CLIMIT

CARBWARE

Development of tools and systems for reporting on forest carbon stocks and stock change under the Kyoto protocol and the UNFCCC

PROJECT TEAM
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December 2011

OBJECTIVES
The overall objective is to develop national forest carbon reporting systems, based on the agreed UNFCCC Common Reporting Formats *Land Use, Land Use Change and Forestry* (LULUCF) and the Intergovernmental Panel on *Climate Change Good Practice Guidance for Land Use, Land Use Change and Forestry*.

Specific targets are:
- Analysis of NFI and IFORIS (forest premiums) data to extract information in a format compatible with CARBWARE.
- Refinement and redevelopment of CARBWARE to include species and yield class (YC) specific or cohort biomass models and verifiable emission factors associated with management and site preparation.
- Sensitivity analyses to select a GPG-LULUCF compliant reporting procedure with low uncertainty and error. This procedure will also enable comparison of different tiers and selection of the best reporting approach.
- The creation of an input database to enable QA/QC and formatting for calculation routines in CARBWARE computations.
- Development of a Windows-based CARBWARE interface compatible with UNFCCC Common Reporting Formats for LULUCF activities, to include afforestation and harvest scenarios and uncertainty analysis.
- Incorporation of a Harvested Wood Product (HWP) C-store reporting procedure in CARBWARE.
- Independent peer review of forest sink reporting mechanisms.
- Issuance of a LULUCF reporting manual, compliant with IPCC GPG, for Irish forests.
- Implications of climate change scenarios on potential sequestration by Irish forests using an ESC yield-based model.

PROGRESS
Reporting LULUCF to the UNFCCC
CARBWARE submits national forest sink data to the EPA for the annual national inventory report to the UNFCCC. Significant modifications were made to the CARBWARE system to include forest fire in national reports as specified in IPCC GPG. A forest fire database was compiled from Coillte and Forest Service data sources. Emissions from fires and the indirect effect on biomass and litter C pools resulted in a small reduction in the CO_2eq sink over the period 1990 to 2006. The mean emission and stock change due to fire amounted to a reduction of -13 G g CO_2eq or 1.5% per year (Figure 1).

Refinements to Kyoto reporting
Work is underway on the refinement of growth models. This work was included in the Irish submission on the draft Kyoto reporting tables, together with a manual, in April 2007.

The extent to which new forest sequesters CO_2 over the Kyoto commitment period (2008-2012) and beyond will depend on the annual afforestation rate, species planted, harvest level and soil type. Assumptions regarding afforestation rate, soil/species breakdown and harvest levels are inherently uncertain. However, estimates will be refined as new information becomes available and models are improved.
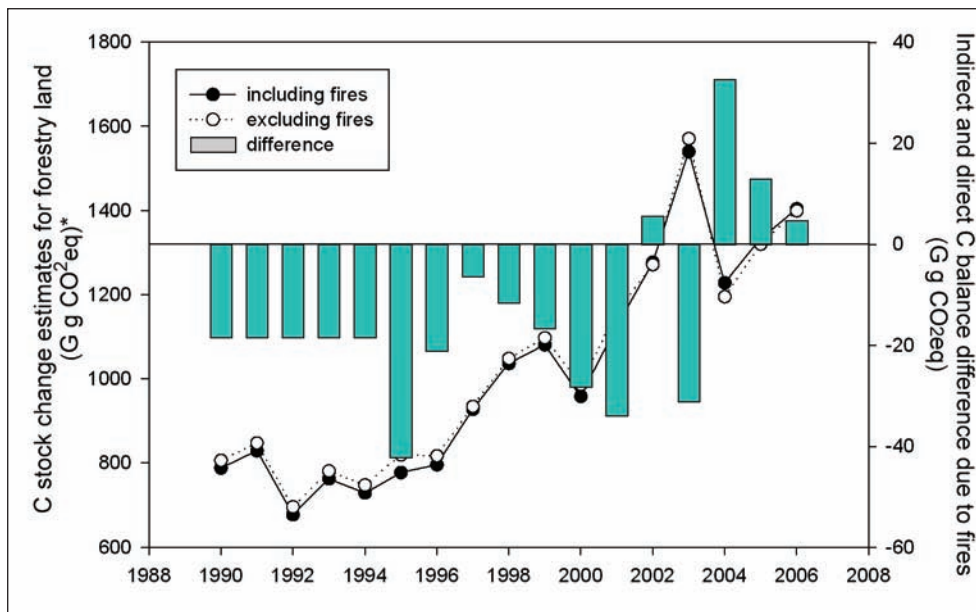
Figure 2 shows the predicted sequestration rate of post-1990 forests over the three successive 5-year 'commitment periods' and four afforestation scenarios. Assuming that an afforestation rate of 10,000 ha is maintained, the annual sequestration rate is expected to rise from ca. 1.7 M t CO_2 in 2006 to 4.5 M t CO_2 by 2022. However, the actual sequestration rate will be lower (3.6 M t CO_2) if the afforestation rate declines to 3,000 ha per year. The afforestation rate over the past four years is running below 10,000 ha per year.

New developments include cohort models for six species groups based on yield tables. Work is now directed at redeveloping Irish models based on Coillte permanent sample plot and NFI data, using stand and tree level growth models.

Growth models

Work has been carried out using Coillte permanent plot and NFI data to develop tree level growth models. The spruce cohort is being developed. The models are based on PROGNOSIS, developed in Austria and North America. This is particularly suitable for application to NFI data, allowing growth and C forecasts to be undertaken.

Data have been extracted using specialised code and will form part of the QA/QC software system. The Coillte database has also been used to develop heuristic models and tree growth models.

