Manaaki Whenua
Landcare Research

MANAAKI WHENUA – LANDCARE RESEARCH

Improving land characterisation with LiDAR

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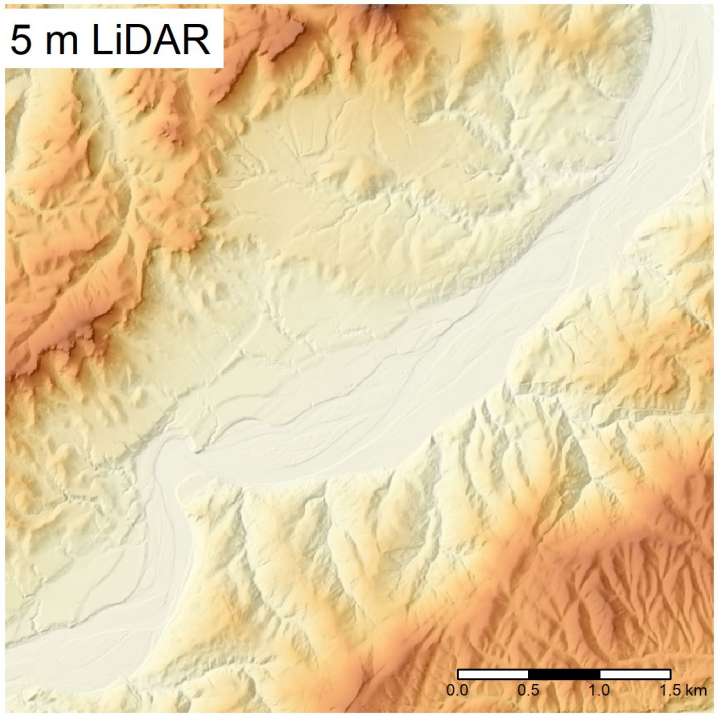
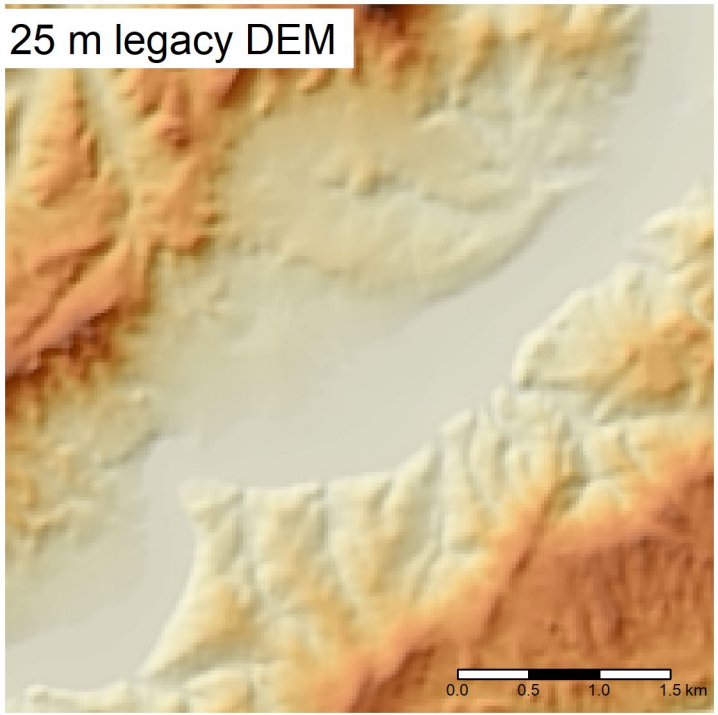
Land characterisation

- Many topographic parameters can be derived from a digital elevation model (DEM)
  - Slope, aspect, curvatures, exposure indices, hydrological parameters, landforms, …
- Geometrically, slope is one of the most important topographic parameters
  - First derivative of elevation
- Slope has an importance influence on many landscape processes
  - Effect on velocity of water
  - Rate of infiltration of water and soil water content
  - Erosion potential
  - Expression of aspect-related effects on microclimate

