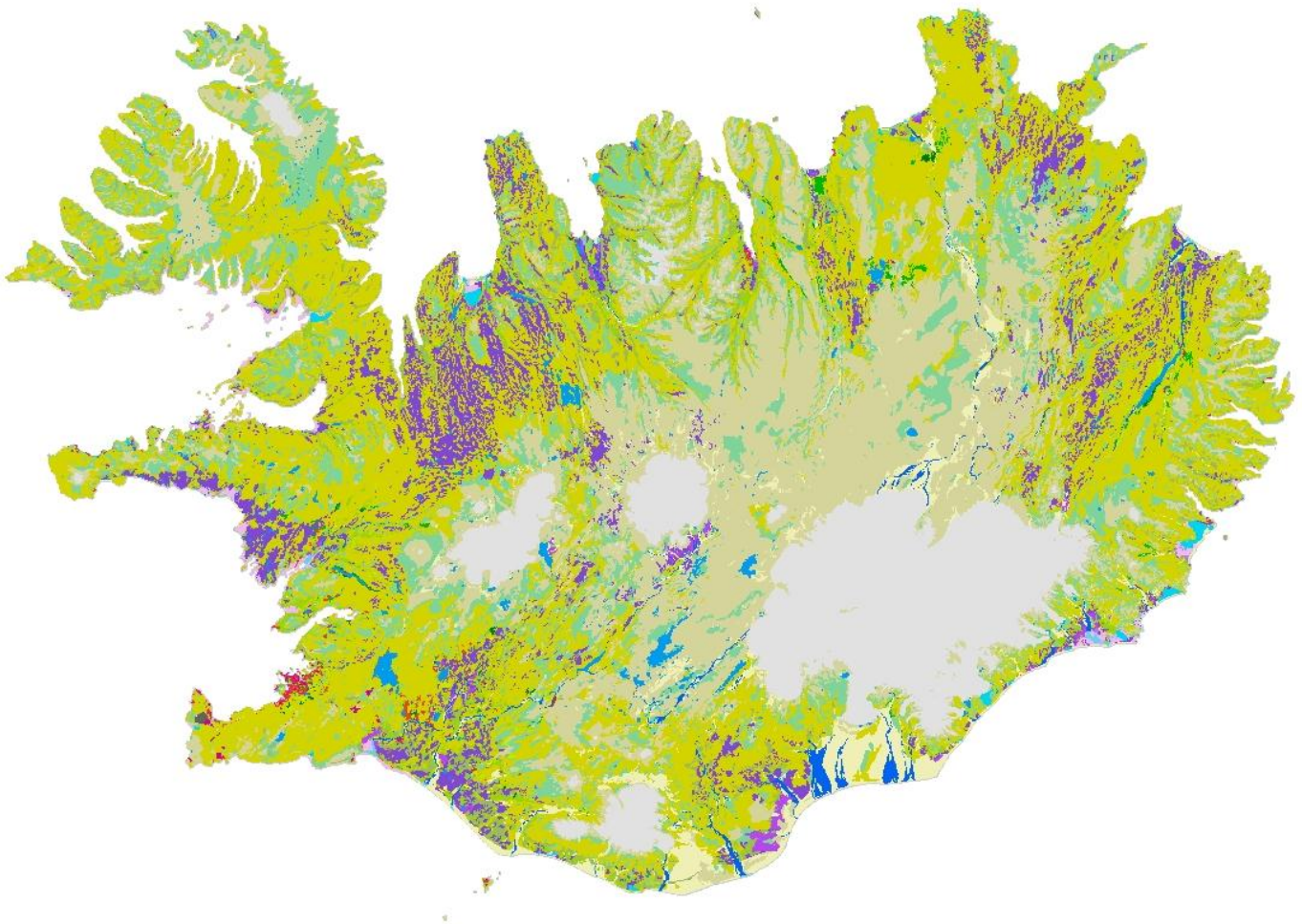


# **CORINE Land Cover 2006 in ICELAND**

**Grant agreement 3601/B2007.EEA53004**



**Final report**

**November 2008**

**National Land Survey of Iceland**

**Landmælingar Íslands**

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# 1. SUMMARY

Iceland joined the CORINE programme in 2007 and CLC2006 is the first detailed land use / land cover classification to be completed that comprises the whole country. The situation therefore differs from most of the other European countries where the CLC2000 and even the CLC1990 have already been completed.

The Ministry for the Environment acts as the national authority for the CLC project and the National Land Survey of Iceland (NLSI) is responsible for its implementation. Many domestic institutions have contributed to the CLC2006 project by providing relevant data which have been integrated into the NLSI data base.

According to original time schedule CLC2006 was to be completed in Q2 of 2008 but the overall project was substantially delayed because of late data delivery from some of the partner institutions. The success of the CLC2006 depended to a large extent on using results of a recent classification of natural surfaces in Iceland (Nytjaland) that was implemented by the Agricultural University (AUI) using multispectral satellite imagery. These data turned out to be erroneous and incomplete and therefore needed significant man power over several months for manual correction. Hence the completion of the CLC2006 was delayed until December 2008 and the costs have gone up accordingly.

Concurrently with the CLC2006 higher resolution data was also collected and integrated into a domestic data base (HiRes Land Cover, or HRLC) at the NLSI. This database comprises all the CORINE classes except some of the natural land cover types where higher mapping accuracy is not relevant (i.e. glaciers, barren land and natural vegetation). The HRLC data base, that is considered to be very important for inland research, has also been completed for 2006 and will shortly be accessible free of charge on the NLSI home page.

Land cover in Iceland is characterised by 32 out of the 44 CORINE Land Cover classes where semi-natural surfaces dominate. 13 land cover classes are infinitesimal in size and some of them almost disappear due to CORINE classification constraints. These 13 classes occupy less than 100 km<sup>2</sup> each and are therefore smaller than 1 promille of the country's total area. The 5 largest classes on the other hand make up almost 90% of the total area.

Level 1 class 1. *Artificial areas* cover 0,36% of the total area where the largest surface types are 142 *Sport and leisure facilities* (mostly settlements of summer houses) and 112 *Discontinuous urban fabric*.

Level 1 class 2. *Agricultural areas* cover 2,4% of the country and consist of only three surface types: 231 *Pastures* (99%), 211 *Non-irrigated arable land* (< 1%) but 242 *Complex Cultivation Patterns* are almost negligible.

Level 1 class 3. *Forest and semi-natural areas* comprise more than 88% of the total area of the country. The largest surface classes are; 322 *Moors and heathland* (36% of the total area of the country), 333 *Bare rocks* (24%), 333 *Sparsely vegetated areas* (14%) and *Glaciers* (10%).

Level 1 class 4. *Wetlands* occupy 6,7% of Iceland of which 87% has been classified as 412 *Peatbogs*.

Finally, Level 1 class 5. *Water* occupies 2,4% of the total area of Iceland.

## **2. INTRODUCTION**

Grant Agreement, 3601/B2007.EEA53004, for the production of Corine Land Cover 2006 was signed with the EEA in June 2007. The Ministry for the Environment acts as the national authority for the CLC project in Iceland and the National Land Survey of Iceland (NSLI) is responsible for its implementation. NSLI already has cooperation contracts with most of the national institutions in Iceland working in the various fields of compilation of land information and GIS processing. Many of these institutions contribute in one way or another to the CLC2006 project, predominantly by providing relevant data and performing accuracy control of the data.

Iceland joined the CORINE programme in 2007 and CLC2006 is the first land use / land cover classification in a relatively large scale (1: 100.000) that covers the whole country. The situation therefore differs somewhat from most of the other European countries where the CLC2000 and even the CLC1990 have already been completed.

According to the original time plan the implementation of the CLC2006 data base for Iceland was supposed to be finished by Q2 of 2008 but the work process was delayed. The main reason for this delay was late delivery of very important data from one of the cooperating institutions and the unfinished status of this data. This report deals with the CLC2006 data processing and classification results.

After the completion of CLC2006 the CORINE project in Iceland will subsequently be continued by back-dating the CLC2006 results to the year 2000 to produce CLC2000 and 2006 – 2000 Change maps. It is planned that this work be finished by end of Q1 2009. This time schedule is realistic as most of the change data have already be collected. A more detailed report will follow when the CLC200 results have been delivered.

### 3. BACKGROUND

#### 3.1. BASIC PRINCIPLES

The CLC nomenclature, described in the CORINE Land Cover Technical Guide (CEC, 1994) and related Addendum (EEA, 2000), is a physical and physiognomic land cover nomenclature relevant for environment, nature and landscape protection. It distinguishes land cover classes grouped in a 3-level hierarchy. The classes of the first level are:

1. artificial surface
2. agricultural areas
3. forests and semi-natural data
4. wetlands and
5. water bodies.

In a second level there are 15 land cover classes and 44 in the third level. The CORINE Land Cover nomenclature is given in Table 1. Each country can add supplementary (4<sup>th</sup> and 5<sup>th</sup>) hierarchical levels, according to its special conditions and priorities, but the first three levels are identical for all countries. The nomenclature is strongly related to the process of image interpretation, the working and publishing scale and the smallest cartographic unit used in elaboration of the database. The smallest cartographic unit is 25 ha with the minimum width of 100 m; mapping scale is 1:100 000; spatial accuracy better than 100 m and thematic accuracy at least 85%.

The mapping scale of 1:100 000 has been chosen bearing in mind pan-European geographical coverage of the database and the fact that it is a basic topographical mapping scale in most of the European countries and used in different environmental projects. This scale enables relatively easy updating of the databases on a regular basis.

Heterogeneity of land cover classes, the limits of which are determined by physiognomic characteristics, does not allow using automated, computerised classification methods. The methodology consists of computer-assisted visual interpretation of satellite images, with the simultaneous application of maps (thematic, topographical) and other ancillary data. Basic data for the Level 1 classes *Artificial surfaces* were computerised planning maps from the municipalities.

#### 3.2. TECHNICAL SPECIFICATIONS

Technical specifications, topologic as well as geometric, are required to control the data contents with regard to the requirements of the database management system. All working units have to fit together to provide a topologically correct seamless database for the entire country. The database format is ArcInfo polygon topology.

##### **Topologic and attribute specifications for CLC 2006 vector data**

- No double lines
- All polygons are closed, no dangles
- The number of polygons is equal to the number of labels.
- The feature ID must be unique; it does not contain the CLC code.
- Each polygon must have a character attribute: the 3-digit CLC code.
- No unclassified polygons (0 code), only codes compatible with nomenclature.

CLC_level 1	CLC_level 2	CLC_level 3	
1. Artificial surfaces	1.1 Urban fabric	1.1.1 Continuous urban fabric	
		<b>1.1.2 Discontinuous urban fabric</b>	
	1.2 Industrial, commercial and transport unit	<b>1.2.1 Industrial or commercial units</b>	
		<b>1.2.2 Roads and associated land</b>	
		<b>1.2.3 Port areas</b>	
		<b>1.2.4 Airports</b>	
	1.3 Mine, dump and construction site	<b>1.3.1 Mineral extraction sites</b>	
		<b>1.3.2 Dump sites</b>	
		<b>1.3.3 Construction sites</b>	
	1.4 Artificial areas, non-agricultural vegetated	<b>1.4.1 Green urban areas</b>	
		<b>1.4.2 Sport and leisure facilities</b>	
	2. Agricultural areas	2.1 Arable land	<b>2.1.1 Non-irrigated arable land</b>
2.1.2 Permanently irrigated land			
2.1.3 Rice fields			
2.2 Permanent crops		2.2.1 Vineyards	
		2.2.2 Fruit trees and berry plantations	
		2.2.3 Olive groves	
2.3 Pastures		<b>2.3.1 Pastures</b>	
2.4 Heterogeneous agricultural areas		2.4.1 Annual crops associated with permanent crops	
		<b>2.4.2 Complex cultivation pattern</b>	
		2.4.3 Land principally occupied by agriculture, with significant areas of natural vegetation	
		2.4.4 Agro-forestry areas	
3. Forest and semi-natural areas		3.1 Forest	<b>3.1.1 Broad-leaved forest</b>
			<b>3.1.2 Coniferous forest</b>
			<b>3.1.3 Mixed forest</b>
	3.2 Shrub and/or herbaceous vegetation associations	<b>3.2.1 Natural grassland</b>	
		<b>3.2.2 Moors and heathland</b>	
		3.2.3 Sclerophyllous vegetation	
		<b>3.2.4 Transitional woodland/shrub</b>	
	3.3 Open spaces with little or no vegetation	<b>3.3.1 Beaches, dunes, and sand plains</b>	
		<b>3.3.2 Bare rocks</b>	
		<b>3.3.3 Sparsely vegetated areas</b>	
		3.3.4 Burnt areas	
		<b>3.3.5 Glaciers and perpetual snow</b>	
4. Wetlands	4.1 Inland wetlands	<b>4.1.1 Inland marshes</b>	
		<b>4.1.2 Peatbogs</b>	
	4.2 Coastal wetlands	<b>4.2.1 Salt marshes</b>	
		4.2.2 Salines	
		<b>4.2.3 Intertidal flats</b>	
5. Water	5.1 Inland waters	<b>5.1.1 Water courses</b>	
		<b>5.1.2 Water bodies</b>	
	5.2 Marine waters	<b>5.2.1 Coastal lagoons</b>	
		<b>5.2.2 Estuaries</b>	
		<b>5.2.3 Sea and ocean</b>	

**Table 1.** CORINE Land Cover Nomenclature. Only the 32 classes written in **bold** are present in Iceland.

- Neighbouring polygons should not have the same CLC code.
- A seamless digital database should be produced without any non-coded gaps; this means a perfect edge matching between the working units.

**Geometric specifications for CLC 2006 vector data**

- The final delivery of the National CLC 2006 results of each country is produced in the national projection system.
- The coordinates of the data delivered to the EEA should have 'double precision'.
- There should be no visible map sheet boundaries in the data set.
- The area of smallest polygons is 25 ha.
- The minimum width of linear features is 100m.