Software development

The USA forest vegetation model (FVM) was scoped for use in Ireland but is not suitable due to unchangeable programming code relating to climatic conditions specific to the USA.

ACTIVITIES PLANNED
- Development of cohort models for spruce, including three publications.
- Development of pine cohort models.
- Software development and extraction of NFI data for growth model simulations.
- Inclusion of spruce growth models and biomass functions for Sitka spruce into software, validation and testing of software.
- Uncertainty analysis on spruce growth predictions.
- Assist FORESTSOILC and CARBiFOR II with selection of paired plots based on previous land use and soil type attributes.
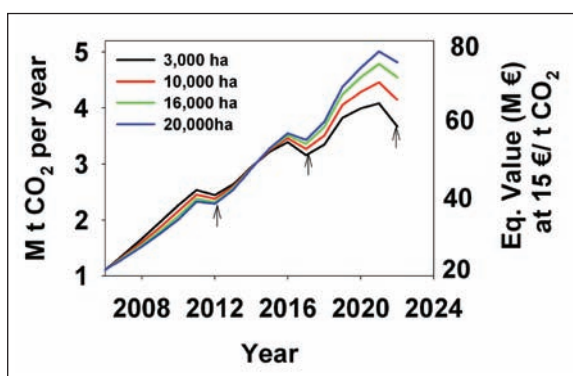

Figure 2: Annual carbon dioxide sequestration and estimated value of post-1990 forests over three successive 5-year periods: 2008-2012; 2013-2017; 2018-2022 (indicated by arrows) for four afforestation scenarios (roundwood harvest is assumed to be at marginal intensity).

Forests
and
Climate
Change

- Submission of national LULUCF report 2006 including emissions due to deforestation and fire.

OUTPUTS

Peer-reviewed articles:

Black, K.G., Bolger, T., Davis, P., Nieuwenhuis, M., Reidy, B., Saiz, G., Tobin, B. and Osborne, B. 2007. Inventory and eddy covariance based estimates of annual carbon sequestration in a Sitka spruce (*Picea sitchensis* (Bong.) Carr.) forest ecosystem. *Journal of European Forest Research* 126: 167-178.

Saiz, G., Black, K., Reidy, B., Lopez, S. and Farrell, E.P. 2007. Assessment of soil CO_2 efflux and its components using a process-based model in a young temperate forest site. *Geoderma* 139:79-89.

Luyssaert, S., Inglima, I., Jung, M., Richardson, A.D., Reichstein, M., Papale, D., Piao, S.L., Schulze, E.-D., Wingate, L., Matteucci, G., Aragao, L., Aubinet, M., Beer, C., Bernhofer, C., Black, K.G., Bonal, D., Bonnefond, J.-M., Chambers, J., Ciais, P., Cook, B., Davis, K.J., Dolman, A.J., Gielen, B., Goulden, M., Grace, J., Granier, A., Grelle, A., Griffis, T., Grünwald, T., Guidolotti, G., Hanson, P.J., Harding, R., Hollinger, D.Y., Hutyra, L.R., Kolari, P., Kruijt, B., Kutsch, W., Lagergren, F., Laurila, T., Law, B.E., Le Maire, G., Lindroth, A., Loustau, D., Malhi, Y., Mateus, J., Migliavacca, M., Misson, L., Montagnani, L., Moncrieff, J., Moors, E., Munger, J.W., Nikinmaa, E., Ollinger, S.V., Pita, G., Rebmann, C., Roupsard, O., Saigusa, N., Sanz, M.J., Seufert, G., Sierra, C., Smith, M.-L., Tang, J., Valentini, R., Vesala, T. and Janssens, I.A. 2007. The CO_2-balance of boreal, temperate and tropical forests. *Global Change Biology* 13:1-29.

Tobin, B., Black, K., McGurdy, L. and Nieuwenhuis, M. 2007. Estimates of decay rates of components of coarse woody debris in thinned Sitka spruce forests. *Forestry* 80 (4): doi: 10.1093/forestry/cpm024.

Proceedings and conferences:

Black, K., Tobin, B., Neville, P. and Osborne, B. 2007. *Variations in annual carbon dioxide exchange over a Sitka spruce stand prior to and following canopy closure*. Proceeding to the conference on greenhouse gas fluxes in terrestrial ecosystems in Ireland, 20 September 2007, Delgany, Co Wicklow, EPA in press.

Black, K. and Gallagher, G. 2007. *Reducing uncertainties associated with the assessment of national forest carbon stock changes. Proceeding to the conference on greenhouse gas fluxes in terrestrial ecosystems in Ireland.* 20 September 2007, Delgany, Co Wicklow, EPA in press.

Black, K. 2007. *Scaling up from the stand to regional level: an analysis based on the major forest species in Ireland*. Proceedings for the 2nd International workshop on uncertainty in greenhouse gas inventories. Institute for Applied Systems Analysis A-2361 Laxenburg, Austria p 9-20.

Hawkings, M., Black, K., Gallagher, G. and Connelly, J. 2007. *Resolution of stochastic issues in estimating forest biomass carbon stock changes using non-linear mixed models*. Proceedings for the 2nd International workshop on uncertainty in greenhouse gas inventories. Institute for Applied Systems Analysis A-2361 Laxenburg, Austria p 97-100.

Black, K. 2007. *Ireland's forest carbon reporting system.* COFORD conference on Forestry, carbon and climate change - local and international perspectives. September 2007, Delgany, Co Wicklow.

Black, K. and Gallagher, G. 2007. *How can we see the carbon from the trees? Exploring the potential use of NFI data for the development of a state-of-the-art national forest carbon accounting system.* Proceedings to Ireland's National Forest Inventory Conference. Forest Service (in press).