UNIVERSITY OF PLYMOUTH

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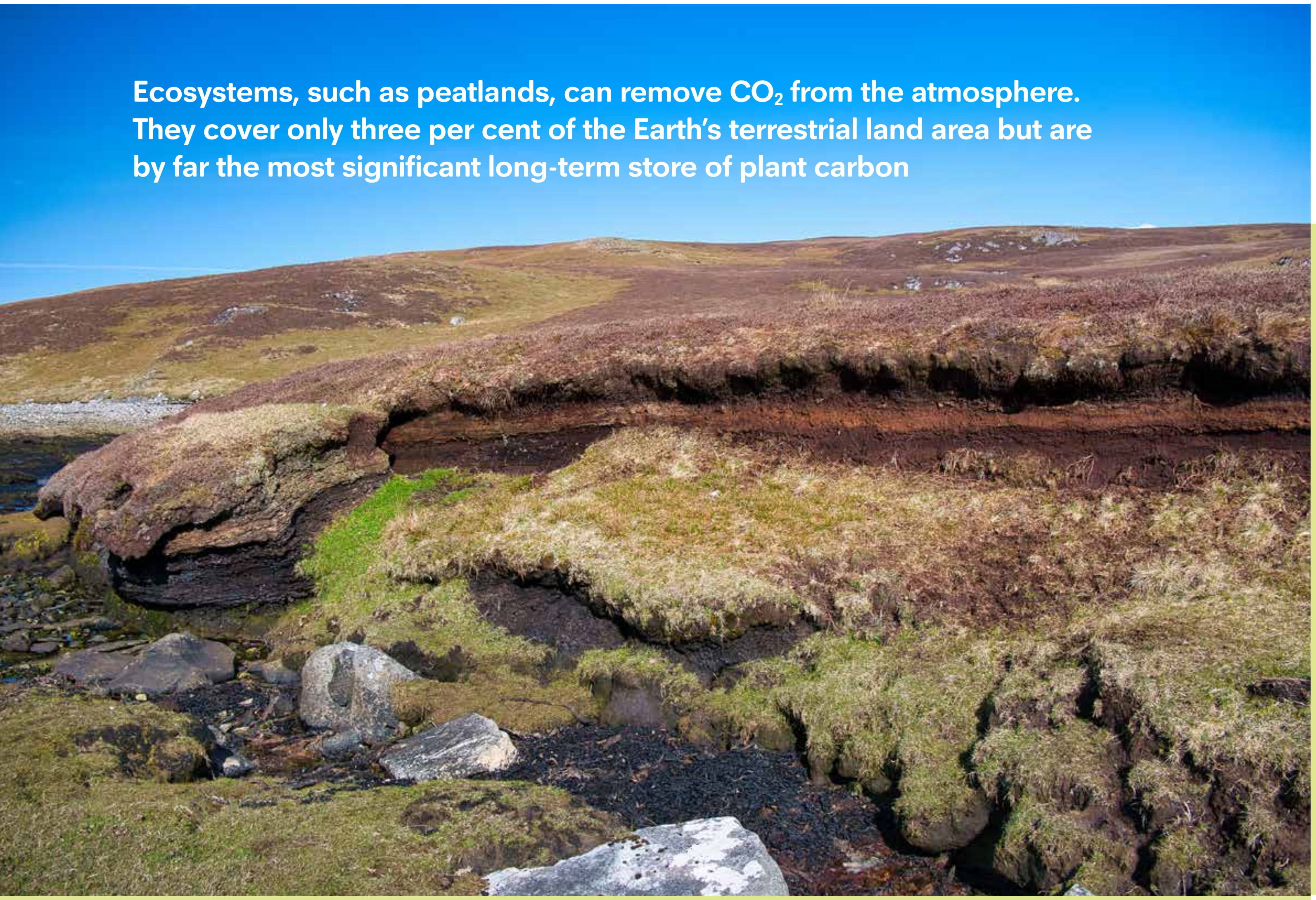
THE ROLE OF PEATLANDS IN ACHIEVING CARBON NET ZERO

Summary

Covering almost 10% of the UK, peatlands represent our single most important terrestrial carbon store. Current indications are that 80% of England's peatlands are in a degraded state [1] (Natural England 2010). Many have been drained for agricultural use, yet a growing body of knowledge suggests that raising water levels in lowland peat crop production areas can reduce greenhouse gas (GHG) emissions as well as other negative environmental impacts. Much research undertaken to date has involved the replacement of drainage-based food crops with (native) plant species that are better suited to wetter conditions. There may also be opportunities to develop novel wetland crops (i.e. sustainable building materials), particularly as climate change influences land management practices. The UK needs to invest more effort in mitigating emissions from UK peatlands used for drainage-based arable and horticulture cultivation; this can help the country reach carbon net zero by 2050.