## 4. ICELAND

### 4. 1. GENERAL

Iceland is situated on the Mid-Atlantic Ridge and its bedrock and surface deposits are almost entirely of volcanic origin. Volcanic activity is very high with, on the average, one eruption every 5 – 10 years. The rift associated with the Mid-Atlantic Ridge, which marks the division between the Eurasian and North American tectonic plates, runs across Iceland from southwest to northeast. The total area of the island is 103.440 km<sup>2</sup>.

About half of Iceland's land area consists of a mountainous lava desert (highest elevation 2110 m above sea level) and other wasteland. Glaciers make up eleven percent. Twenty percent of the land is used for grazing, and only 1% is cultivated (mostly hayfields). An ambitious reforestation program is in progress. It is assumed that prior to human settlement in the 8-900's, trees covered about 30-40% of the island. Today, however, only small patches of the original birch forests are left.

Iceland is very sparsely populated with only 300.000 inhabitants. The inhabited areas are at or close to the coast, particularly in the southwest; the central highlands are totally uninhabited. Because of the Gulf Stream's moderating influence, climate is characterized by damp, cool summers and relatively mild but windy winters. In Reykjavík, the average temperature is 11°C in July and 0°C in January.

The soil cover in Iceland is discontinuous and delicate. The interior is more or less barren. Especially in areas of active volcanism desert-like conditions prevail as the water soaks into the porous ground. The young volcanic terrain of the interior supplies immense quantities of wind blown dust and volcanic ash making the soils of the fringing areas sandy and dry. In the older Tertiary and Plio-Pleistocene areas the soils are more boggy and peat is extensively developed. Since settlement time Iceland has been deprived of much of its soil and vegetation cover, and birch woods have been reduced so thoroughly that today only insignificant remnants are left.

Figure 1 on next page shows a simplified geological map of Iceland. The active Neovolcanic zone crosses the island from the southwest to the north. Due to continental drift the Icelandic bedrock grows gradually older to the west and to the east with increasing distance from the volcanic zone. Consequently the oldest rocks are in the western- and easternmost areas of the country.



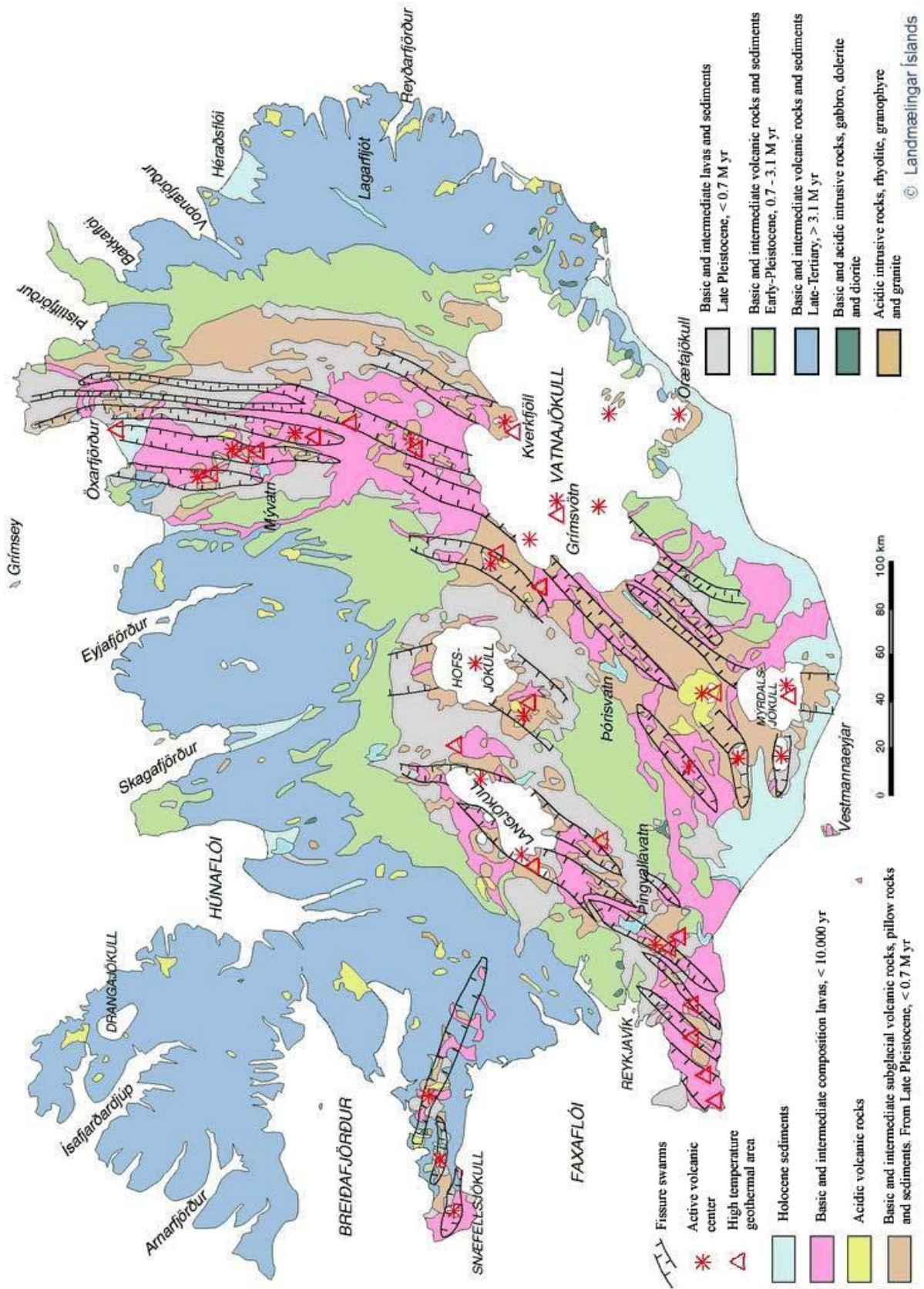


Figure 1. Simplified geological map of Iceland

## 4. 2. ICELAND AND CORINE NOMENCLATURE

Today, Corine data sets and methodology have become a standard for land cover mapping, spatial analysis applications and integrated environmental assessment. Corine Land Cover (CLC) pan-European geographical coverage and unique nomenclature allow to use it as a key reference data for spatial and regional analysis at different territorial levels. Obviously it is very important that original CLC nomenclature is preserved and will not be altered if temporal land cover changes are to be mapped correctly and in a comparable way in all European countries.

The Corine nomenclature was originally defined to fit surface characteristics of countries in Southern- and Central-Europe. As the Nordic countries also joined in the Corine programme this nomenclature has shown to be somewhat problematic regarding some surface types in these countries.

Out of the 44 Corine land cover classes 32 are present in Iceland (73% of the total number of classes). Most of these 32 classes can be relatively easily discerned in Iceland. Some Icelandic land cover types do not fit in the nomenclature and have to be squeezed in one certain Corine class even though it can hardly be regarded as an appropriate class. In the following the most obvious misfits between the Corine nomenclature and Iceland's natural characteristics are discussed.

### 4.2.1. Forests and transitional woodland/schrub (311, 312, 313 and 324)

Prior to the settlement of Iceland large areas are assumed to have been covered by birch woods. Today, however, there are only small patches of the original woods left where most of the trees are only some 4 – 5 meters high. An ambitious reforestation program is now in progress where imported species, both coniferous and broad leaved, are used.

The Forestry Service (FS) has mapped all woods and tree plantations in the country and made the data available to the Corine project. In the FS database the forest trees are considered to be at least 2 meters high (compared to 5m tree height in CLC). Woodland areas composed of trees and bushes less than 2 m high are classified as 322 (Moors and heath-land).

The CLC Technical Team agreed to follow the Icelandic definition of forests with tree height  $\geq$  2 meters (CLC2000/2006 training seminar report, Iceland. EEA subvention 2007).

### 4.2.2. Pastures (231)

Agricultural areas in Iceland are separated in only 3 surface classes: 211 and 231 and 242. According to the CLC definition pastures are areas of dense grass cover mainly used for grazing, but the fodder may also be harvested mechanically.

Pastures in Iceland are composed of hayfields and grazing areas whereof the hayfields have been carefully mapped (can easily be identified on aerial photographs and high resolution satellite images) but grazing areas have not be mapped at all. Traditionally grazing of sheep and horses (and also cattle) is not confined to fenced areas but comprised practically all vegetated land in the country. Sheep are driven into the mountains in spring and rounded up again in the autumn and kept indoors during winter.

In the *CORINE land cover technical guide – Addendum 2000* the following is stated on pastures: **“Pastures can be described as extensively used grasslands with precence of farm structure such as fences, ... drainage, ... ”**. It is almost impossible to obtain solid information on all land parcels used **extensively** for grazing without consulting every farmer in the country. Hence class 231 in Iceland is simply defined as surrounding areas of farms

that can be delineated on high resolution satellite images or areal photographs by following regular structures such as drainage ditches and fences. Some of these areas are presumably not extensively grazed except in spring or autumn and some might not be grazed at all.

In some cases where ditches have obviously had very little draining effect (ditches too far apart in large flat areas) land is classified as wetland (mostly 412).

#### **4.2.3. Peatbogs (412)**

Mires and bogs in Iceland are not always pure peatbogs. The most common mires are slope mires which may have an inclination of up to 10° and are not always characterised by thick peaty ground. Due to active volcanism and wind blown volcanic ash Icelandic soils are not always unmixed histosols but more often have considerable proportion of andosol materials, i.e. histic andosol and gleyic andosol. (Óskarsson, H., O. Arnalds, J. Gudmundsson and G. Gudbergsson, 2004).

As previously stated some drained areas where the ditches have obviously had very little draining effect (clearly wet on satellite images) are classified as wetland (mostly 412). Bogs and mires in Iceland can be further divided in level 4 sub-classes similar to what has been done in Ireland. This division is very likely to be undertaken in the near future but is not relevant for this report.

#### **4.2.4. Sand planes and Bare rock (331 and 332)**

Iceland consists solely of volcanic materials and large parts of the land's total area are mountainous lava deserts and sparsely vegetated areas. In the vicinity of the large glaciers the land is characterised by vast glacio-fluvial planes which are clearly to be classified as 331. Scree and rock outcrops in the mountainous regions on the other hand belong without ambiguity to class 332. But there are continuous intermediate levels between those two extremes.

CLC definitions of classes 331 and 332 (CORINE land cover technical guide – Addendum 2000) seem to be contradictory with regard to Iceland. As previously stated all rocks in Iceland are of volcanic origin and volcanic eruptions are very common, both lava eruptions and pyroclastic eruptions. After large pyroclastic eruptions the airborne materials can form large ash fields which are nothing but typical sand planes. These sand planes are then subsequently formed by winds and running water.

In the definition for class 332, however, it says; “*Sites and products of recent volcanic activities, volcanic ash and lapilli fields, barren lava fields*”. In Iceland the part concerning “volcanic ash and lapilli fields” of recent volcanic activity fits better to class 331 than 332. Discrimination of classes 331 and 332 following strictly their CLC definitions is not always easy in Iceland and therefore it was decided to separate those two classes based on their texture and morphology in satellite images and aerial photographs:

**331:** Barren sand and gravel plains which occur at the coast or close to glaciers, glacial rivers and lakes. These planes are flat and without any distinct morphology or texture but can be characterised by braided riverbeds which may be dry or contain water. This class includes volcanic ash fields of recent volcanic activities (inside the neovolcanic zone).

**332:** All other types of barren land including undular, hilly areas formed during the ice age (morphologically older than 8.000 – 10.000 years). Also recent (holocene) end moraines are part of this class although the adjacent sand planes (made of the same material) belong to 331.

#### **4.2.5. Mosses and lichens**

Much of the vegetation in the Icelandic highlands are mosses and lichens. Also many recent lava flows on the lowlands are covered with mosses. At the beginning these lava flows are completely without any soil and mosses are the first plants to settle on their most often rough surface. Gradually (over centuries) soil is developed and vascular plants take over and root out the mosses.

The issue was discussed with the members of the CLC technical team if only vascular plants should be taken into account when vegetation cover was to be decided or if mosses and lichens should also be regarded. Also the CLC team in Norway was consulted. Based on the traditional vegetation mapping in Iceland and the opinion of leading Icelandic botanists it was finally accepted that mosses and lichens are such an important part of the Icelandic (and arctic in general) vegetation cover that it should definitely be included.

Moss and lichen covered areas are included in class 322 Moors and heathland. It is assumed that class 322 be split in two sub-classes; 3221 Moors and heathland and 3222 Mosses and lichens in later improvements of the Icelandic CLC data base.

## 5. PROJECT FRAMEWORK AND METHODOLOGY

The CLC project is implemented at the National Land Survey in close cooperation with various institutions and other parties working in the fields of land information and mapping. Table 3 is a summing up of the project's working process.

Task	Description of tasks / sub-tasks	2007				2008			
Task 1	Acquisition of data from municipalities	Red	Red	Yellow	Yellow				
	Processing/integration of municipalities data	Red	Red	Red	Red	Yellow			
	Verification of municipalities data		Red	Red	Red	Red	Yellow		
	AUI classification: processing and generalization		Grey	Grey	Grey	Grey	Yellow	Yellow	Yellow
	Forestry Service: Data on forest classes	Grey	Grey	Red	Red	Yellow			
	All other ancillary data, acquisition and QC	Grey	Grey	Red	Red	Red	Yellow		
	General data integration			Red	Red	Red	Yellow	Yellow	Yellow
	Data generalization & production of CLC2006 map					Red	Red	Yellow	Yellow

**Table 2.** List of main tasks and sub-tasks and time schedule for CLC2006 in Iceland. Original time schedule from the technical proposal is in **red** and **grey**. **Grey** represents how much later the work on respective sub-tasks started than originally planned (i.e. the processing and generalization of AUI data did not start in Q2 2007 as planned but not until Q2 2008). **Yellow** labels how much later than originally planned a sub-task was finished. The overall delay of the CLC2006 project was to the greatest part due to late delivery of the AUI "Nytjaland" results.

