



Doolough Protection Group

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CARBON SEQUESTRATION IN BLANKET BOGS

- ESSAY -

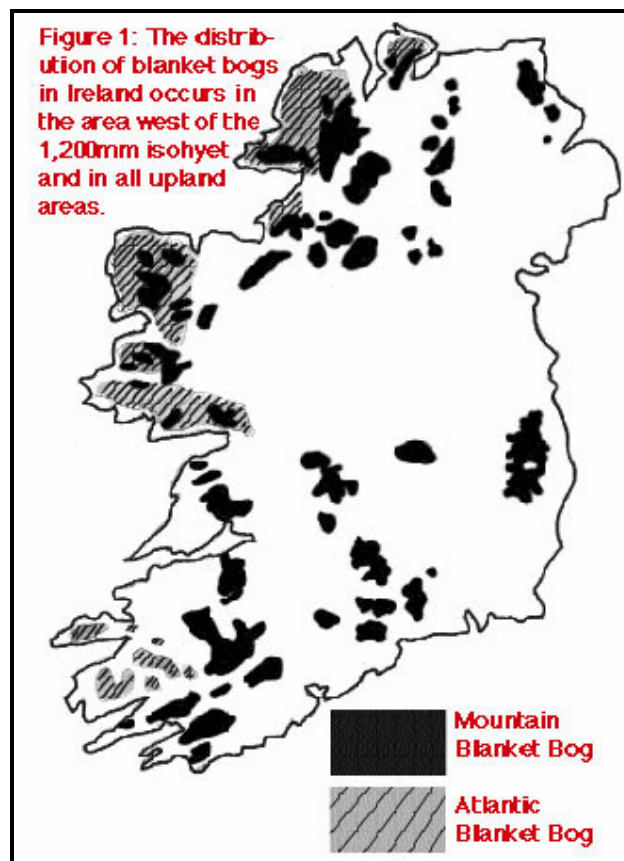
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Carbon sequestration in blanket bogs

1. Introduction

Mention carbon sequestration by natural ecosystems, and lush tropical rainforests come to mind. It comes thus as a surprise to learn that peatlands can absorb more carbon per hectare and per year than tropical rainforests, and that standing stocks of carbon per hectare are also on average higher than in tropical rainforests. It is estimated that peatlands contain on average 5,000 tonnes of carbon per hectare and absorb carbon from the air at 0.7 tonnes per hectare per year. Globally, peat bogs contain more carbon than all the world's tropical rainforests. They are estimated to store $3.0 - 4.6 \times 10^{17}$ g C within 350 million ha.[1]

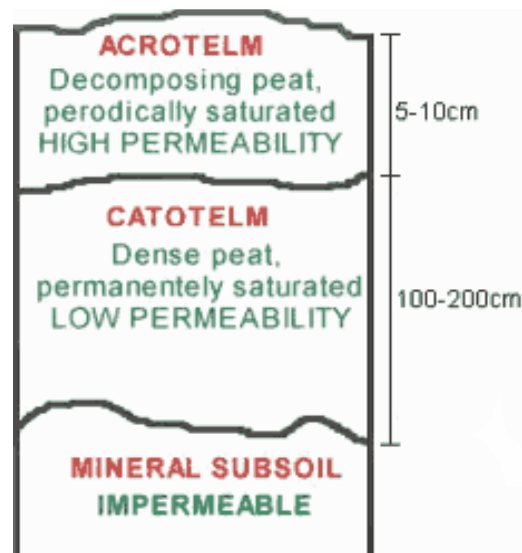
A particular type of peatlands, blanket bogs, cover 10 million hectares of the earth's surface. Ireland possesses 8% of the world's blanket bogs and is the most important country in Europe for this type of habitat. [2]



2. Description of blanket bog habitat [2]

There are two major peatland types found in Ireland: fens, which are alkaline and connected to ground water, and bogs, which are acid and rely solely on nutrient-poor rainwater. Bogs can be further divided into two different types: raised bogs and blanket bogs. Blanket bogs are found along the west coast of Ireland and in mountainous areas around the country where rainfall is 1,200mm per year or more. Depending on the altitude, scientists distinguish between Atlantic blanket bog (below 200m) and mountain blanket bog (above 200m).

