Section 2

Land Use Change and Forestry: The 2002 UK Greenhouse Gas Inventory and projections to 2020

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2. Land Use Change and Forestry: The 2002 UK Greenhouse Gas Inventory and projections to 2020

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2.1. Introduction

The Land Use Change and Forestry Sector differs from others in that it contains both sources and sinks of carbon dioxide. The removals are presented as negative quantities and are reported separately from emissions in the inventory tables. Emissions from land use change and forestry were approximately 2.5% of the UK Total in 2002 and are declining gradually.

The estimates for Land Use Change and Forestry are from work carried out by the Centre for Ecology & Hydrology (Cannell *et al* 1999, Milne and Brown 1999). The data is reported under IPCC categories 5A (Changes in Forests and Other Woody Biomass, 5B (Forest and Grassland Conversion), 5D (CO2 Emissions from Soils) and 5E (Other). No data is included for Category 5C (Abandonment of Managed Lands) as this is considered to be negligible, or not occurring, in the UK.

The UK has been producing annual inventories for land use change and forestry sources and sinks since before the UNFCCC produced the CRF. These early inventories considered many activities and grouped these into categories considered to be appropriate to IPCC categories described in the 1996 Guidelines. These pre-CRF categories of activities have been used in UK NIRs until the present. Differences between the grouping of data from activities for the CRF and the UK NIR categories are highlighted for each CRF Category described here. In addition the activity data and the different groupings for CRF and NIR are discussed in more later.

2.2. Changes in Forests and Other Woody Biomass Stocks (5A)

The carbon uptake by the forests planted since 1920 is calculated by a carbon accounting model (Dewar and Cannell 1992, Cannell and Dewar 1995, Milne *et al.* 1998) as the net change in pools of carbon in standing trees, litter, soil in broadleaf forests and products. Restocking is assumed in all forests. The method of the IPCC 1996 Guidelines is not used. The UK carbon accounting model forests calculates the mass of carbon in trees, litter, soil and wood products from harvested material in new even-aged plantations that were clearfelled and then replanted at the time of Maximum Area Increment (MAI). Two types of input data and two parameter sets were required for the model (Cannell and Dewar, 1995). The input data are a) areas of new forest planted in each year in the past and b) the stemwood growth rate and harvesting pattern. Parameter values were required to estimate i) stemwood, foliage, branch and root masses from the stemwood volume and ii) the decomposition rates of litter, soil carbon and wood products.

For the estimates described here we used the combined area of new private and state planting from 1920 to 2002 for England, Scotland, Wales and Northern Ireland sub-divided into conifers and broadleaves (Milne *et al.* 1998). Restocking was dealt with in the model through the second and subsequent rotations and hence areas restocked each year did not need to be considered separately. The implicit assumption is therefore that the forests are felled according to standard management tables. Data on variation in management, i.e. felling/replanting dates, from that recommended in the standard tables is not available to the Inventory compliers.

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The carbon flow model uses Forestry Commission Yield Tables (Edwards and Christie, 1981) to describe forest growth. It was assumed that all new conifer plantations have the same growth characteristics as Sitka spruce (*Picea sitchensis* (Bong.) Carr.) under an intermediate thinning management. Milne et al. (1998) have shown that mean Yield Class for Sitka spruce varied across Great Britain from 10 to16 m^3 ha^{-1} a^{-1} but with no obvious geographical pattern and that this variation had a less than 10% effect on estimated carbon uptake for the country as a whole. The Inventory data has therefore been estimated by assuming all conifers in Great Britain followed the growth pattern of Yield Class 12 m^3 ha^{-1} a^{-1}, but in Northern Ireland Yield Class 14 m^3 ha^{-1} a^{-1}, Sitka spruce. Milne *et al.* (1998) also showed little effect of different assumptions on broadleaf species. It is assumed here, that broadleaf forests had the characteristics of beech (*Fagus sylvatica* L.) of Yield Class 6 m^3 ha^{-1} a^{-1}. Data in the most recent inventory of British woodlands (Forestry Commission 2002) shows that beech is only about 8% of broadleaf forest (all ages). Although sensitivity analysis of the carbon accounting model shows that different assumptions on the broadleaf species planted has little effect on overall carbon uptake the assumption of using beech as the representative species will be reviewed. Using oak or the sycamore-ash-birch group Yield Class data instead of beech data is likely to have a less than 10% effect on the value of removal of carbon to UK forests. Irrespective of the assumption on representative species the variation in removals from 1990 to the present is determined by the afforestation rate in earlier decades and the effect this has on the age structure in the present forest estate and hence the average growth rate. This afforestation is all on ground that has not been wooded for many decades. Table 2-1 shows the afforestation rate since 1922 and the present age structure of these forests. In addition to these planted forests there are about 840 kha of woodland planted prior to 1922 or not of commercial importance. This area is not included for the purposes of the Greenhouse Gas Inventory. Variation from year to year in the reported removals to woody biomass, soils and harvested products reflect the changing pattern of afforestation over the period of available data. For example, there are increases in removals to harvested products about 50 years (the conifer forest rotation cycle) after a period of increased planting of conifers. It can be shown that if forest expansion continues at the present rate then removals of atmospheric carbon will continue to increase until about 2005 and then will begin to decrease, reflecting the reduction in afforestation rate after the 1970s.

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Table 2-1 Afforestation rate and age distribution of conifers and broadleaves in the United Kingdom.

	Planting rate (000 ha a^{-1})		**Age distribution**	
	Conifers	**Broadleaves**	**Conifers**	**Broadleaves**
1922-1929	4.9	2.4	2.9%	7%
1930-1939	7.2	2.2	5.4%	9%
1940-1949	6.3	1.9	4.7%	7%
1950-1959	20.0	3.0	14.9%	12%

1960-1969	28.4	2.9	21.1%	12%
1970-1979	33.2	1.5	24.8%	6%
1980-1989	22.5	1.4	16.8%	5%
1990	26.8	3.1	2.0%	1%
1991	15.4	5.8	1.1%	2%
1992	13.4	6.8	1.0%	3%
1993	11.6	6.5	0.9%	3%
1994	10.1	8.9	0.8%	3%
1995	7.4	11.2	0.6%	4%
1996	9.5	10.5	0.7%	4%
1997	7.4	8.9	0.6%	4%
1998	7.0	9.7	0.5%	4%
1999	6.6	10.1	0.5%	4%
2000	6.5	10.9	0.5%	4%
2001	4.9	13.4	0.4%	5%

Increases in stemwood volume were based on standard Yield Tables, as in Dewar and Cannell (1992) and Cannell and Dewar (1995), and the mass of carbon in a forest was calculated from this volume by multiplying by wood density, stem to branch and root mass ratios and the fraction of carbon in wood (0.5 assumed). The values used for these parameters for conifers and broadleaves are given in Table 2-2

*Table 2-2 Main parameters for forest carbon flow model for species used to estimates carbon uptake by planting of forests of Sitka spruce (*P. sitchensis *and beech (*F. sylvatica*) in United Kingdom (data from Dewar & Cannell, 1992)*

	P. sitchensis	**P. sitchensis**	**F. sylvatica**
	YC12	**YC14**	**YC6**
Rotation (years)	59	57	92
Initial spacing (m)	2	2	1.2
Year of first thinning	25	23	30
Stemwood density (t m^{-3})	0.36	0.35	0.55
Max. carbon in foliage (t ha^{-1})	5.4	6.3	1.8
Max. carbon in fine roots (t ha^{-1})	2.7	2.7	2.7
Fraction of wood in branches	0.09	0.09	0.18
Fraction of wood in woody roots	0.19	0.19	0.16
Max. foliage litterfall (t ha^{-1} a^{-1})	1.1	1.3	2
Max. fine root litter loss (t ha^{-1} a^{-1})	2.7	2.7	2.7
Dead foliage decay rate (a^{-1})	1	1	3
Dead wood decay rate (a^{-1})	0.06	0.06	0.04

Dead fine root decay rate (a^{-1})	1.5	1.5	1.5
Soil organic carbon decay rate (a^{-1})	0.03	0.03	0.03
Fraction of litter lost to soil organic matter	0.5	0.5	0.5
Lifetime of wood products	57	59	92

The parameters controlling the transfer of carbon into the litter pools and its subsequent decay are given in Table 2-2. Litter transfer rate from foliage and fine roots increased to a maximum at canopy closure. A fraction of the litter was assumed to decay each year, half of which added to the soil organic matter pool that then decayed at a slower rate. Tree species and Yield Class, but not other factors which varied with location, were assumed to control the decay of litter and soil matter. Additional litter was generated at times of thinning and felling.

As in Cannell and Dewar (1995) it was assumed that conifer forests increased the amount of organic carbon in litter but did not increase the net amount of carbon in soil due to gains from the new forest being balanced by loss due to the disturbance at planting. Most conifer afforestation in the UK is on soils with high organic carbon content. Until recently little has been known about carbon losses from such soils when ploughed for forest planting. It was generally believed that, especially for peat, the losses would be large and continue for very long periods (many decades). So, although the new forest would add new organic carbon to the existing soil, carbon would also continue to be lost from the existing soil. In the absence of detailed measurements it was therefore assumed that for most conifer planting the gains and losses would balance but in the case of deep peat there would be a continuing net loss. The rate of this loss was estimated from some preliminary measurements on recently disturbed peat to be about 2 tC ha^{-1} a^{-1}. These estimates of losses on afforested deep peat are reported under Category 5D (Emissions from Soils) in the CRF or Category 5E (Other) in the National Inventory Report (NIR). Broadleaved forests were assumed to increase the net amount of carbon in litter and soil and, since normally planted on mineral soils, the change in emissions from pre-existing soils would be negligible

It is assumed in the carbon accounting model that harvested material from thinning and felling is made into wood products. These products are then assumed to decay over a period equal to the rotation of the forest, conifer or broadleaf as appropriate, since products from broadleaves (e.g. furniture) will decay more slowly than those from conifers (e.g. paper, building timber). The net change in the carbon in this pool of wood products is reported in Category 5A. Calculated in this way that part of the total wood products pool from UK forests is presently increasing due to continuing expansion in forest area. Dewar and Cannell (1992) and Cannell and Dewar (1995) provided a detailed description of all the assumptions in the model.

Uncertainty estimates for the removals calculated in this Category are shown in Table 2-22. Activity data is obtained consistently from same national forestry sources therefore time series consistency of estimated Removals is good.

Analysis of measurements taken at a deep peat moorland, locations covering afforestation of peat from 1 to 9 years previously and at a 26 year old conifer forest have recently been completed (Hargreaves *et al.* 2003) and suggest that long term losses from afforested peatlands are not as great as had been previously thought, settling to about 0.3 tC ha^{-1} a^{-1} thirty years after afforestation. In addition a short burst of regrowth of moorland plant species occurs before forest canopy closure. The pattern of carbon loss and gain from afforested deep peat moorland is summarized in Table 2-3.

Table 2-3 Emissions of carbon from deep peat due to ploughing for afforestation. Negative values mean uptake of carbon from the atmosphere. Here this is due to temporary re-growth of moorland plants between ploughing and forest canopy closure. (Based on work of Hargreaves et al*. 2003).*

Years after afforestation	**Carbon loss ($tC\ ha^{-1}\ a^{-1}$)**
0	0.0
1	2.2
2	3.8
3	2.5
4	1.1
5	-0.3
6	-1.2
7	-1.6
8	-1.6
9	-1.3
10	-1.1
15	-0.2
20	0.1
25	0.2
30	0.3

The data reported for Category 5A and 5D/E is therefore under review in order to include these newer estimates of long-term carbon loss. The revision will also take into account estimates of the areas of deep peat afforested in the decades since 1920. The revision will include, as well as lower losses from deep peat, the carbon incorporated into the soil under the new conifer forests. These latter removals are, in existing data, offset by losses from the pre-existing soil. When smaller estimates of loss from pre-existing soil are introduced there will therefore be a significant increase in the general level of removals of atmospheric carbon dioxide to forest soils. In the NIR for 2001 it was stated that these revisions would be included in the submissions for 2002 but further consideration of the situation relating to emissions from afforested mineral soils was indicted by discussions at COST E21 meetings. The revision of the emissions from afforested soils has therefore been postponed until an assessment of the effect of afforestation on all soils can be made.

The pattern of increases in stemwood volume between planting and first thinning is also presently under review and newly developed curves will be introduced with the revisions to the soils calculations. The change to the estimated Removals by including the revised early growth pattern will however be small.

2.3. Forest and Grassland Conversion (5B)

In previous National Inventory Reports and CRF submissions, it had been assumed that permanent conversion of forest to non-forest in the UK has been negligible. This assumption was based on stringent government guidelines against deforestation, including the need for approval for any permanent forest felling from the Forestry Commission or equivalent in Northern Ireland. Review of this assumption suggests that some deforestation is happening where, for example, urban development is encroaching on old woodlands. This situation is covered by a different set of guidelines and due to the need for new housing permission for felling is more readily obtained.

Levy and Milne (2004) discuss methods for estimating deforestation using a number of data sources. Here we use their approach of combining Forestry Commission felling licence data for rural areas with Ordnance Survey data for non-rural areas.

In Great Britain, some activities that involve tree felling require permission from the Forestry Commission, in the form of a felling licence, or a felling application within the Woodland Grant Scheme. Under the Forestry Act 1967, there is a presumption that the felled areas will be restocked, usually by replanting. Thus, in the 1990s, ~14,000 ha a^{-1} were felled and restocked. However, some licences are granted without the requirement to restock, where there is good reason – so-called unconditional felling licences. Most of these areas are small (1–20 ha), but their summation gives some indication of areas deforested. These areas are not published, but recent figures from the Forestry Commission have been collated.

Only local planning authorities hold documentation for allowed felling for urban development and the need for collation makes estimating the national total difficult. However, in England, The Ordnance Survey (national mapping agency) makes an annual assessment of land use change (Office of The Deputy Prime Minister, 2003) from data it collects for map updating. Eleven broad land-use categories are defined, with a number of sub-categories. The data for England were available to produce a land-use change matrix, quantifying the transitions between land-use classes. Deforestation rate was calculated as the sum of transitions from all forest classes to all non-forest classes.

The rural and non-rural values were scaled up to GB scale, assuming that England accounted for 80 per cent of deforestation to rural uses (based on the distribution of licenced felling between England and the rest of GB) and 51 per cent of deforestation to non-rural uses (assuming it scales simply in proportion with forest area)

Data is available from both sources from 1990 to 1999 and provides a mean deforestation rate for the period of 1185 ha a^{-1} for non-rural and 448 ha a^{-1} for rural locations. Deforestation is not estimated for Northern Ireland. The mean area loss rate (1633 ha a^{-1}) was used in the method described in the IPCC 1996 guidelines (IPCC 1997 a, b, c) to estimate emissions of CO_2, CH_4 and N_2O. These mean emissions are used for each year of the Inventory.

Table 2-22 shows the uncertainty in estimating the emissions due to deforestation for uncertainty estimate. Improvement of the method to include changes of deforestation with time is planned.

2.4. CO_2 Emissions and Removals from Soils (5D)

In this category changes in soil stocks due to land use change are estimated. All forms of land use change except afforestation are considered together and both mineral and organic soils are included. Removals due to afforestation are considered separately using the forest carbon accounting model described in Section 2. The net Emissions due to land use change are reported in the CRF under Category 5D1 & 5D2 (CO_2 Emissions and Removals from Soils – Cultivation of Mineral & Organic Soils) but in the 2002 and earlier UK NIRs are combined with Emissions from soils due to liming of agricultural land and Removals due to the effect of Set Aside

2.4.1. Land Use Change

2.4.1.(a) Land Use Change in Great Britain

The basic method for assessing changes in soil carbon due to land use change is to use a matrix of change from surveys of land linked to a dynamic model of gain or loss of carbon. In the latest version of the method matrices from the Monitoring Landscape Change (MLC) data from 1947 & 1980 and the DETR/ITE Countryside Surveys (CS) of 1984 & 1990 are used. Land use in the UK can be placed into 4 broad groups – (Semi) Natural, Farming, Woodland and Urban – and hence the more detailed categories for the two surveys were combined as shown in Table 2-5 for MLC and Table 2-6 for CS. In both cases only unimproved grassland is included in the Natural category. For the CS the different types of grass are shown in Table 2-7.

A database of soil carbon density for the UK has been constructed (Milne and Brown 1995, Cruickshank et al. 1998) from information provided by the Soil Survey and Land Research Centre, the Macaulay Land Use Research Institute and Queen’s University Belfast on soil type, land cover and carbon content of soil cores. These densities include carbon to a depth of 1 m or to bedrock whichever is the shallower, for mineral and peaty/mineral soils. Deep peat in the North of Scotland is identified separately and depths to 5 m are included but these play a minor role in relation to land use change. Table 2-4 shows average values of soils carbon density for different land covers in the four devolved areas of the UK. The data of Table 2-4 shows no strong evidence of a major difference in the soil carbon density of tilled cropland (arable) or actively managed grass (pasture) hence the inclusion of both uses within the Farm category

Table 2-4 Average soil carbon density (t C ha^{-1}) for different land cover in the UK

Region / Cover	England	Scotland	Wales	N. Ireland
Natural	487	1048	305	551
Woodland	217	580	228	563
Arable	153	156	93	151
Pasture	170	192	200	178
Other	33	141	43	102

Table 2-5 Grouping of MLC land cover types for soil carbon change modelling.

FARM	NATURAL	WOODLAND	URBAN
Crops	Upland heath	Broadleaved wood	Built up
Market garden	Upland smooth grass	Conifer wood	Urban open
Improved grassland	Upland coarse grass	Mixed wood	Transport
Rough pasture	Blanket bog		Mineral workings

	Bracken		Derelict
	Lowland rough grass		
	Lowland heather		
	Neglected grassland		
	Marsh		

Table 2-6 Grouping of CS land cover types for soil carbon change modelling. For Managed grass (I) signifies "Improved", usually by ploughing and seeding, (U) signifies "Unimproved" by such means.

FARM	**NATURAL**	**WOODLAND**	**URBAN**
Tilled land	Rough grass/marsh	Broadleaved/mixed	Communications
Managed grass(I)	Managed grass (U)	Coniferous	Built up
	Dense bracken		Inland bare (Hard areas)
	Moorland grass		
	Dense heath		
	Open heath		

Table 2-7 Different types of CS land cover included in the "Improved" (I) and "Unimproved" (U) Managed grass groups for soil carbon modelling.

Managed grass (I)	**Managed grass (U)**
Recreational	Non-agricultural improved
Recently sown	Calcareous
Pure rye	Upland
Well managed	
Weedy swards	

Area data exist for the period 1930 to 1990 and those from 1984 to 1990 are used to extrapolate forward for the years 1991 to 1998. Land use change matrices for the periods 1947 to 1980 and 1984 to 1990 are used. See Table 2-8 for the sources of information for land use and matrices of change.

