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Summary notes from meeting and field trip on land resource data and forestry issues in the Marlborough Sounds

Envirolink Advice Grant: 1704-MLDC118

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Les Basher

Landcare Research

Prepared for:

Marlborough District Council

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Landcare Research, 231 Morrin Road, St Johns, Private Bag 92170, Auckland 1142, New Zealand, Ph +64 9 574 4100, Fax +64 9 574 4101, www.landcareresearch.co.nz

1 Summary

Improving management of plantation forest harvesting in the Marlborough Sounds is a contentious issue and has been since the 1970s. Steep slopes, short catchments that are mostly directly connected to the marine environment, clay-rich soils, and common high-intensity storms all contribute to the risk of erosion and sedimentation. Plantation forestry is currently mostly a permitted activity; however, Marlborough District Council (MDC) has presented a number of options to try and reduce the input of sediment into coastal waters (Uhrlich 2015). The proposed National Environmental Standard for Plantation Forestry would also impact on forest management and harvesting. A key component of the NES-PF is the Erosion Susceptibility Classification (ESC) derived from regional scale New Zealand Land Resource Inventory (NZLRI) data but there is concern about the scale and accuracy of these data for operational forestry management.

Landcare Research provided MDC with

- a summary of the available NZLRI data for the Marlborough Sounds and contributing catchments,
- a review of the basis of the ESC and how it has been revised (based on Bloomberg et al. 2011; Basher et al. 2014, 2015a, 2016)
- an outline of the process proposed for making future changes to the ESC should the NES-PF be gazetted (Basher et al. 2015b)
- a summary of available land resource data for the Marlborough Sounds and how that might be used to update the NZLRI.

In addition a field trip to several areas of the Sounds between Port Underwood and Opua Bay was used to discuss forest harvesting and sediment issues and the available NZLRI data.

The current NZLRI mapping was some of the earliest completed and is very broad scale with large polygon sizes. The available 15-m DEM could be used to very simply and quickly improve the mapping of slope classes (at 1:10,000 scale) but considerably more work would be required to update the other inventory factors (especially soils and erosion) and there would need to be a real focus on identifying the areas of highly weathered soils and regolith that have the greatest potential to generate fine sediment. It would need to include components of data compilation to utilise the available rock type (Qmap and NZLRI) and soils information (including the available 1:100,000 scale soil map and information on soil-landform-parent material-climate relationships), interpretation of available orthophotos (for erosion) as well as a field component to check the rock type, soil and erosion data.

Just like the NZLRI, the ESC mapping in the Sounds is very broad and is also complicated by the subjective nature of the metric used to define ESC class (i.e. potential erosion). This is reflected in the three different assessments of ESC class that have been produced so far (see slides 36 and 37 of the presentation). The latest iteration (based on subdivision of the High ESC class) results in a large area zoned Very High in which forestry would be a controlled activity. Improving the spatial depiction of LRI/LUC would improve the mapping of ESC class and might allow better targeting of the most erosion-prone landscape components. However, there remains a significant gap in understanding two issues:

- the relative contribution of sediment from mass movement and surface erosion processes (the latter are easier to control)
- the typical location of slope failures (are they on the steepest slopes, or mid-slope as commonly referred to). Without this information (which could come from storm damage characterisation) it remains difficult to determine criteria that might be used to exclude some areas on slopes from re-planting (and/or harvesting) or to exclude or require better management of earthworks within these areas.

While the inherent erosion susceptibility of the Marlborough Sounds landscape may not be as high as some other parts of New Zealand, the sensitivity of the marine receiving environment is very high. A serious deficiency of the NES-PF is that it does not integrate both the land's erosion susceptibility and the sensitivity of receiving environment in determining the rules to apply to forest planting and harvesting.

During the field trip to the Sounds we saw examples of poor forestry practice, including planting and felling right to the water's edge (photo 1), and a high level of slope disturbance where the hauler setup did not allow for sufficient deflection to suspend the logs above the soil surface (photo 2). In one case this had caused deep gouges and some soil rilling and has the potential to form gullies in a big storm event. Slopes like this can be identified during harvest planning and excluded from harvest or alternative harvest strategies developed. We also saw good examples of large setbacks (at least 50 m) from the shoreline (photo 3) that reduce the risk of both trees and sediment entering the water.

I suggest that we consider advancing a large Envirolink grant ($40k) to assess the potential to unlock existing information from the available DEM, rock type, and soils data, supported by limited field work, to update the NZLRI at a scale better suited for land and forest management.

Figure 1 Planting and clearfelling right to the water's edge with high potential for sediment delivery.

Figure 2 Serious scalping and gouging of soil because of insufficient lift in the hauler cable and pulling across slopes. Very high potential for sediment delivery.

Figure 3 Relatively wide setback to control effects of forest harvesting and sediment delivery.

2 References

Basher L, Barringer J, Lynn I, 2016. Update of the Erosion Susceptibility Classification (ESC) for the proposed NES for Plantation Forestry: Subdividing the High and Very High ESC classes. MPI Technical Paper No. 2016/. Landcare Research Contract Report LC2472 prepared for the Ministry for Primary Industries.

Basher L, Lynn I, Page M 2015a. Update of the Erosion Susceptibility Classification (ESC) for the proposed National Environmental Standard for Plantation Forestry – revision of the ESC. MPI Technical Paper No. 2015/13. Landcare Research Contract Report LC2196 for the Ministry for Primary Industries.