In the west of Ireland blanket bogs rest directly on the stumps of Pine trees what were once part of extensive woodlands felled by Neolithic (Stone Age) farmers. Blanket bog formation in the mountains and west of Ireland started at the end of the last glaciation, 10,000 years ago. Heavy rainfall caused minerals such as iron to be washed out or leached from the surface layers of the soil. These were deposited lower down where they formed an impermeable layer known as an iron pan. Water cannot move down through such a layer and the soil surface became waterlogged as a result. Under these conditions the accumulation and spread of peat was made possible.



Peat is a soil that is made up of the partially decomposed remains of dead plants which have accumulated on top of each other in waterlogged places for thousands of years. It consists of Sphagnum moss along with the roots, leaves, flowers and seeds of higher plants. A bog consists of two layers: the upper, very thin layer, known as the acrotelm, is only some 30cm deep, and consists mostly of live Sphagnum mosses. Water can move rapidly through this layer. Below this is a very much thicker bulk of peat, known as the catotelm, where individual plant stems have collapsed under the weight of mosses above them to produce an amorphous, dark brown mass of Sphagnum fragments. Water movement through this amorphous peat is very slow. Peat depth in a blanket bog can reach 12m

Under normal circumstances, the water table within the bog never drops down into the catotelm but remains within a few centimeters of the bog's surface. In its natural state peat in a blanket bog is composed of 85% water and 15% solid material; it is acid with a pH of 3.2 to 4.2; and it has a low ash content, circa 3% or more.

3. The carbon cycle of blanket bogs

As described above, the formation of an iron pan in soils along the west Coast of Ireland and in mountainous areas was necessary for the development of waterlogged soils. Such waterlogged conditions are sustained by high rainfall and low temperatures which result in low evaporation.

The waterlogged soils of blanket bogs are anaerobic or poor in oxygen. Oxygen is essential for the growth of the soil micro-organisms (bacteria and fungi) that bring about the complete breakdown of plant material. In addition, the acid nature of the ground water produced by *Spagnum* moss species slows down decomposition further by preventing the growth of soil micro-organisms. For these reasons, microbial activity is reduced and complete plant decomposition is prevented, causing peat to accumulate in waterlogged areas and thus bogs to act as sinks for atmospheric carbon.

Carbon sequestration in an ecosystem occurs when the rate of plant production exceeds the rate of plant decomposition, in other words when net ecosystem production is positive. To emphasize the uniqueness of bogs in regard to the carbon cycle, it is useful to outline the typical evolution with time of net ecosystem production in the majority of ecosystems around the globe, which are occurring in aerobic (oxygen rich) conditions.

Around the world, the highest rates of net ecosystem production occur in young, pioneer ecosystems. In natural conditions, following an initial phase of fast growth, ecosystem production tends to reach a plateau where carbon accumulation in plants and soils is compensated (or almost compensated) on a yearly basis by organic decomposition. This can be illustrated as an example for a temperate deciduous forest regrowing following a fire or other catastrophic event. In the first decades trees are growing at a fast rate, accumulating carbon from year to year in woody stems (and to a lesser extent in soils through the formation of humus), while leaves and fine roots undergo a complete turnover over the course of a year. As the forest matures, the rate of carbon accumulation in woody compartments slows down as canopy closure is attained and structural limits such as maximum tree height are reached. Scientists are debating whether a zero carbon balance on a yearly basis is ever attained in mature ecosystems, or whether the carbon cycle only ever reaches a true equilibrium over much longer time scales incorporating ecosystem successions. In any case, the rate of carbon sequestration in mature ecosystems occurring in aerobic conditions is a fraction of the rate of that of an equivalent ecosystem in the initial phase of its development.

In that respect, bogs are unique in that they maintain steady, relatively high carbon accumulation rates over thousands of years - potentially for ever, unless climate change or human impacts intervene. Such rates of carbon sequestration result not from faster plant production but from slower decomposition. Indeed, plant production in bogs is limited by the rate of photosynthesis at the ecosystem level, itself limited by a low leaf area per unit surface area. The plant composition of bogs is characterised by low growing vegetation such as mosses, which in other ecosystems mainly constitute an understorey. The range of plant species is limited to species that can adapt to the waterlogged, anaerobic and acid conditions, while such conditions also limit plant growth rates. Thus, while bogs appear to be lowly ecosystems, and are often treated as such, their rate of net ecosystem production makes them a key habitat in the global carbon cycle.

