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Short webinars for environmental policy-makers and practitioners

Manaaki Whenua
Landcare Research

Mitigating Greenhouse Gas Emissions from drained peat (Organic Soils)

The following questions were asked during our live webinar with Jack Pronger and Professor Louis Schipper but due to time restrictions, we were unable to answer these in the session.

Questions and Answers:

Many excellent questions were posed about additional knowledge needed from research as we look to manage emissions from drained peat soils. We have considerable gaps in our knowledge of the size of emissions in New Zealand, its control and consequences of changing land use including retirement. Consequences include potential reductions in greenhouse emissions and impacts on economics and people of the regions farming on peat. Our currently funded programs are starting to focus on (i) establishing the size of emissions, (ii) possible reductions in emissions with changes in land management and use. We have proposed future work under consideration including testing the importance of water table depth and quantifying emissions under less intensive land uses. Further work is needed to include emission measurements in other regions, explore practical challenges associated with raising the water table, and possible options for restoration including the social and economic impacts.

When do you expect to be in a position to share the results from these projects?

The Adaption pathways to sustainable peatland management is a 3-year programme due to finish in June 2027.

Measuring and modelling agricultural management on peat (MAPSERS) is also a 3-year programme due to be completed end of March 2028.

The proposed NZ Agricultural Greenhouse Gas Research Centre (NZAGRC) work is not yet funded but if approved will run from about July 2025 through to end of June 2029.

Reports and publications from these programmes will be made available (pending approval from funders) as they are completed between now and each projects completion.

Also peat on Buller district on northern West Coast, especially land prone to fluvial flooding?

The team are keen to understand more about the issues on the West Coast and we are engaging with stakeholders on the West Coast of the South Island.

Any understanding on potential implications from your research on the ETS?

Before a new category or activity could be introduced to the New Zealand ETS, it would need to be included in the emissions accounting towards New Zealand's Nationally Determined Contribution (the NDC or Paris Agreement emission reduction target). The ETS is New Zealand's primary tool for driving emission reductions toward the NDC target. While, soils, including peat soils, are not currently included in the ETS, our understanding of emissions reduction potential will improve through the current

MAPSERS project and proposed NZAGRC work. We will then be in a better position to provide advice around inclusion of non-forest land (particularly peat soils) in the NDC and ETS.

The RAMSAR definition of wetland includes peatlands but the NZ definition of wetland (in RMA and NPS-FM) excludes peatlands. Do you find that it is difficult to protect peatlands in NZ.

Our understanding is that current legislation does prevent drainage of intact wetlands that includes intact peatlands, and there are some regulations regarding drainage management close to natural wetlands (see for example; National Environmental Standards for Freshwater - S46). However, peatlands that are already drained are not protected from ongoing drainage, so it is therefore difficult to restrict ongoing drainage upgrades that allow emissions to continue long term from drained peatlands.

Is there anyone working on peat soils on the Chatham Islands? Or interested in expanding their work to include the Chathams? We are looking for opportunities to support land use change and restoration, possibly through biodiversity or carbon funding if/when possible.

We are not currently involved in peat soils work on the Chatham Islands, in the past MWLR staff have been involved in peatland vegetation survey work there. GHG emissions and mitigation potential on the Chathams are a large unknown at present and we are interested in exploring opportunities there. We are aware some exploratory work has been done through The Nature Conservancy looking at carbon market opportunities associated with peat soils on the Chatham Islands. We are happy to meet and discuss this further.

What is the likely impact on future sea level rise for Hauraki, e.g., salt intrusion and raising the water table?

We understand some peat soil areas on the Hauraki Plains are at or very close to mean sea level now and drainage infrastructure is also struggling to maintain land drainage in some sub catchments (e.g. Muggeridges). Sea level rise will certainly exacerbate drainage issues and risk of salinisation. WRC have developed a Coastal Inundation Tool (see; Coastal Inundation Tool) that allows users to explore sea level rise scenarios in low-lying locations near the coast like the Hauraki Plains (but it does not account for ongoing soil subsidence). We are not aware of work focused on salt water intrusion in the Hauraki, however hydrodynamic modelling work has been done through the Future Coasts Aotearoa MBIE programme in the lower Waikato River catchment. This work has shown the salt water wedge will move up river with sea level rise and modelling work is likely needed in the Hauraki to better understand this risk.

