Measurement of Soil C COFOR Stock and Stock Changes in **Irish Forest Soils**



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Abstract

39% of global carbon (C) stored is stored in forest soil ecosystems and 77% of global carbon is stored in forest vegetation (Bolin et. Al., 2000). Consequently, this has led to the inclusion of Article 3.3 in the Kyoto Protocol. Article 3.3 allows changes in C stocks due to afforestation, reforestation, and deforestation since 1990 to be used to offset carbon dioxide emissions. Due to Ireland's high level of afforestation since 1990, Article 3.3 offers considerable potential to offset emissions. To meet the requirements of Article 3.3 and to achievement precise estimates of soil C stock and stock changes in Ireland the collection of nationally specific data is required. To accomplish this task, 30 of the Irish National Forest Inventory (NFI) sites will be visited and sampled. The 30 sites will cover the major soil types in the country, namely, Brown Earth, Brown Podzolic, Gley, Podsol, Peaty Gley, and Peaty Podsol. At each mineral soil site the soil will be sampled to a 30 cm depth in order to determine the C content, bulk density and texture. Fine woody debris, litter layer, and humus layer samples will also be taken at each site and analyzed for the organic carbon content of each. Each mineral soil site will have a paired site of the same soil type that will represent the pre-afforestation land use of the forest. The same sampling method will be used at the paired sites. By comparing the forested and nonforested sites we hope to be able to estimate C stock changes due to afforestation. The data collected at the mineral sites will also be used to compute total carbon stocks. At peaty and peaty mineral sites the peat depth will be determined as well as bulk density and SOC content in order to determine total carbon stocks. These sites will not be paired due to large variations in peat depth. From this information new default estimates for soil C stock changes in Irish forest soils (including the litter layer) will be developed. These estimates will substantiate reporting to the United Nations Framework Convention on Climate Change (UNFCCC). Also, with this data, total soil C stock in Irish forest soils can be computed. All soil samples will be archived for possible further analysis.

Background

As discussed above, due to reporting requirements and high rates of afforestation in Ireland the paired plot approach will be utilized to determine the affect of afforestation on mineral soil C content. New Zealand has previously employed this approach successfully (Scott et al. 1999). The New Zealand paired plot studies compared adjoining grassland and afforested sites and found that the afforestation of grassland soils reduces the upper mineral soil (mainly 0 cm - 10 cm) C content by about 4.5 t/ha or 9.5% in the short-term (Davis and Condron, 2002). However, beyond forest age 20 there was no difference in mineral soil C between the two systems. Also, it was found that soil bulk density in the upper layer (0 - 10 cm)was unaffected by afforestation (Davis and Condron, 2002). This method will be used to gather similar information which is the first time this approach will be employed in Ireland.



The current global soil organic carbon stock is estimated to be 1500-1550 Pg (Batjes 1996, Lal 2004, Post et al. 2001, Schlesinger 1995). On a global scale, SOC stocks are directly related to climate and are proportional to moisture levels as increases in precipitation are known to increase soil organic carbon (Jones et al. 2004). Temperature also affects soil organic carbon. SOC stocks double or triple for each 10°C decrease in mean annual temperature (Brady and Weil 1996). Because SOC stock varies depending on multiple factors it important to perform a country specific estimate.

Previously, Tomlinson (2005) estimated the soil C stock and stock changes in Irish soils and emphasized the need for field measurements, particularly bulk density and peat depth, for different soil types and land covers. His work was the first baseline Irish data for 1990. Monitoring carbon emissions from soils is part of the carbon accounting called for by the Kyoto Protocol and requires knowledge of the 1990 baseline levels of SOC in Irich soils

Total national Irish forest soil C stocks and stock changes will be estimated using field measurements of bulk density and peat depth along with the analysis of soil organic carbon on soil samples collected in the field.





Methods

The paired plot approach will be used to investigate the effect of afforestation on mineral soil carbon stock, 21 forested sites from the list of National Forest Inventory (NFI) sites will be chosen. The National Forest Inventory is the first detailed field survey of Irelands forests and woodlands. The Forest Service of th Department of Agriculture and Food completed the statistical inventory in 2007. The purpose of the NFI was to record and assess the composition and condition of the entire forest estate, both public and private, at national level.

Each of these mineral soil sites will have a paired site that will have the same soil type and be located in close proximity to the forested site. The paired site will be representative of preafforested site conditions. Each site will be 20 by 20 meters and will be divided into four quadrants. Within each of the four quadrants one point will be chosen at random. Bulk densit amples, using stainless steel bulk density rings, at 0-5, 5-10, 15-20, and 25-30 cm depth, will be taken at each of the randomly chosen points. At 8 points surrounding the randomly chosen points a dutch auger will be used to sample the soil. See Figure 1 for the appropriate spacing and configuration. The soil will be sampled at depths: 0-10, 10-20, and 20-30 cm depth. Also, at each of the four randomly selected points and at 2 points one meter to the east and west of the randomly selected point fine woody debris, humus, and litter layers within a 0.1 - m2 area will be collected.





10 forest sites on peat will also be chosen from the list of National Forest Inventory sites. At each of the peat sites peat depth, bulk density, and soil organic carbon content will be determined. The plot configuration will be similar to that of mineral soils. The plot will be 20 by 20 meters and divided into four quadrants. At a randomly choose a point within each quadrant the peat depth will be measured and bulk density samples using a Russian sampler will be taken. Also, fine woody debris, humus, and litter layer samples within a 0.1 - m2 area at each of the four randomly selected points and at 2 points one meter to the east and west of the randomly selected point will be collected.

Results

No Results. However, an associated project titled "Soil C" carried out by Nicola McGoff and James Eaton can offer a preview of results to come



Expected Deliverables

•Database of soil C content, bulk density, soil texture and sample archive •National SOC stock and stock change estimates

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