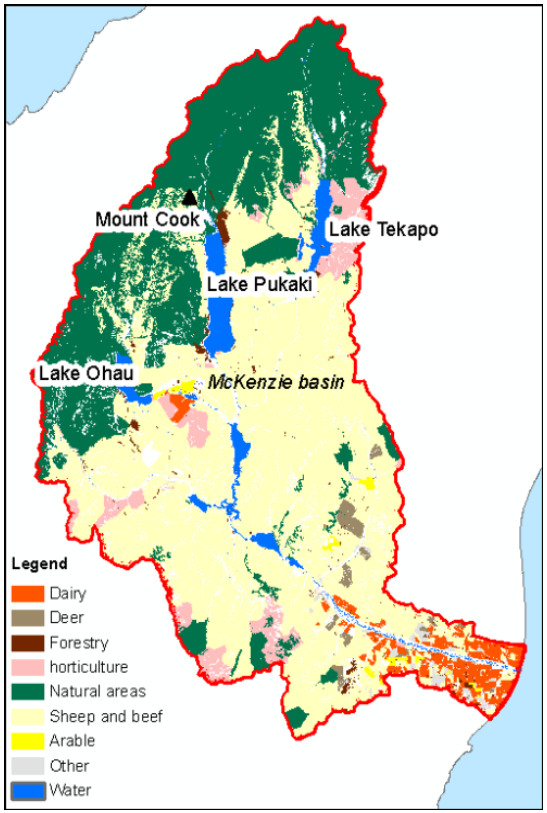
Optimised clean water



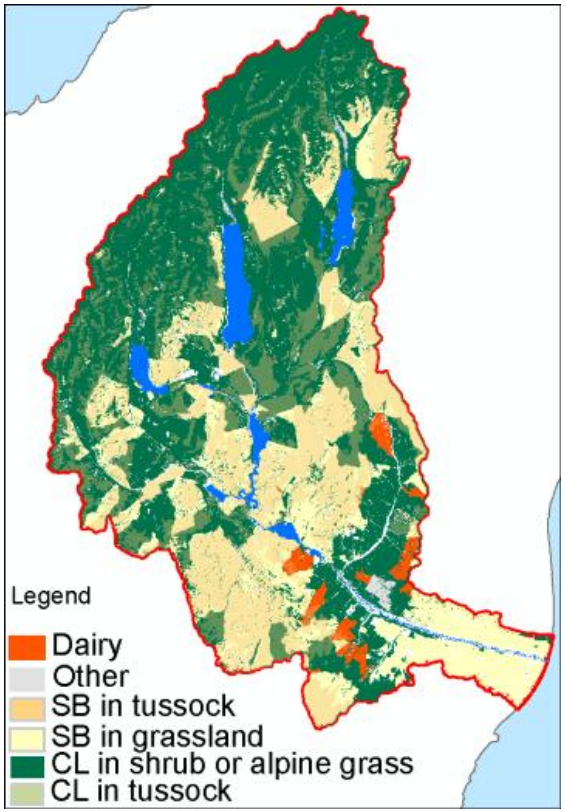


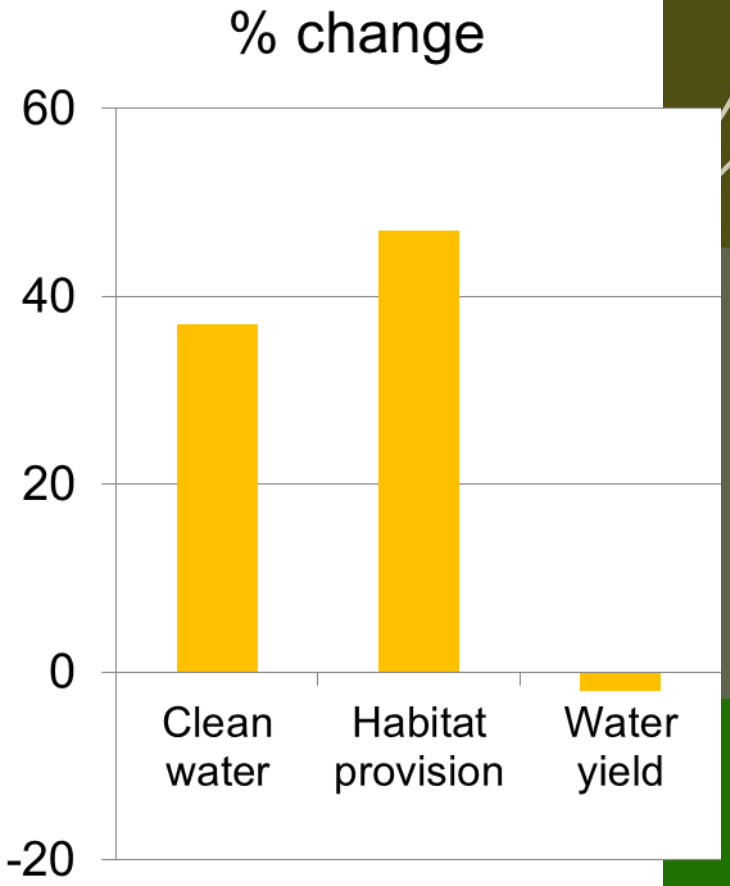
Results: habitat provision

Current land use



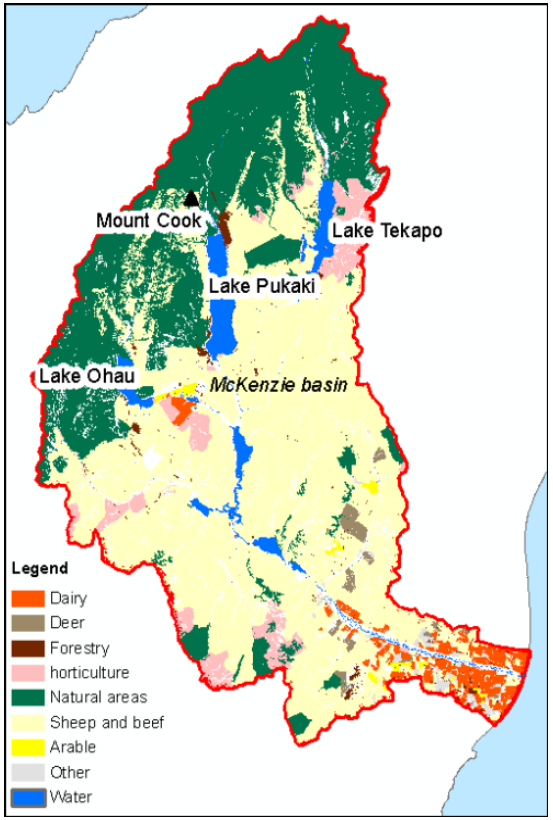
