LAND USE CAPABILITY CLASSIFICATION

A Land Use Capability (LUC) survey contains 2 sets of land resource information:

- Land resource *inventory* (factual information)
- *Land use capability* assessment (interpretive)

LAND RESOURCE INVENTORY

Over the last 20 years, one of the most valuable land use planning tools has been the Land Use Capability Classification. Land Resource Inventory (LRI) was a system devised in the USA and first used in New Zealand in 1941, initially to inventory land resources at a farm scale. It was not until 1967 when the passing of the Water and Soil Conservation Act that wider applications of LRI were envisaged. This was prompted by the demonstrated need for catchment inventories in order to comply with the management implications of the new Act. Surveys were carried out by the former Ministry of Works and Development (now Landcare Research NZ Ltd). The data is stored in a GIS and presented in map form. Surveys were undertaken at a scale of 1:63.360 (one inch to one mile) then 1:50.000 (1 cm to 500 m). In areas of need, more detailed surveys, often at farm scale, have been completed to assist individual farmers in planning land use on their farms and to combat erosion problems. The main clients for the survey were initially the Catchment Boards whose role is now within Regional Councils. The LRI was driven by the vision of one man in particular, Ken Mitchell, the head of the then Ministry of Works and Development.

The LRI worksheets are available from; Landcare Research Ltd,
PB 11-052, Palmerston North

Mapping was done by teams of 3 – 4 recent graduates and summer workers, supervised by personnel experienced in land inventory mapping. A sheet was mapped in 1 - 2 months. Although the original data was published as a series of maps (worksheets), subsequently the data has been digitised and can be stored, manipulated and analysed using computers. Thus present day major users such as Regional Councils can work with the digital data in GIS databases rather than paper maps.

LAND RESOURCE INVENTORY CODE

Rock Type - Soil Unit - Slope e.g. Tp – Ot - A
Present Erosion - Vegetation Cover Θ – P1

Tp = Taupo pumice alluvium
Ot = Otakiri sand
A = 0-3° slope

Θ = No significant erosion
P1 = High producing pasture

The symbols are explained in the legend that accompanies each map.

A series of mapping units are delineated which are physically homogenous within the limitations of the mapping scale: where any one factor changes significantly a boundary is drawn and a new mapping unit created. Using the above inventory parameters and other relevant physical information such as climate, erosion potential, effects of previous land use, land management practices, physical and chemical properties of soils, physical properties of rock types and flood risk; each mapping unit is given an assessment of its LUC, i.e. its capacity for permanent sustained production.

Rock Type

Obvious sources of data for rock types were the published geological maps of New Zealand, produced by the then New Zealand Geological Survey. The whole of New Zealand was covered by the 1:250,000 series but the 1:63,360 (later 1:50,000) series, although comprehensive, was not complete. In particular, the areas not covered were precisely the steep, eroding areas most important for catchment management.

TABLE 1: North Island Rock types used in the NZLRI

Volcanic Lithologies	Sedimentary Lithologies
Ng Ngauruhoe ash	Pt Peat
Ta Tarawera ash and lapilli	Wb Sands-windblown
Rm Rotomahana ash	Lo Loess
Kt Kaharoa and Taupo ashes	Al Undifferentiated flood plain alluvium
Mo Ashes older than Taupo ash	
Lp Lapilli	Gr Gravels
Tp Taupo and Kaharoa breccia and volcanic alluvium	Us Unconsolidated silts, ashes, sands, tuffs and breccias
Ft Breccias older than Taupo breccia	Mm Mudstone or fine siltstone-massive
La Lahar deposits	Mb Mudstone or siltstone - banded
Vo Welded volcanic rocks	Mj Mudstone or siltstone - jointed
Gn Crystalline intrusive rocks	Me Mudstone - bentonitic
	Sm Sandstone or siltstone - massive
Note	
* denotes deep weathering	Sb Sandstone - banded
(Al) significant in patches	Ar Argillite
Lo/Gw stratigraphic succession, surface rocks first	Ac Argillite - crushed
	Li Limestone
	Gw Greywacke

A further problem was that the published maps all recorded map units in terms of rock age rather than rock type. This was of little value for determining surficial rock types that were related to erosion processes, i.e. soil-forming parent materials and susceptibility to erosion. As a result simplified lithological classifications were developed for the LRI worksheets based on rock characteristics that affect land management and water quality. The North and South Islands had separate classifications because the rock types differed considerably. For example, young volcanic ash layers dominate much of the central North Island but are rare in the South Island.

