Source to Sea: Soil carbon transport from forested environments to coastal waters (Ref IAP2-18-72)

University of Stirling, Biological and Environmental Sciences
In partnership with University of St Andrews; Forest Research (CASE)

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Key Words
- Carbon export; carbon sequestration; forestry; biogeochemistry

Overview

Scotland is a carbon (C) nation with significant stores held in both terrestrial and marine environments. Scotland’s peatlands, for example, hold Europe’s largest organic carbon (OC) reserves, and recent research has shown that Scotland’s sea lochs are even more effective carbon stores [1,2]. At the land-ocean interface terrestrial and marine C is closely coupled, with sea lochs storing significant amounts of terrestrially derived C [3]. Land use change and management decisions therefore not only impact the terrestrial C cycle but also the coastal C cycle [4], an aspect largely overlooked. Recent work has shown that over Holocene timescales the removal/loss of forests approximately 5000 years ago triggered a substantial change in the quantity of C sequestration in the coastal ocean [5]. We hypothesize that more recent afforestation (last 100 years) had a similar if not greater effect on the coastal ocean because the rate of recent forest cover change exceeds that seen through the Holocene. In this project we will investigate the effect of conifer afforestation on carbon transport to, and accumulation in, the coastal ocean.

Methodology

To fully understand the current impact of forestry, we will characterise the source C material in detail. We will investigate forest plots (both growing and clear-cut, e.g. Fig. 1) for isotopic, elemental and mineralogical signatures of the soil, living vegetation and dead vegetation, particle size and density, and magnetic susceptibility. Suitable experimental locations will be identified following consultation with Forest Research and the Forestry Commission. We will determine carbon transport pathways by sampling the rivers draining these plots at different points and at different times of the year, measuring δ13C and δ15N and elemental concentrations of both Particulate Organic Carbon (POC) and Dissolved Organic Carbon (DOC). Further we will sample the mouths of these rivers (water and sediment) to build a time series. Iron minerals which play an important role in storage and transport of carbon [6-8] will be characterised in soil, water and sediment using novel Mössbauer
spectroscopy methods developed through projects funded by the Scottish Alliance for Geoscience, Environment and Society (SAGES) and the Marine Alliance for Science and Technology for Scotland (MASTS). The results from the isotopic analysis will be combined with Bayesian mixing models to fingerprint the source of the POC and DOC in the river and coastal water and sediments [3]. The past role of forestry will be examined by using existing sediment cores with precise chronologies covering the modern period of afforestation which began in the early 20th Century. Through the application of the above-mentioned techniques the terrestrial C input associated with forestry activities to the coastal ocean will be quantified. This project will provide insight into the role that forestry plays in coastal C dynamics.

**Timeline**

Months 1-12: Literature review. Identification, assessment and instrumentation of field sites with assistance from Forest Research. Collection of field samples.

Months 13-24: Seasonal collection of field samples. Start iron analyses and isotope analyses. Participate in international geochemistry conference (Goldschmidt) and national meetings (e.g. MASTS and/or SAGES ASM). Option to work at Forest Research’s, Northern Research Station.

Months 25-36: Seasonal collection of field samples and analyses. Write first paper of results. Present results at national meetings (e.g. MASTS and/or SAGES ASM).

Months 37-42: Write up of dissertation and papers. Present results at international conference (Goldschmidt).

**Training & Skills**

Some of the Natural Environment Research Council’s “most wanted” skills will be developed through this project, in particular multi-disciplinarity and fieldwork. Specific skills include: Development of and planning for detailed field sampling programmes; sample collection and storage protocols; C and N isotope analyses; POC and DOC characterization; Mössbauer spectroscopy; forest management including the use of forest data such as the National Forest Inventory; work with Forest Research to bridge between fundamental and applied research; training and experience in national and international conference presentations; preparation and submission of papers to international, peer-reviewed journals. The student will also have access to transferrable skills training provided within Iapetus2, at the Stirling Graduate School and the St Andrews Centre for Academic, Professional and Organisational Development GradSkills programme. The student will also be eligible to participate in the SAGES and MASTS graduate schools.

**References & Further Reading**


**Further Information**

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