"Peatlands provide vital ecosystem services and more should be done to preserve and restore them. Greater consideration should be given to how peat is used, what can be done to prevent the deterioration of peat bogs and how they can be managed more carefully."



Key points

- Greater consideration should be given to how peat is used, what can be done to prevent the deterioration of peat bogs and how they can be managed more carefully.
- Data collected from Fox Tor Mire, Dartmoor, found that over 134 years carbon dioxide (CO_2) stored there was equivalent to the annual present day carbon footprint of ~8,800 UK citizens. [2]
- Peatland restoration can yield both significant public benefits including improvements in carbon sequestration.
- There is a lack of adequate scientific research into the potential of peatland systems to accumulate peat following rewetting.
- More funding support should be offered to encourage progressive farming including wet agriculture (paludiculture).
- Research findings suggest that paludiculture has the potential to reduce CO_2 (and overall GHG emissions) relative to conventional drainage-based agriculture or peat extraction.

Context

Opportunities for the uptake and storage of CO_2 globally are vitally important in reducing the impact of climate change. Ecosystems, such as peatlands, can remove CO_2 from the atmosphere. They cover only three per cent of the Earth's terrestrial land area but are by far the most significant long-term store of plant carbon; 500 gigatons of carbon is stored in peatlands and a further 750 gigatons in the atmosphere (with 3.67 parts CO_2 equivalent for every carbon unit). [3]

The Issue

Peatlands provide the single most important terrestrial carbon store in UK. More attention should be paid to their role in carbon sequestration; this is of particular importance in the fight against climate change. GHG emissions from peat wastage are considerable and peat wastage may further negatively impact microclimate, biodiversity, water storage and flood regulation, and recreational and other cultural services.

Carbon storage (sequestration)

Peatlands in south-west England occur at the extreme of their bioclimatic envelope and understanding changes in peatland growth and function, as a result of climate change, is of vital importance.

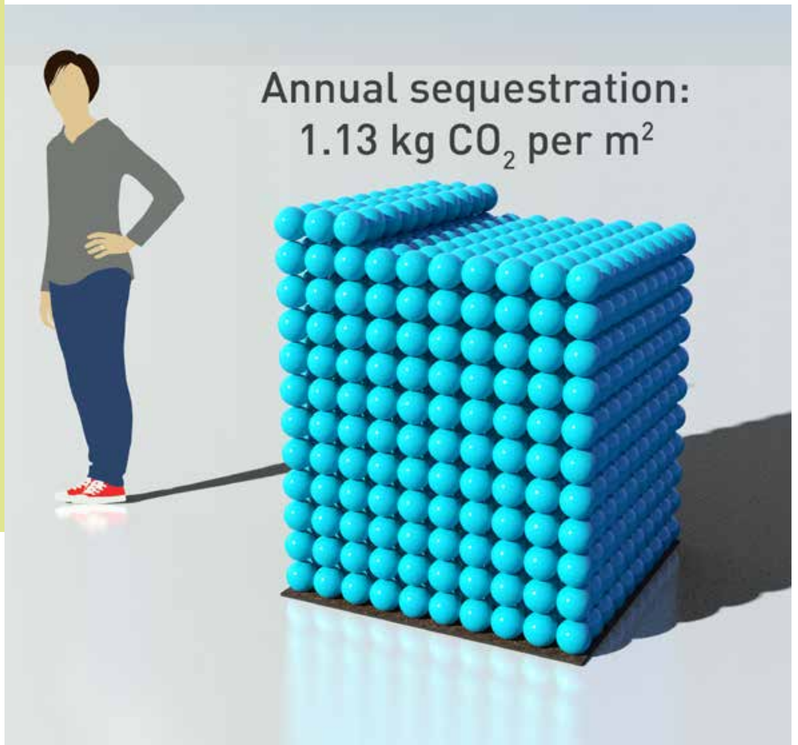
Over six years, academics and students on the University of Plymouth's MSc Environmental Consultancy programme collected data from Fox Tor Mire [2], Dartmoor. Previous mining activity at the mire had left alluvial deposits of china clay that could be used as a distinctive and accurate marker for recording peat growth between 1876-2011.

