

Possibilities for carbon sequestration in Irish forests

Kenneth A. Byrne ⁽¹⁾, Michael Perks ⁽²⁾

⁽¹⁾ Forest Ecosystem Research Group. Department of Environmental Resource Management. University College Dublin. Belfield. Dublin 4 (Ireland). E-mail : kenneth.byrne@ucd.ie

⁽²⁾ Department of Botany. University College Dublin. Belfield. Dublin 4 (Ireland).

Ireland has a rapidly expanding forest estate which covers some 9% of the land area. It is government policy to increase this to 17% by the year 2030. Preliminary studies suggest that forestry activities have the potential to contribute significantly to the mitigation of greenhouse gas emissions. Although some studies have been carried out the determination of the carbon stores and sinks in Irish forests will require a considerable research effort in the future. A key aspect of such studies will be field based studies which measure all components of the carbon cycle and their relationship to climatic and environmental conditions as well as management practices. Many of these issues will be addressed in the recently announced research programme of the Council for Forest Research and Development (COFORD).

Keywords. Kyoto Protocol, carbon pools, carbon sequestration, Ireland.

1. INTRODUCTION

Woodlands were once a dominant feature of the Irish landscape. However, centuries of exploitation created the situation where, at the turn of the twentieth century, only 1% of the land area was forested. Since the 1950's there has been a major national commitment to restore forest cover and there are now some 600,000 hectares of forest, this is equivalent to 9% of the land area (Forest Service, 2000). Species composition is 80% coniferous. Competition with agriculture has meant that afforestation has largely been limited to land considered marginal and sub-marginal for agriculture. Consequently the dominant soil type in Irish forests is peat (**Figure 1**), and while no accurate figures are available, in 1990 there were estimated to be some 200,000 hectares of forest on peat (Farrell, Boyle, 1990). Given the high rates of afforestation during the 1990s, the area of peatland forests has certainly increased in the past decade, although environmental constraints and economic realities have resulted in reduced planting of this site type in recent years. Wet mineral soils also constitute a large proportion of the forest area and represent the most productive site type for the dominant coniferous species, Sitka spruce (*Picea sitchensis* (Bong.) Carr.).

Ireland signed the United Nations Framework Convention on Climate Change (UNFCCC) in June 1992 and ratified it in April 1994. As a signatory to the Kyoto Protocol, Ireland is committed to limiting its greenhouse gas emissions to 13% above the 1990 level by 2008–2012. This was negotiated as Ireland's burden-sharing contribution to the European Union's

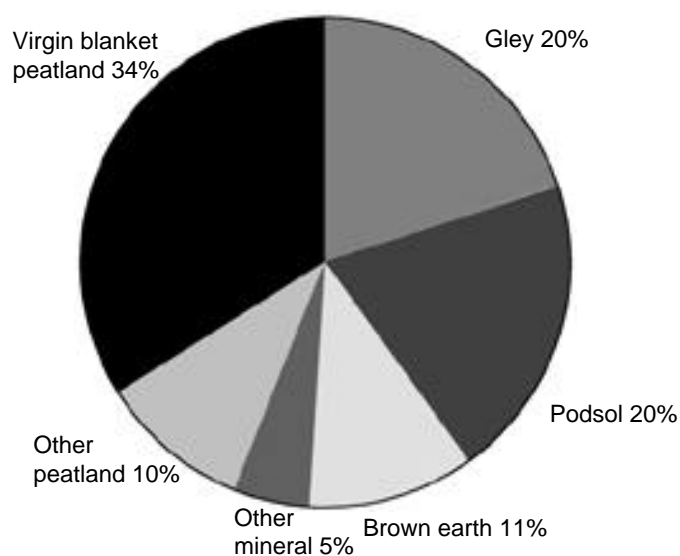


Figure 1. Percent of soil types in state forests (Coillte Teoranta, 1999).

reduction commitment of 8%. National Communications were submitted to the UNFCCC in 1994 and 1996 (Department of the Environment, 1994; 1996). Carbon sequestration was calculated on the basis of national forest stock changes of different tree species for each year. Changes in carbon stocks in soils were not included. Transport and energy account for most of Ireland's CO₂ emissions while agriculture is the dominant source of both methane and nitrous oxide (**Table 1**). Net greenhouse gas emissions increased by

Table 1. Sectoral and total greenhouse gas emissions (Gg) in Ireland in 1990 (Stapleton *et al.*, 2000).

Sector	CO ₂	CH ₄	N ₂ O
Energy and Transformation	11,057		1.39
Combustion in Industry	3,833	0.15	0.38
Combustion in Transport	4,961	1.76	0.28
Other Combustion	9,726	4.27	1.05
Fugitive Emissions from Fuels		6.05	
Industrial Processes	1,931		3.34
Solvents	67		
Agriculture		514.27	22.87
Waste		84.75	
Total	31,575	611.25	29.31

approximately 18% between 1990 and 1998. Current estimates (Fitzgerald, 1999) suggest that if policies remain unchanged emission levels in 2010 will be 32% above 1990. This has serious implications for Ireland's commitment under the Kyoto Protocol. Forestry activities have the potential to contribute significantly to meeting these commitments. Around 86,000 ha have been afforested since 1990 (UNFCCC/SBSTA, 2000) and it is government policy to increase the forest area to 1.2 Mha, or 17% of the land area, by 2030 (Forest Service, 1996).

