Forest Research

Does afforested peatland contribute to climate warming?

Russell Anderson, Georgios Xenakis, Mike Perks, James Morison, Sirwan Yamulki, Elena Vanguelova, Nadeem Shah and Tim Randle

What is known

The greenhouse gas (GHG) balance of afforested peatlands is uncertain. This is despite the clear need for scientific evidence to underpin important policy and practice decisions on how we use and manage deep peat soils. Current evidence indicates that afforested deep peat can be either a net GHG sink or a net source. The net GHG impact depends on the balance between lock-up of CO_2-carbon in the trees and forest products and release of CO_2 and methane (CH_4) from decomposition of peat. The current evidence on whether restoration of afforested land should be included in multi-million €/£ peatland restoration programmes needs strengthening. The danger is that some such restoration activity may actually increase net greenhouse gas emissions as the UK strives to reach net-zero carbon emissions by 2050.

A recent analysis of evidence relevant to UK conditions[1] obtained an estimated average emission of +9.91 $tCO_2e\ ha^{-1}\ yr^{-1}$ for UK afforested peat soil. This included fluvial fluxes but ignored CO_2 absorbed by the trees and stored in the forest ecosystem, which can be substantial. The report noted a complete lack of evidence from above-canopy eddy covariance flux studies, which can integrate both methane and carbon dioxide fluxes and significantly improve our underpinning knowledge of net climate mitigation benefit. Some investigations are beginning to address this knowledge gap but more are needed. The forthcoming IUCN UK Peatland Programme technical review of Peatlands and Forestry is expected to highlight this research need.

Using reasonable assumptions, the whole-ecosystem greenhouse gas balance, including fluvial fluxes and fluxes into and from harvested timber, is estimated[2] to range from -2.2 to +5.1 $tCO_2e\ ha^{-1}\ yr^{-1}$. The lower end of the range applies to a highly productive stand on deep peat (Yield Class 14 Sitka spruce) and the upper end applies to a poorly productive stand on deep peat (Yield Class 6 Lodgepole pine).