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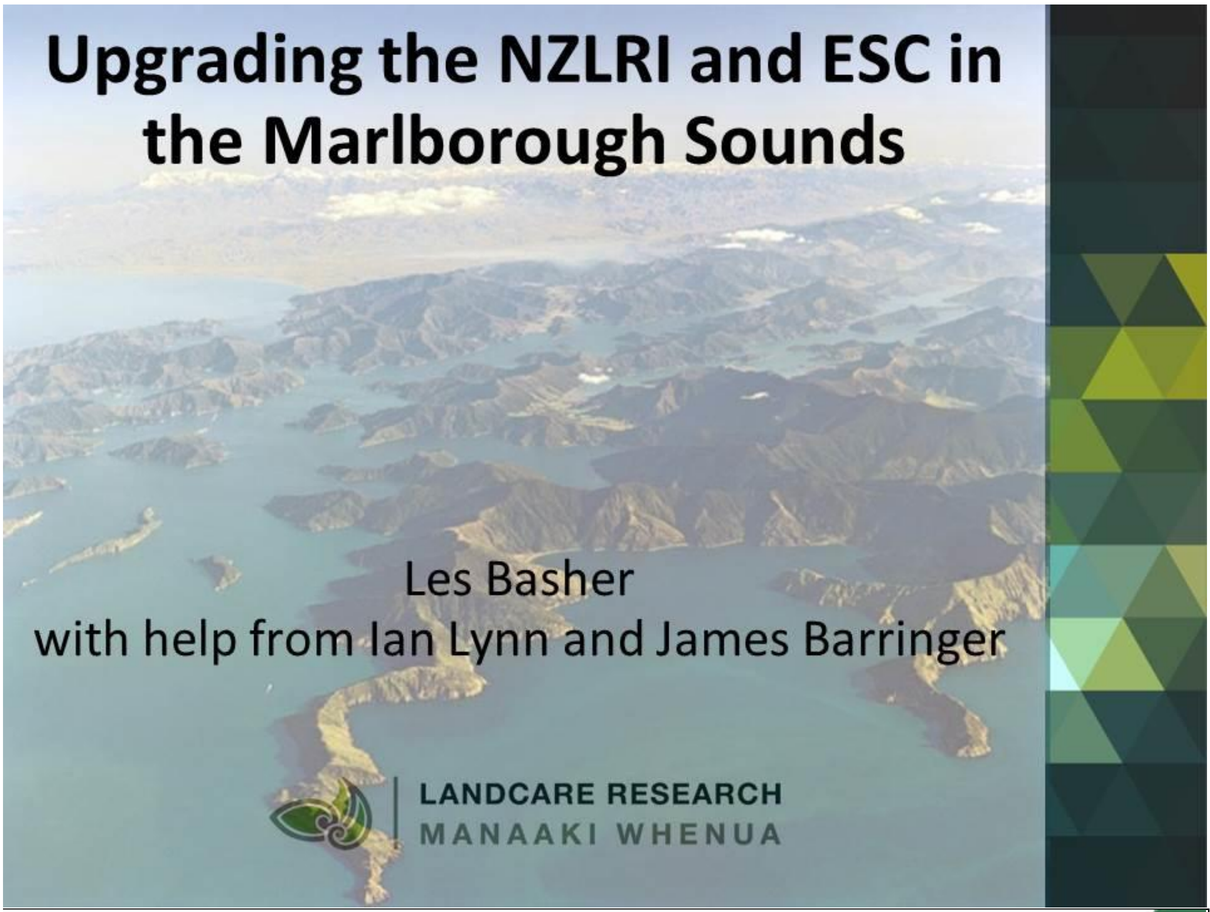
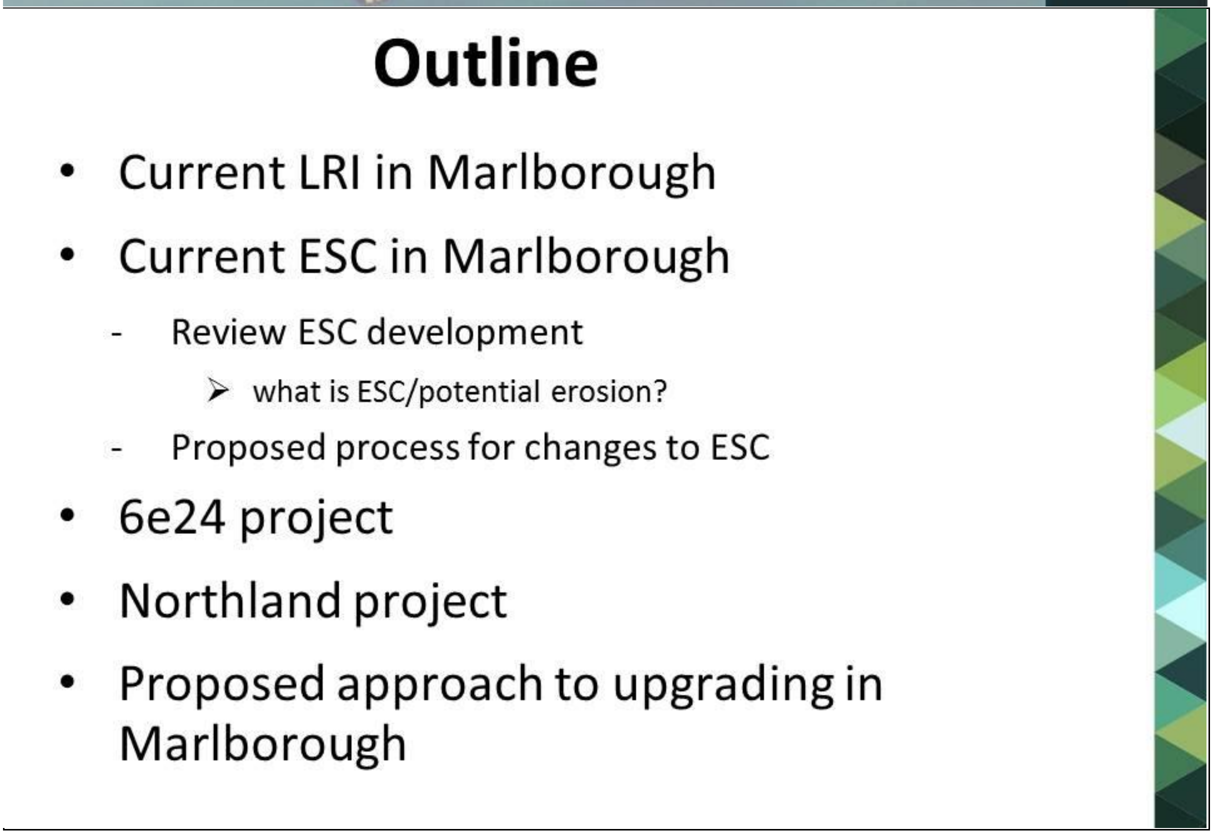
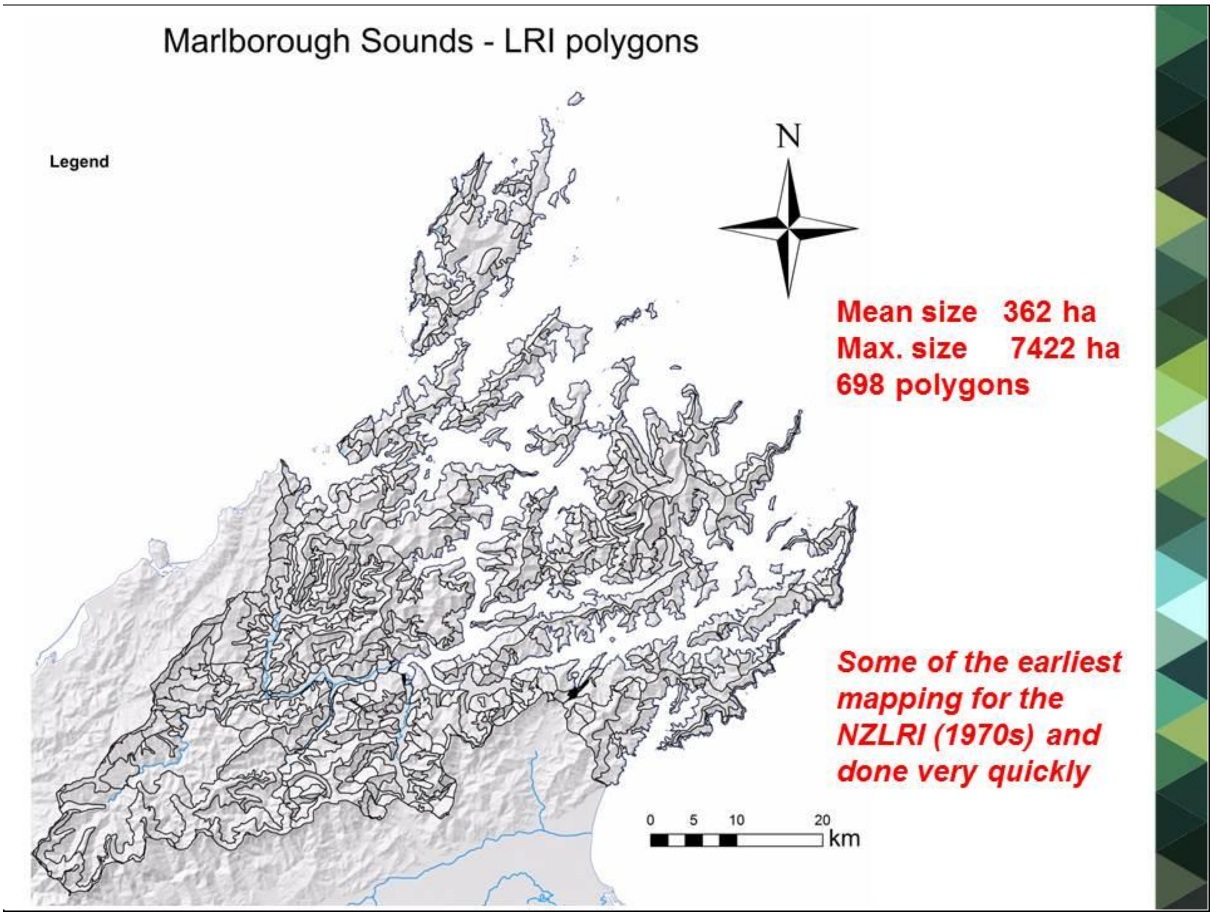
Basher L, Lynn I, Barringer J 2014. Peer review of the process proposed to update the Erosion Susceptibility Classification for the National Environmental Standard for Plantation Forestry. Landcare Research Contract Report LC1877 for Ministry for Primary Industries.

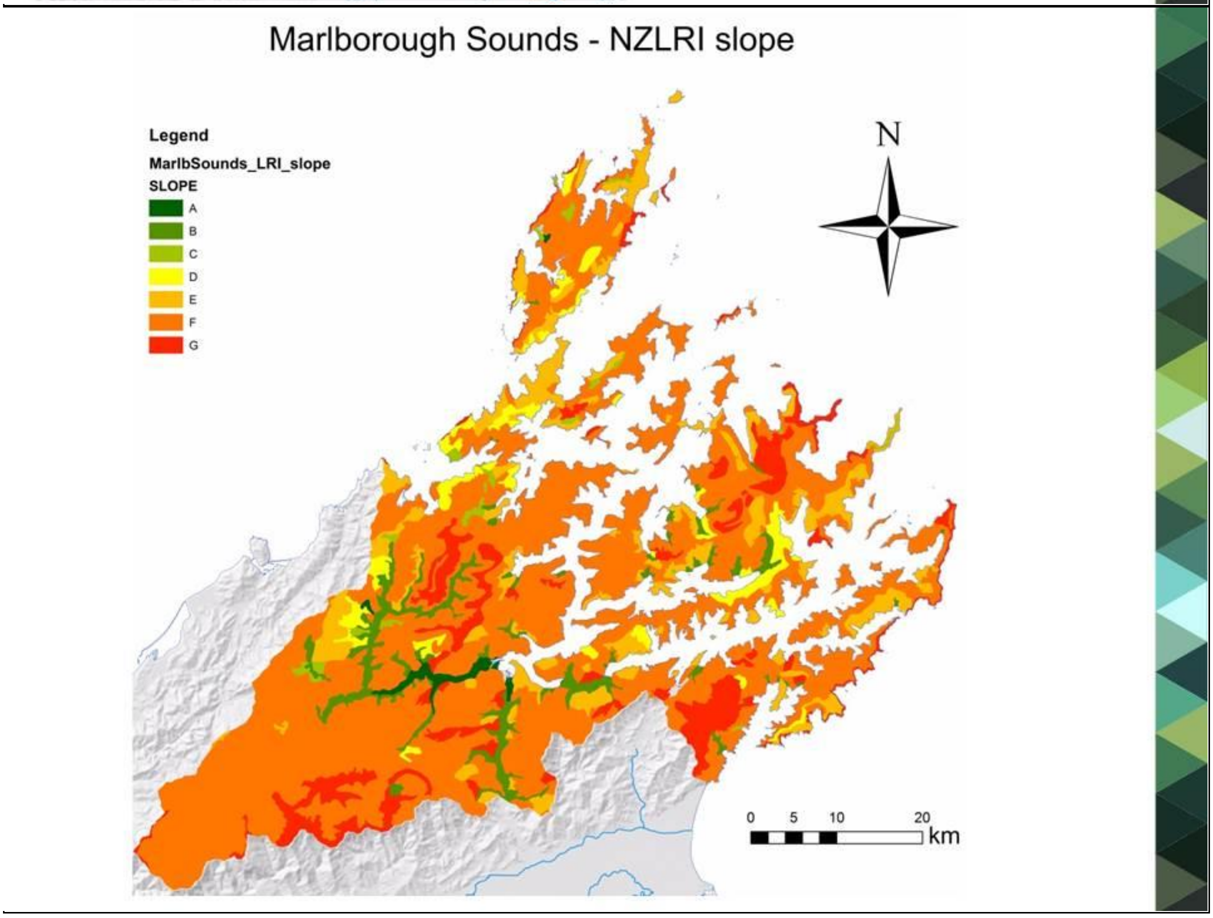
Uhrlich S 2015. Mitigating fine sediment from forestry in coastal waters of the Marlborough Sounds: options for determining plan rules. Technical Report No: 15-009, Marlborough District Council, Blenheim.