Optimised habitat



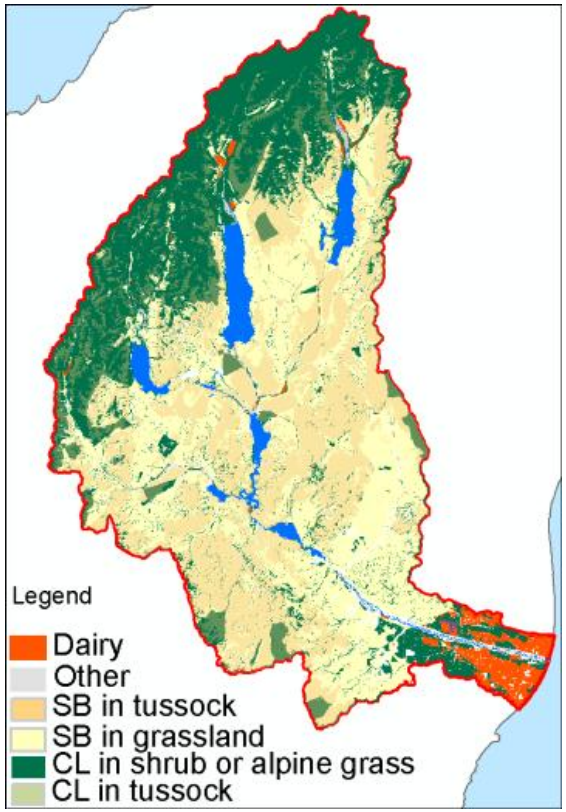


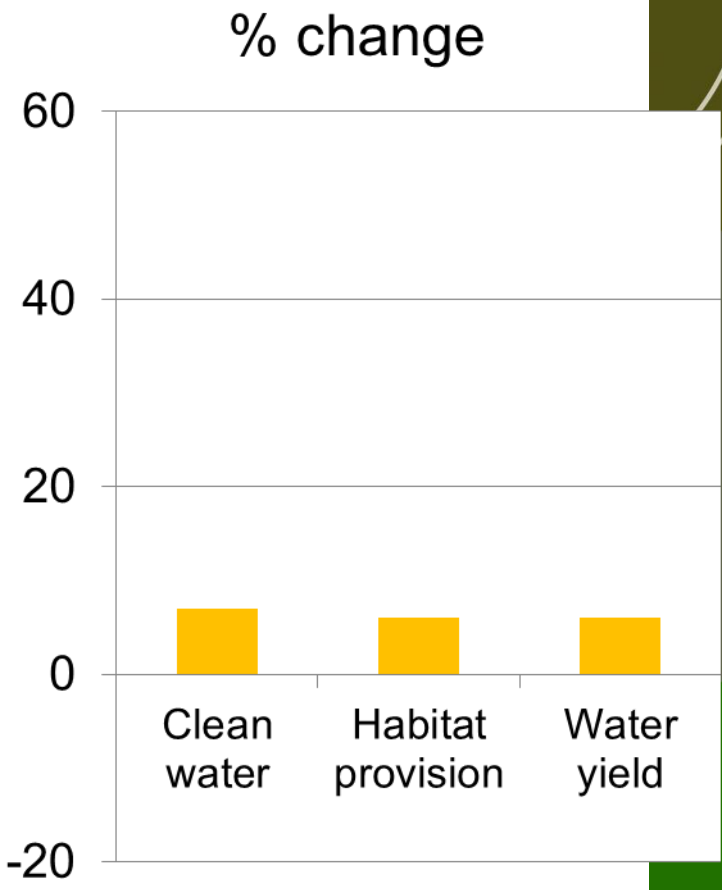
Results: water regulation

Current land use



Optimised water regulation





Spatial Optimisation Use-Cases

Where are the most suitable areas for URBAN DEVELOPMENT?

Objectives: min env. impact; min costs; max value; min distance to hospital;
Constraints: maintain agricultural output; target number of houses;
avoid high class land

