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Preservation and Restoration of Ireland's Peatlands Will Reduce the Amount of Carbon Dioxide in the Atmosphere

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Preservation and Restoration of Ireland's Peatlands Will Reduce the Amount of Carbon Dioxide in the Atmosphere

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Forward thinking. World ready.

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Abstract

Climate change, and the effects of climate change, are of critical importance to the planet and to those who inhabit it. Trees are being planted throughout the world, but they may not be the most efficient way to capture carbon from the atmosphere. This study performed an extensive literature search to determine the relevance of peatlands in capturing carbon. We found that less nitrogen is needed to capture carbon in peatlands than other types of soils, and that overall, the preservation and restoration of Ireland's peatlands are a key part in combatting climate change by reducing the buildup of carbon dioxide in the atmosphere.

Introduction

The purpose of this study was to determine the effects, both current and potential, that peatlands have on greenhouse gas emissions. Peatlands are a type of wetland that is characterized by the accumulation of peat, or dead plant material, in the soil. This buildup of peat results from poor water drainage in an oxygen poor environment, which in turn halts the decomposition process. Overtime, this leads to the buildup of carbon trapped within the peat, allowing peatlands to store enormous quantities of carbon.

However, peatlands are often drained for agriculture, forestry, or even peat extraction (Humpenöder et al., 2020). This degradation of peatlands causes greenhouse gases such as carbon dioxide, as well as other gases, to be released into the atmosphere due to the accelerated decomposition of peat in an oxygen-rich environment. These emissions can continue for hundreds of years if the peatlands are not rewetted.

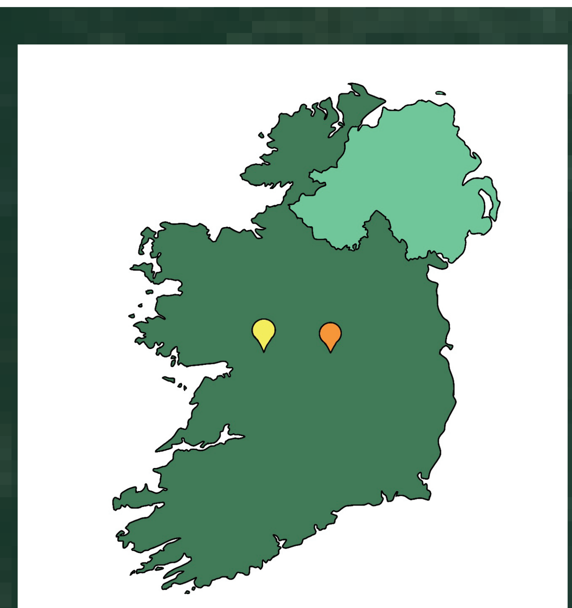
Three articles were used to compare and contrast peatlands' greenhouse gas sink or source potential in order to understand their effects on the atmosphere. As the world continues to warm, people are looking for ways to reduce the amount of greenhouse gases, namely carbon dioxide, emitted into the atmosphere. It is only recently that scientists have seriously investigated the potential value of peatlands to combat climate change.

Exposed peatland subject to erosion and evaporation
Source: https://fieldnotes.nationalgeographic.org/expedition/irishbogs

Methods

Three articles were used in this study and the methods within in them were compared.

Renou-Wilson et al. 2022:
- This study looked at the greenhouse gas dynamics of two raised bogs at two different sites. At the Moyarwood bog, drained versus rewetted peatlands were studied. At the Clara bog the relationship between precipitation and the amount of carbon absorbed or released was studied.
- At Moyarwood greenhouse gas fluctuations were measured using chamber methods throughout the 5-year study. Soil temperature and water table levels were measured.
- At Clara the net ecosystem exchange (NEE) of carbon dioxide was measured using eddy covariance techniques. Researchers also used infra-red gas analyzer, a 3D anemometer, and a meteorological station at the sight. Weather data from Met Eireann station at Horseleap, County Offaly, was also included in the study.
- The two sites used in this study were the raised bog at Moyarwood, located in Galway County in Ireland, and the Clara bog, also a raised bog in Offaly County, Ireland.



