**Research Impact Case Study**

**Title of the case study:** *Peatlands forests in the balance: when a carbon sink is also a source*

**Details of staff conducting the underpinning research**

*Dr Ken Byrne, School of Natural Sciences, University of Limerick*

*Dr A.J. Jovani Sancho, University of Nottingham*

*Dr Thomas Cummins, University College Dublin*

**Underpinning research linked to UN Sustainable Development Goals**

Identify UN Sustainable Development Goals (SDGs) to which the impact is deemed to support.
*Note: not all case studies can be linked to SDG goals and some case studies can be linked to multiple SDGs.*

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| ☐ Not relevant | ☐ Goal 1 No Poverty |
| ☐ Goal 2 Zero Hunger | ☐ Goal 3 Good Health and Well-being |
| ☐ Goal 4 Qualify Education | ☐ Goal 5 Gender Equality |
| ☐ Goal 6 Clean Water and Sanitation | ☐ Goal 7 Affordable and Clean Energy |
| ☐ Goal 8 Decent Work and Economic Growth | ☐ Goal 9 Industry, Innovation, and Infrastructure |
| ☐ Goal 10 Reduced Inequalities | ☐ Goal 11 Sustainable Cities and Communities |
| ☐ Goal 12 Responsible Production and Consumption | ☒ Goal 13 Climate Action |
| ☐ Goal 14 Life Below Water | ☒ Goal 15 Life on Land |
| ☐ Goal 16 Peace, Justice, and Strong Institutions | ☐ Goal 17 Partnerships for the Goal |

**Summary of the impact**

Climate change is an ever-present challenge. If we do not take urgent action, it will have far-reaching consequences for our future. As part of the 2007 Nobel Peace Prize-winning Intergovernmental Panel on Climate Change (IPCC), Dr Ken Byrne's work provided evidence for better understanding the subject leading to methods for compiling greenhouse gas inventories used in countries worldwide. His research focused on how land use impacts greenhouse gas emissions, a driving factor in climate change.

Research by Dr Byrne and his international collaborators also shaped knowledge of the carbon balance in the soil of Ireland's peatland forests. Although these forests are generally considered to be carbon sinks, they found that soil carbon emissions from forested peat soils are three times higher than previously reported. This research means that our assessment of the net carbon sequestration capacity of peatland forests is lower than previously understood. This data informed Ireland's national climate action policy, influencing national strategy on mitigating greenhouse gas emissions and peatland management.

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| **Countries where the impact occurred**: Ireland and worldwide. |
| **Beneficiaries:** National and international policy-makers working in land use and climate change. Environmental NGOs. Forest industry. Community groups interested in community-based initiatives for peatland and forest rehabilitation |

**Description of the impact**

Forests impact climate change, usually by reducing greenhouse gas emissions. This depends on the net balance between carbon input and loss. This research led by Dr Ken Byrne into forest carbon sequestration (absorption) not only advances knowledge of the forest carbon cycle but also impacts climate change research and policy, both globally and nationally.

This research informs current and future land use policy and is necessary to charting a more climate neutral path. It is vital to the formulation of climate policy and emission reduction targets. It is also vital to a robust assessment of the role of forests in emissions mitigation, enabling the sector to maximise its contribution.

As part of the first efforts to quantify carbon sequestration in Irish forests, Dr Byrne's research informed the national assessment of carbon sequestration in peatland forests (Source 3). It also played a key role in advancing understanding of the carbon balance in Irish forests (Source 3, Source 4).

This research also had a global impact through Dr Byrne's work with the Intergovernmental Panel on Climate Change (IPCC), to which he was nominated three times (Source 1). The IPCC is the United Nations body that assesses the science of climate change. Dr Byrne contributed to an important part of this assessment, the development of guidelines on compiling greenhouse gas inventories. When the IPCC received the Nobel Peace Prize in 2007, Dr Byrne was a member the IPCC team that received the award.

As a member of an international team of scientists, he also developed methods for including peat soils in national greenhouse gas inventories. These methods are now widely adopted by countries in compiling their annual greenhouse gas inventory for submission to the United Nations Framework Convention on Climate Change (Source 4). They are particularly relevant to countries with large areas of peatland and countries where peatland-related greenhouse gas emissions are a significant part of their total emissions.

One such country is Ireland and Dr Byrne's research informs Ireland's latest (2021) national climate action plan (Source 2). The national climate action plan aims to reduce national greenhouse gas emissions by 51% by 2030, and it includes the use of forests. His more recent research discovered that carbon emissions from forest peat soils in their current state (which is affected by current land use) are three times higher than previously found. Peatland forests do not currently absorb as much carbon as previously thought.

The above body of work indicates that reducing emissions is more difficult than anticipated, impacting how we respond to climate change globally and nationally.

As a result, the national greenhouse gas inventory adopted Dr Byrne's "emission factors for national reporting to the United Nations Framework Convention on Climate Change (UNFCCC)" (Source 4). The adoption lowers national expectations of how much peatland forests can help reduce greenhouse gas emissions. The national climate action plan acknowledges this, stating that Ireland's projected net emissions is expected to increase more than expected - in part because "the level of carbon removals from forests on organic soils [is] less than previously thought' (Source 2), this finding is as a result of the research from Dr Byrne and his collaborators.

