ICELAND

Informal data submission on LULUCF to the Ad-Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol (AWG-KP)

Introduction and summary

Iceland has a unique emission profile among Annex I countries, with two features standing out. First, Iceland has the highest percentage of renewable energy among Annex I countries, with almost 100% of stationary energy (electricity and heating) provided by hydro and geothermal energy. This significantly limits Iceland's mitigation options. Second, Iceland has a large potential for carbon sequestration in vegetation, forests and soil, as big areas of the country have suffered from centuries of soil erosion and deforestation. Experience shows that these areas can be revegetated and afforested. Therefore, LULUCF has figured prominently in Iceland's climate policy from the start. A recent expert analysis on Iceland's mitigation options has confirmed that LULUCF is the one sector offering the biggest possible mitigation gains for Iceland. There are significant opportunities to reduce emissions from transport and the fishing fleet, but slim gains to be realized in other sectors. Hence, Iceland's effort for mitigation in the next commitment period will largely be focussed on LULUCF and reducing the use of fossil fuels in transport and fisheries. Including LULUCF allows Iceland to undertake comparable effort in mitigation with other Annex I countries, despite the fact that stationary energy generation – the biggest emission sector in most countries – is essentially completely de-carbonized in Iceland.

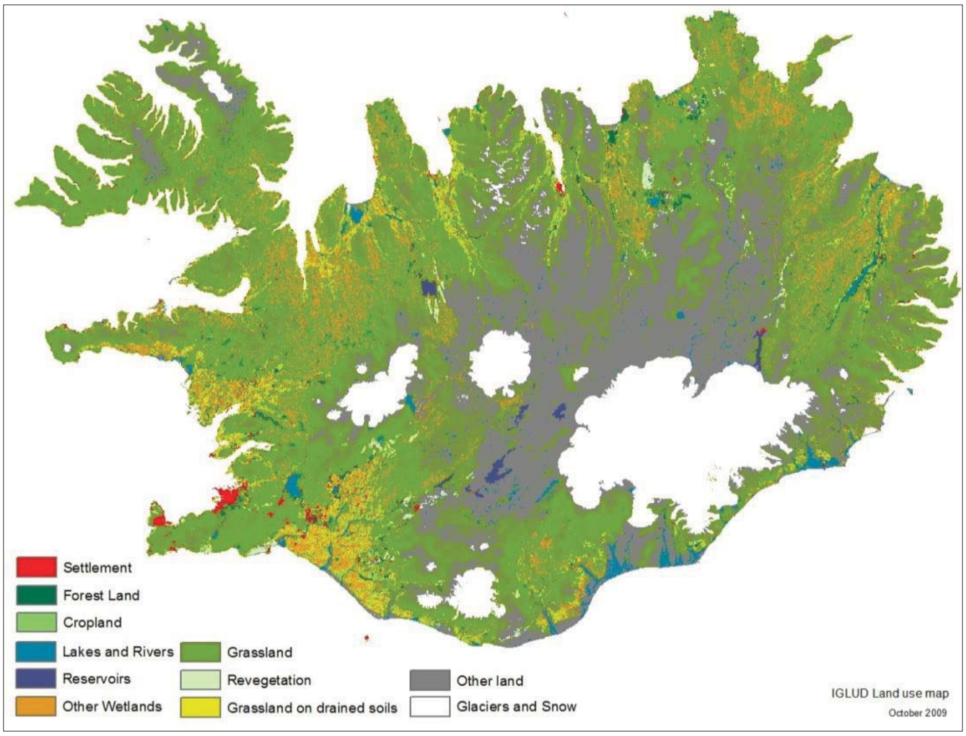
Iceland elected revegetation under Article 3.4 for the first commitment period of the Kyoto Protocol. Significant effort has been made to improve the scientific methodology for measuring carbon sequestration by revegetation of barren and degraded lands. Iceland has in the current negotiations proposed that wetland management be included as an elective activity to reduce net emissions. Iceland expects only moderate mitigation gains from wetland restoration in the next commitment period, as it will take some time to improve the methodology in measuring mitigation gains and losses, set up a solid inventory for wetlands and construct a regime for providing incentives to farmers and other landowners to utilize this activity. In a longer timeframe, wetland conservation and restoration can become a sizable factor in climate mitigation. Including wetland management will create valuable incentive for resarch and development of appropriate methodology.