CLC_level 1	CLC_level 2	CLC_level 3	Working process
1. Artificial surfaces	1.1 Urban fabric	1.1.2 Discontinuous urban fabric	Digitized general plans from all 78 municipalities, georeferenced and overlaid on SPOT-5 mosaic of Iceland, Image2006 data or aerial photographs for visual interpretation and updating at NLSI.  Polygons manually digitized with 0,5 ha minimum mapping units for a HiRes database for inland use.  Interim results sent to planning departments of all municipalities for verification or correction. HiRes database updated at NLSI where needed.  HiRes database generalized to 25 ha MMU polygons.  Local Power Plants provided information on land use for power plants (hydro-power and geothermal) where needed.
		1.2 Industrial, commercial and transport units	
	1.2.2 Roads and associated land		
	1.2.3 Port areas		
	1.2.4 Airports		
	1.3 Mine, dump and construction sites	1.3.1 Mineral extraction sites	
		1.3.2 Dump sites	
		1.3.3 Construction sites	
1.4 Artificial areas, non-agricultural vegetated	1.4.1 Green urban areas		
	1.4.2 Sport and		

		leisure facilities	
2. Agricultural areas	2.1 Arable land	2.1.1 Non-irrigated arable land	FA provided HiRes vector dataset for fodder crops (barley) which was generalized at the NLSI.  FA also provided NLSI with important contacts for information on root crops (potatos).  Polygons digitized using SPOT-5 mosaic and Image2006 taking account of information from the contacts.
	2.3 Pastures	2.3.1 Pastures	Pastures were manually digitized at the NLSI by visual interpretation of SPOT-5 mosaic and comparison with vector data layers of AUI and NLSI.
	2.4 Heterogeneous agricultural areas	2.4.2 Complex cultivation pattern	Complex cultivation patterns were manually digitized by visual interpretation of the SPOT 5 mosaic and Image2006. General plans from municipalities were also taken into consideration for this class.
3. Forest and semi-natural areas	3.1 Forest	3.1.1 Broad-leaved forest	IFS, provided HiRes vector dataset, of all woods. Generalization to 25ha minimum mapping units followed at NLSI.
		3.1.2 Coniferous forest	
		3.1.3 Mixed forest	
	3.2 Shrub and/or herbaceous vegetation associations	3.2.1 Natural grassland	AUI provided HiRes "Nytjaland" raster dataset which unfortunately turned out to be very erroneous. Optical interpretation of SPOT-5 images with close comparison of the Nytjaland results were used to deduce natural grassland and moors and heathland.  Transitional woodland shrubs came with the IFS HiRes dataset.
		3.2.2 Moors and heathland	
		3.2.4 Transitional woodland/shrub	
	3.3 Open spaces with little or no vegetation	3.3.1 Beaches, dunes, and sand plains	Non- and sparsely vegetated areas we could also digitize from the HS, "Nytjaland" raster dataset from the AUI, with much consideration of SPOT5 mosaic and Image2006. We had to split up non vegetated areas into Beaches, dunes, and sand plains and Bare rock, which we did with help of Topographic maps in scale 1:50.000-1:100.000 and remote sensing of the satellite images. HS vector dataset of Glaciers and perpetual snow was provided by the NEAI and we generalized it.
3.3.2 Bare rocks			
3.3.3 Sparsely vegetated areas			
3.3.5 Glaciers and perpetual snow			
4. Wetlands	4.1 Inland wetlands	4.1.1 Inland marshes	IINH provided HS, vector dataset with inland marshes which we generalized. We digitized peat bogs taking in to consideration HS, "Nytjaland" raster dataset from the AUI, Vegetation map in scale 1:500.000 from IINH, remote

		4.1.2 Peat bogs	sensing of the SPOT5 mosaic and Image 2006. Björn Waske, Doctor student at the University of Iceland processed our SPOT5 mosaic with Erdaslmagen to help us detect more Peat bogs
	4.2 Coastal wetlands	4.2.1 Salt marshes	Salt marshes were provided from HS, vector dataset from IINH, we generalized it. We digitized some Intertidal flats from maps from INCG, Hydrographic dep. and some Intertidal flats were digitized with help from Arnþór Garðarsson, professor at the UI
		4.2.3 Intertidal flats	
5. Water	5.1 Inland waters	5.1.1 Water courses	Water courses and water bodies are taken from IS50V database owned by NLSI and generalized. Landsvirkjun (Energy solutions) pointed out to us some backwaters wish had changed theirs size since IS50V was updated.
		5.1.2 Water bodies	
	5.2 Marine waters	5.2.1 Coastal lagoons	Costal lagoons were also taken from IS50V database owned by NLSI and Generalized. Information about Estuaries we got from IFF, we digitied it. Remarks on both Costal Lagoons and Estuaries from Arnþór Garðarsson, UI professor were taken in to a consideration. Sea and ocean we digitized around the coastline data layer from IS50V database, which we had generalized..
		5.2.2 Estuaries	
		5.2.3 Sea and ocean	

**Table 3.** The working process of the CLC2006 database in Iceland

## 6. RESULTS OF THE CLC2006 CLASSIFICATION

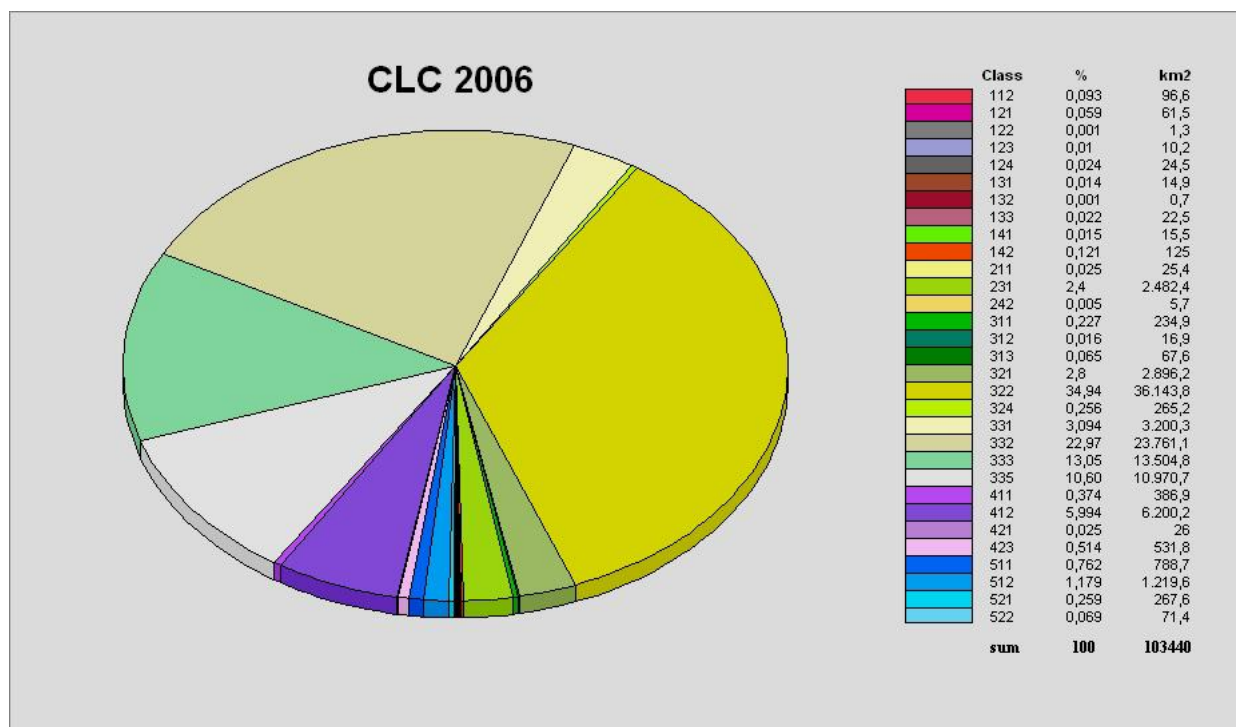
The CLC is the first detailed land use / land cover classification to be completed in Iceland that comprises the whole country. Land cover is characterised by 32 out of the 44 CORINE Land Cover classes where semi-natural surfaces dominate (see Table 1.). 16 land cover classes are infinitesimal in size and some of them almost disappear due to CORINE classification constraints (25 ha MMU and 100 m minimum width of linear features). These 16 classes occupy less than 100 km<sup>2</sup> each and are therefore smaller than 1 promille of the country's total area (103.440 km<sup>2</sup>). The 5 largest classes on the other hand make up almost 90% of the total area of the country.

The statistical results of the CLC2006 classification in Iceland are given in Figure 2 and Table 4. The pie chart of Figure 2 shows total areas (in km<sup>2</sup>) and percentage areas (in %) of all 32 CLC classes in Iceland. Additionally Table 4 depicts the number of mapped polygons for each class.

Fig. 3. next page shows the CLC2006 map of Iceland. Most obvious classes are the large glaciers (white), the barren lava and ash deserts of the Neovolcanic zone and the yellowish colour of class 322 *Moors and heathland* which also comprises moss and lichen covered areas. Also compare Figure 3 with the geological map in Figure 1.

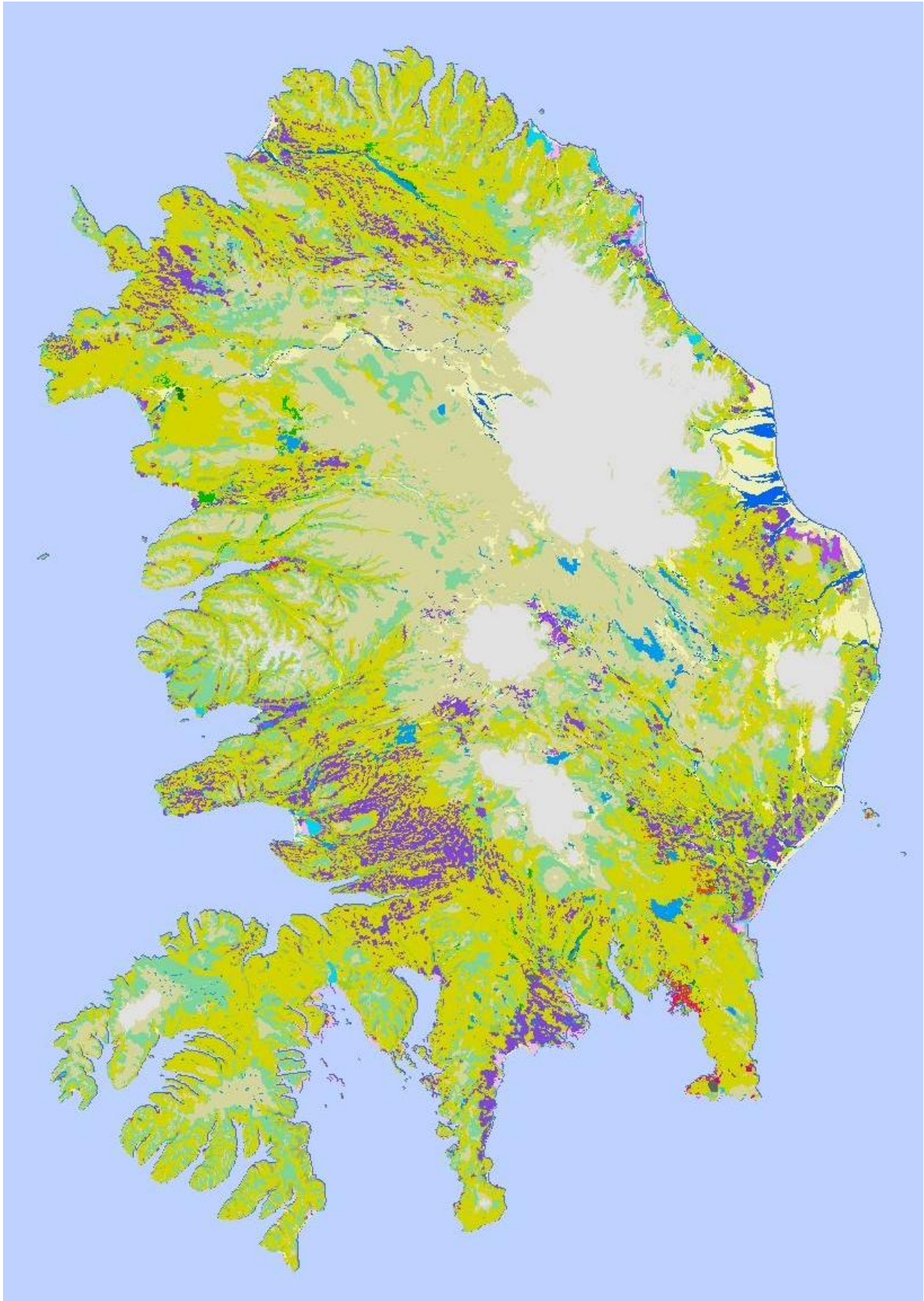
It is interesting to compare the mean polygon area of individual land cover classes (the ratio of the total area and the number of mapped polygons of each class) which can be thought of as a measure for the homogeneity or smoothness of the land cover where the respective classes occur. For the 5 largest classes the mean polygon areas **A** are as follows:

- **A**(322) = 18,3 km
- **A**(332) = 16,8 km
- **A**(333) = 3,5 km
- **A**(335) = 59,3 km
- **A**(412) = 2,6 km



**Figure 2.** CLC2006 results for Iceland. The graph shows total area (km<sup>2</sup>) and percentage area ( % ) of all 32 CLC classes in Iceland.





**Figure 3.** CLC2006 map of Iceland. Most obvious classes are the large glaciers (white), the barren lava and ash deserts of the Neovolcanic zone and the yellowish colour of class 322. See also geological map of Iceland in Figure 1.

