SECTION 2

The Land Use Change and Forestry Sector in the 1999 UK Greenhouse Gas Inventory

Land Use Change and Forestry: The 1999 UK Greenhouse Gas Inventory.

R. Milne[1], R. Tomlinson[2] & J. Gauld[3]
[1]Centre for Ecology & Hydrology, Bush Estate, Penicuik. [2] Queen's University, Belfast.
[3] Macaulay Land Use Research Institute, Craigiebuckler, Aberdeen

1. Introduction

This chapter expands Appendix 6 of the UK National GHG Inventory for 1990 to 1999 where methods for estimating removals and emissions of carbon dioxide due to Land Use Change and Forestry (LUCF) are described. (Salway et al. 2001).

The estimates for Land Use Change and Forestry are from work carried out by the Centre for Ecology & Hydrology and described in the scientific literature (Cannell et al 1999, Milne and Brown 1999) and in Contract Reports to DETR (Milne et al. 1999, 2000, Cruickshank & Tomlinson 2000). The data is reported under IPCC categories 5A (Changes in Forests and Other Woody Biomass, 5C (CO_2 Emissions from Soils) and 5E (Other). No data is included for Categories 5B (Forest and Grassland Conversion) or 5C (Abandonment of Managed Lands) as these are considered to be negligible, or not occurring, in the UK.

Here some further detail on the methods used, and recent changes to estimates, are described to further the adoption of "Good Practice". IPCC (2000) provides guidance related to Sectors other than LUCF and similar recommendation are being developed for LUCF.

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

The UK GHG estimates for carbon uptake related to changes in forests are based on data for the areas of forest plantation published by the UK Forestry Commission and the Northern Ireland Department of Agriculture (for 1999 data see Forestry Commission 2001, Forest Service 2000). The carbon uptake 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. All commercial forest is assumed to be restocked. It should be noted that for consistency with previous reports those parts of the net uptake by litter, soils and products are included in the data reported in this category for the National Report (Salway et al. 2001), but are included as a removals under the Soils category in the Common Reporting Format tables. The litter and soils components of these Removals are also provided in footnotes to the National Report tables to allow comparison with data from countries which report only changes in woody biomass and exclude soils etc.

The carbon accounting model of Dewar and Cannell (1992) calculated the mass of carbon in trees, litter, soil and wood products from harvested material in new even-aged plantations which 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 1921 to 1999 for England, Scotland, Wales and Northern Ireland sub-divided into conifers and broadleaves. Restocking was dealt with in the model through the second and subsequent rotations for the 'new' areas and hence areas restocked each year did not need to be considered separately.

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 to 16 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. 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 at al. (1998) also showed little effect of different assumptions on broadleaf species. Hence it was assumed here, that broadleaf forests had the characteristics of beech (*Fagus sylvatica* L.) of Yield Class 6 m^3 ha^{-1} a^{-1} .
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 1.

Table 1: 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
Foliage decay rate (a^{-1})	1	1	3
Wood decay rate (a^{-1})	0.06	0.06	0.04
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

The parameters controlling the transfer of carbon into the litter pools and its subsequent decay are given in Table 1. 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 which then decayed at a slower rate. The decay of litter and soil matter was assumed to be controlled only by tree species

and Yield Class and unaffected by other factors which varied with location. 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. Further data on these changes is presently being analyzed and is discussed in the draft paper appended to this report (Hargreaves et al. 2001) and will be incorporated into a modified C-Flow before the next Inventory. Broadleaved forests were assumed to increase the net amount of carbon in litter and soil. Harvested material from thinning and felling, which is made into wood products, was 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). A detailed description of all the assumptions in the model was given by Dewar and Cannell (1992) and Cannell and Dewar (1995) and the effect of assuming all forests to be of either Sitka spruce or beech in Milne et al. (1998).

3 CO_2 Emissions and Removals from Soils (5D)

Three processes are reported in this category: changes in soil stocks due to land use change, change in soil stocks due specifically to the change in land use from arable in Set Aside schemes and emissions due to the application of lime and dolomite.

3.1.1 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. 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 peats in the North of Scotland are identified separately and depths to 5 m are included but these play a minor role in relation to land use change. MLURI reviewed and revised downwards the values of soil carbon density for some peaty soils types in Scotland for this 1999 Inventory.
The basis for estimating soil carbon densities in Scotland is the National Soil Map Of Scotland at 1:250, 000 scale. For each 1:250, 000 map unit the area of different soil types is recorded in a database e.g.:

MAP UNIT 153:	PEATY PODZOLS, HUMUS IRON PODZOLS; SOME PEAT AND PEATY GLEYS
MAP UNIT 310:	PEATY GLEYS, HUMIC GLEYS; SOME SHALLOW PEAT
MAP UNIT 07:	PEATY PODZOLS, PEAT; SOME PEATY GLEYS AND HUMUS IRON PODZOLS.

For each 1 km x 1 km square in Scotland the area of each component soil series within the map unit was calculated. The dominant soil series for each square was then assigned. If 2 soils were of occurred equally then that with the greater carbon content (generally more peaty) was assigned dominance. In the latest revision all carbon in layers between the junction of the B & C horizons was neglected to match the method adopted by SSLRC for the soils of England and Wales. A lower detection level (0.2 rather than 0.5 g cm^{-3}) was assumed for carbon content under the present review. The bulk density of peats were also reassessed. Values previously used by MLURI of 0.35 g

cm^{-3} (still used for peats in England and Wales) were probably too large. Peat topsoils are more likely to be about 0.2 g cm^{-3}, and even lower for basin and blanket peats. Bulk density for basin and blanket peat have already been modified in this way by Milne & Brown (1995) and incorporated into the database for flux calculations, but the other changes notes above were included for the 1999 GHG Inventory. In Scotland, there is no soil carbon data for urban areas. Previously a value of zero had been assumed for these areas, but here a representative value of 18.6 t ha^{-1} was calculated from data for England and Wales and applied to urban squares in Scotland. (Note that all improvements introduced for a new Inventory are applied retrospectively for estimates for all years from 1990 to the latest year in the new Inventory). Table 2 summarises the improved soil carbon density data for Scotland.

Table 2. Soil carbon in Scotland showing effect of revisions noted in text. ** Revised values determined by relative occurrence of urban squares marked as 'No Data' or 'Not soils' in soil survey database, but assigned carbon value of 18.6 t ha^{-1} here. ** Total soil carbon in Scotland, if depth restricted to 1 m for peats.*

Soil type	Area km^2	Original carbon kt	Revised carbon kt	Carbon above 1m kt
Alluvial soil (undiff)	1,161	27,438	20,382	
Alpine podzol	601	24,786	18,245	
Brown calcareous soil	435	2,309	7,382	
Brown forest soil	10,851	251,248	238,037	
Brown forest soil with gleying	3,628	72,570	57,652	
Brown magnesian soil	19	731	512	
Calcareous gley (GW)	77	505	1,167	
Complex	294	2,019	3,992	
Humus-iron podzol	9,315	359,547	214,156	
Immature raised beach soil	253	3,711	3,917	
Iron podzol	127	3,500	2,198	
Magnesian gley (SW)	91	2,051	1,905	
Noncalcareous gley	1,437	36,352	30,993	
Noncalcareous gley (GW)	10	199	137	
Noncalcareous gley (GW)?	32	516	413	
Noncalcareous gley (SW)	7,456	179,896	151,570	
Noncalcareous regosol	5	41	58	
Peat, basin	612	81,090	81,090	20,575
Peat, blanket	25,641	4,442,038	4,442,038	1,254,699
Peaty gley	4,620	363,846	157,746	
Peaty gley (GW)	13	270	307	
Peaty gley (SW)	2,998	229,961	107,938	
Peaty podzol	8,850	704,306	354,274	
Peaty ranker	656	46,617	18,218	
Podzolic ranker	78	4,560	1,706	
Saline alluvial soil	43	424	629	
Saline gley	90	317	1,665	
Subalpine podzol	2,900	101,584	84,422	
No data *	1,100	-	15,059	
Not soil *	1,408	-	5,032	
Miscellaneous	127	5,800	5,800	
TOTAL	**84,928**	**6,948,232**	**6,028,642**	**** 2,780,788**

Table 2a shows average values of soils carbon density for different land covers in the four devolved areas of the UK. The data of Table 2a shows no strong evidence of a major difference in the soil carbon density of tilled cropland or actively managed grass hence the inclusion of both uses within the Farm category in the flux calculations described below.