Table 2-8 Area and change data sources for different periods in estimation of changes in soil carbon. (1) Stamp (1962), (2) MLC (1986), (3) Barr et al. *(1993).*

Year or Period	**Area data**	**Change matrix or data**
1930	Land use Survey (1)	
1930 – 1947	Interpolated	MLC 1947->MLC1980
1947	MLC (2)	
1947-1980	Interpolated	MLC 1947->MLC1980
1980	MLC (2)	

1980-1984	Interpolated	Interpolated
1984	CS1984 (3)	
1984-1990	Interpolated	CS1984->CS1990
1990	CS1990 (3)	
1990-2010	Extrapolated from 84->90	CS1984->CS1990

The core equation describing changes in soil carbon with time for any land use transition is

$$C_t = C_f - (C_f - C_0)e^{-kt}$$

C_t is carbon density at time t
C_0 is carbon density initially
C_f carbon density after change to new land use
k is time constant of change

If the inventory year is 1990 and A_T is area in a particular land use transition in year T considered from 1930 onwards then total carbon lost or gained from 1930 to 1990 (X_{1990}) and from 1930 to 1989 (X_{1989}) is given by

$$X_{1990} = \sum_{T=1930}^{t=1990} A_T (C_0 - C_f)(1 - e^{-k(1990-T)})$$

$$X_{1989} = \sum_{T=1930}^{T=1989} A_T (C_0 - C_f)(1 - e^{-k(1989-T)})$$

Hence flux of carbon in 1990 is given by difference:

$$F_{1990} = X_{1990} - X_{1989}$$

The land use transitions considered are each of those between the (Semi) Natural, Farm, Woodland and Urban categories. Scotland, England and Wales are treated separately. Northern Ireland does not yet have a matrix of land use change and changes in soil carbon are calculated by a method based on that recommended by the IPCC (1997b, c). The area data for Great Britain are shown in Table 2-9 to Table 2-11. The data from the CS has had a small adjustment applied to account for one of the detailed land types (Non-cropped arable) actually bridging the main Natural and Farm categories.

Table 2-9 Area of land in England for each use category from field and area surveys (1) Stamp (1962), (2) MLC (1986), (3) Barr et al. *(1993).*

		Area (ha)			
Source	Year	**Farm**	**Natural**	**Urban**	**Woodland**
lus (1)	***1930***	9,542,340	1,543,000	1,034,858	843,800
mlc (2)	***1947***	9,242,777	1,639,511	823,665	865,370
mlc (2)	***1980***	9,013,401	1,307,178	1,301,965	948,779
cis (3)	***1984***	8,670,815	1,908,436	1,249,383	1,303,455
cis (3)	***1990***	8,336,428	2,120,609	1,323,084	1,353,399

Table 2-10 Area of land in Wales for each use category from field and area surveys (1) Stamp (1962), (2) MLC (1986), (3) Barr et al. *(1993).*

		Area (ha)			
Source	**Year**	**Farm**	**Natural**	**Urban**	**Woodland**
lus (1)	***1930***	1,094,187	771,520	77,298	120,439
mlc (2)	***1947***	1,061,571	701,347	71,422	160,077
mlc (2)	***1980***	1,148,150	521,131	121,459	203,677
cis (3)	***1984***	1,155,174	585,248	176,112	221,521
cis (3)	***1990***	1,132,768	593,918	188,628	222,953

Table 2-11 Area of land in Scotland for each use category from field and area surveys (1) Stamp (1962), (2) MLC (1986), (3) Barr et al. *(1993).*

		Area(ha)			
Source	**Year**	**Farm**	**Natural**	**Urban**	**Woodland**
lus (1)	***1930***	1,861,215	5,265,673	146,906	443,187
mlc (2)	***1947***	2,037,860	5,209,630	260,313	447,753
mlc (2)	***1980***	2,100,125	4,667,711	297,076	890,644
cis (3)	***1984***	2,109,333	4,940,892	287,471	1,019,931
cis (3)	***1990***	2,059,553	4,935,184	294,291	1,068,543

In the model, the change is required in equilibrium carbon density from the initial to the final land use during a transition. Here, these are calculated for each land use category as averages for Scotland, England and Wales. In order to account for variation in carbon density and Land Use Change in different soil types these averages are weighted by the area of soil groups used by IPCC (1997c). They define five groups, which are represented in Great Britain, on the basis of their carbon content and activity namely: aquic, high activity clay, and low activity clay, sandy and organic. In Great Britain few clay soils truly fall into the 'high activity' class so the *total* *clay content* is used to divide these soils into 'high' and 'low' groups. For Great Britain all soil types not falling into these five types an 'undefined' groups is used. Mean soil carbon density change are calculated as:

$$\overline{C}_{ijc} = \frac{\sum_{s=1}^{6}(C_{sijc}L_{sijc})}{\sum_{s=1}^{6}L_{sijc}}$$

which is the weighted mean, for each country, of change in equilibrium soil carbon when land use changes and

i = initial land use (Natural, Farm, Woods, Urban)
j = new land use (Natural, Farm, Woods, Urban)
c = country (Scotland, England & Wales)
s = soil group (High clay, low clay, aquic, organic, sandy, undefined)
C_{sijc} is change in equilibrium soil carbon for a specific land use transition within a soil group region in a specific country
L_{sijc} is area change (1984 to 1990) for a specific land use transition within a soil group region in a specific country.

The weighted mean change in equilibrium soil carbon calculated for England, Scotland and Wales are shown in Table 2-12 to Table 2-14.

Table 2-12 LUC area weighted mean change in equilibrium soil carbon (tC ha^{-1})for England

Initial / Final	Farm	Natural	Urban	Woods
Farm		-79	-8	-39
Natural	78		71	-20
Urban	9	-63		-24
Woods	38	20	31	

Table 2-13 LUC area weighted mean change in equilibrium soil carbon (tC ha^{-1}) for Scotland

Initial / Final	Farm	Natural	Urban	Woods
Farm		-410	85	-260
Natural	279		324	-30
Urban	-63	-286		-551
Woods	204	30	396	

Table 2-14 LUC area weighted mean change in equilibrium soil carbon (tC ha^{-1}) for Wales

Final \ Initial	Farm	Natural	Urban	Woods
Farm		-30	40	-23
Natural	31		78	-10
Urban	-38	-72		-53
Woods	25	10	89	

The rate of loss or gain of carbon is dependent on the type of land use transition (Table 2-15). For transitions where carbon is lost e.g. transition from Natural to Farm land, a 'fast' rate is applied whilst a transition that gains carbon occurs much more slowly. This 'slow' rate had in the 1998, and earlier, GHG Inventories been set such that 99% of the change occurred in 100 years throughout GB as had been observed at Rothamsted (Howard et al. 1994). However, it was observed that due to the high carbon densities in Scottish soils that the uptake rates of carbon in that country were unreasonably large when land moved to the Natural class from the Farm class. In the 1998 Inventory a smaller rate of change was therefore used so that the uptake of soil carbon in such transitions was less than the order of net primary productivity for cold temperate grasslands (about 300 g m^{-2} a^{-1}). Thus a rate of soil carbon accumulation in Scotland that took the equivalent of 800 years to reach 99% of the new values was used. Since the 1999 Inventory, a different approach to taking account of the uncertainty in such rates of transition has been adopted. A literature search for information on measured rates of changes of soil carbon due to land use was carried out and, in combination with expert judgement, ranges of possible times for completion of different transitions were selected. These are shown in Table 2-16.

Table 2-15 Rates of change of soil carbon for land use change transitions. ("Fast" & "Slow" refer to 99% of change occurring in times shown in Table 2-12 to Table 2-14).

		1984			
		Farm	Natural	Urban	Woods
1990	**Farm**		*fast*	*slow*	*fast*
	Natural	*slow*		*slow*	*fast*
	Urban	*fast*	*fast*		*fast*
	Woods	*slow*	*slow*	*slow*	

Table 2-16 Range of times for soil carbon to reach 99% of a new value after a change in land use in England (E), Scotland (S) and Wales (W).

	Low (years)	**High (years)**
Carbon loss ("fast") E, S, W.	50	150
Carbon gain ("slow") E, W.	100	300
Carbon gain ("slow") S.	300	750

The model of change was then run 500 times with the time constant for change in soil carbon being selected separately using a Monte Carlo approach for England, Scotland and Wales from within the ranges of Table 2-16. The mean carbon flux for each region resulting from this imposed random variation was then reported as the estimate for the Inventory. An adjustment was made to these calculations for each country to remove increases in soil carbon due to afforestation, as the value for this was considered to be better estimated by the C-Flow model used for the Changes in Forests and Other Woody Biomass Stocks (5A) category. The ranges of the variation in estimated changes in soil carbon are shown for each country in Table 2-17.

Variations from year to year in the reported net emissions reflect the trend in land use change as described by the matrix of change between 1984 and 1990. New survey data covering changes between 1990 and 1998 has recently become available and this will be used to improve estimation of the trend of emissions and removals in future Inventories.

Table 2-17 Summary of range of emissions from Monte Carlo variation of rate parameters for effect of land use change on soil carbon. (ktC per year)

		Minimum	**Mean**	**Maximum**
Scotland	**1990**	1434	2616	3794
	2002	1242	2717	3939
England	**1990**	-1522	186	1910
	2002	-3316	-649	1443
Wales	**1990**	41	159	267
	2002	-2	146	260
N Ireland	**1990**	353	353	353
	2002	216	216	216

Table 2-18 Summary of changes in areas of land use and resulting changes in soil carbon in Northern Ireland using the IPCC "default" method.

000ha	**Arable**	**Grass**	**Semi-natural (not peat)**	**Semi-natural (peat/bog)**	**Urban**	**Carbon flux (Loss) kt/yr**
1970	96.9	740.3	249.9	149	40.4	
1971	94.4	745.2	248	148.4	40.6	
1972	84.2	759.5	233.5	147.8	47.7	
1973	77.6	754.5	227.8	147.1	65.2	
1974	74.8	761.1	239.1	146.5	49.6	
1975	73.4	758.5	226.5	145.9	65.7	
1976	79.2	773.9	226.1	145.3	44.6	
1977	82.9	772.5	214.8	144.7	53.3	
1978	79.9	776.1	210.1	144.1	57.4	

1979	76.8	784.2	220.2	143.5	42.1	
1980	77.5	791.2	212.9	142.9	43.1	
1981	75.1	781.5	221.1	142.3	46.9	
1982	71.8	788.6	213.1	141.7	51.3	
1990	61.5	797.9	212.6	136.9	67.7	-353
1991	62.8	806.1	210.9	135.5	61.2	-361
1992	64	800.3	202.6	134.9	70.9	-351
1993	63	817.2	199.9	134.9	57.2	-245
1994	57.6	814.8	197.2	134.9	66.6	-366
1995	56.4	819.1	191	134.9	68.7	-278
1996	56.5	821	188.9	134.9	67.8	-310
1997	58.1	826.7	184.2	134.9	64.4	-222
1998	57.4	832.3	177.7	134.9	65.3	-290
1999	54.8	835.3	177.3	134.9	64.6	-288
2000	52.5	831	175	134.9	74.1	-259
2001	52.6	841.6	172.6	134.9	65.2	-273
2002	51.1	845.2	170.1	134.9	65.2	-216

Land use change activity data is obtained from several sources. The periods 1947 to 1980 and from 1984 to 1990 have separate good internal consistency but there is poorer consistency between these periods. There may be carry over effects on emission/removal estimates for the reported years due to the long time response of soil systems.

The Emission for 1999 in the NIR/CRF for 2001 has been reduced by 96.01 Gg CO_2 to correct an arithmetic error. An arithmetic error in the Emission for 2000 reported in the NIR/CRF for 2001 has been corrected but this was less than 0.01 Gg CO_2.

In the long term the UK is planning to implement the use of a process based model for estimating Emissions and Removals from soils. This approach is unlikely to be available for a number of years. The present approach will therefore be enhanced under an interim review. This review and enhancement will a) use land use data from a survey conducted in 1998 to provide annual activity information for years after 1990 in place of the existing extrapolated data and b) extend the Monte Carlo approach the area activity data and to the values for changes in soil carbon from equilibrium under the initial land use to equilibrium under a new land use.

2.4.1.(b) Land use change in Northern Ireland

For this region the default method of the IPCC Guidelines (IPCC 1997) continues to be used. Cruickshank & Tomlinson (2000) provides a general description of the method as applied to Northern Ireland.

Points relevant to preparation of the 2002 Inventory are given in an Appendix to this chapter. A summary of the changes in land uses and the resulting changes in stored soil carbon are shown in Table 2-18.

No uncertainty analyses have been carried out for the changes on soil carbon for Northern Ireland.

2.4.1.(c) Changes in soil carbon in the UK

UK time series of changes in soil carbon can be calculated by adding the mean, maximum and minimum data from each region together to provide aggregate mean, maximum and minimum series for the UK. The mean, maximum and minimum values for Northern Ireland were assumed to each be equal to the data from the default method. Adjustment to remove uptake of carbon into afforestation was made prior to aggregation for each region, except Northern Ireland where the default method did not include afforestation. The UK aggregate mean value was used for GHG Inventory purposes. The time series for each region and the UK are shown in Fig. 1.

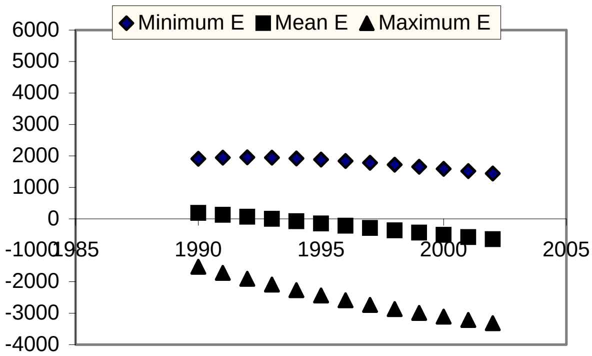
2.4.2. Set Aside

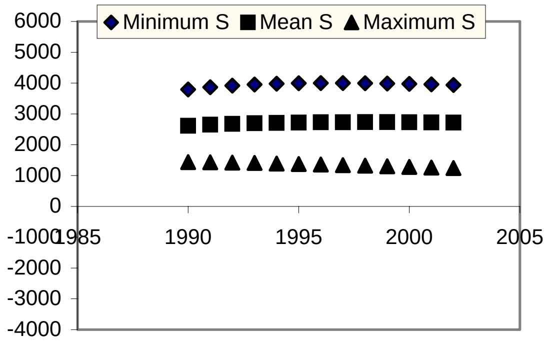
Various scheme for arable land to be set aside from agricultural production have been in place in the UK since 1990. The modelling described in Section 4 for assessing the effect of land use change on soil carbon stocks cannot include the effect of such Set Aside because the land use change areas are extrapolated from data collected before 1990. A separate estimate is therefore made of the changes in stocks of soil carbon (a net sink) due to this activity. The estimate is made using a similar methodology to that describe in Section 4. The net Removals due to this activity are reported separately in the CRF under Category 5D5 (CO_2 Emissions and Removals from Soils - Other) but in this and earlier UK NIRs are combined with emissions from soils due to land use change and also application of lime.

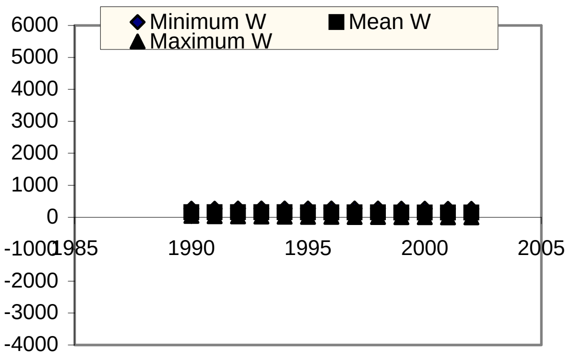
The estimation of changes in soil carbon calculated by the matrix method of land use changed described in Section 4 for all transitions does not fully include the effects of the policy of Set Aside from production of arable areas. This is the case because although the schemes were introduced in 1988 there was a slow rate of acceptance by farmers and it was not until after 1990 that significant area is recorded in the Annual Farm Census. In this post-1990 period the matrix method of Section 4 uses an extrapolation of the CS field data from 1984 to 1990. Therefore a separate estimate of the effect of Set Aside on soil carbon for these later years has been made. The recorded area of Set Aside in the UK has varied since 1990. This probably reflects the fact that Schemes will be phased out, to be replaced with others with different objectives. The data reported here therefore takes into account not only the effect of soil carbon increasing in areas where land is not used for arable purposes but the subsequent loss of the extra accumulated carbon from the soil when land is returned to arable use.

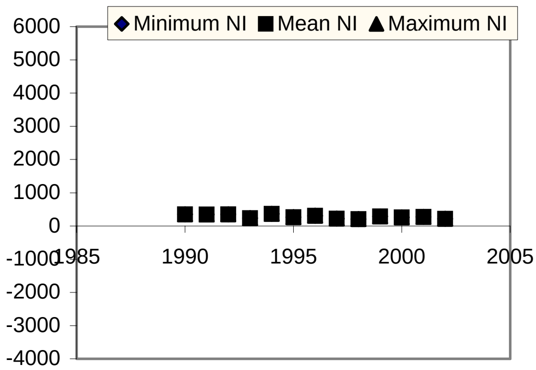
Set Aside areas are taken from the Annual Farm Census for Scotland and England & Wales separately. Scottish soils coming out of arable use are assumed to be able to take up 300 t/ha but that this happens at a rate that would only allow 99% of that change to occur in 500 years. For English & Welsh soils it is assumed that the change in equilibrium soil carbon density would be 60 t/ha and that 99% of this change would occur in 200 years. These times fall in the middle of the ranges used in the main calculation for the effect of land use change causing an increase in soil carbon. The new areas of land in Set Aside are calculated from increases in area for periods when the total is increasing. To compensate for losses when the total area is reducing, two assumptions were made: a) the area lost in each year is assumed to have been in Set Aside for 3 years and b) the carbon gained in these 3 years would be lost at a rate which would cause 99% of the change to occur in 20 years. The 3-year assumption is made, as there is no clear indication of how long any area does remain in Set Aside. This value is not unreasonable but may be low given that some Set Aside could have existed from 1988. Prior to the 1998 Inventory it was assumed that all Set Aside was simply abandoned but between 30 and 50% is actually managed by cutting etc. Such areas will not be very different from other rotational pasture situations that we have already shown to have similar soil carbon to arable areas. Hence such areas have been excluded from estimates of the effect of Set Aside reported here. Thus for the estimates reported here the assumptions are: Set Aside area may rise or fall, uptake occurs slowly in Scotland and 50% of areas in the Agricultural Census are excluded because they are in a rotational form of management. Northern Ireland has negligible change in soil carbon due to Set Aside.

Activity data is obtained consistently from same national forestry sources therefore time series consistency of estimated Removals is good.









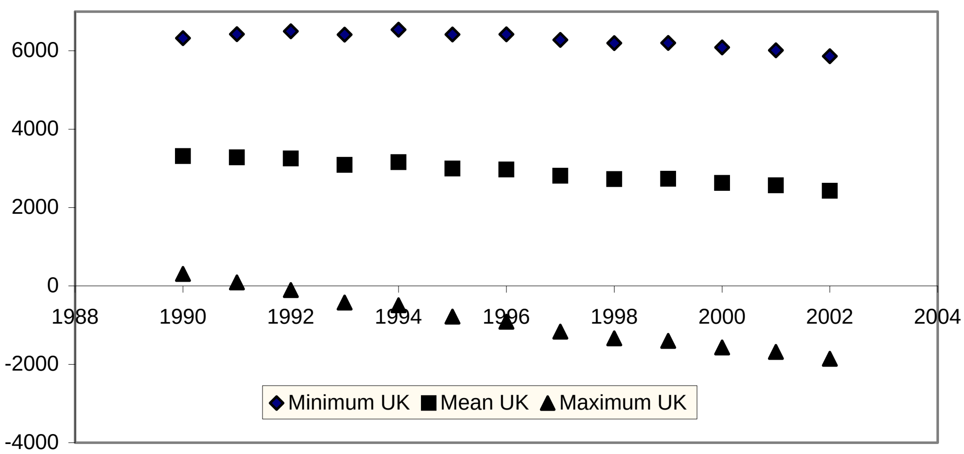


Figure 2-1 Range of estimates for changes in soil carbon in England (E), Scotland (S), Wales (W) and Northern Ireland (N) and the aggregates for the United Kingdom (UK).

