Section 1

Key Activities and Results for 2004 – 2005

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Land Use Change and Forestry: The 2003 UK Greenhouse Gas Inventory and projections to 2020

- Treatment of losses from soils with conifer afforestation revised. Overall losses have been significantly reduced.
- Soil carbon densities from UK database fully revised. Equilibrium changes in soil carbon due to land use change tend be less when calculated from the revised database.
- Changes to soil carbon stocks with land use change restricted to those occurring in top 1m of soil.
- The Removal of atmospheric CO_2 to Woody Biomass Stocks caused by UK forests in 2003 expansion was estimated to be 9808 Gg CO_2 but there was a source of 248 Gg due to a decrease in the stock of carbon in undecayed forest products from these forests. Removals to Woody Biomass have been varying around 7000 Gg since 1996 but appear now to be on an upward trend. Removals to wood products had been increasing since that date but have now fallen considerably. Removals to Woody Biomass increased from 6014 Gg CO_2 in 1990 to a peak of 7561 Gg CO_2 in 1994, fell to 7137 by 1996 but have now reached a new peak. Removals to products fell from 1587 Gg CO_2 in 1990 to 942 Gg CO_2 in 1994 and were varying around 1200 Gg CO_2 from 1996 to 2000 before the fall to the present source of 248 Gg CO_2.
- Forest soil carbon stocks are now estimated to have increased due to a sink of 5610 Gg CO_2 for 2003. Removals of atmospheric carbon dioxide to the soils of new forests have not varied much over the period 1990 to 2003 but show a peak of 6633 Gg in 1998 followed by a slow downward trend.
- Variation in emissions of greenhouse gases due to deforestation in Great Britain are now included in inventory reports. Emissions are small with a low of 107 Gg CO_2 in 1992 and a high of 297 Gg CO_2 in 1999.
- 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 2003 the Emission of CO_2 is estimated to be 11565 Gg compared to 13522 Gg in 1990.
- The picture of net emissions in the UK from the Land Use Change and Forestry Sector of the UK has changed significantly due to the data revisions introduced this year. For 1990 the UK remains a net emitter but the value of the emission is now estimated to be 2645 Gg CO_2 made up of 17558 Gg emissions offset by 14913 Gg of removals.
- With the revised data Scotland is shown to be a net remover of atmospheric CO_2 in 1990 because of the combination of enhanced estimates for net removals to the soil of the extensive conifer forest and reduced estimates for losses from the soils of other land.
- England and N. Ireland are estimated to be net emitters in 1990 and Wales a net remover.
- The net CO_2 flux for the UK followed a downward trend, reaching zero between 1997 and 1998 continuing to a net removal of 1536 Gg in 2003. This downward trend is similar but a little less steep than reported in previous inventories
- Data is resented to show emissions and removals for LULUCF in the UK in the reporting format defined by the IPCC Good Practice Guidance for LULUCF

- Projections of Removals and Emissions for the Land Use Change and Forestry Sector up to the year 2020 are presented.
- Estimates of removals and emissions of CO_2 by post-1990 afforestation and deforestation relevant to Article 3.3 of the Kyoto Protocol are presented.
- Estimates of the trend in emissions of CO_2 by Cropland Management and Grassland Management relevant to Article 3.4 of the Kyoto Protocol are presented.

The influence of land use change from and to forestry on the emissions of nitrous oxide and methane

- Data collated on areas of land use change and forestry in UK that may cause emissions of nitrous oxide and methane
- Methods describe in IPCC Good Practice Guidance on LULUCF evaluated and applied to UK
- Results indicate emissions due to these activities are very small in the UK.

Carbon Stock Changes due to Harvested Wood Products: UK

- The EXPHWP spreadsheet model will be useful in calculating carbon flows due to harvested wood products (HWP) in the UK.
- The model provides three methods of calculating carbon flows due to HWP: the Stock-Change Approach, the Atmospheric-Flow Approach and the Production Approach.
- The model uses forestry data from FAOSTAT that is of high quality and regularly updated
- Estimates of the domestic component in HWP production in the Production Approach can be improved
- Results from the EXPHWP model are comparable with those previously produced by CEH using the C-Flow model

Mapping of carbon emissions and removals in the UK due to changes in stocks of soil carbon

- Land use change matrices for each 20km by 20km grid-cell in Great Britain estimated
- Method of modeling changes in soil carbon stocks used at national scales applied to each 20km by 20 km grid-cell in UK
- Good agreement between grid-cell scale totals and national values.

