Section 1

Key Activities and Results for 2005 – 2006

1. Key activities and results for 2005 – 2006

Land Use Change and Forestry: The 2004 UK Greenhouse Gas Inventory and projections to 2020

- The Categories of the IPCC Good Practice Guidance for LULUCF will from now be the basis for all reporting in the UK Greenhouse Gas Inventory. Net fluxes within Categories are used without identification of the constituent emissions and removals.
- The flux of GHGs in the UK from the Land Use Change and Forestry Sector for 1990 is shown to have been a net emission of 2,915 Gg CO_2. The level of emission fell to zero in 1998 and has become a removal more recently, equal to -1,942 Gg CO_2 in 2004.
- Within the Forest Land Category revisions to the methodology for estimating changes in stock of carbon have been implemented. The major change was to take account for some locations of conifer planting of shorter rotation periods from the 1920s to the 1950s compared to the standard.
- The methodology for assessing changes in stocks of non-forest biomass has been replaced with an approach similar to that used for changes in stocks of carbon in non-forest soils.
- Emissions of CO_2 due to the use of peat as a fuel have been removed from the Land Use Change and Forestry Sector and are now reported in the Energy Sector.
- In the Forest Land Category there was a net removal of -12,203 GgCO_2 in 1990. This increased to -16,302 Gg CO_2 in 2004. Removals to forest products are reported separately to other changes in stocks of carbon in forest carbon and fell from -1456 Gg CO_2 in 1990 to -633 Gg CO_2 in 1994. Net fluxes due to changes in stocks of wood products varied around -1100 Gg CO_2 from 1996 to 2000 before a change to a source of 619 Gg CO_2 in 2004..
- Scotland is shown to have been a net remover of -2,535 GgCO_2 in 1990 changing to -4,617 Gg CO_2 by 2004.
- Wales was a net remover of -241 Gg CO_2 in 1990 changing to -69 Gg CO_2 in 1994 returning to -249 Gg CO_2 in 2004.
- England is shown to have been a net emitter of 5,736 Gg CO_2 in 1990, falling steadily to 3,231 Gg CO_2 in 2004.
- N. Ireland was a net remover in 1990 at -45 Gg CO_2 steadily changing to -307 Gg CO_2 in 2004.
- Projections of net fluxes for the Land Use Change and Forestry Sector up to the year 2020 are presented for England, Scotland, Wales and Northern Ireland.
- The projections for the Land Use Change and Forestry Sector indicate that a peak for removals has now been reached in the UK and the net flux will be of increasing emissions over the next 15 years.
- Estimates of removals and emissions of CO_2 by post-1990 afforestation and deforestation in the UK relevant to Article 3.3 of the Kyoto Protocol are presented.
- Estimates of the trend in emissions of CO_2 by Forest Management relevant to Article 3.4 of the Kyoto Protocol are presented.

Variations in Forest Management

- Information from the National Inventory of Woodlands and Trees (NIWT) and historical woodland censuses was compared with the national planting series (afforestation since 1921) used in the C-Flow forest carbon accumulation model at the national level (England, Scotland and Wales).
- Normal harvesting practices and management of woodland established before 1921 accounted for most of the difference between the national planting series and the rate of woodland establishment inferred from the NIWT for conifer forest in Great Britain.
- Processes of change affecting forest established before 1921 (normal management, conversion of coppice, mixed and scrub woodland, natural regeneration) accounted for the differences between the national planting series and the NIWT establishment rate for broadleaf woodland in Great Britain.
- The standard management scenario in C-Flow was adjusted to take account of shorter rotations (inferred from the analysis) in conifer woodland in England and Wales (1921-1950). This adjustment did not have a large impact on the estimated carbon flux from forests (0.05 Mt C in 2004) but represents a first step in the better representation of variability in forest characteristics in C-Flow.

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

- The report provides an overview of the position reached in development of a methodology for a national forest carbon inventory for monitoring, validating and reporting of forestry based LULUCF activities.
- The assessment protocol has evolved from that initially proposed in 2003. The revised system has seven modules: mapping of forest areas, stand-level sample assessments, statistical relationships and models, field verification of models, model-based upscaling of carbon stock estimates, statistically based verification of upscaled carbon stock estimates and reporting.
- The system aims to use the GIS-based National Inventory of Woodlands and Trees (NIWT), the specification of which is currently being updated. NIWT data will be used as the basis for selection of forest carbon field assessment sites, and as the basis for deriving upscaled district/national/regional estimates of forest carbon stocks.
- Field assessments will consist of measurements of standing trees and soil carbon, for which draft protocols have been developed.
- The BSORT model will be applied, in conjunction with the recently developed M1 algorithmic yield model, to estimate and forecast standing carbon stocks in a diversity of forest stand types.
- A protocol for the verification of the model-based results has been developed.