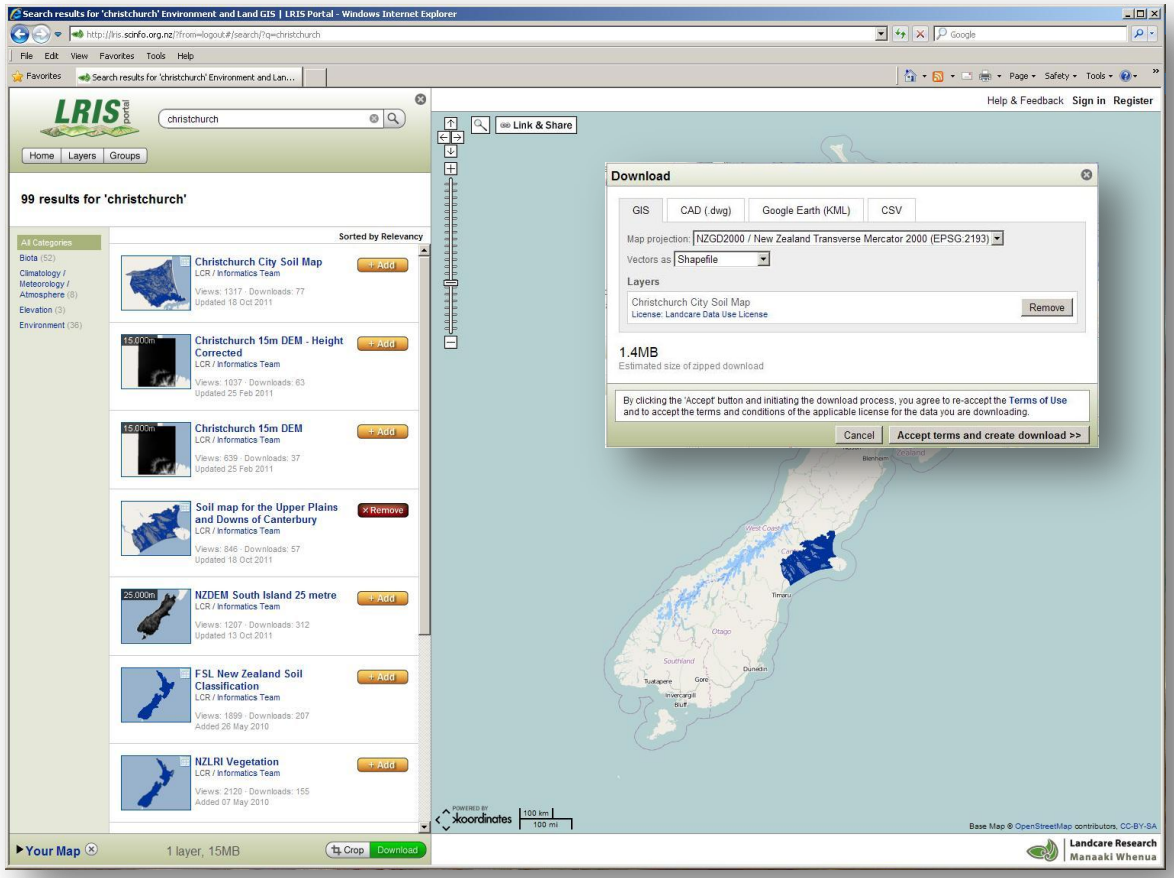
What is the most efficient ALLOCATION OF WATER?

Objectives: max agricultural output; min supply costs
Constraints: water cap; budget cap

What are the most suitable areas for BIODIVERSITY OFFSETTING?

Objectives: max ecosystem services; min development/maintenance costs
Constraints: suitability zones; target biodiversity value; connectedness with current conservation estates;