20 years. The 3-year assumption is made, as there is no clear indication of how long any area does remain in Set Aside. This value is not unreasonable but may be low given that some Set Aside could have existed from 1988. Prior to the 1998 Inventory it was assumed that all Set Aside was simply abandoned but between 30 and 50% is actually managed by cutting etc. Such areas will not be very different from other rotational pasture situations that we have already shown to have similar soil carbon to arable areas. Hence such areas have been excluded from estimates of the effect of Set Aside reported here.

Thus for the estimates reported here the assumptions are: Set Aside area rises to a maximum in 1995 then falls away to zero by 1999, uptake occurs slowly in Scotland and 50% of areas in the Agricultural Census are in rotational form of management are excluded. Northern Ireland has negligible change in soil carbon due to Set Aside.

2.4.3. Emissions of CO2 from soil due to liming

Emissions of carbon dioxide from the application of limestone, chalk and dolomite to agricultural soils were estimated using the method described in the IPCC 1996 Guidelines (IPCC 1997 a, b, c). Data on the use of limestone, chalk and dolomite for agricultural purposes is reported in BGS (2003). They also include ‘material for calcination’. In agriculture, all three minerals are applied to the soil and CO2 emissions, weight for weight, from limestone and chalk will be identical since they have the same chemical formula. Dolomite, however, will have a slightly higher emission due to the presence of Mg. Estimates of the individual materials had to be made this year as only their total was published because of commercial confidentiality rules for small quantities. It is assumed that all the carbon contained in the materials applied is released in the year of use.

The Emissions due to this activity are reported separately in the CRF under Category 5D4 (CO2 Emissions and Removals from Soils – Liming of Agricultural Soils) but in the 2002 and earlier UK NIRs are combined with Emissions from soils due to land use change and Removals due to the effect of Set Aside.

For limestone and chalk, an emission factor of 120 t C/kt applied is used, and for dolomite application, 130 t C/kt. These factors are based on the stoichiometry of the reaction and assume pure limestone/chalk and dolomite.

Only dolomite is subjected to calcination. However, some of this calcinated dolomite is not suitable for steel making and is returned for addition to agricultural dolomite – this fraction is reported in PA1007 as ‘material for calcination’ under agricultural end use. Calcinated dolomite, having already had its CO2 removed, will therefore not cause the emissions of CO2 and hence is not included here. Lime (calcinated limestone) is also used for carbonatation in the refining of sugar but this is not specifically dealt with in the UK LUCF GHG Inventory. No improvements planned for this source

Uncertainty in both the activity data and emission factor used for this source are judged to be low. The main source of uncertainty in the estimates is the caused by non-publication of some data due to commercial restrictions although these are not judged to be very significant. Time-series consistency is very good due to the continuity in data source. Rounding errors in the Emissions for 1999 and 2000 reported in the NIR/CRF for 2001 have been corrected but these were less than 0.01 Gg CO_2. The Emission for 2001 in the NIR/CRF for 2001 has been reduced by 4.84 Gg CO_2 to correct an error in the exclusion of calcinated material.

2.5. Other sources and sinks (5E)

These are: 1) a sink due to changes in crop biomass and three sources due to 2) Peat extraction, 3) Drainage of lowland wetlands, 4) Drainage of upland deep peat.

The activity data and carbon fluxes are based on data from Adger and Subak (1996) for the sink and from Bradley (1997), Cannell *et al.* (1993), Cruickshank *et al.* (1997), Hargreaves and Fowler (1997) for the sources.

2.5.1. Changes in Crop Biomass

This includes annual changes in the biomass of vegetation in the UK due to all land use change but excludes forestry. Much of this change involves changes to or from agricultural crops, hence the use of the term "crop biomass".

Adger and Subak (1996) estimated recent changes in carbon storage in biomass on non forest lands in the U.K., including land used for agriculture, horticulture and urbanization. The land area converted to forest was specifically excluded to avoid overlap with estimates for Category 5A. They used agricultural census statistics for the period 1988 to 1992 published by the Ministry of Agriculture, Fisheries and Food. These statistics are strongly correlated with agricultural land cover data in 1984 and 1990 U.K. Countryside Surveys, which were used to calculate changes in soil carbon on non forest lands, so the two estimates are considered to be compatible.

Two carbon sinks were quantified. First, 0.23 MtC a^{-1} was estimated to be accumulating in biomass as a result, mainly, of (i) the transfer of land from arable crops with 2.2 tC ha^{-1} biomass to set aside land with 5.0 tC ha-1 biomass, (ii) the establishment of woodlands on farms in response to financial incentives (Farm Woodland Scheme and Farm Woodland Premium), assuming that these woodlands increased in biomass by 2.8 tC ha^{-1} a^{-1}, (iii) the transfer of agricultural land to urban uses, assuming that urban land has an average carbon density of 3 tC ha^{-1} and (iv) the transfer of rough grass to permanent grass.

Second, 0.14 MtC a^{-1} was estimated to be accumulating on agricultural land, without a change in crop type, on the assumption that the annual average standing biomass has increased linearly with yield. Most of this component was due to increases in cereal yields.

Thus, the total increase in biomass on non-forest land was estimated to be 0.37 MtC a^{-1}. However, this is an upper bound, because some of the farm woodlands were also counted in Forestry Commission statistics which were used to calculate the forest biomass carbon for Category 5A, and because increases in `harvest index' mean that crop biomass generally increases proportionately less than yield. Thus, the lower estimate for this component of 0.3 MtC a^{-1} ±30% has been adopted. From the 1998 Inventory onwards more recent data from the Agricultural Census were considered but did not support any change to the existing estimate. This rate is therefore reported for all years from 1990 to 2002.

Changes in "crop biomass" are reported as a constant average value in each year. No improvements planned. "Changes in crop biomass" will in future be referred to as "Changes in non-forest biomass".

2.5.2. Peat Extraction

Peat is extracted in the UK for use as either a fuel or in horticulture. Estimates are made separately for each of these end uses. Peat is not a "renewable" fuel but has not been included in the Energy Sector of the UK Inventory.

Cruickshank *et al.* (1997) provide initial estimates of Emissions due to peat extraction. Since their work trends in peat extraction in Scotland and England over the period 1990 to 2002 have been estimated from activity data taken from the UK Minerals Handbook (BGS 2003). In Northern Ireland no new data on use of peat for horticultural use has been available but a recent survey of extraction for fuel use suggested that there is no significant trend for this purpose. The contribution of emissions due to peat extraction in Northern Ireland is therefore incorporated as constant from 1990 to 2002. Peat extraction is negligible in Wales. Emissions factors are from Cruickshank *et al.* (1997) and are shown in Table 2-19.

Activity data for peat extraction come from a number of sources, only some of which are reliable. The time series consistency of the peat extraction Emissions is therefore only medium.

Table 2-19 Emission Factors for Peat Extraction (GB Great Britain, NI Northern Ireland)

	Emission Factor	
	kg C m^{-3}	**Gg C/Gg**
GB Horticultural Peat	55.7	-
GB Fuel Peat	55.7	-
NI Horticultural Peat	44.1	-
NI Fuel Peat	-	0.3

2.5.3. Lowland (fen) peat drainage (Reported in Category 5D in CRF)

Fenland areas on England have been drained for many decades for use for agriculture, although there are now pressures for no further drainage and for drained areas to be taken out of agriculture This activity is not adequately modelled by the broad scale approach described in Section 4.1 and separate estimates of recent emissions have been included here. The emissions due to this activity are reported in the CRF under Category 5D5 (CO_2 Emissions and Removals - Other) but are reported in this and earlier UK NIRs under Category 5E (Other).

Bradley (1997) described the methods used for this activity. The baseline (1990) for the area of drained lowland wetland for the UK was taken as 150,000 ha. This represents all of the East Anglian Fen and Skirtland and limited areas in the rest of England. This total consists of 24,000 ha of land with thick peat (more than 1m deep) and the rest with thinner peat. Different loss rates were assumed for these two thicknesses as shown in Table 2-20.

The trend in emissions after 1990 was estimated on the assumption that no more area has been drained since then but the existing areas have continued to lose carbon. The annual loss decreases for a specific location in proportion to the amount of carbon remaining. But, in addition to this, as the peat loses carbon it will become more mineral in structure. Burton (1995) provides data on how these soil structure changes proceed with time. The Century model of plant and soil carbon was used to average the carbon losses for the areas of component soils as they thinned to lose peat, become humose and possibly even mineral (Bradley 1997)

Table 2-20 Area and carbon loss rates of UK fen wetland in 1990.

	Area	**Organic carbon content**	**Bulk density kg m^{-3}**	**Volume loss rate $m^3\ m^{-2}\ a^{-1}$**	**Carbon mass loss GgC a^{-1}**	**Implied emission factor gC $m^{-2}\ a^{-1}$**
'Thick' peat	$24 \times 10^7\ m^2$ (24,000 ha)	21%	480	0.0127	307	109
'Thin' peat	$126 \times 10^7\ m^2$ (126,000 ha)	12%	480	0.0019	138	1280
Total	$150 \times 10^7\ m^2$ (150,000 ha)				445	297

2.5.4. Upland (forestry) peat drainage (Reported in Category 5D in CRF)

This source is due to the ploughing and drainage of deep peat for the purposes of establishment of new forests. This has occurred most significantly in upland locations. The practice has now been discontinued but was significant in the 1970s and 1980s. The implicit assumption in the forest carbon accounting model described in Section 2 is that there are negligible losses of carbon from afforested soils. For deep peat this is inaccurate hence the separate estimate described here. The emissions due to this activity are reported in the CRF under Category 5D5 (CO_2 Emissions and Removals - Other) but are reported in the 2002, and earlier, UK NIRs under Category 5E (Other).

The data included in this and previous year's CRF submissions and NIRs for emissions from drainage of upland peat for forestry are based on areas of planted forest in Cannell *et al.* (1993) (see Table 2-21) and an emission rate from Hargreaves and Fowler (1997) and Hargreaves *et al.* (2003) measured in the field one year after forest planting. The value for emission is assumed to continue indefinitely at about at this early rate. The continuing rate is taken to be 2tC $ha^{-1}\ a^{-1}$ (The resulting emission is therefore the same for each year of the Inventory (Table 2-21).

Table 2-21 Activity and Emission Factor Data for Upland Drainage

	Afforested peat (000 ha)	**Emission rate (tC $ha^{-1}\ a^{-1}$)**	**Annual loss (ktC)**
England	20	2	40
Wales	10	2	20
Scotland	160	2	320
Northern Ireland	10	2	20
UK	200	2	400

2.6. Summary Tables

The basic data for the each flux relevant to the Land Use Change and Forestry Sector of the UK GHG Inventory for 2002 are presented in Table A1. 1A. These data are used for several different submissions and reports and 2 main formats have been used to summarise them.. Originally a format derived from submissions to the UNFCCC prior to the introduction of the Common Reporting Format was used for all purposes. This is still used for the UK Digest of Environmental Statistics. This style if often referred to as the "NIR" format and for LUCF Removals of carbon to soils due to Set Aside were combined with other changes in soils to provide a figure for net soil emission. In the Common Reporting Format (CRF) the Set Aside Removal is entered separately and since the 2001 submission to the UNFCCC the Emissions from drainage of upland and lowland soils are included under Category 5D Soils (Emissions) rather than 5E Other (Emissions). The "NIR" and "CRF" styles of summary for the 2002 submissions are presented for the UK in Table A1. 1B & Table A1. 1C.

The constituent data for the devolved administrative regions of England, Scotland, Wales and Northern Ireland are presented in Table A1. 2B, Table A1. 3B, Table A1. 4B & Table A1. 5B in "NIR" format as used by NETCEN for the Devolved Administration Inventory Report (In prep). The UK data in units of Gg of CO_2 as used in the National Report are presented in Table A1. 6.

The uncertainty for each of the Categories is presented in Table 2-22.

Table 2-22 Approximate uncertainty of estimates of emissions or removals in each of the Categories reported.

Category	5A Changes in Forest Biomass	5B Forest Conversion	5D Soils	5E Other
Uncertainty in Emission/Removal %	30	20	60	50

2.7. Results

The data for the 2002 Inventory and equivalent values for 1990 to 2001 can be summarised from Table A1. 6A and the NIR Format in Table A1. 6B. The same data is also presented in an Appendix in the Common Reporting Format Table 5 Sectoral Report style for each year separately.

2.7.1. Changes in Forest and Other Woody Biomass Stocks

2.7.1.(a) Temperate Forest

The Removal of atmospheric CO_2 to Woody Biomass Stocks caused by expanding UK forests in 2002 was estimated to be 7722 Gg with an additional sink of 722 Gg due to an increase in the stock of carbon in undecayed forest products from these forests. Removals to Woody Biomass have been varying around 7000 Gg since 1996. Removals to wood products had been increasing since that date but have now fallen considerably. Removals to Woody Biomass increased from 5731 Gg in 1990 to a peak of 7605 Gg in 1995, fell to 7271 in 1996 but have now reached a new peak. Removals to products fell from 1573 Gg in 1990 to 913 Gg in 1995 and were varying around 1200 Gg from 1996 to 2001 before the fall to the present 722 Gg. These changes reflect variation in planting rates in past decades which feed through growth and felling to the carbon uptake trends reported here. Changes in forest soils are discussed with other processes related to changes in soils.

2.7.2. Forest Conversion

2.7.2.(a) Deforestation

Emissions of greenhouse gases due to due to deforestation in Great Britain are now included in inventory reports. The data are reported as a constant value for each year from 1990 to 2002 but work is in progress to provide individual values for each year. Emissions of CO_2 are 259 Gg per year, along with 1.13 Gg CH_4 and 0.01 Gg N_2O.

2.7.3. CO_2 Emissions and Removals from Soil

2.7.3.(a) Land use change

Estimates of changes in stored soil carbon due to land use change (excluding afforestation) continue to indicate large emissions to the atmosphere although the trend continues downwards. For 2002 the Emission of CO_2 is estimated to be 10934 Gg compared to 14186 Gg in 1990. Emissions from Scotland continue to be the primary source, with additional small source contributions from Wales and Northern Ireland being balanced by a sink in England. Land use changes on both mineral and organic soils are included in these estimates but those transitory fluxes due to changes involving new forest planting or continuous emissions due to drainage of organic soils for forestry or agriculture are discussed elsewhere.

2.7.3.(b) Liming of Agricultural Soils

Emissions due to liming of agricultural soils follow the downward trend that started in 1997. The peak emission was 1514 Gg in 1996 but in 2001 this has fallen to 752 Gg. No information is presently available to explain this trend but it may be related to present poor economic conditions in farming. Minor arithmetic corrections were made this year to the data reported in previous Inventories for recent years.

2.7.3.(c) Forest Soils

Forest soil carbon stocks were estimated to have increased due to a sink of 2138 Gg for 2002. As in previous Inventories this estimate comes from the C-FLOW forest carbon accounting model and it is assumed that soils under new conifer forest do not change their original pre-forest carbon stock due to a balance of losses from the disturbance of the typically high carbon content soils by the addition of new carbon from the litter of high productivity plantations. Removals of atmospheric carbon dioxide to the soils of the new broadleaf soils have not varied much over the period 1990 to 2001 but have shown a small increasing trend from a low of 1991 Gg in 1993 which reflects planting in the past now working through the slowly responding soil turnover system.

2.7.3.(d) Set Aside

In general, the Set Aside sink strength had fallen from 1995, as fewer new areas were being brought into this type of scheme but increases have now been recorded for 2000, 2001 and 2002. This reflects a revived interest in the scheme in recent years. In 2002 it is estimated that the Removal was 1749 Gg having increased from 297 Gg in 1999. The maximum Removal of 2007

Gg occurred in 1995 after the period when many arable areas were taken out of annual ploughing and sequestered carbon. From 1995 to 1998 there was limited new areas of Set Aside and the carbon uptake rate fell. The areas of Set Aside now appear to be increasing again and this trend is likely to continue.

2.7.4. Other

2.7.4.(a) Changes in Crop Biomass

The uptake of carbon due to improvements in the productivity and area of crops is estimated in 2002 to be unchanged from previous years at 1100 Gg.

2.7.4.(b) Peat Extraction

The estimated emission of carbon due to peat extraction shows variation both upwards and downwards over the 13 reported years with the latest year of 2002 showing an emission of 682 Gg compared to the lowest of the 11 years of 704 Gg estimated for 1998. Emissions were greatest at 950 Gg in 1995 and around 800 Gg in the early part of the decade.

2.7.4.(c) Lowland (fen) peat drainage

The downward trend in Emissions from drainage of organic soils in the lowlands (primarily English fens) continues for 2002. The Emissions are estimated to have fallen from 1650 Gg in 1990 to 1239 Gg in 2002 reflecting fewer new areas of drainage and stabilisation of changes in older drained areas.

2.7.4.(d) Upland (forestry) peat drainage

No new areas of organic soil have been ploughed for forestry recently due to government policy and hence the estimated Emission due to this process is assumed to remain constant 1467 Gg over the period 1990 to 2002.

2.7.5. Net UK Emissions/Removals

The Land Use Change and Forestry Sector of the UK is estimated, in 2002, to have continued to be an overall emitter of carbon dioxide with a value of 1903 Gg. This net figure is made up from Emissions of 13585 Gg offset by 11682 Gg of Removals, using the NIR Format grouping of activities. In 2001 the net emission was 3476 Gg, with Emissions of 15271 Gg and Removals of 11616 Gg. The net improvement from 2001 to 2002 in net emissions was due to a combination of improvements of 2406 Gg from changes in forest biomass, effects of land use change and set aside on soils, changes in lowland drainage and peat extraction with deteriorations of 863 Gg from changes to forest soils, forest products and liming. The equivalent values for 1990 were a net emission of 9053 Gg due to 19609 Gg of Emissions offset by 10556 Gg of Removals. Note that in comparison to previous reports these data include emissions due to deforestation.

2.7.6. Projections of Emissions and Removals to 2020

Estimates have been made of Emissions and Removals over the period 2003 to 2020 based on the 1990 to 2002 Inventory data.

Three scenarios for projections were used: “High” emission scenario to consider situation where emissions would tend to be greater and Removals lesser than in 2002, “Mid” following a “business-as usual” approach to management issues and “Low” where management which would cause greater Removals or lesser Emissions were considered. The assumptions for each LUCF process are summarised in Table 2-23 to Table 2-30 for each scenario.

