Queensland Decarbonisation Hub

Policy Brief

Unique fire-resistant Queensland peatlands: A nature-based carbon storage solution

Authors: Professor Catherine Yule[1], Dr Gareth Chalmers[1], A/Professor Sanjeev Srivastava[1], Dr Adrian McCallum[1], Professor David Chittleborough[1], Dr Chin Chin Too[2], Dr Fernanda Adame[3], Professor Clare Murphy[4], Dr Max Desservettaz[4], Deepa Roy[4], Meagan Porter[5], Scott Foyster[5], Dr Allen Gontz[6]

Affiliations: [1]University of the Sunshine Coast, [2]University of Vienna, [3]Australian Rivers Institute - Griffith University, [4]University of Wollongong, [5]University of Tasmania, [6]Clarkson University

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Queensland Decarbonisation Hub

About the Hub

The Queensland Decarbonisation Hub brings together knowledge, people and innovation to co-create solutions to accelerate Queensland's clean growth future. We connect Queensland universities, industry, communities, First Nations people and government to build and share the knowledge needed to reduce emissions. The Hub's vision is for Queensland to become a leading decarbonised economy in which communities, industry and the environment thrive.

About this policy brief

In 2024, the Queensland Decarbonisation Hub initiated a funded research stream, inviting proposals for research that could contribute to understanding and supporting Queensland's decarbonisation transition. The Hub's Advisory Committee, which brings together representatives from industry and other sectors, helped inform the selection process by identifying areas where research could add value to emerging policy and practice. Eight projects were selected across a diverse range of topics, including the research featured in this brief.

Each project has produced a detailed technical report, which is undergoing review prior to publication. Alongside these reports, the Hub has worked with the research teams to consider a different question: what does the research mean for policy and practice?

This question was explored through a series of workshops and the Hub's Research Showcase, where researchers presented their findings to an audience drawn from government, industry, research and the wider community. These policy briefs build on that process. They are intended as short, accessible companions to the technical reports, highlighting the findings that matter most beyond the research itself and the questions and opportunities they raise for Queensland and Australia more broadly.

About this research

Responding to climate change is often discussed in terms of reducing emissions from energy, industry and transport. This research draws attention to another part of the equation by examining the role of subtropical peatlands as significant natural carbon stores. The findings suggest these ecosystems represent an important, but largely unrecognised, component of Queensland's natural capital and raise questions about whether existing planning, land management and carbon accounting frameworks adequately reflect their contribution.

The research also shows that protecting these carbon stores depends on active management. Water table condition, vegetation composition and fire management all influence whether peatlands continue to accumulate and retain carbon or begin to degrade and release it. In particular, the findings provide further evidence that maintaining healthy *Empodisma*-dominated peatlands and avoiding prolonged peat combustion are central to preserving both their ecological function and long-term carbon storage.

As governments continue to consider nature-based approaches to climate mitigation, this research suggests there is value in broadening the evidence base used to inform policy and investment decisions. Better mapping, monitoring and understanding of subtropical peatlands would strengthen future decisions about conservation, fire management, land use and carbon accounting while helping to protect ecosystems that provide important climate, environmental and community benefits.

Dr Liz Young

Research Director, Queensland Decarbonisation Hub

From the Showcase Session Facilitator

Research conducted through this project highlighted that whilst peatlands only cover a small proportion of the Earth's surface they hold more carbon than all the world's forests combined. This was backed up by the work here that showed a single hectare of K'gari peat stores 20-50 times to that of adjacent rainforests. The implications of this research in the way we need to value peatlands and manage them in the future has large implications not only around carbon storage and greenhouse gas emissions, but also for land-use planning per se.

The other practical implication of this research work is improving our understanding of how we manage fire around peatlands in the future as they emit enormous amounts of toxic greenhouse gases when burning (e.g., managed burn sites on K'gari emit 30-300 times more methane than wildfire-affected sites). This research again provides new information around fire management and protecting these critical natural systems.

Chris Norman

CEO, NRM Regions Queensland

1. Why this research matters

Peatlands are among the world's most important nature-based climate solutions, storing carbon in layers of slowly accumulated plant material built up over thousands of years. Despite covering a small fraction of the Earth's surface, they hold more carbon than all the world's forests combined. Yet peatlands are increasingly threatened by climate change. As droughts intensify and fires become more severe, peatlands that have functioned as carbon sinks for millennia are beginning to release their stored carbon back into the atmosphere.