During the study, peat cores and depth measurements were taken at regular intervals across the mire to determine the rate of peat accumulation that had formed in the valley mire site since 1876. The peat core was analysed to determine carbon and CO_2 content.

The study found that:

- Each year a metre square of peat was able to store 1.1 kg of carbon dioxide
- On average peat growth was 9.5mm per year and over 134 years produced a depth of 127cm
- This 127cm depth of peat over the entire 58.3 hectare peat body at Fox Tor Mire holds the equivalent of 88,000 tonnes of carbon dioxide gas [2].

To put this figure in context, this amount of carbon dioxide stored over the 134 years is equivalent to the annual present day carbon footprint of ~8,800 UK citizens (the annual carbon footprint for the average British citizen is ~10 tons CO_2 equivalent per year).

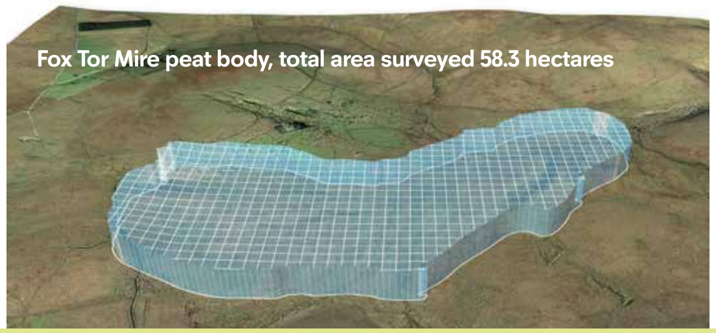


Addressing the issue

Peatland restoration can yield both significant public benefits with improvements in nature conservation value, carbon sequestration, attenuation of flood water and improvements in potable water quality. This has already been evidenced for severely degraded peatlands in Northern England, where restoration was carried out by the water utilities as part of Sustainable Catchment Monitoring Programme (SCaMP).[4]

By restoring the plant community, less carbon is released into the atmosphere. Emissions from drained peatlands are estimated at 1.9 gigatonnes of CO_2e annually. This is equivalent to 5% of global anthropogenic greenhouse gas emissions. Greenhouse gas emissions from degraded peatlands account for 3.5% [5] of all UK annual GHG emissions). The Government needs to take more notice of this as a solution. The Climate Change Committee recommended to the UK Government that, in order to achieve a Balanced Net Zero Pathway by 2050, all upland peat is restored by 2045, 50% of the area of lowland grassland on deep peat is rewetted by 2050 and 75% of lowland cropland on deep peat is either rewetted or sustainably managed by 2050.

Whilst the government's data on how much carbon has been released from damaged peatlands is good, the lack of adequate long-term monitoring data on the rapid growth of peat in a rewetted and restored system has been one of the major knowledge gaps in peatland science. Better technology and equipment will be required to monitor the gas exchange on peatlands in a cost-effective way that is accessible to scientists, landowners and others. Efforts are underway to address this on the southern moors through the Dartmoor and Exmoor Mires Projects. A recent paper in Science of the Total Environment [2] compares past (last 150 years) with present day carbon uptake and sequestration in blanket bog and valley mire sites and provides a model for carbon exchange. Further research aims to improve understanding of the ecosystem services provided by 'active' peatlands, with work in review on net ecosystem carbon exchange (NECE) of pasture peatlands on the Somerset Levels.



Fox Tor Mire peat body, total area surveyed 58.3 hectares

Total stored carbon as 88,000 tonnes CO_2 gas

Re-wetting

Re-wetting peatland by blocking up ditches and elevating the water table helps keep the water levels high. Sphagnum (bog moss) rich plant communities on upland blanket bog and lowland mire on Dartmoor can be restored in this way. However, in lowland agriculturally-modified peatlands the nutrient status is too high. It is possible to rewet and restore reed beds with typha (reed mace) and phragmities (common reed) rich wetlands. Wetland reeds can be used as alternative agricultural crops for sustainable building materials e.g. Typha boards and as the plant fibre in the University of Plymouth's CobBauge building project. The focus should now be on rewetting peatlands that have been drained for agricultural purposes. This is a straightforward solution to implement and should be encouraged.

Work is underway for evaluating processes of vegetation change following hydrological restoration on mire sites. This will prove fundamental to our understanding of mire vegetation recovery following hydrological restoration and is based on one of the UK's most extensive mire restoration monitoring programmes at Dartmoor National Park. Findings of the work show a 90% colonisation by aquatic Sphagnum in pools following successful hydrological restoration, with the spread of mire vegetation into existing terrestrial vegetation taking 5-10 years.