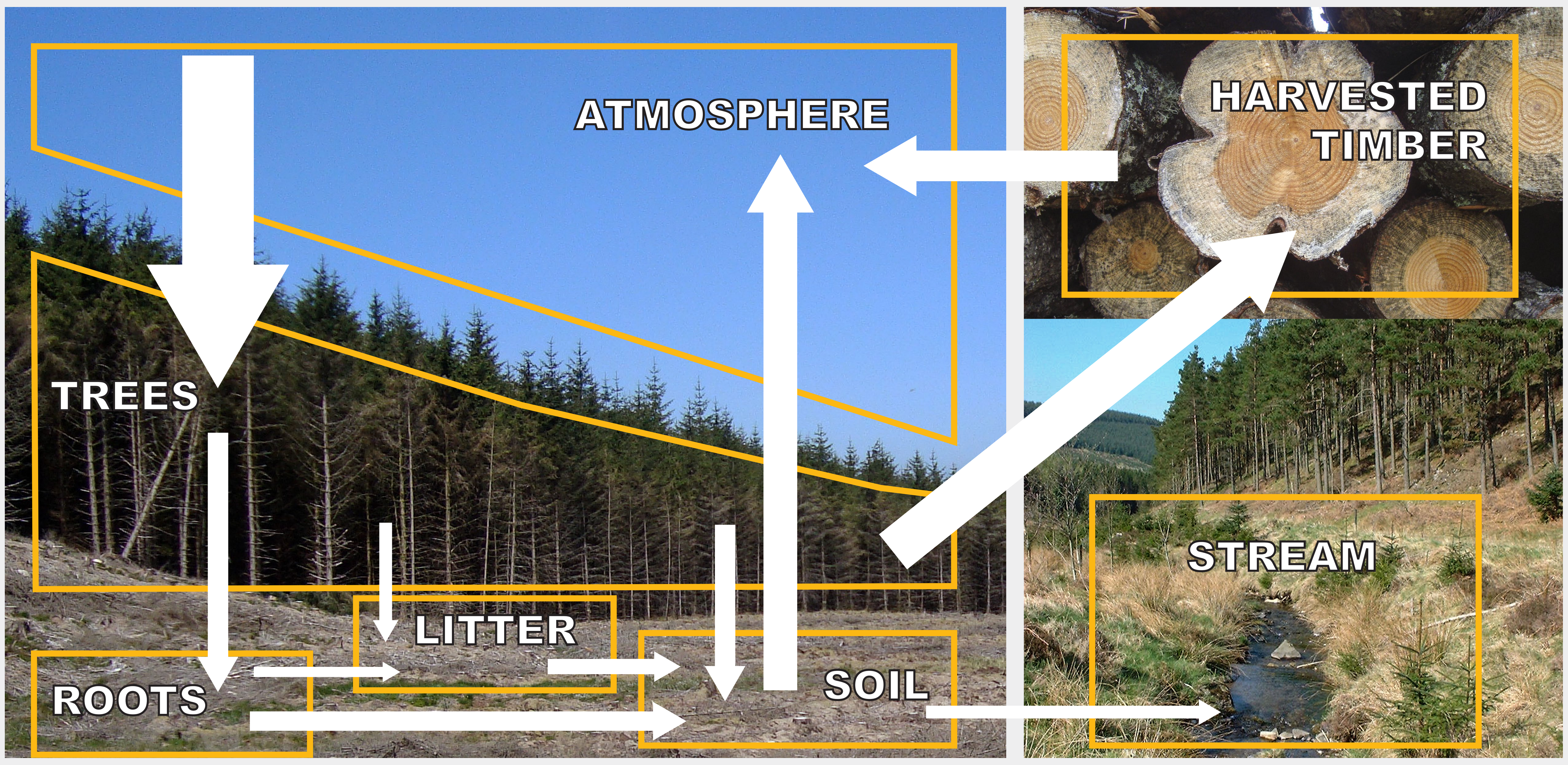

Figure 1. The main component fluxes contributing to the net greenhouse gas balance of afforested peatlands.

Ecosystem	Net greenhouse balance ($tCO_2e\ ha^{-1}\ yr^{-1}$)	Effect on climate
Soil of afforested peatland [1]	+9.91	Warming
Estimate for afforested peatland (including trees and harvested timber) [2]	-2.2 to +5.1	Cooling to warming (depending on productivity)

What is needed

There is a strong and urgent need for more studies combining eddy covariance flux measurements above the tree canopy with fluvial flux measurements from afforested peatlands. Ideally these need to cover the main afforested peatland types and different stages of the forestry cycle, including a second or subsequent rotation. Data obtained can be used to challenge and constrain modelling, which to date has only dealt with carbon dynamics[3].

Forest Research is making a concerted effort to build a partnership to undertake a major research project on afforested peatland GHG dynamics. We need to find and agree the partners, scope the project, assess combined core funding and develop a network approach to funding bids. We would like to hear from other organisations interested in contributing funding, expertise or support to the partnership.

Left: Above-canopy eddy covariance tower on peaty gley soil at Harwood Forest;
Centre: Anemometers and Infra-red gas analyser mounted on above-canopy tower;
Right: Eddy covariance tower on forestry restocking site at Harwood.

Further information

1. Evans, C, Artz, R, Moxley, J, Smyth, M-A, Taylor, E, Archer, N, Burden, A, Williamson, J, Donnelly, D, Thomson, A, Buys, G, Malcolm, H, Wilson, D, Renou-Wilson, F 2019. The implementation of an emissions inventory for UK peatlands. A report to the Department for Business, Energy and Industrial Strategy.
2. Unpublished estimate based on the following assumptions: (a) Range is based on calculations for the species normally planted on deep peat, i.e. lodgepole pine and Sitka spruce, and on Yield Classes 6–14; (b) A biomass expansion factor of 1.43 is used to multiply up timber yield to aboveground biomass yield [Levy, Hale & Nicoll (2004) Biomass expansion factors and root:shoot ratios for coniferous tree species in Great Britain. Forestry 77 (5) 421–430]; (c) Root-to-shoot ratios of 0.33 for lodgepole pine and 0.40 for Sitka spruce are used to add below-ground biomass [Levy, Hale & Nicoll (2004) Biomass expansion factors and root:shoot ratios for coniferous tree species in Great Britain. Forestry 77 (5) 421–430]; (d) 30% of the carbon in the harvested timber is locked up for at least 50 years in harvested wood products; (e) carbon from above-ground forest litter incorporated into the soil amounts to 1–2 $tCO_2e\ ha^{-1}\ yr^{-1}$.
3. Minnuno, F, Xenakis, G, Perks, MP & Mencuccini, M 2010. Calibration and validation of a simplified process-based model for the prediction of the carbon balance of Scottish Sitka spruce (*Picea sitchensis*) plantations. Canadian Journal of Forest Research 40: 2411-2426.

FR(GR-RA)/A0/SEP9/0037