Land use areas

Iceland covers an area of 103.000 km^2, which is characterized by grasslands and open spaces with limited vegetation. Iceland thus differs from most other European countries, which are dominated by vegetated land, forests and agricultural lands. Iceland is also the most sparsely populated country in Europe, with only three inhabitants per square kilometer.

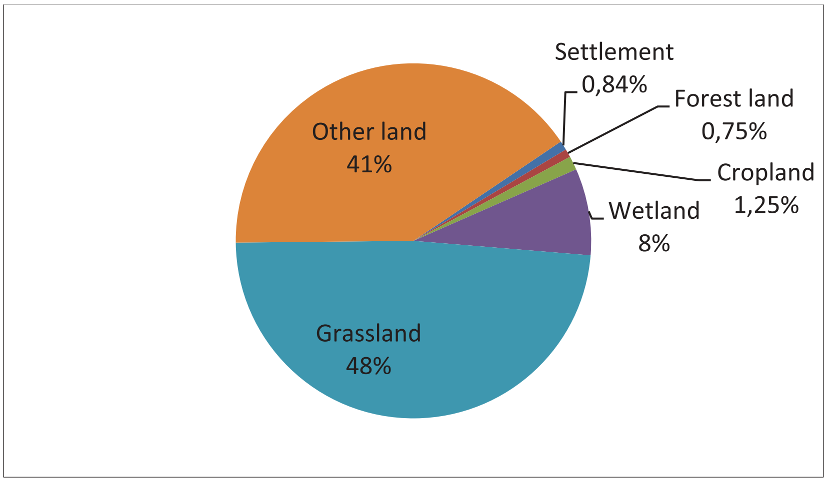
The map below shows the distribution of the land use areas with subcategories as reported to the UNFCCC.

Figure 1. Map showing land use categories



Land that is classified under Grassland, Other land and Wetlands covers 97% of the surface area of Iceland. The remaining 3% falls under Settlement (0,8%), Cropland (1,3%) and Forest land (0,8%).

Figure 2. Relative area of land use categories



About 62% of Forest land in Iceland is natural birch forest. Forest plantations cover 30.000 ha, most of which are younger than 20 years old. Wetlands are dominated by mires and fens, while lakes and rivers, and reservoirs cover 23% and 6% of wetlands respectively.

Table 1. Absolute area of land use categories

	[kha]
Settlement	**86**
Forest land	**78**
Plantations	30
Natural birch forest	48
Cropland	**129**
Wetland	**812**
Reservoirs	45
Lakes and rivers	188
Other wetlands	579
Grassland	**4993**
Other Grasslands	4427
Revegetation areas	194
Drained soils	371
Other land	**4188**
Glaciers and snow	1327
Other (sparsely or not vegetated land)	2565
Total area	**10285**

Iceland has elected revegetation under Article 3.4 of the Kyoto protocol for the first commitment period. Revegetation areas in Iceland covered 194.000 ha in 2007, of which 95.000 ha have been revegetated since 1990. The revegetation activity involves establishing vegetation on eroded or desertified land or reinforcing existing vegetation. The carbon is not only sequestered in vegetation, but mainly in the soil. A high proportion of Icelandic soils are classified as andosol which has a high propensity for carbon accumulation. Iceland has a century long experience in reclaiming eroded land and most efforts have involved establishing vegetation on land with less than 20% cover of vascular plants. All revegetated land is reported as Land being converted to Grassland. Sparsely vegetated land and land with no vegetation cover 2.5 million ha, or 25% of the surface area of Iceland. Converting land in this category to grassland by regvegetation does not only sequester carbon by establishing soil and vegetation but also helps fight erosion and limit loss of carbon to the atmosphere, retain moisture and reduce the frequency of sandstorms.

