

What is the impact of afforestation on the carbon stocks of Irish mineral soils?

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Background :

Soils contain approximately two-thirds of the C stored within temperate forest ecosystems (Dixon et al., 1994). The residence time of stable fractions of SOC (soil organic carbon) can be > 1000 years (von Lutzow et al., 2006) making it a much more stable sink than living plant biomass (Laganière et al., 2010).

The soil C is controlled by factors, including: previous land use (grasslands, cropland etc); tree species; soil cultivation method; soil properties (clay content); stand age; site management; topography; climatic zone and methodological approaches (Guo and Gifford, 2002; Paul et al., 2002; Jandl et al., 2007; Laganière et al., 2010).

The objectives of this paired plot study were: (1) to quantify the carbon stored in the forest floor and soil (0-30 cm) of 44 forest sites and their adjacent non-forest site on same soils; and (2) to assess the impacts of afforestation on soil carbon stocks using the paired plot method.

Study Sites:

The National Forest Inventory (NFI, 2007) includes 1,742 forest sites selected using a randomised systematic grid sample design. From this NFI database, 44 sites with forest age greater than 15 years, were selected to represent the major forest and soil types planted in Ireland (brown earth, gley, podzol and brown podzolic).

The impact of afforestation, was assessed by comparing these sites with adjacent non-forest sites that had the same current land use as the forest site had prior to afforestation and the same relief, aspect, elevation, soil type etc. as the forest site.

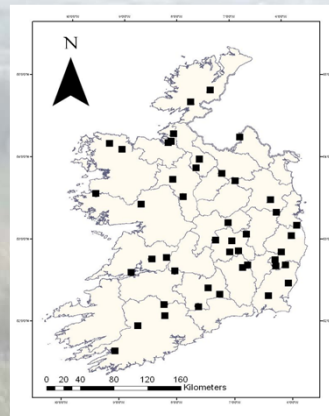


Figure 1. Locations of all 44 sites within Ireland

Methodology:

At both the forest and adjacent non-forest sites, a 20 m x 20 m plot was established and divided into four, 10 m x 10 m quadrants. Within each quadrant, a soil pit was dug at a pre-selected random point and soil type determined. Soil samples were taken to 30cm depth for SOC, bulk density and soil texture analysis. At three points within each quadrant, the forest floor was sampled for organic carbon (OC %).

Results :

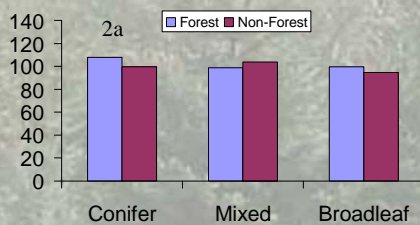


Figure 2a. Effect of forest type on soil organic carbon (SOC, Mg C ha⁻¹)
Figure 2b. Effect of forest type on C content of organic layer.

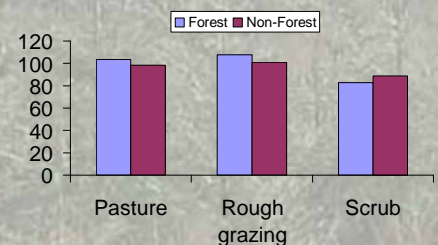
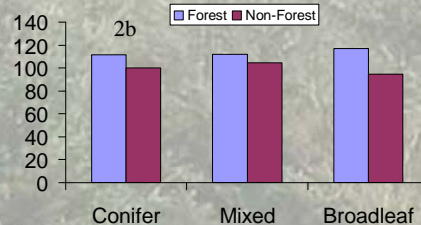


Figure 3. Effect of pre-afforestation land use on soil organic carbon (Mg C ha⁻¹).

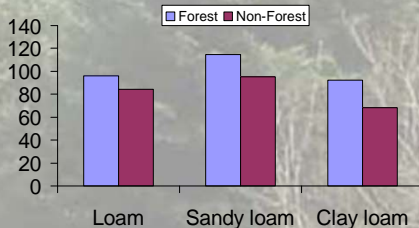


Figure 4. Effect of soil texture on soil organic carbon in forested and non-forested sites (Mg C ha⁻¹)

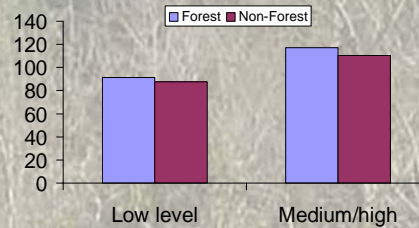


Figure 5. Effect of level of cultivation disturbance on soil organic carbon in forested and non-forested sites (Mg C ha⁻¹).

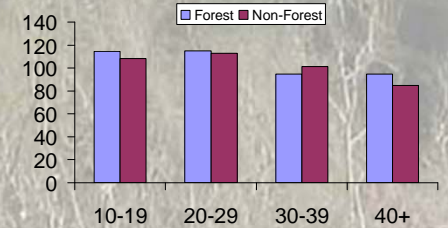


Figure 6. Soil organic carbon content of forest and non-forest soils (Mg C ha⁻¹) in relation to age of plantation.

- SOC under broadleaf and conifer species increased following afforestation (4, 7%), while those sites planted with mixed species lost SOC (-5%). Fig. 2a.
- When the forest floor was included broadleaf, conifer and mixed plots SOC increased (19, 10, 7%). Fig. 2b.
- The soil organic carbon in pasture and rough grazing sites increase slightly following afforestation (4, 6%), while the SOC of the scrub decreased (-7%). Fig. 3.
- Sites with a clay loam soil had the largest increase in SOC following afforestation (26%) in comparison to sandy loam and loam sites (11, 17%). Fig. 4.
- Small increases in SOC (5, 4%) were associated with site management which involved both medium/high-level and low-level disturbance Fig. 5.
- Sites of different ages showed differing results varying from a loss (-7%) in the 30-39 age group to a gain (10%) in the 40+ year group Fig. 6.

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