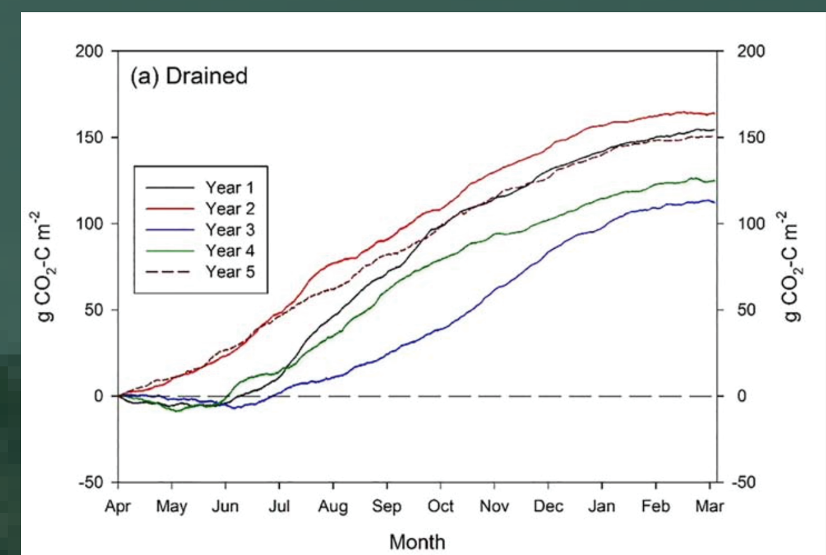
Locations of the Moyarwood bog (yellow) and Clara bog (orange) in Ireland.

Humpenöder et al. 2020:
- This study looked at peatland degradation and its potential impacts from associated greenhouse gases along with the growing demand for food to feed a growing population. The researchers examined three peatland protection and restoration scenarios, along with the predicted changes in greenhouse gas levels.
- First they created a map that shows current area of degraded and intact peatlands.
- Researchers then used MAgPIE, model 4.2.1, which considered both economic and biophysical approaches to generate scenarios with different land uses. Changes in cropland, pasture, and forestry were studied.
- Greenhouse gas emission factors (which differ based on the type of gas that is being emitted) from drained and rewetted peatlands were also documented.
- Climate region maps were done via Koeppen-Geiger climate classification.
- For the three protection and restoration scenarios, the economic impact was calculated using pricing of greenhouse gas emissions.

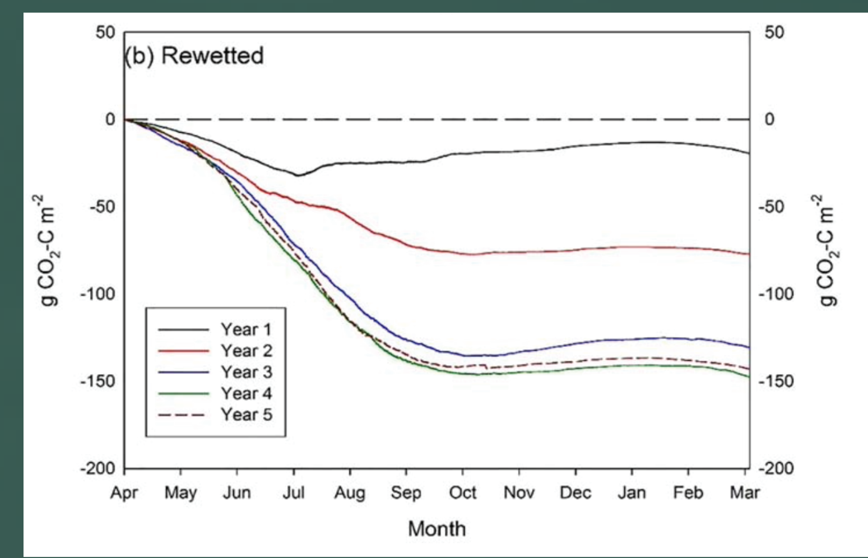
Leifeld & Menichetti 2018:
- This study looked at the potential for avoidable emissions via soil carbon sequestration and peatland restoration. By using data previously compiled in other studies, the researchers were able to analyze and compare the potential cost and benefit of each strategy, including the amount of nitrogen required.
- Created a set of maps via ArcGIS and Goode homolosine projection that showed peatland distribution globally and the potential and actual amounts of GHG emissions of each area annually. Looked at emission potentials of carbon dioxide, nitrous oxide, methane, and dissolved organic carbon (DOC).
- Calculated mitigation potentials for organic and mineral soil restoration strategies and how nitrogen limits those strategies.
- ISRIC WISE database was used to determine carbon to nitrogen ratios for the soils considered.
- Future projections of emissions globally were calculated based on a combination of various factors, such as amount of carbon stocks, peatland degradation, and mitigation potentials of mineral soils.