Emissions and removals

The total emissions of greenhouse gases (without LULUCF) from Iceland in 2007 amounted to 4.48 Mt CO_2-eq which corresponds to 0.02% of the emissions from the Annex-I countries and less than 0.01% of global emissions.
The largest contributor of greenhouse gas emissions in Iceland is the energy sector, followed by industrial processes, then agriculture, waste and solvent and other product use. The energy sector in Iceland is unique in many ways. The proportion of domestic renewable energy in the total energy budget is near 80%, which is the highest share in OECD countries. While one of the most important mitigation opportunities lie globally in switching energy supply from

fossil fuels to renewables, this change has already taken place in Iceland. Emissions from energy industries, producing electricity and heat, accounted for only 1.4% of the sector's total and 0.7% of the total GHG emissions in Iceland in 2007. The energy sector's emissions in 2007 were thus mainly from transport (49%) followed by the fisheries (29%) and the manufacturing industries and construction (21%).

Table 2. Total emissions of greenhouse gases by sources in Iceland 1990 – 2007 (Gg CO_2-eq)

	1990	1995	2000	2005	2006	2007
Energy	1771	1906	2039	2088	2166	2222
Fuel	1704	1824	1875	1965	2009	2070
Geothermal	67	82	163	123	156	152
Industrial processes	863	535	946	918	1335	1486
Solvent and other product use	14	14	15	16	9	12
Agriculture	573	524	530	479	512	534
Waste	180	194	201	194	213	228
Total without LUUCF	3400	3173	3730	3694	4236	4482
Forest land	-19	-30	-44	-61	-68	-78
Cropland	NE	NE	NE	3	4	5
Grassland	1520	1465	1380	1289	1270	1254
Wetland converted to Grassland	1800	1797	1793	1788	1788	1787
Revegetation	-280	-332	-412	-499	-518	-534
Wetland	4	14	17	17	19	30
Hydropower reservoirs	4	14	17	17	19	30
Other emissions	0	0	1	1	2	1
Total LULUCF	1506	1450	1354	1251	1226	1212

Production of raw materials is the main source of industrial process related emissions, which accounted for about 33% of the national GHG emissions in 2007. The most significant category within this sector is metal production, which accounted for 91% of the emissions in 2007. Aluminium production and ferrosilicon production were the main sources, accounting for 66% and 25% respectively of industrial process emissions.

The LULUCF sector is a net source of emissions in Iceland because of emissions from drained wetlands. The emissions from the sector have decreased since 1990, mainly because of carbon sequestration by afforestation and revegetation of land with little or no vegetation.

Forest

Country-specific definition of forest has been adopted. The minimal crown cover of forest is 10%, the minimal height at maturity 2 m, minimal area 0.5 ha and minimal width 20 m. All forests, both naturally regenerated and planted, are defined as managed, as they are affected directly by human activity. The natural birch woodlands have been under continuous use for ages. Until the middle of the 19^{th} century, they where the main source for fuel wood for house heating and cooking in Iceland. Most of the woodlands were and still are used for grazing, although some areas have now been protected from grazing.

In 2005 Icelandic Forest Research (IFR) started a new national forest inventory (NNFI), both in the natural birch woodlands and in the cultivated forest. NNFI is built on systematic sampling with field plots. The first inventory round was finalized this autumn.