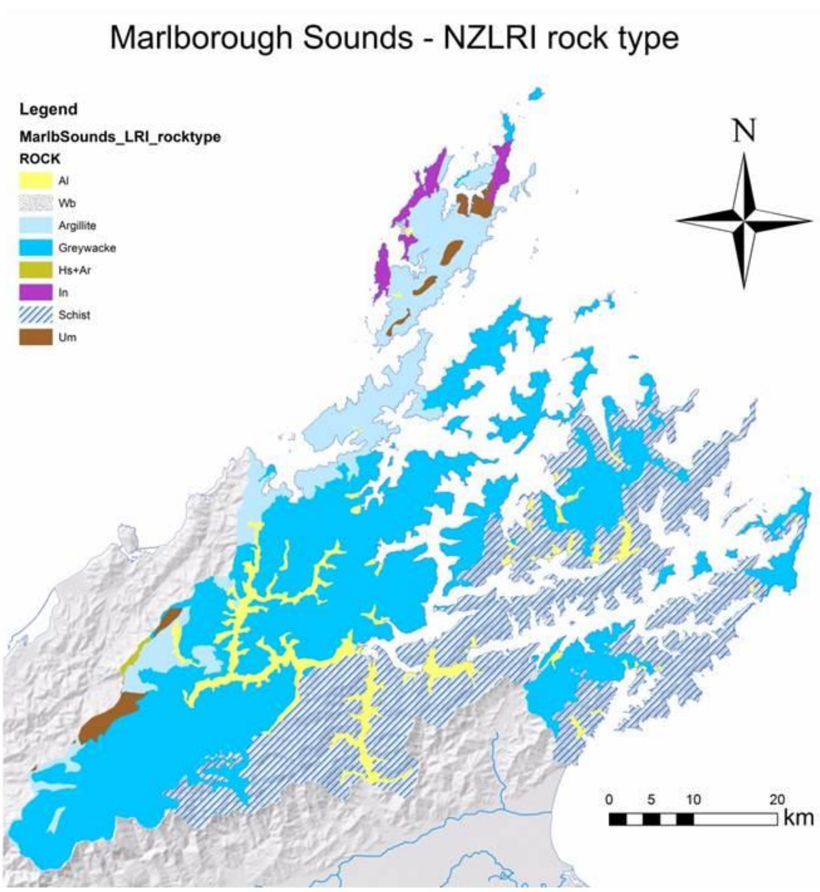
Appendix – Workshop Presentation

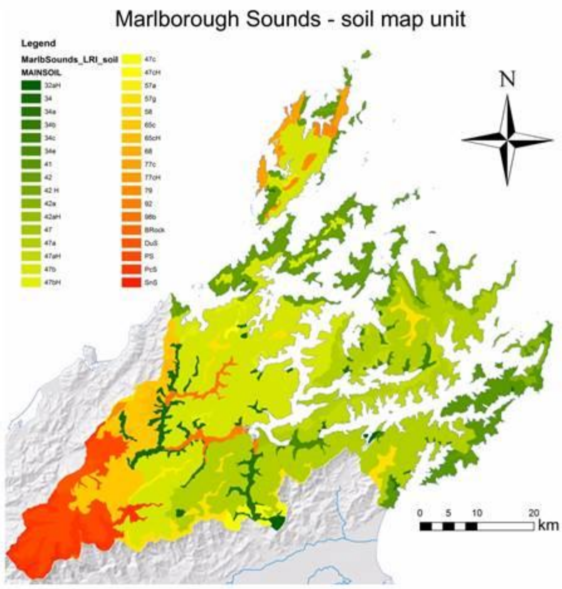


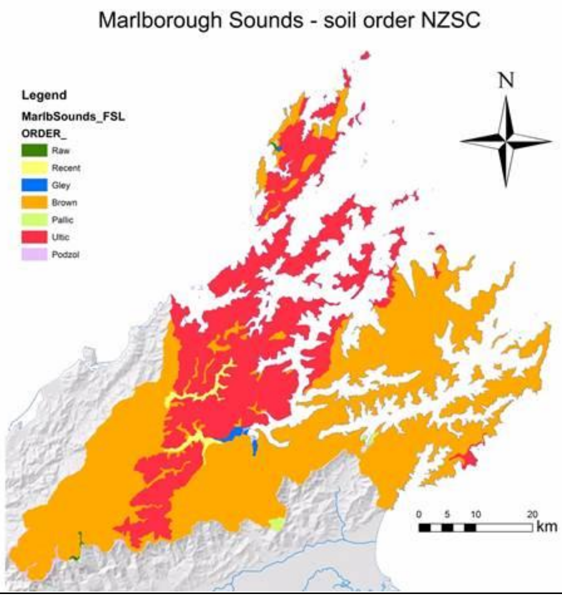



Marlborough Sounds - LRI polygons
Legend
N
Mean size 362 ha
Max. size 7422 ha
698 polygons
Some of the earliest mapping for the NZLRI (1970s) and done very quickly
0 5 10 20 km

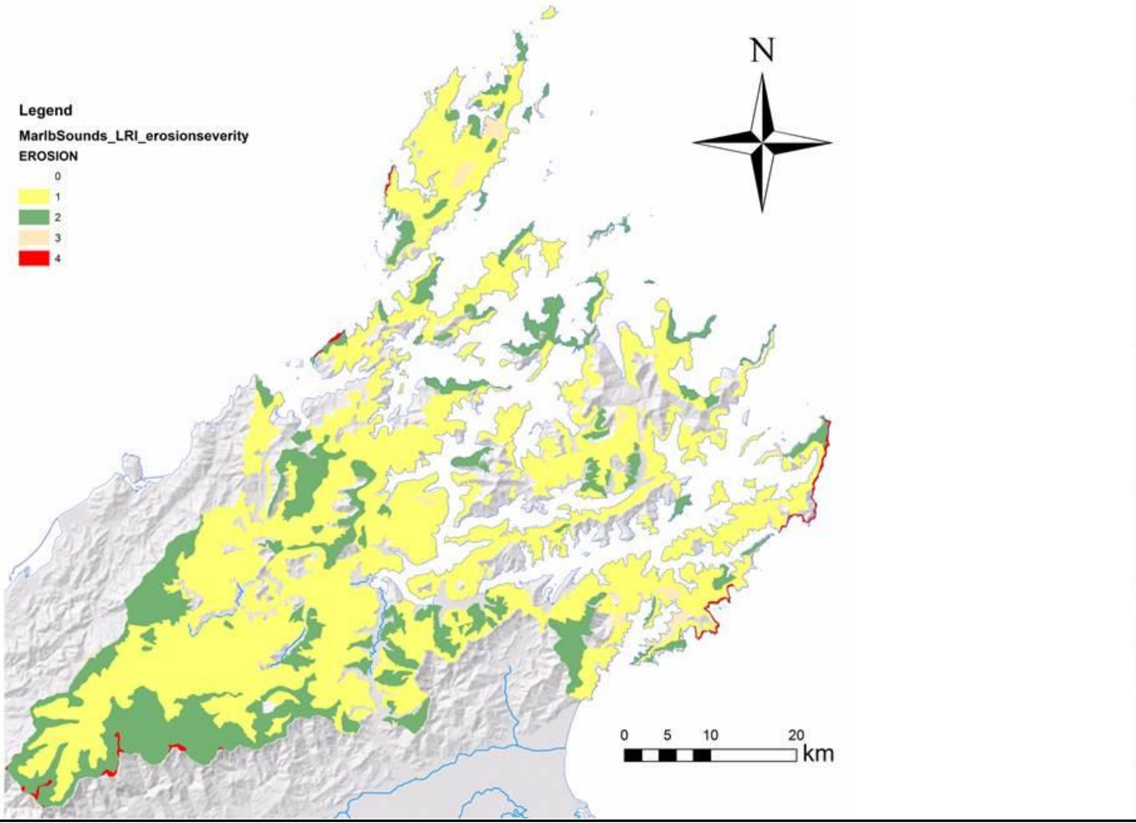

Marlborough Sounds - NZLRI slope
Legend
MarlbSounds_LRI_slope
SLOPE
A
B
C
D
E
F
G
N
0 5 10 20 km


Marlborough Sounds - NZLRI rock type
Legend
MarlbSounds_LRI_rocktype
ROCK
Al
Wb
Argillite
Greywacke
Hs+Ar
In
Schist
Um
N
0 5 10 20
km

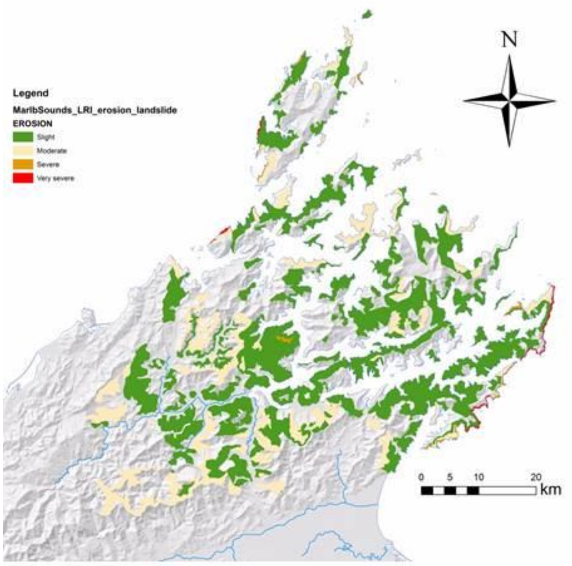

Marlborough Sounds - soil map unit
Legend
MarlbSounds_LRI_soil
MAINSOIL
32aH
34
34a
34b
34c
34e
41
42
42 H
42a
42aH
47
47a
47aH
47b
47bH
47c
47cH
57a
57g
58
65c
65cH
68
77c
77cH
79
92
96b
BRock
DuS
PS
PcS
SnS
N
0 5 10 20
km