LiDAR for terrain analysis





Applications of slope

- Use in land use capability (LUC) assessment
- Use in Intensive Winter Grazing (IWG) rules

Applications: Land Use Capability

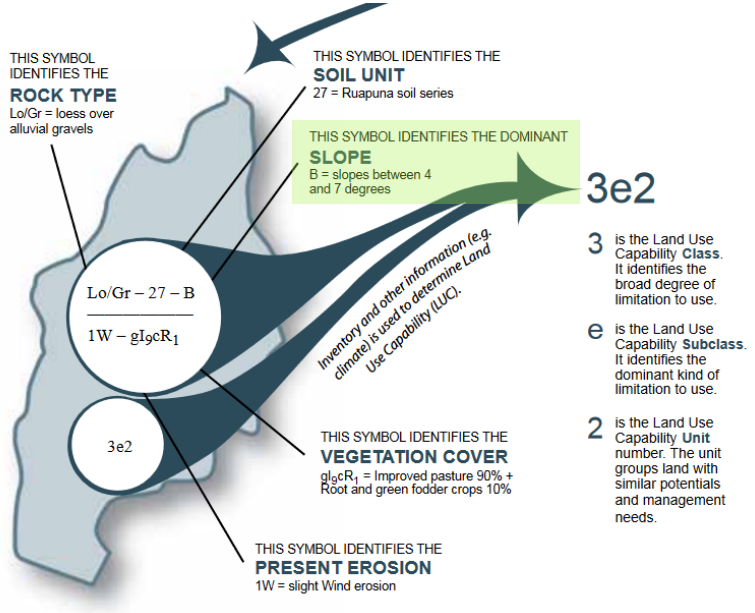
2. INVENTORY OF PHYSICAL FACTORS

An understanding of the physical nature of the landscape is a requirement for sustainable land use and water management. However, no single parameter can be used in isolation to adequately describe the limitations and potentials of land.

The LUC system uses Land Resource Inventory (LRI) as a basis for assessing a minimum of five primary physical factors considered to be critical for long-term sustainable land use. The five factors include:

1. Rock type
2. Soil
3. Slope angle
4. Erosion type and severity
5. Vegetation cover

These physical factors vary in their relative importance in different areas, but all have some influence, either individually or in combination, on long-term land use potential. By using these factors, together with an understanding of the climate and the experience gained from past land use, the capability of the land for permanent and sustained production can be assessed.



Lynn IH, Manderson AK, Page MJ, Harmsworth GR, Eyles GO, Douglas GB, Mackay AD, Newsome PJF. 2021. **Land use capability survey handbook: A New Zealand handbook for the classification of land 3rd ed.** (revised and reprinted). Hamilton, New Zealand: AgResearch Ltd.

Applications: Intensive Winter Grazing rules

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Consideration 1: Slope

Slope is a key vulnerability. Research shows that it is difficult to manage adverse effects to freshwater when IWG activity is on slopes greater than 10 degrees. Steeper slopes, particularly over greater distances, increase erosive energy and erodibility of exposed soil. This increases the speed of overland flow pathways which impacts contamination risks for P, sediment and E.coli losses from your winter forage crops.[3]

Table 1: The NES-F permitted activity conditions:

NES-F Permitted Activity conditions Resource consent or certified freshwater farm plan (when available in your region) will be required if you can't comply with all permitted activity conditions	**Comply? Yes/no**
1. The area of the farm that is used for IWG **must be no greater than 50 hectares or 10 percent of the area of the farm**, whichever is greater.	
2. The slope of any land under an annual forage crop that is used for intensive winter **grazing must be 10 degrees or less**, determined by measuring the slope over any 20 m distance of the land	
3. Livestock must be kept at least **5 metres away from the bed of any river, lake, wetland or drain**, regardless of whether there is any water in it at the time.	
4. Between 1 May and 30 September of any year, in relation to any critical source area that is within, or adjacent to, any area of land that is used for intensive winter grazing on a farm,— (i) the critical source area **must not be grazed**; and (ii) **vegetation must be maintained as ground cover** over all of the critical source area; and (iii) maintaining that vegetation **must not include any cultivation or harvesting** of annual forage crops.	