Results

Renou-Wilson et al. 2022:
- Moyarwood Results: 5-year study (2013-2018)
  - Soil temperature fluctuated less in the rewetted areas than in the drained areas.
  - Drained site was a carbon source throughout the study.
  - The rewetted site was a carbon sink throughout the study, with highest uptake in year four.
  - Drained areas were a greenhouse gas source throughout the study.
  - The rewetted site fluctuated between carbon source and carbon sink.
  - Rewetted site had two times more methane emissions than Clara bog, but still operated as a net carbon sink four of the five years.
- Clara Results: 2-year study (2018-2019)
  - Carbon uptake and release rates were affected by changes in water table levels.
  - Was a carbon source in 2018 but a sink in 2019, probably due to drought period and shorter growing season in 2018.
  - Limited water means more carbon lost than gained. Rewetted site also saw an increase of methane emissions.
- Some rewetted peatlands may have the ability to act as net carbon sinks as long as drains are blocked.
- Even though rewetted peatlands emitted methane, the long term benefits of carbon sequestration outweighs the affects methane will have in the near future.

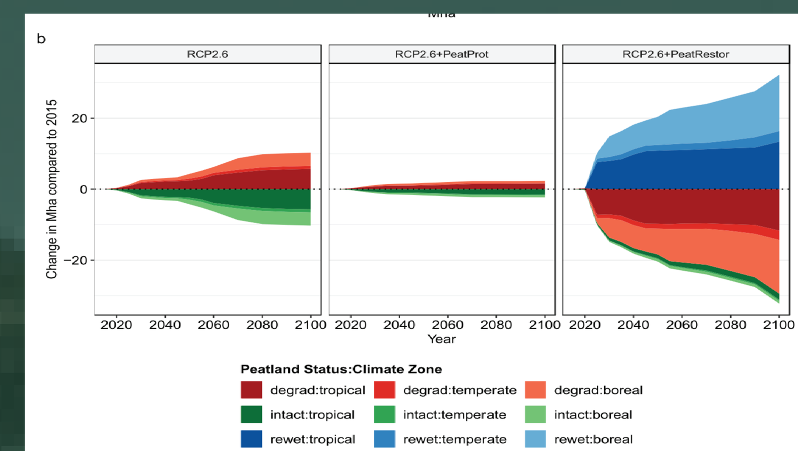


Cumulative net ecosystem exchange for drained areas
Source: Leifeld & Menichetti (2018)

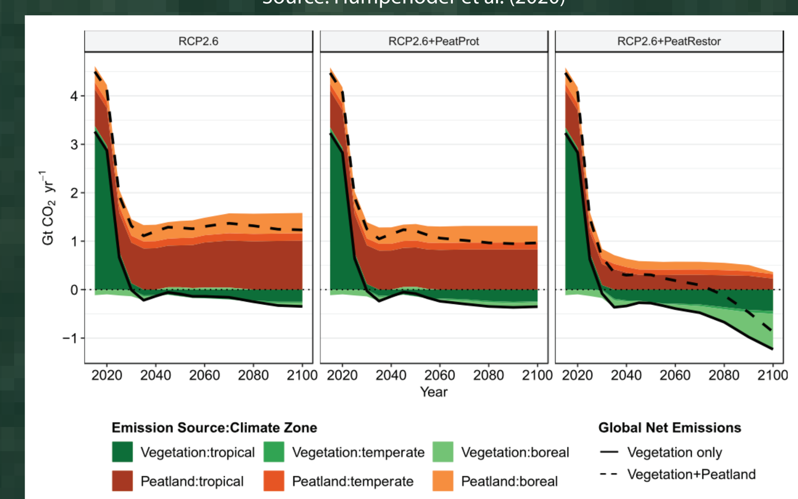


Cumulative net ecosystem exchange for rewetted areas
Source: Leifeld & Menichetti (2018)