Class	km <sup>2</sup>	% of total	Number of polygons
1.1.2 Discontinuous urban fabric	96,6	0,093	107
1.2.1 Industrial or commercial units	61,5	0,059	86
1.2.2 Roads and associated land	1,3	0,001	1
1.2.3 Port areas	10,2	0,01	25
1.2.4 Airports	24,5	0,024	11
1.3.1 Mineral extraction sites	14,9	0,014	24
1.3.2 Dump sites	0,7	0,001	2
1.3.3 Construction sites	22,5	0,022	30
1.4.1 Green urban areas	15,5	0,015	20
1.4.2 Sport and leisure facilities	125	0,121	185
2.1.1 Non-irrigated arable land	25,4	0,025	33
2.3.1 Pastures	2482,4	2,4	1916
2.4.2 Complex cultivation pattern	5,7	0,005	8
3.1.1 Broad-leaved forest	234,9	0,227	177
3.1.2 Coniferous forest	16,9	0,016	34
3.1.3 Mixed forest	67,6	0,065	73
3.2.1 Natural grassland	2896,2	2,8	1901
3.2.2 Moors and heathland	36143,8	34,942	1977
3.2.4 Transitional woodland/shrub	265,2	0,256	374
3.3.1 Beaches, dunes, and sand plains	3200,3	3,094	826
3.3.2 Bare rocks	23761,1	22,971	1413
3.3.3 Sparsely vegetated areas	13504,8	13,056	3838
3.3.5 Glaciers and perpetual snow	10970,7	10,606	185
4.1.1 Inland marshes	386,9	0,374	121
4.1.2 Peat bogs	6200,2	5,994	2340
4.2.1 Salt marshes	26	0,025	32
4.2.3 Intertidal flats	531,8	0,514	186
5.1.1 Water courses	788,7	0,762	75
5.1.2 Water bodies	1219,6	1,179	833
5.2.1 Coastal lagoons	267,6	0,259	66
5.2.2 Estuaries	71,4	0,069	20
Sum	103440	100	16919

**Table 4. CLC2006 results for Iceland.** The Table shows total area (km<sup>2</sup>), percentage area and number of mapped polygons for all 32 CLC classes in Iceland. The smallest classes, 122 Roads and 132 Dump sites are only 1 and 2 polygons respectively. The largest class, 322, that covers 35% of the country is divided into 1977 polygons or 10% of the total number of polygons whereas the 5<sup>th</sup> largest class, 412 Peatbogs with 6% of the total area, has 2340 polygons or almost 14% of their total number. As a result class 322 is much “smoother” than class 412 which appears very patchy on the map in Fig. 3.

## 6. 1. SOME DETAILS OF THE CLC2006 RESULTS

In the following the results of the CLC2006 classification in Iceland and particular characteristics and occurrences that might seem unusual or strange are discussed for all 5 Level 1 classes.

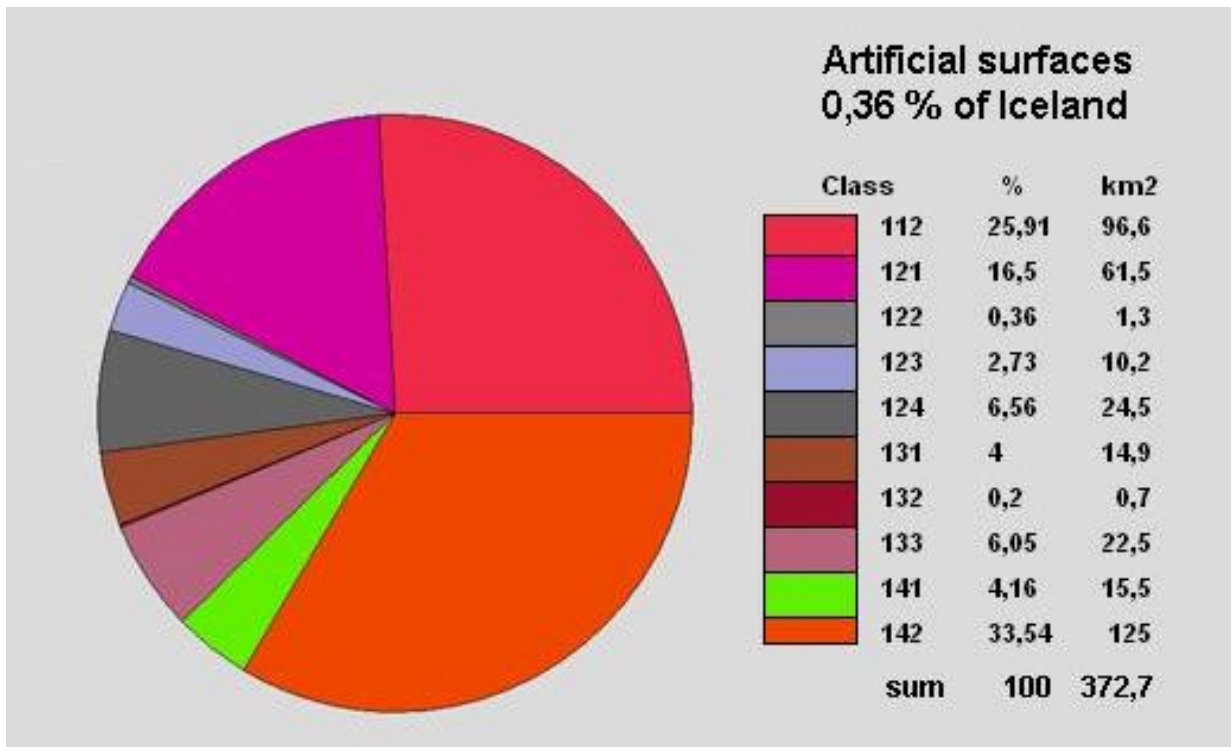
### 6.1.1. Level 1 class 1. *Artificial areas*, 0,36% of the total area of Iceland

Subdivision of the Level 1 *class 1. Artificial areas* into surface classes and their areas is listed in Figure 4. *Artificial areas* cover 0,36% of the total area of the country. The largest surface types are *142 Sport and leisure facilities* (mostly settlements of summer houses) and *112 Discontinuous urban fabric*.

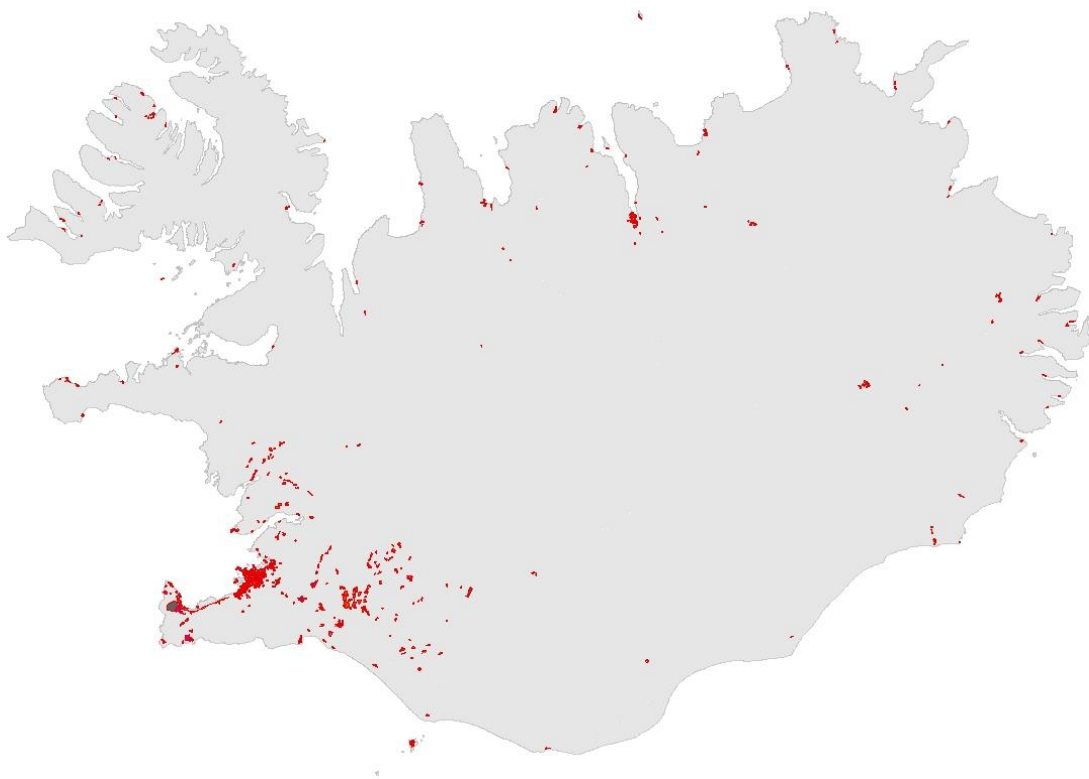
**Continuous urban fabric (111)** doesn't exist in Iceland when CORINE condition of 25 ha minimum mapping unit is applied.

There is no rail network in Iceland and the **road system (122)** consists almost entirely of roads with only one lane in each direction. Hence all roads go out in the CLC database except a segment of the highway from Reykjavik to the international airport in Keflavik. The area of class *122 roads* is only 1,34 km<sup>2</sup>. This class is a single polygon in the CLC database.

The smallest CLC class in the country is **132 Dump sites** with an area of only 0,7 km<sup>2</sup>. Only two dumpsites, both in Reykjavik, are large enough to stay in the Corine data base.



**Figure 4.** Pie chart showing the division of Level 1 class 1. *Artificial areas* in Iceland into 10 Level 3 surface classes. Class 111 does not exist.



**Figure 5.** Distribution of Level 1 class 1. *Artificial areas* in Iceland. Almost all Urban areas are at or near the coast. More than 60% of the inhabitants live in Reykjavik and adjacent cities in SW-Iceland. Small inland patches of artificial surfaces are mostly areas of summer houses.

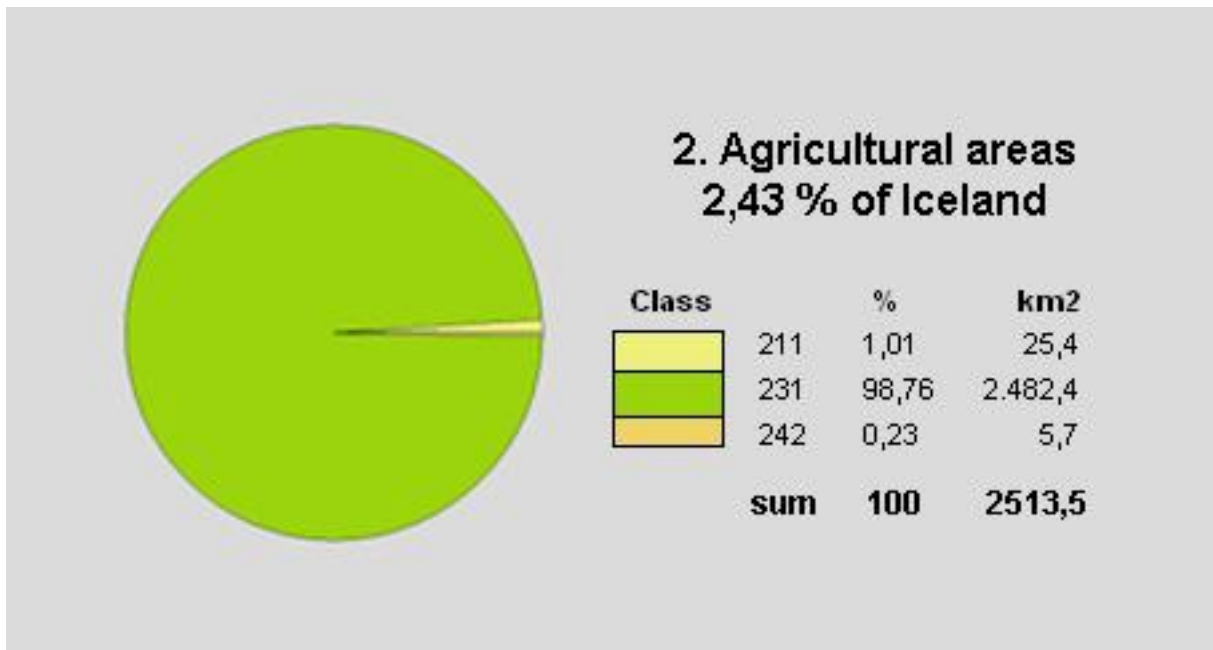
### **6.1.2. Level 1 class 2. Agricultural areas, 2,4% of the total area**

Level 1 class 2. *Agricultural areas* cover 2,4% of the country and consist of only three surface types: *231 Pastures* (almost 99% and 2.482 km<sup>2</sup>), *211 Non-irrigated arable land* ( 1%) and *242 Complex Cultivation Patterns* that is almost negligible.

**Class 231** is defined in chapter 4.2.2. It comprises almost all agricultural land in the country.

**Class 211** consists mostly of potatoe fields and fodder crops. Individual fields are usually small and scattered and must therefore be discarded in the Corine classification. The total area of this class in the CLC database is only 25,4 km<sup>2</sup>, but its actual size is 41,7 km<sup>2</sup> according to the records of the Farmers Association.

**Class 242** comprises only 8 small areas in the southwestern part of Iceland. These locations are connected with local geothermal areas and consist of scatterd houses with greenhouse and open air cultivation. The total area of class 242 is only 5,7 km<sup>2</sup>.



**Figure 6.** Division of Level 1 *class 2. Agricultural areas* in the three relevant surface classes in Iceland. Almost all agricultural areas are pastures. *Class 211* consists mostly of small and scattered fields and hence must be discarded in the CLC classification. The total area of the original *class 211* dataset before generalisation to 25 ha MMU is 41,7 km<sup>2</sup>.



**Figure 7.** Distribution of Level 1 *class 2. Agricultural areas* in Iceland. Only three Level 3 *agricultural surface classes* exist in Iceland of which *pastures* are almost 99%.