Marlborough Sounds - soil order NZSC
Legend
MarlbSounds_FSL
ORDER_
Raw
Recent
Gley
Brown
Pallic
Ultic
Podzol
N
0 5 10 20
km

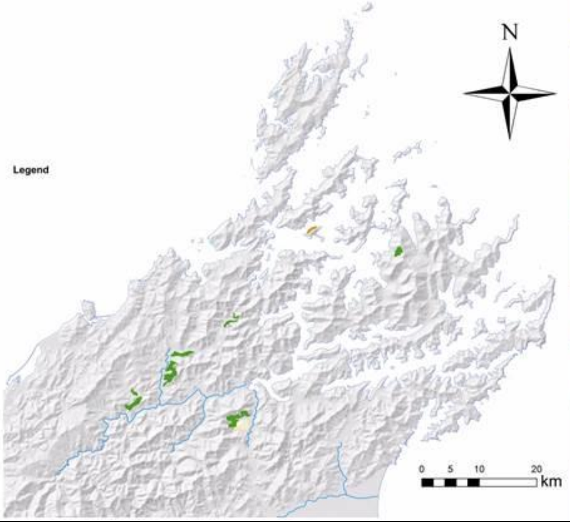
Marlborough Sounds - erosion severity (NZLRI)



Marlborough Sounds - landslide erosion severity (NZLRI)



Marlborough Sounds - gully erosion severity (NZLRI)



NES Erosion Susceptibility Classification (ESC)

- What is it
- How was it derived
- Issues

Options for deriving ESC (2011)

NZLRI

Highly Erodible Land model

NZeem

Erosion terrains

Factor-of-safety analysis (e.g. SINMAP)

Terrain stability analysis

LiDAR

Also intended linkage to freshwater (via FENZ)

Decision made to use NZLRI (*2 weeks work proposed*)

NES Erosion Susceptibility Classification (ESC)

- Derived from potential erosion data (type and severity) in LRI/LUC surveys by Bloomberg et al. (2011)
- 4 classes of susceptibility

Potential erosion severity (PES)	ESC class
0 = negligible	Low
1 = slight	Low
2 = moderate	Moderate
3 = severe	High
4 = very severe	Very high
5 = extreme	Very high

All LUC Class 1 to 5 land was assigned Low ESC;

All Class 8e land was assigned Very High ESC;

All polygons with dual LUC assigned ESC rating of LUC with highest ESC

Potential erosion

- Definition (NWASCO 1979)

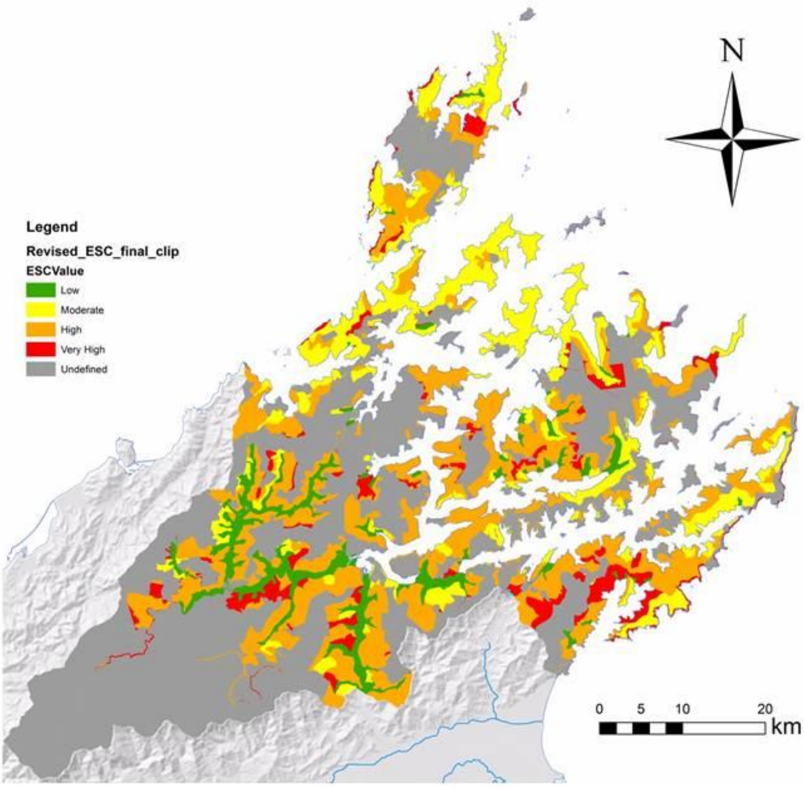
  'the potential erosion under an actual or assumed grassland cover with no soil conservation measures applied'

- No documentation that describes how it was originally determined
- Derived for LUC units post-survey
- Partly based on maximum mapped erosion but also incorporates concepts of past erosion events, frequency of storms, difficulty of repair
- Roughly equates to "inherent susceptibility of land to erode"

ESC only considers mass movement and gully erosion types

LUC unit used to map ESC spatially

Marlborough Sounds - ESC original



Other issues

- In Sth Island only one erosion severity for multiple erosion types

    e.g. 3ShSsG *interpreted as 3Ss*

    c.f. North Island 3Sh2Ss1G

- Dual LUC units

    e.g. 6e22 + 8e3

Widely acknowledged to have issues related to

- *Mapping scale*
- *Misclassification of ESC of some LUC units*

Development of ESC since 2011

- Experimental remapping of 6e24
  - ➢test case using LiDAR and DEMs
  - ➢tricky issue of potential erosion
- Revision of the ESC
- Managing changes to the ESC and incorporating detailed mapping
- Subdivision of “orange” and “red” ESC classes

Remapping 6e24

- Remapping of LUC unit 6e24 (legend 04) based on best available information on
  - ➢ Geology (Qmap)
  - ➢ Soils (S-map)
  - ➢ Slope
    - 15-m contour-based DEM
    - 2-m LiDAR-based DEM
    - classified and mapped using an automated modelling procedure in ArcGIS
  - ➢ Erosion
- Field visit to assess potential erosion
- 1:10,000 scale

Remapping of 6e24

Described as

'flat to rolling dissected slopes on Taupo breccia, occurring frequently as wide infilled valleys. The coarse-textured soils have a low natural fertility and are subject to drought. The dissection of the ephemeral waterways and their potential for severe gully erosion precludes cropping on this unit'

Potential erosion

Extended legend	3G, Sb, 2Sh	
Bulletin	2-3G, Sh, Sb, 2R	**High ESC class**

LRI mapping

133 polygons, mean size 159 ha

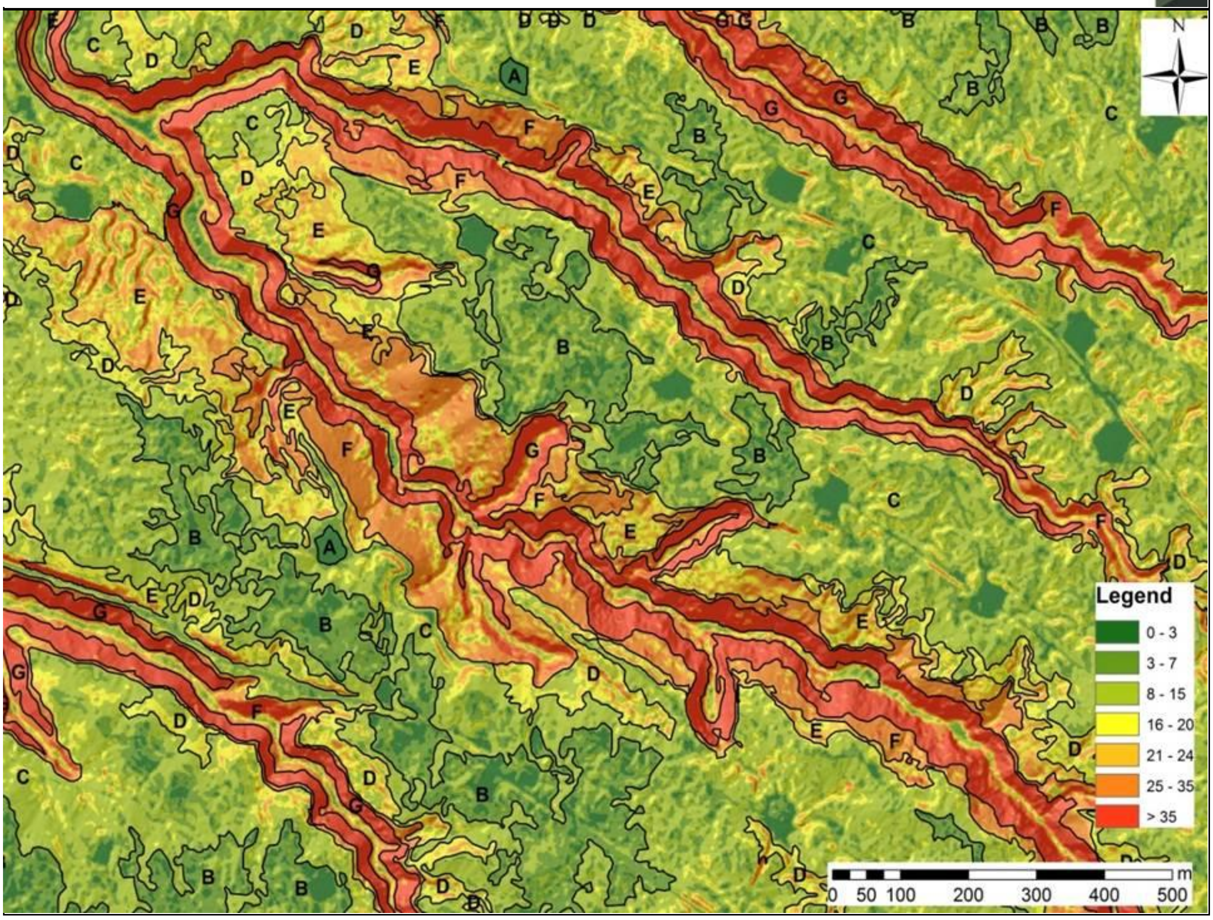
Mostly compound, dissected slope in inventory