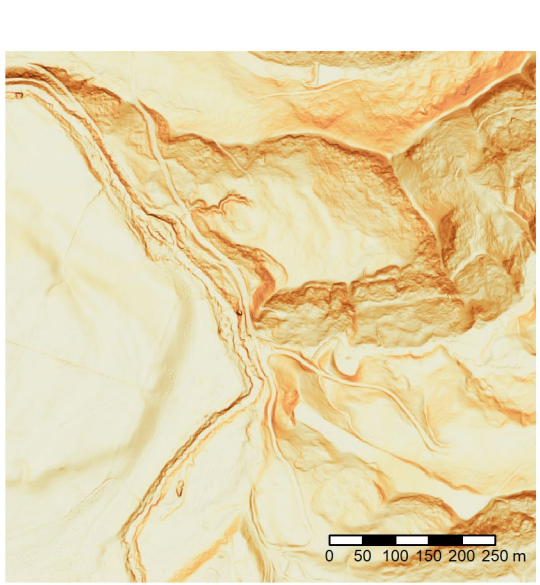
Ministry for Primary Industries, Ministry for the Environment. 2022. **Intensive Winter Grazing Module.** Wellington, New Zealand: Ministry for Primary Industries.

How do we compute slope?

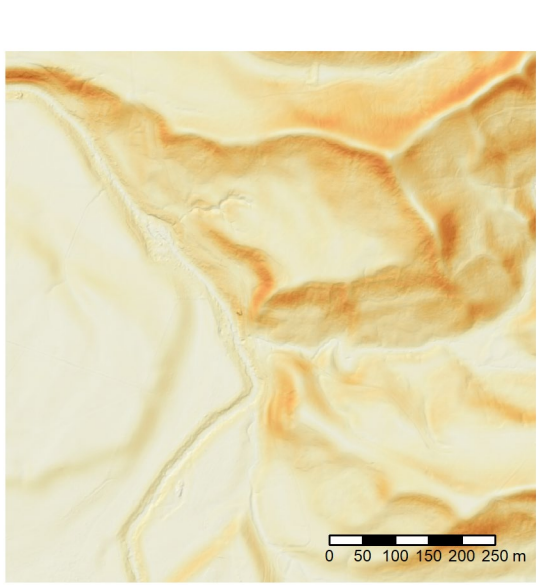
- Two DEMs: 1 m and 5 m resolution
- Slope in degrees
- Conventional moving window approach
- We chose to use the following moving window sizes:
  - 21×21 cells (1 m DEM)
  - 5×5 cells (5 m DEM)
- These moving windows enable our best estimate of the slope required for implementation of the IWG rules (20 m×20 m footprint; “20 m distance of land”)

- (Not the same as resampling the DEM to 20 m resolution and deriving slope from it)

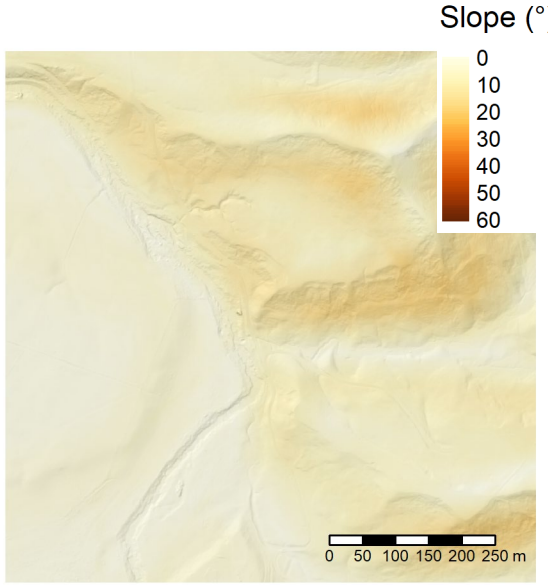
Moving window smoothing effect



3×3 cells (2 m×2 m)



21×21 cells (20 m×20 m)



101×101 cells (100 m×100 m)

LUC slope classes

Table 6: Slope groupings.