### 6.1.3. Level 1 class 3. *Forest and semi-natural areas*

Level 1 class 3. *Forest and semi-natural areas* is by far the largest CLC class in Iceland. It comprises more than 88% of the total area of the country. The four largest surface types in Iceland belong to *Semi-natural areas*.

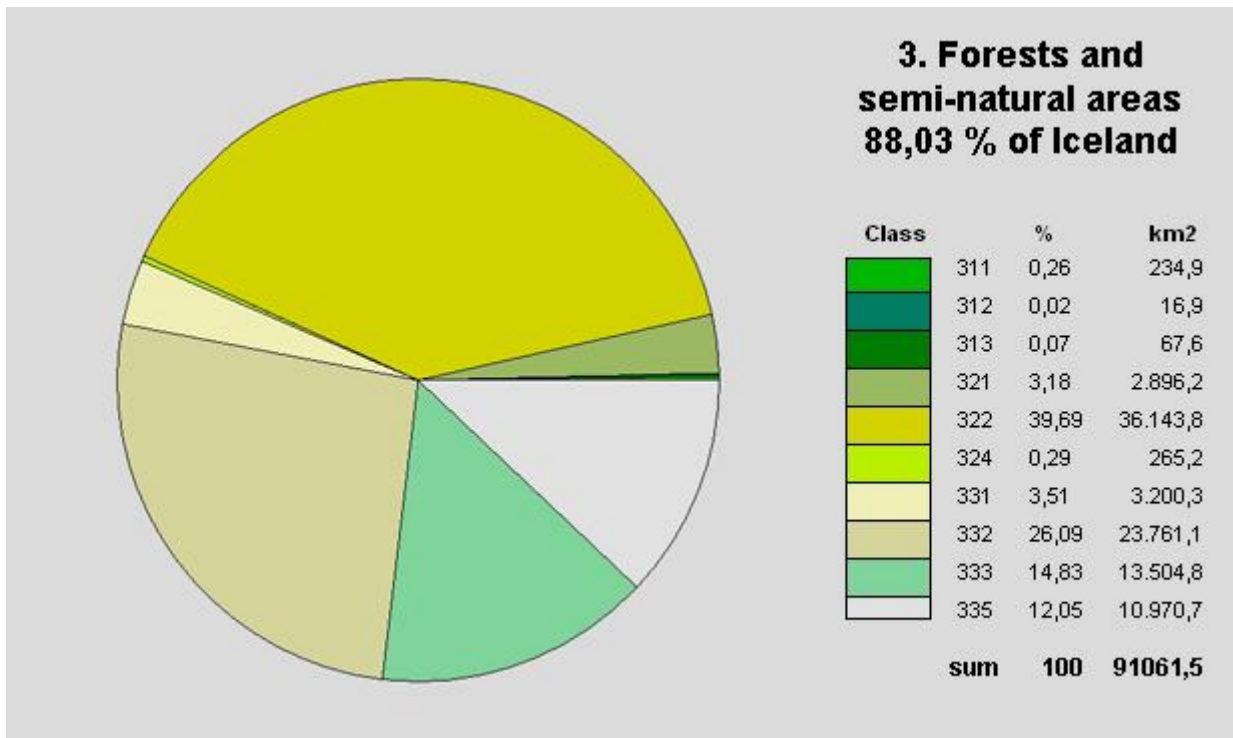
**Forest classes and tree plantations.** It is assumed that prior to human settlement in the 8-900's, trees covered about 30-40% of the island. Today, however, only small patches of the original birch forests are left. The sum of all forest classes and tree plantations (311, 312, 313 and 324) is only 585 km<sup>2</sup> or 0,57% of the total area of the country. An ambitious reforestation program is in progress.

**Semi-natural surfaces.** The 4 largest surface classes in Iceland all belong to Level 1 class 3. *Semi-natural surfaces*. These 4 classes are:

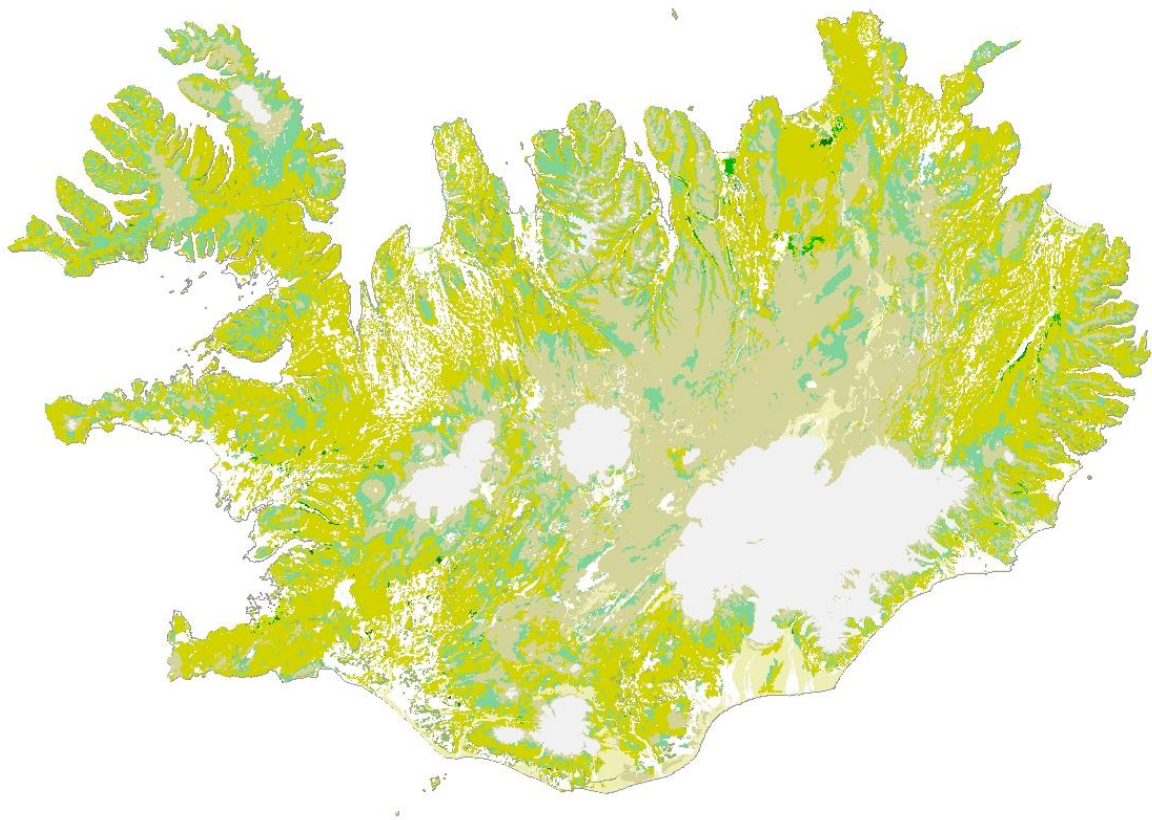
- 322 *Moors and heathland* (35% of the total area of the country),
- 332 *Bare rocks* (23%),
- 333 *Sparsely vegetated areas* (13%) and
- 335 *Glaciers* (11%).

The total area of these 4 classes is 84.380 km<sup>2</sup> or almost 82% of Iceland.

Barren and sparsely vegetated areas consist of 3 classes: 331, 332 and 333. These classes make up 40.466 km<sup>2</sup> or 39% of the total area of the country. Comparison of the CLC2006 result in Figure 3 and the geological map in Figure 1 shows that these classes are mainly situated inside the Neovolcanic zone. Other barren surfaces are the montaneous areas in north-western, northern and eastern parts of the country as well as the extensive glacio-fluvial sand planes close to the largest glaciers.



**Figure 8.** Division of Level 1 class 3. Forests and semi-natural areas in surface classes in Iceland.



**Figure 9.** Distribution of Level 1 class 3. Forests and semi-natural areas in surface types in Iceland. Forests and semi-natural areas cover 88% of the country whereof the forests and tree plantations only amount to 0,57% of the total area of the country.



#### **6.1.4. Level 1 class 4. Wetlands**

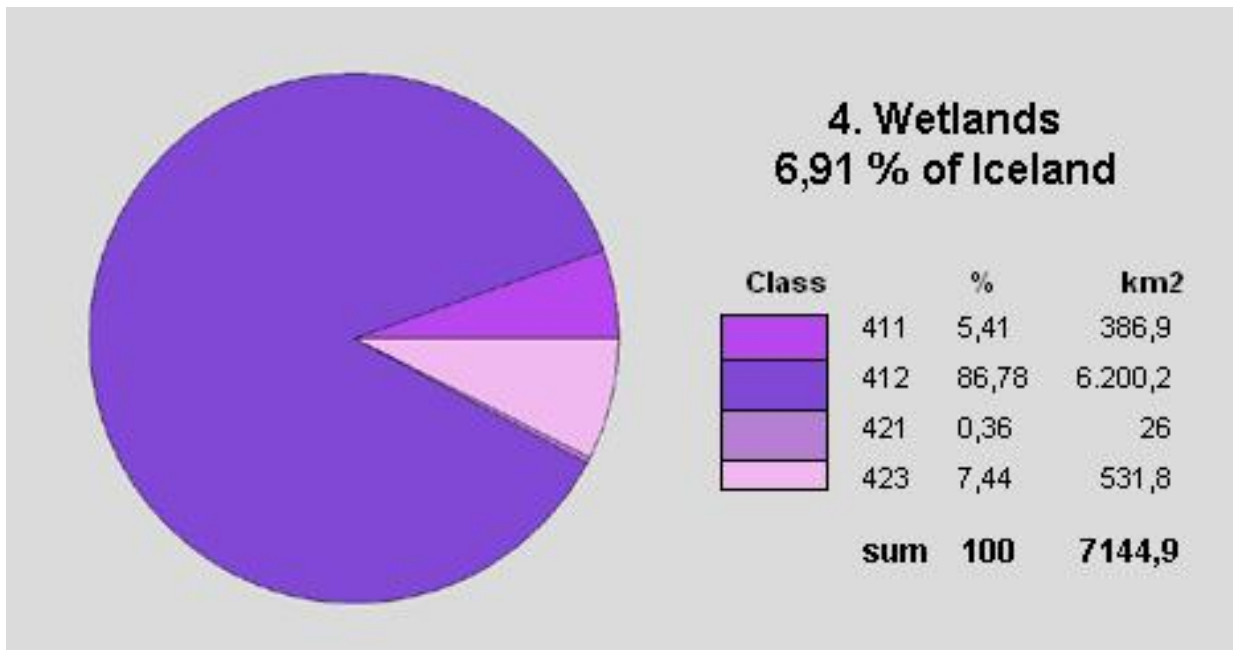
Level 1 *class 4. Wetlands* occupy 6,9% of Iceland of which 87% has been classified as *412 Peatbogs* although this class includes types of bogs other than pure peatbogs (see previous chapter). Figure 10 depicts the subdivision of wetlands into surface classes and lists total areas of each class.

The necessary data for class **411 Inland marshes** were provided by the Institute for Natural History (INH). This class only occurs in restricted areas mainly in the lowlands close to the largest rivers and cannot be separated from 412 by image interpretation. Its total area is 387 km<sup>2</sup>.

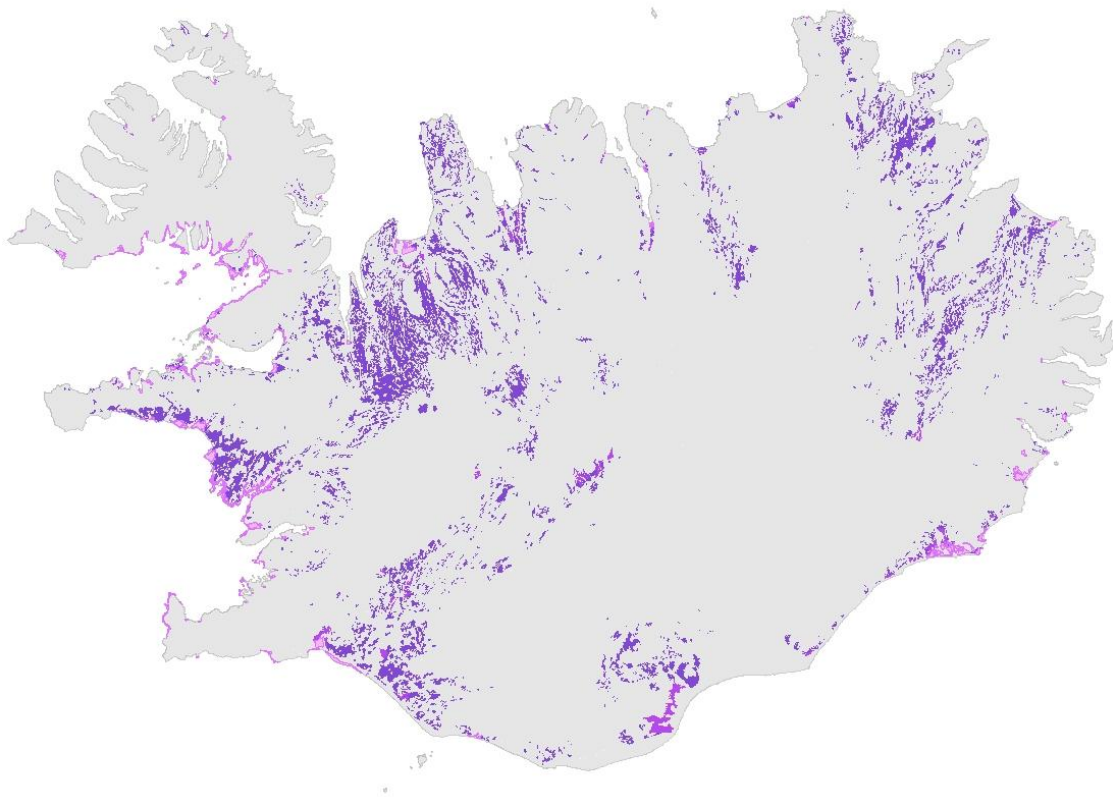
The definition of **class 412 Peatbogs** is discussed in the previous chapter. This class, along with 411, can most often be identified on multispectral satellite imagery. Its total area is 6.200 km<sup>2</sup> and it occupies 87% of all wetland area in the country.