The next step would be to gain an understanding of how much carbon sequestration re-wetting would contribute. Recently published monitoring on NECE found a big uptake of CO_2 – on average in restored valley mire plant communities up to nine tonnes of CO_2 is sequestered per year, per hectare [2].

Change in government subsidies for agriculture

Current agricultural environmental stewardship funding can lead to continued oxidative loss of peat and high CO_2 emissions. This needs to be reversed. Intensively-managed, drained deep peatlands lose on average 1cm depth of peat through agriculture every year. Whilst government funding for the most damaging practices such as drainage, burning, forest planation and over stocking is no longer in place, farmers are still receiving stewardship payments to manage deep peatland areas as wet grasslands for grazing and nature conservation in places like the Somerset Levels. From a nature conservation perspective these payments can be justified but, from a purely net zero carbon perspective, they do not make sense.

Farmers and landowners should be better rewarded to change how they use the land, and to factor carbon storage into that. Studies are underway to capture the data that could inform that policy. Under the Peatland Carbon Code landowners can receive payment for storing 1 tonne per hectare per year in 'active' mire communities, but the rate of carbon sequestration could be much higher in good condition and early succession re-wetted mire communities and, as previously mentioned, having access to the right equipment to monitor this will be hugely important.

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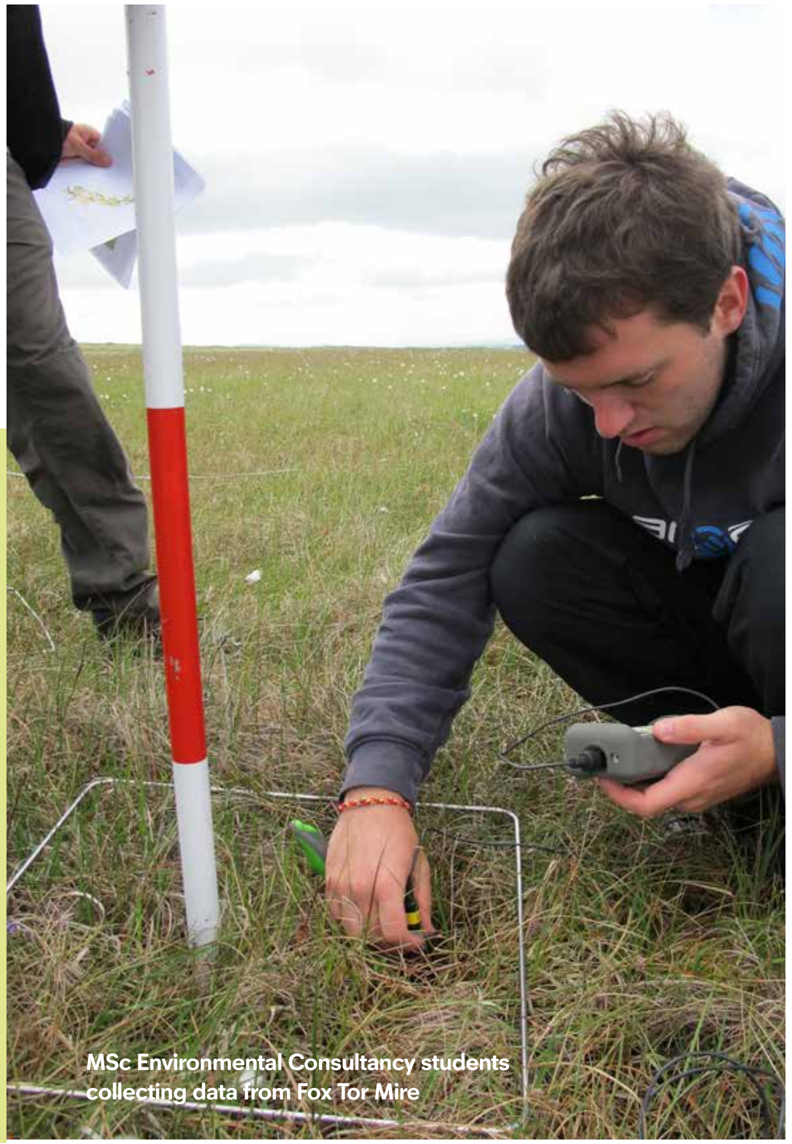


MSc Environmental Consultancy students collecting data from Fox Tor Mire

Chambers used to sample methane release from lawn and hummock *Sphagnum* communities

Paludiculture: farming and agroforestry systems designed to generate a commercial crop from wetland conditions using species that are typical or tolerant of wetland habitats.