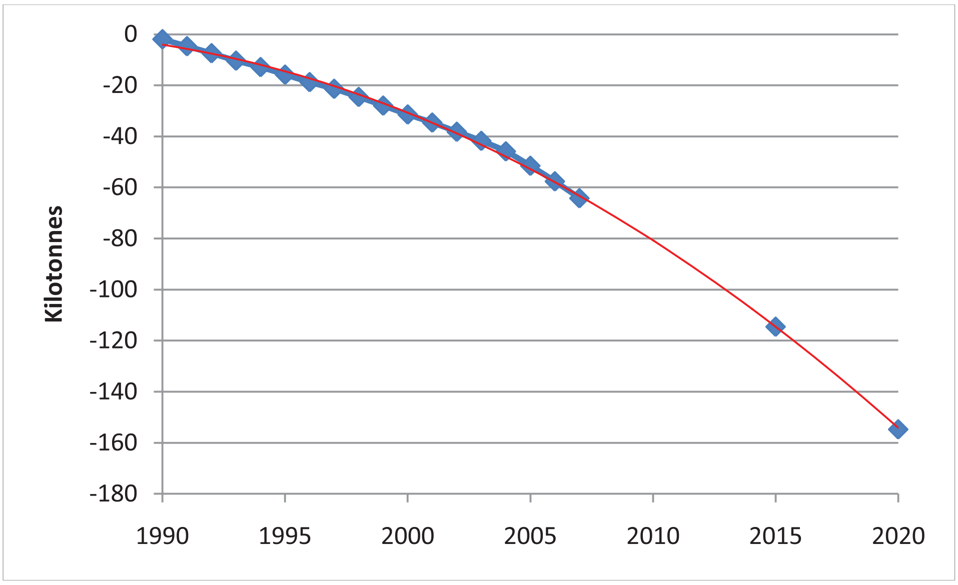
According to estimates of data from the NNFI the total area of birch woodlands is 84 kha. The total area of plantations older than 20 years (planted 1988 and earlier) is estimated at 4.8 kha in 2008. Plantation 1-20 years old (planted 1989- 2008) are estimated at 26.2 kha.

The biomass of forest plantations of known age in Iceland has been measured. These measurements have shown biomass increments ranging from 0.1-1.2 t C/ha/yr for young forests (9-16 years old), to 1.1-3.0 t C/ha/yr for middle aged forests (32-54 years old). Data from the NNFI are used to estimate more accurately the current increment of biomass in trees. Most of the cultivated forests in Iceland are relatively young, with only 16% older than 20 years and clear cutting has not started yet.

Newly published research results have also shown considerable C accumulation (0.4 t C/ha/yr) in brown andosols (that is the most common mineral soil in Iceland) up to 50 years after afforestation.

IFR has used forest yield measurements of eleven most commonly used tree species in cultivated forest and annual production of seedling of the same species as an input in a model forecasting CO_2-removals of afforestation since 1990. This model has been calibrated towards the estimated present figures of CO_2-removals conducted through the NNFI. CO_2-removal by fixed factor for the forest soil to the age of 50yr is also added. The results shown in Figure 3 are outputs, assuming that 5 million seedlings are planted annually. It has to been kept in mind that this forecast does only take into account moderate thinning of the forest stands and no permanent deforestation. Accordingly the output has to be considered as maximum value of forecasted CO_2-removals owing to ARD. The recent economic downturn in Iceland could have an effect on the assumption of the planting rate.

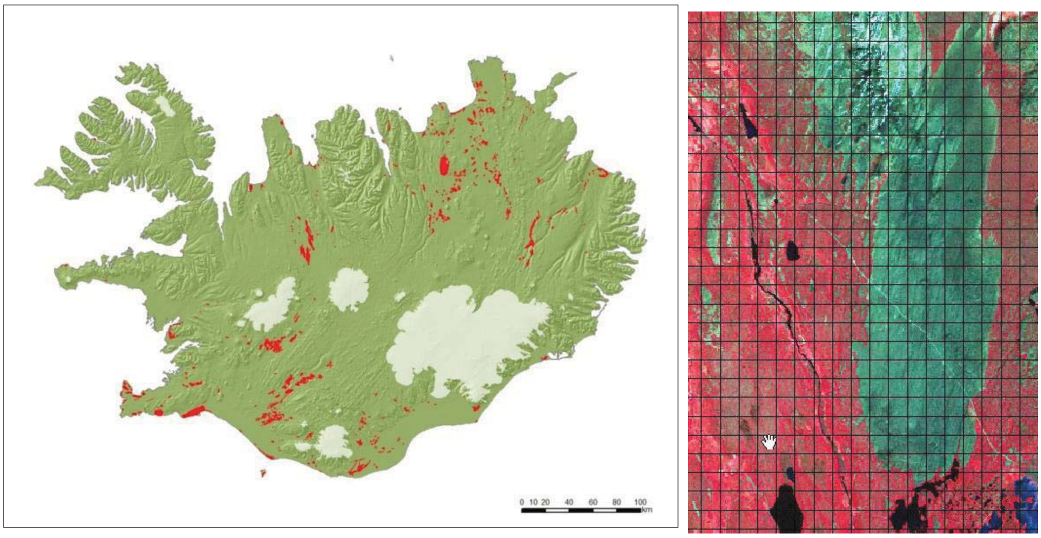
Figure 3. Afforestation: Historic and projected CO_2 removals