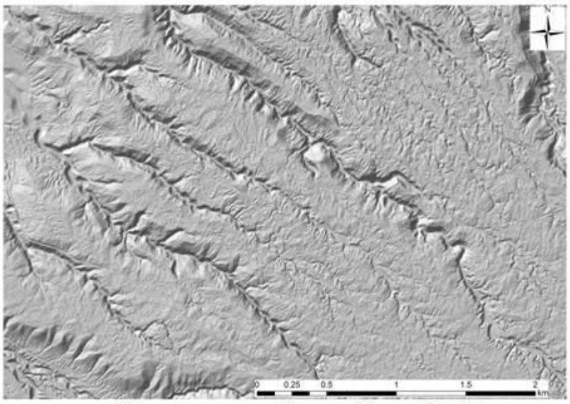
eg. B' + F

Erosion mostly 0, 1G or 2G

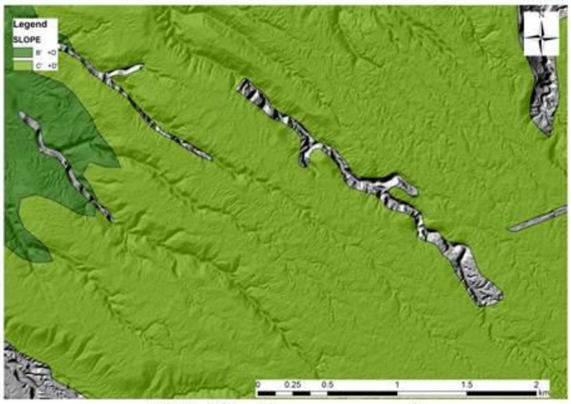
Automated slope mapping 15-m and 2-m DEM

- Raster slope map from DEM
- Filter slope map to simplify (3 cells)
- Convert raster to vector format
- Small polygons (<1000 m^2) merged with larger neighbours
- Smooth and simplify functions to create smooth boundaries
- Eliminate function to merge small areas (<2500 m^2) with larger neighbours
- Zonal statistics to give mean, maximum and minimum slope for polygons from the original slope grid

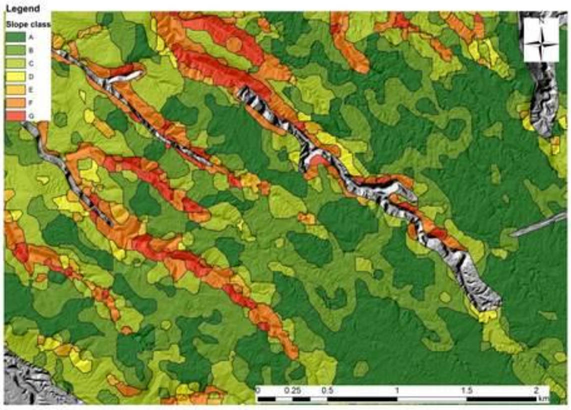




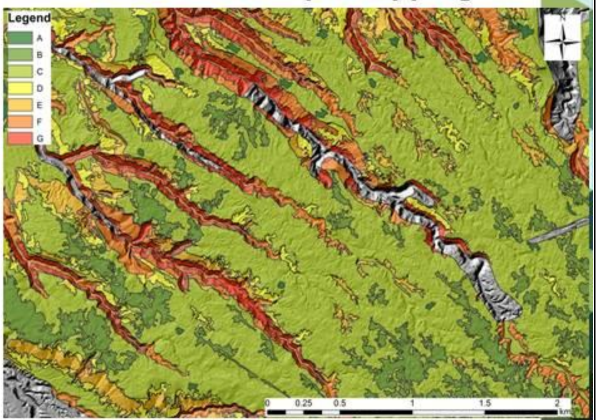
Shade map from 2-m DEM



NZLRI slope mapping



15-m DEM slope mapping



2-m DEM slope mapping

	Whole area slope mapping		Part area slope mapping	
	NZLRI[1]	15-m DEM	15-m DEM	2-m DEM
Number of polygons	133	4499	3002	1755
Mean size (ha)	159.2	4.7	2.34	4.03
Max. size (ha)	3667.2	2939.5	429.9	2562.5
Min. size (ha)	0.3	0.009	0.0004	0.0001

Main results

- Successfully developed an approach to automate slope mapping from DEM
- Assessment of potential erosion still difficult
    - ➢ high soil erodibility BUT
    - ➢ low run off potential (especially under grassland)
- Upgrading other LRI factors (soils and geology) much more difficult
- Suggested more focus on directly assessing potential erosion to assign the correct ESC class (rather than via LUC unit)
- LiDAR not the “silver bullet”

Revision of the ESC (Basher et al. 2015)

The ESC has errors relating to

- ➢ scale
- ➢ misclassification of LUC units

LCR tasked with

1. Identify misclassified (High and Very High) LUC units and reclassify them
    - ➢ Interpretation of PES from NZLRI legends (e.g. 2-3Ss)
    - ➢ Interpretation of PES where only one erosion severity listed for multiple erosion types (e.g. 5ShWG)
2. Design a process by which a party can
    - ➢ apply to have ESC units/polygons reassessed,
    - ➢ create new LUC units and define their ESC class

Reclassification process

- Recompiled and reinterpreted all PES data
- Checked for
  - consistency between mapped erosion and PES
  - consistency between correlated and related LUC units
  - Considered major factors influencing erosion susceptibility (rock type, slope steepness, rainfall)
- Proposed changes to ESC class discussed with regional council and forestry industry staff

Results of reclassification process

- ESC class changed for c.16% of LUC units
- Mostly revision resulted in a lower ESC class
- Major changes for
  - ➢ Sth Island LUC units with single erosion severity for multiple erosion types, mass movement subdominant
  - ➢ reassessed relative erosion susceptibility of different rock types
    - ✓ Tertiary-age soft rocks given higher ESC class than more indurated and typically older rocks (e.g. greywacke)
    - ✓ ESC rating for many greywacke LUC units has decreased.
- The most erosion-prone Sth Island terrain considered less susceptible to erosion than worst North Island terrain

Results of reclassification process

- Where possible a one ESC class difference was maintained between related Class 6, 7, 8 units
- Class 8 LUC units evaluated using same methodology as for Class 6 and 7, rather than → Class 8e land to Very High ESC class
- Sand dune LUC units re-evaluated
- Remaining difficulties
  - subjectivity of the ESC
  - poor definition of the concept and method of assessment of potential erosion
  - broad definition of some LUC units

Subdivision of orange and red

After public notification of revised NES-PF concern about

a) suitability of the ESC

b) whether the level of control of harvesting and earthworks operations on land in the High ESC class was adequate

MPI asked for a

a) more detailed subdivision of the High ESC class (based on dominant erosion process, rock type and topography)

b) consideration of relationship between related LUC units in the High and Very High ESC classes

Methods

Subdivisions of the High and Very High ESC classes derived from "erosion terrain" classification

Erosion terrains regrouped to provide a terrain classification relevant to forestry by amalgamating terrains with

a) similar dominant erosion process

b) rock types with similar erosion susceptibility

c) similar topography

Each LUC unit allocated to a terrain grouping

Recommendations for management of erosion risk made

Results

Four classes of terrain dominated by gully erosion

Two terrains dominated by earthflows

Twelve terrains dominated by landsliding

Three minor terrains

Has been used by MPI to define "light orange" and "dark orange" ESC classes

dark orange ≡ red

Gully erosion terrains

- terraces and fans on young flow and water sorted Taupo tephra

  LUC units in both the High and Very High ESC classes

- hill country and hilly steeplands developed on crushed argillite with large-scale gully erosion

  LUC units mostly in Very High ESC class, some in High ESC class

- upland plains and plateaux with tephra cover
- hill country with young, deep tephra

  All LUC units in the High ESC class

Earthflow terrains

Hill country on crushed argillite, Tertiary-aged mudstone and sandstone with moderate earthflow erosion.