Australia's peatlands span from subtropical Queensland to alpine regions in southern Australia, but they remain poorly studied and largely absent from national and international carbon accounting frameworks. In South East Queensland, coastal peatlands on offshore islands, such as K'gari (Fraser Island) and along the mainland coast, represent a globally unusual ecosystem. These fire-adapted peatlands support unique and highly adapted fauna and flora that have coexisted with burning for thousands of years under the stewardship of the Butchulla people and other First Nations communities. These systems challenge assumptions about how peatlands behave and what makes them vulnerable.

Our research into these subtropical peatlands reveals extraordinary carbon storage capacity, dynamic greenhouse gas emissions, and the first data on toxic gas emissions from eastern Australian peat fires. At a time when Australia is developing its approach to land-based carbon accounting and nature-based climate solutions, understanding what these ecosystems store, emit, and need to remain functional is scientifically important and a practical necessity for sound climate, land management, and public safety policy.

2. Key findings

- Subtropical Queensland peatlands store between 300 and 2,500 t C/ha, with some sites reaching up to 3,600 t C/ha, approximately AUD$343 million of carbon market value.
- The critical control on peatland function and carbon storage is whether the deep, waterlogged peat layer and the *Empodisma* root mat that protects it remain intact. Cool managed burns, conducted when the water table is high and the peat is saturated, preserve this structure, while prolonged smouldering wildfires destroy it. Managed burns can therefore help protect peatlands from severe wildfire.
- Substantial amounts of methane (CH_4) are produced by microorganisms in the deep, oxygen-free peat layers, but whether large quantities of methane are finally emitted to the atmosphere is yet to be determined as methane may be recycled by microbes associated with *Empodisma.*
- The full climate value of intact peatlands extends beyond methane emissions. It includes avoiding the release of stored carbon and maintaining the ongoing uptake of CO_2 through continued peat accumulation — a benefit that is lost if the peat-forming system collapses. Managed burning, through maintaining the dominance of the fire

resistant *Empodisma,* preserving peat integrity and supporting rapid vegetation recovery, helps protect both.

- Carbon monoxide (CO) emissions from burning peat are substantially higher than emissions from burning a wide range of Australian plant types, including eucalypts and other native species.
- Hydrogen cyanide (HCN) emissions from burning peat are disproportionately elevated relative to other fuel types. A high HCN/CO ratio means that CO monitoring alone will systematically underestimate the toxicity risk from peat smoke — a serious and currently unmonitored occupational health hazard.
- Fine particulate matter ($PM_{2.5}$) is highest immediately after ignition and drops rapidly thereafter. Firefighters closest to the fire front during initial ignition face the greatest acute exposure to both toxic particles and gases.
- Mainland peatlands may face pressures from surrounding development, such as nutrient enrichment, in addition to drainage and fire.

3. Why the findings matter in practice

These findings have direct implications for how governments account for, protect, and manage peatland carbon. Currently, subtropical peatlands are not formally recognised in Australia's national carbon accounting framework. This means that both their substantial carbon stores and their methane emissions are effectively invisible to policy. A first step towards incorporating them is better mapping of their extent and depth. These data remain incomplete for both mainland and offshore island sites, including Bribie, Moreton and Stradbroke Islands. The carbon density figures now available in this study provide a compelling case for treating these ecosystems as high-priority assets in land use planning, conservation, and carbon market frameworks.

The water table and fire-related findings are particularly important for land management practice. Drainage of peatlands for agriculture or development converts a highly fire-resistant carbon store into a fire-prone liability. This challenge has direct relevance for planning decisions, fire management resourcing, and the assessment of land clearing proposals in coastal Queensland.

The methane findings require further investigation as healthy *Empodisma* cover may actively reduce net methane emissions. They add important nuance to carbon accounting. High methane emissions from intact, managed peatlands might be a signal that the peat system is functioning normally, not a liability. Management decisions that reduce methane by degrading peat integrity — whether through drainage, development, or uncontrolled wildfire — would represent a net climate harm, rather than a benefit. The evidence supports maintaining and restoring *Empodisma* dominance and high water tables as central objectives of peatland management.

The emission findings have immediate practical implications for Queensland Fire Department, and for state and national air quality agencies. Current occupational health

guidelines do not account for the elevated HCN and CO emissions characteristic of peat fires. The data in this study provide a basis for developing peat-specific exposure standards and monitoring requirements.