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

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

Areas of land changing use are described by matrices from the Monitoring Landscape Change (MLC) data from 1947 & 1980 and the DETR/ITE Countryside Surveys (CS) of 1984 & 1990. 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 3a for MLC and 3b 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 4.

Table 3a: 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 3b: 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 4: Different types of CS land cover included in the "Improved" and "Unimproved" 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	

Table 5: 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

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 with a small adjustment taking into account general trends in farmed areas.. Land use change matrices for the periods 1947 to 1980 and 1984 to 1990 are used. See Table 5 for the sources of information for land use and matrices of change.

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 6. 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 6a: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 6b: 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 6c: 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, from the initial to the final land use, in equilibrium carbon density is required. 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, 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 7 a-c.

Table 7a. 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 7b 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 7c LUC area weighted mean change in equilibrium soil carbon (tC ha^{-1}) for Wales

Initial / Final	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 8). For transitions where carbon is lost e.g. transition from Natural to Farm land, a 'fast' rate is applied whilst a transition which 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. For the 1998 Inventory the rate of uptake was therefore reduced until 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 equivalent to taking 800 years to reach 99% of a new value was used. Here, for the 1999 Inventory, a different approach to taking account of the uncertainty in such rates of transition was

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 8.

Table 8: 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

Table 9: Rates of change of soil carbon for land use change transitions. ("Fast" & "Slow" refer to 99% of change occurring in times shown in Table 7.

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

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 8. 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 after these calculations for each country to remove increases in soil carbon due to afforestation, because 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.

Histograms of the variation in estimated changes in soil carbon are shown in Figure 1.

Figure 1a: Histogram of estimates of annual changes in soil carbon due variation in variation in rate parameter in soil carbon change model for England. Removals are –ve, Emissions are +ve.

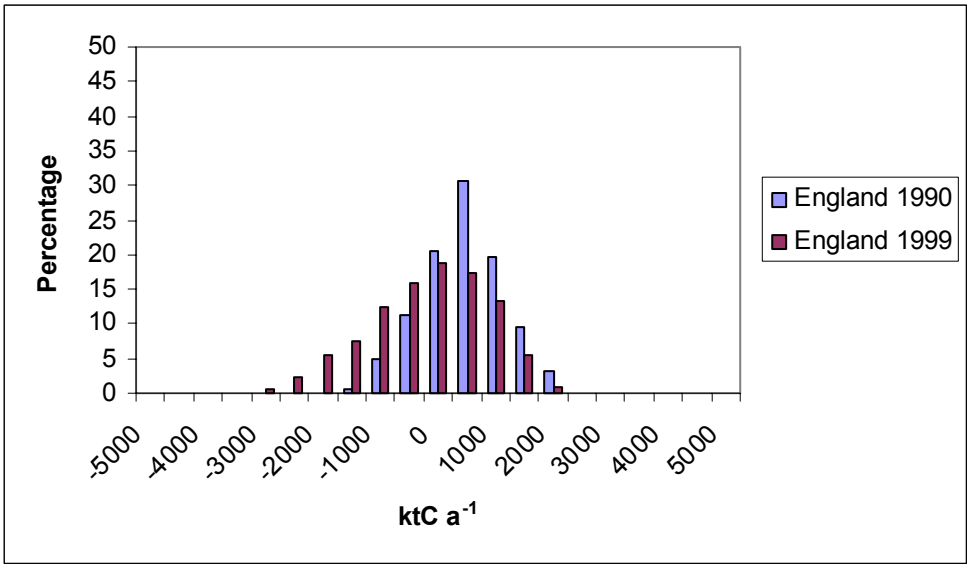


Figure 1b: Histogram of estimates of annual changes in soil carbon due variation in variation in rate parameter in soil carbon change model for Scotland. Removals are –ve, Emissions are +ve.

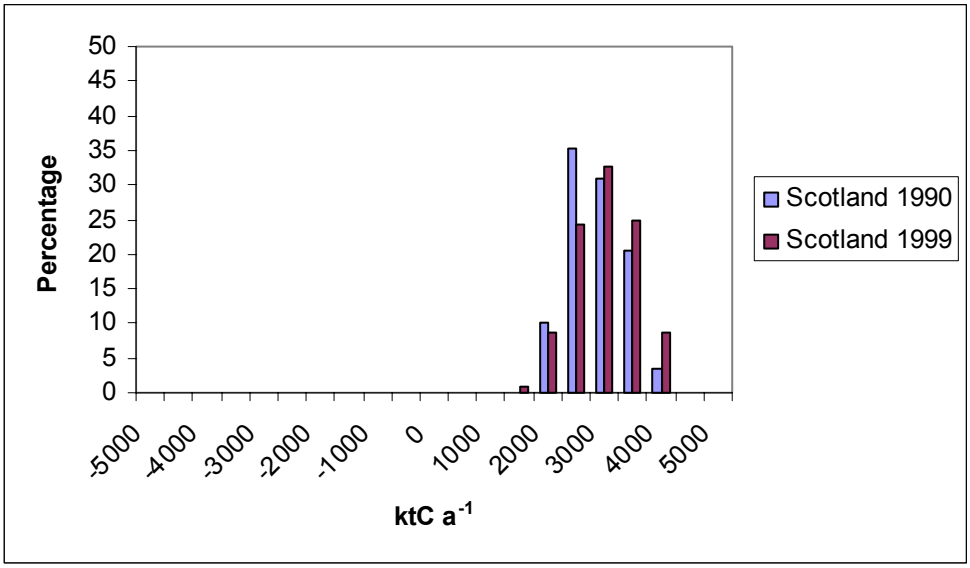
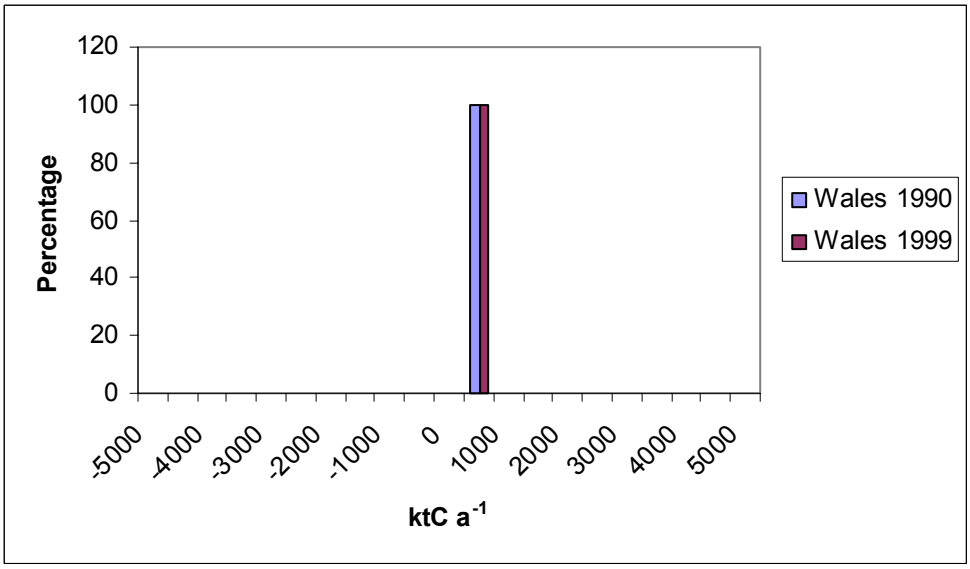


Figure 1c: Histogram of estimates of annual changes in soil carbon due variation in variation in rate parameter in soil carbon change model for Wales. Removals are –ve, Emissions are +ve.