Paludiculture

One area of sustainable farming which could be supported is wet agriculture, also known as paludiculture. Raising water levels to reduce emissions in peatlands currently managed for agricultural production would require new ways of growing existing crops or changing to crops capable of thriving with elevated water tables. This avoids CO_2 emissions by reducing oxidation of peat and provides water storage, flood water attenuation as well as habitats for rare and threatened species.

Construction materials

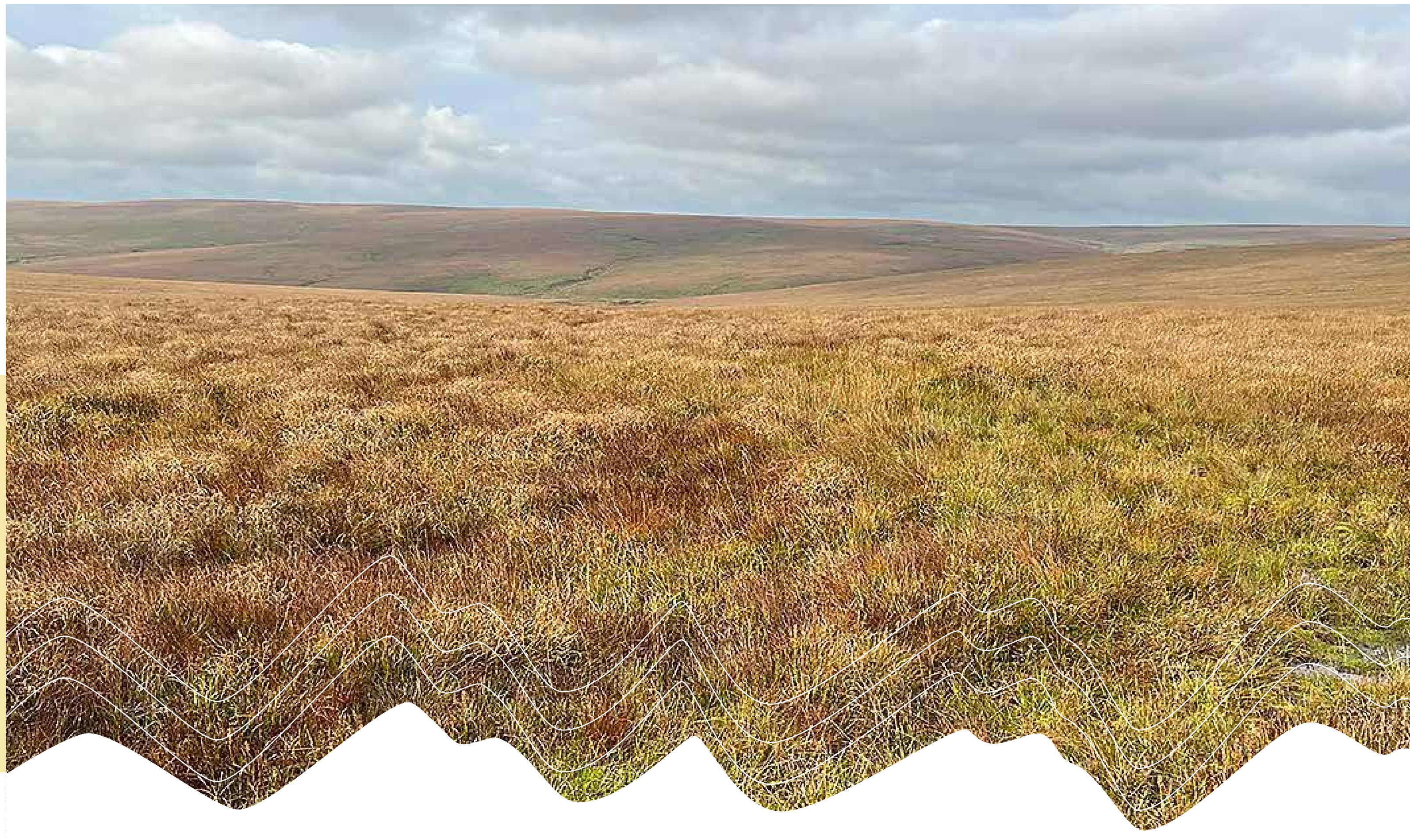
Perennial wetland reeds have been used for millennia as a construction material, especially for thatched roofing. The UK imported 1.5-1.8 million bundles (75-85% of usage) of reeds to meet supply shortfalls in 1989. Import quantities are similar today, indicating there is strong market demand for reed thatch and a lack of domestic supply. These reeds can be grown in wetland conditions. The South West has limited sources of local building materials; having a native species growing nearby that could be used in sustainable construction is important, especially compared to the current use of concrete in construction. Current average cement production emits approximately 0.31 kg of CO_2 per kg of cement from energy consumption. The embodied CO_2 in concrete equates to between 100 to 300 kg of CO_2 for every cubic meter of concrete, depending on the strength of the mix.

