The Potential Use of the Land Capability for Agriculture Classification for Determining Support to Disadvantaged Areas of Scotland

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Executive summary

1. A draft EC Rural Development Regulation 2004/0161 (Article 35) suggested that future LFA support should be provided for sustainable use of agricultural land through payments to farmers in areas with natural handicaps. For areas other than mountain areas, it was suggested that payments could only be justified where the areas were 'affected by significant natural handicaps, notably low soil productivity or poor climate conditions……. '

2. On the basis that the definition of 'significant natural handicaps' was likely being based on soil and climatic criteria, the Scottish Executive Environment and Rural Affairs Department (SEERAD) commissioned the Macaulay Institute (in late 2004/early 2005) to research whether the existing Macaulay Land Capability for Agriculture (LCA) classification system could be used as a systematic basis for defining such areas of natural handicap in Scotland.

3. This research was completed before the final Rural Development Regulation (1698/2005) was agreed. Although no agreement was reached on the re-designation of LFAs, the new Council regulation includes provision for a revision to LFA designation and support, which will not come into force until 2010.

4. As a contribution to the debate on options for re-designation, the Macaulay Institute, with the agreement of SEERAD, has produced this publication, which summarises the research on the relationships between the distribution of the Macaulay LCA classes and the areas currently designated as LFA in Scotland.

5. The Land Capability for Agriculture classification was developed by the Macaulay Institute to describe the agricultural potential of land based on the degree of limitation imposed by its biophysical properties. It is based primarily on climate, a number of soil properties, (for example depth and stoniness), wetness, erosion risk and slope. Also included are the overall pattern, i.e. variability, and, in one of the classes (Class 6), vegetation cover is also taken into account.

6. The spatial coincidence between LFA and non-LFA land and LCA classification was examined for all IACS registered land (N.B. only about 60% of land within the LFA is classed as agricultural land, i.e. IACS registered).

7. For the IACS registered land the results of this comparison show that there is a close correlation between the current LFA designation and the distribution of LCA classes in Scotland. Nearly all Macaulay LCA Class 1, 2 and 3.1 land is non-LFA, while virtually all Class 4, 5, 6 and 7 land lies within the LFA boundary. However, Class 3.2 land occurs within both LFA and non-LFA designation: 41.8% of Class 3.2 land is LFA and 56.8% is non LFA[1].

8. On the basis of this research it is concluded that the Macaulay LCA classification system, and the associated published LCA maps, offer a potentially robust method for designating LFA land in Scotland in the future.

[1] Note that these figures do not add up to 100% as 1.4% of Class 3.2 land had no LFA status described.

1. Introduction

Support to the Less Favoured Areas (LFA) of Scotland is currently provided by the Less Favoured Area Support Scheme. Designation of LFA was defined in Council Directive 75/268 in 1975 on mountain and hill farming and farming in certain less favoured areas. LFA Directive 2328/91 provided a framework for payment of annual compensatory allowances to farmers in designated LFAs which were characterised by;

- Permanent handicaps (altitude, poor soils, climate and steep slopes)
- Undergoing depopulation or having very low densities of settlements, and
- Experiencing poor drainage, having inadequate infrastructure or needing support for rural tourism, crafts and other supplementary activities.

LFA policy was revised under Agenda 2000 EU Rural Development Regulation 1257/99 (RDR) Articles (13-21) and with the inclusion of a more explicit link to environmental protection the updated objectives were:

- to ensure continued land use and thereby contribute to the maintenance of a viable rural community;
- to maintain the countryside; and
- to maintain and promote sustainable farming systems which take account of environmental protection requirements.

A draft Rural Development Regulation, COM 2004/0161 (Article 35). suggested that support should be provided (amongst other things) for sustainable use of agricultural land through:

(i) natural handicap payments to farmers in mountain areas,
(ii) payments to farmers in areas with handicaps, other than mountain areas.

Article 47 stated that Member States should designate areas eligible for payment areas defined under (i) and (ii) above. To be eligible under (i) mountain areas had to be characterised by a considerable limitation of the possibilities for using the land and an appreciable increase in the cost of working it due:

(a) to the existence, because of altitude, of very difficult climatic conditions, the effect of which is substantially to shorten the growing season

(b) at a lower altitude, to the presence over the greater part of the area in question of slopes too steep for the use of machinery or requiring the use of very expensive special equipment, or to a combination of these two factors, where the handicap resulting from each taken separately is less acute but the combination of the two gives rise to an equivalent handicap.