…

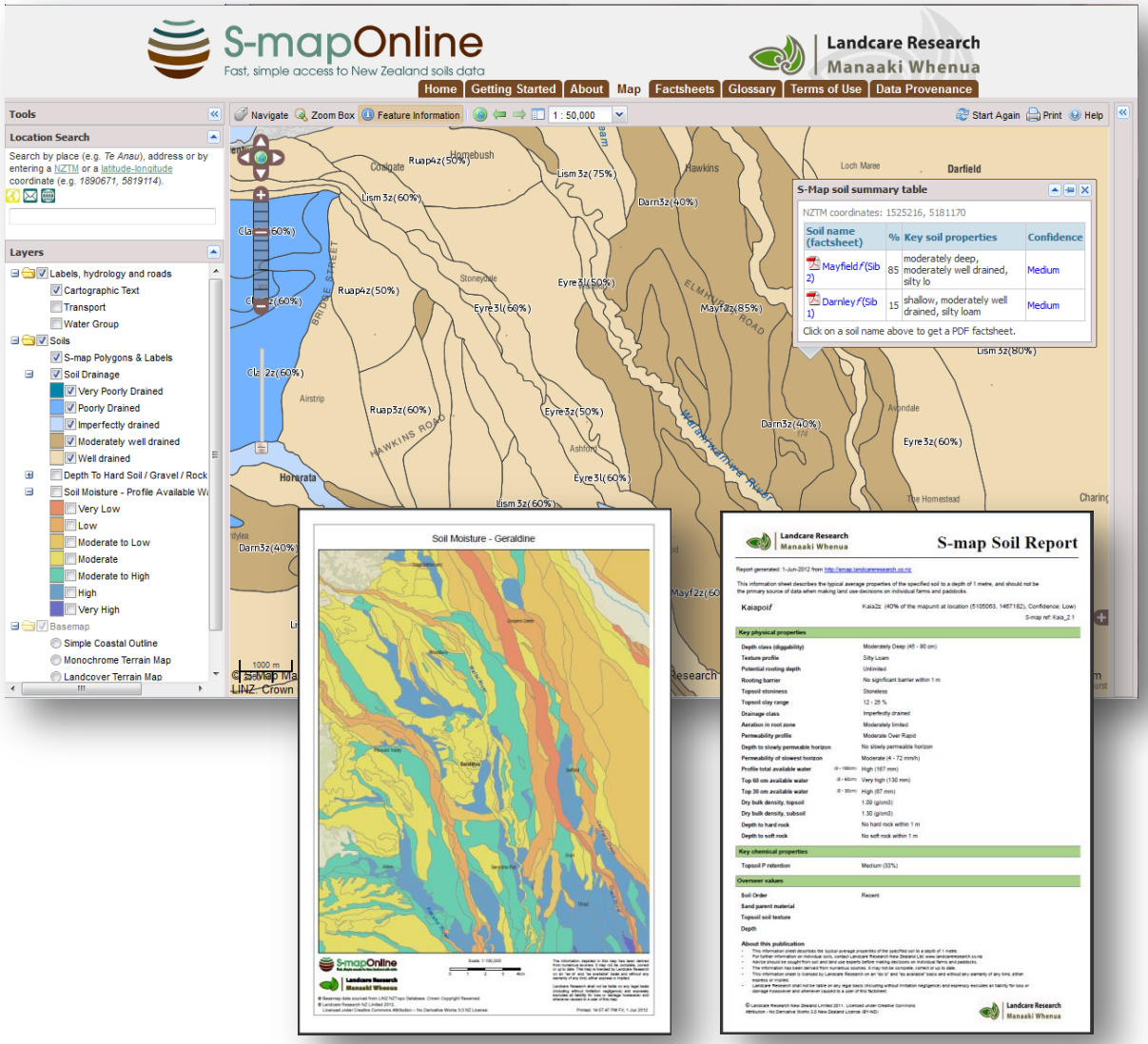


- Launched August 2010
- Data download facility
- Free
- 130+ data sets
- Aimed at GIS professionals
- Easy to use
- Many formats supported and different projections
- Comes with supporting materials
- Strong standards-based metadata component
- Requires registration
- New – web services