Soil

This was the most controversial aspect of the LRI mapping. Soil map coverage of New Zealand is limited at the 1:63,360 or 1:50,000 scale and the only national coverage was at 1:250,000. The information from these small-scale maps had to be carefully interpreted and was not really easily transposed to a 1:63,360 map. The soils information was supplemented by additional field observations, interpretations of soil parent materials and analysis of aerial photographs. This led to some conflict between the then Soil Bureau and MOWD over the

accuracy of the soils information. On the one hand the MOWD staff were not usually experienced at soil mapping, were working quickly and were focussed on applications to erosion. On the other hand Soil Bureau staff were experienced at soil mapping but traditional soil mapping was slow and recorded very detailed information about a soil.

Symbols and names on the worksheets were drawn from existing soil surveys, where available, and the user is referred to the appropriate soil map and bulletin on the worksheet for more detailed soils information. Note that the worksheets are not soil maps but they will give an indication of the soils you are most likely to find.

TABLE 2: South Island Rock types used in the NZLRI

Al	Alluvium, colluvium, moraine	Wb	Sand
Th	Basic - intermediate ash	Lo	Loess
Ms	Soft mudstone	Ss	Soft sandstone
Cg	Soft Conglomerate	Ls	Soft limestone
Fy	Interbedded soft sandstone and rnudstone	Gw	Greywacke
		Ma	Marble
Hl	Hard limestone	Ms	Hard sandstone
St	Schist		
An	'Argillite', hard mudstone	Ar2	Sheared argillite
On	Coarse crystalline rocks	Um	Ultramafite
Vo	Volcanic lavas, flows	Pt	Peat
In	Intrusives, ancient volcanics	I	Perennial ice and snow
Os	Gneiss		

Note

()	denotes significance in patches
Lo/Gw	denotes stratigraphic succession, surface rocks first
w	denotes deep weathering

Note that on flat land the major difference between LRI units is usually the soil factor and soil maps will give more detailed information that can be interpreted for land use or management. In hill country, however, erosion processes dominate and the other LRI factors are more important for land use or management interpretations.

Slope

Slope angles for each area were measured using an Abney level or estimated visually in the field. The data was recorded in one of seven slope groups and the slope group recorded in the LRI code.

Table 3: NZLRI Slope Groups

Slope Groups	Description	**Landform Units**	Limitations	
A 0°-3°	Flat to gently undulating	Floodplains, terraces	Problems of rill erosion and topsoil	
B 4°-7°	Undulating	Fans, gently sloping downs	displacement increase with slope	
C 8°-15°	Rolling	Downs, steep fans		ARABLE
D 16°-20°	Strongly rolling	Easy hill country, downs	Cultivate for pasture development	
E 21°-25°	Moderately steep	Hill country		
F 26°-35°	Steep	Steep hill country, mountain lands		NON-ARABLE
G >35°	Very steep	Very steep slopes, rock faces, cliffs		

Note that compound slopes can be recorded, for example C + D indicates slopes of both groups present. C/D indicates slopes borderline between the twos slope classes. The use of an apostrophe indicates a dissected slope, for example A' indicates flat land dissected by gullies.

Erosion

Erosion mapping was based on common types of erosion with relevance to land use and includes a rating for severity. The mapped erosion was that current at the time of the survey and still showing evidence of activity in the form of bare ground or surface expression.

Fourteen erosion types were mapped (Table 2.1-3). Severity was estimated on the basis of area for wind, sheet and scree creep and on "seriousness" for the remaining erosion types. The factors used in this assessment included rock type, rate and depth of movement, frequency of erosion events, cost and feasibility of control and economic effect.

Table 4: NZLRI Erosion type and degree

Types of Erosion				Degree of Erosion	
Sh	sheet	EF	earth flow	θ	negligible
W	wind	MF	mud flow	1	slight
Sc	scree slip	R	rill	2	moderate
SSi	soil slip	G	gully	3	severe
ESi	earth slip	T	tunnel gully	4	very severe
Su	slump	Sb	streambank	5	extreme
DaF	debris avalanche	D	deposition		

Erosion types are discussed in detail in the section on management of eroding soils.