It was proposed that areas north of the 62nd parallel and certain adjacent areas be regarded as mountain areas.

To be eligible for payments under (ii), areas should be:

(a) affected by significant natural handicaps, notably a low soil productivity or poor climate conditions and where maintaining extensive farming activity is important for the management of the land, or

(b) affected by specific handicaps, and where land management should be continued in order to conserve or improve the environment, maintain the countryside and preserve

the tourist potential of the area or in order to protect the coastline. (These areas cannot exceed 10% of the area of a Member State).

The proposed definition of 'significant natural handicaps' being based on low soil productivity and poor climate conditions, led to the Scottish Executive Environment and Rural Affairs Department commissioning the Macaulay Institute in late 2004/early 2005 to explore how Land Capability for Agriculture (LCA) might be used to define such areas in the future.

This work was completed before the final Rural Development Regulation (1698/2005) was agreed. Although no agreement was reached on the re-designation of LFAs, the new Council regulation includes provision for a revision to LFA designation and support which will not come into force until 2010.

As a contribution to the debate on options for re-designation the Macaulay Institute, with the agreement of SEERAD, has produced this publication, which explores the link between Land Classification for Agriculture and current LFA designation in Scotland.

2. Land Capability for Agriculture

The Land Capability for Agriculture classification was developed by the Macaulay Institute to describe the agricultural potential of land based on the degree of limitation imposed by its biophysical properties. It is based primarily on climate, a number of soil properties, (for example depth and stoniness), wetness, erosion risk and slope. Also included are the overall pattern, i.e. variability, and, in one of the classes (Class 6), vegetation cover is also taken into account. The classification is supported by a series of guidelines to ensure that classification by different users and in different areas will be as objective and consistent as possible. (Bibby *et al.*1991). A summary of the definition of each Class is given in Appendix 1. There have been two phases of LCA mapping in Scotland the first was at 1:250,000 scale in 1981 and a later 1:50,000 scale phase in 1987.

There are a number of important assumptions that underpin the classification and it is important that they are recognised when use is made of the system. The classification:

- is designed to assess the value of land for agriculture
- is based largely on physical characteristics and the degree to which they limit agricultural flexibility
- does not group land according to its most profitable use
- assumes a *satisfactory level of management*
- does not include location, farm structure and condition and access to markets and therefore these criteria do not influence grading
- is based on current knowledge; revisions may be required with new experience or technological innovations

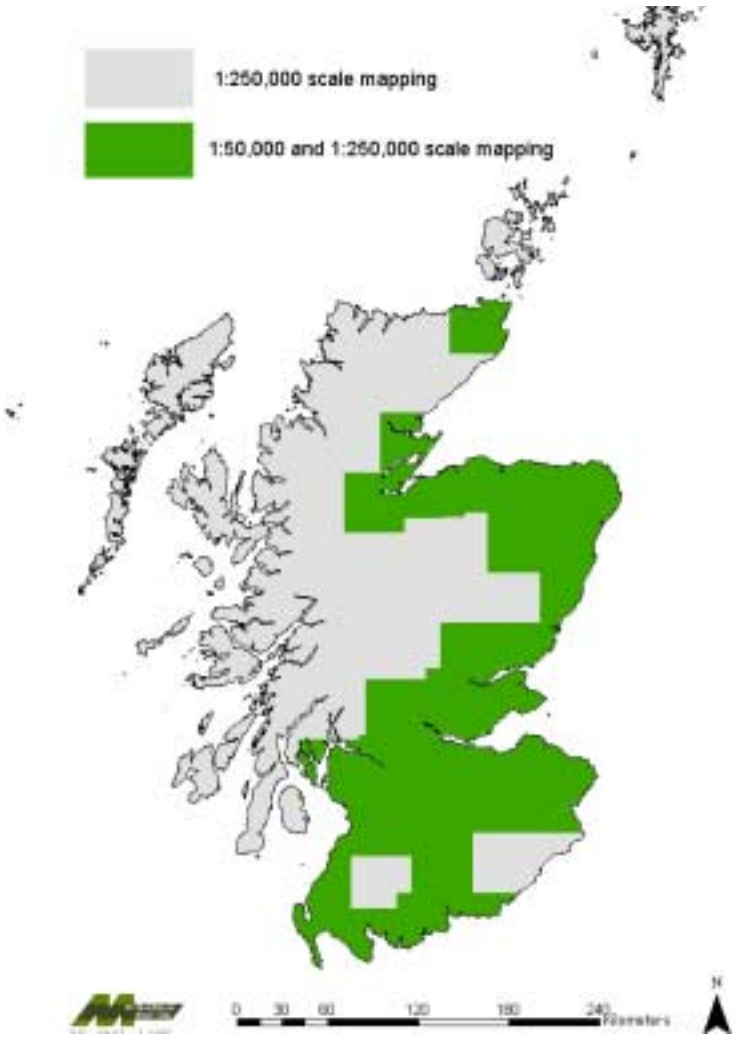
Given that the LCA is based primarily on climate and soil it is an obvious candidate for consideration as a method for classifying land in relation to Article 47 Section 3(a) of the Council Regulation 2004/0161.