Slope Group	Slope angle (degrees)	Description	Typical examples
A	0–3°	Flat to gently undulating	Flats, terraces
B	4–7°	Undulating	Terraces, fans
C	8–15°	Rolling	Downlands, fans
D	16–20°	Strongly rolling	Downlands, hill country
E	21–25°	Moderately steep	Hill country
F	26–35°	Steep	Hill country and steeplands
G	>35°	Very steep	Steeplands, cliffs

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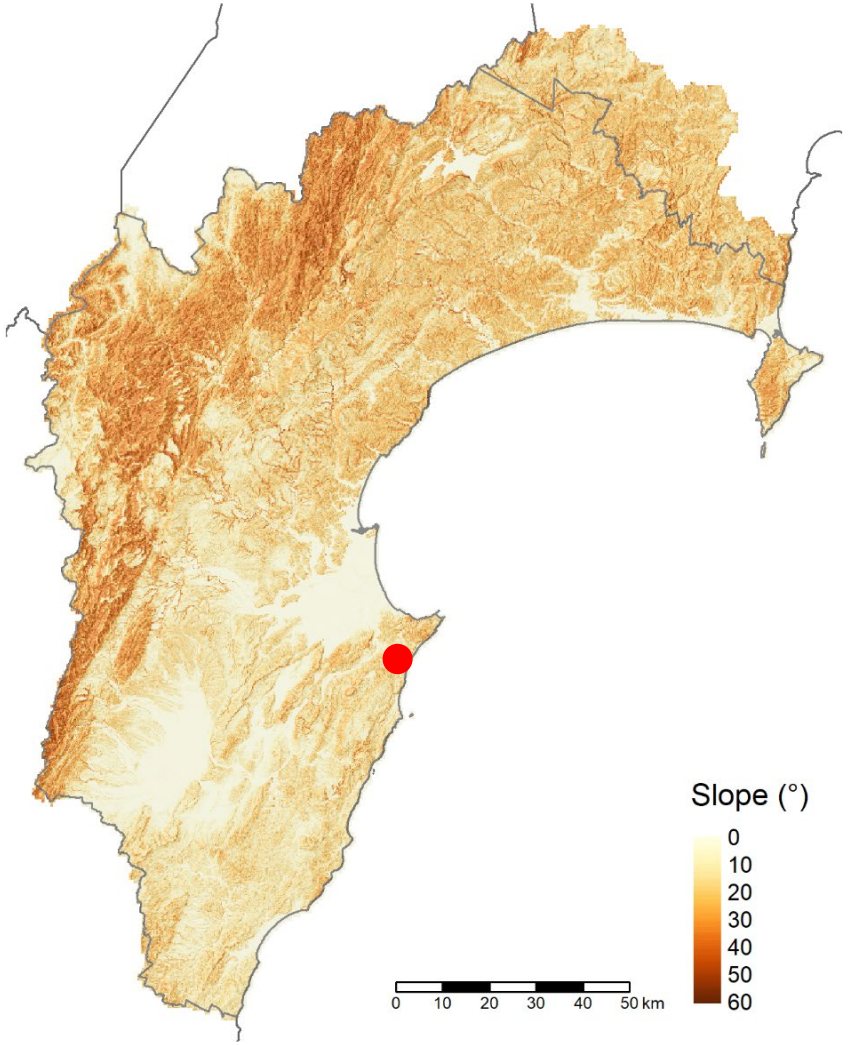
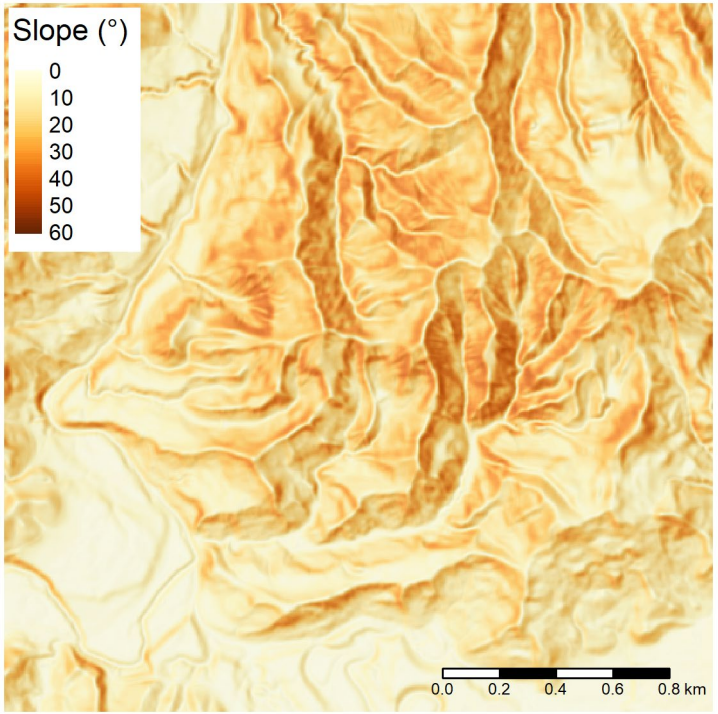
IWG slope classes