Methods for making such estimates have been improved from the scenarios for forest and agricultural management used for the projections in the UK Third National Communication (3NC)- (DEFRA 2001). There have now been 13 years of data for each activity and where appropriate the variation in these past years can be used to guide the range of uncertainty for future emissions. The “Mid” projections for the effects of application of lime to agricultural soil, peat extraction in Scotland and England and the effect of land use change in Northern Ireland have now been based on extrapolation of the data along a line fitted to the 1990 to 2002 data. The “High” and “Low” scenarios for these activities follow extrapolations of the upper and lower 95% confidence limits for the fitted line. Other activities are projected on the same basis as used for the UK Third National Communication

2.7.6.(a) Forestry

Forestry projections were made using contrasting assumptions on areas of new planting in the future. The “Mid” scenario assumed that forest planting would continue at the annual rate recorded in 2002. The “Low” emissions scenario assumed that planting in each year from 2003 would be 30,000 ha in total. The ratio of conifers to broadleaves in each devolved administration area is assumed to be equal to that for 2002 and the total is the existing UK “target” for planting. The “High” emission scenario assumed there would be no new planting from 2003. The removal of carbon dioxide from the atmosphere by these projections was then estimated using the C-Flow model. The range of future forest removals presented in 3NC (DEFRA 2001) was based on the “Low” and “Mid” scenarios. The projections of fluxes associated post-1990 afforestation was calculated in a similar way but omitting all earlier planted areas from the model runs.

The assumptions about future forest planting are becoming increasingly uncertain. This is due to two factors. Firstly planting rates have stabilised but the ratio of broadleaf to conifer is increasing. In 2000 about 7,000 ha of conifer compared to about 11,000 ha of broadleaves were planted. In 2001 these rates became 5,000 ha of conifers and 13,000 ha of broadleaves. Secondly, planting policy is now to be determined at the devolved regional scale within the Forestry Commission and as yet the new targets are not known. Our previous projections for the “Low” emission scenario were based on a UK target of 30,000 ha per year. The devolved Forestry Commission offices and the N. Ireland Forest Service were asked to comment on the above scenarios. The Scottish FC office accepted the proposal for their area but no response was received from the others.

2.7.6.(b) Deforestation

Emissions due to deforestation are assumed to continue at the average rate used for the period 1990 to 2002. Mid, Low and High scenarios are assumed to be equal.

2.7.6.(c) LUC on soils GB

The trend in the effect of land use change on emissions from soils was estimated by considering the trends that had occurred not only in the data used for the 2002 GHG Inventory (the mean estimates from the Monte Carlo study on parameter uncertainty) but also the trends in the maximum and minimum estimates from the Monte Carlo study.

Trends for changes in soil carbon are probably the most uncertain of those presented. It is unlikely that the project investigating the use of the process model RothC for such purposes will provide an operational method before 2005. It is therefore recommended that, in the interim, the present model used for both general land use change and set aside should be reviewed. The use of LUC matrices from Countryside Survey 2000 as a means to treat all land use consistently rather than with Set Aside separately should be a key objective. Additionally the effect of LUC prior to 1984 on recent and future trends of soil carbon stock change should also be assessed.

2.7.6.(d) Set Aside

Trends in Set Aside were based on combinations of assumptions of activity (area) data and trends in fluxes based on calculations from the model used for that process in the GHG Inventory. The “Mid” scenario assumed that the area of land set aside would double between 2002 and 2010 but then remain constant until 2020. For the “Low” scenario this data was used for the period 2002 to 2010 but the trend in the flux was then assumed to continue until 2020 at the mean rate between 2002 and 2010 without defining how this would be achieved in area terms. The “High” scenario assumed that the area set aside would remain constant at the amount in 2001 but the flux would therefore equilibrate to zero.

2.7.6.(e) Results for projections of LUCF Categories

Figure 2-2 to Figure 2-5 show the trends fitted using the statistical approach for generating high and low scenarios.

The data from each country in the UK used to prepare the “Mid” scenario are given in Table A1. 2 to Table A1. 5 and for the UK in Table A1. 1. The “Low”, “Mid” and “High” scenario data at 5 year intervals are given in Table 2-31.

Figure 2-6 shows the UK projections for Emissions and Removals using the “NIR” form of grouping the processes

2.7.6.(f) Removals associated with post-1990 afforestation

The approach used is that introduced in 2003 when it was reported (Milne et al. 2003) that the effect of planting in 1990 had not been included in previous estimates. In part, this basis came about because of a mismatch between the labelling of years for the reported Forestry Commission planting data and that used for GHG Inventories. The FC year data are for (using 1990 as example) April 1990 to March 1991. Most but not all of the planting in calendar year 1990 (as required for UNFCCC Inventories) will take place in this period. In previously derived post-1990 estimates of forestry carbon uptake this was not included therefore the 1990 the flux was zero. These forests are now included.

The results are presented in Appendix 4. The data for the First Commitment period (2008 to 2012) are highlighted in Tables A4.1 to A4.5.

Table 2-23 Assumptions in scenarios for projection of LUCF Emissions and Removals from 1990 to 2002 data to 2003 onwards

a	**Scenario assumption: Scotland**		
Category	**LOW Emission**	**MID Emission**	**HIGH Emission**
Forestry	UK Total of 30 kha/yr from 2003 in proportion to 2002 planting	Conifer planting from 2003 assumed to be as in 2002. Broadleaf planting from 2003 assumed to be as in 2002.	Conifer planting from 2003 assumed to be 0 ha/yr. Broadleaf planting from 2003 assumed to be 0 ha/yr.
Land Use Change (Soils)	Flux (including forest soils) changes at maximum MODEL rate of fall in 1990 to 2002.	Flux (including forest soils) changes at average MODEL rate of change for 1990 to 2002.	Flux (including forest soils) changes at minimum MODEL rate of change for 1990 to 2002.
Set Aside	Flux sink rate becomes greater due to SA doubling by 2010. Flux continues to icrease at 2002-2010 slope	Flux sink rate becomes greater due to SA area doubling by 2010 then staying fixed	Flux increases from 2002 value to become emission due to areas returning to arable (SA area fixed after 2002)
Peat extraction	Flux changes at fastest rate determined from fitting of linear trend to data for 1990 to 2002	Flux reduces linear path fitted from data for 1990 to 2002	Flux changes at slowest rate determined from fitting of linear trend to data for 1990 to 2002
Liming	Flux changes at fastest rate determined from fitting of linear trend to data for 1990 to 2002	Flux reduces linear path fitted from data for 1990 to 2002	Flux changes at slowest rate determined from fitting of linear trend to data for 1990 to 2002
Upland drainage	Flux remains at 2002 value	Flux remains at 2002 value	Flux remains at 2002 value
Lowland drainage	NA	NA	NA
Crop biomass	Flux remains at 2002 value	Flux remains at 2002 value	Flux remains at 2002 value

Table 2-24 Assumptions in scenarios for projection of LUCF Emissions and Removals from 1990 to 2002 data to 2003 onwards

b	**Scenario assumption: England**		
Category	**LOW Emission**	**MID Emission**	**HIGH Emission**
Forestry	UK Total of 30 kha/yr from 2003 in proportion to 2002 planting	Conifer planting from 2003 assumed to be as in 2002. Broadleaf planting from 2003 assumed to be as in 2002.	Conifer planting from 2003 assumed to be 0 ha/yr. Broadleaf planting from 2003 assumed to be 0 ha/yr.
Land Use Change (Soils)	Flux (including forest soils) changes at maximum MODEL rate of fall in 1990 to 2002.	Flux (including forest soils) changes at average MODEL rate of change for 1990 to 2002.	Flux (including forest soils) changes at minimum MODEL rate of change for 1990 to 2002.
Set Aside	Flux sink rate becomes greater due to SA doubling by 2010.	Flux sink rate becomes greater due to SA area	Flux increases from 2002 value to become emission due to

	Flux continues to icrease at 2002-2010 slope	doubling by 2010 then staying fixed	areas returning to arable (SA area fixed after 2002)
Peat extraction	Flux changes at fastest rate determined from fitting of linear trend to data for 1990 to 2002	Flux reduces linear path fitted from data for 1990 to 2002	Flux changes at slowest rate determined from fitting of linear trend to data for 1990 to 2002
Liming	Flux changes at fastest rate determined from fitting of linear trend to data for 1990 to 2002	Flux reduces linear path fitted from data for 1990 to 2002	Flux changes at slowest rate determined from fitting of linear trend to data for 1990 to 2002
Upland drainage	Flux remains at 2002 value	Flux remains at 2002 value	Flux remains at 2002 value
Lowland drainage	Flux changes at MODEL rate of change for 1990 to 2000	Flux changes at MODEL rate of change	Flux changes at MODEL rate of change for 2010 to 2020
Crop biomass	Flux remains at 2002 value	Flux remains at 2002 value	Flux remains at 2002 value

Table 2-25 Assumptions in scenarios for projection of LUCF Emissions and Removals from 1990 to 2002 data to 2003 onwards

c	**Scenario assumption: Wales**		
Category	**LOW Emission**	**MID Emission**	**HIGH Emission**
Forestry	UK Total of 30 kha/yr from 2003 in proportion to 2002 planting	Conifer planting from 2003 assumed to be as in 2002. Broadleaf planting from 2003 assumed to be as in 2002.	Conifer planting from 2003 assumed to be 0 ha/yr. Broadleaf planting from 2003 assumed to be 0 ha/yr.
Land Use Change (Soils)	Flux (including forest soils) changes at maximum MODEL rate of fall in 1990 to 2002	Flux (including forest soils) changes at average MODEL rate of change for 1990 to 2002.	Flux (including forest soils) changes at minimum MODEL rate of change for 1990 to 2002.
Set Aside	Flux sink rate becomes greater due to SA doubling by 2010. Flux continues to icrease at 2002-2010 slope	Flux sink rate becomes greater due to SA area doubling by 2010 then staying fixed	Flux increases from 2002 value to become emission due to areas returning to arable (SA area fixed after 2002)
Peat extraction	Flux zero	Flux zero	Flux zero
Liming	Flux changes at fastest rate determined from fitting of linear trend to data for 1990 to 2002	Flux reduces linear path fitted from data for 1990 to 2002	Flux changes at slowest rate determined from fitting of linear trend to data for 1990 to 2002
Upland drainage	Flux remains at 2002 value	Flux remains at 2002 value	Flux remains at 2002 value
Lowland drainage	NA	NA	NA
Crop biomass	Flux remains at 2002 value	Flux remains at 2002 value	Flux remains at 2002 value

Table 2-26 Assumptions in scenarios for projection of LUCF Emissions and Removals from 1990 to 2002 data to 2003 onwards

d	**Scenario assumption: Northern Ireland**		
Category	**LOW Emission**	**MID Emission**	**HIGH Emission**
Forestry	UK Total of 30 kha/yr from 2003 in proportion to 2002 planting	Conifer planting from 2003 assumed to be as in 2002. Broadleaf planting from 2003 assumed to be as in 2002.	Conifer planting from 2003 assumed to be 0 ha/yr. Broadleaf planting from 2003 assumed to be 0 ha/yr.
Land Use Change (Soils)	Flux changes at fastest rate determined from fitting of linear trend to data for 1990 to 2002	Flux reduces linear path fitted from data for 1990 to 2002	Flux changes at slowest rate determined from fitting of linear trend to data for 1990 to 2002
Set Aside	NA	NA	NA
Peat extraction	Flux remains at 2002 value	Flux remains at 2002 value	Flux remains at 2002 value
Liming	Flux changes at fastest rate determined from fitting of linear trend to data for 1990 to 2002	Flux reduces linear path fitted from data for 1990 to 2002	Flux changes at slowest rate determined from fitting of linear trend to data for 1990 to 2002
Upland drainage	Flux remains at 2002 value	Flux remains at 2002 value	Flux remains at 2002 value
Lowland drainage	NA	NA	NA
Crop biomass	Flux remains at 2002 value	Flux remains at 2002 value	Flux remains at 2002 value

Table 2-27 Methods for projecting emissions fluxes in Scotland after 2002. Values are change in kTC/year/year where simple linear trends are assumed

Scotland	**"Low" emissions**	**"Mid" emissions**	**"High" emissions**
Land Use Change	-11	+8	+34
Peat extraction	Lower 95% CL	Linear trend	Upper 95% CL
Liming	Lower 95% CL	Linear trend	Upper 95% CL
Lowland drainage	NA	NA	**NA**

Table 2-28 Methods for projecting emissions fluxes in England after 2002. Values are change in TC/year/year where simple linear trends are assumed

England	**"Low" emissions**	**"Mid" emissions**	**"High" emissions**
Land Use Change	-109	-70	-19
Peat extraction	Lower 95% CL	Linear trend	Upper 95% CL
Liming	Lower 95% CL	Linear trend	Upper 95% CL
Lowland drainage	-10	Model	-2

Table 2-29 Methods for projecting emissions fluxes in Wales after 2002. Values are change in kTC/year/year where simple linear trends are assumed

Wales	"Low" emissions	"Mid" emissions	"High" emissions
Land Use Change	-4	-1	2
Peat extraction	NA	NA	NA
Liming	Lower 95% CL	Linear trend	Upper 95% CL
Lowland drainage	NA	NA	NA

Table 2-30 Methods for projecting emissions fluxes in Northern Ireland after 2002. Values are change in kTC/year/year where simple linear trends are assumed

Northern Ireland	"Low" emissions	"Mid" emissions	"High" emissions
Land Use Change	Lower 95% CL	Linear trend	Upper 95% CL
Peat extraction	0	0	0
Liming	Lower 95% CL	Linear trend	Upper 95% CL
Lowland drainage	NA	NA	NA

Table 2-31 Inventory (1990 to 2000) and projected (2005 to 2020) Emissions and Removals data (kTC/year) for three scenarios using NIR grouping of activities. (See text) (-ve sign indicates Removal)

Year	Emissions (LOW)	Removals LOW)	Net (LOW)	Emissions (MID)	Removals (MID)	Net (MID)	Emissions (HIGH)	Removals (HIGH)	Net (HIGH)
1990	5347	-2879	2468	**5347**	**-2879**	**2468**	5347	-2879	2468
1995	4493	-3144	1349	**4493**	**-3144**	**1349**	4493	-3144	1349
2000	4170	-3178	992	**4170**	**-3178**	**992**	4170	-3178	992
2005	3122	-3520	-398	**3287**	**-3438**	**-151**	3456	-3373	83
2010	2363	-3622	-1259	**2467**	**-3388**	**-921**	2731	-3197	-466
2015	1616	-3311	-1695	**2035**	**-2919**	**-884**	2295	-2601	-306
2020	868	-3116	-2248	**1697**	**-2566**	**-869**	1926	-2125	-199

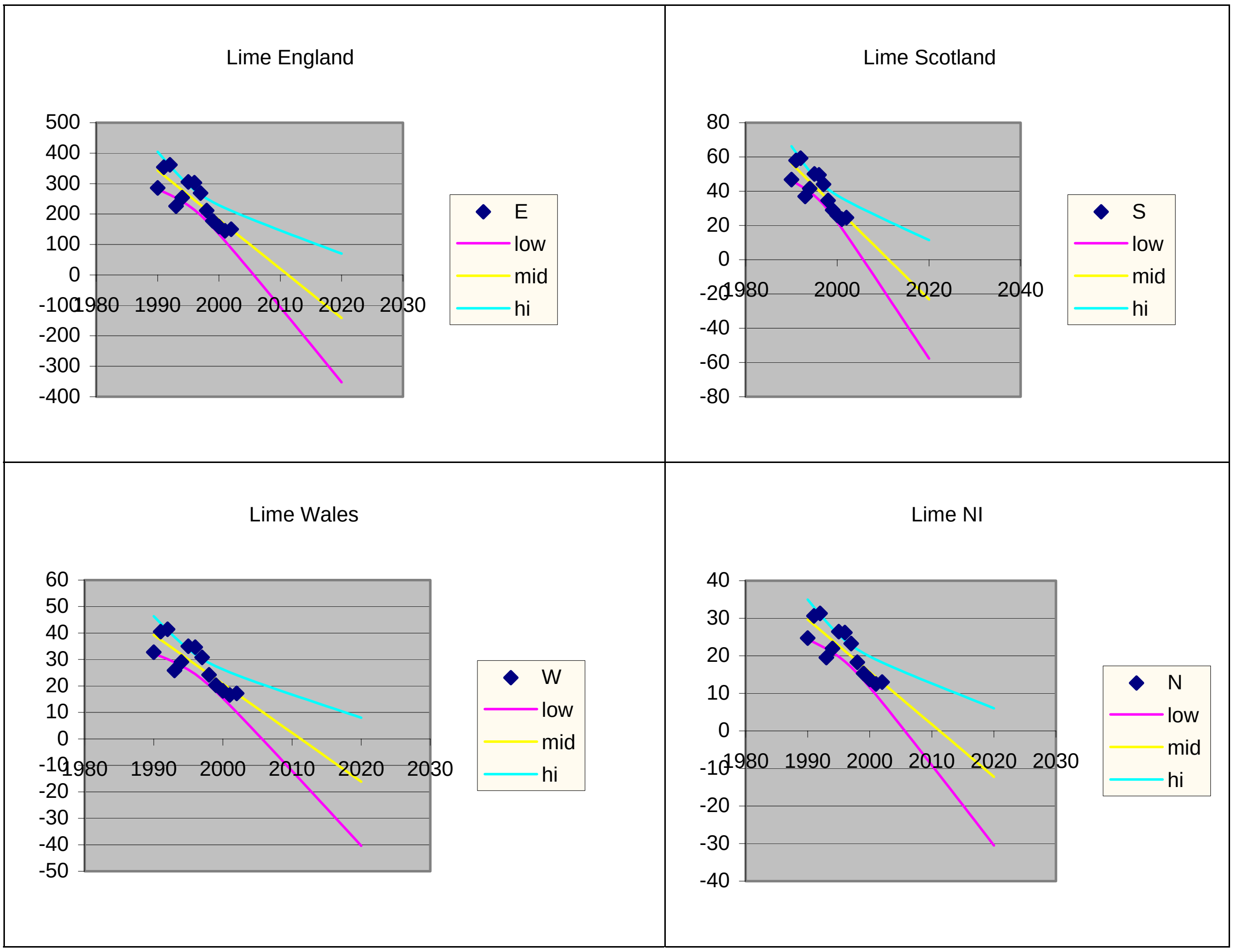


Figure 2-2 Linear trend prediction of effect of application of lime to agricultural land on emissions of carbon dioxide. Note that the pattern of variation is determined from UK national data but the contribution from each of the devolved areas depends on the area of agricultural land in that area.