**Class 421 Salt marshes** is of very limited spatial extent in Iceland. All occurrences of this surface class are known and have been investigated and mapped by researches of the University of Iceland and the INH. In many locations 421 is confined to very narrow strips that don't fulfill the 100 m minimum width of mapped features. Total CLC area is 26 km<sup>2</sup>.

**Class 423 Intertidal flats** in Iceland amount to hundreds of square kilometers but mostly they are too narrow to be mapped for the CLC database. Of importance to the Corine mapping are only their occurrences in W-Iceland where the tidal differences are > 4 meters and some large mud planes in SE-Iceland.



**Figure 10.** Division of Level 1 class 4. Wetlands in surface classes in Iceland. Wetlands classified as 412 Peatbogs are 6.200 km<sup>2</sup> in area and occupy 87% of all wetland area in the country.



**Figure 11.** Distribution of Level 1 class 4. Wetlands in Iceland. Wetlands are mainly confined to several large areas outside the Neovolcanic zone and consist of numerous relatively small polygons. The mean area of peatbogs in Iceland is only 2,6 km<sup>2</sup>.

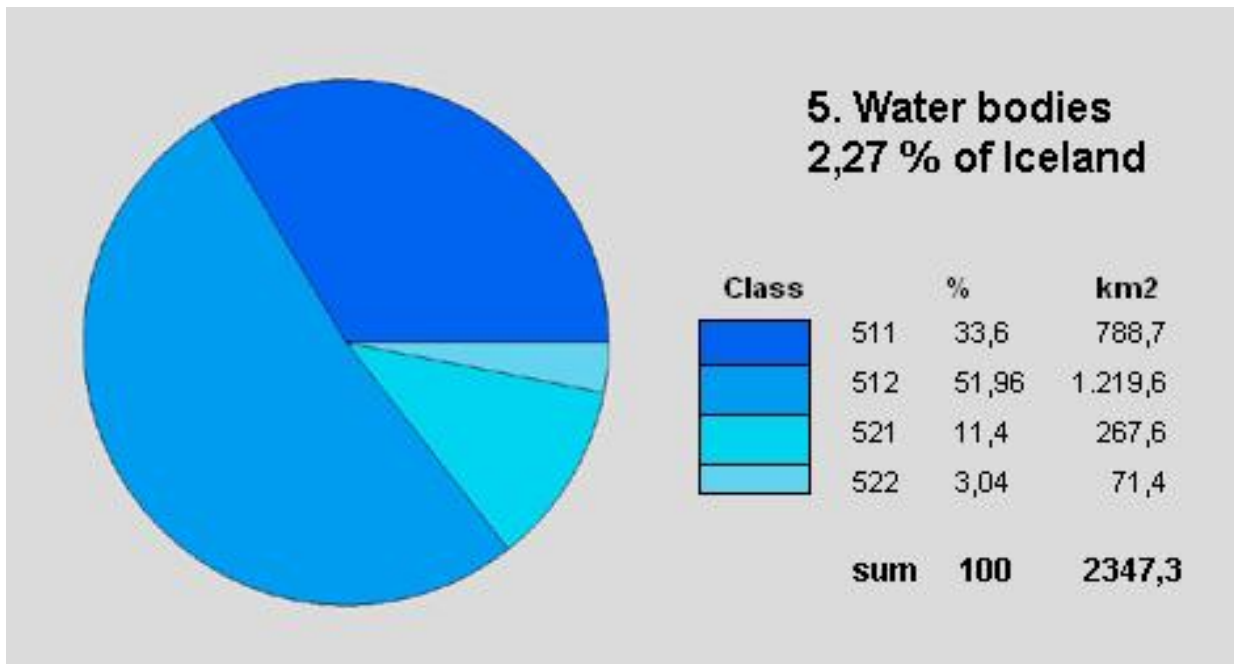
### 6.1.5. Level 1 class 5. Water

Level 1 class 5. Water occupies 2,3% of the total area of Iceland. About half of all water surfaces are 512 water bodies and 34% belong to class 511 water courses. Figure 12 depicts the division of wetlands into surface classes and lists total areas of each class.

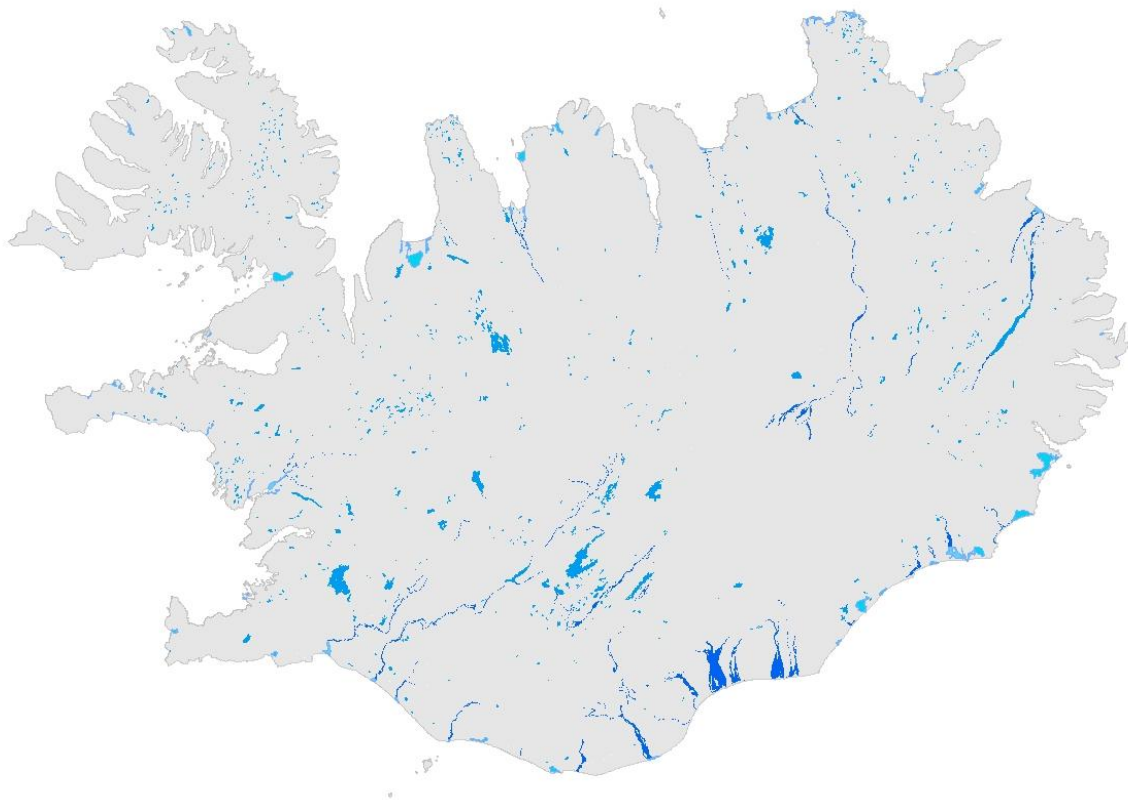
All four water classes are small in spatial extent compared to the total area of Iceland and therefore tend to be underestimated in the generalised CLC database. A comparison between the water classes in the CLC2006 database on one hand and the HiRes inland use database on the other hand is shown in Table 5.

Class	CLC2006		HiRes database	
	No of polygons	Total area (km <sup>2</sup> )	No of polygons	Total area (km <sup>2</sup> )
511	30	789	2500	?
512	833	1220	24.326	1737
521	66	268	94	72
522	20	71	2500	?

**Table 5.** Comparison between the water classes in the CLC2006 database and the HiRes inland use database showing the reduction of polygons in the CLC2006 database due to Corine conditions. Direct comparison between the total areas for classes 511 and 522 is not possible because many rivers are displayed as vector lines in the HiRes database.



**Figure 12.** Division of Level 1 *class 5. Water* into the 4 Level 3 water classes in Iceland (class 523 Sea and ocean is excluded).



**Figure 13.** Distribution of Level 1 *class 5. Water* in Iceland.

## 7. FINANCIAL REPORT

As the CLC2006 was the first Corine mapping in Iceland the standard CLC2000 cost model of the EEA was applicable as the CLC2006 cost model for Iceland. According to this model the cost (in €) is as follows:

Total area of Iceland (km <sup>2</sup> )	102.820
<b>Total cost for Iceland, 3,13 €/km<sup>2</sup> ( € )</b>	<b>322.000</b>
Cost covered by EEA centralised services ( € )	67.000
Maximum EEA financial contribution ( € )	94.000
<b>Minimum cost covered by Iceland ( € )</b>	<b>161.000</b>

**Table 6.** Total cost of the CLC2006 mapping in Iceland (first CLC mapping in the country) according to the standard CLC2000 cost model.

According to the standard CLC2000 model the total cost for Iceland is 322.000 € whereby the minimum cost covered by Iceland is 50% or 161.000 €.

Preparatory work for the CLC2006 mapping started in 2005 with a experimental classification on a 1500 km<sup>2</sup> large test area. The project work then continued through the year 2006 and consequently the NLSI had invested several man months in the project until the end of 2006.

According to estimations based on the experience gathered in 2005 - 2007 the total national contribution for the generation of the CLC2006 for Iceland was supposed to be somewhat higher than stated in Table 3 or €180.000 instead of the €161.000 cost minimum.

This plan changed drastically end of 2007 when it was clear that one of the most important datasets for the CLC2006, the Nyttjaland classification results of the Agricultural University, was not delivered on time. Actually it was delivered end of March 2008 with a delay of more than 4 months and furthermore this dataset was as well incomplete as erroneous and needed considerable work load to be completed. It was a full time work for 5 GIS-workers at the NLSI until November 2008 to correct and vectorise this dataset and integrate it into the CLC2006 database. The cost covered by Iceland is accordingly higher.

### **Breakdown of costs for CLC2006 in 2007 in Iceland.**

In the following breakdown of costs the preparatory work in 2005 –2006 (partly research work financed by the Icelandic Research Council) is not considered to be a part of CLC2006 classification for Iceland. Only the costs in the years 2007 and 2008 are included in the following table.

The costs for CLC2006 are as much as 88% personnel costs and almost 11% were spent on data from sub-contractors. As previously stated the costs for the CLC2006 turned out to be much higher than planned due to highly defective data from the Agricultural University. Hence the total costs covered by Iceland are € 268.000 or almost 50% higher than the originally planned costs of € 180.000.

<b>Year 2007, breakdown of costs</b>	<b>CLC2006</b>
Costs of personnel assigned to CLC2006	31 Man-Months (MM) at the NLSI, @3750 €/MM Total personnel costs: 31 x 3750 €/mm = <b>116.250 €</b>
Travel and subsidence costs	Only several short inland travels and meetings. Total costs: <b>1.800 €</b>
Durable equipment and stationary costs	<b>0 €</b>
Sub-contracting and/or transfer of funds	Dataset (Nytjaland) from the Agricultural University of Iceland. Total sub-contracting costs 2007: <b>21.000 €</b>
Acquisition of ancillary data	<b>0 €</b>
Other direct costs	<b>0 €</b>
EEA financial contribution at time of interim report.	53% of 94.000 € = <b>49.820 €</b>
<b>Year 2008, breakdown of costs</b>	<b>CLC2006</b>
Costs of personnel assigned to CLC2006	54 Man-Months (MM) at the NLSI, @3750 €/MM Total personnel costs: 54 x 3750 €/mm = <b>202.500 €</b>
Travel and subsidence costs	Only several short inland travels and meetings. Total costs: <b>2.200 €</b>
Durable equipment and stationary costs	<b>0 €</b>
Sub-contracting and/or transfer of funds	Forests and tree plantations (Forestry service) Inland marshes and salt marshes (Institute for Natural History) Total sub-contracting costs 2008: <b>18.300 €</b>
Acquisition of ancillary data and other direct costs	<b>0 €</b>
EEA financial contribution at time of final report.	47% of 94.000 € = <b>44.180 €</b>

**Table 7.** Breakdown of costs for CLC2006 in 2007 and 2008 in Iceland. Because of data delivery behind schedule and highly defective data from the Agricultural University the costs for the CLC2006 turned out to be much higher than planned. Hence the total costs covered by Iceland are €268.000 or almost 50% higher than the originally planned costs of € 180.000.

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## Annex 1.