Vegetation

Five major groups were used to record vegetation cover; cropland, grasslands, forest, scrub and fern, and miscellaneous weeds. Further subdivision was made to emphasise agriculturally important species or associations of species. A maximum of three vegetation groups are recorded for each unit area. Note that the vegetation groups recorded were those present at the time of the survey.

Table 5: NZLRI Vegetation Classes

GRASSLAND	CROPLAND
P Unspecified grassland P1 High producing pasture P2 Low producing pasture or native grassland P3 Short tussock assns, mainly silver and hard tussock, etc P4 Snow tussock associations P5 Red tussock associations P6 Sand dune associations	L Unspecified crops L1 Cereals L2 Orchards and vineyards L3 Roots and green fodder crops L4 Horticulture
SCRUBLAND	FOREST
M Unspecified scrub associations M1 Manuka, kanuka M2 Tauhinu (Cassinia) M3 Dracophyllum M4 Fern M5 Sub-alpine scrub associations M6 Mixed native scrub associations M7 Broom M8 Gorse M9 Blackberry M10 Sweet briar M11 Matagouri M12 Mangroves	N Unspecified forest associations N1 Coastal forest N2 Kauri N3 Podocarp-hardwood (a) Lowland (b) Mid latitude N4 Nothofagus (a) Lowland (b) Highland N5 Hardwood N6 Exotic forest N7 Podocarps N8 Conservation trees
WEEDS, HERBS, ETC H Unspecified herbaceous plant association H1 Swamp associations H2 Rushes, sedges H3 Sand dune associations H4 Sub-alpine herb associations H5 Salt tolerant associations H6 Pakihi H7 Semi-arid herbfield associations	
A capital letter indicates type of vegetation comprises >40% of the unit area and a small letter <40% while c indicates cutover forest.	

Recent Changes to LRI

The LRI code has been recently updated and the changes are described in detail in the lastest LUC Handbook available from Landcare Research. This also can be accessed as a black and white pdf file from the Landcare website *www.landcare.cri.nz* .

The significant changes include revision of categories in rock types, use of the new NZ Soil classification in more recent surveys, condensing soil slip and earth slip into a single category of soil slip, addition of a modifier to indicate shallow or deep movement in relavant erosion types, more detailed criteria for assessing erosion intensity such as % area in a unit that is eroded and modifications to vegetation information that provide more detailed information. These changes are most relevant to more recent maps, however, the older paper copy LRI Worksheets use only the earlier definitions. To reiterate – the information on a worksheet is relevant to the time that the worksheet was complied and can change with time. Always check the date and bear this in mind when examining worksheet data.

LAND USE CAPABILITY

Introduction

Land Use Capability (LUC, or Rural Land Use Capability, RLUC, to distinguish it from Urban LUC) is an assessment of the land according to its suitability for permanent, sustained production. This is based on its physical properties determined in the LRI. The assessment carries a use-risk factor as it is an assessment based on current technology and conditions at the time of assessment and outcomes of land use may depend on other influences, such as technology change. It does not indicate a preferred land use for a given area; rather it shows the currently assessed capability of the land within its determined physical limitations.

LUC Classes

The major grouping of the LUC assessment is the LUC class (Figure 1). There are 8 classes ranked in order of decreasing capability for use from I to VIII (Table 6). The capability class of an area of land indicates its total degree of limitation and the higher the class the less versatile the land. Class I to IV lands are generally arable while class V to VIII land is unsuitable for cropping. Class I land is the best agricultural and horticultural land in New Zealand and is able to be used for a wide variety of crops with insignificant physical limitations to arable use. In contrast, Class VIII land has maximum limitations to land use with no capacity for permanent, sustainable production.

