



Update of the Erosion Susceptibility Classification (ESC) for the proposed NES for Plantation Forestry – subdividing the High and Very High ESC classes

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Executive Summary

Project and client

The Ministry for Primary Industries (MPI) is leading a process to deliver a National Environmental Standard for Plantation Forestry (NES-PF). The Erosion Susceptibility Classification (ESC) is a critical input into the proposed NES-PF as it underpins the level of resource consent control for different plantation forestry activities. Public submissions on the proposed NES-PF raised concerns about the suitability of the ESC and whether the level of control of harvesting and earthworks operations on land in the High ESC class was adequate. As a result, MPI asked Landcare Research to provide a more detailed subdivision of the High ESC class based on dominant erosion process, rock type and topography, and detail the relationship between related LUC units classed in the High and Very High ESC classes.

Objectives

- Refine the ESC so that it can be used to assess erosion risk associated with plantation forestry activities in the High and Very High ESC classes with more accuracy.
- Provide descriptions of the revised classes within the High and Very High ESC classes and the erosion risk for different forestry activities, so that appropriate controls and conditions can be applied through the NES-PF to manage the effects of these activities.

Methods

Subdivisions of the High and Very High ESC classes were derived from an existing “erosion terrain” classification. The revised ESC dataset was joined to the erosion terrain data (using the LegLUC field to implement the attribute join in ArcMap). The erosion terrains present in the High and Very High ESC classes were then extracted from this dataset and a pivot table used to identify which erosion terrains were present in the High and Very High ESC classes. Because the erosion terrain classification provides a very detailed subdivision of the New Zealand landscape with respect to rock type and topography they were regrouped to amalgamate terrains with similar dominant erosion process, rock types with similar erosion susceptibility, and similar topography, to provide a terrain classification relevant to forestry.

Results

Erosion terrains in the High and Very High ESC classes were grouped by dominant erosion process to identify 6 major groupings – gullying, earthflows, landsliding, tunnel gullying, wind erosion, bank erosion and deposition. Erosion terrains were then grouped by rock types with similar strength and erodibility, and topography (hill country dominated by slopes $<25^\circ$ and hilly steeplands dominated by slopes $>25^\circ$). A total of 21 terrains were identified.

Four classes of terrain dominated by gully erosion were recognised – terraces and fans on young flow and water sorted Taupo tephra, hill country and hilly steeplands developed on crushed argillite with large-scale gully erosion, upland plains and plateaux with tephra cover, hill country with young, deep tephra.

Two terrains dominated by earthflows occur on rolling to moderately steep hills and are formed in a range of crushed and sheared, highly erodible rock types. This terrain is also prone to gullying and large scale slumping. Both terrains have similar characteristics (slope, rock type, erosion type) with the major difference being the extent of present erosion.

Twelve terrains dominated by landsliding are recognised, with differences in underlying rock type and topography. Of these, five terrains occur in hill country dominated by slopes $<25^\circ$ and are formed in different rock types – weak Tertiary mudstone, weak Tertiary sandstone, weathered volcanic rocks, young tephra cover, and hard sedimentary rock. Seven terrains occur in hilly steeplands dominated by slopes $>25^\circ$ and are formed in different rock types – non-cohesive sands and gravels, weak Tertiary mudstone, other weak Tertiary rock types (sandstone, limestone, conglomerate, moraine, and alluvium), weathered rock types (including volcanics, greywacke, schist and granite), young tephra, old tephra cover and other volcanics, hard sedimentary, metamorphic and igneous rocks.

Three other minor terrains are recognised – steep to very steep slopes formed in deep loess highly susceptible to tunnel gully erosion, floodplains with very active bank erosion and deposition, and foredunes with severe wind erosion risk.

Management of erosion risk varies according to the dominant erosion process. In terrains at risk of gully erosion management of runoff during earthworks and harvesting is critical. In terrains underlain by tephra avoidance of compaction is important to reduce runoff generation both at harvest and throughout the forest rotation. Disturbance near existing gullies should be avoided so gullies are not reactivated. Replanting as soon as possible after harvest, or oversowing with grass, also helps manage erosion.

In terrains at risk of earthflow erosion mapping the extent and location of earthflows should be part of harvest and earthworks planning. Earthworks should avoid cuts across earthflows where possible, and runoff from roads and landings should be managed carefully to avoid increasing soil moisture on earthflows. Replanting as soon as possible after harvest helps lower soil moisture.

In terrains at risk of landslide erosion the most important issue is the occurrence of post-harvest landsliding on clearcuts and associated with earthworks. Managing cut-and-fill and runoff associated with earthworks, slash management and replanting as soon as possible following harvest helps improve slope stability and reduce soil moisture levels.

Conclusions

- A terrain classification based on dominant erosion process, rock type and topography was developed from an existing “erosion terrain” classification. A total of 21 classes were defined and described: four terrains dominated by gully erosion; two terrains dominated by earthflows; twelve terrains dominated by landsliding; and three other minor terrains (hill country with tunnel gully erosion, floodplains with very active bank erosion and deposition, and foredunes with severe wind erosion risk). The terrain classification provides a structure for generalising the types of terrain present within the High and Very High ESC classes but ignores the detailed variability inherent in the underlying NZLRI polygon data. Management of erosion risk varies according to the dominant erosion process.

1 Introduction

The Ministry for Primary Industries (MPI) is leading a process to deliver greater national consistency in the management of plantation forestry under the Resource Management Act (RMA) by implementing a National Environmental Standard for Plantation Forestry (NES-PF). The Erosion Susceptibility Classification (ESC) developed by Bloomberg et al. (2011) from potential erosion and Land Use Capability (LUC) data associated with the New Zealand Land Resource Inventory (NZLRI) is a critical input into the proposed NES as it underpins the level of control for different plantation forestry activities. Following the initial release of the proposed NES-PF it was recognised that the ESC had limitations related to scale of the underlying NZLRI mapping and misclassification of some land (Robson 2013; Basher et al. 2014) that will result in ongoing changes to the ESC once the NES-PF is implemented.

In 2014 MPI engaged Landcare Research to refine the ESC for misclassified land and to establish a process by which changes to the ESC might be managed once the NES-PF is implemented. The work originally requested included 3 components:

- 1) Design of process by which a party can apply to have ESC units/polygons refined, reassessed, or new units created, and, where appropriate, officially reclassified,
- 2) Reclassification of those ESC units/polygons that were clearly misclassified as ‘orange’ (ESC class high) or ‘red’ (ESC class very high) under the original ESC (Bloomberg et al. 2011),
- 3) A classification of ‘graded level of severity’ applied to the ‘orange’ category under the updated ESC.

In 2015 components 1 and 2 were completed (Basher et al. 2015a, b) and were released with the consultation document on the NES-PF (MPI 2015). The consultation document included the proposed rule set for controlling forestry activities on the 4 ESC classes of land. Public submissions raised concerns about the suitability of the ESC and whether the level of control of harvesting and earthworks operations on land in the High ESC class (the ‘orange’ zone) was adequate. In response MPI decided to complete the third component of the original work request.

2 Background

The proposed NES-PF applies different levels of resource consent control for forestry activities (permitted, controlled, restricted discretionary) depending on the effects of the activity and the environmental risks to be managed. The draft rule set for the NES-PF sets controls for eight forestry activities – afforestation, harvesting, earthworks, mechanical land preparation, quarrying, river crossings, pruning and thinning-to-waste, and replanting. It is based on 3 principles:

- Where possible, forestry activities should be permitted, provided robust permitted activity conditions are met
- As the risk of adverse environmental effects increases (especially erosion), the requirement for resource consent becomes more likely and conditions become more stringent
- The rules should provide a consistent national approach but also reflect local conditions

The proposed NES-PF was open for public consultation between 17 June and 11 August 2015 and a large number of submissions were received. Many submissions expressed concern that the level of control applied to harvesting and earthworks operations in the High ESC zone would not adequately manage the risks of sediment generation and delivery to waterways. Harvesting and earthworks are core forestry activities and have a higher risk of adverse environmental effects in more erodible landscapes (see Fransen et al. 2001; Phillips et al. 2012).