All LUC units in the High ESC class

Hill country developed on crushed argillite, mudstone, and greywacke with severe earthflow erosion

LUC units in both the High and Very High ESC classes

Landslide terrains

Split according to topography and rock type

1) Hill country (mostly slopes <25°), 5 terrains on

- weak Tertiary mudstone
- weak Tertiary sandstone
- hard sedimentary rock
- weathered volcanic rocks
- young and old tephra and volcanic rocks

All LUC units in the High ESC class

2) Hilly steeplands (mostly slopes >25°), 7 terrains on

- non-cohesive sands and gravels
- weak Tertiary mudstone
- other weak Tertiary rocks
- weathered volcanic rocks
- young and old tephra
- old tephra and volcanic rocks
- hard sedimentary, igneous and metamorphic rocks

LUC units in both the High and Very High ESC classes

Minor terrains

Steep to very steep slopes in deep loess

highly susceptible to tunnel gully erosion

High ESC class

Floodplains

very active bank erosion and deposition

High and Very High ESC classes

Foredunes

severe wind erosion risk

Very High ESC class

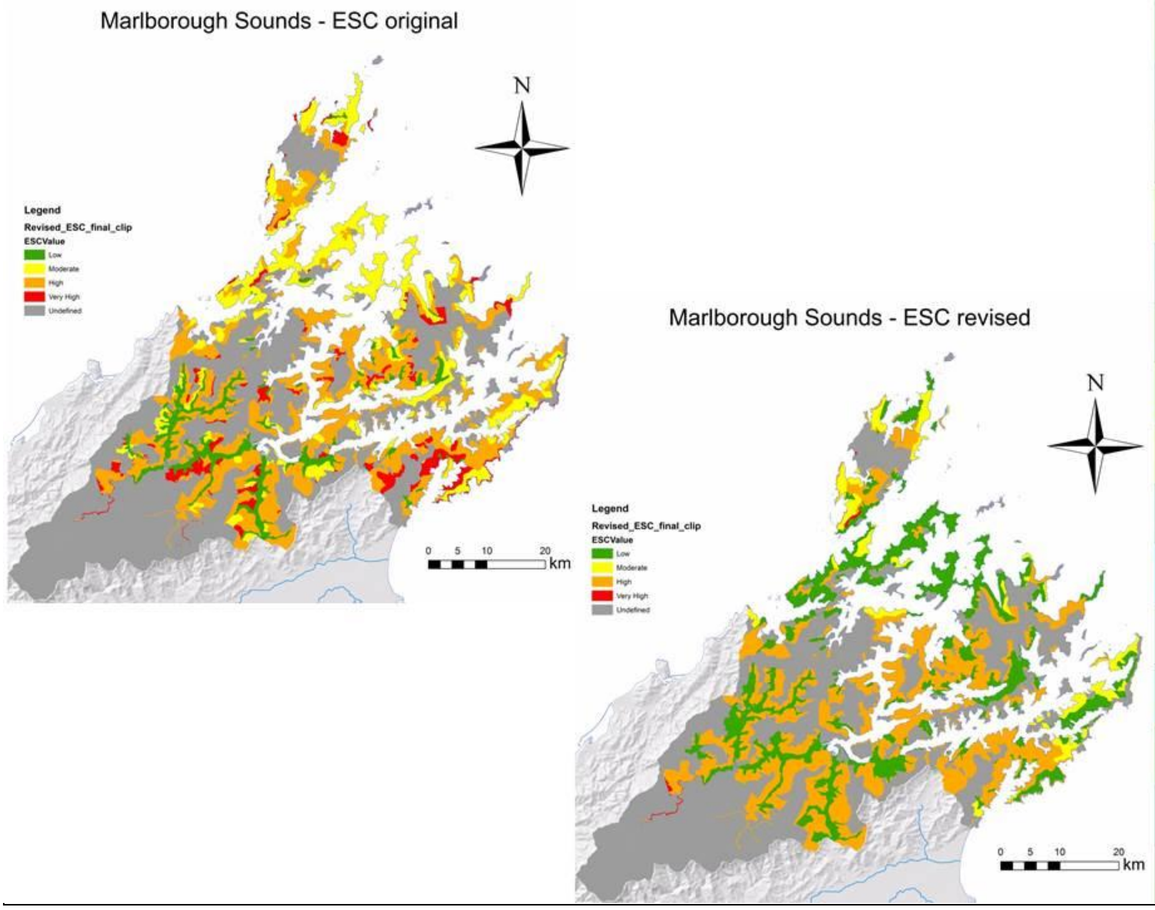
Changes to ESC in Marlborough

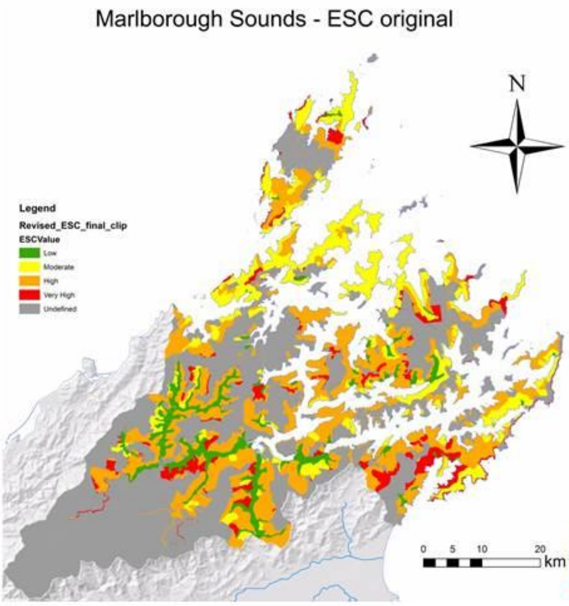
Moderate → Low 6e11, 6e21

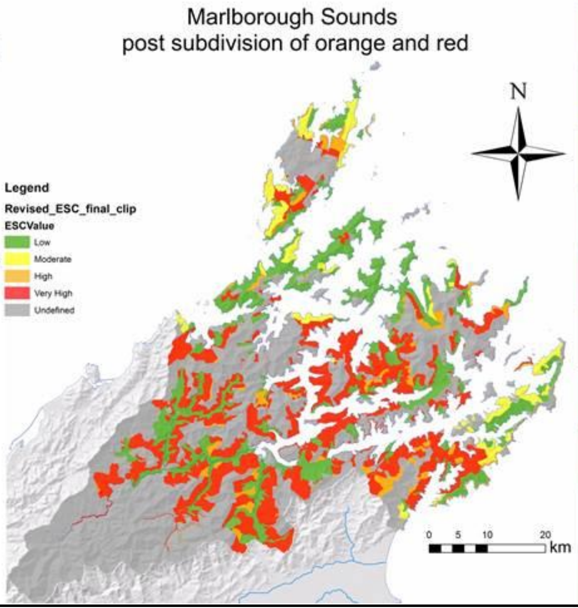
High → Moderate 7e3

Very High → High 8e2, 8e8

(all from Sth Island extended legend)







Managing changes to the ESC and incorporating detailed mapping (Basher et al. 2015)

Currently no process to update or refine ESC despite acknowledgement of likely widespread errors due to scale and misclassification

Outcome

1. A process for managing changes in ESC class related to scale or misclassification errors
2. Maintenance of national consistency for ESC
3. Identification of key "players"

Errors in the ESC

Scale

- interpreting regional scale information at forestry operational scale
- line placement

Misclassification of ESC class

Due to errors in

- inventory
- boundary placement
- LUC
- potential erosion

Scale errors

- Scale errors likely to be common
  - Mapping/digitising errors
  - Dual LUC units
  - Single erosion severity
- <u>Solution</u>
  - Remap at detailed scale
  - Apply existing LUC units, assess need for new LUC units
  - Likely to be a need for new LUC units

Misclassification of ESC class

- potential erosion wrong for individual LUC units

e.g. Nelson	7e11 on stable Moutere gravels (2-3ShSsG)	High
	7e25 on highly erodible SPG (3ShSs)	High

- single erosion severity for multiple erosion types (mass movement sub-dominant)

e.g. SIHC 7e23 (3-4ShScSsDaW) Very High

- Solution: change ESC by considering
  - ➢ maximum present mass movement erosion
  - ➢ evidence of past mass movement
  - ➢ frequency and magnitude of erosion events
  - ➢ interpretation of susceptibility of rock, regolith, soils, and landforms
  - ➢ consistency in rankings of related LUC units and definition of PE
  - ➢ historical experience with managing the terrain of that LUC unit and its current resource consent status

Results

- Scale errors inevitable and likely to be widespread
- Misclassification corrected as far as possible
- Likely to be a need for new LUC units
- Need for a 'gatekeeper' of changes

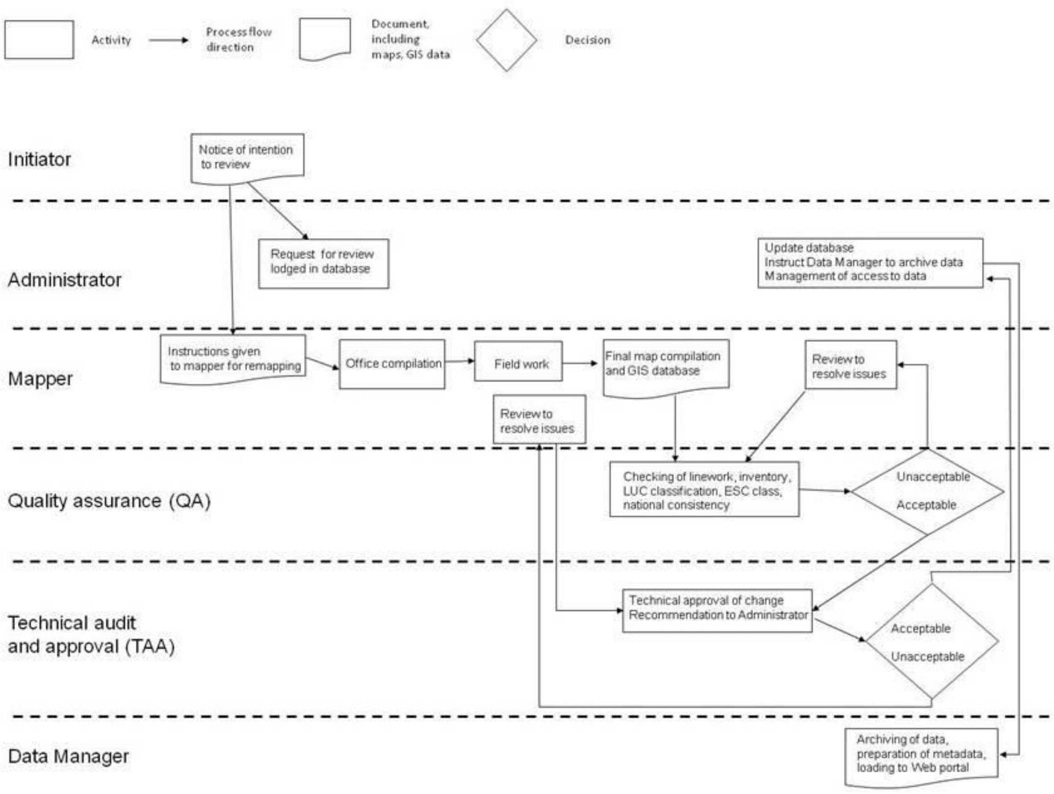
  - Will be needed for national consistency

