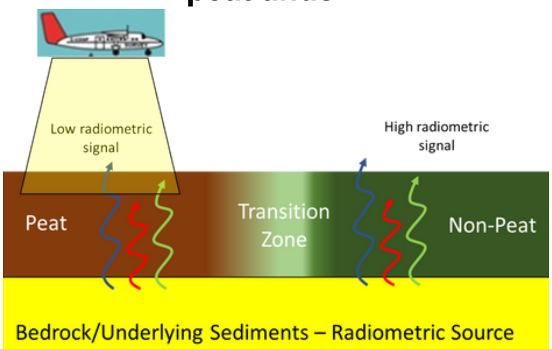
TECHNOLOGY AND MAPPING

Aircraft flying over Co. Wicklow acquiring geophysical data of peatlands.



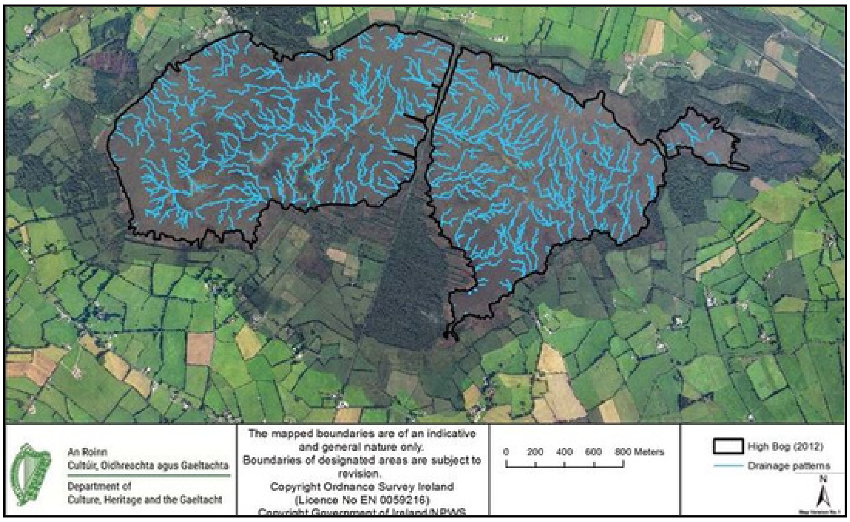
Source: David O'Leary (652)

"Securing peatlands for the future, and abating their contribution to atmospheric carbon levels, means digitally mapping them now. Digital mapping using field observations combined with remotely-sensed images and statistical models is an avenue to more accurately map peatlands and decrease this knowledge gap" (566).

Introduction

Interest in mapping peatland information derived from digital data has grown exponentially in the last two decades. This includes remote sensed data (e.g. satellite images, geophysical surveys), as well as other digital mapping (historic maps) and Machine Learning technologies. There are now multiple means to remotely monitor peatland areas, their status and the effects of management (especially rewetting and restoration), ranging from space-based satellite measurements (optical and radar) to airborne, drone and ground based geophysical measurements (Ground Penetrating Radar (GPR), Electro-Magnetic and Radiometric (passive measure of naturally occuring radiation).

To date, the analysis and classification of land cover, land use, peat depth and 3D terrain modelling has been one of the principal applications but methodologies are also being increasingly deployed to monitor the environmental conditions of peatlands, vegetation and disturbances, such as drains. A variety of data sources are now available, such as Earth Observation (EO) data (images) with missions operated by NASA (Landsat) or European Space Station (Sentinel), airborne geophysical surveys (e.g. Geological Survey Ireland's Tellus project) or LIDAR (Light Detection and Ranging) surveys operated on drone or aeroplane platforms. The use of a combination of data sources, such as satellite imagery and geophysical products, combined with machine learning algorithms, will help achieve sustainable peatland management by providing more accurate maps, as well as tools to more efficiently monitor the status of peatlands.



Clara Bog SAC, Offaly. Drainage paths derived from LiDAR imagery 2012. Source: NPWS (1007)

TECHNOLOGY AND MAPPING

Aerial view of Cloncrow Bog using a drone.