A number of methods are used to measure the rate of carbon sequestration and other components of the carbon cycle of bogs. Spatial, temporal and between-species variability exists in the carbon dynamics of bogs, due to climate, phenology, and physiology (which cannot be controlled), but also due to water table depth, grazing, burning and the distribution and abundance of primary peat-forming species and communities (which are susceptible to management). [1]

4. Land use changes

Although peatlands originally covered more than 17% or 1,178,798ha of the land surface in the Republic of Ireland, the introduction of large-scale, mechanised turf extraction schemes in the 1940s, afforestation programmes commencing in the 1950s, intensification of agriculture following Ireland's entry to the European Community in 1973 and land reclamation involving drainage, fertilisation, and removal of peat have seriously depleted the area of peatland. There has been a 92% loss of raised bogs and an 82% loss of blanket bogs. Today only 19% of the peatland resource remains in a relatively intact condition (220,902ha). [2]

Grazing pressure on blanket bogs although particularly severe during the last century mainly by cattle did not result in degradation of this habitat. Sheep have now replaced cattle as the principal grazing animal on blanket bogs due to the system of headage payment and premia grants under the EU Common Agricultural Policy. In addition the widespread subdivision of commonage has concentrated grazing on smaller areas of blanket bog causing severe erosion and complete loss of sites.

Overgrazing has led to erosion and habitat loss of 7% of the area of blanket bog in the last ten years and a further 7% is threatened by this activity.[2]

Traditional cutting of the bogs by turbarry over the last 400 years has had a serious impact on both raised and blanket bogs. 68% of the raised bogs and 46% of the blanket bogs have been cutaway by this process. Peat is still being cut privately and the introduction of machinery and a grant aid scheme under the Turf Development Act 1981 has enabled many small scale extraction programmes to get underway each year, resulting in further loss of sites. New measures introduced in 2004 by the Department of the Environment aim at phasing out private turf cutting over the next ten years.

State planting on peatlands has virtually ceased. However private afforestation is still continuing. The plantations established in the last fifteen years have had a significant detrimental effect on a large expanse of blanket bogs. Large scale afforestation schemes have had the greatest impact in the blanket bog areas with 27% of the area of blanket bogs now under afforestation.[2] In some areas the percentage of blanket bog afforested reaches 50, as in the Slieve Aughties in Co. Galway and other areas of mountain blanket bog [3]. 84% of new Irish forestry plantation in the 1990-2000 period was on peatland.[4]

Notwithstanding their large negative impacts, the land use changes described above can be still considered as intensification of "traditional" land use changes, involving the farming community as principal actors. Since the implementation of the Kyoto protocol, a new threat is facing blanket bogs in Ireland. Because of their low monetary value due to low grazing value and poor access, blanket bogs are increasingly chosen as the potential site for land hungry industrial developments such as "wind farming".

5. Implications for Kyoto protocol

As a result of the Irish government signing the Kyoto agreement in 1997, which set legally binding limits on the emissions of greenhouse gases from individual industrial countries, it is likely that credit trading will develop across international boundaries. This will become particularly important should the imposition of carbon (or energy) taxation become statutory in Ireland, as was so far unsuccessfully proposed in 2004.

Pro-farming agencies and organisations are describing trees as " the lungs of the planet" and promote their role in absorbing and retaining CO₂ and releasing oxygen. The average rate of carbon storage in Irish plantation forests has been estimated by a recent study at approximately 3.6 tonnes of carbon per hectare per year. [6] Though this figure may appear higher than the rate of 0.7 tonnes of carbon stored by bogs per hectare per year quoted above, there are a number of problems with the strict comparison of these numbers.