The whole of Scotland has been mapped for LCA at 1:250,000 scale, while part of the country has also been mapped at 1:50,000 scale (Map 1). The 1:50,000 scale data cover most of the improved agricultural land and the adjacent upland fringe and cover most of the

east coast, the central belt and the Solway Coast. Both datasets are available in digital form.

This report explores the potential of using the LCA as a means of defining natural handicap in relation to Article 47 Section 3(a). In particular it examines the geographical coincidence between the existing Less Favoured Areas (LFA) in Scotland and the LCA classification.

Map 1. Extent of 1:250,000 and 1:50,000 scale LCA data



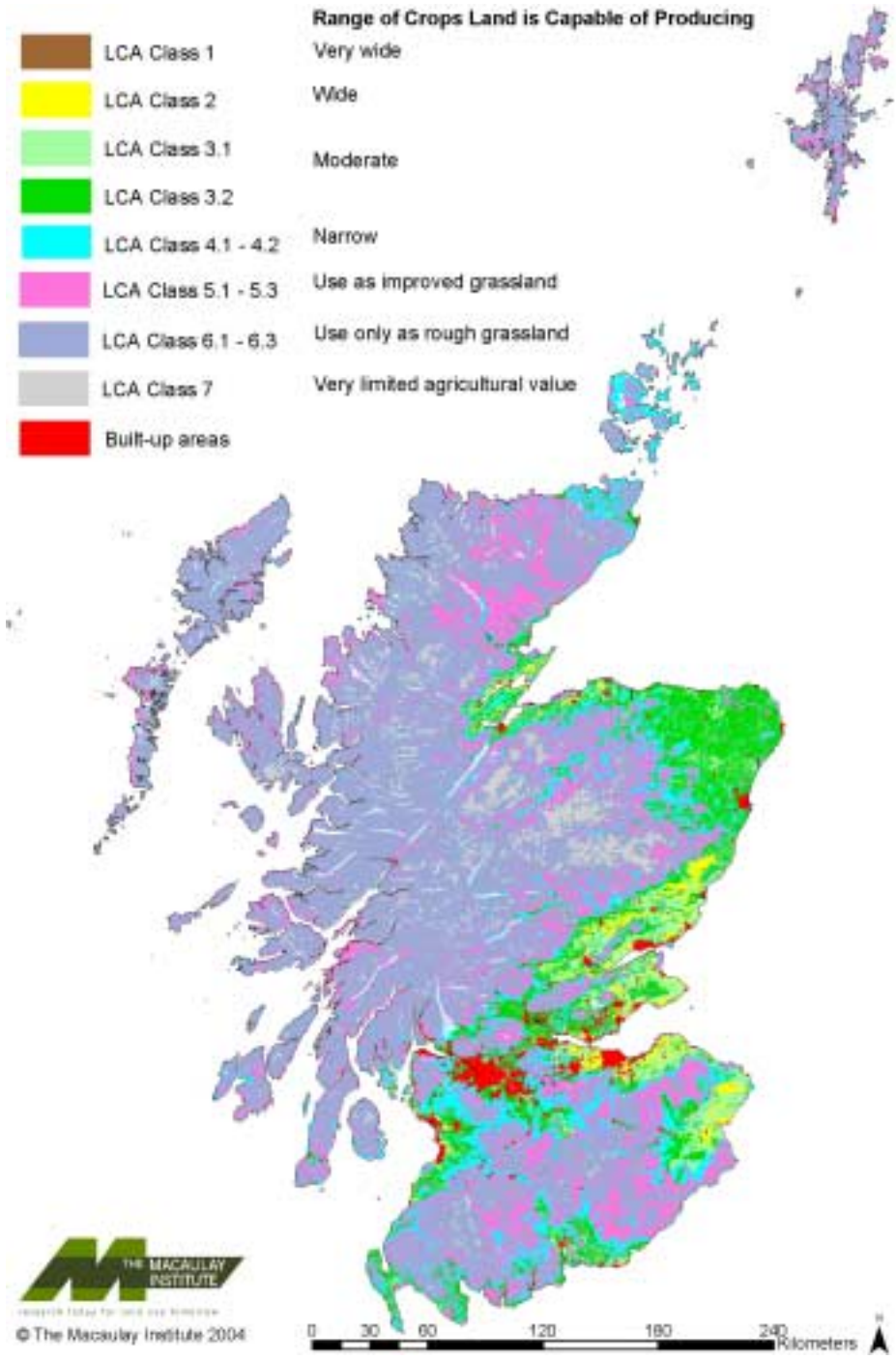
3. Data used in the analysis

A 'fused' version of the Land Capability for Agriculture dataset was prepared. This contained 1:50,000 scale data, where these are available, and 1:250,000 scale data where the 1:50,000 scale data are not available (Map 2). The majority of the inland boundaries of the

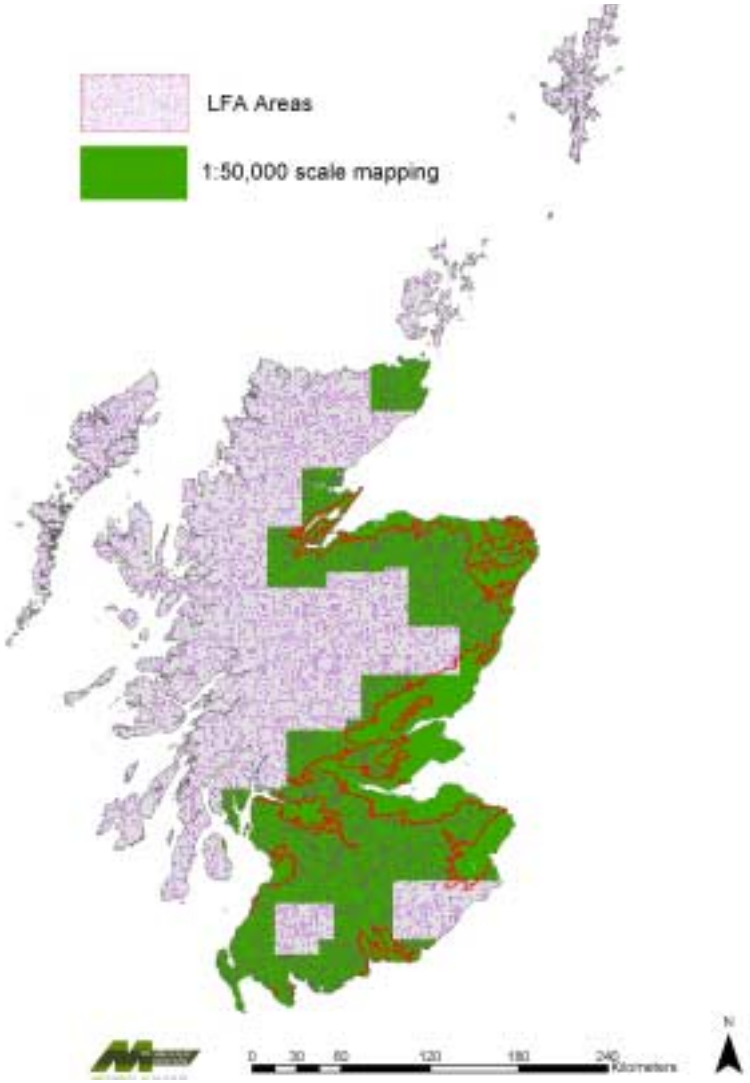
LFA fall within the extent of the 1:50,000 scale dataset (i.e. areas with the highest resolution of mapping). This is shown on Map 3.