3.1.2 Land use change in Northern Ireland

For this region the default method of the IPCC Guidelines (IPCC 1997) continues to be used. A description of how the results were obtained for the 1998 Inventory was given by Cruickshank & Tomlinson (2000). A summary of the changes in land uses and the resulting changes in stored soil carbon are shown in Table 9.

For the 1999 Inventory the following points are relevant:

- Through the mid to late 1990s, since the introduction of IACS forms, the 'total area farmed' in the Agricultural Census for N Ireland remained constant. However, in

1999, this total showed an increase of 4,500 ha on 1998 (and for 2000 a fall of 8,000 ha over the 1998 figure)

- Consultation with the Statistics Branch revealed that the figure for 'total area farmed' was entirely reliant on the farmers' census returns so that an area of land may be included one year but not in another. Reasons for inclusion/omission vary but include failure to let/rent land - in which case that land would not appear in the total for that farm business. Note also that 1998 and 1999 Census was a sample census, in 2000 it returned to a full census.
- The Forest Service Annual Reports have become less informative now that the Service has become an Agency. Accordingly there is no breakdown of the Forest Estate that enables areas of e.g. semi-natural, peatland etc in the estate to be estimated. In the absence of this information, it has been assumed that the trends of earlier years have continued and areas have been calculated accordingly.
- As urban area is estimated as the residual after all other land uses have been accounted for the urban area in 1999 was found to less than for 1998.This is not sensible but this problem has arisen previously (see Table 1.10 in Cruickshank & Tomlinson, 2000) By ignoring the increase in the 'farmed area' (almost all of which went into grass i.e. in excess of any move from arable to grass) the 'extra' has been removed from the grass total area, which then gives a residual urban area not too different from 1997 and1998.
- We are increasingly aware of the problems associated with this default method – the statistics are really not good enough, and in some respects getting worse.

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

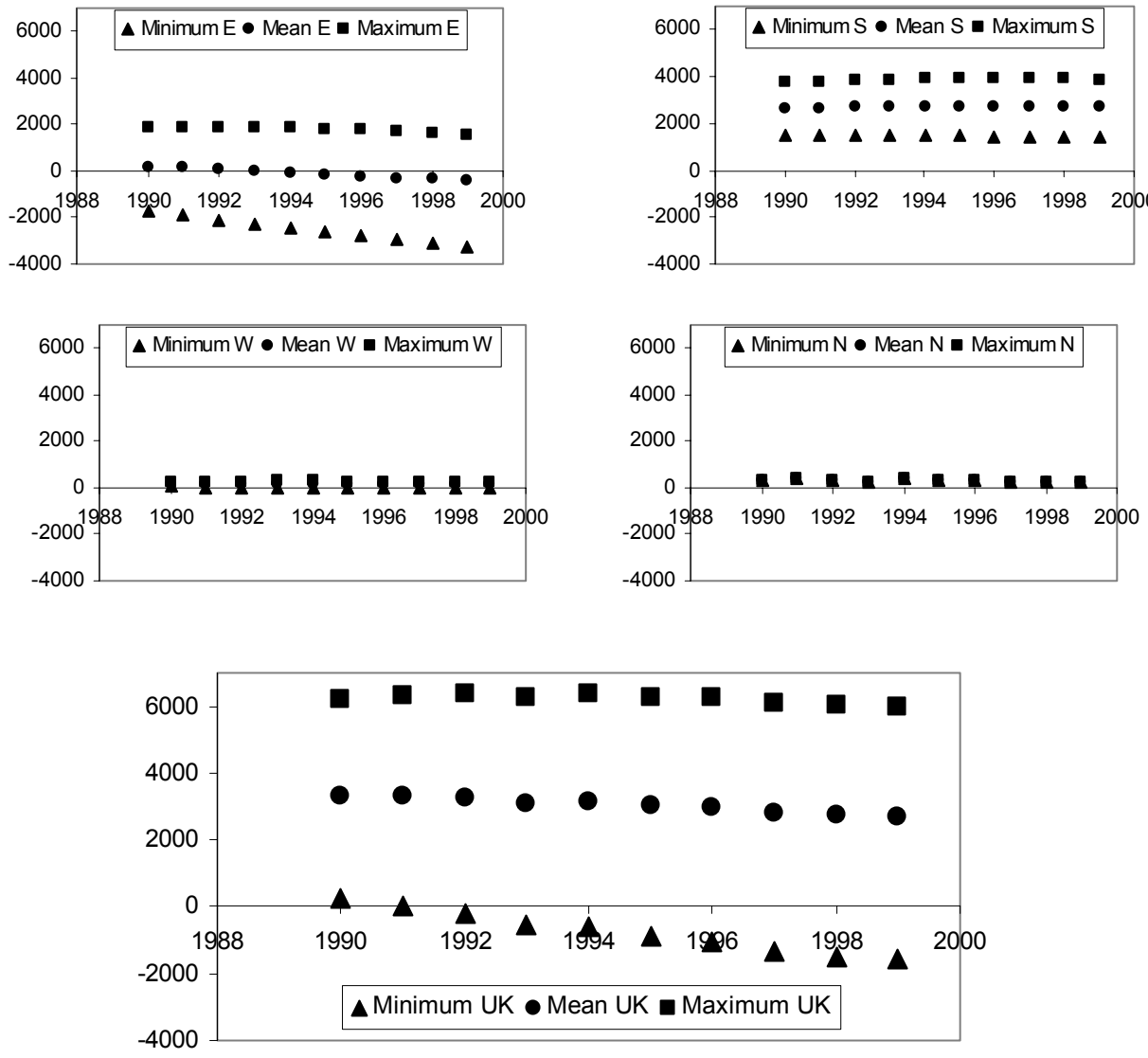
Table 10: Summary of changes in areas of land use and resulting changes in soil carbon in Northern Ireland using the IPCC "default" method.

kha	Arable	Grass	Semi-natural (not peat)	Semi-natural (peat/bog)	Urban	Carbon loss kt/yr
1970	96.9	740.3	249.9	149.0	40.4	
1971	94.4	745.2	248.0	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	777.1	219.0	143.5	50.4	
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	64.0	800.3	202.6	134.9	70.9	-351
1993	63.0	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	191.0	134.9	68.7	-278
1996	56.5	821.0	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	835.2	177.3	134.9	64.7	-262

3.1.3 Changes in soil carbon in the UK

UK time series of changes in soil carbon we calculated by adding the mean, maximum and minimum data from each region together to provide aggregate, mean, maximum and minimum series for the UK. Mean, maximum and minimum values for Northern Ireland were all assumed to be given by the data from the default method. The 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. 2.

Figure 2. 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).



3.2 Set Aside

The estimation of changes in soil carbon calculated by the matrix method 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 areas are recorded in the Annual Farm Census. In this post-1990 period the matrix method 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. Data reported in inventories prior to 1997 were based on the observation from the Annual Farm Census that Set Aside was continuing to increase in total area. However from more recent Census data it would seem that the total area has now passed its maximum and is beginning to fall. This reflects the fact that the Schemes will be phased out, to be replaced with others with different objectives. The data reported here therefore take 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 which 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 the increases in area up to the maximum total recorded area (in 1995 throughout GB). The emission of carbon from these areas are calculated for years up until 1999 when it is assumed that all land will have returned to arable. To compensate for the reducing area, two assumptions were made: a) the area lost in each year from 1995 onwards was 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 which 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

3.3 Emissions of CO_2 from soil due to liming

Emissions of carbon dioxide from the application of limestone, chalk and dolomite to agricultural soils were estimated using the IPCC (1997a, b, c) default method. Data on the use of limestone, chalk and dolomite for agricultural purposes is reported in BGS (2001). It is assumed that all the carbon contained in the lime is released in the year of use. For limestone and chalk, a factor of 120 t C/kt is used, and for dolomite application, 130 t C/kt. These factors are based on the stoichiometry of the reaction and assume pure limestone and dolomite.