Slope class	Slope angle
Grazeable	0–≤10°
Not grazeable	>10°

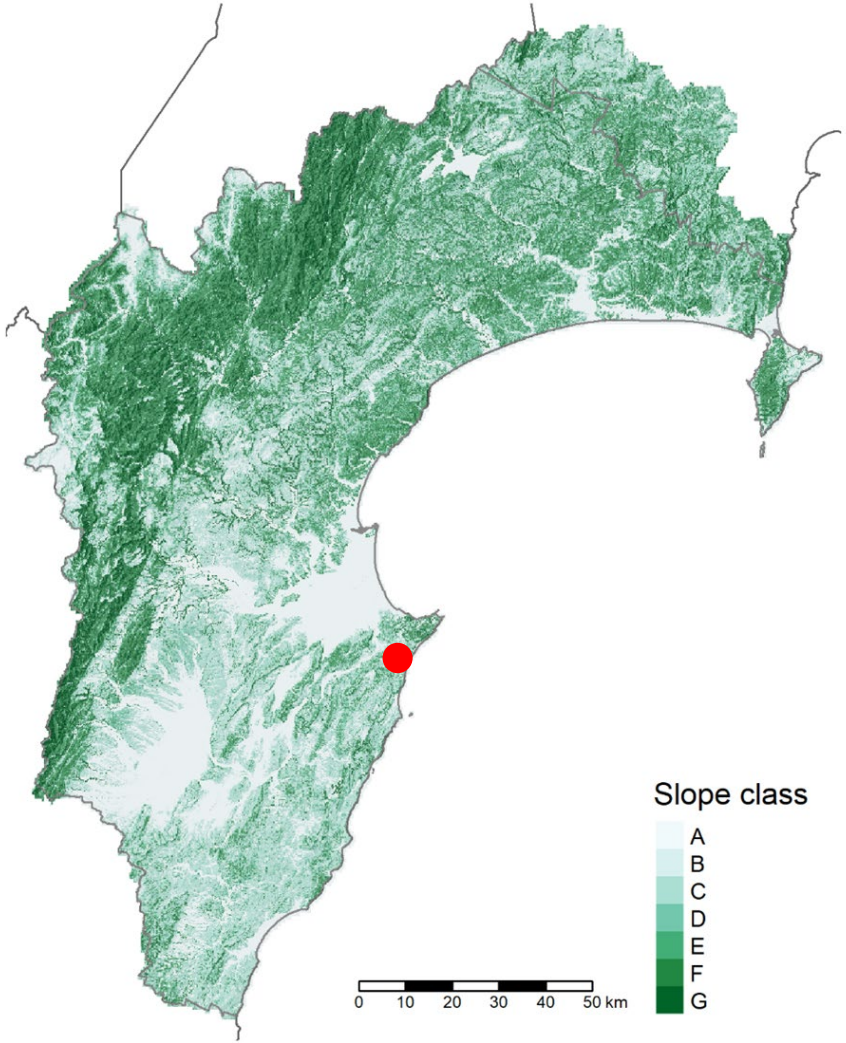
Ministry for Primary Industries, Ministry for the Environment. 2022. **Intensive Winter Grazing Module.** Wellington, New Zealand: Ministry for Primary Industries.