Survey Methods for Kyoto Protocol Monitoring and Verification of UK Forest Carbon Stocks

- This report details progress that has been made in the development of inventory-based methods for Kyoto Protocol monitoring of forestry based LULUCF activities.

- There is a description of the development of the carbon stock assessment protocol, which will use the updated National Inventory of Woodland and Trees (planned for 2006-2015), including all woods greater than 0.5 ha in area.
- The BSORT model has been applied for carbon stock and stock change assessment, producing estimates for a pilot study area in agreement with national estimates.
- The verification process is described, including an analysis of uncertainty associated with the quantification and use of biomass expansion factors/functions.

Estimating Biogenic Carbon Fluxes from Flux tower measurements and Earth Observation data

- The models used by CTCD to estimate carbon fluxes have been extended to improve the modelling of catchment hydrology.
- A coherence earth observation product from radar-based satellites has been used to produce estimates of the age structure and NEP of all UK forests, with significant differences from inventory-based estimates.
- Improvements have been made in model data assimilation and in the assessment of uncertainties associated with land cover parameterisation and soil carbon stocks.
- Net Ecosystem Productivity and associated uncertainties have been estimated for England and Wales using a dynamic global vegetation model: this will be extended to Scotland in 2005/2006.

Use of Rothamsted Carbon model, RothC, in deriving the UK Carbon inventory

- Investigation has begun of functional forms to describe output from the RothC model that predict in soil carbon stocks due to land use change
- Four functional forms compared to RothC output for Pasture to Arable, Pasture to Semi-natural, Pasture to Forest and Arable to Forest land use transitions.
- An 8 parameter function with 3 exponentials was found to provide a good fit to the all the outputs

RothC-BIOTA v05 plant-soil C turnover model – parameterization and evaluation

- New equilibrium link between RothC and plant growth module.
- Spatial/non spatial functionality of the new coupled model tested.
- Collation of crop parameters.
- Sensitivity tests for spring barley at Hoosfield.
- Improved results of the coupled model in comparison with RothC (Hoosfield).
- Simulation of winter wheat – evaluation continued.

Field Measurements of Soil Carbon Loss following Ploughing

- Eddy covariance measurements of CO_2 flux over ploughed and unploughed fields at Poldean Farm, begun in March 2002, were ended in April 2004. Data analysis is now complete.
- Soil cores taken in November 2003 have now been analysed to give a direct measurement of the change in soil carbon stocks following ploughing.
- The show a highly significant decrease in soil carbon after ploughing ($p < 0.001$). The magnitude of this decrease is 1.15 kg C m^{-2} or 39 % of the initial value (or 0.80 kg C m^{-2} y^{-1} or 27 % y^{-1}, counting 528 days between the date of ploughing and the final soil sampling).
- The direct measurement of soil carbon stock change gives a somewhat higher estimate than the eddy covariance flux measurements (by 0.29 kg C m^{-2} y^{-1}). This is probably caused by the eddy covariance measurements failing to account for fluxes at very high and very low frequencies, and thereby underestimating the flux.

Carbon Balance of Peatlands at Moor House

- Eddy covariance instrumentation was installed at Moor House in the North Penines between 17-25 June 2004.
- The site is an area of extensive blanket peatland and upland grasslands, owned by English Nature. Research at this site dates back to the 1930s, and there is a large body of data from historical and ongoing research.
- The first year's data is presented, which shows characteristic responses of CO2 fluxes to light and temperature.
- The annual land-atmosphere carbon balance is estimated from the measurements, using a simple gap-filling model where observations are unavailable. This gives an annual net flux to be a small source of carbon, of 19 g C m-2.
- These results are provisional because of currently unavailable weather data, and particularly poor data coverage during the first four months of 2005 because of a run of instrument failures and lack of site access because of snow. All data will be re-processed offline over the next year.