The proposed NES-PF requires that a resource consent be obtained for harvesting and earthworks in the Very High ESC zone; however, the activities are permitted (subject to compliance with permitted activity conditions) in the High ESC zone, except for earthworks on slopes $>25^\circ$, which also require a resource consent. The High ESC zone comprises c. 365 000 hectares of land under plantation forest. LUC units in the High ESC class commonly have similarities in rock type, topography, and erosion type to related LUC units in the Very High ESC class; however, generally the slopes are less steep and/or the susceptibility to erosion is lower. This report provides a more detailed subdivision of the High ESC class based on dominant erosion process, rock type and topography, and details the relationship between LUC units classed as High and Very High ESC.

3 Objectives

- Refine the ESC so that it can be used to assess erosion risk associated with plantation forestry activities in the High and Very High ESC classes with more accuracy.
- Provide descriptions of the revised classes within the High and Very High ESC classes and the erosion risk for different forestry activities.

4 Methods

Subdivisions of the High and Very High ESC classes were derived from an existing “erosion terrain” classification held as part of Landcare Research’s Our Environment portal¹. An erosion terrain is defined as a landtype with a unique combination of erosion processes and associated erosion rates. The spatial coverage of erosion terrains was derived by assigning LUC units from the NZLRI to produce terrains that had unique combinations of rock type, landform, slope, erosion type and severity. The full list of erosion terrains for New Zealand is given in Appendix 1. The boundaries of the erosion terrains are coincident with the ESC mapping boundaries, having been derived from the same underlying NZLRI dataset.

The revised ESC dataset (Basher et al. 2015b) provided to MPI (file name “Revised_ESC_final.shp”) was joined to the erosion terrain data (file name “nz_erosion”) using the LegLUC field to implement the attribute join in ArcMap. The erosion terrains present in the High and Very High ESC classes were then extracted from this dataset and a pivot table used to identify which erosion terrains were present in the High and Very High ESC classes.

¹ Available at

http://ourenvironment.scinfo.org.nz/ourenvironment#layerIds=94,76,125,77,113,107,78,85,82,84,103,127,128,129,106,139&activeLayer=lri_observed_erosion¢er=5409587.1080631,1588434.5102024&z=7&pq=1587108.4158835,5410905.4412552

The erosion terrain classification provides a very detailed subdivision of the New Zealand landscape with respect to rock type and topography with 74 classes (Appendix 1), of which 48 were present in the High and Very High ESC classes. Therefore, the erosion terrains were regrouped to amalgamate terrains with similar dominant erosion process, rock types with similar erosion susceptibility. The erosion terrain groupings of topography were retained (Appendix 1). This reduced the total number of classes in the High and Very High ESC from 48 to 21 (Table 1). The classes are simply referred to as terrains.

The terrain class for each LUC unit present in the High and Very High ESC classes was identified. Where dual LUC units were present (e.g. 2s3+7e7) they were treated in the same way as Bloomberg et al. (2011) and Basher et al. (2015b). That is, they were allocated to the terrain class with the highest ESC rating. A full list of LUC units and their associated terrain class is given in Appendix 2.

The alternative approach of deriving a classification directly from the NZLRI data was considered but rejected for a number of reasons:

- Many polygons have multiple rock types, multiple slope classes and multiple erosion types and severity. The LUC unit description and associated erosion terrain class generalises this variability in the raw NZLRI data.
- Differences in erosion recording between South Island 1st edition NZLRI mapping and North Island and 2nd edition NZLRI mapping complicate analysis of the raw NZLRI erosion data.
- As a consequence, it was considered that a query of the raw NZLRI data would produce a complex result that would then have to be generalised to produce useful subdivisions according to erosion type and severity, dominant rock type, and dominant slope.

It was considered that utilising the erosion terrains provided a filter to generalise the detail in the individual NZLRI polygons that classified patterns of erosion type and severity and provided a boundary at 25° (separating hill country dominated by slopes <25° from hilly steeplands and mountain steeplands dominated by slopes >25°), which is used in the proposed rule set for the High ESC class under the NES-PF. However, it needs to be recognised that the erosion terrain classification provides a structure for generalising the types of terrain present within the High and Very High ESC classes but ignores the detailed variability inherent in the underlying NZLRI polygon data.

5 Results

5.1 Basis of the groupings

Erosion terrains in the High and Very High ESC classes were grouped by dominant erosion process to identify 6 major groupings (Table 1) – gullying, earthflows, landsliding, tunnel gullying, wind erosion, bank erosion and deposition. Then erosion terrains were grouped by rock types with similar strength and erodibility. This grouped together erosion terrains on old hard rock types (Gw, Ar, Ma, Hs, St2, Sy, Gn, In, Vo²), separated weaker (Mb, Mm, Mj, Ms) from stronger (Sm, Sb, Ss, Cw, Cg, Li, Gr) Tertiary soft rock types, and identified erosion

² Abbreviations for rock type slope, and erosion in the text follow Lynn et al. (2009) or NWASCO (1979)

terrains on strongly weathered rock types. The last were not consistently recorded in the NZLRI inventory, therefore utilising the erosion terrain classification provided a means to identify those LUC units dominated by strongly weathered soils and regolith.

The erosion terrain classification also included a topographic subdivision between hill country (dominated by slopes $<25^\circ$) and hilly steeplands (dominated by slopes $>25^\circ$), which coincides with the slope threshold used to require a resource consent for earthworks in the High ESC zone. However, the erosion terrain classification also distinguished two broad groups on the basis of relief (hilly steeplands with <300 m relief and mountainous steeplands with >300 m relief). This distinction was not considered relevant in a forestry context since in high relief terrain slope length is typically broken by roads, and therefore hilly steeplands and mountainous steeplands formed on similar rock types were grouped together (Table 1).

The allocation of the erosion terrains (from Appendix 1) to terrain groupings is shown in Table 1. Maximum mapped mass movement erosion, potential erosion and revised ESC rating for each LUC unit is given in Basher et al. (2015b).

Table 1: List of LegLUC values in High and Very High ESC classes arranged according to dominant erosion process and terrain grouping

Dominant erosion process	Terrain grouping	High ESC class	Very high ESC class	Erosion terrains ³
Gullying	Terraces and fans on young flow and water sorted tephra	047e124, 077e16, 107e19	048e 2, 078e 4, 108e 2	4.2.2, 4.2.3
	Hilly steeplands developed on crushed argillite with severe gully-dominated erosion	016e19, 067e 8	017e 8, 067e21, 067e22, 067e24, 068e 9, 077e15, 087e13	6.4.4, 7.3.2
	Upland plains and plateaux with tephra cover	047e15, 048e 5		8.1.1
	Hill country with deep tephra	076e15		6.2.3
Earthflows	Hill country developed on crushed argillite, Tertiary-aged mudstone and sandstone with moderate earthflow-dominated erosion	007e 5, 067e 7, 086e12, 107e 6		6.4.2, 6.4.5
	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion	017e 2, 027e 4, 067e 6, 067e 9, 067e12, 077e 6, 087e 7, 087e 9, 107e12	067e18, 067e19, 067e25, 077e10, 087e 6, 087e 8, 088e 3, 107e14	6.4.3
Landsliding	Hill country on weak Tertiary mudstone	076e 7		6.4.1
	Hill country on weak Tertiary sandstone	007e20		6.1.1, 6.4.5, 6.4.7, 6.4.8
	Hill country on weathered volcanics	016e16, 036e11		6.7.2, 6.7.4
	Hill country with young tephra cover; both landsliding and gullying	047e 8, 047e13, 047e14, 077e19		6.2.2, 6.2.3
	Hill country on hard sedimentary rock	007e 7, 117e26		6.5.1, 6.5.2, 6.5.3