Are you considering the time lag between rewetting, subsequent CH4 emissions and then CO2 sequestration?

We are aware that the net GHG benefits of rewetting are highly uncertain in the short term, as you mention there could be increases in methane emissions that are not offset by the reduction in C emissions, or sequestration, in the short term. We need measurements over rewetted systems to better understand the short-term effects. In the longer term we are confident the net GHG benefit of rewetting is large due to the avoided emissions.

How much available info is there on strategies to mitigate the emissions caused by peat draining internationally, especially for areas most similar to those in NZ? Thank you!

Peatlands in NZ are unique, largely formed by the vascular restiad species in a warmer climate compared to the non-vascular sphagnum which is the common peat former in cooler northern hemisphere temperate peatlands. Therefore, while there is a reasonable amount of international work

focused on mitigating GHG emissions from drained peatlands it is difficult to know how relevant it is to our unique situation and we will need to test international mitigation strategies locally. We have done some work for Waikato regional Council in this area, for example see Review of potential management interventions to reduce peat subsidence and CO2 emissions in the Waikato | Waikato Regional Council

Roughly what percentage are NZ wetland GHG emissions under pasture (using the current ICPP EF) to total NZ land use GHG emissions from stock?

Total agricultural emissions were 40.613 Mt CO_2e based on NZs 2023 GHG inventory. Below we compare the size of emissions from drained peat soils, and also separately peaty mineral soils, relative to these total agricultural emissions. A true estimate of % contribution would require emissions from peats and peaty mineral soils to also be included in the agricultural reporting and so is not straight forward, please see notes and sources of information at the end of this answer. Emissions from peat soils are currently accounted for in the land use, land-use change and forestry (LULUCF) section of NZs GHG inventory (i.e. separate from agriculture) and emissions from peaty mineral soils are not currently accounted for in either the agriculture or LULUCF inventory.

The emissions from grassland drained peat soils are about 8.6% of total agricultural emissions (3.51 Mt CO_2e/40.61 Mt CO_2e = 8.6%), not including emissions from animals on peat soils. Livestock farming on grassland peat soils likely contribute about another 1.46 Mt CO_2e and if this is included, the contribution from peat soils increases to about 4.97 Mt CO_2e or 12.2% relative to agricultural emissions (4.97 Mt CO_2e/40.61 Mt CO_2e = 12.2%).

With higher uncertainty, drainage of grassland peaty-mineral soils could be a significant emission source at national scale. We have estimated soil emission from these soils (mineral soil with a peaty layer greater than 10 cm thick, but less than the 30 cm required to meet criteria for an organic soils) at 2.3 Mt CO_2e using default emission factors from IPCC 2013. Livestock farming on these peaty mineral soils likely contributes another 0.95 Mt CO_2e. The combined contribution for soil and livestock emissions from these peaty mineral soils is then estimated at 3.25 Mt CO_2e or 8.0% relative to total NZ emissions from agriculture (3.25 Mt CO_2e/40.61 Mt CO_2e = 8.0%).

Combining the peat soil emissions, peaty mineral soil emissions, and a conservative estimate of livestock farming on both peat and peaty mineral soils, the total contribution to agricultural emissions is estimated at about 8.22 Mt CO_2e or 20.2% relative to agricultural emissions (8.22 Mt CO_2e/40.61 Mt CO_2e = 20.2%) recognising high uncertainty in these estimates.

Background information:

Drained peatland GHG emissions from grassland are estimated at 3.51 Mt CO_2e using IPCC 2013 Wetland Supplement default emission factors (compared to total drained peatland emissions across all managed land uses of 3.85 Mt CO_2e)

Accepting very high uncertainty with respect to both the total area of peaty mineral soils, and appropriate emission factors, we have estimated emissions from drained grassland peaty mineral soils at about 2.3 Mt CO_2e using IPCC 2013 Wetland Supplement default emission factors.

We have based emissions associated with livestock farming on these soils on per hectare farm emissions as described here: 28329-total-greenhouse-gas-emissions-from-farm-systems-with-increasing-use-of-supplementary-feeds-across-different-regions-of-new-zealand, conservatively we have used the low emissions estimate for a Waikato dairy farm of 10.95 t CO_2e/ha (Table 11). For context emissions likely range from 10.95 to 14.57 t CO_2-e/ha for Waikato dairy farms and this range is similar for Southland dairy farms (11.37-13.88 t CO_2-e/ha). These two regions are the largest peat soil areas in NZ.