- Needs to be more focus on directly assessing potential erosion/ESC

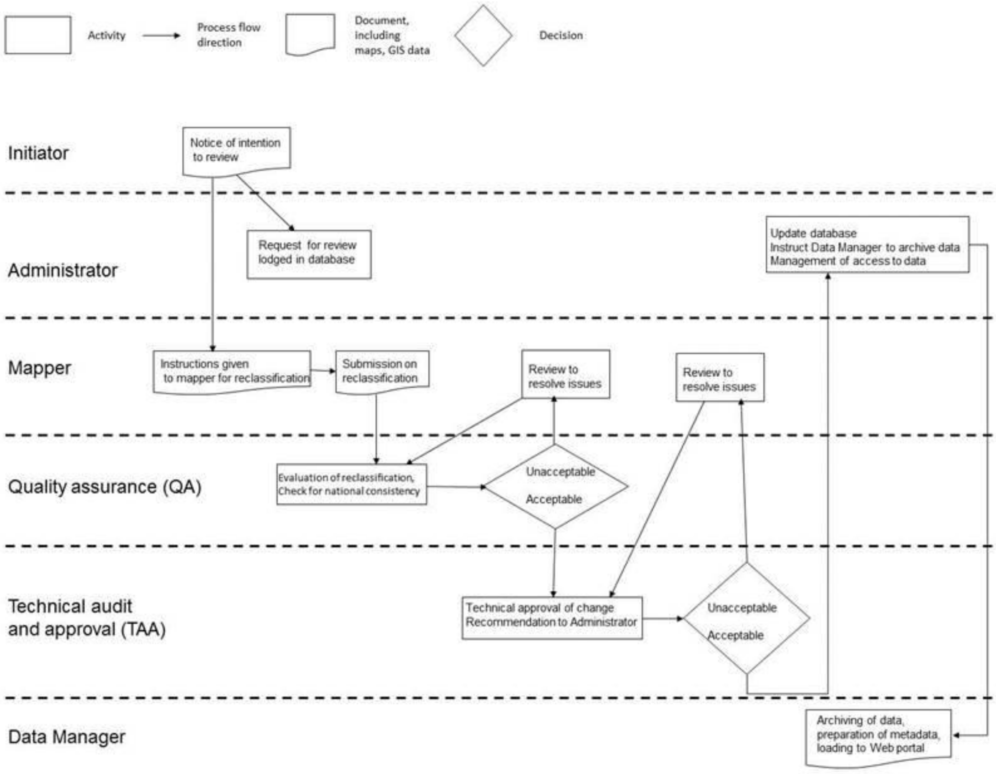
Process for managing changes

Title	Role	Possible agency
Initiator	Requests change	Forestry company/owner, landowners, RCs, central government (MPI, MfE)
Administrator	Agency responsible for NES-PF, manages process and archives results	MPI
Mapper	Provide detailed technical input for ESC corrections	Accredited mappers
Quality Assurance (QA)	Review information from Mapper, recommending approval to TAA	LCR, regional council or central government agency
Technical Audit and Approval (TAA)	Provide independent oversight of changes to LUC mapping and ESC class	TAG of LUCCS Governance Group
Data Manager	Archive all new mapping and classification data, delivery via Web portal	LCR, central government agency

Managing changes to ESC mapping



Managing changes to ESC class for LUC units



Experimental upgrading of the NZLRI in Northland

Goal

- use modern technology to upgrade the NZLRI/LUC for part of Northland
- assemble data as single factor layers and merge to "LRI-type" product
- farm scale (nominally 1:10,000)
- detailed, high resolution land resource dataset for a wide range of land management and land use planning purposes

Comparison of modern approach with traditional approach

Modern methods and data sources

LiDAR → DEM → slope map

Rock type – radiometrics + ??

Soils - Digital Soil Mapping, S-map conventions

Erosion – mapping, erosion susceptibility classification

Vegetation – LCDB4, LiDAR

LUC – better description of LUC units and class boundaries

BUT \$500,000 for 100 km²

Remapping Marlborough Sounds: available resource data

Geology – Qmap + NZLRI

Soils - soil landscape model

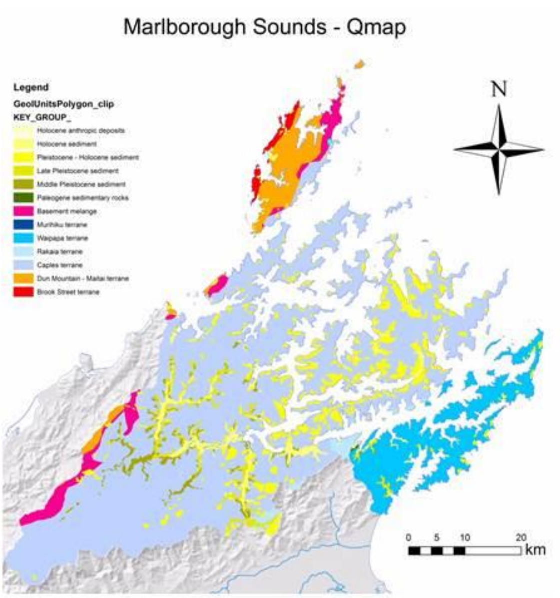
Slope - DEM

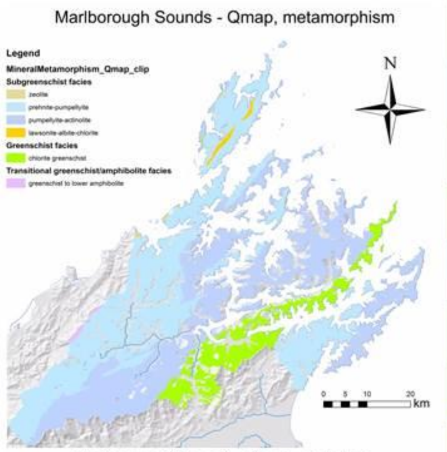
Vegetation - LCDB

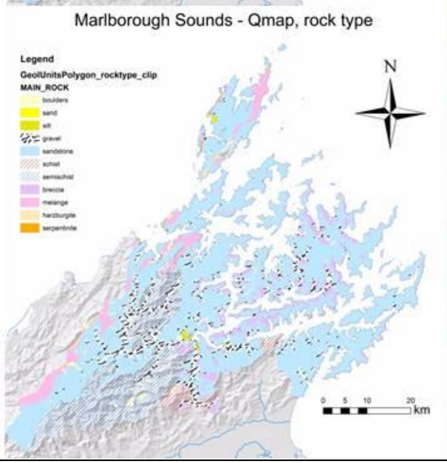
Erosion?

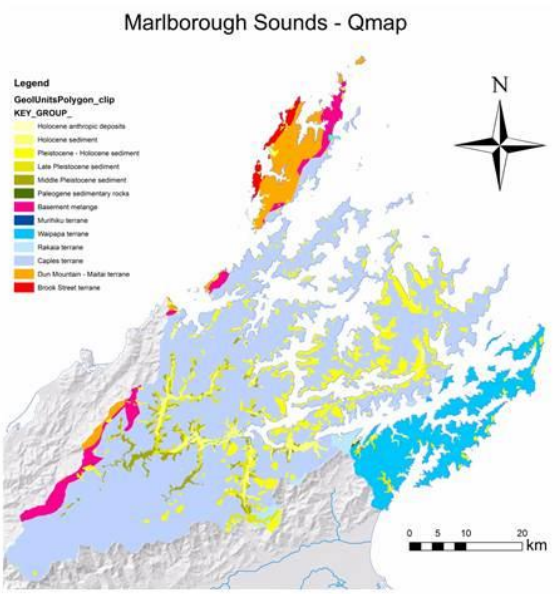
2nd edition LRI legend

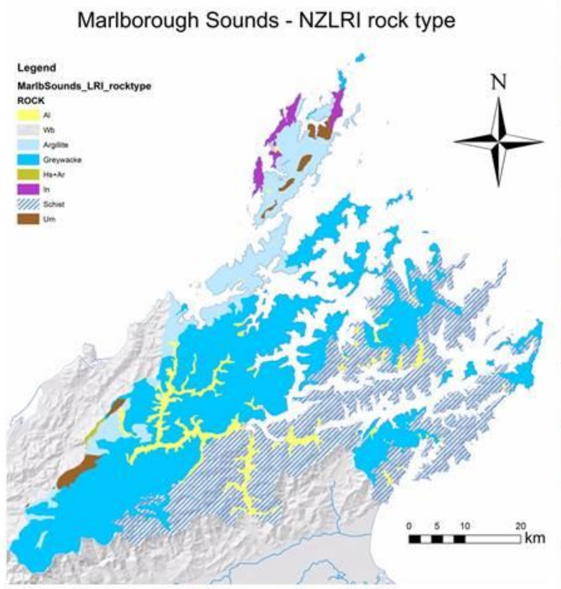
Translation to ESC











Soils

Soils of Marlborough Sounds (Laffan et al. 1987), includes map

Soils described /mapped at 1:1 000 000

19 soil-physiographic units (topography, climate, parent materials, drainage)