³ For the complete list of erosion terrains see Appendix 1

⁴ Note the LegLUC unit format is xxyyyy where xx = legend (00 = South Island 1st edition, 01 = Northland, 02 = Waikato, 03 = Coromandel, 04 = Bay of Plenty–Volcanic Plateau, 05 = Eastern Bay of Plenty, 06 = Gisborne-East Coast, 07 = Northern Hawke’s Bay, 08 = Southern Hawke’s Bay-Wairarapa, 09 = Wellington, 10 = Taranaki Manawatu, 11 = Marlborough), yyyy = LUC unit

Dominant erosion process	Terrain grouping	High ESC class	Very high ESC class	Erosion terrains3	
	Hilly steeplands developed on non-cohesive sands, and gravels; both landsliding and gullyng	027e10	107e16	7.4.3	
	Hilly steeplands on weak Tertiary mudstone	007e 4, 067e 2, 067e 3, 067e 4, 067e 5, 077e 1, 077e 2, 078e 3, 087e 1, 087e 2, 107e 1, 107e 2, 107e 7	067e 1, 067e23, 068e 2, 068e 3, 077e 4, 077e11, 087e12, 107e20, 118e 3	7.3.1	
	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium	007e13, 007e22, 017e 4, 027e 1, 027e12, 067e10, 067e14, 067e15, 067e16, 067e17, 077e 3, 077e 5, 077e 8, 077e 9, 078e 2, 087e 4, 107e 3, 107e 4, 107e 5, 107e 9, 107e11, 107e13, 107e17, 107e23, 117e 6, 117e13, 117e16	068e 6, 088e 1, 088e 2, 108e 3	7.4.1. 7.4.2	
	Hilly steeplands on weathered volcanics, greywacke, argillite, schist, granite	007e 9, 017e 1, 017e 7, 026e17, 027e 8, 037e 1, 037e 2, 037e 3, 037e 7, 067e13, 117e12, 118e 4	068e 5	7.6.1, 7.6.2, 7.7.1, 7.7.2, 7.7.3	
	Hilly steeplands with young tephra cover; both landsliding and gullyng	047e 2, 047e 3, 047e 9, 047e11, 067e20, 077e14		7.1.1, 7.1.2	
	Hilly steeplands with old tephra cover and other volcanics	027e11, 047e 4, 047e 5, 048e 3	048e 4	7.1.3, 7.2.1	
	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous rocks	007e 8, 007e25, 008e 1, 008e 2, 008e 3, 008e 4, 008e 8, 008e 9, 017e 3, 017e 5, 017e 6, 018e 2, 018e 3, 027e 6, 027e 9, 028e 1, 028e 2, 028e 3, 037e 4, 037e 5, 037e 8, 037e 9, 038e 2, 047e10, 048e 6, 048e 7, 058e 1, 058e 2, 067e11, 077e 7, 078e 5, 078e 7, 078e 8, 078e 9, 088e 5, 088e 7, 088e 8, 097e 5, 098e 2, 098e 3, 098e 4, 107e18, 108e 4, 108e 5, 108e 6, 108e 8, 117e 5, 117e 8, 117e11, 117e18, 118e 1, 118e 2, 118e 5, 118e 6, 118e 7, 118e 8, 118e 9, 118e11, 118e12, 118e13		008e 5, 008e 7, 008e11, 038e 3, 038e 4, 068e 4, 068e 7, 068e 8, 078e 6, 088e 6, 098e 5, 108e 7, 108e 9,	7.5.1, 7.5.2, 7.5.3, 7.5.4, 7.5.5, 8.2.1, 8.3.1, 8.3.2, 8.3.3, 8.6.1, 8.6.2
Tunnel gullyng	Hill country on deep loess	007e14, 117e17		6.2.1	
Bank erosion and deposition	Floodplains with severe bank erosion and deposition	067e26	068s2	1.1.1	
Wind erosion, some gullyng on older dunes	Sand country, foredunes	017e 9	008e10, 018e 1, 028e 4, 038e 1, 048e 1, 068e 1, 078e 1, 088e 4, 098e 1, 108e 1, 118e15	2.1.1, 2.1.2, 2.1.3	

5.2 Terrains dominated by gullying

Four classes of terrain dominated by gully erosion are recognised:

- a) Terraces and fans on young flow and water sorted Taupo tephra (Tp). Class 7 LUC units are in the High ESC class and occur on flat to rolling terraces with incised gullies, and with soils developed on young, highly erodible tephra. Soils have low natural fertility, are highly permeable but have poor structure, weak soil strength, and are highly erodible if disturbed. There is a potential for very severe gully and streambank erosion, and severe sheet erosion. Related class 8 LUC units are in the Very High ESC class and occur on similar parent materials where the terraces are more dissected, slopes tend to be steeper, and present erosion is more active. These LUC units are restricted to the central North Island Volcanic Plateau.

In this terrain runoff control is critical both at harvest and inter-rotation. In an undisturbed state the soils are highly permeable but when they are compacted infiltration is reduced to very low rates and runoff can cause severe erosion. Runoff control associated with earthworks (roads and landings) needs to be maintained throughout the forest rotation. Providing surface cover of slash can also help to reduce runoff generation and control its effects.

- b) Hilly steeplands developed on crushed argillite with severe gully-dominated erosion. Moderately steep to steep terrain on highly erodible crushed argillite (Ar), greywacke (Gw), sandstone (Sm), and mudstone (Mj) with severe, large-scale gully erosion. Large-scale slump and earthflow erosion can also occur in this terrain which is some of the most naturally susceptible to erosion in New Zealand. The topography is mostly steep (F slopes dominant), but there are also significant areas of easier slope (E) included within this terrain.

Most of this terrain is in Very High ESC class but two LegLUC units in the High ESC class tend to be less steep and have less present erosion; however, the High ESC terrain also has the potential for increased erosion if not well managed. This terrain is located mostly in the Gisborne-East Coast area, with related LegLUC units in Northland.

In this terrain runoff control is critical at harvest, especially associated with earthworks on sloping terrain. Where possible, disturbance near existing gullies should be avoided so gullies are not reactivated. Replanting as soon as possible after harvest also helps manage erosion; however, gullies should not be replanted in a harvestable species and the gully should be allowed to revert to provide continuous cover in gullies. Earthworks should avoid existing gullies.

- c) Upland plains and plateaux with tephra cover. This terrain comprises flat to rolling slopes mantled with very young tephra (mostly mapped as Ng and Ta). Because the tephra is very young it has less of a history of gully erosion than the terraces and fans on Taupo tephra; however, it is very susceptible to gully erosion if disturbed and compacted. Two related LegLUC units are both in the High ESC class.

Runoff control critical both at harvest and inter-rotation. In an undisturbed state the soils are highly permeable but when they are compacted infiltration is reduced to very

low rates and runoff can cause severe erosion. Providing surface cover of slash can also help to reduce runoff generation and control its effects.

- d) Hill country with deep tephra. This occurs on rolling to moderately steep hills with a mantle of deep Kaharoa and Taupo airfall tephra (Kt) over Waimihia Lapilli (Lp). There is a potential for severe gully erosion and slight soil slip erosion. Only one LegLUC unit occurs in this terrain and it is in the High ESC class. It is located in the hill country east of Lake Taupo

Like the other gully erosion-prone terrains formed in young tephra, runoff control is critical both at harvest and inter-rotation. Because slopes are steeper there is potential for greater erosion where runoff is generated.