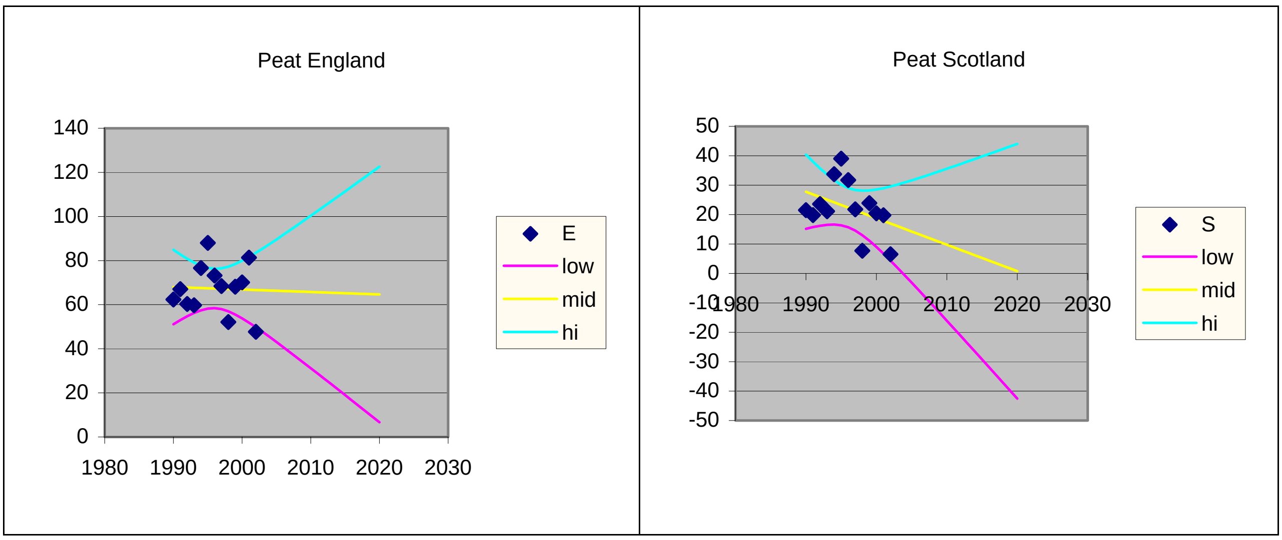


Figure 2-3 Linear trend prediction of effect of peat extraction on emissions of carbon dioxide in Scotland and England.

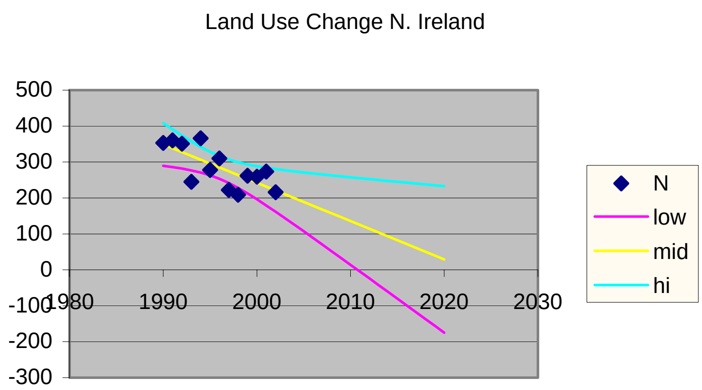


Figure 2-4 Linear trend prediction of effect of land use change on emissions of carbon dioxide in Northern Ireland.

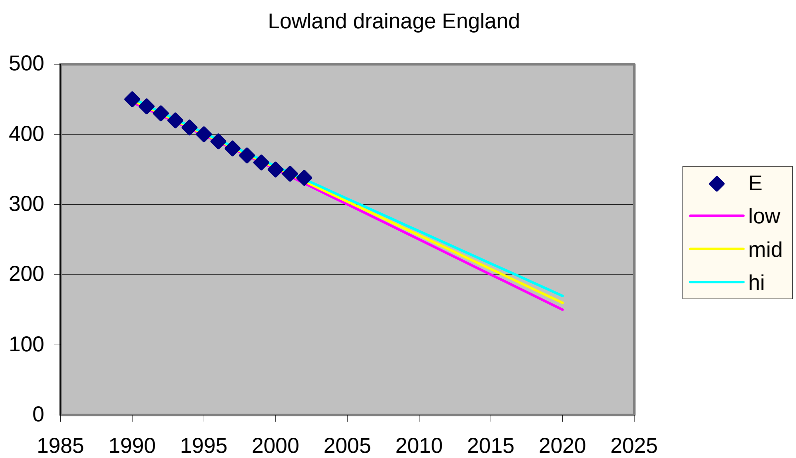


Figure 2-5 Linear trend prediction of effect of lowland drainage on emissions of carbon dioxide in England. The data for 1990 to 2002 comes from a mechanistic model of the processes, hence the very small uncertainty.

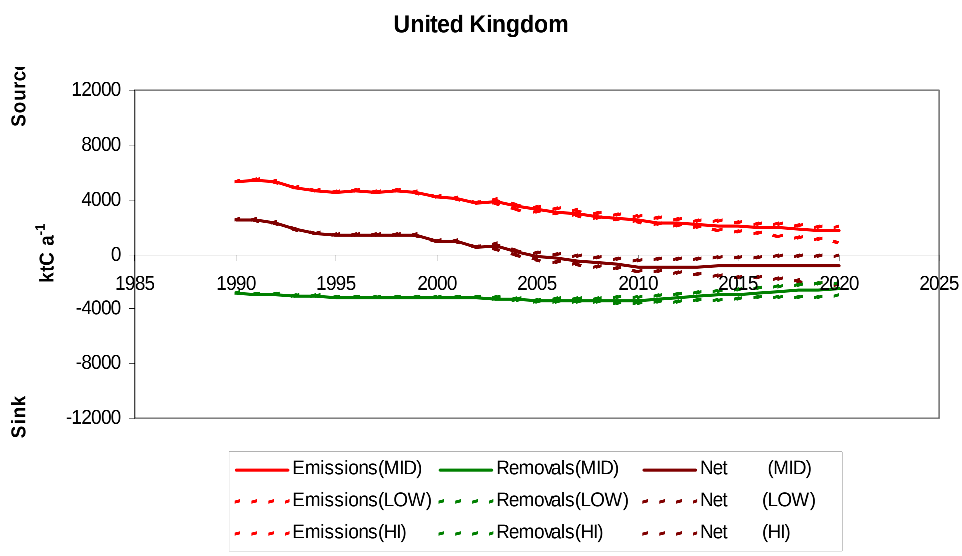


Figure 2-6 Projections to 2020 of Emissions and Removals of carbon from atmosphere by UK land use change and forestry.

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APPENDIX 1

A.1. Data Tables

Table A1. 1: United Kingdom data for 2002 UK GHG Inventory: A: component fluxes, B: "NIR" summary, C: "CRF" summary. (Italics are "Mid" projections – see text) (Forest Loss = Deforestation)

A Gg carbon	Forest biomass	Forest soils & litter	Forest products	Forest Loss	Land Use Change (Net)	Set Aside	Liming	Upland drainage	Lowland drainage	Peat extraction	Crop biomass
1990	-1563	-587	-429	71	3869	-48	390	400	450	216	-300
1991	-1587	-592	-430	71	3858	-72	483	400	440	219	-300
1992	-1724	-566	-368	71	3785	-96	494	400	430	216	-300
1993	-1872	-543	-305	71	3609	-127	308	400	420	213	-300
1994	-1935	-544	-299	71	3665	-517	346	400	410	242	-300
1995	-2074	-521	-249	71	3494	-547	417	400	400	259	-300
1996	-1983	-569	-315	71	3503	-421	413	400	390	237	-300
1997	-1965	-584	-303	71	3359	-275	367	400	380	222	-300
1998	-1905	-612	-327	71	3302	-37	289	400	370	192	-300
1999	-1862	-632	-353	71	3300	-81	242	400	360	224	-300
2000	-1952	-612	-314	71	3203	-292	217	400	350	223	-300
2001	-1867	-647	-354	71	3177	-307	198	400	344	233	-300
2002	-2106	-583	-197	71	2982	-477	205	400	338	186	-300
2003	*-2392*	*-520*	*-41*	*71*	*2913*	*-274*	*182*	*400*	*332*	*215*	*-300*
2004	*-2614*	*-477*	*60*	*71*	*2839*	*-541*	*160*	*400*	*326*	*214*	*-300*
2005	*-2855*	*-435*	*152*	*71*	*2766*	*-619*	*138*	*400*	*320*	*213*	*-300*
2006	*-2606*	*-531*	*11*	*71*	*2692*	*-690*	*116*	*400*	*314*	*212*	*-300*
2007	*-2329*	*-630*	*-155*	*71*	*2618*	*-755*	*94*	*400*	*308*	*211*	*-300*
2008	*-1936*	*-753*	*-400*	*71*	*2545*	*-816*	*72*	*400*	*302*	*210*	*-300*
2009	*-1766*	*-803*	*-527*	*71*	*2471*	*-872*	*50*	*400*	*296*	*209*	*-300*
2010	*-1480*	*-887*	*-721*	*71*	*2397*	*-926*	*28*	*400*	*290*	*208*	*-300*
2011	*-974*	*-1012*	*-961*	*71*	*2324*	*-977*	*6*	*400*	*288*	*207*	*-300*
2012	*-1065*	*-958*	*-844*	*71*	*2250*	*-970*	*0*	*400*	*286*	*205*	*-300*
2013	*-862*	*-1000*	*-914*	*71*	*2176*	*-963*	*0*	*400*	*284*	*204*	*-300*
2014	*-545*	*-1092*	*-1059*	*71*	*2103*	*-955*	*0*	*400*	*282*	*203*	*-300*
2015	*-487*	*-1079*	*-1053*	*71*	*2029*	*-947*	*0*	*400*	*280*	*202*	*-300*
2016	*-316*	*-1098*	*-1086*	*71*	*1955*	*-938*	*0*	*400*	*278*	*201*	*-300*
2017	*-380*	*-1047*	*-995*	*71*	*1882*	*-929*	*0*	*400*	*276*	*200*	*-300*
2018	*-486*	*-991*	*-888*	*71*	*1808*	*-920*	*0*	*400*	*274*	*199*	*-300*
2019	*-572*	*-951*	*-812*	*71*	*1734*	*-910*	*0*	*400*	*272*	*198*	*-300*
2020	*-278*	*-1022*	*-966*	*71*	*1661*	*-901*	*0*	*400*	*270*	*197*	*-300*

B Gg Carbon	Forest Conversion	Changes in woody biomass	Soils		Other	Other	NET Emission (+) Removal (-)
1990	71	-2579	4211		1066	-300	2468
1991	71	-2609	4269		1059	-300	2489
1992	71	-2658	4183		1046	-300	2342
1993	71	-2720	3790		1033	-300	1873
1994	71	-2778	3494		1052	-300	1539
1995	71	-2844	3363		1059	-300	1349
1996	71	-2867	3495		1027	-300	1426
1997	71	-2852	3451		1002	-300	1372
1998	71	-2844	3553		962	-300	1442
1999	71	-2847	3461		984	-300	1369
2000	71	-2878	3127		973	-300	992
2001	71	-2868	3068		977	-300	948
2002	71	-2886	2710		924	-300	519
NIR Format	5B (Emissions)	5A (Removals)	5D (Emissions)		5E (Emissions)	5E (Removals)	
	Deforestation	Forest biomass, soils, litter, products	Effect of LUC (Net), Set Aside soils (Removal), liming of soils		Drainage of soils, peat extraction	Crop biomass	

C Gg Carbon	Forest Conversion	Changes in woody biomass	Soils	Soils	Other	Other	NET Emission (+) Removal (-)
1990	71	-1992	5109	-635	216	-300	2468
1991	71	-2017	5181	-664	219	-300	2489
1992	71	-2092	5109	-662	216	-300	2342
1993	71	-2177	4737	-670	213	-300	1873
1994	71	-2234	4821	-1061	242	-300	1539
1995	71	-2323	4711	-1068	259	-300	1349
1996	71	-2298	4706	-990	237	-300	1426
1997	71	-2268	4506	-859	222	-300	1372
1998	71	-2232	4360	-649	192	-300	1442
1999	71	-2215	4302	-713	224	-300	1369
2000	71	-2266	4169	-904	223	-300	992
2001	71	-2221	4119	-954	233	-300	948
2002	71	-2303	3925	-1060	186	-300	519
CRF Format	5B (Emissions)	5A (Removals)	5D (Emissions)	5D (Removals)	5E (Emissions)	5E (Removals)	5 Net
	Deforestation	Forest biomass, forest products	Effect on soils of LUC(Net), liming, drainage.	Forest soils, forest litter, Set aside soils	Peat extraction	Crop biomass	

Table A1. 2: England data for 2002 UK GHG Inventory: A: component fluxes, B: "NIR" summary. C: "CRF" Summary. (Italics are "Mid" projections – see text) (Forest Loss = Deforestation)

A Gg carbon	Forest biomass	Forest soils & litter	Forest products	Forest Loss	Land Use Change	Set Aside	Liming	Upland drainage	Lowland drainage	Peat extraction	Crop biomass
1990	-174	-250	-202	35	436	-35	286	40	450	62	-255
1991	-288	-215	-128	35	344	-52	354	40	440	67	-255
1992	-324	-206	-105	35	271	-69	362	40	430	60	-255
1993	-364	-198	-82	35	195	-92	226	40	420	60	-255
1994	-366	-200	-83	35	125	-404	254	40	410	77	-255
1995	-383	-197	-72	35	49	-431	306	40	400	88	-255
1996	-361	-206	-80	35	-15	-331	303	40	390	73	-255
1997	-382	-201	-63	35	-93	-205	269	40	380	68	-255
1998	-357	-210	-77	35	-156	-24	211	40	370	52	-255
1999	-323	-221	-96	35	-217	-57	177	40	360	68	-255
2000	-336	-217	-87	35	-292	-228	159	40	350	70	-255
2001	-332	-220	-84	35	-360	-230	145	40	344	81	-255
2002	-406	-199	-35	35	-450	-383	150	40	338	48	-255
2003	*-488*	*-180*	*12*	*35*	*-520*	*-187*	*133*	*40*	*332*	*67*	*-255*
2004	*-541*	*-171*	*40*	*35*	*-590*	*-422*	*117*	*40*	*326*	*66*	*-255*
2005	*-609*	*-158*	*72*	*35*	*-660*	*-486*	*101*	*40*	*320*	*66*	*-255*
2006	*-556*	*-180*	*43*	*35*	*-730*	*-544*	*85*	*40*	*314*	*66*	*-255*
2007	*-496*	*-202*	*6*	*35*	*-800*	*-597*	*69*	*40*	*308*	*66*	*-255*
2008	*-355*	*-246*	*-80*	*35*	*-870*	*-645*	*52*	*40*	*302*	*66*	*-255*
2009	*-267*	*-270*	*-132*	*35*	*-940*	*-690*	*36*	*40*	*296*	*66*	*-255*
2010	*-207*	*-286*	*-169*	*35*	*-1010*	*-733*	*20*	*40*	*290*	*66*	*-255*
2011	*-140*	*-301*	*-195*	*35*	*-1080*	*-772*	*4*	*40*	*288*	*66*	*-255*
2012	*-208*	*-277*	*-143*	*35*	*-1150*	*-767*	*0*	*40*	*286*	*66*	*-255*
2013	*-143*	*-296*	*-172*	*35*	*-1220*	*-760*	*0*	*40*	*284*	*65*	*-255*
2014	*130*	*-388*	*-322*	*35*	*-1290*	*-753*	*0*	*40*	*282*	*65*	*-255*
2015	*127*	*-377*	*-310*	*35*	*-1360*	*-745*	*0*	*40*	*280*	*65*	*-255*
2016	*181*	*-385*	*-324*	*35*	*-1430*	*-737*	*0*	*40*	*278*	*65*	*-255*
2017	*164*	*-371*	*-303*	*35*	*-1500*	*-729*	*0*	*40*	*276*	*65*	*-255*
2018	*110*	*-350*	*-262*	*35*	*-1570*	*-721*	*0*	*40*	*274*	*65*	*-255*
2019	*63*	*-335*	*-229*	*35*	*-1640*	*-713*	*0*	*40*	*272*	*65*	*-255*
2020	*66*	*-337*	*-231*	*35*	*-1710*	*-705*	*0*	*40*	*270*	*65*	*-255*

B Gg Carbon	Forest Conversion	Changes in woody biomass	Soils		Other	Other	NET Emission (+) Removal (-)
1990	35	-626	687		552	-255	394
1991	35	-631	646		547	-255	342
1992	35	-635	564		530	-255	240
1993	35	-644	330		520	-255	-14
1994	35	-649	-25		527	-255	-367
1995	35	-652	-76		528	-255	-420
1996	35	-647	-43		503	-255	-406
1997	35	-646	-28		488	-255	-405
1998	35	-644	32		462	-255	-370
1999	35	-640	-97		468	-255	-488
2000	35	-640	-362		460	-255	-761
2001	35	-636	-445		465	-255	-835
2002	35	-640	-683		426	-255	-1117
NIR Format	5B (Emissions)	5A (Removals)	5D (Emissions)		5E (Emissions)	5E (Removals)	
	Deforestation	Forest biomass, soils, litter, products	Effect of LUC (Net), Set Aside soils (Removal), liming of soils		Drainage of soils, peat extraction	Crop biomass	

C Gg Carbon	Forest Conversion	Changes in woody biomass	Soils	Soils	Other	Other	NET Emission (+) Removal (-)
1990	35	-376	1212	-285	62	-255	394
1991	35	-416	1178	-267	67	-255	342
1992	35	-429	1103	-275	60	-255	240
1993	35	-446	881	-290	60	-255	-14
1994	35	-449	829	-604	77	-255	-367
1995	35	-455	795	-628	88	-255	-420
1996	35	-441	718	-537	73	-255	-406
1997	35	-445	596	-406	68	-255	-405
1998	35	-434	465	-234	52	-255	-370
1999	35	-419	360	-278	68	-255	-488
2000	35	-423	256	-445	70	-255	-761
2001	35	-416	169	-450	81	-255	-835
2002	35	-441	78	-582	48	-255	-1117
CRF Format	5B (Emissions)	5A (Removals)	5D (Emissions)	5D (Removals)	5E (Emissions)	5E (Removals)	5 Net
	Deforestation	Forest biomass, forest products	Effect on soils of LUC(Net), liming, drainage.	Forest soils, forest litter, Set aside soils	Peat extraction	Crop biomass	

Table A1. 3: Scotland data for 2002 UK GHG Inventory: A: component fluxes, B: "NIR" summary. C: "CRF" Summary. (Italics are "Mid" projections – see text) (Forest Loss = Deforestation)