Thanks for the nice talk(s)! I am hearing the effects of drainage/water table height and plant species, on GHG emissions in peat areas. Are there any aligned projects that look at the biology? For example, are there aerobic versus anaerobic communities (microbial/invertebrate) that may affect the rates of change with the mitigation approaches?

We do not have aligned work in this space at present. Our research to date has focused largely on paddock scale measurements of GHG emissions and now we are also starting work with process-based modelling. This modelling work should help us determine where further process-based understanding is needed.

What are the CO2 emissions from farmed peat expressed on a per ha basis?

The few existing measurements from the Peatwise Programme found per ha CO_2 emissions varied considerably ranging from about 7.2 to 30.4 t CO_2/ha/yr with a mean very similar to the default IPCC EF for nutrient poor drained grassland (19.4 t CO_2/ha/yr). In addition to CO_2 emissions there are also some nitrous oxide and methane emissions which increase the default IPCC EF for nutrient poor drained grassland to 24.6 t CO_2e/ha/yr (using IPCC 2013 Wetlands Supplement methods). This does not include emissions associated with animals on the land which for Waikato dairy farms likely contributes a further 10.95-14.57 t CO_2e/ha/yr.

Peatland-related carbon emissions are not currently included in New Zealand's Greenhouse Gas Inventory. Given their significance, is there a strategy to incorporate these emissions in future inventories?

GHG emissions from drained peat soils are included in the LULUCF category of New Zealand National GHG inventory but using outdated 2006 IPCC default methodology. These emissions are difficult to see in our inventory because they are included in the LULUCF category and offset by forestry uptake (you need to drill into the common reporting format (CRF) tables of the national inventory in detail to find this). NZ needs to move to the 2013 Wetlands Supplement methods, default EFs in this updated approach appear much closer to the mean from the few measurements we have from NZ drained peat soils.

Additionally, is there an approach to include peatlands in the New Zealand Emissions Trading Scheme?

We understand the Government is keen to include non-forest areas in the ETS where possible. At present measurement data is limited to inform mitigation potential and therefore inclusion in the ETS is problematic. However, our future planned work, if funded, will help determine if including avoided emissions (and potentially sequestration in a restoration scenario) in the ETS is workable in future.

To what degree are councils and industry looking at drainage schemes and impacts on GHG emissions in NZ?

Waikato Regional Council are doing work in this space funded through their Long Term Plan and we have been involved in work for them looking at emissions from drained peatlands where they manage drainage. We are also aware of other regional councils, see question below that includes "a number of councils are currently collaborating on a harmonised regional/local GHG inventory approach, and we're exploring how to improve the completeness of our land-based emissions estimates, including emissions from peat and organic soils". Last year Waikato Regional Council produced a report of regional GHG emissions from drained peat soils, see Organic soil emissions in the Waikato region

Is there work being done in Southland and what are some practical on farm mitigations we can do to reduce ghgs on peat soils for a dairy farm?

We are working with Environment Southland in our Adaptation pathways to sustainable peatland management programme and will soon be remeasuring peat soil depth at sites around Awarua where depths were previously measured in the 1970s. We have also done a review for Waikato Regional Council focused on mitigation options (Review of potential management interventions to reduce peat subsidence and CO2 emissions in the Waikato | Waikato Regional Council and will be extending on this work also as part of the Adaptation pathways to sustainable peatland management programme.

Any work done on GHG emissions from peat mining operations in NZ?

Emissions from peat mines are included in our national GHG Inventory and also in Waikato Regional Councils GHG inventory report (e.g. see Appendix A and B of Organic soil emissions in the Waikato region). There has been work done on restoration approaches for peat mining in the Hauraki but not with a focus on GHG emissions. The emissions are low as mining represents a small area.

If land retirement is considered as mitigation alternative, have you estimated the economic impacts? or any plans on doing it?

Some retirements could be on land that is currently not profitable. For broader scale uptake of this option, understanding the implications of mitigation options for communities including the social and economic impacts is certainly needed, and we need to involve a much wider range of skills beyond the physical science. We are doing a small amount of work in that space through objective 4 of the Adaption Pathways for Sustainable Peatland Management project where we will use the Land use management support system (LUMASS) model, essentially a multi-objective spatial optimisation framework, and involve a panel of stakeholders who iteratively draw on and engage with adaptation scenarios generated using the model.