2. WORKING GROUP 1 RELATED ACTIVITIES (Inventory of C sinks and sources)

Forest inventory data forms the basis on which greenhouse gas emissions and removals associated with land-use change and forestry are calculated. The figures which are reported to the UNFCCC are based on the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC/OECD/IEA, 1996). Studies on the sink capacity of Irish forests are limited. Kilbride *et al.* (1999), using the model developed by Dewar and Cannell (1992), estimated that the average rate of carbon sequestration in Irish forest plantations is approximately 3.36 t C·ha⁻¹·y⁻¹. Cruickshank *et al.* (2000) have estimated the carbon stored in vegetation in Ireland using the CORINE land cover database and reported that forests account for 4.3% of the land cover of Ireland and contain 43% of the vegetation carbon store. This is likely to be an underestimate since only areas greater than 25 ha were mapped. The unit area of many of the recently established plantations is small in addition to which, young plantations are often difficult to detect on the satellite images.

3. WORKING GROUP 2 RELATED ACTIVITIES (analysis of forest management practices)

Preliminary analysis of data submitted to the UNFCCC on August 1st 2000 (UNFCCC/SBSTA, 2000) suggests that carbon sequestration due to afforestation, reforestation and deforestation since 1990 would be equivalent to 5% of Ireland's 1990 emissions. No analyses of other forest management practices have been carried out although there is potential to make progress, for instance through the replacement of low productivity stands of Lodgepole pine (*Pinus contorta* Dougl.) with high productivity crops, such as Sitka spruce.

4. PERSPECTIVES AND RESEARCH NEEDS

Only a small number of studies have been carried out on carbon stores and sinks in Irish forests. These include studies on the effect of forestry development on the carbon balance in blanket peatland (Byrne, 1999; Byrne *et al.*, 2000b). Studies of the carbon balance in plantation forest on industrial cutaway peatland are ongoing (Byrne *et al.*, 2000a). At national level there is an urgent need for good estimates of the carbon store in Irish forests as well as for verifiable models of carbon uptake by Irish forests according to age, productivity, species and soil type. Such studies will require field based studies which measure all components of the carbon cycle and their relationship to climatic and environmental conditions as well as management practices. Specific models will be required to deal with non-CO₂ greenhouse gases. At EU level there is a need for methods to facilitate upscaling and to integrate forest inventory and remote sensing with site specific methods such as eddy-covariance. There is also a need for models for carbon balances in forests with are process based rather than empirical, tools will also need to be developed to separate the so-called residual sink from direct human induced increases in carbon stocks. The National Council for Forest Research and Development (COFORD) has recently issues a call for research proposals to deal with carbon sequestration in Irish forests. Particular areas of research will include:

- estimation of carbon stocks and sinks;
- estimation of carbon fluxes;
- carbon accounting and prices.

Bibliography

- Byrne KA. (1999). *Studies on the carbon balance in a blanket peatland forest*. Ph.D. thesis, Nat. Univ. Ireland, Univ. Coll. Dublin, 180 p.

- Byrne KA., Farrell EP., O'Toole P. (2000a). Greenhouse gas emissions in restored industrial cutaway peatlands in central Ireland. In Rochefort L., Daigle YV. (eds.). *Sustaining our peatlands. Proceedings of the 11th international peat congress. II*, p. 873–877.
- Byrne KA., Farrell EP., Papen H., Butterbach-Bahl K. (2000b). *Carbon dioxide and methane fluxes in forested and virgin blanket peatland in the west of Ireland*. International Association of Theoretical and Applied Limnology, Verhandlungen (Proceedings; 27). (In press).
- Coillte Teoranta (1999). *Coillte's forests. A vital resource*. Leeson Lane: Coillte Teoranta.
- Cruickshank MM., Tomlinson RW., Trew S. (2000). Application of CORINE land-cover mapping to estimate carbon stored in the vegetation of Ireland. *J. Environ. Manage.* **58**, p. 269–287.
- Department of the Environment (1994). *Communication under the United Nations framework convention on climate change*. Dublin: Department of the Environment.
- Department of the Environment (1996). *Communication under the United Nations framework convention on climate change*. Dublin: Department of the Environment.
- Dewar RC., Cannell MGR. (1992). Carbon sequestration in the trees, products and soils of forest plantations. An analysis using UK examples. *Tree Physiol.* **11** (1), p. 49–72.
- Farrell EP., Boyle G. (1990). Peatland forestry in the 1990s. 1. Low-level blanket bog. *Ir. For.* **47** (2), p. 69–78.
- Fitzgerald J. (ed.) (1999). *National investment priorities for the period 2000–2006*. (Policy research series; 33). Dublin: The Economic and Social Research Institute.
- Forest Service (1996). *Growing for the future. A strategic plan for the development of the forestry sector in Ireland*. Dublin: The Stationery Office.
- Forest Service (2000). *Irish national forest standard*. Dublin: The Stationery Office.
- IPCC; OECD; IEA (1996). *Revised 1996 guidelines for national greenhouse gas inventories. Reference manual*. Paris: IPCC; OECD; IEA.
- Kilbride CM., Byrne KA., Gardiner JJ. (1999). *Carbon sequestration and Irish forests*. Dublin: COFORD, 37 p.
- Stapleton L., Lehane M., Toner P. (eds.) (2000). *Ireland's environment. Amillennium report*. Ireland: Environmental Protection Agency.
- UNFCCC; SBSTA (2000). FCCC/SBSTA/2000/MISC.6 *Methodological issues, land-use, land-use change and forestry. Submission from parties, note by the secretariat*.

(16 ref.)

Manuscript received 16 October 2000