Source: Kevin Collins

Key Research Findings

Mapping peat depth, land use

Despite the fact that peatlands have been mapped for more than 200 years, with the Bog Commissioners producing some of the first accurate peatland maps in Ireland (567), it is only recently that maps of peat soils have been updated using a combination of data sources including digital data and technology thus **improving the accuracy of the total extent and types of peatlands**, which had hitherto been underestimated (158, 162). Airborne geophysical (e.g. radiometric) surveys provide relevant subsurface information to update or redefine peatland extent maps at a national scale (652).

A recent study mapped and assessed four peatland land use categories (industrial peat extraction, forestry, grassland, and residual peatland) and found that over **30% of peatlands have seen significant changes in the past 30 years** (352).

Many studies have now demonstrated the use of remote sensed datasets (satellite imagery, radiometric) to refine previous estimates (566, 567), for example to produce land cover maps (119) or land use map over given periods (115) but also to **map disturbances with high accuracy** (e.g. drains in blanket bog) (156, 160) or detect change to the surface vegetation (629).

Latest methodologies for monitoring

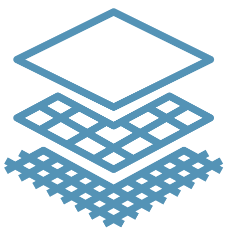
Airborne radiometric and LIDAR survey data can help map upland peat depth and the large extent of relic peat under grassland (32, 324). Together with remotely sensed data, geophysics can potentially be used to **provide estimates of peat thickness or soil moisture**.

Geophysical analysis of blanket peat has also been shown to be a useful tool to help **monitoring organic matter decomposition** at the surface of bogs (459).

Paludiculture (wet agriculture) is an emerging green sector that would benefit from harnessing digital technologies and innovation. Developing business models for sustainable and viable products from paludiculture on industrial cutaway peatlands and other sites is now needed.

Paludiculture products
Power to the Peatlands Conference 2023

Source: David O'Leary



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- While satellite data and specific algorithms can be used to monitor the health of peatlands, the addition of **drones** and **machine learning analysis** have been found to be a useful tool for vegetation communities mapping. Studies have set out clear steps from the selection of the area to be captured by drone images to the final creation of classified annual wetland maps (41, 42, 43, 44). The use of drones at the highest legal altitude (120 m) was found to be ideal to map vegetation patterns in raised bogs (804).

- Airborne Radiometric data from the GSI Tellus Survey is sensitive to the presence or absence of peat soils (652). Peat acts to block the natural radiation emitted by geological material due to the high water content of peat soils. In addition, **radiometric data**, when combined with satellite remote sensing images, can be used to **divide a peatland into distinct geographic zones** (653) showing areas with similar vegetation and peat soil conditions.

- Several studies have investigated the feasibility of adopting **multi-temporal InSAR** (interferometry of Synthetic Aperture Radar) based on Sentinel-1 data for the detection and monitoring of millimetre-scale surface movements in natural peatlands (291) and correlate these with in-situ ground displacements ("bog breathing") and water table depth measurements (395).

- Remote sensing and non-parametric methods have been employed to measure **evapotranspiration** based on net radiation, ground heat flux, air temperature and surface temperature (396).

- **Paludiculture** (wet agriculture) is an emerging sector transitioning towards a sustainable green sector that would benefit from harnessing the digital transformation (i.e. digital technologies developed for Agriculture 4.0 and Industry 5.0) (757).

How can we effectively address the sustainable management of Irish peatlands using the latest digital technology?

The advent of digital technology can enhance environmental and ecological sensing and provide robust methods to track and monitor peatland land use and land use changes and management practices over time. However, several challenges still exist before widespread deployment in all peatland projects. Collaborative and interdisciplinary research and development of these new tools is required. Consideration should be given to the infrastructure required to store and manage data, given the environmental externalities produced by the data. The governance and ownership of data related to peatland restoration also requires consideration and should adhere to the principles of open science to ensure the greatest impact.

Database

This factsheet is part of a series produced by Peat Hub Ireland (PHI). The reference numbers in brackets refer to individual publications in the PHI database which link to the original source of evidence. Use the QR codes to access the database or view research projects associated with the themes. All factsheets in the series are available on the PHI website.

Research Projects