LUC CODE

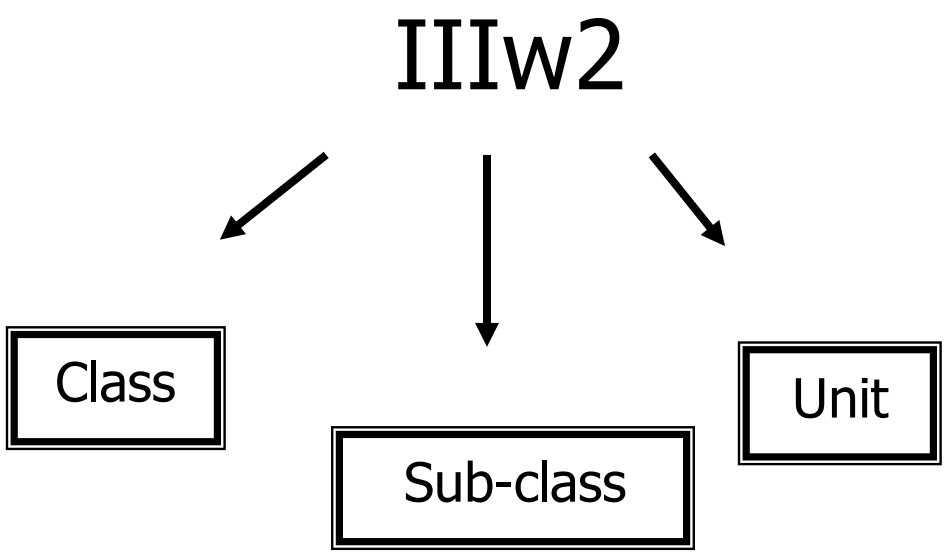

Figure 1: The LUC code and its components

Table 6: Description of LUC Classes

CLASS	LIMITATIONS	LANDSCAPE AND CLIMATE	LOCATION
I	Versatile, multiple use land with minimal physical limitations to arable land use. No plant nutrient deficiencies and respond to fertiliser applications. Minimal erosion risk.	Flat to nearly flat with deep, easily worked soils. Climate favourable to growth of a variety of plants	Confined to small areas of well drained soils derived from alluvium and are mostly located on flood plains of major rivers. Occurs throughout New Zealand but the total area is small.
II	Very good land with slight limitations to arable use that can be overcome by management and conservation practises. Limitations are wetness, slight textural problems or shallow soils.	Flat to undulating land that can be used for cultivated crops, forestry or pastures.	More abundant than class I land and occur in similar locations with the addition of some areas of fine textured volcanic loam in the North Island.
III	Moderate limitations restrict the range of crops and/or make special conservation measures necessary. Moderate erosion risk when cultivated, shallow or stony soils of plains and terraces and soils of narrow river valleys where runoff causes wetness.	Undulating to rolling country that can be used for some cultivated crops, pastures and forestry.	Widely distributed throughout New Zealand on undulating to rolling country.
IV	Severe limitations to arable use, such as erosion, shallow, stony and/or low fertility soils, excessive wetness and climate effects of altitude requiring careful management and/or intensive conservation.	Undulating to strongly rolling country, but with more pronounced limitations than Class III land. Colder, higher altitudes.	Occurring in similar situations to Class III land but with more severe limitations to cropping.
V	High producing pastoral land unsuitable for cropping but with few limitations to pastoral or forestry use. Limitations to arable use are slope, presence of boulders or rock outcrops and excessive wetness. Erosion is not a dominant limitation in this class with	Strongly rolling to moderately steep hill country or bouldery river flats. Often has a climate limitation.	Limited extent and confined to stable hill country or localised areas of river flats.

	the land surface stable under a permanent vegetation cover.		
VI	Non-arable land with moderate limitations and hazards under perennial plant cover. Erosion is the dominant limitation but can be minimised by using appropriate conservation measures. Soil limitations occur but wetness and climatic factors are less dominant.	Relatively stable hill country and some shallow soils on fans and terraces.	Widely distributed and includes most of New Zealand's good, relatively stable hill country.
VII	Unsuitable for cultivation with severe limitations or hazards under perennial vegetation. Similar limitations to Class VI but more intense. Risk of erosion is usually the dominant limitation, requiring careful conservation for grazing use. Can also have severe soil, wetness and climate limitations. Can only support extensive grazing or erosion control forestry.	Eroding hill and steeplands, high altitude lands and shallow, stony and/or low fertility soils of the fans and terraces.	Most of the eroding hill and steepland soils of the North Island and the South island "high country" and West Coast Pakahi soils
VIII	Very severe to extreme limitations and hazards; unsuitable for arable, pastoral or production forestry use. Soil conservation and water quality are the main issues in land use. Main limitation is extreme actual or potential erosion. Used for catchment protection, recreation and water management.	High mountainous country but may include very steep slopes or highly erodable areas such as foredunes at lower altitudes.	Land of the axial ranges and other mountainous areas of both North and South Islands, coastal dunes and areas of very steep slopes in hill and steepland areas.

Examples of classes I to VIII are shown in Figure 2.