At http://lris.scinfo.org.nz

S-mapOnline

Fast, simple access to New Zealand soils data

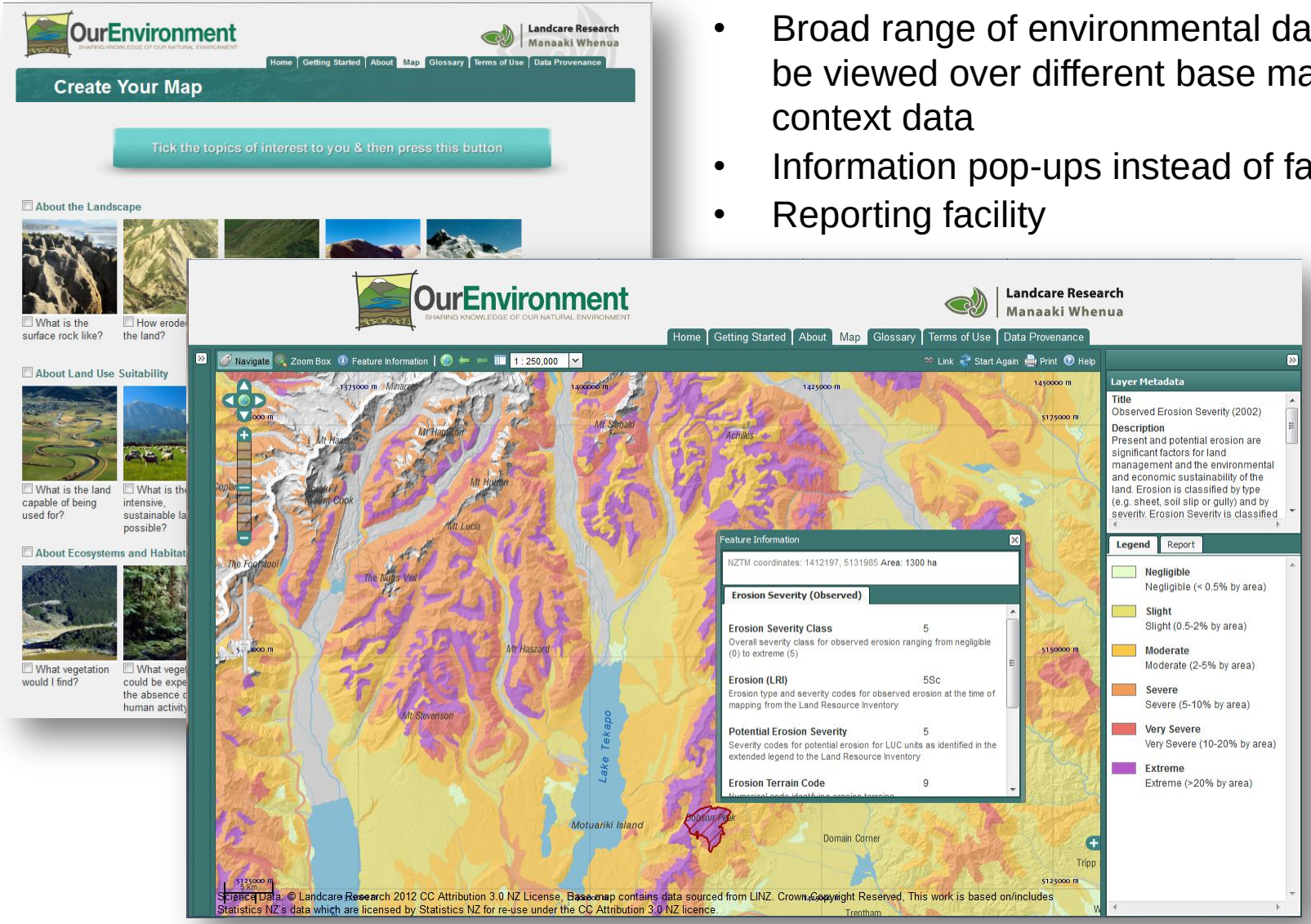


- A new multi-layer digital soil spatial information system for New Zealand
- Soil classes and attributes with resolution at least equiv. to 1:50,000
- High quality on-screen maps
- Search by coordinates/ location/address
- Link to soil fact sheets
- Metadata, legends and explanatory inform-ation
- High quality hard copy cartography (PDF)

At http://smap.landcareresearch.co.nz

OurEnvironment
SHARING KNOWLEDGE OF OUR NATURAL ENVIRONMENT

- S-map Online like features +
- Targeted at interested lay person but of value to experts also
- Broad range of environmental data can be viewed over different base maps and context data
- Information pop-ups instead of factsheets
- Reporting facility



At http://ourenvironment.scinfo.org.nz