Revegetation

Since the settlement of Iceland former vegetated areas have been severely eroded and in large areas the entire soil mantle has been lost. The revegetation of those deserted areas facilitates the recreation of the carbon rich volcanic soils, and is thus the key step in large scale soil carbon sequestration.

Figure 4. Map showing revegetation areas (red, left) established during 1990-2007, and an infrared SPOT image of one of the revegetation areas (right). The 1×1 km sampling grid is shown.



The area of land being revegetated is divided into two categories based on when the activity started; Land revegetated before 1990 and Land revegetated since 1990. The Soil Conservation Service of Iceland (SCSI) now keeps a national inventory on revegetation areas since 1990 based on best available data. The objectives of this inventory are to monitor the changes in C-stocks, to control/improve the existing mapping and gather data to improve current methodology. The National Inventory on Revegetation Area (NIRA) is based on systematic sampling at predefined grid points. The same basic grid is used by the Icelandic Forestry Service (IFS) for their NNFI. The basic grid unit, as applied by SCSI is a 1.0×1.0 km square, calculated from a randomly selected starting coordinate. All grid points that overlap revegetation areas larger than 0.5 ha and active since 1990 are preselected for measurement and will be visited. A 30 m buffer zone is also established around each revegetation area, and plots that fall within this buffer zone, and are on totally denuded land, are also selected for measurement serving as control plots in the first commitment period, hence representing the status of the area before revegetation activities started. However, after the first commitment period, data will be collected by repeating measurements of the established plots. New revegetation areas will also be measured prior to establishment and added to the NIRA database. It is estimated that the final database will contain around 1000 plots, 800 in revegetation areas and 200 controls. Each plot is 10×10 m. Within each, five 0.5×0.5 m randomly selected subplots will be used for soil and vegetation sampling for C-stock estimation.

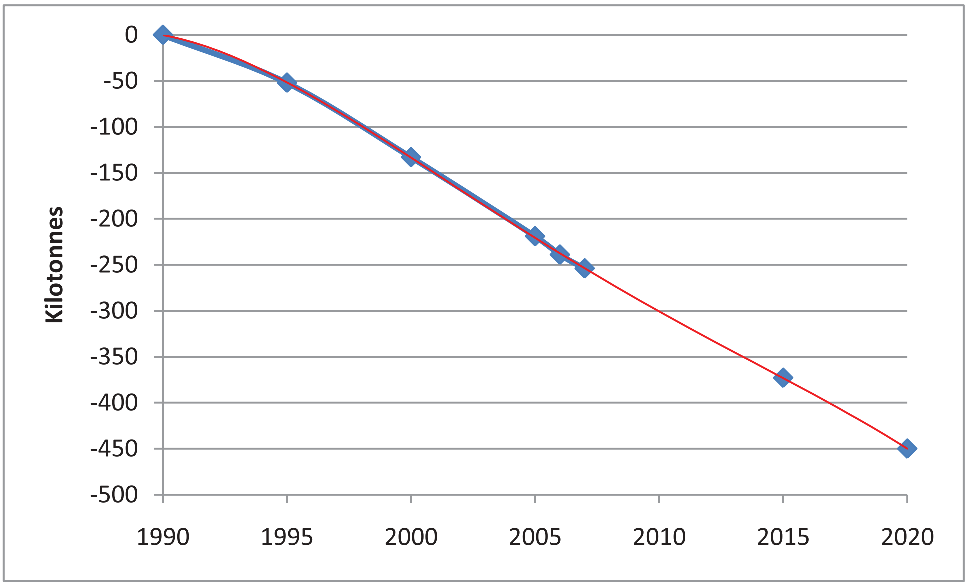
The current estimate for the total area of revegetated areas prior to 1990 is 99 kha and 95 kha for areas since 1990. These figures will be constantly revised as better data is accumulated both through improved mapping and as sites are visited during NIRA data accumulation.