LUC Subclasses

The second factor in the LUC code is the subclass, which indicates the dominant kind of limitation (Table 7). Note that only one subclass can be expressed and the dominant is selected; there may be other subordinate limitations also present. Each LUC unit must have a subclass and some units to which the erodability, wetness or soil limitations do not apply are classed as having a climate limitation by default. There is an inverse relationship between limitations and versatility (Table 8).

Table 7: LUC Subclass definitions

Subclass	Description	Definition
e	erodability	where the susceptibility to erosion is the dominant limitation to land use
w	wetness	where a high water table, slow internal drainage and/or flooding constitutes the major limitation to use
s	soil limitation	where the major limitation to land use is a limitation in the rooting zone. This can be due to a shallow profile, stoniness, rock outcrops, low soil water holding capacity, low fertility (where this is difficult to correct) and salinity or toxicity
c	climate	where the climate is the major limitation to land use

LUC Units

The land use capability (represented by an Arabic number) *groups together those inventory units which require the same kind of management, the same kind and intensity of conservation treatment and are capable of growing the same kind of crops, ,pasture or forest species with about the same potential yield.*
For example, four areas of land might be classed as VIe3, VIe7, VIe12 and VIe16 respectively. All have the same broad degree of limitation (Class VI) and all have the same dominant type of limitation (subclass e). However, the units differ in the kinds of crops able to be grown and potential yields, or management or conservation techniques required for sustainable production. LUC units are only relevant to a particular regional survey, e.g. Taranaki –Manawatu, and cannot be compared across regions. Capability units are arranged in order of decreasing versatility and increasing limitation to use, e.g. VIIIe5 has a higher capability than VIIe8 but not as high as VIIe2.

Table 8: LUC Limitations vs Versatility

Increasing Limitations to use

Class	Cropping Suitability	General Pastoral & Production Forestry Suitability	General Suitability
I	High	High	Multiple Use Land
II			
III	Medium		
IV	Low		
V		Medium	
VI	Unsuitable	Low	Pastoral or Forestry Land
VII			Catchment Protection land
VIII			

Decreasing versatility

Extended Legends

Each set of worksheets is accompanied by a set of extended legends that vary from region to region. These comprise tables of the physical data relating to each of the LUC units. Table 9 is an example of an extended legend for the Taranaki –Manawatu Region.

Examples of each of the LUC classes is shown on the STREAM site.

Table 9: Example of an LUC extended legend.

.UNIT	UNIT DESCRIPTION	PRESENT LAND USE	GRAZING Carrying Capacity (SU/ha)			POTENTIAL LAND USE		
			Present Average	Top farmer	Attainable physical potential	CROPPING	FORESTRY	EXOTIC FOREST GROWTH POTENTIAL (site index *P. radiata*)
IIw2	Flat river terraces with deep fertile soils which have a continuing slight wetness limitation after drainage. Unit occurs predominantly in the Manawatu but is widespread throughout the region	Intensive grazing, incl. Dairying. Horticulture incl. Vegetable cropping. Cereal cropping. Root and green fodder cropping.	19	25	30	Horticulture. Cereals. Root and green fodder crops.	Production	33-35

PASTURE FERTILISER REQUIREMENTS FOR SHEEP AND CATTLE GRAZING			TYPICAL SOILS		
	MAINTENANCE	ROCK TYPE			

INITIAL	At present average grazing capacity	At attainable physical potential grazing levels	Trace elements			NAME	Symbol	*Survey
600 kg/ha super-phosphate	250 kg/ha super-phosphate	400 kg/ha super-phosphate		Undifferentiated flood plain alluvium	Al	Gley Recent soils: Kairanga silt loam and clay loam Kairanga silt loam Kairanga fine sandy loam Kairanga heavy silt loam Gley soils: Te Arakura silt loam Te Arakura fine sandy loam Te Arakura sandy loam	 2 K 4 K1 4b 8 8a 8b Te2	 1 7 9 10 9 9 9 9 10

SLOPE	EROSION		VEGETATION	TYPE LOCALITY	SOIL CONSERVATION AND WATER MANAGEMENT MEASURES	ADDITIONAL COMMENTS
	PRESENT	POTENTIAL				
A	Nil to slight streambank	Nil to slight streambank	High producing pasture. Cereals. Root and green fodder crops.	N149/070365 Intersection of Flygers Line and Gillespies Line.		Shelterbelts required for horticulture.