4 Other sources and sinks (Table 5E)

These are:

Sources

- Drainage of deep peat
- Drainage of lowland wetlands
- Peat extraction

and sink

- Changes in crop biomass
-

The activity data and carbon fluxes are based on data from (Bradley 1997, Cannell *et al.* 1993, Cruickshank et al. 1997, Hargreaves and Fowler 1997) for sources and from (Adger and Subak 1995) for the sink.

4.1 Changes in Crop Biomass

This value was originally derived by Adger & Subak (1995) using Agricultural Census and other data up to 1992. 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 1999.

4.2 Peat Extraction

Trends in peat extraction in Scotland and England over period 1990 to 1999 are included. In Northern Ireland no new data on use of peat for horticultural use was available and 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 are therefore incorporated as constant from 1990 to 1999. Peat extraction is negligible in Wales.

4.3 Lowland (fen) peat drainage

The trend in emissions due to changing areas of drainage is based on the work of Bradley (1997).

4.4 Upland (forestry) peat drainage

The area of forestry on peat is unlikely to change significantly under present afforestation policies. Emissions from planted areas tend to exist for considerable periods due to the large stock of carbon that is available for decomposition and hence the emissions included under this heading are reported as constant from 1990 to 1999.

Emission factors are summarised in Tables 11 and 12.

Table 11 Summary of Emission Factor Data for Deep Peat Drainage and Lowland Wetland Drainage

	Emission Factor g $C/m^2/y$
Deep Peat Drainage	200
Lowland Wetland Drainage	297

Table 12 Summary of Emission Factor Data 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

5 Summary Tables

The basic data for the each flux relevant to the Land Use Change and Forestry Sector of the UK GHG Inventory for 1999 are presented in Table 13A. 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 "IPCC" 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. The "IPCC" and "CRF" styles of summary are presented for the UK in Table 13B & 13C.
The constituent data for the devolved administrative regions of England, Scotland, Wales and Northern Ireland are presented in Tables 14,15,16 & 17. The UK data in units of Gg of CO_2 as used in the National Report are presented in Table 18.

6 Results

The data for the 1999 Inventory and equivalent values for 1990 to 1998 using the improvements to methods adopted for 1999 can be summarised from Table 18. The same data is also presented in an Appendix in the Common Reporting Format Table 5 Sectoral Report style for each year separately.

6.1 Changes in Forest and Other Woody Biomass Stocks

6.1.1 Temperate Forest

The Removal of atmospheric CO_2 to Woody Biomass Stocks caused by expanding UK forests in 1998 was estimated to be 6827 Gg with an additional sink of 1294 Gg due to an increase in the stock of carbon in undecayed forest products from these forests. These latter continue the downward trend in Removals to Woody Biomass which began in 1995, but wood products are showing a small increase in uptake for 1999. Thus Removals to Woody Biomass increased from 5731 Gg in 1990 to a peak of 7605 Gg in 1995 and had fallen to 6827 Gg by 1998. Removals to products fell from 1573 Gg in 1990 to 913 Gg in 1995 but had recovered to 1294 Gg by 1999. 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 reported with other processes related to changes in soils.

6.2 CO_2 Emissions and Removals from Soil

6.2.1 Cultivation of Soils

Estimates of changes in stored soil carbon continue to indicate large emissions to the atmosphere although the trend continues downwards. The revised data for Scottish soil and the revised method for considering the time constants of change have reduced the

net fluxes by about 50%. For 1999 the Emission of CO_2 is estimated to be 12961 Gg compared to 15617 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 reported elsewhere.

6.2.2 Liming of Agricultural Soils

Emissions due to liming of agricultural soils fell to 859 Gg in 1999 from 1027 Gg in 1998. This reduction continues a downward trend which started in 1997. No information is presently available to explain this trend but it may be related to present poor economic conditions in farming.

6.2.3 Forest Soils

Forest soil carbon stocks were estimated to have increased due to a sink of 2317 Gg for 1999. 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 1998 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.

6.2.4 Set Aside

Uptake of atmospheric carbon by arable areas which have been Set Aside were also revised to take account of the new Scottish soils data. In general, the Set Aside sink strength has fallen from 1995, as fewer new areas now being brought into this type of scheme. Although a small increase is shown for 1999. In 1999 it is estimated that the Removal was 298 Gg having fallen from a peak of 2007 Gg in 1995 when many arable areas were taken out of annual ploughing and sequestered carbon. As more areas are now being re-ploughed as part of rotational management, there is likely to have been a small and possibly increasing, net emission of carbon dioxide which will begin to appear in future GHG Inventories.

6.3 Other

6.3.1 Changes in Crop Biomass

The uptake of carbon due to improvements in the productivity and area of crops is estimated in 1999 to be unchanged from previous years at 1100 Gg.

6.3.2 Peat Extraction

The estimated emission of carbon due to peat extraction shows variation both upwards and downwards over the 10 reported years with the latest year of 1999 showing an emission of 821 Gg compared to the lowest of the 10 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.

6.3.3 Lowland (fen) peat drainage

The downward trend in Emissions from drainage of organic soils in the lowlands (primarily English fens) firstly entered into the Inventory in 1998 continues for 1999. The Emissions are estimated to have fallen from 1650 Gg in 1990 to 1320 Gg in 1999 reflecting fewer new areas of drainage and stabilisation of changes in older drained areas.

6.3.4 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 1999.

6.4 Net UK Emissions/Removals

The Land Use Change and Forestry Sector of the UK is estimated, in 1999, to have continued to be an overall emitter of carbon dioxide, but with a value of 4732 Gg, much reduced due to the revision of the estimates of changes in soil carbon due to land use change and set aside. This net figure is made up from Emissions of 16271 Gg offset by 11539 Gg of Removals. The equivalent values for 1990 were a net emission of 8791 Gg due to 19348 Gg of Emissions offset by 10556 Gg of Removals.

Table 13. United Kingdom data for 1999 UK GHG Inventory: A: component fluxes, B: "IPCC" summary, C: "CRF" summary.

A Gg carbon	Forest biomass	Forest soils & litter	Forest products	Land Use Change	Set Aside	Liming	Upland drainage	Lowland drainage	Peat extraction	Crop biomass
1990	-1563	-587	-429	3869	-48	390	400	450	216	-300
1991	-1587	-592	-430	3858	-72	483	400	440	219	-300
1992	-1724	-566	-368	3785	-96	494	400	430	216	-300
1993	-1872	-543	-305	3609	-127	308	400	420	213	-300
1994	-1935	-544	-299	3665	-517	346	400	410	242	-300
1995	-2074	-521	-249	3494	-547	417	400	400	259	-300
1996	-1983	-569	-315	3503	-421	413	400	390	237	-300
1997	-1965	-584	-303	3359	-275	367	400	380	222	-300
1998	-1905	-612	-327	3302	-37	280	400	370	192	-300
1999	-1862	-632	-353	3300	-81	234	400	360	224	-300

B Gg Carbon	Changes in woody biomass		Soils	Other	Other	NET Emission (+) Removal (-)
1990	-2579		4211	1066	-300	2398
1991	-2609		4269	1059	-300	2419
1992	-2658		4183	1046	-300	2271
1993	-2720		3790	1033	-300	1803
1994	-2778		3494	1052	-300	1468
1995	-2844		3363	1059	-300	1278
1996	-2867		3495	1027	-300	1355
1997	-2852		3451	1002	-300	1302
1998	-2844		3545	962	-300	1362
1999	-2847		3454	984	-300	1291
IPCC Format Tables	5A (Removals)		5D (Emissions)	5E (Emissions)	5E (Removals)	
	Forest biomass, forest soils, forest litter, forest products		*Effect of LUC (Net), Set Aside soils (Removal), liming of soils*	*Drainage of soils, peat extraction*	*Crop biomass*	