Estimating Biogenic Carbon Fluxes over the UK

- Three models are available in the Centre for the estimation of carbon fluxes to terrestrial ecosystems from knowledge of land cover.
- Past management and age-of-forests strongly influences carbon flux. Age-of-forest may be estimated using radar remote sensing.

- Eddy covariance flux data are becoming available for a representative set of land cover in Eurioe, and in the UK there are examples from coniferous and broadleaved forests, grassland, moorland and agriculture.
- There is one operational tall tower in the UK, in Fife, Scotland. Tall towers are designed to measure trace gas fluxes from all sources (anthropogenic and biogenic). This is operated by Edinburgh University with European funding. Another tower, situated in mid-England, would be needed for total coverage of the UK.
- From the Sheffield Dynamic Vegetation Model (DGVM) we estimate that the land cover of England and Wales is a biotic carbon sink of strength 7.61 ± 0.61 Mt C/year.

The potential use of the Rothamsted Carbon model, RothC, in GHG inventories

- Methods to incorporate RothC into the UK soils carbon inventory were compared: (1) meta-models (extensions of the current coefficient method) and (2) call RothC directly from the spreadsheet
- Surprisingly, parameters for the meta–models derived from RothC were very variable making this route a poor prospect for the inventory
- RothC has been modified to run from a call within Microsoft® Excel©. If adopted, this route would future-proof the inventory since upgrades to RothC and add-ins such as vegetation modelling would be quickly and simply available. It also presents the smoothest and most straightforward means to move the inventory gradually towards RothCUK, the GIS version
- Some data both for RothC and RothCUK are commercially sensitive. Means to access this data without breaking confidentiality are suggested

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

- RothC-BIOTA model has been developed as a coupled link between GIS-RothCv03, a model of soil C dynamics, and BIOTA, a process-based model of plant C dynamics.
- Recent model developments include the incorporation of crop rotation (with an extended range of arable crop plant functional types for the UK), the impact of nitrogen fertilization (from mineral and organic fertilizer and atmospheric N deposition) on yields, and alternative methods of estimating SOC equilibrium (using model fitting or dynamic modelling).
- Parameterization of crop yields has been undertaken: there is good simulation of cereal and oilseed rape yields but under-estimation of root crop yields
- RothC-BIOTA was evaluated at two sites, one at Rothamsted, and one in Germany. There was over-prediction of SOC at equilibrium, which is thought to be related to the N limitation effect on yields. This is an issue when previous land-use history at a site is unknown.
- Overall, RothC-BIOTA is able to accurately simulate SOC dynamics, but some adjustments in the modelling methods are required.

A plot-scale experiment to detect the effect of cultivation on soil organic carbon

- A plot-scale experiment to detect the effect of cultivation on soil organic carbon content was established on House O' Muir Farm near CEH Edinburgh.
- A Latin Square design of 81 experimental plots was laid out, with three treatments: an uncultivated control, a single cultivation, and bi-annual cultivation. The first cultivation treatment was applied in November 2005.
- Measurements of soil carbon content and soil respiration were made prior to the treatment being applied. The results show that there are no clear differences between the treatment and control plots at the start of the experiment.
- Measurements of nitrous oxide (N_2O) and methane (CH_4) flux are in progress at the time of writing (April 2006). These will allow us to calculate the effect of cultivation on the total greenhouse warming potential (GWP).

Incorporating effects of changes in climate, nitrogen deposition and CO_2 in projections of forest carbon budgets

- A process based model of forest growth (BASFOR) using an intermediate number of parameters has been developed
- Forest growth data from 2 locations in the UK has been obtained from Forest Research for calibration purposes.
- Sequential data assimilation & uncertainty quantification by Bayesian calibration of BASFOR has been shown to work well.
- BASFOR used to attribute changes in growth over 1920 to 2000 to different environmental drivers , with quantified uncertainty
- Tree data for calibration and environmental data of model drivers still limited. Key issue: soil nitrogen
- Environmental factor analysis for Dodd Wood showed importance of elevated CO_2, but may be artefact of soil data used.
- Planned use of calibrated BASFOR to calculate yield table modifiers for use by C-FLOW (effects of CO2, climate change and N-deposition), with measures of uncertainty