Only about 60% of the land within the LFAs is classed as agricultural land, i.e. IACS registered. In order to restrict the analysis to IACS registered land, information on the location of IACS land was provided by SEERAD and merged with the 'fused' LCA data. This allowed the IACS registered land to be classified for LCA.

Map 2. Land Capability for Agriculture



Map 3. LFA areas in relation to availability of 1:50,000 scale LCA data



To allow comparison of the effects of using 1:50,000 or 1:250,000 scale data, two final datasets were created, both covering only the areas where 1:50,000 scale LCA data are available. One dataset comprised IACS data and 1:50,000 scale LCA and the other comprised IACS data and 1:250,000 scale LCA

4. Results

Comparison of LCA with LFA

The area of LFA (both Disadvantaged and Severely Disadvantaged) and non-LFA land in each LCA class, for the IACS registered land, is shown in Figure 2 and Table 1. Table 2

shows the percentage of LFA and non-LFA IACS registered land in each LCA class.

Figure 1

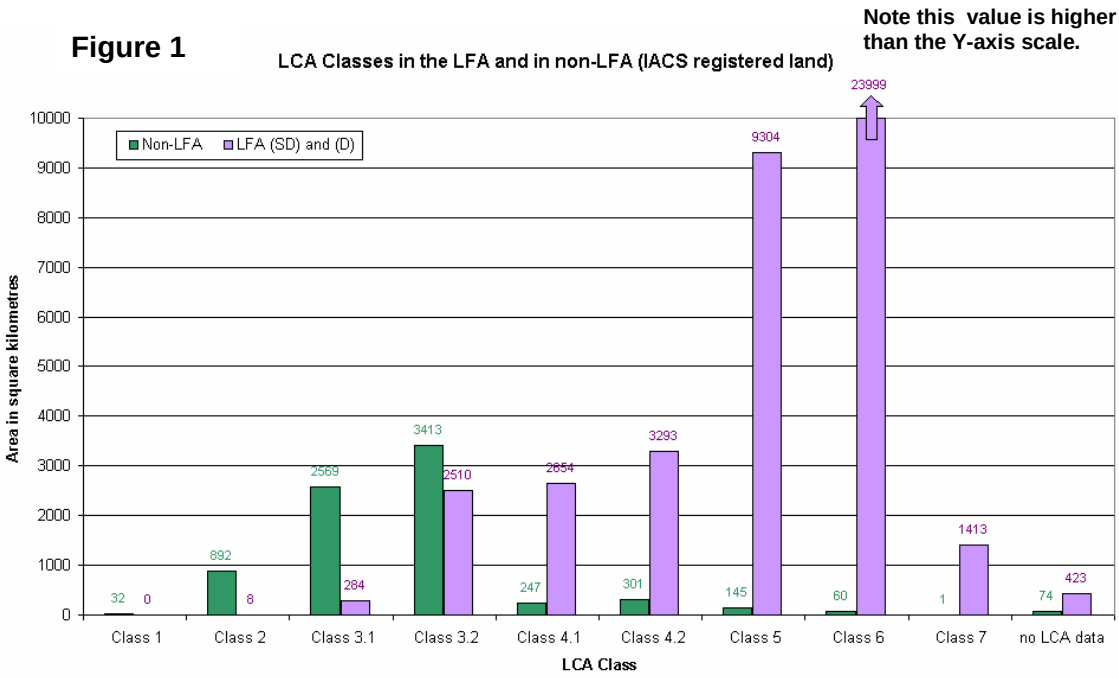


Table 2. The area of LFA and non-LFA land in each LCA class in Scotland (IACS registered land only)