C Gg Carbon	Changes in woody biomass	Soils	Soils	Other	Other	NET Emission (+) Removal (-)
1990	-1992	-635	4259	1066	-300	2398
1991	-2017	-664	4341	1059	-300	2419
1992	-2092	-662	4279	1046	-300	2271
1993	-2177	-670	3917	1033	-300	1803
1994	-2234	-1061	4011	1052	-300	1468
1995	-2323	-1068	3911	1059	-300	1278
1996	-2298	-990	3916	1027	-300	1355
1997	-2268	-859	3726	1002	-300	1302
1998	-2232	-649	3582	962	-300	1362
1999	-2215	-713	3535	984	-300	1291
CRF Format Tables	5A (Removals)	5D (Removals)	5D (Emissions)	5E (Emissions)	5E (Removals)	5 Net
	Forest biomass, forest products	*Forest soils, forest litter, Set aside soils (Removal)*	*Effect of LUC(Net), liming of soils*	*Drainage of soils, peat extraction*	*Crop biomass*	

Table 14. England data for 1999 UK GHG Inventory: A: component fluxes, B: "IPCC" summary, C: "CRF" summary.

A Gg carbon	Forest biomass	Forest soils & litter	Forest products	Land Use Change	Set Aside	Liming	Upland drainage	Lowland drainage	Peat extraction	Crop biomass
1990	-174	-250	-202	436	-35	287	40	450	62	-255
1991	-288	-215	-128	344	-52	355	40	440	67	-255
1992	-324	-206	-105	271	-69	362	40	430	60	-255
1993	-364	-198	-82	195	-92	226	40	420	60	-255
1994	-366	-200	-83	125	-404	254	40	410	77	-255
1995	-383	-197	-72	49	-431	306	40	400	88	-255
1996	-361	-206	-80	-15	-331	304	40	390	73	-255
1997	-382	-201	-63	-93	-205	270	40	380	68	-255
1998	-357	-210	-77	-156	-24	206	40	370	52	-255
1999	-323	-221	-96	-217	-57	172	40	360	68	-255

B Gg Carbon	Changes in woody biomass		Soils	Other	Other	NET Emission (+) Removal (-)
1990	-626		688	552	-255	359
1991	-631		647	547	-255	308
1992	-635		565	530	-255	205
1993	-644		330	520	-255	-49
1994	-649		-25	527	-255	-402
1995	-652		-75	528	-255	-454
1996	-647		-42	503	-255	-441
1997	-646		-28	488	-255	-440
1998	-644		26	462	-255	-411
1999	-640		-102	468	-255	-529
IPCC Format Tables	5A (Removals)		5D (Emissions)	5E (Emissions)	5E (Removals)	
	Forest biomass, forest soils, forest litter, forest products		*Effect of LUC (Net), Set Aside soils (Removal), liming of soils*	*Drainage of soils, peat extraction*	*Crop biomass*	

C Gg Carbon	Changes in woody biomass	Soils	Soils	Other	Other	NET Emission (+) Removal (-)
1990	-376	-285	723	552	-255	359
1991	-416	-267	698	547	-255	308
1992	-429	-275	634	530	-255	205
1993	-446	-290	422	520	-255	-49
1994	-449	-604	379	527	-255	-402
1995	-455	-628	355	528	-255	-454
1996	-441	-537	289	503	-255	-441
1997	-445	-406	177	488	-255	-440
1998	-434	-234	50	462	-255	-411
1999	-419	-278	-45	468	-255	-529
CRF Format Tables	5A (Removals)	5D (Removals)	5D (Emissions)	5E (Emissions)	5E (Removals)	5 Net
	Forest biomass, forest products	*Forest soils, forest litter, Set aside soils (Removal)*	*Effect of LUC(Net), liming of soils*	*Drainage of soils, peat extraction*	*Crop biomass*	

Table 15. Scotland data for 1999 UK GHG Inventory: A: component fluxes, B: "IPCC" summary, C: "CRF" summary.

A Gg carbon	Forest biomass	Forest soils & litter	Forest products	Land Use Change	Set Aside	Liming	Upland drainage	Lowland drainage	Peat extraction	Crop biomass
1990	-1070	-242	-170	2858	-13	47	320	0	22	-37
1991	-1060	-257	-195	2907	-20	58	320	0	20	-37
1992	-1132	-251	-173	2927	-27	59	320	0	24	-37
1993	-1214	-244	-149	2940	-33	37	320	0	21	-37
1994	-1287	-239	-135	2949	-109	42	320	0	34	-37
1995	-1385	-226	-111	2946	-112	50	320	0	39	-37
1996	-1346	-257	-155	2984	-86	50	320	0	32	-37
1997	-1305	-280	-166	3011	-66	44	320	0	22	-37
1998	-1287	-296	-168	3029	-11	34	320	0	8	-37
1999	-1299	-302	-166	3034	-22	28	320	0	24	-37

B Gg Carbon	Changes in woody biomass		Soils	Other	Other	NET Emission (+) Removal (-)
1990	-1482		2891	342	-37	1714
1991	-1512		2945	340	-37	1736
1992	-1556		2960	344	-37	1711
1993	-1607		2944	341	-37	1642
1994	-1661		2881	354	-37	1537
1995	-1722		2884	359	-37	1484
1996	-1758		2948	352	-37	1504
1997	-1751		2990	342	-37	1543
1998	-1751		3052	328	-37	1592
1999	-1767		3040	344	-37	1580
IPCC Format Tables	5A (Removals)		5D (Emissions)	5E (Emissions)	5E (Removals)	
	Forest biomass, forest soils, forest litter, forest products		*Effect of LUC (Net), Set Aside soils (Removal), liming of soils*	*Drainage of soils, peat extraction*	*Crop biomass*	

C Gg Carbon	Changes in woody biomass	Soils	Soils	Other	Other	NET Emission (+) Removal (-)
1990	-1240	-255	2905	342	-37	1714
1991	-1255	-277	2965	340	-37	1736
1992	-1305	-278	2987	344	-37	1711
1993	-1363	-277	2977	341	-37	1642
1994	-1422	-348	2991	354	-37	1537
1995	-1496	-338	2996	359	-37	1484
1996	-1501	-343	3034	352	-37	1504
1997	-1471	-346	3056	342	-37	1543
1998	-1455	-307	3063	328	-37	1592
1999	-1465	-324	3062	344	-37	1580
CRF Format Tables	5A (Removals)	5D (Removals)	5D (Emissions)	5E (Emissions)	5E (Removals)	5 Net
	Forest biomass, forest products	*Forest soils, forest litter, Set aside soils (Removal)*	*Effect of LUC(Net), liming of soils*	*Drainage of soils, peat extraction*	*Crop biomass*	

Table 16. Wales data for 1999 UK GHG Inventory: A: component fluxes, B: "IPCC" summary, C: "CRF" summary.