### CLC2006 METADATA

<b>Title of working layer:</b>	<i>1. Artificial areas, 2. Agricultural areas, 3.2.1 Natural grassland, 3.2.2 Moors and heath land, 3.3.1 Beaches, dunes and sand plains, 3.3.2 Bare rocks, 3.3.3 Sparsely vegetated areas, 4.1.2 Peat bogs, 4.2.3 Intertidal flats, 5. Water bodies</i>
--------------------------------	--

#### A: GENERAL INFORMATION

<b>Sponsor:</b>	National Land Survey of Iceland
<b>Address:</b>	Stillholt 16-18, 300 Akranes
<b>Phone:</b>	+354/ 430-9000
<b>Fax:</b>	+354/ 430-9090
<b>Responsible :</b>	Kolbeinn Árnason
<b>E-mail:</b>	<a href="mailto:kolbeinn@lmi.is">kolbeinn@lmi.is</a>

<b>Contractor / data provider:</b>	
<b>Address:</b>	
<b>Phone:</b>	
<b>Fax:</b>	
<b>Project leader:</b>	Kolbeinn Árnason, Ingvar Matthiasson
<b>E-mail:</b>	<a href="mailto:kolbeinn@lmi.is">kolbeinn@lmi.is</a> , <a href="mailto:ingvar@lmi.is">ingvar@lmi.is</a>

#### 1. Main data used (thematic data, areal photos, city maps, vegetation maps, etc)

Data source/type	Remark
General Plans	From 78 Municipalities
Delineations	From Local Hydropower Plants
Vegetation MAP	From IINH in scale 1:500:000
2.500 Field Photographs	From AUI
Areal Photographs	From various years
Peat bogs raster datalayer	Processed SPOT-5 Satellite images with Erdas Imagine by Björn Waske, post doc researcher at the UI

#### 2. Topographic maps used

Scale	Title/Name	Year of production	Remark
1:50.000	IS50V	1999-pending	Database
1:100.000	Atlas	1900-1935	87 sheets
1:50.000	AMS	1946-1951	107,5 sheets
1:50.000	DMA	1977-1997	128 sheets



### 3. IMAGE2006 satellite data used

SPOT-4/5 XI and / or IRS LISS III scene(s)		
Satellite & Sensor	Date (m/d/y)	Remark (e.g. clouds)
SPOT4-5	2005-2007	Mosaic for Iceland, some parts are covered with clouds

### 4. Additional satellite data used

Landsat-7 ETM and / or other scene(s)		
Satellite & Sensor	Date (m/d/y)	Remark (e.g. clouds)
SPOT 5	2003-2008	Mosaic for Iceland with 10m resolution

## B: GENERALISATION, DATA INTEGRATION, FINAL TECHNICAL QUALITY CONTROL

### 1. Generalisation, control of topology, unnecessary boundaries, 25 ha limit, invalid codes (Internal Control)

	Date (m/d/y)	Controlled by
CLC2006	December 5, 2008	Ingvar Matthíasson
	December 5, 2008	Kolbeinn Árnason

### 2. Verification and acceptance of CLC2006

	Date (m/d/y)	Name	Signature
National level	December 5, 2008	Ásta Óladóttir	
	December 5, 2008	Ingvar Matthíasson	
	December 5, 2008	Jóhann Helgason	
	December 5, 2008	Kolbeinn Árnason	
	December 5, 2008	Margrét Ragnarsdóttir	
	December 5, 2008	Saulius Prizginas	
	December 5, 2008	Sigrún Árnadóttir	
	December 5, 2008	Þórey Þórðardóttir	

## C: SOFTWARE / HARDWARE

Work phase	Software used	Hardware used
Database compilation, generalization	ARC INFO	PC
Satellite image processing	ARC INFO, ErdasImagen	PC
Technical quality control	ARC INFO	PC

<b>Title of working layer:</b>	<i>2.1 Arable land</i>
--------------------------------	------------------------

#### A: GENERAL INFORMATION

<b>Sponsor:</b>	National Land Survey of Iceland	<b>Contractor / data provider:</b>	The Farmers Association
<b>Address:</b>	Stillholt 16-18, 300 Akranes	<b>Address:</b>	Bændahöllin Hagatorgi, 101 Reykjavík
<b>Phone:</b>	+354/ 430-9000	<b>Phone:</b>	+354/ 563-0300
<b>Fax:</b>	+354/ 430-9090	<b>Fax:</b>	+354/ 563-0358
<b>Responsible :</b>	Kolbeinn Árnason	<b>Project leader:</b>	Borgar Páll Bragason
<b>E-mail:</b>	<a href="mailto:kolbeinn@lmi.is">kolbeinn@lmi.is</a>	<b>E-mail:</b>	<a href="mailto:bb@bondi.is">bb@bondi.is</a>

#### 1. Main data used (thematic data, areal photos, city maps, vegetation maps, etc)

Data source/type	Remark
Areal photos	From various years

#### 2. Topographic maps used

Scale	Title/Name	Year of production	Remark
1:50.000	IS50V	1999-pending	Database

#### 3. IMAGE2006 satellite data used

SPOT-4/5 XI and / or IRS LISS III scene(s)		
Satellite & Sensor	Date (m/d/y)	Remark (e.g. clouds)
SPOT4-5	2005-2007	Mosaic for Iceland, some parts are covered with clouds

#### 4. Additional satellite data used

Landsat-7 ETM and / or other scene(s)		
Satellite & Sensor	Date (m/d/y)	Remark (e.g. clouds)
SPOT 5	2003-2008	Mosaic for Iceland with 10m resolution

## B: GENERALISATION, DATA INTEGRATION, FINAL TECHNICAL QUALITY CONTROL

1. Generalisation, control of topology, unnecessary boundaries, 25 ha limit, invalid codes (Internal Control)

	Date (m/d/y)	Controlled by
CLC2006	December 5, 2008	Ingvar Matthíasson
	December 5, 2008	Kolbeinn Árnason

2. Verification and acceptance of CLC2006

	Date (m/d/y)	Name	Signature
National level	December 5, 2008	Ásta Óladóttir	
	December 5, 2008	Ingvar Matthíasson	
	December 5, 2008	Kolbeinn Árnason	
	December 5, 2008	Margrét Ragnarsdóttir	
	December 5, 2008	Sigrún Árnadóttir	
	December 5, 2008	Þórey Þórðardóttir	

## C: SOFTWARE / HARDWARE

Work phase	Software used	Hardware used
Database compilation, generalization	ARC INFO	PC
Satellite image processing	ARC INFO	PC
Technical quality control	ARC INFO	PC

<b>Title of working layer:</b>	<i>3.1 Forest and 3.2.4 Transitional woodland/shrub</i>
--------------------------------	---

## A: GENERAL INFORMATION

<b>Sponsor:</b>	National Land Survey of Iceland
<b>Address:</b>	Stillholt 16-18, 300 Akranes
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<b>Fax:</b>	+354/ 430-9090
<b>Responsible :</b>	Kolbeinn Árnason
<b>E-mail:</b>	<a href="mailto:kolbeinn@lmi.is">kolbeinn@lmi.is</a>

<b>Contractor / data provider:</b>	Iceland Forestry Service
<b>Address:</b>	Miðvangur 2-4, 700 Egilstaðir
<b>Phone:</b>	+354/ 471-2100
<b>Fax:</b>	+354/ 471-2172
<b>Project leader:</b>	Björn Traustason, Arnór Snorrason
<b>E-mail:</b>	<a href="mailto:bjorn@skogur.is">bjorn@skogur.is</a> , <a href="mailto:arnor@skogur.is">arnor@skogur.is</a>

### 1. Main data used (thematic data, areal photos, city maps, vegetation maps, etc)

Data source/type	Remark
Field Control points	Extensive Fieldwork
Field Check-up points	Extensive Fieldwork

### 2. Topographic maps used

Scale	Title/Name	Year of production	Remark
1:50.000	IS50V	1999-pending	Database

### 3. Additional satellite data used

Landsat-7 ETM and / or other scene(s)		
Satellite & Sensor	Date (m/d/y)	Remark (e.g. clouds)
SPOT 5	2003-2008	Mosaic for Iceland with 10m resolution

## B: GENERALISATION, DATA INTEGRATION, FINAL TECHNICAL QUALITY CONTROL

1. Generalisation, control of topology, unnecessary boundaries, 25 ha limit, invalid codes (Internal Control)

	Date (m/d/y)	Controlled by
CLC2006	December 5, 2008	Ingvar Matthíasson
	December 5, 2008	Kolbeinn Árnason

2. Verification and acceptance of CLC2006

	Date (m/d/y)	Name	Signature
National level	December 5, 2008	Ásta Óladóttir	
	December 5, 2008	Ingvar Matthíasson	
	December 5, 2008	Kolbeinn Árnason	
	December 5, 2008	Margrét Ragnarsdóttir	
	December 5, 2008	Sigrún Árnadóttir	
	December 5, 2008	Þórey Þórðardóttir	

## C: SOFTWARE / HARDWARE

Work phase	Software used	Hardware used
Database compilation, generalization	ARC INFO	PC
Satellite image processing	ARC INFO	PC
Technical quality control	ARC INFO	PC

<b>Title of working layer:</b>	<i>3.2.1 Natural grassland, 3.2.2 Moors and heath land, 3.3.1 Beaches, dunes and sand plains, 3.3.2 Bare rocks, 3.3.3 Sparsely vegetated areas, 4.1.2 Peat bogs</i>
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## A: GENERAL INFORMATION

<b>Sponsor:</b>	National Land Survey of Iceland
<b>Address:</b>	Stillholt 16-18, 300 Akranes
<b>Phone:</b>	+354/ 430-9000
<b>Fax:</b>	+354/ 430-9090
<b>Responsible :</b>	Kolbeinn Árnason
<b>E-mail:</b>	<a href="mailto:kolbeinn@lmi.is">kolbeinn@lmi.is</a>

<b>Contractor / data provider:</b>	Agricultural University of Iceland
<b>Address:</b>	Hvanneyri, 311 Borgarnes
<b>Phone:</b>	+354/ 433-5000
<b>Fax:</b>	+354/ 433-5001
<b>Project leader:</b>	Ólafur Arnalds, Sigmar Metúsalemsson, Jón Guðmundsson
<b>E-mail:</b>	<a href="mailto:oa@lbhi.is">oa@lbhi.is</a> , <a href="mailto:jong@lbhi.is">jong@lbhi.is</a>

### 1. Main data used (thematic data, areal photos, city maps, vegetation maps, etc)

Data source/type	Remark
Field Control points	12.800 points collected before semi-automatic classification
Field Check-up points	7.700 points collected after the classification to check the results
Field photographs	20.500 photographs taken during the extensive fieldtrips

### 2. Topographic maps used

Scale	Title/Name	Year of production	Remark
1:50.000	IS50V	1999-pending	Database
1:100.000	Atlas	1900-1935	87 sheets
1:50.000	AMS	1946-1951	107,5 sheets
1:50.000	DMA	1977-1997	128 sheets

### 3. IMAGE2006 satellite data used

SPOT-4/5 XI and / or IRS LISS III scene(s)		
Satellite & Sensor	Date (m/d/y)	Remark (e.g. clouds)
SPOT4-5	2005-2007	Mosaic for Iceland, some parts are covered with clouds

#### 4. Additional satellite data used

Landsat-7 ETM and / or other scene(s)		
Satellite & Sensor	Date (m/d/y)	Remark (e.g. clouds)
SPOT 5	2003-2008	Mosaic for Iceland with 10m resolution
Landsat-7	1999	Mosaic covers big part of Iceland

### B: GENERALISATION, DATA INTEGRATION, FINAL TECHNICAL QUALITY CONTROL

#### 1. Generalisation, control of topology, unnecessary boundaries, 25 ha limit, invalid codes (Internal Control)

	Date (m/d/y)	Controlled by
CLC2006	December 5, 2008	Ingvar Matthíasson
	December 5, 2008	Kolbeinn Árnason

#### 2. Verification and acceptance of CLC2006

	Date (m/d/y)	Name	Signature
National level	December 5, 2008	Ásta Óladóttir	
	December 5, 2008	Ingvar Matthíasson	
	December 5, 2008	Kolbeinn Árnason	
	December 5, 2008	Margrét Ragnarsdóttir	
	December 5, 2008	Sigrún Árnadóttir	
	December 5, 2008	Þórey Þórðardóttir	

### C: SOFTWARE / HARDWARE

Work phase	Software used	Hardware used
Database compilation, generalization	ARC INFO	PC
Satellite image processing	ARC INFO, ErdasImagen	PC
Technical quality control	ARC INFO	PC

<b>Title of working layer:</b>	<i>3.3.5 Glaciers and perpetual snow</i>
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#### A: GENERAL INFORMATION

<b>Sponsor:</b>	National Land Survey of Iceland
<b>Address:</b>	Stillholt 16-18, 300 Akranes
<b>Phone:</b>	+354/ 430-9000
<b>Fax:</b>	+354/ 430-9090
<b>Responsible :</b>	Kolbeinn Árnason
<b>E-mail:</b>	<a href="mailto:kolbeinn@lmi.is">kolbeinn@lmi.is</a>

<b>Contractor / data provider:</b>	National Energy Authority
<b>Address:</b>	Orkugarðurinn, Grensásvegur 9, 108 Reykjavík
<b>Phone:</b>	+354/ 569-6000
<b>Fax:</b>	+354/ 568-8896
<b>Project leader:</b>	Oddur Sigurðsson
<b>E-mail:</b>	<a href="mailto:osig@os.is">osig@os.is</a>

#### 1. Main data used (thematic data, areal photos, city maps, vegetation maps, etc)

Data source/type	Remark
Areal Photographs	From 1999-2003
Stereo Photographs	From 1998-2000 projected on DMA topographic maps
GPS Track	GPS field tracking measurements from 2002-2003

#### 2. Topographic maps used

Scale	Title/Name	Year of production	Remark
1:50.000	DMA	1977-1997	128 sheets

#### 3. IMAGE2006 satellite data used

SPOT-4/5 XI and / or IRS LISS III scene(s)		
Satellite & Sensor	Date (m/d/y)	Remark (e.g. clouds)
SPOT4-5	2005-2007	Mosaic for Iceland, some parts are covered with clouds

#### 4. Additional satellite data used

Landsat-7 ETM and / or other scene(s)		
Satellite & Sensor	Date (m/d/y)	Remark (e.g. clouds)
SPOT-5	2003-2008	Mosaic for Iceland with 10 resolution



Landsat 7	1999	ID 7217015009921650
Landsat 7	2000	ID 7217015000026750
Landsat 7	20.8.2000	ID 7217015000023350
SPOT-5	16.8.2004	
SPOT-5	18.7.2004	
SPOT-5	16.7.2003	
SPOT-5	15.9.2003	
SPOT-5	26.8.2003	

## B: GENERALISATION, DATA INTEGRATION, FINAL TECHNICAL QUALITY CONTROL

1. Generalisation, control of topology, unnecessary boundaries, 25 ha limit, invalid codes (Internal Control)

	Date (m/d/y)	Controlled by
CLC2006	December 5, 2008	Ingvar Matthíasson
	December 5, 2008	Kolbeinn Árnason