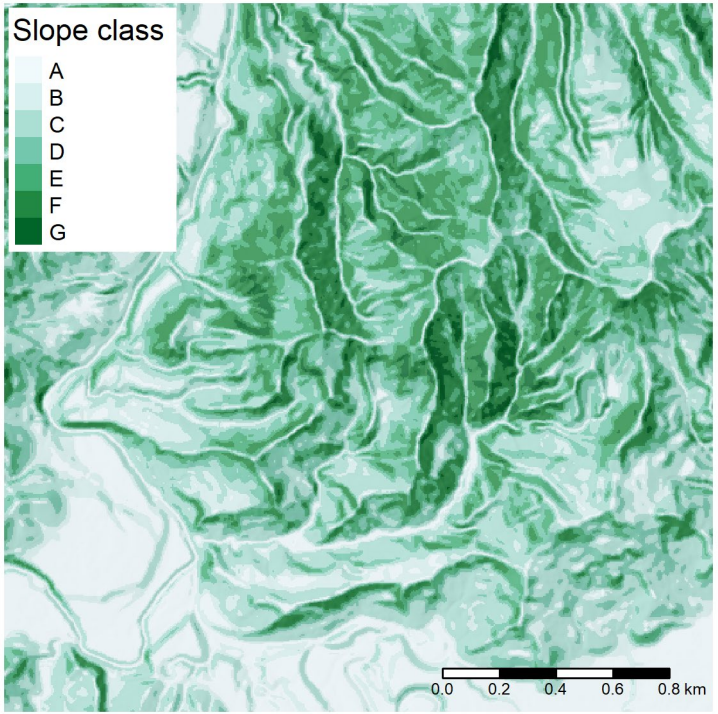
Results: slope gradient



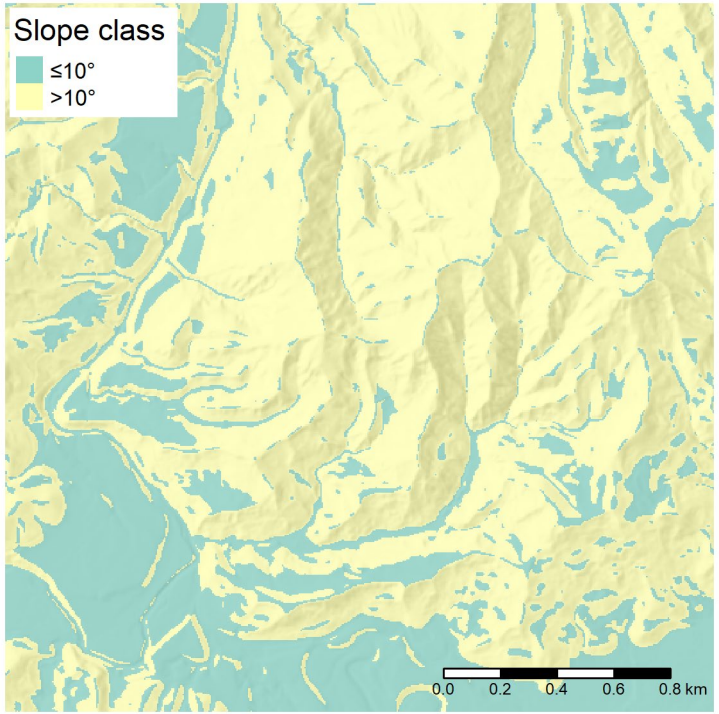


Results: LUC slope classes





Results: IWG slope classes



Results

- Three sets of slope maps at two grid resolutions
- Starting point for use in a range of applications
  - Further analysis, interpretation or context may be required to inform use