A Gg carbon	Forest biomass	Forest soils & litter	Forest products	Land Use Change	Set Aside	Liming	Upland drainage	Lowland drainage	Peat extraction	Crop biomass
1990	-209	-63	-43	222	0	33	20	0	0	-4
1991	-120	-89	-95	247	0	40	20	0	0	-4
1992	-145	-78	-77	236	0	41	20	0	0	-4
1993	-164	-71	-64	228	-2	26	20	0	0	-4
1994	-169	-69	-61	225	-4	29	20	0	0	-4
1995	-180	-65	-54	220	-4	35	20	0	0	-4
1996	-163	-69	-60	223	-4	34	20	0	0	-4
1997	-168	-65	-52	218	-4	31	20	0	0	-4
1998	-151	-68	-59	220	-3	23	20	0	0	-4
1999	-135	-71	-67	222	-1	20	20	0	0	-4

B Gg Carbon	Changes in woody biomass		Soils	Other	Other	NET Emission (+) Removal (-)
1990	-315		255	20	-4	-44
1991	-304		288	20	-4	0
1992	-300		277	20	-4	-7
1993	-299		251	20	-4	-32
1994	-299		250	20	-4	-33
1995	-299		251	20	-4	-32
1996	-292		254	20	-4	-22
1997	-285		245	20	-4	-24
1998	-278		241	20	-4	-21
1999	-273		240	20	-4	-17
IPCC Format Tables	5A (Removals)		5D (Emissions)	5E (Emissions)	5E (Removals)	
	Forest biomass, forest soils, forest litter, forest products		*Effect of LUC (Net), Set Aside soils (Removal), liming of soils*	*Drainage of soils, peat extraction*	*Crop biomass*	

C Gg Carbon	Changes in woody biomass	Soils	Soils	Other	Other	NET Emission (+) Removal (-)
1990	-252	-63	255	20	-4	-44
1991	-215	-89	288	20	-4	0
1992	-222	-78	277	20	-4	-7
1993	-228	-73	254	20	-4	-32
1994	-230	-73	254	20	-4	-33
1995	-234	-69	255	20	-4	-32
1996	-223	-73	258	20	-4	-22
1997	-220	-69	249	20	-4	-24
1998	-210	-71	243	20	-4	-21
1999	-202	-72	241	20	-4	-17
CRF Format Tables	5A (Removals)	5D (Removals)	5D (Emissions)	5E (Emissions)	5E (Removals)	5 Net
	Forest biomass, forest products	*Forest soils, forest litter, Set aside soils (Removal)*	*Effect of LUC(Net), liming of soils*	*Drainage of soils, peat extraction*	*Crop biomass*	

Table 17. Northern Ireland data for 1999 UK GHG Inventory: A: component fluxes, B: "IPCC" summary , C: "CRF" summary.

A Gg carbon	Forest biomass	Forest soils & litter	Forest products	Land Use Change	Set Aside	Liming	Upland drainage	Lowland drainage	Peat extraction	Crop biomass
1990	-110	-32	-14	353	0	24	20	0	132	-4
1991	-119	-31	-12	360	0	30	20	0	132	-4
1992	-123	-31	-13	351	0	31	20	0	132	-4
1993	-130	-30	-10	245	0	19	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	17	20	0	132	-4
1999	-105	-38	-24	262	0	15	20	0	132	-4

B Gg Carbon	Changes in woody biomass		Soils	Other	Other	NET Emission (+) Removal (-)
1990	-156		377	152	-4	369
1991	-162		390	152	-4	376
1992	-167		382	152	-4	363
1993	-170		264	152	-4	242
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		226	152	-4	203
1999	-167		277	152	-4	258
IPCC Format Tables	5A (Removals)		5D (Emissions)	5E (Emissions)	5E (Removals)	
	Forest biomass, forest soils, forest litter, forest products		*Effect of LUC (Net), Set Aside soils (Removal), liming of soils*	*Drainage of soils, peat extraction*	*Crop biomass*	

C Gg Carbon	Changes in woody biomass	Soils	Soils	Other	Other	NET Emission (+) Removal (-)
1990	-124	-32	377	152	-4	369
1991	-131	-31	390	152	-4	376
1992	-136	-31	382	152	-4	363
1993	-140	-30	264	152	-4	242
1994	-133	-36	388	152	-4	367
1995	-138	-33	304	152	-4	281
1996	-133	-37	336	152	-4	314
1997	-132	-38	245	152	-4	223
1998	-133	-38	226	152	-4	203
1999	-129	-38	277	152	-4	258
CRF Format Tables	5A (Removals)	5D (Removals)	5D (Emissions)	5E (Emissions)	5E (Removals)	5 Net
	Forest biomass, forest products	*Forest soils, forest litter, Set aside soils (Removal)*	*Effect of LUC(Net), liming of soils*	*Drainage of soils, peat extraction*	*Crop biomass*	

Table 18. UK Data for 1999 UK GHG Inventory expressed in units of Gg of CO_2: A: component fluxes, B: "IPCC" summary , C: "CRF" summary .

A Gg Carbon dioxide	Forest biomass	Forest soils & litter	Forest products	Land Use Change	Set Aside	Liming	Upland drainage	Lowland drainage	Peat extraction	Crop biomass
1990	-5731	-2152	-1573	14187	-178	1430	1467	1650	792	-1100
1991	-5819	-2171	-1577	14145	-264	1772	1467	1613	803	-1100
1992	-6321	-2075	-1349	13880	-351	1810	1467	1577	792	-1100
1993	-6864	-1991	-1118	13231	-465	1130	1467	1540	781	-1100
1994	-7095	-1995	-1096	13439	-1897	1270	1467	1503	889	-1100
1995	-7605	-1910	-913	12810	-2007	1529	1467	1467	950	-1100
1996	-7271	-2086	-1155	12843	-1542	1515	1467	1430	869	-1100
1997	-7205	-2141	-1111	12316	-1007	1346	1467	1393	815	-1100
1998	-6985	-2244	-1199	12106	-136	1027	1467	1357	704	-1100
1999	-6827	-2317	-1294	12102	-298	859	1467	1320	821	-1100

B Gg Carbon dioxide	Changes in woody biomass		Soils	Other	Other	NET Emission (+) Removal (-)
1990	-9456		15439	3908	-1100	8791
1991	-9566		15653	3883	-1100	8869
1992	-9746		15338	3835	-1100	8327
1993	-9973		13897	3787	-1100	6610
1994	-10186		12811	3859	-1100	5384
1995	-10428		12332	3883	-1100	4687
1996	-10512		12816	3766	-1100	4969
1997	-10457		12655	3675	-1100	4773
1998	-10428		12997	3527	-1100	4995
1999	-10439		12663	3608	-1100	4732
IPCC Format Tables	5A (Removals)		5D (Emissions)	5E (Emissions)	5E (Removals)	
	Forest biomass, forest soils, forest litter, forest products		*Effect of LUC (Net), Set Aside soils (Removal), liming of soils*	*Drainage of soils, peat extraction*	*Crop biomass*	

C Gg Carbon dioxide	Changes in woody biomass	Soils	Soils	Other	Other	NET Emission (+) Removal (-)
1990	-7304	-2330	15617	3908	-1100	8791
1991	-7396	-2435	15917	3883	-1100	8869
1992	-7671	-2426	15689	3835	-1100	8327
1993	-7982	-2456	14362	3787	-1100	6610
1994	-8191	-3892	14708	3859	-1100	5384
1995	-8518	-3917	14339	3883	-1100	4687
1996	-8426	-3629	14358	3766	-1100	4969
1997	-8316	-3148	13662	3675	-1100	4773
1998	-8184	-2380	13133	3527	-1100	4995
1999	-8122	-2615	12961	3608	-1100	4732
CRF Format Tables	5A (Removals)	5D (Removals)	5D (Emissions)	5E (Emissions)	5E (Removals)	5 Net
	Forest biomass, forest products	*Forest soils, forest litter, Set aside soils (Removal)*	*Effect of LUC(Net), liming of soils*	*Drainage of soils, peat extraction*	*Crop biomass*	

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Appendix

Sectoral Tables for Land Use Change and Forestry Sector submitted as UK 1998 Greenhouse Gas Inventory