A Gg carbon	Forest biomass	Forest soils & litter	Forest products	Forest Loss	Land Use Change	Set Aside	Liming	Upland drainage	Lowland drainage	Peat extraction	Crop biomass
1990	-1070	-242	-170	29	2858	-13	47	320	0	22	-37
1991	-1060	-257	-195	29	2907	-20	58	320	0	20	-37
1992	-1132	-251	-173	29	2927	-27	59	320	0	24	-37
1993	-1214	-244	-149	29	2940	-33	37	320	0	21	-37
1994	-1287	-239	-135	29	2949	-109	42	320	0	34	-37
1995	-1385	-226	-111	29	2946	-112	50	320	0	39	-37
1996	-1346	-257	-155	29	2984	-86	50	320	0	32	-37
1997	-1305	-280	-166	29	3011	-66	44	320	0	22	-37
1998	-1287	-296	-168	29	3029	-11	35	320	0	8	-37
1999	-1299	-302	-166	29	3034	-22	29	320	0	24	-37
2000	-1372	-290	-141	29	3019	-61	26	320	0	20	-37
2001	-1292	-325	-191	29	3049	-74	24	320	0	20	-37
2002	-1404	-301	-118	29	3018	-91	25	320	0	7	-37
2003	*-1571*	*-268*	*-33*	*29*	*3026*	*-85*	*22*	*320*	*0*	*16*	*-37*
2004	*-1715*	*-242*	*25*	*29*	*3034*	*-116*	*19*	*320*	*0*	*15*	*-37*
2005	*-1857*	*-222*	*67*	*29*	*3042*	*-129*	*17*	*320*	*0*	*14*	*-37*
2006	*-1712*	*-281*	*-19*	*29*	*3050*	*-142*	*14*	*320*	*0*	*13*	*-37*
2007	*-1578*	*-337*	*-103*	*29*	*3058*	*-154*	*11*	*320*	*0*	*12*	*-37*
2008	*-1432*	*-389*	*-202*	*29*	*3066*	*-166*	*9*	*320*	*0*	*12*	*-37*
2009	*-1418*	*-403*	*-242*	*29*	*3074*	*-177*	*6*	*320*	*0*	*11*	*-37*
2010	*-1291*	*-449*	*-346*	*29*	*3082*	*-188*	*3*	*320*	*0*	*10*	*-37*
2011	*-921*	*-549*	*-534*	*29*	*3090*	*-199*	*1*	*320*	*0*	*9*	*-37*
2012	*-954*	*-526*	*-477*	*29*	*3098*	*-198*	*0*	*320*	*0*	*8*	*-37*
2013	*-786*	*-566*	*-547*	*29*	*3106*	*-198*	*0*	*320*	*0*	*7*	*-37*
2014	*-731*	*-573*	*-559*	*29*	*3114*	*-197*	*0*	*320*	*0*	*6*	*-37*
2015	*-669*	*-577*	*-574*	*29*	*3122*	*-196*	*0*	*320*	*0*	*5*	*-37*
2016	*-601*	*-581*	*-580*	*29*	*3130*	*-195*	*0*	*320*	*0*	*4*	*-37*
2017	*-666*	*-546*	*-511*	*29*	*3138*	*-194*	*0*	*320*	*0*	*3*	*-37*
2018	*-777*	*-501*	*-419*	*29*	*3146*	*-194*	*0*	*320*	*0*	*3*	*-37*
2019	*-826*	*-480*	*-379*	*29*	*3154*	*-193*	*0*	*320*	*0*	*2*	*-37*
2020	*-611*	*-535*	*-496*	*29*	*3162*	*-192*	*0*	*320*	*0*	*1*	*-37*

B Gg Carbon	Forest Conversion	Changes in woody biomass	Soils		Other	Other	NET Emission (+) Removal (-)
1990	29	-1482	2891		342	-37	1743
1991	29	-1512	2945		340	-37	1764
1992	29	-1556	2960		344	-37	1740
1993	29	-1607	2944		341	-37	1670
1994	29	-1661	2881		354	-37	1566
1995	29	-1722	2884		359	-37	1513
1996	29	-1758	2948		352	-37	1533
1997	29	-1751	2990		342	-37	1572
1998	29	-1751	3053		328	-37	1621
1999	29	-1767	3041		344	-37	1609
2000	29	-1803	2984		340	-37	1513
2001	29	-1808	2999		340	-37	1522
2002	29	-1823	2951		327	-37	1446
NIR Format	5B (Emissions)	5A (Removals)	5D (Emissions)		5E (Emissions)	5E (Removals)	
	Deforestation	Forest biomass, soils, litter, products	Effect of LUC (Net), Set Aside soils (Removal), liming of soils		Drainage of soils, peat extraction	Crop biomass	

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C Gg Carbon	Forest Conversion	Changes in woody biomass	Soils	Soils	Other	Other	NET Emission (+) Removal (-)
1990	29	-1240	3225	-255	22	-37	1743
1991	29	-1255	3285	-277	20	-37	1764
1992	29	-1305	3307	-278	24	-37	1740
1993	29	-1363	3297	-277	21	-37	1670
1994	29	-1422	3311	-348	34	-37	1566
1995	29	-1496	3316	-338	39	-37	1513
1996	29	-1501	3354	-343	32	-37	1533
1997	29	-1471	3376	-346	22	-37	1572
1998	29	-1455	3384	-307	8	-37	1621
1999	29	-1465	3383	-324	24	-37	1609
2000	29	-1513	3365	-351	20	-37	1513
2001	29	-1483	3392	-399	20	-37	1522
2002	29	-1522	3362	-392	7	-37	1446
CRF Format	5B (Emissions)	5A (Removals)	5D (Emissions)	5D (Removals)	5E (Emissions)	5E (Removals)	5 Net
	Deforestation	Forest biomass, forest products	Effect on soils of LUC(Net), liming, drainage.	Forest soils, forest litter, Set aside soils	Peat extraction	Crop biomass	

Table A1. 4: Wales data for 2002 UK GHG Inventory: A: component, B: "NIR" summary. C: "CRF" Summary. (Italics are "Mid" projections – see text) (Forest Loss = Deforestation)

A Gg carbon	Forest biomass	Forest soils & litter	Forest products	Forest Loss	Land Use Change	Set Aside	Liming	Upland drainage	Lowland drainage	Peat extraction	Crop biomass
1990	-209	-63	-43	6	222	0	33	20	0	0	-4
1991	-120	-89	-95	6	247	0	41	20	0	0	-4
1992	-145	-78	-77	6	236	0	41	20	0	0	-4
1993	-164	-71	-64	6	228	-2	26	20	0	0	-4
1994	-169	-69	-61	6	225	-4	29	20	0	0	-4
1995	-180	-65	-54	6	220	-4	35	20	0	0	-4
1996	-163	-69	-60	6	223	-4	35	20	0	0	-4
1997	-168	-65	-52	6	218	-4	31	20	0	0	-4
1998	-151	-68	-59	6	220	-3	24	20	0	0	-4
1999	-135	-71	-67	6	222	-1	20	20	0	0	-4
2000	-136	-68	-65	6	217	-3	18	20	0	0	-4
2001	-128	-67	-63	6	215	-3	17	20	0	0	-4
2002	-169	-52	-34	6	198	-2	17	20	0	0	-4
2003	*-213*	*-39*	*-6*	*6*	*197*	*-2*	*15*	*20*	*0*	*0*	*-4*
2004	*-253*	*-27*	*17*	*6*	*196*	*-3*	*13*	*20*	*0*	*0*	*-4*
2005	*-281*	*-20*	*31*	*6*	*195*	*-3*	*12*	*20*	*0*	*0*	*-4*
2006	*-251*	*-29*	*16*	*6*	*194*	*-4*	*10*	*20*	*0*	*0*	*-4*
2007	*-173*	*-50*	*-27*	*6*	*193*	*-4*	*8*	*20*	*0*	*0*	*-4*
2008	*-91*	*-71*	*-73*	*6*	*192*	*-4*	*6*	*20*	*0*	*0*	*-4*
2009	*-37*	*-81*	*-102*	*6*	*191*	*-5*	*4*	*20*	*0*	*0*	*-4*
2010	*62*	*-104*	*-158*	*6*	*190*	*-5*	*2*	*20*	*0*	*0*	*-4*
2011	*160*	*-124*	*-204*	*6*	*189*	*-5*	*0*	*20*	*0*	*0*	*-4*
2012	*153*	*-112*	*-187*	*6*	*188*	*-5*	*0*	*20*	*0*	*0*	*-4*
2013	*108*	*-92*	*-150*	*6*	*187*	*-5*	*0*	*20*	*0*	*0*	*-4*
2014	*87*	*-83*	*-131*	*6*	*186*	*-5*	*0*	*20*	*0*	*0*	*-4*
2015	*91*	*-80*	*-127*	*6*	*185*	*-5*	*0*	*20*	*0*	*0*	*-4*
2016	*115*	*-81*	*-128*	*6*	*184*	*-5*	*0*	*20*	*0*	*0*	*-4*
2017	*111*	*-74*	*-118*	*6*	*183*	*-5*	*0*	*20*	*0*	*0*	*-4*
2018	*124*	*-73*	*-119*	*6*	*182*	*-5*	*0*	*20*	*0*	*0*	*-4*
2019	*122*	*-69*	*-114*	*6*	*181*	*-5*	*0*	*20*	*0*	*0*	*-4*
2020	*200*	*-87*	*-155*	*6*	*180*	*-5*	*0*	*20*	*0*	*0*	*-4*

B Gg Carbon	Forest Conversion	Changes in woody biomass	Soils		Other	Other	NET Emission (+) Removal (-)
1990	6	-315	255		20	-4	-38
1991	6	-304	288		20	-4	6
1992	6	-300	277		20	-4	-1
1993	6	-299	252		20	-4	-25
1994	6	-299	250		20	-4	-27
1995	6	-299	251		20	-4	-26
1996	6	-292	254		20	-4	-16
1997	6	-285	245		20	-4	-18
1998	6	-278	241		20	-4	-14
1999	6	-273	240		20	-4	-10
2000	6	-269	232		20	-4	-14
2001	6	-258	228		20	-4	-8
2002	6	-255	213		20	-4	-19
NIR Format	5B (Emissions)	5A (Removals)	5D (Emissions)		5E (Emissions)	5E (Removals)	
	Deforestation	Forest biomass, soils, litter, products	Effect of LUC (Net), Set Aside soils (Removal), liming of soils		Drainage of soils, peat extraction	Crop biomass	

C Gg Carbon	Forest Conversion	Changes in woody biomass	Soils	Soils	Other	Other	NET Emission (+) Removal (-)
1990	6	-252	275	-63	0	-4	-38
1991	6	-215	308	-89	0	-4	6
1992	6	-222	297	-78	0	-4	-1
1993	6	-228	274	-73	0	-4	-25
1994	6	-230	274	-73	0	-4	-27
1995	6	-234	275	-69	0	-4	-26
1996	6	-223	278	-73	0	-4	-16
1997	6	-220	269	-69	0	-4	-18
1998	6	-210	264	-71	0	-4	-14
1999	6	-202	262	-72	0	-4	-10
2000	6	-201	255	-71	0	-4	-14
2001	6	-191	251	-70	0	-4	-8
2002	6	-203	235	-54	0	-4	-19
CRF Format	5B (Emissions)	5A (Removals)	5D (Emissions)	5D (Removals)	5E (Emissions)	5E (Removals)	5 Net
	Deforestation	Forest biomass, forest products	Effect on soils of LUC(Net), liming, drainage.	Forest soils, forest litter, Set aside soils	Peat extraction	Crop biomass	

Table A1. 5: Northern Ireland data for 2002 UK GHG Inventory: A: component fluxes, B: "NIR" summary. C: "CRF" Summary. Italics are "Mid" projections – see text) (Forest Loss = Deforestation)

A Gg carbon	Forest biomass	Forest soils & litter	Forest products	Forest Loss	Land Use Change	Set Aside	Liming	Upland drainage	Lowland drainage	Peat extraction	Crop biomass
1990	-110	-32	-14		353	0	25	20	0	132	-4
1991	-119	-31	-12		360	0	31	20	0	132	-4
1992	-123	-31	-13		351	0	31	20	0	132	-4
1993	-130	-30	-10		245	0	20	20	0	132	-4
1994	-113	-36	-20		366	0	22	20	0	132	-4
1995	-126	-33	-12		278	0	26	20	0	132	-4
1996	-113	-37	-20		310	0	26	20	0	132	-4
1997	-110	-38	-22		222	0	23	20	0	132	-4
1998	-110	-38	-23		209	0	18	20	0	132	-4
1999	-105	-38	-24		262	0	15	20	0	132	-4
2000	-108	-37	-21		259	0	14	20	0	132	-4
2001	-115	-35	-16		273	0	13	20	0	132	-4
2002	-127	-31	-10		216	0	13	20	0	132	-4
2003	*-120*	*-33*	*-14*		*210*	*0*	*12*	*20*	*0*	*132*	*-4*
2004	*-105*	*-37*	*-22*		*200*	*0*	*10*	*20*	*0*	*132*	*-4*
2005	*-108*	*-35*	*-18*		*189*	*0*	*9*	*20*	*0*	*132*	*-4*
2006	*-87*	*-41*	*-29*		*178*	*0*	*7*	*20*	*0*	*132*	*-4*
2007	*-82*	*-41*	*-31*		*168*	*0*	*6*	*20*	*0*	*132*	*-4*
2008	*-58*	*-47*	*-45*		*157*	*0*	*5*	*20*	*0*	*132*	*-4*
2009	*-44*	*-49*	*-51*		*146*	*0*	*3*	*20*	*0*	*132*	*-4*
2010	*-44*	*-48*	*-48*		*136*	*0*	*2*	*20*	*0*	*132*	*-4*
2011	*-73*	*-38*	*-28*		*125*	*0*	*0*	*20*	*0*	*132*	*-4*
2012	*-56*	*-43*	*-37*		*114*	*0*	*0*	*20*	*0*	*132*	*-4*
2013	*-41*	*-46*	*-45*		*104*	*0*	*0*	*20*	*0*	*132*	*-4*
2014	*-31*	*-48*	*-47*		*93*	*0*	*0*	*20*	*0*	*132*	*-4*
2015	*-36*	*-45*	*-42*		*82*	*0*	*0*	*20*	*0*	*132*	*-4*
2016	*-11*	*-51*	*-54*		*72*	*0*	*0*	*20*	*0*	*132*	*-4*
2017	*11*	*-56*	*-63*		*61*	*0*	*0*	*20*	*0*	*132*	*-4*
2018	*57*	*-67*	*-88*		*50*	*0*	*0*	*20*	*0*	*132*	*-4*
2019	*69*	*-67*	*-90*		*40*	*0*	*0*	*20*	*0*	*132*	*-4*
2020	*67*	*-63*	*-84*		*29*	*0*	*0*	*20*	*0*	*132*	*-4*

B Gg Carbon	Forest Conversion	Changes in woody biomass	Soils		Other	Other	NET Emission (+) Removal (-)
1990		-156	378		152	-4	370
1991		-162	391		152	-4	377
1992		-167	382		152	-4	363
1993		-170	265		152	-4	243
1994		-169	388		152	-4	367
1995		-171	304		152	-4	281
1996		-170	336		152	-4	314
1997		-170	245		152	-4	223
1998		-171	227		152	-4	204
1999		-167	277		152	-4	258
2000		-166	273		152	-4	255
2001		-166	286		152	-4	268
2002		-168	229		152	-4	209
NIR Format	5B (Emissions)	5A (Removals)	5D (Emissions)		5E (Emissions)	5E (Removals)	
	Deforestation	Forest biomass, soils, litter, products	Effect of LUC (Net), Set Aside soils (Removal), liming of soils		Drainage of soils, peat extraction	Crop biomass	

C Gg Carbon	Forest Conversion	Changes in woody biomass	Soils	Soils	Other	Other	NET Emission (+) Removal (-)
1990		-124	398	-32	132	-4	370
1991		-131	411	-31	132	-4	377
1992		-136	402	-31	132	-4	363
1993		-140	285	-30	132	-4	243
1994		-133	408	-36	132	-4	367
1995		-138	324	-33	132	-4	281
1996		-133	356	-37	132	-4	314
1997		-132	265	-38	132	-4	223
1998		-133	247	-38	132	-4	204
1999		-129	297	-38	132	-4	258
2000		-129	293	-37	132	-4	255
2001		-131	306	-35	132	-4	268
2002		-137	249	-31	132	-4	209
CRF Format	5B (Emissions)	5A (Removals)	5D (Emissions)	5D (Removals)	5E (Emissions)	5E (Removals)	5 Net
	Deforestation	Forest biomass, forest products	Effect on soils of LUC(Net), liming, drainage.	Forest soils, forest litter, Set aside soils	Peat extraction	Crop biomass	

Table A1. 6: UK Data for 2002 UK GHG Inventory expressed in units of Gg of CO_2: A: component fluxes, B: "NIR" summary, C: "CRF" summary(Italics are "Mid" projections – see text) (Forest Loss = Deforestation)

A Gg CO_2	Forest biomass	Forest soils & litter	Forest products	Forest Loss	Land Use Change (Net)	Set Aside	Liming	Upland drainage	Lowland drainage	Peat extraction	Crop biomass
1990	-5731	-2152	-1573	260	14186	-176	1430	1467	1650	792	-1100
1991	-5819	-2171	-1577	260	14146	-264	1771	1467	1613	803	-1100
1992	-6321	-2075	-1349	260	13878	-352	1811	1467	1577	792	-1100
1993	-6864	-1991	-1118	260	13233	-466	1129	1467	1540	781	-1100
1994	-7095	-1995	-1096	260	13438	-1896	1269	1467	1503	887	-1100
1995	-7605	-1910	-913	260	12811	-2006	1529	1467	1467	950	-1100
1996	-7271	-2086	-1155	260	12844	-1544	1514	1467	1430	869	-1100
1997	-7205	-2141	-1111	260	12316	-1008	1346	1467	1393	814	-1100
1998	-6985	-2244	-1199	260	12107	-136	1060	1467	1357	704	-1100
1999	-6827	-2317	-1294	260	12100	-297	887	1467	1320	821	-1100
2000	-7157	-2244	-1151	260	11744	-1071	796	1467	1283	818	-1100
2001	-6846	-2372	-1298	260	11649	-1126	726	1467	1261	854	-1100
2002	-7722	-2138	-722	260	10934	-1749	752	1467	1239	682	-1100
2003	*-8771*	*-1907*	*-150*	*260*	*10681*	*-1005*	*667*	*1467*	*1217*	*788*	*-1100*
2004	*-9585*	*-1749*	*220*	*260*	*10410*	*-1984*	*587*	*1467*	*1195*	*785*	*-1100*
2005	*-10468*	*-1595*	*557*	*260*	*10142*	*-2270*	*506*	*1467*	*1173*	*781*	*-1100*
2006	*-9555*	*-1947*	*40*	*260*	*9871*	*-2530*	*425*	*1467*	*1151*	*777*	*-1100*
2007	*-8540*	*-2310*	*-568*	*260*	*9599*	*-2768*	*345*	*1467*	*1129*	*774*	*-1100*
2008	*-7099*	*-2761*	*-1467*	*260*	*9332*	*-2992*	*264*	*1467*	*1107*	*770*	*-1100*
2009	*-6475*	*-2944*	*-1932*	*260*	*9060*	*-3197*	*183*	*1467*	*1085*	*766*	*-1100*
2010	*-5427*	*-3252*	*-2644*	*260*	*8789*	*-3395*	*103*	*1467*	*1063*	*763*	*-1100*
2011	*-3571*	*-3711*	*-3524*	*260*	*8521*	*-3582*	*22*	*1467*	*1056*	*759*	*-1100*
2012	*-3905*	*-3513*	*-3095*	*260*	*8250*	*-3557*	*0*	*1467*	*1049*	*752*	*-1100*
2013	*-3161*	*-3667*	*-3351*	*260*	*7979*	*-3531*	*0*	*1467*	*1041*	*748*	*-1100*
2014	*-1998*	*-4004*	*-3883*	*260*	*7711*	*-3502*	*0*	*1467*	*1034*	*744*	*-1100*
2015	*-1786*	*-3956*	*-3861*	*260*	*7440*	*-3472*	*0*	*1467*	*1027*	*741*	*-1100*
2016	*-1159*	*-4026*	*-3982*	*260*	*7168*	*-3439*	*0*	*1467*	*1019*	*737*	*-1100*
2017	*-1393*	*-3839*	*-3648*	*260*	*6901*	*-3406*	*0*	*1467*	*1012*	*733*	*-1100*
2018	*-1782*	*-3634*	*-3256*	*260*	*6629*	*-3373*	*0*	*1467*	*1005*	*730*	*-1100*
2019	*-2097*	*-3487*	*-2977*	*260*	*6358*	*-3337*	*0*	*1467*	*997*	*726*	*-1100*
2020	*-1019*	*-3747*	*-3542*	*260*	*6090*	*-3304*	*0*	*1467*	*990*	*722*	*-1100*