Humpenöder et al. 2020:
- Without any peatland policies:
  - Area of degraded peatland increases by 10.3 Mha with strongest increase in the tropics.
  - Increase coincides w/ conversion of land for cropland and bioenergy production.
  - Global CO_2 emissions increase to 1.58 Gt CO_2 yr^{-1} by 2100, which is 25% higher than in 2015.
  - Other gas emissions, such as CH_4 and N_2O, increase by ~25% globally.
- Peatland Protection Only:
  - Area of degraded peatland increases by 2.3 Mha.
  - Most emissions come from peatlands already degraded.
  - Global CO_2 emissions increase to 0.96 Gt CO_2 yr^{-1} by 2100.
  - Still remains a net source of CO_2 throughout 21st century.
- Peatland Protection and Restoration:
  - Area of degraded peatland decreases by 29.4 Mha due to rewetting.
  - Global CO_2 emissions decrease to 0.36 Gt CO_2 yr^{-1} by 2100.
  - CH_4 emissions double between 2015 and 2100 due to rewetting.
  - Peatlands become a global net carbon sink by year 2075.
- Even with peatland protection and restoration, the costs for agricultural production as a whole increases only slightly.
- The cost for food does not appear to change.
  - This could potentially affect Sub-Saharan Africa differently though, as many areas are already food insecure.
- Even though rewetted peatlands emit methane, the long term benefits of absorbing carbon outweigh the affects methane will have in the near future.



Peatland area in tropical, temperate, and boreal climatezones. Shows changes of peatland area over time until 2100 for the three policy scenarios.
Source: Humpenöder et al. (2020)



Land-related emissions through 2100 for tropical, temperate, and boreal climate zones by the three scenarios.
Source: Humpenöder et al. (2020)

Leifeld & Menichetti 2018:
- 83.3% of all total peatland area is located in boreal and polar areas, with tropics coming in second at 12.7%.
- Tropical peatlands have the biggest potential to be carbon sources in the future.
- Degraded peatlands emit about 1.91 Gt of CO_2 and store ~80.8 Gt.
- The potential for organic soil restoration is estimated to be 0.08-0.92 Gt of carbon per year.
- The sequestration potential for agricultural mineral soils ranges from 24-64 Gt of carbon after 63 years.
- Without substantial peatland restoration, even complete mineral soil mitigation would only be able to combat future emissions, but would not be a carbon sink.
- Sequestration of mineral soils also requires more nitrogen than peatland restoration.
- In terms of soil-born emissions, net mitigation is not achievable without including restoration of peatlands and their organic soils.

Discussion and Conclusion

- Humpenöder et al. (2020) and Leifeld & Menichetti (2018) both show that degraded peatlands contribute to greenhouse gas emissions, presently and in the future.
- Humpenöder et al. (2020) compared future emission projections of peatlands by 2100 based on three different policies governments could take, emphasizing the necessity of preservation and restoration.
- Leifeld & Menichetti (2018) compared carbon mitigation potentials of both organic and mineral soils.
- Humpenöder et al. (2020) and Leifeld & Menichetti (2018) both showed the consequences of not including peatland conservation in carbon mitigation plans.
- Renou-Wilson et al. (2022) looked at emissions of two peatlands in Ireland specifically.
- Renou-Wilson et al. (2022) compared emissions of drained and rewetted peatlands, as well as how the water table affects carbon uptake and release rates.

Two men construct a peat damn by hand
Source: https://www.bordnamona.ie/wp-content/uploads/2021/03/IWM99_RB_Restoration_Best-Practice-Guidance.pdf

Humpenöder et al. (2020) is the most impactful by showing the different projections of greenhouse gases based on what policies may or may not be implemented. It was clear that while protecting peatlands is a starting point, restoration is necessary. With this said, all three articles demonstrated the importance of protection and restoration peatlands, not only in Ireland, but throughout the world as well.

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