Actions which impact forest management can have direct and indirect impact on carbon storage, biodiversity, water quality, local and regional hydrology as well as economic and resource management impacts in the wider context of the circular economy. The Climate Change Advisory Council sought a report from Dr Byrne which include evidence and recommendations for the Council to consider. The Council commended the study as having "identified important gaps in knowledge, relevant to Ireland's specific circumstances, where additional research and analysis is required before major policy initiatives should be undertaken. In brief, the study represents an important and timely contribution to the national

debate on how Ireland can manage our forests in a sustainable and resilience manner, whilst meeting the diverse needs of society and the natural environment." (Source 6)

**Evidence of impact (up to 6)**

- Source 1: Member of the Intergovernmental Panel on Climate Change (IPCC), which was awarded the Nobel Peace Prize in 2007 along with its chair Al Gore
- Source 2: 'Climate Action Plan 2021 – Securing Our Future'. https://www.gov.ie/en/campaigns/2f87c-climate-action-plan-2021/
- Source 3: Managing Directors, Coillte Forest and Land Solutions
- Source 4: Director, FERS, Specialists in climate change, ecological impact assessments
- Source 5: Climate Change Advisory Council, Ireland

**Research description**

Forests in Ireland cover 770,020 hectares, that is, 11% of the land area[1]. Forests are a key component of the carbon cycle. They add to and reduce greenhouse gas emissions. Through the process of photosynthesis, trees sequester carbon dioxide ($CO_2$). The carbon is stored in plant biomass, soil, and wood products. Although some carbon is returned to the atmosphere through respiration and decomposition, sustainably managed forests are net absorbers (*sinks*) of carbon. This can help reduce greenhouse gas emissions and mitigate climate change.

In Ireland, forests store an estimated 312 million tonnes of carbon and between 2007 and 2016 removed an average of 3.8 million tonnes of CO2 per year from the atmosphere. However, the benefit from Ireland's forests is complicated by their relationship to peatlands.

Peatlands cover some 20% of the Irish landscape2. In their natural condition, peatlands are net sinks for carbon. However, drainage and land use change alter this by lowering the water table, allowing aeration to occur, causing the peat to decompose and emit $CO_2$ to the atmosphere.

38.7% of Ireland's forests are on peatland, and much of that peatland has been drained and changed to a different land use. The crucial question in assessing the role of these forests in carbon sequestration is whether the losses of soil carbon from peatland drainage are compensated by carbon uptake in the growing forest The question is central to the carbon sequestration capacity of Ireland's forests and their contribution to achieving climate policy targets. However, despite the large area of peatland forests in Ireland, very few studies have investigated the carbon cycle in these forests.

Dr Byrne's research addressed this knowledge gap. Building on his research into carbon sequestration by forests and by peatlands, Dr Byrne and his collaborators looked into what happens when both types of land overlap.

In a two-year period, Dr Byrne and his team investigated the soil carbon balance at eight peatland forest sites in southwest Ireland. They measured soil carbon emissions through *litterfall traps* (plastic containers which collect needles and dead branches when they fall from trees) and measurements of root biomass. By comparing these sets of measurements, they could assess whether these soils are accumulating or losing carbon. The results published in Global Change Biology (2021) demonstrated that these forested peat soils are *net* sources of soil carbon: they emit more carbon than they absorb. Across these eight sites and two years, the average loss of soil carbon was 1.68 tonnes of carbon per

[1]Forest Service. 2018. Ireland's National Forest Inventory 2017 – Results. Covering the National Forest Inventory 2015 to 2017. Forest Service, Department of Agriculture, Food and the Marine.

2. Connolly J, Holden NM (2009) Mapping peat soils in Ireland: updating the derived Irish peat map. Irish Geography 42(3):343–352

hectare per year. This is three times higher than previously reported. This finding has a significant impact on Ireland's Climate Action Plan and associated implementation strategies.

**Research outputs**


1. Jovani-Sancho, A.J., Cummins, T. and Byrne, K.A. (2021), Soil carbon balance of afforested peatlands in the maritime temperate climatic zone. Global Change Biology. Accepted Author Manuscript. https://doi.org/10.1111/gcb.15654 (Open Access)
2. Byrne, K.A. and Farrell, E.P. 2005. The effect of afforestation on soil carbon dioxide emissions in blanket peatland in Ireland. Forestry, 78(3): 217-227. doi:10.1093/forestry/cpi020
3. Jovani Sancho, A.J., Cummins, T. and Byrne K.A. 2018. Soil respiration partitioning in afforested temperate peatlands. Biogeochemistry. 141(1): 1-21. DOI: 10.1007/s10533-018-0496-0
4. Byrne, K.A., Lanigan, G., Creamer, R. and Renou-Wilson, F. 2017. Soils and carbon storage. In: O'Sullivan, L. and Creamer, R. (Eds.). Soils of Ireland. Springer. 246-256.
5. Wirth, T., Zhang, C., Anshari, G.J., Byrne, K., Hodson, E., Joosten, H., Kaufmann, J.B., Klemedtsson, L., Lapvetelainen, T.E., Mueller, C., O'Brien, P. and Osaki, M. Introduction. In: IPCC 2014, 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands, Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. and Troxler, T.G. (eds). Published: IPCC, Switzerland.
6. Prince, S., Von Maltitz, G., Zhang, F., Byrne, K., Driscoll, C., Eshel, G., Kust, G., Martínez-Garza, C., Metzger, J. P., Midgley, G., Moreno-Mateos, D., Sghaier, M., and Thwin, S. Chapter 4: Status and trends of land degradation and restoration and associated changes in biodiversity and ecosystem functions. In IPBES (2018): The IPBES assessment report on land degradation and restoration. Montanarella, L., Scholes, R., and Brainich, A. (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem services, Bonn, Germany, pp. 221-340.


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