Recognising the extent and location of existing gullies should be part of harvest and earthworks planning to avoid disturbing existing gullies in all the gully-erosion prone terrains. Replanting as soon as possible after harvest, or oversowing with grass, helps manage erosion

5.3 Terrains dominated by earthflows

Two terrains dominated by earthflows are recognised. Both are on rolling to moderately steep hills and are formed in a range of crushed and sheared, highly erodible rock types:

- a) Hill country developed on crushed argillite (Ac), Tertiary-aged mudstone (Mj, Mb), and sandstone (Sm, Ss) with moderate earthflow-dominated erosion. All LegLUC units in this terrain are in the High ESC class.
- b) Hill country developed on crushed argillite (Ac), mudstone (Mj, Me, Mb), and greywacke (Gw) with severe earthflow-dominated erosion. LegLUC units in this terrain are in both the High and Very High ESC classes

These terrains are also prone to gullying and large-scale slumping. Both terrains have similar characteristics (slope, rock type, erosion type), with the major difference being that the extent of present erosion is greater in the terrain with severe earthflow-dominated erosion. Most of the earthflow-dominated terrain is located in the Gisborne region but it also occurs in Northland, Waikato, Hawke's Bay, Taranaki, Manawatu, and there is a small area in North Canterbury.

Recognising the extent and location of earthflows should be part of harvest and earthworks planning. Earthworks should avoid earthflows where possible as this may reactivate them. Runoff from roads and landings should be managed carefully to avoid increasing soil moisture levels on earthflows. Replanting as soon as possible after harvest helps lower soil moisture levels. If necessary, springs on earthflows can be drained to help reduce soil moisture.

5.4 Terrains dominated by landsliding

Twelve terrains dominated by landsliding are recognised. They are distinguished by differences in underlying rock type and topography.

Five terrains occur in hill country dominated by slopes $<25^\circ$. In order of decreasing erosion susceptibility these are:

- hill country on weak Tertiary mudstone (Mm). This terrain is dominated by E slopes but there are significant areas of F slopes in many polygons. Shallow landslides are characteristic in this terrain. It is only mapped in northern Hawke’s Bay.
- hill country on weak Tertiary sandstone (Ss). This terrain is dominated by E and D slopes but there are smaller areas of F slopes in many polygons. Shallow landslides are characteristic in this terrain which is only mapped in Southland.
- hill country on hard sedimentary rock (Hs). The topography is dominated by E and D slopes but there are significant areas of F and G slopes within some polygons. This is mapped mostly in southern Marlborough, with small areas in north and south Canterbury.
- hill country on weathered volcanic rocks (Vo', Vu'). Both shallow and deep landslides occur within this terrain. It is mapped in Northland and the Coromandel. The topography is dominated by E slopes but there are significant areas of F slopes within most polygons and it could be grouped with ‘Hilly steeplands on weathered volcanics, greywacke, argillite, schist, granite’. This terrain occurs in areas where high intensity storms are common and has the potential to produce large amounts of fine sediment because the soils and regolith have high clay content.
- hill country with young Tarawera (Ta), Taupo and Kaharoa (Tp, Kt) tephra cover, underlain by lapilli (Lp), older tephra (Mo) and volcanic rocks (Vo) which is prone to both landsliding and gully erosion. The topography is dominated by E and D slopes but there are significant areas of F slopes within some polygons. This terrain is mapped in the hill country to the east of Lake Taupo and the Rotorua lakes.

All LegLUC units in the hill country are in the High ESC class.

Seven terrains occur in hilly steeplands dominated by slopes $>25^\circ$ – in order of decreasing erosion susceptibility these are:

- hilly steeplands on non-cohesive sands and gravels (Us) susceptible to both landsliding and gully erosion. The rock is poorly consolidated and highly erodible while the topography is steep with mostly F and G slopes. This terrain occurs scattered through the Waikato where it is mapped in High ESC class and also in the Wanganui and Manawatu where it is mapped in the Very High ESC class.
- hilly steeplands on weak Tertiary mudstone (Mb, Mm, Mj, Ms). The topography is steep, with mostly F and G slopes, and shallow soils over weakly indurated mudstone. Extensive shallow landsliding occurs in this terrain following high intensity storms. This terrain is split between the High and Very High ESC classes but both occur on similar rock type. It is mapped extensively in the Gisborne-East Cape area, northern and Southern Hawke’s Bay, Taranaki, northern Manawatu, and scattered areas of the South Island West Coast, and inland Marlborough. .
- hilly steeplands on other weak Tertiary rock types including sandstone (Sm, Sb, Ss), limestone (Li), conglomerate (Cw, Cg), moraine, and alluvium (Gr). The topography is steep, with mostly F and G slopes, and shallow soils over a range of weakly indurated rock types. Extensive shallow landsliding can occur in this terrain following high intensity storms, although it tends to be less affected than the mudstone terrain. Most of this terrain is mapped in the High ESC class with some class 8 LUC units mapped in the Very High ESC class. It is mapped extensively in Taranaki, northern Manawatu, Gisborne-East Cape, northern Hawke’s Bay, and scattered areas in southern Northland, north Westland, Nelson, and Marlborough.

- hilly steepplands on weathered volcanics (Vu', Vo), greywacke (Gw'), schist (St2, Sy) and granite (Gn). The topography is mostly steep (F slopes dominant), although in the South Island significant areas of easier slope (E) are included. Landslides are mostly shallow but deeper landslides, and gullying, can occur within this terrain. It is mapped extensively in Northland, northern Waikato, and the Coromandel, and also in Nelson and Marlborough (including the Marlborough Sounds). This terrain also occurs in areas where high intensity storms are common and it has the potential to produce large amounts of fine sediment because the soils and regolith have high clay content. It also includes the Separation Point Granite in Nelson which produces coarse sandy sediment from landsliding. This terrain is mapped in the High ESC class except for one class 8 LUC unit mapped in the Very High ESC class in the Gisborne area.
- hilly steepplands with young Taupo and Kaharoa tephra (Kt), and older ash (Mo) susceptible to both shallow landsliding and gullying. The topography is dominated by F slopes but there are significant areas of easier (E) slopes within some polygons. This terrain is mapped in the Bay of Plenty around the Rotorua lakes and in inland Gisborne. This terrain is all mapped in the High ESC class.
- hilly steepplands with old tephra cover (Mo) and other volcanics (Vo). The topography is dominated by F and G slopes. This terrain is mapped extensively in the hilly steepplands of the Bay of Plenty and to the south-east of Lake Taupo. It is mostly mapped in the High ESC class except for one class 8 LUC unit.
- hilly and mountainous steepplands on hard sedimentary (Gw, Ar, Ma, Hs), metamorphic (St2, Sy) and igneous rocks (Gn, In, Vo). This terrain is extensively mapped through the ranges of the South and North Islands, with minor areas in the Northland and Coromandel ranges. While this terrain is steep (F and G slopes) it is mostly stable. While shallow landsliding occurs after high intensity storms the density is typically lower than in the Tertiary soft rock hill country. Most of this terrain is mapped in the High ESC class except for some class 8 LUC units which tend to be in high rainfall areas.

The LegLUC units in the hilly steepplands typically have related units in the High and Very High ESC classes and for several terrains the underlying rock type is similar to LegLUC units in the hill country (see Table 1).

For forest management the most important issue is the occurrence of post-harvest landsliding (Phillips et al. 2012). This occurs both on clearcuts and associated with earthworks. Managing cut-and-fill and runoff associated with earthworks is important for reducing the incidence of landsliding. Slash management can also help with managing debris flows associated with post-harvest landslides. Replanting as soon as possible following harvest helps improve slope stability and reduce soil moisture levels. Oversowing with grass can also help to manage erosion.

5.5 Terrains dominated by tunnel gullying

This terrain has steep to very steep slopes (mostly E and F) formed in deep loess (Lo) over weakly indurated sedimentary (Cw, Mm) or volcanic (Vo) rocks. The loess is highly susceptible to tunnel gully erosion and is also susceptible to landslides in high intensity storms. This terrain is mapped in the Marlborough area and Banks Peninsula. Both LegLUC units are in the High ESC class.

Control of runoff is key to avoiding tunnel gully erosion. Runoff associated with earthworks needs to be managed carefully. Replanting as soon as possible following harvest helps improve slope stability and reduce soil moisture levels.