B Gg Carbon	Forest Conversion	Changes in woody biomass	Soils		Other	Other	NET Emission (+) Removal (-)
1990	260	-9456	15440		3909	-1100	9049
1991	260	-9566	15653		3883	-1100	9126
1992	260	-9746	15338		3835	-1100	8587
1993	260	-9973	13897		3788	-1100	6868
1994	260	-10186	12811		3857	-1100	5643
1995	260	-10428	12331		3883	-1100	4946
1996	260	-10512	12815		3766	-1100	5229
1997	260	-10457	12654		3674	-1100	5031
1998	260	-10428	13028		3527	-1100	5287
1999	260	-10439	12690		3608	-1100	5020
2000	260	-10553	11466		3568	-1100	3637
2001	260	-10516	11249		3582	-1100	3476
2002	260	-10582	9937		3388	-1100	1903
NIR Format	5B (Emissions)	5A (Removals)	5D (Emissions)		5E (Emissions)	5E (Removals)	NET
	Deforestation	Forest biomass, soils, litter, products	Effect of LUC (Net), Set Aside soils (Removal), liming of soils		Drainage of soils, peat extraction	Crop biomass	

C Gg Carbon	Forest Conversion	Changes in woody biomass	Soils	Soils	Other	Other	NET Emission (+) Removal (-)
1990	260	-7304	18733	-2328	792	-1100	9049
1991	260	-7396	18997	-2435	803	-1100	9126
1992	260	-7671	18733	-2427	792	-1100	8587
1993	260	-7982	17369	-2457	781	-1100	6868
1994	260	-8191	17677	-3890	887	-1100	5643
1995	260	-8518	17274	-3916	950	-1100	4946
1996	260	-8426	17255	-3630	869	-1100	5229
1997	260	-8316	16522	-3150	814	-1100	5031
1998	260	-8184	15987	-2380	704	-1100	5287
1999	260	-8122	15774	-2614	821	-1100	5020
2000	260	-8309	15286	-3315	818	-1100	3637
2001	260	-8144	15103	-3498	854	-1100	3476
2002	260	-8444	14392	-3887	682	-1100	1903
CRF Format	5B (Emissions)	5A (Removals)	5D (Emissions)	5D (Removals)	5E (Emissions)	5E (Removals)	5 Net
	Deforestation	Forest biomass, forest products	Effect on soils of LUC(Net), liming, drainage.	Forest soils, forest litter, Set aside soils	Peat extraction	Crop biomass	

APPENDIX 2

A.2. Sectoral Tables for Land Use Change and Forestry Sector submitted as UK 2002 Greenhouse Gas Inventory

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (**2002**)

Units are Gg CO_2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 emissions	CO2 removals	Net CO2 emissions/ removals	CH4	N2O	NOx	CO
				(Gg)			
Total Land-Use Change and Forestry	**15,332.49**	**-13,429.35**	**1,903.14**	**1.13**	**0.01**	**0.28**	**9.88**
A. Changes in Forest and Other Woody Biomass Stocks	**0.00**	**-8,444.33**	**-8,444.33**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NO	-7,722.00	-7,722.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NO	NO	0.00				
5. Other (please specify)	0.00	-722.33	-722.33				
Harvested Wood (1)	NO	-722.33	-722.33				
			0.00				
B. Forest and Grassland Conversion (2)	**258.83**			**1.13**	**0.01**	**0.28**	**9.88**
1. Tropical Forests	NO			NO	NO	NO	NO
2. Temperate Forests	258.83			1.13	0.01	0.28	9.88
3. Boreal Forests	NO			NO	NO	NO	NO
4. Grasslands/Tundra	NO			NO	NO	NO	NO
5. Other (please specify)	0.00			0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NE	NE	0.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NE	NE	0.00				
5. Other (please specify)	0.00	0.00	0.00				
			0.00				
D. CO2 Emissions and Removals from Soil	**14,390.74**	**-3,885.01**	**10,505.73**				
Cultivation of Mineral Soils	10,932.72	IE	10,932.72				
Cultivation of Organic Soils	IE	IE	0.00				
Liming of Agricultural Soils	752.03	NO	752.03				
Forest Soils	NO	-2,137.67	-2,137.67				
Other (please specify)(3)	2,706.00	-1,747.35	958.65				
Upland Drainage	1,466.67	NO	1,466.67				
Lowland Drainage	1,239.33	NO	1,239.33				
Set Aside	0.00	-1,747.35	-1,747.35				
			0.00				
E. Other (please specify)	**682.92**	**-1,100.00**	**-417.08**	**0.00**	**0.00**	**0.00**	**0.00**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00				
Peat Extraction	682.92	NO	682.92				
			0.00				

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (**2001**)

Units are Gg CO_2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 emissions	CO2 removals	Net CO2 emissions/ removals	CH4	N2O	NOx	CO
				(Gg)			
Total Land-Use Change and Forestry	**16,215.25**	**-12,740.96**	**3,474.29**	**1.13**	**0.01**	**0.28**	**9.88**
A. Changes in Forest and Other Woody Biomass Stocks	**0.00**	**-8,143.67**	**-8,143.67**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NO	-6,845.67	-6,845.67				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NO	NO	0.00				
5. Other (please specify)	0.00	-1,298.00	-1,298.00				
Harvested Wood (1)	NO	-1,298.00	-1,298.00				
			0.00				
B. Forest and Grassland Conversion (2)	**258.83**			**1.13**	**0.01**	**0.28**	**9.88**
1. Tropical Forests	NO			NO	NO	NO	NO
2. Temperate Forests	258.83			1.13	0.01	0.28	9.88
3. Boreal Forests	NO			NO	NO	NO	NO
4. Grasslands/Tundra	NO			NO	NO	NO	NO
5. Other (please specify)	0.00			0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NE	NE	0.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NE	NE	0.00				
5. Other (please specify)	0.00	0.00	0.00				
			0.00				
D. CO2 Emissions and Removals from Soil	**15,101.75**	**-3,497.30**	**11,604.45**				
Cultivation of Mineral Soils	11,649.24	IE	11,649.24				
Cultivation of Organic Soils	IE	IE	0.00				
Liming of Agricultural Soils	724.50	NO	724.50				
Forest Soils	NO	-2,372.33	-2,372.33				
Other (please specify)(3)	2,728.00	-1,124.96	1,603.04				
Upland Drainage	1,466.67	NO	1,466.67				
Lowland Drainage	1,261.33	NO	1,261.33				
Set Aside	0.00	-1,124.96	-1,124.96				
			0.00				
E. Other (please specify)	**854.68**	**-1,100.00**	**-245.32**	**0.00**	**0.00**	**0.00**	**0.00**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00				
Peat Extraction	854.68	NO	854.68				
			0.00				

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (**2000**)
Units are Gg CO_2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 emissions	CO2 removals	Net CO2 emissions/ removals	CH4	N2O	NOx	CO
				(Gg)			
Total Land-Use Change and Forestry	**16,362.82**	**-12,723.87**	**3,638.95**	**1.13**	**0.01**	**0.28**	**9.88**
A. Changes in Forest and Other Woody Biomass Stocks	**0.00**	**-8,308.67**	**-8,308.67**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NO	-7,157.33	-7,157.33				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NO	NO	0.00				
5. Other (please specify)	0.00	-1,151.33	-1,151.33				
Harvested Wood (1)	NO	-1,151.33	-1,151.33				
			0.00				
B. Forest and Grassland Conversion (2)	**258.83**			**1.13**	**0.01**	**0.28**	**9.88**
1. Tropical Forests	NO			NO	NO	NO	NO
2. Temperate Forests	258.83			1.13	0.01	0.28	9.88
3. Boreal Forests	NO			NO	NO	NO	NO
4. Grasslands/Tundra	NO			NO	NO	NO	NO
5. Other (please specify)	0.00			0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NE	NE	0.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NE	NE	0.00				
5. Other (please specify)	0.00	0.00	0.00				
			0.00				
D. CO2 Emissions and Removals from Soil	**15,287.92**	**-3,315.21**	**11,972.71**				
Cultivation of Mineral Soils	11,743.74	IE	11,743.74				
Cultivation of Organic Soils	IE	IE	0.00				
Liming of Agricultural Soils	794.18	NO	794.18				
Forest Soils	NO	-2,244.00	-2,244.00				
Other (please specify)(3)	2,750.00	-1,071.21	1,678.79				
Upland Drainage	1,466.67	NO	1,466.67				
Lowland Drainage	1,283.33	NO	1,283.33				
Set Aside	0.00	-1,071.21	-1,071.21				
			0.00				
E. Other (please specify)	**816.08**	**-1,100.00**	**-283.92**	**0.00**	**0.00**	**0.00**	**0.00**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00				
Peat Extraction	816.08	NO	816.08				
			0.00				

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (**1999**)

Units are Gg CO_2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 emissions	CO2 removals	Net CO2 emissions/ removals	CH4	N2O	NOx	CO
				(Gg)			
Total Land-Use Change and Forestry	**16,855.79**	**-11,837.09**	**5,018.71**	**1.13**	**0.01**	**0.28**	**9.88**
A. Changes in Forest and Other Woody Biomass Stocks	**0.00**	**-8,121.67**	**-8,121.67**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NO	-6,827.33	-6,827.33				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NO	NO	0.00				
5. Other (please specify)	0.00	-1,294.33	-1,294.33				
Harvested Wood (1)	NO	-1,294.33	-1,294.33				
			0.00				
B. Forest and Grassland Conversion (2)	**258.83**			**1.13**	**0.01**	**0.28**	**9.88**
1. Tropical Forests	NO			NO	NO	NO	NO
2. Temperate Forests	258.83			1.13	0.01	0.28	9.88
3. Boreal Forests	NO			NO	NO	NO	NO
4. Grasslands/Tundra	NO			NO	NO	NO	NO
5. Other (please specify)	0.00			0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NE	NE	0.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NE	NE	0.00				
5. Other (please specify)	0.00	0.00	0.00				
			0.00				
D. CO2 Emissions and Removals from Soil	**15,775.37**	**-2,615.42**	**13,159.95**				
Cultivation of Mineral Soils	12,101.78	IE	12,101.78				
Cultivation of Organic Soils	IE	IE	0.00				
Liming of Agricultural Soils	886.93	NO	886.93				
Forest Soils	NO	-2,317.33	-2,317.33				
Other (please specify)(3)	2,786.67	-298.09	2,488.58				
Upland Drainage	1,466.67	NO	1,466.67				
Lowland Drainage	1,320.00	NO	1,320.00				
Set Aside	0.00	-298.09	-298.09				
			0.00				
E. Other (please specify)	**821.59**	**-1,100.00**	**-278.41**	**0.00**	**0.00**	**0.00**	**0.00**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00				
Peat Extraction	821.59	NO	821.59				
			0.00				

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (**1998**)

Units are Gg CO_2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 emissions	CO2 removals	Net CO2 emissions/ removals	CH4	N2O	NOx	CO
	(Gg)						
Total Land-Use Change and Forestry	**16,949.81**	**-11,664.08**	**5,285.73**	**1.13**	**0.01**	**0.28**	**9.88**
A. Changes in Forest and Other Woody Biomass Stocks	**0.00**	**-8,184.00**	**-8,184.00**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NO	-6,985.00	-6,985.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NO	NO	0.00				
5. Other (please specify)	0.00	-1,199.00	-1,199.00				
Harvested Wood (1)	NO	-1,199.00	-1,199.00				
			0.00				
B. Forest and Grassland Conversion (2)	**258.83**			**1.13**	**0.01**	**0.28**	**9.88**
1. Tropical Forests	NO			NO	NO	NO	NO
2. Temperate Forests	258.83			1.13	0.01	0.28	9.88
3. Boreal Forests	NO			NO	NO	NO	NO
4. Grasslands/Tundra	NO			NO	NO	NO	NO
5. Other (please specify)	0.00			0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NE	NE	0.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NE	NE	0.00				
5. Other (please specify)	0.00	0.00	0.00				
			0.00				
D. CO2 Emissions and Removals from Soil	**15,987.44**	**-2,380.08**	**13,607.36**				
Cultivation of Mineral Soils	12,106.06	IE	12,106.06				
Cultivation of Organic Soils	IE	IE	0.00				
Liming of Agricultural Soils	1,058.05	NO	1,058.05				
Forest Soils	NO	-2,244.00	-2,244.00				
Other (please specify)(3)	2,823.33	-136.08	2,687.25				
Upland Drainage	1,466.67	NO	1,466.67				
Lowland Drainage	1,356.67	NO	1,356.67				
Set Aside	0.00	-136.08	-136.08				
			0.00				
E. Other (please specify)	**703.55**	**-1,100.00**	**-396.45**	**0.00**	**0.00**	**0.00**	**0.00**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00				
Peat Extraction	703.55	NO	703.55				
			0.00				

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (**1997**)
Units are Gg CO_2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 emissions	CO2 removals	Net CO2 emissions/ removals	CH4	N2O	NOx	CO
				(Gg)			
Total Land-Use Change and Forestry	**17,595.78**	**-12,564.03**	**5,031.75**	**1.13**	**0.01**	**0.28**	**9.88**
A. Changes in Forest and Other Woody Biomass Stocks	**0.00**	**-8,316.00**	**-8,316.00**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NO	-7,205.00	-7,205.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NO	NO	0.00				
5. Other (please specify)	0.00	-1,111.00	-1,111.00				
Harvested Wood (1)	NO	-1,111.00	-1,111.00				
			0.00				
B. Forest and Grassland Conversion (2)	**258.83**			**1.13**	**0.01**	**0.28**	**9.88**
1. Tropical Forests	NO			NO	NO	NO	NO
2. Temperate Forests	258.83			1.13	0.01	0.28	9.88
3. Boreal Forests	NO			NO	NO	NO	NO
4. Grasslands/Tundra	NO			NO	NO	NO	NO
5. Other (please specify)	0.00			0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NE	NE	0.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NE	NE	0.00				
5. Other (please specify)	0.00	0.00	0.00				
			0.00				
D. CO2 Emissions and Removals from Soil	**16,522.10**	**-3,148.03**	**13,374.07**				
Cultivation of Mineral Soils	12,315.72	IE	12,315.72				
Cultivation of Organic Soils	IE	IE	0.00				
Liming of Agricultural Soils	1,346.38	NO	1,346.38				
Forest Soils	NO	-2,141.33	-2,141.33				
Other (please specify)(3)	2,860.00	-1,006.69	1,853.31				
Upland Drainage	1,466.67	NO	1,466.67				
Lowland Drainage	1,393.33	NO	1,393.33				
Set Aside	0.00	-1,006.69	-1,006.69				
			0.00				
E. Other (please specify)	**814.85**	**-1,100.00**	**-285.15**	**0.00**	**0.00**	**0.00**	**0.00**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00				
Peat Extraction	814.85	NO	814.85				
			0.00				

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (**1996**)

Units are Gg CO_2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 emissions	CO2 removals	Net CO2 emissions/ removals	CH4	N2O	NOx	CO
	(Gg)						
Total Land-Use Change and Forestry	**18,382.55**	**-13,154.74**	**5,227.82**	**1.13**	**0.01**	**0.28**	**9.88**
A. Changes in Forest and Other Woody Biomass Stocks	**0.00**	**-8,426.00**	**-8,426.00**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NO	-7,271.00	-7,271.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NO	NO	0.00				
5. Other (please specify)	NO	-1,155.00	-1,155.00				
Harvested Wood (1)	NO	-1,155.00	-1,155.00				
			0.00				
B. Forest and Grassland Conversion (2)	**258.83**			**1.13**	**0.01**	**0.28**	**9.88**
1. Tropical Forests	NO			NO	NO	NO	NO
2. Temperate Forests	258.83			1.13	0.01	0.28	9.88
3. Boreal Forests	NO			NO	NO	NO	NO
4. Grasslands/Tundra	NO			NO	NO	NO	NO
5. Other (please specify)	0.00			0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NE	NO	0.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NE	NO	0.00				
5. Other (please specify)	0.00	0.00	0.00				
			0.00				
D. CO2 Emissions and Removals from Soil	**17,254.75**	**-3,628.74**	**13,626.02**				
Cultivation of Mineral Soils	12,842.92	IE	12,842.92				
Cultivation of Organic Soils	IE	IE	0.00				
Liming of Agricultural Soils	1,515.16	NO	1,515.16				
Forest Soils	NO	-2,086.33	-2,086.33				
Other (please specify)(3)	2,896.67	-1,542.40	1,354.26				
Upland Drainage	1,466.67	NO	1,466.67				
Lowland Drainage	1,430.00	NO	1,430.00				
Set Aside	0.00	-1,542.40	-1,542.40				
			0.00				
E. Other (please specify)	**868.98**	**-1,100.00**	**-231.02**	**0.00**	**0.00**	**0.00**	**0.00**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00				
Peat Extraction	868.98	NO	868.98				
			0.00				

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (**1995**)
Units are Gg CO_2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 emissions	CO2 removals	Net CO2 emissions/ removals	CH4	N2O	NOx	CO
				(Gg)			
Total Land-Use Change and Forestry	**18,481.08**	**-13,534.88**	**4,946.20**	**1.13**	**0.01**	**0.28**	**9.88**
A. Changes in Forest and Other Woody Biomass Stocks	**0.00**	**-8,517.67**	**-8,517.67**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NO	-7,604.67	-7,604.67				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NO	NO	0.00				
5. Other (please specify)	0.00	-913.00	-913.00				
Harvested Wood (1)	NO	-913.00	-913.00				
			0.00				
B. Forest and Grassland Conversion (2)	**258.83**			**1.13**	**0.01**	**0.28**	**9.88**
1. Tropical Forests	NO			NO	NO	NO	NO
2. Temperate Forests	258.83			1.13	0.01	0.28	9.88
3. Boreal Forests	NO			NO	NO	NO	NO
4. Grasslands/Tundra	NO			NO	NO	NO	NO
5. Other (please specify)	0.00			0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NE	NE	0.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NE	NE	0.00				
5. Other (please specify)	0.00	0.00	0.00				
			0.00				
D. CO2 Emissions and Removals from Soil	**17,272.40**	**-3,917.21**	**13,355.19**				
Cultivation of Mineral Soils	12,809.63	IE	12,809.63				
Cultivation of Organic Soils	IE	IE	0.00				
Liming of Agricultural Soils	1,529.44	NO	1,529.44				
Forest Soils	NO	-1,910.33	-1,910.33				
Other (please specify)(3)	2,933.33	-2,006.88	926.45				
Upland Drainage	1,466.67	NO	1,466.67				
Lowland Drainage	1,466.67	NO	1,466.67				
Set Aside	0.00	-2,006.88	-2,006.88				
			0.00				
E. Other (please specify)	**949.85**	**-1,100.00**	**-150.15**	**0.00**	**0.00**	**0.00**	**0.00**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00				
Peat Extraction	949.85	NO	949.85				
			0.00				

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (**1994**)