2. Verification and acceptance of CLC2006

	Date (m/d/y)	Name	Signature
National level	December 5, 2008	Ásta Óladóttir	
	December 5, 2008	Ingvar Matthíasson	
	December 5, 2008	Kolbeinn Árnason	
	December 5, 2008	Margrét Ragnarsdóttir	
	December 5, 2008	Sigrún Árnadóttir	
	December 5, 2008	Prizginas, Saulius	
	December 5, 2008	Þórey Þórðardóttir	

## C: SOFTWARE / HARDWARE

Work phase	Software used	Hardware used
Database compilation, generalization	ARC INFO	PC
Satellite image processing	ARC INFO	PC
Technical quality control	ARC INFO	PC

<b>Title of working layer:</b>	<i>4.1.1 Inland marshes, 4.2.1 Salt marshes</i>
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## A: GENERAL INFORMATION

<b>Sponsor:</b>	National Land Survey of Iceland
<b>Address:</b>	Stillholt 16-18, 300 Akranes
<b>Phone:</b>	+354/ 430-9000
<b>Fax:</b>	+354/ 430-9090
<b>Responsible :</b>	Kolbeinn Árnason
<b>E-mail:</b>	<a href="mailto:kolbeinn@lmi.is">kolbeinn@lmi.is</a>

<b>Contractor / data provider:</b>	The Icelandic Institute of Natural History
<b>Address:</b>	Hlemmi 3, 125 Reykjavík
<b>Phone:</b>	+354/ 590-0500
<b>Fax:</b>	+354/ 590-0595
<b>Project leader:</b>	Borgþór Magnússon, Guðmundur Guðjónsson, Rannveig Thoroddsen
<b>E-mail:</b>	<a href="mailto:borgthor@ni.is">borgthor@ni.is</a> , <a href="mailto:gudm@ni.is">gudm@ni.is</a> , <a href="mailto:rannveig@ni.is">rannveig@ni.is</a>

### 1. Main data used (thematic data, areal photos, city maps, vegetation maps, etc)

Data source/type	Remark
Areal Photographs	From various years
Field data	Extensive fieldwork
Vegetation map of Iceland	In scale 1:500.000 from IINH

### 2. Topographic maps used

Scale	Title/Name	Year of production	Remark
1:50.000	IS50V	1999-pending	Database

### 3. IMAGE2006 satellite data used

SPOT-4/5 XI and / or IRS LISS III scene(s)		
Satellite & Sensor	Date (m/d/y)	Remark (e.g. clouds)
SPOT4-5	2005-2007	Mosaic for Iceland, some parts are covered with clouds

### 4. Additional satellite data used

Landsat-7 ETM and / or other scene(s)		
Satellite & Sensor	Date (m/d/y)	Remark (e.g. clouds)

SPOT 5	2003-2008	Mosaic for Iceland with 10m resolution
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## B: GENERALISATION, DATA INTEGRATION, FINAL TECHNICAL QUALITY CONTROL

1. Generalisation, control of topology, unnecessary boundaries, 25 ha limit, invalid codes (Internal Control)

	Date (m/d/y)	Controlled by
CLC2006	December 5, 2008	Ingvar Matthíasson
	December 5, 2008	Kolbeinn Árnason

2. Verification and acceptance of CLC2006

	Date (m/d/y)	Name	Signature
National level	December 5, 2008	Ásta Óladóttir	
	December 5, 2008	Ingvar Matthíasson	
	December 5, 2008	Kolbeinn Árnason	
	December 5, 2008	Margrét Ragnarsdóttir	
	December 5, 2008	Sigrún Árnadóttir	
	December 5, 2008	Þórey Þórðardóttir	

## C: SOFTWARE / HARDWARE

Work phase	Software used	Hardware used
Database compilation, generalization	ARC INFO	PC
Satellite image processing	ARC INFO	PC
Technical quality control	ARC INFO	PC

<b>Title of working layer:</b>	<i>4.2.3 Intertidal flats, 5.2.1 Coastal lagoons</i>
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#### A: GENERAL INFORMATION

<b>Sponsor:</b>	National Land Survey of Iceland	<b>Contractor / data provider:</b>	University of Iceland, Biology department
<b>Address:</b>	Stillholt 16-18, 300 Akranes	<b>Address:</b>	Sturlugata 7, 101 Reykjavík
<b>Phone:</b>	+354/ 430-9000	<b>Phone:</b>	+354/ 525-4000
<b>Fax:</b>	+354/ 430-9090	<b>Fax:</b>	+354/ 521-1331
<b>Responsible :</b>	Kolbeinn Árnason	<b>Project leader:</b>	Arnpór Garðarsson, Agnar Ingólfsson
<b>E-mail:</b>	<a href="mailto:kolbeinn@lmi.is">kolbeinn@lmi.is</a>	<b>E-mail:</b>	<a href="mailto:aganaring@hi.is">aganaring@hi.is</a> , <a href="mailto:arnthor@hi.is">arnthor@hi.is</a>

#### 1. Main data used (thematic data, areal photos, city maps, vegetation maps, etc)

Data source/type	Remark
Areal Photographs	From various years
Field data	Extensive fieldwork and years of studies

#### 2. Topographic maps used

Scale	Title/Name	Year of production	Remark
1:50.000	IS50V	1999-pending	Database
1:100.000	Atlas	1900-1935	87 sheets
1:50.000	AMS	1946-1951	107,5 sheets
1:50.000	DMA	1977-1997	128 sheets

#### 3. IMAGE2006 satellite data used

SPOT-4/5 XI and / or IRS LISS III scene(s)		
Satellite & Sensor	Date (m/d/y)	Remark (e.g. clouds)
SPOT4-5	2005-2007	Mosaic for Iceland, some parts are covered with clouds

#### 4. Additional satellite data used

Landsat-7 ETM and / or other scene(s)		
Satellite & Sensor	Date (m/d/y)	Remark (e.g. clouds)

SPOT 5	2003-2008	Mosaic for Iceland with 10m resolution
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## B: GENERALISATION, DATA INTEGRATION, FINAL TECHNICAL QUALITY CONTROL

2. Generalisation, control of topology, unnecessary boundaries, 25 ha limit, invalid codes (Internal Control)

	Date (m/d/y)	Controlled by
CLC2006	December 5, 2008	Ingvar Matthíasson
	December 5, 2008	Kolbeinn Árnason

2. Verification and acceptance of CLC2006

	Date (m/d/y)	Name	Signature
National level	December 5, 2008	Ásta Óladóttir	
	December 5, 2008	Ingvar Matthíasson	
	December 5, 2008	Kolbeinn Árnason	
	December 5, 2008	Margrét Ragnarsdóttir	
	December 5, 2008	Sigrún Árnadóttir	
	December 5, 2008	Þórey Þórðardóttir	

## C: SOFTWARE / HARDWARE

Work phase	Software used	Hardware used
Database compilation, generalization	ARC INFO	PC
Satellite image processing	ARC INFO	PC
Technical quality control	ARC INFO	PC

<b>Title of working layer:</b>	<i>4.2.3 Intertidal flats</i>
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#### A: GENERAL INFORMATION

<b>Sponsor:</b>	National Land Survey of Iceland	<b>Contractor / data provider:</b>	The Icelandic Coast Guard, Hydrographic Department
<b>Address:</b>	Stillholt 16-18, 300 Akranes	<b>Address:</b>	Skógarhlíð 14, 105 Reykjavík
<b>Phone:</b>	+354/ 430-9000	<b>Phone:</b>	+354/ 545-2000
<b>Fax:</b>	+354/ 430-9090	<b>Fax:</b>	+354/ 545-2101
<b>Responsible :</b>	Kolbeinn Árnason	<b>Project leader:</b>	Árni Þór Vésteinnsson, Niels Bjarki Finsen
<b>E-mail:</b>	<a href="mailto:kolbeinn@lmi.is">kolbeinn@lmi.is</a>	<b>E-mail:</b>	<a href="mailto:arni@lhg.is">arni@lhg.is</a> , <a href="mailto:niels@lhg.is">niels@lhg.is</a>

#### 1. Main data used (thematic data, areal photos, city maps, vegetation maps, etc)

Data source/type	Remark
Nautical Charts	From various years
Hydrographic data	extensive research and field navigations

#### 2. Topographic maps used

Scale	Title/Name	Year of production	Remark
1:50.000	IS50V	1999-pending	Database
1:100.000	Atlas	1900-1935	87 sheets
1:50.000	AMS	1946-1951	107,5 sheets
1:50.000	DMA	1977-1997	128 sheets

#### 3. IMAGE2006 satellite data used

SPOT-4/5 XI and / or IRS LISS III scene(s)		
Satellite & Sensor	Date (m/d/y)	Remark (e.g. clouds)
SPOT4-5	2005-2007	Mosaic for Iceland, some parts are covered with clouds

#### 4. Additional satellite data used

Landsat-7 ETM and / or other scene(s)		
Satellite & Sensor	Date (m/d/y)	Remark (e.g. clouds)



SPOT 5	2003-2008	Mosaic for Iceland with 10m resolution
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## B: GENERALISATION, DATA INTEGRATION, FINAL TECHNICAL QUALITY CONTROL

3. Generalisation, control of topology, unnecessary boundaries, 25 ha limit, invalid codes (Internal Control)

	Date (m/d/y)	Controlled by
CLC2006	December 5, 2008	Ingvar Matthíasson
	December 5, 2008	Kolbeinn Árnason

2. Verification and acceptance of CLC2006

	Date (m/d/y)	Name	Signature
National level	December 5, 2008	Ásta Óladóttir	
	December 5, 2008	Ingvar Matthíasson	
	December 5, 2008	Kolbeinn Árnason	
	December 5, 2008	Margrét Ragnarsdóttir	
	December 5, 2008	Sigrún Árnadóttir	
	December 5, 2008	Þórey Þórðardóttir	

## C: SOFTWARE / HARDWARE

Work phase	Software used	Hardware used
Database compilation, generalization	ARC INFO	PC
Satellite image processing	ARC INFO	PC
Technical quality control	ARC INFO	PC

<b>Title of working layer:</b>	<i>5.2.2 Estuaries</i>
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#### A: GENERAL INFORMATION

<b>Sponsor:</b>	National Land Survey of Iceland (NLSI)	<b>Contractor / data provider:</b>	Institute of Freshwater Fisheries
<b>Address:</b>	Stillholt 16-18, 300 Akranes	<b>Address:</b>	Keldnaholti, 112 Reykjavík
<b>Phone:</b>	+354/ 430-9000	<b>Phone:</b>	+354/ 580-6300
<b>Fax:</b>	+354/ 430-9090	<b>Fax:</b>	+354/ 580-6301
<b>Responsible :</b>	Kolbeinn Árnason	<b>Project leader:</b>	Ingi Rúnar Jónsson
<b>E-mail:</b>	<a href="mailto:kolbeinn@lmi.is">kolbeinn@lmi.is</a>	<b>E-mail:</b>	<a href="mailto:ingi@veidimal.is">ingi@veidimal.is</a>

#### 1. Main data used (thematic data, areal photos, city maps, vegetation maps, etc)

Data source/type	Remark
Field data	Data from local specialists

#### 2. Topographic maps used

Scale	Title/Name	Year of production	Remark
1:50.000	IS50V	1999-pending	Database
1:100.000	Atlas	1900-1935	87 sheets
1:50.000	AMS	1946-1951	107,5 sheets
1:50.000	DMA	1977-1997	128 sheets

#### 3. IMAGE2006 satellite data used

SPOT-4/5 XI and / or IRS LISS III scene(s)		
Satellite & Sensor	Date (m/d/y)	Remark (e.g. clouds)
SPOT4-5	2005-2007	Mosaic for Iceland, some parts are covered with clouds

#### 4. Additional satellite data used

Landsat-7 ETM and / or other scene(s)		
Satellite & Sensor	Date (m/d/y)	Remark (e.g. clouds)
SPOT 5	2003-2008	Mosaic for Iceland with 10m resolution

## B: GENERALISATION, DATA INTEGRATION, FINAL TECHNICAL QUALITY CONTROL

4. Generalisation, control of topology, unnecessary boundaries, 25 ha limit, invalid codes (Internal Control)

	Date (m/d/y)	Controlled by
CLC2006	December 5, 2008	Ingvar Matthíasson
	December 5, 2008	Kolbeinn Árnason

2. Verification and acceptance of CLC2006

	Date (m/d/y)	Name	Signature
National level	December 5, 2008	Ásta Óladóttir	
	December 5, 2008	Ingvar Matthíasson	
	December 5, 2008	Kolbeinn Árnason	
	December 5, 2008	Margrét Ragnarsdóttir	
	December 5, 2008	Sigrún Árnadóttir	
	December 5, 2008	Þórey Þórðardóttir	

## C: SOFTWARE / HARDWARE

Work phase	Software used	Hardware used
Database compilation, generalization	ARC INFO	PC
Satellite image processing	ARC INFO	PC
Technical quality control	ARC INFO	PC

## Annex 2.

### Abbreviations

<b>AUI</b>	Agricultural University of Iceland
<b>DEM</b>	Digital Elevation Model
<b>EEA</b>	European Environment Agency
<b>EO</b>	Earth observation
<b>FA</b>	The Farmers Association
<b>GCP</b>	Global Carbon Project
<b>HiRes</b>	High resolution data (i.e. satellite images)
<b>HRLC</b>	High resolution land cover
<b>ICG</b>	The Icelandic Coast Guard
<b>IFF</b>	Institute of Freshwater Fisheries
<b>IINH</b>	The Icelandic Institute of Natural History
<b>IFS</b>	Iceland Forestry Service
<b>JRC</b>	Joint Research Center
<b>LGG+</b>	“LandGerða Grunnur” High resolution database for inland use
<b>MM</b>	Man-Months
<b>MMU</b>	Minimum mapping unit
<b>NEA</b>	National Energy Authority
<b>NLSI</b>	National Land Survey of Iceland
<b>RA</b>	Road Administration
<b>UI</b>	University of Iceland
<b>WP</b>	Work package
<b>WU</b>	Working unit