Hard copy map

Marlborough Sounds LRI (Marlborough Catchment Board 1987)

1:25,000 scale

16 hard copy maps (rock type, soils, slope, erosion, vegetation, LUC

Draft LUC extended legend (34 units)

Potential erosion rarely included in extended legend

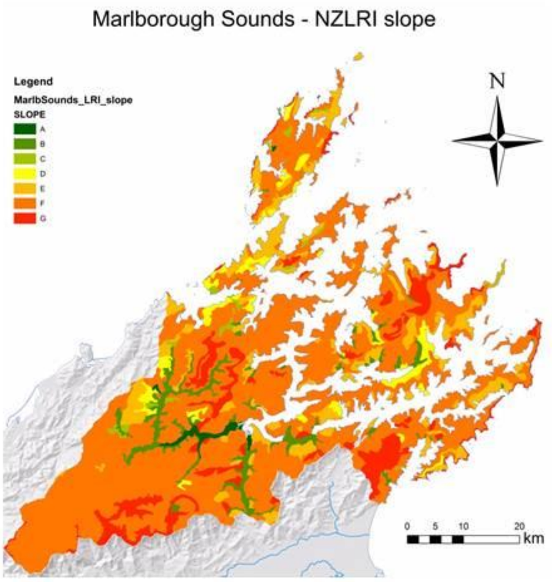
Does Council have this electronically?

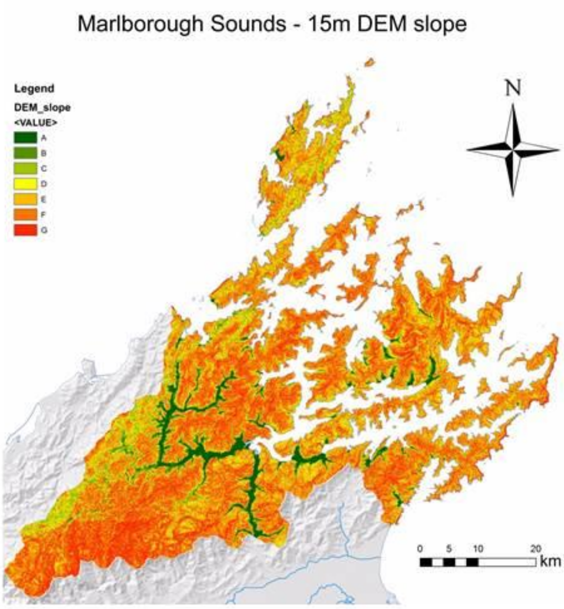
Papers incl. soils of Maud Island, Stephens Island, soil-vegetation relationships in Marlborough Sounds, relationship between podzolised soils and landform/slope/altitude

Enough data to derive a first attempt at soil-landscape models?

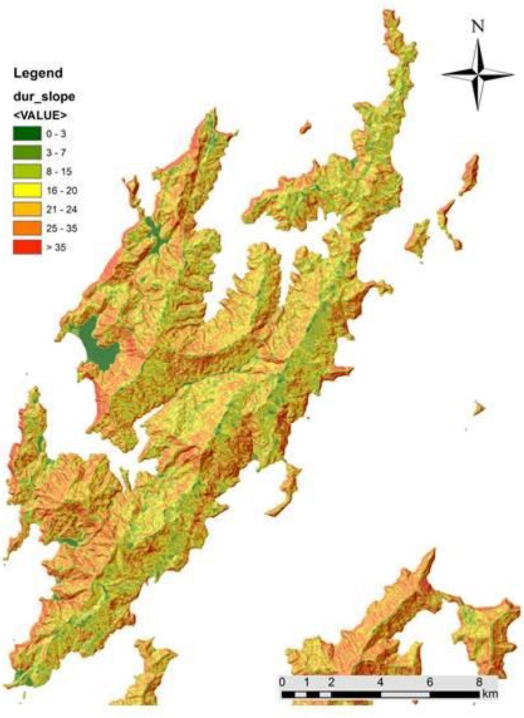
Getting distribution of highly weathered soils/regolith critical

Slope

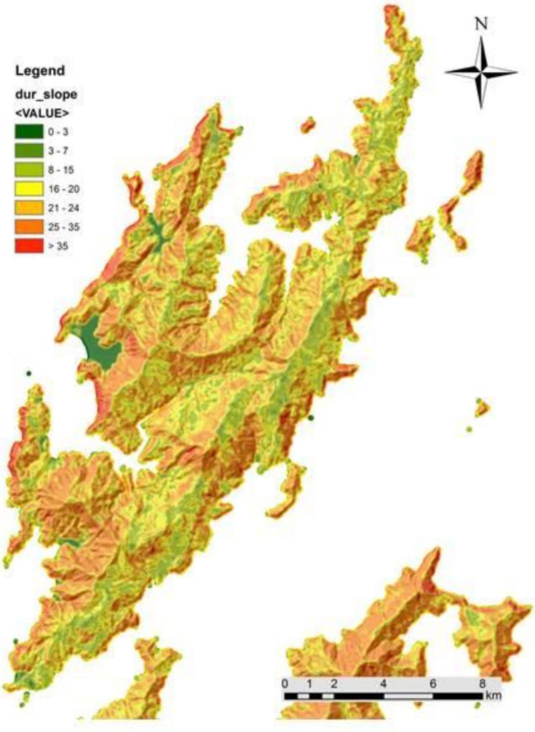




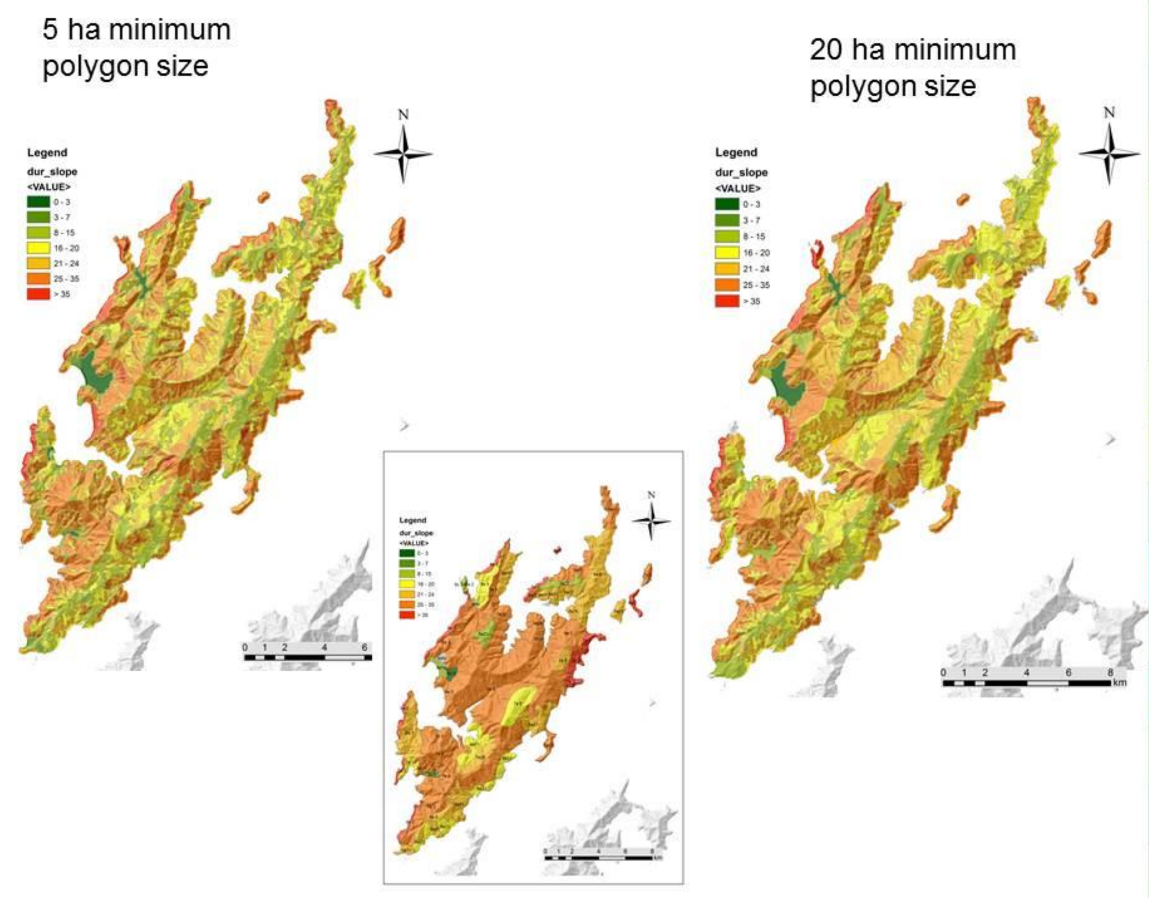
D'urville Island example



DEM slope



DEM mean slope



Erosion

Traditional style of mapping from orthophotos

0.4 m, 2011-12

No simple way of mapping erosion

Erosion susceptibility?

Vegetation

LCDB4

LRI/LUC

2nd edition Marlborough LUC extended legend includes Marlborough Sounds LUC units

But designed for 1:50,000 scale application so will probably need modification at more detailed scale

Marlborough Catchment Board - Marlborough Sounds Land Resource Survey 1987?

Sixteen map sheets, 1:25 000 scale

Draft extended legend

Not in electronic form?

Field component

Distribution of highly weathered regolith and soils

Rock type checking

Erosion

What scale?

ESC

Follow previous approach based on LUC/potential erosion

Define erosion susceptibility directly