Units are Gg CO_2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 emissions	CO2 removals	Net CO2 emissions/ removals	CH4	N2O	NOx	CO
				(Gg)			
Total Land-Use Change and Forestry	**18,825.98**	**-13,183.02**	**5,642.95**	**1.13**	**0.01**	**0.28**	**9.88**
A. Changes in Forest and Other Woody Biomass Stocks	**0.00**	**-8,191.33**	**-8,191.33**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NO	-7,095.00	-7,095.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NO	NO	0.00				
5. Other (please specify)	0.00	-1,096.33	-1,096.33				
Harvested Wood (1)	NO	-1,096.33	-1,096.33				
			0.00				
B. Forest and Grassland Conversion (2)	**258.83**			**1.13**	**0.01**	**0.28**	**9.88**
1. Tropical Forests	NO			NO	NO	NO	NO
2. Temperate Forests	258.83			1.13	0.01	0.28	9.88
3. Boreal Forests	NO			NO	NO	NO	NO
4. Grasslands/Tundra	NO			NO	NO	NO	NO
5. Other (please specify)	0.00			0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NE	NE	0.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NE	NE	0.00				
5. Other (please specify)	0.00	0.00	0.00				
			0.00				
D. CO2 Emissions and Removals from Soil	**17,678.37**	**-3,891.69**	**13,786.68**				
Cultivation of Mineral Soils	13,438.55	IE	13,438.55				
Cultivation of Organic Soils	IE	IE	0.00				
Liming of Agricultural Soils	1,269.82	NO	1,269.82				
Forest Soils	NO	-1,994.67	-1,994.67				
Other (please specify)(3)	2,970.00	-1,897.02	1,072.98				
Upland Drainage	1,466.67	NO	1,466.67				
Lowland Drainage	1,503.33	NO	1,503.33				
Set Aside	0.00	-1,897.02	-1,897.02				
			0.00				
E. Other (please specify)	**888.79**	**-1,100.00**	**-211.21**	**0.00**	**0.00**	**0.00**	**0.00**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00				
Peat Extraction	888.79	NO	888.79				
			0.00				

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (**1993**)

Units are Gg CO_2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 emissions	CO2 removals	Net CO2 emissions/ removals	CH4	N2O	NOx	CO
				(Gg)			
Total Land-Use Change and Forestry	**18,407.81**	**-11,538.58**	**6,869.23**	**1.13**	**0.01**	**0.28**	**9.88**
A. Changes in Forest and Other Woody Biomass Stocks	**0.00**	**-7,982.33**	**-7,982.33**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NO	-6,864.00	-6,864.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NO	NO	0.00				
5. Other (please specify)	0.00	-1,118.33	-1,118.33				
Harvested Wood (1)	NO	-1,118.33	-1,118.33				
			0.00				
B. Forest and Grassland Conversion (2)	**258.83**			**1.13**	**0.01**	**0.28**	**9.88**
1. Tropical Forests	NO			NO	NO	NO	NO
2. Temperate Forests	258.83			1.13	0.01	0.28	9.88
3. Boreal Forests	NO			NO	NO	NO	NO
4. Grasslands/Tundra	NO			NO	NO	NO	NO
5. Other (please specify)	0.00			0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NE	NE	0.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NE	NE	0.00				
5. Other (please specify)	0.00	0.00	0.00				
			0.00				
D. CO2 Emissions and Removals from Soil	**17,368.44**	**-2,456.25**	**14,912.19**				
Cultivation of Mineral Soils	13,231.45	IE	13,231.45				
Cultivation of Organic Soils	IE	IE	0.00				
Liming of Agricultural Soils	1,130.32	NO	1,130.32				
Forest Soils	NO	-1,991.00	-1,991.00				
Other (please specify)(3)	3,006.67	-465.25	2,541.42				
Upland Drainage	1,466.67	NO	1,466.67				
Lowland Drainage	1,540.00	NO	1,540.00				
Set Aside	0.00	-465.25	-465.25				
			0.00				
E. Other (please specify)	**780.54**	**-1,100.00**	**-319.46**	**0.00**	**0.00**	**0.00**	**0.00**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00				
Peat Extraction	780.54	NO	780.54				
			0.00				

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (**1992**)

Units are Gg CO_2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 emissions	CO2 removals	Net CO2 emissions/ removals	CH4	N2O	NOx	CO
				(Gg)			
Total Land-Use Change and Forestry	**19,783.18**	**-11,197.14**	**8,586.04**	**1.13**	**0.01**	**0.28**	**9.88**
A. Changes in Forest and Other Woody Biomass Stocks	**0.00**	**-7,670.67**	**-7,670.67**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NO	-6,321.33	-6,321.33				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NO	NO	0.00				
5. Other (please specify)	0.00	-1,349.33	-1,349.33				
Harvested Wood (1)	NO	-1,349.33	-1,349.33				
			0.00				
B. Forest and Grassland Conversion (2)	**258.83**			**1.13**	**0.01**	**0.28**	**9.88**
1. Tropical Forests	NO			NO	NO	NO	NO
2. Temperate Forests	258.83			1.13	0.01	0.28	9.88
3. Boreal Forests	NO			NO	NO	NO	NO
4. Grasslands/Tundra	NO			NO	NO	NO	NO
5. Other (please specify)	0.00			0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NE	NE	0.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NE	NE	0.00				
5. Other (please specify)	0.00	0.00	0.00				
			0.00				
D. CO2 Emissions and Removals from Soil	**18,732.78**	**-2,426.47**	**16,306.31**				
Cultivation of Mineral Soils	13,879.86	IE	13,879.86				
Cultivation of Organic Soils	IE	IE	0.00				
Liming of Agricultural Soils	1,809.58	NO	1,809.58				
Forest Soils	NO	-2,075.33	-2,075.33				
Other (please specify)(3)	3,043.33	-351.14	2,692.19				
Upland Drainage	1,466.67	NO	1,466.67				
Lowland Drainage	1,576.67	NO	1,576.67				
Set Aside	0.00	-351.14	-351.14				
			0.00				
E. Other (please specify)	**791.57**	**-1,100.00**	**-308.43**	**0.00**	**0.00**	**0.00**	**0.00**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00				
Peat Extraction	791.57	NO	791.57				
			0.00				

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (**1991**)
Units are Gg CO_2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 emissions	CO2 removals	Net CO2 emissions/ removals	CH4	N2O	NOx	CO
				(Gg)			
Total Land-Use Change and Forestry	**20,057.95**	**-10,930.20**	**9,127.75**	**1.13**	**0.01**	**0.28**	**9.88**
A. Changes in Forest and Other Woody Biomass Stocks	**0.00**	**-7,395.67**	**-7,395.67**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NO	-5,819.00	-5,819.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NO	NO	0.00				
5. Other (please specify)	0.00	-1,576.67	-1,576.67				
Harvested Wood (1)	NO	-1,576.67	-1,576.67				
			0.00				
B. Forest and Grassland Conversion (2)	**258.83**			**1.13**	**0.01**	**0.28**	**9.88**
1. Tropical Forests	NO			NO	NO	NO	NO
2. Temperate Forests	258.83			1.13	0.01	0.28	9.88
3. Boreal Forests	NO			NO	NO	NO	NO
4. Grasslands/Tundra	NO			NO	NO	NO	NO
5. Other (please specify)	0.00			0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NE	NE	0.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NE	NE	0.00				
5. Other (please specify)			0.00				
			0.00				
D. CO2 Emissions and Removals from Soil	**18,996.53**	**-2,434.53**	**16,562.00**				
Cultivation of Mineral Soils	14,144.58	IE	14,144.58				
Cultivation of Organic Soils	IE	IE	0.00				
Liming of Agricultural Soils	1,771.95	NO	1,771.95				
Forest Soils	NO	-2,170.67	-2,170.67				
Other (please specify)(3)	3,080.00	-263.86	2,816.14				
Upland Drainage	1,466.67	NO	1,466.67				
Lowland Drainage	1,613.33	NO	1,613.33				
Set Aside	0.00	-263.86	-263.86				
			0.00				
E. Other (please specify)	**802.60**	**-1,100.00**	**-297.40**	**0.00**	**0.00**	**0.00**	**0.00**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00				
Peat Extraction	802.60	NO	802.60				
			0.00				

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (**1990**)

Units are Gg CO_2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 emissions	CO2 removals	Net CO2 emissions/ removals	CH4	N2O	NOx	CO
				(Gg)			
Total Land-Use Change and Forestry	**19,784.12**	**-10,734.08**	**9,050.03**	**1.13**	**0.01**	**0.28**	**9.88**
A. Changes in Forest and Other Woody Biomass Stocks	**0.00**	**-7,304.00**	**-7,304.00**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NO	-5,731.00	-5,731.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NO	NO	0.00				
5. Other (please specify)	0.00	-1,573.00	-1,573.00				
Harvested Wood (1)	NO	-1,573.00	-1,573.00				
			0.00				
B. Forest and Grassland Conversion (2)	**258.83**			**1.13**	**0.01**	**0.28**	**9.88**
1. Tropical Forests	NO			NO	NO	NO	NO
2. Temperate Forests	258.83			1.13	0.01	0.28	9.88
3. Boreal Forests	NO			NO	NO	NO	NO
4. Grasslands/Tundra	NO			NO	NO	NO	NO
5. Other (please specify)	0.00			0.00	0.00	0.00	0.00
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**				
1. Tropical Forests	NO	NO	0.00				
2. Temperate Forests	NE	NE	0.00				
3. Boreal Forests	NO	NO	0.00				
4. Grasslands/Tundra	NE	NE	0.00				
5. Other (please specify)			0.00				
			0.00				
D. CO2 Emissions and Removals from Soil	**18,733.72**	**-2,330.08**	**16,403.64**				
Cultivation of Mineral Soils	14,186.61	IE	14,186.61				
Cultivation of Organic Soils	IE	IE	0.00				
Liming of Agricultural Soils	1,430.45	NO	1,430.45				
Forest Soils	NO	-2,152.33	-2,152.33				
Other (please specify)(3)	3,116.67	-177.75	2,938.92				
Upland Drainage	1,466.67	NO	1,466.67				
Lowland Drainage	1,650.00	NO	1,650.00				
Set Aside	0.00	-177.75	-177.75				
			0.00				
E. Other (please specify)	**791.57**	**-1,100.00**	**-308.43**	**0.00**	**0.00**	**0.00**	**0.00**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00				
Peat Extraction	791.57	NO	791.57				
			0.00				

APPENDIX 3

A.3. Notes on the preparation of the data for Northern Ireland for the 2002 GHG Inventories.

1. In 2001 DARD published another long series of revised agriculture statistics (1981-2001) and, as last year, this has been used.

2. It was noted last year that the figures for 2001 show a large increase in 'common rough grazing' after many years of a fairly constant figure. If that new figure had been used there was a *reduction* in the urban area (because urban is the residual figure) for 2001, back down to an urban area as of around 1991. Clearly that is most unlikely. The calculations therefore used the previous figure for 'common rough grazing'.

For 2002, the new estimated area of common rough grazing has been retained in the published statistics. Two sets of figures are returned – one that uses the original estimated area of common rough grazing and the other uses the new estimate. The effect is seen in the slight reduction in urban area. The estimated overall annual loss of C is not affected.

3. The agriculture statistics are based on a sample of farms – not a full census as in 2000.

Land cover 1982 Sources **(000ha)**

Arable/cultivated	DARD: all crops – from published long series 1981-2002	71.825
Grass/pasture	DARD: all grass - from published long series. Plus area beneath fruit trees	788.645
Semi-nat/rgr non-peat	DARD: sole ownership (191.256); half original estimate of common (17.25); Forest Service unplantable other + 36% of plantable reserve in 1982 (10.672). Less 36% of forest increase 1982-2002 (6.12)	213.058
Semi-nat, peatbog	Reduced figure for conversion to grass/arable	141.697
Saltmarsh	As for 1990, assume no change	0.078
Inland water	As for 1990, assume no change	63.8
Subtotal		1279.103
Urban and other	Residue of all other classes	51.297
Total land and water area	UK Digest of Environmental Statistics 1993 (1414.4). Because the soil carbon change due to forest planting is included in modelling forest carbon storage, the total area for calculation was found by removing the total forest area in 2002	1330.4
Total Forest (State & Private)	NI Annual Abstract of Statistics	84

Land cover 2002 Sources **(000 ha)**

Arable/cultivated	DARD: all crops	51.1
Grass/pasture	DARD: all grass Plus area beneath fruit trees	845.2
Semi-nat/rgr non-peat	DARD: sole ownership (151.6); half original estimate of common (17.25); Forest Service - no information on unplantable etc assume has remained about the same as in 1999	~170.1
Semi-nat, peatbog	As for 1992 because no more forest planting thereafter	134.89
Saltmarsh	As for 1990, assume no change	0.078
Inland water	As for 1990, assume no change	63.8
Subtotal		1265.168
Urban and other	Residue of all other classes	65.232
Total land and water area	UK Digest of Environmental Statistics 1993 (1414.4). Because the soil carbon change due to forest planting is included in modelling forest carbon storage, the total area for calculation was found by removing the total forest area in 2002	1330.4
Total Forest (State & Private)	NI Annual Abstract of Statistics for planted area 2001/2	84

APPENDIX 4

A.4. Estimated Removals of atmospheric carbon by post-1990 afforestation in the UK

Estimated Removals of atmospheric carbon by post-1990 afforestation in the UK

The following notes apply to all Tables

Low Mid High refer to Emissions Scenarios

Low means more forestry - proportion of UK planting of 30,000 ha/year distributed by conifer & broadleaf to the four individual countries by proportions in 2002.

Mid means "BAU" forestry -proportion of UK planting of 5 kha/year conifer, 13 kha/year broadleaf distributed across the four countries

High means less forestry - 0 kha/year conifer, 0 kha/year broadleaf

These data include, biomass, litter, soils and products

Products are small in the time period covered

Units are ktC per year

Table A4. 1 Removal of atmospheric carbon by post-1990 afforestation –United Kingdom

UK	**kT (Gg) Carbon per year**		
	Forestry (Low)	**Forestry (Mid)**	**Forestry (High)**
Year			
1990	-63	-63	-63
1991	-104	-104	-104
1992	-140	-140	-140
1993	-169	-169	-169
1994	-197	-197	-197
1995	-223	-223	-223
1996	-252	-252	-252
1997	-276	-276	-276
1998	-300	-300	-300
1999	-325	-325	-325
2000	-351	-351	-351
2001	-377	-377	-377
2002	-397	-397	-397
2003	-443	-418	-397
2004	-492	-439	-395
2005	-543	-460	-394
2006	-594	-482	-392
2007	-647	-505	-390
2008	-702	**-529**	-390
2009	-759	**-555**	-391
2010	-881	**-647**	-457
2011	-973	**-707**	-493
2012	-1062	**-765**	-524
2013	-1144	-815	-550
2014	-1220	-860	-568
2015	-1222	-831	-514
2016	-1314	-891	-549
2017	-1410	-955	-588
2018	-1506	-1020	-628
2019	-1608	-1092	-674
2020	-1631	-1083	-641

Table A4. 2 Removal of atmospheric carbon by post-1990 afforestation –Scotland

Scotland	**kT (Gg) Carbon per year**		
	Forestry (Low)	**Forestry (Mid)**	**Forestry (High**
Year			
1990	-56	-56	-56
1991	-87	-87	-87
1992	-112	-112	-112
1993	-132	-132	-132
1994	-149	-149	-149
1995	-161	-161	-161
1996	-179	-179	-179
1997	-193	-193	-193
1998	-207	-207	-207
1999	-220	-220	-220
2000	-233	-233	-233
2001	-247	-247	-247
2002	-256	-256	-256
2003	-283	-266	-253
2004	-310	-277	-250
2005	-339	-288	-246
2006	-367	-299	-243
2007	-397	-310	-241
2008	-426	**-322**	-238
2009	-456	**-334**	-236
2010	-548	**-409**	-296
2011	-611	**-453**	-326
2012	-669	**-494**	-352
2013	-724	-531	-375
2014	-775	-564	-394
2015	-752	-523	-339
2016	-810	-564	-365
2017	-871	-608	-395
2018	-934	-653	-426
2019	-1000	-702	-462
2020	-988	-673	-419

Table A4. 3 Removal of atmospheric carbon by post-1990 afforestation –England

England	**kT (Gg) Carbon per year**		
	Forestry (Low)	**Forestry (Mid)**	**Forestry (High)**
Year			
1990	-3	-3	-3
1991	-9	-9	-9
1992	-16	-16	-16
1993	-23	-23	-23
1994	-31	-31	-31
1995	-41	-41	-41
1996	-50	-50	-50
1997	-59	-59	-59
1998	-67	-67	-67
1999	-77	-77	-77
2000	-87	-87	-87
2001	-98	-98	-98
2002	-108	-108	-108
2003	-125	-117	-111
2004	-143	-126	-113
2005	-161	-136	-115
2006	-180	-145	-116
2007	-200	-154	-117
2008	-220	**-163**	-118
2009	-239	**-173**	-119
2010	-262	**-184**	-121
2011	-284	**-195**	-123
2012	-307	**-206**	-125
2013	-329	-217	-127
2014	-351	-228	-129
2015	-373	-238	-129
2016	-398	-252	-134
2017	-426	-268	-141
2018	-455	-285	-149
2019	-485	-304	-158
2020	-490	**-360**	-159

Table A4. 4 Removal of atmospheric carbon by post-1990 afforestation –Wales

Wales	**kT (Gg) Carbon per year**		
	Forestry (Low)	**Forestry (Mid)**	**Forestry (High)**
Year			
1990	-2	-2	-2
1991	-3	-3	-3
1992	-4	-4	-4
1993	-5	-5	-5
1994	-5	-5	-5
1995	-6	-6	-6
1996	-7	-7	-7
1997	-8	-8	-8
1998	-8	-8	-8
1999	-10	-10	-10
2000	-11	-11	-11
2001	-12	-12	-12
2002	-12	-12	-12
2003	-13	-13	-12
2004	-14	-13	-13
2005	-15	-14	-13
2006	-17	-14	-13
2007	-18	-15	-13
2008	-19	**-15**	-13
2009	-20	**-16**	-13
2010	-23	**-18**	-15
2011	-25	**-20**	-16
2012	-27	**-21**	-16
2013	-29	-22	-17
2014	-30	-23	-17
2015	-30	-22	-15
2016	-32	-23	-16
2017	-34	-25	-17
2018	-37	-27	-18
2019	-40	-29	-20
2020	-40	-28	-19

Table A4. 5 Removal of atmospheric carbon by post-1990 afforestation –N. Ireland

N. Ireland	**kT (Gg) Carbon per year**		
	Forestry (Low)	**Forestry (Mid)**	**Forestry (High)**
Year			
1990	-2	-2	-2
1991	-5	-5	-5
1992	-8	-8	-8
1993	-10	-10	-10
1994	-12	-12	-12
1995	-14	-14	-14
1996	-16	-16	-16
1997	-17	-17	-17
1998	-18	-18	-18
1999	-19	-19	-19
2000	-20	-20	-20
2001	-20	-20	-20
2002	-21	-21	-21
2003	-23	-22	-20
2004	-25	-22	-20
2005	-28	-23	-20
2006	-30	-24	-19
2007	-33	-25	-19
2008	-37	**-28**	-21
2009	-43	**-32**	-24
2010	-48	**-36**	-26
2011	-53	**-39**	-28
2012	-59	**-43**	-31
2013	-62	-45	-31
2014	-63	-44	-29
2015	-68	-48	-31
2016	-74	-52	-34
2017	-78	-54	-35
2018	-81	-55	-35
2019	-83	-56	-34
2020	-87	-59	-35