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (1999)
(Units are Gg CO2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals
Total Land-Use Change and Forestry	**16,569.10**	**-11,837.09**	**4,732.01**
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)]	**0.00**		
1. Tropical Forests	NO		
2. Temperate Forests	NO		
3. Boreal Forests	NO		
4. Grasslands/Tundra	NO		
5. Other *(please specify)*	0.00		
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**
1. Tropical Forests	NO	NO	0.00
2. Temperate Forests	NO	NE	0.00
3. Boreal Forests	NO	NO	0.00
4. Grasslands/Tundra	NO	NE	0.00
5. Other *(please specify)*	0.00	0.00	0.00
			0.00
D. CO_2 Emissions and Removals from Soil	**12,961.10**	**-2,615.42**	**10,345.68**
Cultivation of Mineral Soils	12,101.78	IE	12,101.78
Cultivation of Organic Soils	IE	IE	0.00
Liming of Agricultural Soils	859.32	NO	859.32
Forest Soils	NO	-2,317.33	-2,317.33
Other *(please specify)*[(3)]	0.00	-298.09	-298.09
Set Aside	0.00	-298.09	-298.09
			0.00
E. Other *(please specify)*	**3,608.00**	**-1,100.00**	**2,508.00**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00
Peat Extraction	821.33	NO	821.33
Lowland Drainage	1,320.00	NO	1,320.00
Upland Drainage	1,466.67	NO	1,466.67
			0.00

[(1)] Following the IPCC Guidelines, the harvested wood should be reported under Changes in Forest and Other Woody Biomass Stocks (Volume 3. Reference Manual, p.5.17).
[(2)] Include only the emissions of CO_2 from Forest and Grassland Conversion. Associated removals should be reported under section D.
[(3)] Include emissions from soils not reported under sections A, B and C.

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (1998)
(Units are Gg CO2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals
Total Land-Use Change and Forestry	**16,740.73**	**-11,921.42**	**4,819.31**
A. Changes in Forest and Other Woody Biomass Stocks	**0.00**	**-8,279.33**	**-8,279.33**
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	-1,294.33	-1,294.33
Harvested Wood [(1)]	NO	-1,199.00	-1,199.00
			0.00
B. Forest and Grassland Conversion [(2)]	**0.00**		
1. Tropical Forests	NO		
2. Temperate Forests	NO		
3. Boreal Forests	NO		
4. Grasslands/Tundra	NO		
5. Other *(please specify)*	0.00		
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**
1. Tropical Forests	NO	NO	0.00
2. Temperate Forests	NO	NE	0.00
3. Boreal Forests	NO	NO	0.00
4. Grasslands/Tundra	NO	NE	0.00
5. Other *(please specify)*	0.00	0.00	0.00
			0.00
D. CO_2 Emissions and Removals from Soil	**13,132.73**	**-2,542.09**	**10,590.64**
Cultivation of Mineral Soils	12,106.06	IE	12,106.06
Cultivation of Organic Soils	IE	IE	0.00
Liming of Agricultural Soils	1,026.67	NO	1,026.67
Forest Soils	NO	-2,244.00	-2,244.00
Other *(please specify)*[(3)]	0.00	-298.09	-298.09
Set Aside	0.00	-136.08	-136.08
			0.00
E. Other *(please specify)*	**3,608.00**	**-1,100.00**	**2,508.00**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00
Peat Extraction	704.00	NO	704.00
Lowland Drainage	1,356.67	NO	1,356.67
Upland Drainage	1,466.67	NO	1,466.67
			0.00

[(1)] Following the IPCC Guidelines, the harvested wood should be reported under Changes in Forest and Other Woody Biomass Stocks (Volume 3. Reference Manual, p.5.17).
[(2)] Include only the emissions of CO_2 from Forest and Grassland Conversion. Associated removals should be reported under section D.
[(3)] Include emissions from soils not reported under sections A, B and C.

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (1997)
(Units are Gg CO2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals
Total Land-Use Change and Forestry	**17,336.95**	**-12,564.03**	**4,772.93**
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)]	**0.00**		
1. Tropical Forests	NO		
2. Temperate Forests	NO		
3. Boreal Forests	NO		
4. Grasslands/Tundra	NO		
5. Other *(please specify)*	0.00		
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**
1. Tropical Forests	NO	NO	0.00
2. Temperate Forests	NO	NE	0.00
3. Boreal Forests	NO	NO	0.00
4. Grasslands/Tundra	NO	NE	0.00
5. Other *(please specify)*	0.00	0.00	0.00
			0.00
D. CO_2 Emissions and Removals from Soil	**13,662.10**	**-3,148.03**	**10,514.07**
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)]	0.00	-1,006.69	-1,006.69
Set Aside	0.00	-1,006.69	-1,006.69
			0.00
E. Other *(please specify)*	**3,674.85**	**-1,100.00**	**2,574.85**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00
Peat Extraction	814.85	NO	814.85
Lowland Drainage	1,393.33	NO	1,393.33
Upland Drainage	1,466.67	NO	1,466.67
			0.00

[(1)] Following the IPCC Guidelines, the harvested wood should be reported under Changes in Forest and Other Woody Biomass Stocks (Volume 3. Reference Manual, p.5.17).
[(2)] Include only the emissions of CO_2 from Forest and Grassland Conversion. Associated removals should be reported under section D.
[(3)] Include emissions from soils not reported under sections A, B and C.

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (1996)
(Units are Gg CO2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals
Total Land-Use Change and Forestry	**18,123.73**	**-13,154.74**	**4,968.99**
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)*	0.00	-1,155.00	-1,155.00
Harvested Wood [(1)]	NO	-1,155.00	-1,155.00
			0.00
B. Forest and Grassland Conversion [(2)]	**0.00**		
1. Tropical Forests	NO		
2. Temperate Forests	NO		
3. Boreal Forests	NO		
4. Grasslands/Tundra	NO		
5. Other *(please specify)*	0.00		
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**
1. Tropical Forests	NO	NO	0.00
2. Temperate Forests	NO	NE	0.00
3. Boreal Forests	NO	NO	0.00
4. Grasslands/Tundra	NO	NE	0.00
5. Other *(please specify)*	0.00	0.00	0.00
			0.00
D. CO_2 Emissions and Removals from Soil	**14,358.09**	**-3,628.74**	**10,729.35**
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)]	0.00	-1,542.40	-1,542.40
Set Aside	0.00	-1,542.40	-1,542.40
			0.00
E. Other *(please specify)*	**3,765.64**	**-1,100.00**	**2,665.64**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00
Peat Extraction	868.98	NO	868.98
Lowland Drainage	1,430.00	NO	1,430.00
Upland Drainage	1,466.67	NO	1,466.67
			0.00

[(1)] Following the IPCC Guidelines, the harvested wood should be reported under Changes in Forest and Other Woody Biomass Stocks (Volume 3. Reference Manual, p.5.17).
[(2)] Include only the emissions of CO_2 from Forest and Grassland Conversion. Associated removals should be reported under section D.
[(3)] Include emissions from soils not reported under sections A, B and C.

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (1995)
(Units are Gg CO2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals
Total Land-Use Change and Forestry	**18,222.25**	**-13,534.88**	**4,687.38**
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)]	**0.00**		
1. Tropical Forests	NO		
2. Temperate Forests	NO		
3. Boreal Forests	NO		
4. Grasslands/Tundra	NO		
5. Other *(please specify)*	0.00		
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**
1. Tropical Forests	NO	NO	0.00
2. Temperate Forests	NO	NE	0.00
3. Boreal Forests	NO	NO	0.00
4. Grasslands/Tundra	NO	NE	0.00
5. Other *(please specify)*	0.00	0.00	0.00
			0.00
D. CO_2 Emissions and Removals from Soil	**14,339.07**	**-3,917.21**	**10,421.86**
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)]	0.00	-2,006.88	-2,006.88
Set Aside	0.00	-2,006.88	-2,006.88
			0.00
E. Other *(please specify)*	**3,883.19**	**-1,100.00**	**2,783.19**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00
Peat Extraction	949.85	NO	949.85
Lowland Drainage	1,466.67	NO	1,466.67
Upland Drainage	1,466.67	NO	1,466.67
			0.00

[(1)] Following the IPCC Guidelines, the harvested wood should be reported under Changes in Forest and Other Woody Biomass Stocks (Volume 3. Reference Manual, p.5.17).
[(2)] Include only the emissions of CO_2 from Forest and Grassland Conversion. Associated removals should be reported under section D.
[(3)] Include emissions from soils not reported under sections A, B and C.