5.6 Terrains dominated by bank erosion and deposition

Two related LegLUC units with high rates of sediment delivery, deposition and bank erosion occur in rivers of the Gisborne region. One (067e26) is on flat to undulating usually extremely gravelly and bouldery, low river terraces subject to frequent flooding, gravel deposition, and persistent severe streambank erosion; and also on some extremely gravelly alluvial fans that frequently receive erosion debris from active gullies. This unit is mapped in the High ESC class. The other (068s 2) is on very active river beds also subject to frequent flooding, gravel deposition, and persistent severe streambank erosion. Land in both units is at risk of complete destruction during the lifetime of a forest rotation.

This risk can only be alleviated by not planting these areas.

5.7 Terrains dominated by wind erosion

This terrain is on undulating and rolling foredunes subject to extreme wind erosion and is mapped in most regions. This terrain was all mapped in the Very High ESC class. Also includes areas in Northland on older stable dunes (LegLUC 017e9) with strongly rolling to very steep slopes that are subject to both wind and gully erosion.

The risk of erosion can be managed by maintaining cover (including slash) and replanting rapidly.

6 Conclusions

A terrain classification based on dominant erosion process, rock type and topography was developed from an existing “erosion terrain” classification. A total of 21 classes were defined and described: four terrains dominated by gully erosion; two terrains dominated by earthflows; twelve terrains dominated by landsliding; and three other minor terrains (hill country with tunnel gully erosion, floodplains with very active bank erosion and deposition, and foredunes with severe wind erosion risk). The terrain classification provides a structure for generalising the types of terrain present within the High and Very High ESC classes but ignores the detailed variability inherent in the underlying NZLRI polygon data. Management of erosion risk varies according to the dominant erosion process. This report makes recommendations for managing risk from the dominant erosion processes for different forestry activities.

7 References

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Appendix 1 – List of erosion terrains in New Zealand

Abbreviations for dominant erosion process and rock type follow Lynn et al. (2009) or NWASCO (1979).

Terrain No.	Description	Dominant Erosion Process
Active floodplains		
1.1.1	Alluvium from various sources on active floodplains and fans	Sb, D
Sand country		
2.1.1	Sands and gravels from various sources, South Island	W
2.1.2	Recent fresh dune sand, North Island	W
2.1.3	Mature moderately weathered dune sand, North Island	W, Sh, G, Ss
Peatland		
3.1.1	Lowland and upland peat swamps and domed peats	Sb, W
Terraces, low fans, laharc aprons (most slopes <8°)		
4.1.1	Terrace and fan alluvium, including gravelly laharc aprons, above the recent floodplain	Sb, W
4.2.1	Loess mantled terraces and fans	Sb, W
4.2.2	Terraces and fans of young tephra, mostly pumiceous (Waimihia and younger)	Sb, W, G
4.2.3	Basins infilled with Taupo tephra flow deposits—intensely gullied	G, Sh, Sb, Ss
4.2.4	Terraces and fans of mid-aged (late Pleistocene/early Holocene) tephra, older tephra, or tephric loess	Sb, G
4.3.1	Fine grained, weathered, undifferentiated terrace alluvium—above the level of modern flood plains	Sb
Downland (most slopes 8–15°)		
5.1.1	Downlands developed on moraine and dissected alluvium	Sh, W, Ss
5.2.1	Downlands developed on deep >1m loess	Sh, R, W
5.2.2	Downlands developed on Waimihia and younger tephra	Sh, R, W, G
5.2.3	Downlands developed on Mid-aged (late Pleistocene/early Holocene) tephra, older tephra, or tephric loess	Sh
5.3.1	Downlands developed on young basalt lava fields and low domes (parts are flatter than typical downland)	Sh
5.3.2	Downlands developed on weathered sedimentary and non-tephric igneous rocks	Sh, R
5.3.3	Downlands developed on soft sedimentary rocks, includes all Ms, Ss, Cw and Ls	Sh, R, W
5.4.1	Downlands developed on hard sedimentary rocks (Gw, Ar, Hs, Cg)	Sh, W, R
5.4.2	Downlands developed on hard schist rocks (St1, St2, or Sx, Sy)	Sh, W, R
5.4.3	Downlands developed on hard coarse grained igneous or metamorphic (Gn, Gs) and fine igneous rocks (Vo)	Sh, W, Ss
Hill country (most slopes 16–25°)		
6.1.1	Hill country developed on moraine and dissected alluvium	Sh, W, Ss
6.2.1	Hill country developed on deep >1m loess	Ss, Sh, T
6.2.2	Hill country developed on shallow (0.3–1.0 m) Waimihia or younger tephra, usually over older tephra	Ss, Sh, T, G
6.2.3	Hill country developed on deep (>1.0m) Waimihia or younger tephra, usually over older tephra	Sh, G, T
6.2.4	Hill country developed on Mid-aged (late Pleistocene/early Holocene) tephra, or	Ss, Sh

Terrain No.	Description	Dominant Erosion Process
	tephric loess, covers	
6.3.1	Hill country developed on young basalt domes and cones	Ss, Sh
6.4.1	Hill country developed on weak to very weak Tertiary-aged mudstone	Ss, Sh, Ef, G
6.4.2	Hill country developed on crushed Tertiary-aged mudstone, sandstone; argillite, or ancient volcanic rock (frequently, with tephra covers in the Northern Hawke's Bay–East Coast area)—with moderate earthflow-dominated erosion	Ef, G, T, Su
6.4.3	Hill country developed on crushed mudstone or argillite with severe earthflow-dominated erosion	Ef, G, Su, Ss, Sh
6.4.4	Hill country developed on crushed argillite, sandstone, or greywacke, with severe gully-dominated erosion	G, Sh, Ss, Su, T, Ef
6.4.5	Hill country developed on soft sedimentary sandstone Ss	Ss, Sh, W, G
6.4.6	Hill country on-cohesive Tertiary-aged sandstone	Ss, Sh, Su, Ef, T, G
6.4.7	Hill country developed on soft sedimentary conglomerate Cw	Ss, Sh, G
6.4.8	Hill country developed on soft calcareous sediments and limestone Ls	Sh, Ss
6.5.1	Hill country developed on unweathered to moderately weathered hard sedimentary rocks, (Gw, Ar, Hs, Cg)	Ss, Sh
6.5.2	Hill country developed on hard schist rocks (St1, St2 or Sx, Sy)	Sh, W
6.5.3	Hill country developed on hard coarse grained igneous or metamorphic rocks (Gn, Gs)	Ss, Sh
6.5.4	Hill country developed on hard fine grained igneous rocks (Vo)	Ss, Sh
6.6.1	Hill country developed on unweathered to slightly weathered white argillite	Sh, W
6.7.1	Hill country developed on residual weathered to highly (often deeply) weathered Tertiary-aged sedimentary rocks	Ss, Sh, Su, T
6.7.2	Hill country developed on residual weathered to highly (often deeply) weathered ancient basalt and andesite	Ss, Sh, W, G
6.7.3	Hill country developed on residual weathered to highly (often deeply) weathered welded rhyolite	Ss, Sh, G
6.7.4	Hill country developed on residual weathered to highly (often deeply) weathered greywacke/argillite	Ss, Sh, Su, G
Hilly steepplands (most slopes >25°)		
7.1.1	Hilly steepplands developed on shallow (0.3–1.0 m) Waimihia or younger tephra, usually over older tephra	Ss, Sh, T, G
7.1.2	Hilly steepplands developed on deep (>1.0 m) Waimihia or younger tephra, usually over older tephra	Sh, G, Ss, T
7.1.3	Hilly steepplands developed on mid-aged (late Pleistocene/early Holocene) tephra covers	Ss, Sh
7.2.1	Hilly steepplands developed on fresh to slightly weathered welded rhyolitic rock, or bouldery andesitic lahar deposits	Ss, Sh
7.3.1	Hilly steepplands developed on weak to very weak Tertiary-aged mudstone	Ss, Sh, Ef, G
7.3.2	Hilly steepplands developed on crushed argillite with gully-dominated erosion	G, Sh, Ef
7.4.1	Hilly steepplands developed on cohesive, generally weak to moderately strong Tertiary-aged sandstone	Ss, Sh, W, G
7.4.2	Hilly steepplands developed on soft sedimentary conglomerate (Cw)	Ss, Sh, G
7.4.3	Hilly steepplands developed on non-cohesive Tertiary-aged sandstone, and younger sandy gravels and gravelly sands	Ss, G, Sh
7.5.1	Hilly steepplands developed on hard sedimentary rocks (Gw, Ar, Hs, Cg)	Sh, Ss, W