Although Irish plantation forests are generally young and fast growing and new land is planted each year (thus artificially maintained in the "pioneer" phase, see paragraph 3 above) , the potential of the Irish forest estate to sequester carbon can only be estimated from desk studies until the results of detailed research are known. In many case, such research tends to neglect carbon compartments difficult to study, in particular under-ground carbon stocks and fluxes. Therefore claims for forestry's role as a carbon sink are unsupported by scientific data. The role of the entire forestry sector should also be taken into account, since wood processing industries are net consumers of fossil fuels and the fate of Irish wood products should be included. [7]

When forestry plantations are established on peatlands, the additional potential for carbon losses arising from land use change is also very little known. Both methane and carbon dioxide molecules are involved in the carbon cycle of peatlands. Carbon losses following afforestation of peatlands are due to a number of factors, mostly related to drainage. Following drainage, carbon is lost in particulate form, particularly in the early phases (erosion in drain water), and in gaseous forms in later phases, as the drains and subsequent cracking tend to dry out the peatland and turn hydrological conditions from anaerobic to aerobic.

Recently, a second favoured use of mountain blanket bogs emerged as a location for windfarms, ostensibly for their high wind resource and relative isolation from human settlements. Most importantly, the carbon pricing structure for renewable energy tends to compel producers to locate

wind farms in upland areas so as to increase the economic viability of the proposal.[2] As a result a number of wind farms sited on mountain blanket bogs are planned, under construction or operational. The principal perceived advantage of wind power over energy derived from fossil fuels is in reducing greenhouse gas emissions. As in the case of the forestry sector above, the wind energy sector is in itself a net consumer of fossil fuels, which tends to negate the carbon savings from electricity generation. Carbon emissions incur in the manufacture, transport, installation, maintenance and decommissioning of the turbines. [8] This issue is compounded when windfarms are sited on blanket bogs.

The infamous windfarm of Derrybrien has provided some figures in that respect. A 70 acre landslide which occurred in October 2003 resulted in a loss of half a million cubic meters of peat from the site of the windfarm. If all the peat lost in the bog slide is oxidised, and all of the loss is attributed to one turbine, scientists have estimated that there would be no CO₂-emission advantage to operating it until 30 years after commissioning. Following the bog slide and to reduce the risk of further ground instability, some consultants have recommended that the whole of the summit peat blanket be comprehensively and permanently drained. The volume of peat within the wind farm boundary was estimated at 7.1 million m³. In these conditions, similar calculations led to the conclusion that the Derrybrien wind farm will have, in practice, an approximate neutral effect on carbon emissions to the atmosphere over its 20 years lifetime, and that the "do-nothing" option of no development could be just as effective in these terms.

6. Discussion

Implementation of the Kyoto protocol does not involve useful or financially rewarding mechanisms for the conservation of existing carbon stores, and even less for the preservation of highly efficient natural carbon storage systems such as blanket bogs. Instead, the sole mechanisms promoted in Ireland are Forestry as a Carbon Offset and the Alternative Energy Provision. Companies are being set up in Ireland to utilise land management activities, particularly afforestation, and investment in wind energy technology, particularly wind farms, to offset energy (carbon) costs for companies by the mechanism of "Green Credits." [5]

As described in chapter 5 above, the potential for long term carbon storage by forestry, particularly if it negates the potential of blanket bogs to carry out this natural function, is debatable. Similarly, the true carbon budget of wind energy is debatable, particularly when wind turbines are sited on blanket bogs. Instead, conservation of blanket bogs as a store of fossil carbon and as an active carbon sink, supported both by financial incentives and legal enforcement, would be void of such loopholes and would have many further advantages from a nature conservation point of view.

Finally, alternative mechanisms resulting in the effective conservation of the remaining blanket bogs is technically more simple than for other habitats which require complex management strategies (for instance the limestone pavement of the Burren which can only be maintained by regular grazing). Blanket bog is a natural climax vegetation type. In other words, even if grazing was removed it would not change into any other vegetation type. Its conservation requires a relatively low stocking density which ideally is evenly dispersed over the whole bog, and wild deer have been proposed as the ideal grazer in this respect.[10]

In conclusion, it is unfortunate to note that the implementation of the Kyoto protocol in Ireland conflicts with the potential of blanket bogs to accomplish their irreplaceable role in the global carbon cycle, and measures to remedy such counter-productive mechanisms and to save a threatened habitat world-wide should be supported.

References

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