LCA Class	Area of LFA (km^2)	Area of non-LFA (km^2)	Land with no LFA status described (km^2)[2]	Total (km^2)
Class 1	0.0	32.2	0.4	32.7
Class 2	7.7	892.2	7.1	907.0
Class 3.1	284.4	2568.6	28.5	2881.5
Class 3.2	2510.4	3413.0	84.5	6007.9
Class 4.1	2653.5	247.3	46.1	2946.9
Class 4.2	3292.5	300.6	72.6	3665.7
Class 5	9304.1	145.3	192.0	9641.4
Class 6	23998.8	60.3	933.2	24992.3
Class 7	1412.8	1.3	77.7	1491.7
No LCA data	423.2	73.8	22.0	519.0
Total IACS registered land	43887.4	7734.62	1464.1	53086.1

[2] Some land in the IACS dataset contains no information on LFA status. Although there may be many reasons for this, this land has been included in all of the analyses and is included in Tables 2 and 3. The distribution of LCA classes in this area (where no LFA status is defined) is very similar to that for the rest of the country, so the exclusion of this area is not considered to be a serious omission.

Less that 1% of LFA land falls into LCA Classes 1, 2 and 3.1 while 94% of LFA land falls into Class 4.1 or poorer quality. Thus LCA Classes 1 to 3.1 and 4.1 to 7 provide excellent discrimination between the current LFA and non-LFA designation. This suggests that LCA could in principle provide a useful method of classifying natural disadvantage. However land in Class 3.2 occurs widely in both LFA and non-LFA.

Table 3. The percentage of LFA and non-LFA IACS registered land in each LCA Class

LCA Class	Area of LFA (%)	Area of non-LFA (%)	Land with no LFA status described (%)
Class 1	0.00	0.42	0.03
Class 2	0.02	11.54	0.48
Class 3.1	0.65	33.21	1.94
Class 3.2	5.72	44.13	5.77
Class 4.1	6.05	3.20	3.15
Class 4.2	7.50	3.89	4.96
Class 5	21.20	1.88	13.11
Class 6	54.68	0.78	63.74
Class 7	3.22	0.02	5.31
No LCA data	0.96	0.95	1.50
Total IACS registered land	100.00	100.00	100.00

Effect of scale of LCA mapping

Because of the different scales and systems of mapping (1:50,000 scale is 1cm to 0.5 km and 1:250,000 scale is 1cm to 2.5 km), it is reasonable to expect differences in the way the same area would be mapped. In order to test the importance of these differences, an analysis was carried out to compare the areas of the different LCA classes on those parts of Scotland where both 1:50,000 scale and 1:250,000 scale data were available (see Map 1).

Tables 4 and 5 show the areas identified in the different LCA classes fro the two scales of data, along with the percentage difference. Table 4 shows the data for all land, while Table 5 shows IACS registered land only. Notably, the differences are most marked with LCA Class 2 and LCA Class 3.1 land.

The agreement between the two scales is generally good, apart from in LCA Classes 2, 3.1 and 7, where the area is greater at the 1:250,000 scale. However it must be remembered that the areas mapped at the 1:50,000 scale tends to be the better quality land, so the proportion of Class 7 land in this restricted data set is very small. With this caveat, the agreement is generally good for the LCA classes that are of interest within the current LFA designation. Generally the agreement is better for the IACS registered land than for all of the land.

Table 4. Areas of different LCA Class, and percentage difference in the LCA Classification mapped at 1:50,000 and 1:250,000 scales (all land covered by 1:50,000 LCA data).

LCA Class	Area of Land (km^2)		Ratio (%)
	1:50,000 scale	1:250,000 scale	
Class 1	43.2	40.3	93.4
Class 2	1064.8	1723.7	161.9
Class 3.1	3357.0	4404.6	131.2
Class 3.2	7060.9	6781.0	96.0
Class 4.1	3090.0	3039.7	98.4
Class 4.2	3499.7	3385.9	96.8
Class 5	6870.0	6935.1	100.9
Class 6	7714.6	6963.6	90.3
Class 7	206.7	252.4	122.1
No LCA data	2070.9	1434.0	
Total	34997.8	34960.2	

Table 5. Areas of different LCA Class, and percentage difference in the LCA Classification mapped at 1:50,000 and 1:250,000 scales (only IACS registered land covered by 1:50,000 LCA data).