Terrain No.	Description	Dominant Erosion Process
7.5.2	Hilly steeplands developed on hard schist rocks (St1, St2 or Sx, Sy)	Sh, Ss, W
7.5.3	Hilly steeplands developed on hard coarse grained igneous or metamorphic rocks (Gn, Gs)	Sh, Ss
7.5.4	Hilly steeplands developed on hard carbonate rocks Ls, Ma	Sh, Ss, Sc, RF
7.5.5	Hilly steeplands developed on hard fine grained igneous rocks Vo	Sh, Ss
7.6.1	Hilly steeplands developed on weathered hard schist & greywacke rocks St1, St2, Sx, Sy, Gw, Marlborough Sounds esp lower slopes	Ss, Sh
7.6.2	Hilly steeplands developed on weathered coarse grained igneous rocks, Gn, eg Motueka catchment	Ss, Sh, G
7.6.3	Hilly steeplands developed on unweathered to slightly weathered white argillite	Sh, W, Sc, Ss
7.7.1	Hilly steeplands developed on residual weathered to highly (often deeply) weathered ancient basalt and andesite	Ss, Sh, G, W
7.7.2	Hilly steeplands developed on residual weathered to highly (often deeply) weathered welded rhyolite	Ss, Sh, G
7.7.3	Hilly steeplands developed on residual weathered to highly (often deeply) weathered greywacke/argillite	Ss, Sh, Su, G
Upland plains and plateaux		
8.1.1	Upland plains and plateaux with tephra covers	W, Sh, G
Mountain steeplands and upland hills (most slopes >25°, relief >300m)		
8.2.1	Mountain steeplands developed on greywacke/argillite or younger sedimentary rocks prone to landslide erosion	Ss, Sc, G, Sh
8.3.1	Mountain steeplands developed on hard sedimentary rocks (Gw, Ar, Hs, Cg)	Sh, W, Sc, G, Ss
8.3.2	Mountain steeplands developed on hard schist rocks (St1, St2, or Sx, Sy)	Sh, Ss, Da, Sc
8.3.3	Mountain steeplands developed on hard coarse grained igneous and metamorphic rocks (Gn, Gs, and ultramafic terrain)	Sh, Ss, Da, Sc
8.4.4	Mountain steeplands developed on hard fine grained igneous and tuffaceous sedimentary rocks	Sh, Ss, Sc
8.5.5	Mountain steeplands developed on weathered coarse grained igneous rocks (Gn e.g., Motueka catchment)	Sh, Ss, G
8.6.1	Mountain steeplands developed on volcanic rocks in mountain terrains and upland hills	Ss, Sh, Sc
8.6.2	Mountain steeplands on the upper flanks of volcanoes	Sc, W, Sh, G
9	Alpine	SC

Appendix 2 – List of mapped LUC units in the High and Very High ESC classes and their associated terrain class

LegLUC	ESC_revised	Terrain
002s 3+7e 7	High	Hill country on hard sedimentary rock, landsliding dominant
003e 8+7e 7	High	Hill country on hard sedimentary rock, landsliding dominant
003e12+7e 7	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
003e12+8e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
003s 3+8e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
004e 4+7e 7	High	Hill country on hard sedimentary rock, landsliding dominant
004e 4+8e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
004e 6+7e 7	High	Hill country on hard sedimentary rock, landsliding dominant
004s 6+7e 7	High	Hill country on hard sedimentary rock, landsliding dominant
004s14+8e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
006c 2+8e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
006c 2+8e 3	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
006e 5+7e 8	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
006e 8+7e 7	High	Hill country on hard sedimentary rock, landsliding dominant
006e 8+7e14	High	Hill country on deep loess, tunnel gullying
006e 8+8e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
006e11+8e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
006e13+7e14	High	Hill country on deep loess, tunnel gullying
006e15+7e14	High	Hill country on deep loess, tunnel gullying
006e21+7e 9	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
006e21+8e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
006e25+7e13	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
006s 6+7e13	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
006s 6+7e22	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
006s 6+8e 3	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e 2+8e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e 3+8e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous

LegLUC	ESC_revised	Terrain
		rocks, landsliding dominant
007e 3+8e11	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e 4	High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
007e 4+6e18	High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
007e 4+8e 3	High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
007e 5	High	Hill country developed on crushed argillite, Tertiary-aged mudstone and sandstone with moderate earthflow-dominated erosion
007e 7	High	Hill country on hard sedimentary rock, landsliding dominant
007e 7+8e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e 8	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e 8+8e 1	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e 9	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
007e 9+6e21	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
007e 9+8e 2	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
007e 9+8e 8	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
007e11+8e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e13	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
007e13+6e25	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
007e14	High	Hill country on deep loess, tunnel gulying
007e20	High	Hill country on weak Tertiary sandstone, landsliding dominant
007e20+6e28	High	Hill country on weak Tertiary sandstone, landsliding dominant
007e20+8e 5	Very High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e21+8e 9	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e22	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
007e22+6e21	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
007e22+6e28	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
007e22+7s 7	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
007e22+8e 3	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
007e22+8e 5	Very High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant

LegLUC	ESC_revised	Terrain
007e23+8e 8	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e23+8e 9	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e24+8e 4	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e25	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e25+6s 6	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e25+7s 1	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e25+7s 7	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e25+8e 1	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e25+8e 3	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e25+8e 5	Very High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e25+8s 1	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
007e26+8e 9	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 1	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 1+7e 8	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 2+6e16	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 2+6s 8	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 2+7e 3	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 2+7e 9	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 3	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 3+7e 4	High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
008e 3+7e13	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
008e 3+7e22	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 3+7e25	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 3+7s 7	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant

LegLUC	ESC_revised	Terrain
008e 3+8s 1	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 4	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 4+7e21	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 5	Very High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 5+7e22	Very High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 5+7e25	Very High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 7	Very High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 8	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 8+7e 3	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 8+7e23	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 8+8e 9	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 9	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 9+7e12	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 9+7e21	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 9+7e23	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e 9+7e26	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e10	Very High	Sand country, foredunes
008e11	Very High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
008e11+8c 2	Very High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
016e16	High	Hill country on weathered volcanics, landsliding dominant
016e19	High	Hilly steepplands developed on crushed argillite with severe gully-dominated erosion
017e 1	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
017e 2	High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
017e 3	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
017e 4	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
017e 5	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant

LegLUC	ESC_revised	Terrain
017e 6	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
017e 7	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
017e 8	Very High	Hilly steepplands developed on crushed argillite with severe gully-dominated erosion
017e 9	High	Sand country, foredunes
018e 1	Very High	Sand country, foredunes
018e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
018e 3	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
021s 1+7e10	High	Hilly steepplands developed on non-cohesive sands, and gravels; both landsliding and gullying
023s 1+7e10	High	Hilly steepplands developed on non-cohesive sands, and gravels; both landsliding and gullying
026e 1+7e 1	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
026e 1+7e 6	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
026e17	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
027e 1	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
027e 4	High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
027e 6	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
027e 8	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
027e 9	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
027e10	High	Hilly steepplands developed on non-cohesive sands, and gravels; both landsliding and gullying
027e10+3w 1	High	Hilly steepplands developed on non-cohesive sands, and gravels; both landsliding and gullying
027e11	High	Hilly steepplands with old tephra cover and other volcanics, landsliding dominant
027e12	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
028e 1	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
028e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
028e 3	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
028e 4	Very High	Sand country, foredunes
036e11	High	Hill country on weathered volcanics, landsliding dominant
037e 1	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant

LegLUC	ESC_revised	Terrain
037e 2	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
037e 3	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
037e 4	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
037e 5	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
037e 7	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
037e 8	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
037e 9	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
038e 1	Very High	Sand country, foredunes
038e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
038e 3	Very High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
038e 4	Very High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
043e 5+7e 2	High	Hilly steepplands with young tephra cover; both landsliding and gullying
043e10+8e 2	Very High	Terraces and fans on young flow and water sorted tephra, gullying dominant
043w 1+7e 2	High	Hilly steepplands with young tephra cover; both landsliding and gullying
043w 1+7e 9	High	Hilly steepplands with young tephra cover; both landsliding and gullying
044e 4+7e 9	High	Hilly steepplands with young tephra cover; both landsliding and gullying
044e18+7e12	High	Terraces and fans on young flow and water sorted tephra, gullying dominant
046e 2+8e 3	High	Hilly steepplands with old tephra cover and other volcanics, landsliding dominant
046e 5+7e 2	High	Hilly steepplands with young tephra cover; both landsliding and gullying
046e 6+7e 5	High	Hilly steepplands with old tephra cover and other volcanics, landsliding dominant
046e 7+7e 3	High	Hilly steepplands with young tephra cover; both landsliding and gullying
046e 7+8e 2	Very High	Terraces and fans on young flow and water sorted tephra, gullying dominant
046e11+7e 4	High	Hilly steepplands with old tephra cover and other volcanics, landsliding dominant
046e24+7e12	High	Terraces and fans on young flow and water sorted tephra, gullying dominant
047e 2	High	Hilly steepplands with young tephra cover; both landsliding and gullying
047e 2+3e 5	High	Hilly steepplands with young tephra cover; both landsliding and gullying
047e 2+4e 5	High	Hilly steepplands with young tephra cover; both landsliding and gullying
047e 2+6e24	High	Hilly steepplands with young tephra cover; both landsliding and gullying
047e 3	High	Hilly steepplands with young tephra cover; both landsliding and gullying
047e 4	High	Hilly steepplands with old tephra cover and other volcanics, landsliding dominant
047e 5	High	Hilly steepplands with old tephra cover and other volcanics, landsliding dominant
047e 8	High	Hill country with young tephra cover; both landsliding and gullying
047e 8+4e 5	High	Hill country with young tephra cover; both landsliding and gullying
047e 9	High	Hilly steepplands with young tephra cover; both landsliding and gullying
047e10	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous

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		rocks, landsliding dominant
047e11	High	Hilly steeplands with young tephra cover; both landsliding and gulying
047e12	High	Terraces and fans on young flow and water sorted tephra, gulying dominant
047e12+6e16	High	Terraces and fans on young flow and water sorted tephra, gulying dominant
047e13	High	Hill country with young tephra cover; both landsliding and gulying
047e14	High	Hill country with young tephra cover; both landsliding and gulying
047e15	High	Upland plains and plateaux with tephra cover, gulying dominant
048e 1	Very High	Sand country, foredunes
048e 2	Very High	Terraces and fans on young flow and water sorted tephra, gulying dominant
048e 2+4e18	Very High	Terraces and fans on young flow and water sorted tephra, gulying dominant
048e 3	High	Hilly steeplands with old tephra cover and other volcanics, landsliding dominant
048e 4	Very High	Hilly steeplands with old tephra cover and other volcanics, landsliding dominant
048e 5	High	Upland plains and plateaux with tephra cover, gulying dominant
048e 6	High	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
048e 7	High	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
058e 1	High	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
058e 2	High	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
063s 1+8s 2	Very High	Floodplains with severe bank erosion and deposition
063s 2+8e 2	Very High	Hilly steeplands on weak Tertiary mudstone, landsliding dominant
063w 3+8s 2	Very High	Floodplains with severe bank erosion and deposition
064s 1+7e26	High	Floodplains with severe bank erosion and deposition
064w 1+7e26	High	Floodplains with severe bank erosion and deposition
064w 1+8s 2	Very High	Floodplains with severe bank erosion and deposition
066s 3+8e 1	Very High	Sand country, foredunes
066s 3+8s 2	Very High	Floodplains with severe bank erosion and deposition
067e 1	Very High	Hilly steeplands on weak Tertiary mudstone, landsliding dominant
067e 2	High	Hilly steeplands on weak Tertiary mudstone, landsliding dominant
067e 3	High	Hilly steeplands on weak Tertiary mudstone, landsliding dominant
067e 3+7e23	Very High	Hilly steeplands on weak Tertiary mudstone, landsliding dominant
067e 3+8s 1	High	Hilly steeplands on weak Tertiary mudstone, landsliding dominant
067e 4	High	Hilly steeplands on weak Tertiary mudstone, landsliding dominant
067e 5	High	Hilly steeplands on weak Tertiary mudstone, landsliding dominant
067e 6	High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
067e 7	High	Hill country developed on crushed argillite, Tertiary-aged mudstone and sandstone with moderate earthflow-dominated erosion
067e 8	High	Hilly steeplands developed on crushed argillite with severe gully-dominated erosion
067e 9	High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
067e10	High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant

LegLUC	ESC_revised	Terrain
067e11	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
067e11+8s 1	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
067e12	High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
067e13	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
067e14	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
067e15	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
067e15+8e 3	Very High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
067e15+8s 1	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
067e16	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
067e17	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
067e18	Very High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
067e19	Very High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
067e19+8s 2	Very High	Floodplains with severe bank erosion and deposition
067e20	High	Hilly steepplands with young tephra cover; both landsliding and gullying
067e21	Very High	Hilly steepplands developed on crushed argillite with severe gully-dominated erosion
067e22	Very High	Hilly steepplands developed on crushed argillite with severe gully-dominated erosion
067e23	Very High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
067e23+7e 8	Very High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
067e24	Very High	Hilly steepplands developed on crushed argillite with severe gully-dominated erosion
067e24+8e 7	Very High	Hilly steepplands developed on crushed argillite with severe gully-dominated erosion
067e25	Very High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
067e26	High	Floodplains with severe bank erosion and deposition
067e26+8s 2	Very High	Floodplains with severe bank erosion and deposition
068e 1	Very High	Sand country, foredunes
068e 1+7e27	Very High	Sand country, foredunes
068e 2	Very High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
068e 3	Very High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
068e 4	Very High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
068e 5	Very High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
068e 6	Very High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
068e 7	Very High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant

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068e 8	Very High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
068e 9	Very High	Hilly steepplands developed on crushed argillite with severe gully-dominated erosion
068s 1+7e11	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
068s 2	Very High	Floodplains with severe bank erosion and deposition
068s 2+3s 1	Very High	Floodplains with severe bank erosion and deposition
068s 2+3w 3	Very High	Floodplains with severe bank erosion and deposition
068s 2+6w 1	Very High	Floodplains with severe bank erosion and deposition
068s 2+7e26	Very High	Floodplains with severe bank erosion and deposition
074s 2+8e 4	Very High	Terraces and fans on young flow and water sorted tephra, gullying dominant
076e 7	High	Hill country on weak Tertiary mudstone, landsliding dominant
076e15	High	Hill country with deep tephra, gullying dominant
077e 1	High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
077e 2	High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
077e 3	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
077e 3+8e 2	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
077e 4	Very High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
077e 5	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
077e 6	High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
077e 7	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
077e 7+8e 4	Very High	Terraces and fans on young flow and water sorted tephra, gullying dominant
077e 8	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
077e 9	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
077e 9+8e 2	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
077e10	Very High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
077e11	Very High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
077e11+8e 2	Very High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
077e14	High	Hilly steepplands with young tephra cover; both landsliding and gullying
077e15	Very High	Hilly steepplands developed on crushed argillite with severe gully-dominated erosion
077e16	High	Terraces and fans on young flow and water sorted tephra, gullying dominant
077e19	High	Hill country with young tephra cover; both landsliding and gullying
078e 1	Very High	Sand country, foredunes
078e 2	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
078e 3	High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant

LegLUC	ESC_revised	Terrain
078e 4	Very High	Terraces and fans on young flow and water sorted tephra, gulying dominant
078e 4+4e 5	Very High	Terraces and fans on young flow and water sorted tephra, gulying dominant
078e 4+4s 2	Very High	Terraces and fans on young flow and water sorted tephra, gulying dominant
078e 4+7e16	Very High	Terraces and fans on young flow and water sorted tephra, gulying dominant
078e 5	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
078e 6	Very High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
078e 7	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
078e 8	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
078e 9	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
082s 1+7e 4	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
083e 2+7e 4	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
083s 2+7e 2	High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
083s 2+7e 4	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
083s 3+7e 1	High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
083s 3+7e 2	High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
083s 3+7e 4	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
083w 1+7e 2	High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
083w 2+7e 4	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
084e 1+8e 1	Very High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
084s 1+7e 4	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
086e12	High	Hill country developed on crushed argillite, Tertiary-aged mudstone and sandstone with moderate earthflow-dominated erosion
086s 3+6e12	High	Hill country developed on crushed argillite, Tertiary-aged mudstone and sandstone with moderate earthflow-dominated erosion
087e 1	High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
087e 1+7e 8	Very High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
087e 2	High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
087e 2+3w 1	High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
087e 4	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
087e 6	Very High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
087e 6+7e 5	Very High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion

LegLUC	ESC_revised	Terrain
087e 7	High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
087e 8	Very High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
087e 8+6e10	Very High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
087e 9	High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
087e 9+4s 1	High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
087e12	Very High	Hilly steeplands on weak Tertiary mudstone, landsliding dominant
087e12+3s 4	Very High	Hilly steeplands on weak Tertiary mudstone, landsliding dominant
087e13	Very High	Hilly steeplands developed on crushed argillite with severe gully-dominated erosion
088e 1	Very High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
088e 1+2w 1	Very High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
088e 1+3s 2	Very High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
088e 2	Very High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
088e 3	Very High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
088e 4	Very High	Sand country, foredunes
088e 5	High	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
088e 6	Very High	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
088e 7	High	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
088e 8	High	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
094s 2+8e 3	High	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
096e 9+8e 2	High	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
097e 4+8e 2	High	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
097e 5	High	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
098e 1	Very High	Sand country, foredunes
098e 2	High	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
098e 3	High	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
098e 4	High	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
098e 5	Very High	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous

LegLUC	ESC_revised	Terrain
		rocks, landsliding dominant
102c 1+8e 3	Very High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
102s 2+7e 3	High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
102w 2+7e 6	High	Hill country developed on crushed argillite, Tertiary-aged mudstone and sandstone with moderate earthflow-dominated erosion
102w 2+8e 3	Very High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
103e 4+8e 3	Very High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
103e 5+8e 3	Very High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
103e 8+8e 2	Very High	Terraces and fans on young flow and water sorted tephra, gullying dominant
103s 2+8e 3	Very High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
103s 6+7e19	High	Terraces and fans on young flow and water sorted tephra, gullying dominant
103s 6+8e 2	Very High	Terraces and fans on young flow and water sorted tephra, gullying dominant
103w 2+8e 3	Very High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
104e 8+7e 2	High	Hilly steeplands on weak Tertiary mudstone, landsliding dominant
106c 3+7e13	High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
106s 7+7e 9	High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
106s 8+8s 1	High	Hilly and mountainous steeplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
107e 1	High	Hilly steeplands on weak Tertiary mudstone, landsliding dominant
107e 1+8e 3	Very High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
107e 2	High	Hilly steeplands on weak Tertiary mudstone, landsliding dominant
107e 3	High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
107e 4	High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
107e 4+3e 4	High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
107e 5	High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
107e 6	High	Hill country developed on crushed argillite, Tertiary-aged mudstone and sandstone with moderate earthflow-dominated erosion
107e 7	High	Hilly steeplands on weak Tertiary mudstone, landsliding dominant
107e 9	High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
107e11	High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
107e11+6e20	High	Hilly steeplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant

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107e11+6e23	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
107e12	High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
107e13	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
107e13+8e 3	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
107e14	Very High	Hill country developed on crushed argillite, mudstone and greywacke with severe earthflow-dominated erosion
107e16	Very High	Hilly steepplands developed on non-cohesive sands, and gravels; both landsliding and gulying
107e17	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
107e18	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
107e19	High	Terraces and fans on young flow and water sorted tephra, gulying dominant
107e20	Very High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
107e20+6e20	Very High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
107e23	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
108e 1	Very High	Sand country, foredunes
108e 2	Very High	Terraces and fans on young flow and water sorted tephra, gulying dominant
108e 2+3s 6	Very High	Terraces and fans on young flow and water sorted tephra, gulying dominant
108e 3	Very High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
108e 3+2c 1	Very High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
108e 3+2s 1	Very High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
108e 3+3c 1	Very High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
108e 3+3e 5	Very High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
108e 3+3s 2	Very High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
108e 3+3w 2	Very High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
108e 3+4e13	Very High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
108e 4	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
108e 5	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
108e 6	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
108e 7	Very High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant

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108e 8	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
108e 9	Very High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
116e 6+7e 6	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
116e 6+8e 3	Very High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
116e 7+7e 5	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
116e 7+7e12	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
116e15+7e16	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
116e16+7e13	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
116e16+7e17	High	Hill country on deep loess, tunnel gulying
117e 2+7e26	High	Hill country on hard sedimentary rock, landsliding dominant
117e 2+8e 7	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
117e 4+8e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
117e 5	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
117e 6	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
117e 6+7s 1	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
117e 6+8e 3	Very High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
117e 7+8e 9	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
117e 8	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
117e11	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
117e12	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
117e12+4s 7	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
117e12+6e11	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
117e12+8e 4	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
117e13	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
117e13+6e16	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
117e13+8e 3	Very High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
117e14+8e 9	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous

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		rocks, landsliding dominant
117e15+8e 1	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
117e16	High	Hilly steepplands on weak Tertiary sandstone, limestone, conglomerate, moraine, alluvium, landsliding dominant
117e17	High	Hill country on deep loess, tunnel gullying
117e17+4e 6	High	Hill country on deep loess, tunnel gullying
117e17+6e16	High	Hill country on deep loess, tunnel gullying
117e17+7e19	High	Hill country on deep loess, tunnel gullying
117e18	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
117e19+8e15	Very High	Sand country, foredunes
117e20+7e26	High	Hill country on hard sedimentary rock, landsliding dominant
117e20+8e 7	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
117e20+8e 8	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
117e23+8e 8	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
117e24+8e 9	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
117e26	High	Hill country on hard sedimentary rock, landsliding dominant
117s 2+8e 1	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e 1	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e 1+7e 3	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e 3	Very High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
118e 3+7e 1	Very High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
118e 3+7e 6	Very High	Hilly steepplands on weak Tertiary mudstone, landsliding dominant
118e 4	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
118e 4+7e12	High	Hilly steepplands on weathered volcanics, greywacke, argillite, schist, granite, landsliding dominant
118e 5	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e 6	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e 6+7e12	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e 6+7e18	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e 6+7e24	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant

LegLUC	ESC_revised	Terrain
118e 7	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e 7+7e 2	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e 7+7e20	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e 7+7e26	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e 8	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e 9	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e 9+7e24	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e 9+8e11	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e11	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e11+8e 9	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e11+8e13	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e12	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e13	High	Hilly and mountainous steepplands on hard sedimentary, metamorphic and igneous rocks, landsliding dominant
118e15	Very High	Sand country, foredunes