Kia ora, a number of councils are currently collaborating on a harmonised regional/local GHG inventory approach, and we're exploring how to improve the completeness of our land-based emissions estimates, including emissions from peat and organic soils. Does MPI have any measurement data, regionally relevant emission factors, or methodological guidance that councils can use to estimate GHG emissions from peat or organic soils, ideally in a way that aligns with New Zealand's national GHG inventory?

MPI and MfE are using default IPCC EF to estimate emissions from drained peat soils because we do not have enough measurement data for country specific EFs, let alone regionally specific EFs. Last year, Waikato Regional Council produced a regional report on GHG emissions from peat soils (see Organic soil emissions in the Waikato region) which aligned with NZs GHG inventory approaches but also included estimates using a few local measurements, if you have not seen this I would recommend reading it and then discussing with the authors (or contact us in the first instance).

How is Waikato Regional Council using the results of this study to inform its policies and decision-making processes related to land use, freshwater management, or livestock health?

We have been working with Waikato Regional Council (WRC) over an extended period on issues around drained peat soils in their region. They have commissioned a report to explore mitigations options (e.g. Review of potential management interventions to reduce peat subsidence and CO2 emissions in the Waikato | Waikato Regional Council) and currently monitor subsidence and water table depth at multiple sites across the region. Additionally, work funded through WRCs Long Term plan will help understand

the risk of ongoing land subsidence and GHG emissions, identify rewetting opportunities, test priority mitigation options, and produce a guide to better management of Organic Soils.

What impact does the depth of the peat layer have on emissions?

We still have a lot to untangle here, for example we are aware that what are referred to as peaty mineral soils, which have a peaty layer greater than 10 cm thick but less than the 30 cm thickness required to meet the definition of an Organic Soil, are increasingly being recognised internationally as an emission source. But again we have no measurement data for NZ. For Organic Soils that continue to be drained, deeper soils will continue to be an emissions source for much longer because there is a much larger carbon stock.

Given climate change, in Hauraki is there sufficient surface water to adequately re-wet, and if doing so, what is a modest area estimate to expand Kopuatai/Torehape? Farmers have flood and drought challenges now, so some future opportunities.

My understanding is allocating additional water for rewetting would be a challenge. Exploratory scenarios that account for likely water use and existing allocations are needed to estimate potential area that could be rewet. We are also interested in exploring approaches to reduce surface evaporation of water, we know on a per ha basis surface evaporation is much lower over the natural bog vegetation at Kopuatai compared to Waikato pastoral land and this reduction is attributed to the water conserving properties of the restiad bog vegetation. If we could find approaches to reduce surface evaporation (one approach could be diversion of available energy for solar power) the volume of water required to rewet could be decreased as it would be provided through rainfall.

Can peat soils be used as an additive to rejuvenate degraded soils - i mean use it in contouring new land for setting up orchards/pastures etc

This would add organic material to degraded soils that may have had carbon stock depleted due to cropping but a large proportion of the added organic material would likely be decomposed and so would be a large emissions source.

Where in Northland is your research looking at/considering?

We do not currently have any emissions focused research underway in Northland but there is a need in the future to make measurements in Northland to capture effects of their warmer climate. In collaboration with Northland Regional Council we have recently remeasured peat soil depth up around Hikurangi and Waipu where depths were previously measured in the 1970s. We are aware there is scoping work underway in Hikurangi looking at rewetting of some areas for multiple benefits.

Do you think farmers could be incentivised to rewet their drained peatlands currently under agriculture, and restore them for biodiversity and carbon benefits, if they could earn carbon credits for this? Or is the current dairy use just too profitable?

This is an area that needs to be developed further. At present farmers do not pay for their emissions from these soils which means all costs are not being accounted for. In future if some component of these emissions was accounted for then farmers could be incentivised to reducing their emissions through rewetting. It is likely a combination of carbon and biodiversity markets would make such land use change more attractive.

What is the opportunity cost (in relation to agricultural production) of restoring these soils?

More work is needed here but opportunity cost will vary spatially. Where profitability is low due to nutrient deficiencies or poor existing drainage the opportunity cost will be lower and rewetting more attractive compared to situations where large investment has been made in farm infrastructure and fertiliser and where drainage is comparatively cheaper, for example gravity drained compared to pumped drainage.