The NIRA project started in 2007 and is thus in its third sampling year. The first season was used for developing methods and assessing the extent of the program ahead by visiting a limited number of, but videly distributed, revegetation areas. But since 2008 a systematic sampling has been carried out, using the protocol developed in 2007. Data from 2007 is now available and is currently (fall 2009) being used to calculate new coefficients for C-stocks in revegetation. Data for 2008 and 2009 is expected to be available late 2010 and will then be used to revise existing estimates.

The measurement plots will be revisited every 5 years, hence the first plots established in 2007 will be resampled in 2012. It is expected that from that point in time and onwards, a good picture of soil carbon sequestration in land reclamation areas will be available.
The current soil carbon sequestration coefficients (-0.75 ktonnes C/ha/yr) are currently being revised based on new data from the NIRA database.

The figure below shows possible projected CO_2 removals from revegetation, assuming a continued effort to expand revegetation into new areas annually until 2020. This projection does not take into account possible effects of the recent economic downturn in Iceland on the financing of such projects.

Figure 5. Revegetation: Historic and projected CO_2 removals.



Land Restoration Training Program in Iceland

Much experience and knowledge has been gained during 100 years of fighting soil erosion and restoring land quality in Iceland. This experience is the basis for a Land Restoration Training program launched by the Government of Iceland in 2007. The training program is open for post-graduates and/or professionals from the developing countries. The aim is to increase the capacity of the students to lead projects on land restoration in their home countries. The Land Restoration Training program has now become one of the United Nations University training centers.

Wetlands

Soils are the biggest store of carbon on land, especially in the form of peat and other soils rich in organic material formed by wetlands. Wetlands are internationally recognized as being one of the most important ecosystems/biomes/habitats for the conservation of biodiversity. Apart from a high biodiversity value, wetlands provide various ecosystem services such as water purification, hydrological buffering, groundwater replenishment, nutrient retention and cycling, sediment retention, wildlife habitat and recreation areas.

Draining wetlands turns them into a net source emitting substantial amount of greenhouse gases. The restoration of damaged wetlands by rewetting can halt emissions of carbon dioxide and even reverse them. Yet, there are few incentives in the current climate regime for wetland restoration, nor disincentives to drain or damage wetlands. The inclusion of wetland management (as a system of practices for rewetting and draining of land) in the second commitment period would create this incentive and lead to improvement in accounting methodology.

The total extent of wetlands in Iceland is 812 kha. Wetlands are significant part of the Icelandic physical landscape, covering around 8% of its land area. Thereof around 70% are classified as “mires and swamps” and around 23% as lakes and rivers. Wetland drainage was practiced from the fifties until the early eighties as an effort to increase agricultural production. The current estimates of the extent of drained wetlands are based on the analysis of satellite images. Drainage ditches are easily visible on such images since open grasslands are the dominant land type in Iceland. According to these estimates the total area of drained wetlands is about 370 kha. Greenhouse gas emissions from drained wetlands amounted to 1.79 Mt CO_2-eq in 2007, which is significant in relation to Iceland’s overall GHG emissions.

Iceland would not expect big actual gains to be realized by wetland restoration in the next decade or so. The first phase of a coordinated effort to restore wetlands would be to construct a solid scientific, financial and political framework for this activity. A key requirement would be the creation of a comprehensive inventory of wetlands, both intact and drained ones, an improved estimate of emissions from drained wetlands, and an approved methodology to measure the climate gains of wetland restoration. A framework would have to be set up to select priority land for wetland restoration and finance restoration projects. With these requirements in place a pilot phase could be run, which would provide guidance for a possible bigger-scale wetland restoration.

A rough estimate is that wetland restoration could yield net gains of 50-100 Gg CO_2 a year by the year 2020. Actual gains from electing the activity might be greater, as it would be expected that this would also deter draining of intact wetlands. Gains after 2020 could be greater, if the results of a pilot phase are positive and technical and political hurdles are overcome.