Where trials have been undertaken, findings suggest that paludiculture has the potential to reduce CO_2 (and overall) emissions relative to conventional drainage-based agriculture or peat extraction. This mitigation potential largely takes the form of avoided present-day CO_2 emissions from deep-drained peat cropland, which can be as high as 25-30 tCO_2e ha-1y-1 10. [6]

Various studies suggest that paludiculture sites could become net CO_2 negative thereby helping to sequester GHGs from the atmosphere. Capturing CO_2 by the adoption and uptake of paludiculture techniques has the potential to make an important contribution to achieving the UK's commitment to net zero carbon emissions by 2050.

It should be noted that methane (CH_4) emissions are typically higher from wetlands (including sites managed by paludiculture) compared to drained cropland. This could partly offset the climate mitigation benefits of reducing CO_2 emissions. The highest CH_4 emissions occur when water levels are above the peat surface but, with careful crop selection and water management, it should be possible to minimise CH_4 emissions, whilst also sequestering CO_2 .

Despite its potential, paludiculture does not yet offer an economically viable, large-scale or immediately implementable solution to tackle the high GHG emissions from cultivated lowland peats. This should not preclude continued research and development into the potential of high-water table crops or to the development and expansion of paludiculture.



Supporting literature

1 Lunt PH, Fyfe RM & Tappin AD (2019) 'Role of recent climate change on carbon sequestration in peatland systems' Science of the Total Environment 667, 348-358

2 Lunt PH, Fyfe RM & Tappin AD (2019) 'Role of recent climate change on carbon sequestration in peatland systems' Science of the Total Environment 667, 348-358

3 Lees K.J, QuaifeT, ArtzR.R.E. KhomikM, ClarkJ.M Potential for using remote sensing to estimate carbon fluxes across northern peatlands – A review

4 Sustainable Catchment Monitoring Programme (SCaMP)

5 IUCN Peatland Programme: Peatland addition to the UK GHG inventory adds 3.5% to national emissions

6 Defra Project SP1218 An assessment of the potential for paludiculture in England and Wales. Mulholland, B., Abdel-Aziz, I., Lindsay, R., McNamara, N., Keith, A., Page, S., Clough, J., Freeman, B., Evans C. (2020). An assessment of the potential for paludiculture in England and Wales.

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Sustainable Earth Institute

Evidence summary for policymakers

Relating to the following Global Sustainability Development Goals

13 CLIMATE ACTION

15 LIFE ON LAND

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This Policy Brief is part of a series aiming to inform policy-makers of our sustainability research, in particular around Net-Zero Carbon and Healthy Landscapes.

To read more in the series visit: www.plymouth.ac.uk/sei-impact

Voice of a sustainable earth

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Dr Paul Lunt is an associate professor in Environmental Science. His current research is focussed on habitat restoration, in particular evaluation of levels of carbon sequestration, flood risk management and nature conservation. He has carried out the vegetation monitoring evaluation on a £1.5 million hydrological restoration project on Dartmoor's headwater mires catchments. He was also a contributing author on the International Union for the Conservation of Nature (IUCN) UK Commission of Inquiry on Peatlands and was the lead author of the (IUCN) UK review and consultation exercise on peatland restoration (Lunt et al 2010). He also sits on DEFRA's Southwest Lowland Agricultural Peat Task Force.

The University of Plymouth has a national and international track record in specific areas of data acquisition as well as the interpretation and visualisation of environmental data. It is currently working draw these strengths together to deliver the next generation of environmental monitoring and assessment. Building on research bases within environmental monitoring and fate, sensors, agri-tech, and biology we have formed a University-wide Sensors group, which is already forging new collaborations and gaining funding.