LCA Class	Area of Land (km^2)		Ratio (%)
	1:50,000 scale	1:250,000 scale	
Class 1	32.7	28.1	86.1
Class 2	885.6	1358.4	153.4
Class 3.1	2830.5	3617.7	127.8
Class 3.2	5821.5	5270.0	90.5
Class 4.1	2425.9	2329.8	96.0
Class 4.2	2646.2	2480.9	93.8
Class 5	4571.6	4597.3	100.6
Class 6	4801.0	4365.6	90.9
Class 7	153.9	194.7	126.5
No LCA data	181.1	105.2	
Total	24349.8	24347.7	

There are a number of possible reasons for the differences in area between the two scales:

- The minimum mapping unit, or the smallest area that is capable of being shown on a map, is much smaller at 1:50,000 scale than at 1:250,000, bearing in mind that 1cm represents a linear distance of 0.5 km (1:50,000) and 2.5km (1:250,000) respectively. Thus where land classes tend to occupy relatively small areas they will tend to be systematically omitted at smaller map scales (i.e. 1:250,000). In mapping science this is termed aggregation bias with a systematic under-recording of features that tend to occur in small aerial units.

- The 1:50,000 and 1:250,000 mapping programmes were not carried out at the same time. The 1:250,000 scale map was produced in 1981 at the same time as the production of the LCA guidelines. As a result, there had been little actual practical operation of the guidelines and there was some reassessment as familiarity with the guidelines increased when the 1: 50,000 scale data were compiled in 1987. Also some new data became available between the two survey dates, leading directly to reassessment of some soils.

5. Conclusions

For the IACS registered land the results of this comparison show that there is a close correlation between the current LFA designation and the distribution of LCA classes in Scotland. Nearly all Macaulay LCA Class 1, 2 and 3.1 land is non-LFA, while virtually all Class 4, 5, 6 and 7 land lies within the LFA boundary. However, Class 3.2 land occurs within both LFA and non-LFA designation: 41.8% of Class 3.2 land is LFA and 56.8% is non LFA[3].

On the basis of this research it is concluded that the Macaulay LCA classification system, and the associated published LCA maps, offer a potentially robust method for designating LFA land in Scotland in the future.

6. Reference

Bibby J S *et al,* 1991. Land Capability Classification for Agriculture. The Macaulay Land Use Research Institute, Aberdeen. ISBN 0 7084 0508 8

[3] Note that these figures do not add up to 100% as 1.4% of Class 3.2 land had no LFA status described.

Appendix 1. Description of Land Capability for Agriculture Classes

Land Suited to Arable Cropping

Class Descriptions	Capability Class	Division Descriptions
Land capable of producing a very wide range of crops Cropping is Highly flexible and includes the more exacting crops such as winter harvested vegetables, cauliflower, Brussels sprouts, leeks). The level of yield is consistently high. Soils are usually well-drained deep loam, sandy loams, silty loams or their related humic variants with good reserves of moisture. Sites are level or gently sloping and the climate is favourable. There are no or only very minor physical limitations affecting agricultural use.	1	Not Divided
Land capable of producing a wide range of crops Cropping is very flexible and a wide range of crops can be grown but the land may be unsuited to winter harvested crops. The level of yield is high but less consistently obtained than Class 1 land due to the effects of minor limitations affecting cultivation, crop growth or harvesting. The limitations include either singly or in combination, slight workability or wetness problems slightly unfavourable soil structure or texture, moderate slopes or slightly unfavourable climate. The limitations are always minor in their effects and land in the class is highly productive	2	Not Divided
Land capable of producing a moderate range of crops Land in the class is capable of producing yields of a narrow range of crops, principally cereals and grass, and/or moderate yields of a wider range including potatoes, some vegetables crops (e.g. field beans and summer harvested brassicae) and oil seed rape. The degree of variability between years will be greater than is the case for Classes 1 and 2, mainly due to interactions between climate, soil and management factors affecting the timing and type of cultivations, sowing and harvesting. The moderate limitations require careful management and include wetness restrictions to rooting depth, unfavourable structure or texture, strongly sloping ground, slight erosion or a variable climate. The range of soil types within the class is greater than the previous classes.	3.1 3.2	Land in this division is capable of producing consistently high yields of a narrow range of crops (principally cereals and grass) and/or moderate yields of a wider range (including potatoes, field beans and other common root crops). Short grass leys are common. Land in this division is capable of average production but high yields of barley, oats and grass are often obtained. Other crops are limited to potatoes and forage crops. Grass leys are common and reflect the increasing growth limitations for arable crops and degree or risk involved on their production.
Land capable of producing a narrow range or crops The land is suitable for enterprises based primarily on grassland with short arable breaks (e.g. barley, oats, and forage crops). Yields of arable crops are variable due to soil, wetness or climate factors. Yields of grass are often high but difficulties of production or utilisation may be encountered. The moderately severe levels of limitations restrict the choice of crops and demand careful management. The limitations may include moderately severe wetness, occasional damaging floods, shallow or very stony soils, moderately steep gradients, moderate erosion risk, moderately severe climate or interactions of these which increase the level of farming risk.	4.1 4.2	Land in this division is suited to rotations which, although primarily based on ley grassland, include forage crops and cereals for stock feed. Yields of grass are high but difficulties of utilisation and conservation may be encountered. Other crop yields are very variable and usually below the national average. Land in this division is primarily grassland with some limited potential for other crops. Grass yields can be high but the difficulties of conservation or utilisation may be severe, especially in areas of poor climate or on very wet soils. Some forage cropping is possible and, when the extra risks involved can be accepted, an occasional cereal crop.