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (1994)
(Units are Gg CO2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals
Total Land-Use Change and Forestry	**18,567.15**	**-13,183.02**	**5,384.13**
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)]	**0.00**		
1. Tropical Forests	NO		
2. Temperate Forests	NO		
3. Boreal Forests	NO		
4. Grasslands/Tundra	NO		
5. Other *(please specify)*	0.00		
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**
1. Tropical Forests	NO	NO	0.00
2. Temperate Forests	NO	NE	0.00
3. Boreal Forests	NO	NO	0.00
4. Grasslands/Tundra	NO	NE	0.00
5. Other *(please specify)*	0.00	0.00	0.00
			0.00
D. CO_2 Emissions and Removals from Soil	**14,708.37**	**-3,891.69**	**10,816.68**
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)]	0.00	-1,897.02	-1,897.02
Set Aside	0.00	-1,897.02	-1,897.02
			0.00
E. Other *(please specify)*	**3,858.79**	**-1,100.00**	**2,758.79**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00
Peat Extraction	888.79	NO	888.79
Lowland Drainage	1,503.33	NO	1,503.33
Upland Drainage	1,466.67	NO	1,466.67
			0.00

[(1)] Following the IPCC Guidelines, the harvested wood should be reported under Changes in Forest and Other Woody Biomass Stocks (Volume 3. Reference Manual, p.5.17).
[(2)] Include only the emissions of CO_2 from Forest and Grassland Conversion. Associated removals should be reported under section D.
[(3)] Include emissions from soils not reported under sections A, B and C.

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (1993)
(Units are Gg CO2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals
Total Land-Use Change and Forestry	**18,148.98**	**-11,538.58**	**6,610.40**
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]	**0.00**		
1. Tropical Forests	NO		
2. Temperate Forests	NO		
3. Boreal Forests	NO		
4. Grasslands/Tundra	NO		
5. Other *(please specify)*	0.00		
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**
1. Tropical Forests	NO	NO	0.00
2. Temperate Forests	NO	NE	0.00
3. Boreal Forests	NO	NO	0.00
4. Grasslands/Tundra	NO	NE	0.00
5. Other *(please specify)*	0.00	0.00	0.00
			0.00
D. CO_2 Emissions and Removals from Soil	**14,361.77**	**-2,456.25**	**11,905.53**
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]	0.00	-465.25	-465.25
Set Aside	0.00	-465.25	-465.25
			0.00
E. Other *(please specify)*	**3,787.21**	**-1,100.00**	**2,687.21**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00
Peat Extraction	780.54	NO	780.54
Lowland Drainage	1,540.00	NO	1,540.00
Upland Drainage	1,466.67	NO	1,466.67
			0.00

[1] Following the IPCC Guidelines, the harvested wood should be reported under Changes in Forest and Other Woody Biomass Stocks (Volume 3. Reference Manual, p.5.17).
[2] Include only the emissions of CO_2 from Forest and Grassland Conversion. Associated removals should be reported under section D.
[3] Include emissions from soils not reported under sections A, B and C.

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (1992)
(Units are Gg CO2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals
Total Land-Use Change and Forestry	**19,524.35**	**-11,197.14**	**8,327.21**
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)]	**0.00**		
1. Tropical Forests	NO		
2. Temperate Forests	NO		
3. Boreal Forests	NO		
4. Grasslands/Tundra	NO		
5. Other *(please specify)*	0.00		
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**
1. Tropical Forests	NO	NO	0.00
2. Temperate Forests	NO	NE	0.00
3. Boreal Forests	NO	NO	0.00
4. Grasslands/Tundra	NO	NE	0.00
5. Other *(please specify)*	0.00	0.00	0.00
			0.00
D. CO_2 Emissions and Removals from Soil	**15,689.45**	**-2,426.47**	**13,262.97**
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)]	0.00	-351.14	-351.14
Set Aside	0.00	-351.14	-351.14
			0.00
E. Other *(please specify)*	**3,834.90**	**-1,100.00**	**2,734.90**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00
Peat Extraction	791.57	NO	791.57
Lowland Drainage	1,576.67	NO	1,576.67
Upland Drainage	1,466.67	NO	1,466.67
			0.00

[(1)] Following the IPCC Guidelines, the harvested wood should be reported under Changes in Forest and Other Woody Biomass Stocks (Volume 3. Reference Manual, p.5.17).
[(2)] Include only the emissions of CO_2 from Forest and Grassland Conversion. Associated removals should be reported under section D.
[(3)] Include emissions from soils not reported under sections A, B and C.

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (1991)
(Units are Gg CO2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals
Total Land-Use Change and Forestry	**19,799.13**	**-10,930.20**	**8,868.93**
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)]	**0.00**		
1. Tropical Forests	NO		
2. Temperate Forests	NO		
3. Boreal Forests	NO		
4. Grasslands/Tundra	NO		
5. Other *(please specify)*	0.00		
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**
1. Tropical Forests	NO	NO	0.00
2. Temperate Forests	NO	NE	0.00
3. Boreal Forests	NO	NO	0.00
4. Grasslands/Tundra	NO	NE	0.00
5. Other *(please specify)*	0.00	0.00	0.00
			0.00
D. CO_2 Emissions and Removals from Soil	**15,916.53**	**-2,434.53**	**13,482.00**
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)]	0.00	-263.86	-263.86
Set Aside	0.00	-263.86	-263.86
			0.00
E. Other *(please specify)*	**3,882.60**	**-1,100.00**	**2,782.60**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00
Peat Extraction	802.60	NO	802.60
Lowland Drainage	1,613.33	NO	1,613.33
Upland Drainage	1,466.67	NO	1,466.67
			0.00

[(1)] Following the IPCC Guidelines, the harvested wood should be reported under Changes in Forest and Other Woody Biomass Stocks (Volume 3. Reference Manual, p.5.17).
[(2)] Include only the emissions of CO_2 from Forest and Grassland Conversion. Associated removals should be reported under section D.
[(3)] Include emissions from soils not reported under sections A, B and C.

TABLE 5 SECTORAL REPORT FOR LAND-USE CHANGE AND FORESTRY (1990)
(Units are Gg CO2, NO = Not Occurring, NE = Not Established and IE = Included Elsewhere)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals
Total Land-Use Change and Forestry	**19,525.29**	**-10,734.08**	**8,791.21**
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)]	**0.00**		
1. Tropical Forests	NO		
2. Temperate Forests	NO		
3. Boreal Forests	NO		
4. Grasslands/Tundra	NO		
5. Other *(please specify)*	0.00		
C. Abandonment of Managed Lands	**0.00**	**0.00**	**0.00**
1. Tropical Forests	NO	NO	0.00
2. Temperate Forests	NO	NE	0.00
3. Boreal Forests	NO	NO	0.00
4. Grasslands/Tundra	NO	NE	0.00
5. Other *(please specify)*	0.00	0.00	0.00
			0.00
D. CO_2 Emissions and Removals from Soil	**15,617.05**	**-2,330.08**	**13,286.97**
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)]	0.00	-177.75	-177.75
Set Aside	0.00	-177.75	-177.75
			0.00
E. Other *(please specify)*	**3,908.24**	**-1,100.00**	**2,808.24**
Changes in Crop Biomass	NO	-1,100.00	-1,100.00
Peat Extraction	791.57	NO	791.57
Lowland Drainage	1,650.00	NO	1,650.00
Upland Drainage	1,466.67	NO	1,466.67
			0.00

[(1)] Following the IPCC Guidelines, the harvested wood should be reported under Changes in Forest and Other Woody Biomass Stocks (Volume 3. Reference Manual, p.5.17).
[(2)] Include only the emissions of CO_2 from Forest and Grassland Conversion. Associated removals should be reported under section D.
[(3)] Include emissions from soils not reported under sections A, B and C.