The nutrient enrichment finding at Woodland Block, Peregian, adds a new dimension to the threats facing mainland peatlands. Evidence that urban groundwater can enrich otherwise oligotrophic peatlands — altering vegetation structure and potentially destabilising carbon storage — means that peatland buffers from adjacent development need to be explicitly considered in planning decisions, something current frameworks do not require.

4. Who should pay attention

Government environmental agencies need this research because subtropical peatlands are currently absent from carbon accounting and biodiversity frameworks despite storing globally significant amounts of carbon. Decisions about land clearing, drainage, and fire management in coastal Queensland directly affect these stores.

The Clean Energy Regulator and agencies responsible for Australia's carbon markets should note that these ecosystems represent a potentially significant but currently unaccounted carbon asset.

Fire and Emergency Services, and national occupational health and safety agencies, should consider the implications of the elevated HCN and CO emissions from Australian peat fires for firefighter exposure guidelines, monitoring and personal protective equipment.

Parks agencies, local government (including Noosa, Sunshine Coast, Redlands Councils and others managing coastal peatlands), and Fire and Emergency Services can use the findings to inform fire and land management of coastal peatlands, including the management of drained mainland peatlands.

State and local government planners in South East Queensland should be aware that coastal peatlands in the region may represent high-value carbon ecosystems warranting consideration in planning decisions involving land use change, drainage, or coastal development.

For First Nations organisations, particularly the Butchulla People, Kabi Kabi (of the southeast coast), and Quandamooka (of Minjerribah/ Stradbroke Island), traditional custodianship of peatlands includes long-standing burning practices that are central to any future management framework. The research supports the ecological value of cultural burning and the place-based knowledge that informs when and how burns are conducted.

5. What could happen next

The most immediate need is a systematic subsurface mapping of the extent and depth of subtropical Queensland peatlands, particularly on the mainland, where drainage and land

use change have reportedly affected many sites, and where current knowledge is very limited.

Quantifying the net greenhouse gas balance of different fire and management regimes is a key research priority. Further research is also needed to understand methane production and oxidation in intact peatlands. This is necessary before these ecosystems can be responsibly incorporated into carbon accounting or offset frameworks.

For firefighter and public safety, the emission factor data provide the scientific basis for developing peat-specific occupational exposure standards, air quality models, and personal protective equipment recommendations. This work should proceed in collaboration with Fire and Emergency Services and Safe Work Australia. Field measurements during actual fire events are needed to test the laboratory findings under real conditions.

There is a clear opportunity to develop co-designed management guidelines with First Nations custodians, building on the evidence that traditional cool burning practices are ecologically beneficial. Active restoration trials at Bowarrady — including water table management and *Empodisma* replanting, in collaboration with Butchulla Traditional Owners — are a priority.

For drained peatlands, especially on the mainland, the potential for a targeted rewetting program to reduce fire risk and restore carbon-storing function warrants investigation, alongside the broader carbon and biodiversity benefits of peatland restoration in Queensland.

In the longer term, if extent mapping confirms significant total carbon stocks, there may be a case for including these ecosystems in Australia's Nationally Determined Contribution under the Paris Agreement and for developing specific peatland protection provisions within Queensland's land clearing and biodiversity legislation.

6. Points to note

Carbon storage estimates are based on field measurements from a limited number of sites on K'gari and the South East Queensland coast. Regional and national carbon stock estimates will, therefore, depend on better mapping of peatland extent and depth.

The GHG flux findings are based on a single seasonal sampling campaign (August 2025) across six sites on K'gari plus one mainland site (Peregian Swamp, sampled before and after a managed burn). They require confirmation through multi-year, multi-season measurement across a broader range of sites and fire histories. Further work is also needed to understand how representative site-level measurements are of whole-peatland GHG dynamics and to test the relationship between fire, microbial processes and methane production.

The threshold of 50% *Empodisma* cover for peat accumulation is based on field observations of multiple sites on K'gari and on the mainland, yet the mechanisms involved require further investigation.

Generalised management guidelines regarding water tables require more systematic hydrological monitoring across a broader range of peatland types and conditions.

The emission factor results from the FireLab3 study are preliminary, with full statistical analyses still in progress. The HCN and CO findings are, however, consistent with international literature on peat fire toxicity and are sufficiently robust to support action on firefighter safety guidance.

These qualifications do not diminish the significance of the findings but indicate where further investment in research would most directly strengthen the policy case.

7. Contact

Professor Catherine Yule: cyule@usc.edu.au