Land Suited only to Improved Grassland and Rough Grazings

Class Descriptions	Capability Class	Division Descriptions
Land capable of use as improved grassland The agricultural use of land in Class 5 is restricted to grass production but such land frequently plays an important role in the economy of British hill lands. Mechanised surface treatments to improve the grassland, ranging from ploughing through rotavation to surface seeding and improvement by non-disruptive techniques are often possible. Although an occasional pioneer forage crop may be grown, one of more severe limitations render the land unsuitable for arable cropping. These include adverse climate, wetness, frequent damaging floods, steep slopes, soil defects or erosion risks. Grass yields within the class can be variable and difficulties in production and particularly utilisation are common.	5.1	Establishment of a grass sward and its maintenance present few problems and potential yields are high with ample growth throughout the season. Patterns of soil, slope or wetness may be slightly restricting but the land has few poaching problems. High stocking rates are possible.
	5.2	Sward establishment presents no difficulties but moderate or low trafficability, patterned land and/or strong slopes cause maintenance problems. Growth rates are high and despite some problems of poaching satisfactory stocking rates are achievable.
	5.3	Land in this division has properties which lead to serious trafficability and poaching difficulties and although sward establishment may be easy, deterioration in quality is often rapid. Patterns of soil, slop, and wetness may seriously interfere with establishment and/or maintenance. The land cannot support high stock densities without damage and this may be serious after heavy rain even in summer.
Land capable of use as rough grazings The land has very severe site, soil or wetness limitations which generally prevent the use of tractor-operated machinery for improvement. Reclamation of small areas to encourage stock to range is often possible. Climate is often a very significant limiting factor. A range of widely different qualities of grazing is included from very steep land with significant grazing value in the lowland situation to moorland with a low but sustained production in the zones of the mountains but below this level grazings which can be utilised for five moths or longer in any year are included in the class. Land affected by industrial pollution or dereliction may be included if the effects of the pollution are non-toxic.	6.1	Land in this division has high proportions of palatable herbage in the sward, principally the better grasses, e.g. meadow grass-bent grassland and bent-fescue grassland.
	6.2	Moderate quality herbage such as white and flying bent grasslands, rush pastures and herb-rich moorlands or mosaics of high and low grazing values characterise land in this division.
	6.3	This vegetation is dominated by plant communities with low grazing values. Particularly heather moor, bog heather moor and blanket bog.
Land of very limited agricultural value. This land has extremely severe limitations that cannot be rectified. The limitations may result from one or more of the following; extremely severe wetness, extremely stony rocky land, unvegetated soils, scree or beach gravels, toxic waste tips and dereliction, very steep gradients, severe erosion including intensively hagged peatland and extremely severe climates (exposed situations, protracted snow cover and short growing season). Agriculture use is restricted to very poor rough grazing.	7	Not Divided

Other Categories

Built up areas

Water

Main Roads