Is avoided peatland conversion a cost-effective approach to climate change mitigation?

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Introduction

- Peatlands are among the planet's most important carbon sinks; yet, they are being drained and converted to agricultural land, releasing large amounts of greenhouse gases.
- Canada holds approximately 27% of the world's peatland area (over 110 million hectares) and about 150 Gt of peat soil carbon (UNEP, 2022).
- In Canada, peatlands drained for agriculture are estimated to cover up to 1.3 million hectares (Rochefort et al., 2022). Meanwhile, annual emissions from peat soils that have been drained and converted to cropland are estimated to range from 1.4 to 35 Mt CO_2e (median ≈ 18 Mt) (Strack et al., 2025).

Research Questions:

1. What is the opportunity cost to farmers of avoided conversion of peatlands to cropland in the Canadian province of Alberta?
2. What carbon incentive (CAD/tCO_2e) would make conservation financially competitive?

Evidence of Agricultural Expansion into Peatlands

The difference between the two overlay maps roughly indicates the expansion of agricultural land onto peatlands over the past two decades.

Peatland Inventory Data Sources

- Alberta Merged Wetland Inventory (AMWI) (1998-2017)
- Alberta Biodiversity Monitoring Institute (ABMI) Wetland Inventory (2017-2018)

Agricultural Footprint Sub-Layer Data

- ABMI's Wall-to-Wall Human Footprint Inventory (HFI) database (2020-2021)

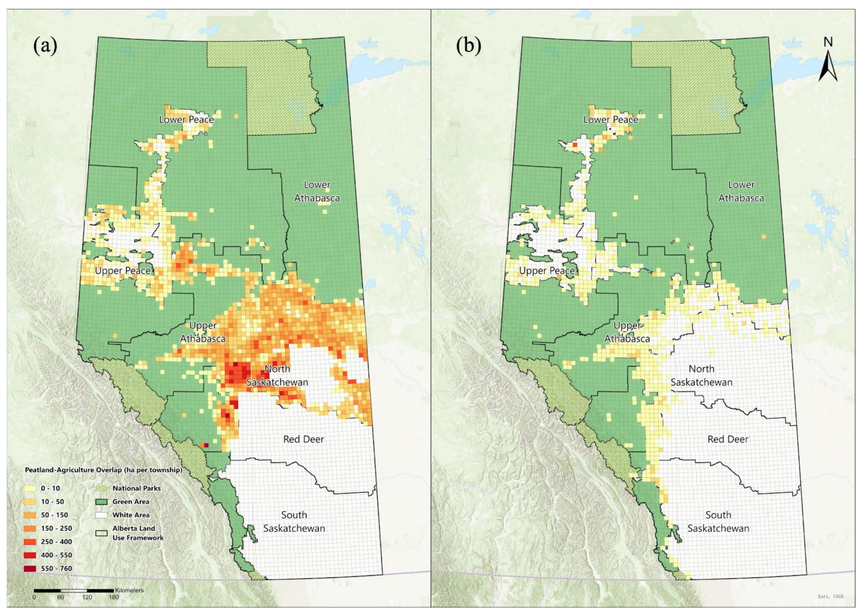

Figure 1. Peatland converted to agriculture by the township in Alberta (hectares). Panel (a) uses the Alberta Merged Wetland Inventory (AMWI), and panel (b) uses the ABMI Wetland Inventory. Each grid cell represents an Alberta township (approximately 93 km²).

Methods

Estimating opportunity costs of peatland-to-cropland conversion

- Representative farm: Athabasca County, Alberta
- Model: Farm-level net present value (NPV) over a 20-year horizon plus terminal value, based on 1,000 Monte Carlo simulations
- Uncertainty and costs: Incorporates stochastic crop yields, prices, and input costs, includes peatland drainage costs, and evaluates multiple crop rotations.
- Policy component: Estimates impacts on participation and outcomes under Business Risk Management (BRM) programs (crop insurance and AgriStability)

Initial peat carbon stock (pre-drainage)

Annual carbon decay rate (post-drainage)

Translate the opportunity costs into a carbon price

- Estimate the break-even carbon price—the CAD/tCO_2e payment needed to offset a landowner's forgone profits from conserving peatlands.
- Calculated as: (opportunity cost of conversion) ÷ (present value of avoided CO_2 emissions).

Results

Figure 2. Baseline opportunity costs of cropland uses

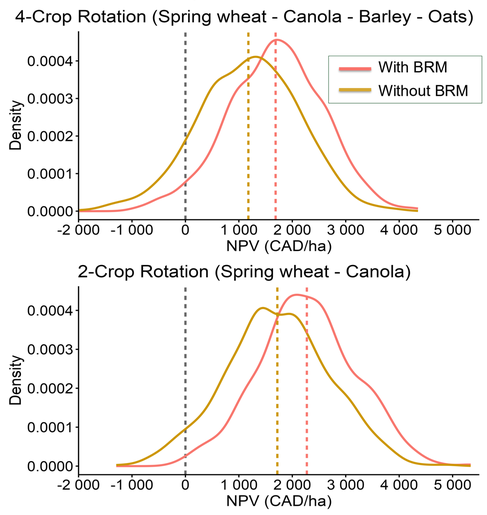

Figure 3. Break-even carbon price (CAD/tCO_2e)

Carbon price required to make conservation financially indifferent to conversion by scenario

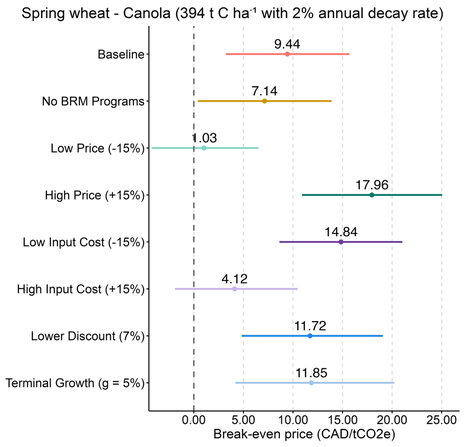

Table 1. Estimated break-even carbon prices for the baseline of conserving peatlands from agricultural expansion

Crop rotations	Break-even carbon prices (CAD / tCO_2)							
	1180 t C ha^{-1}				394 t C ha^{-1}			
	2% decay rate		5% decay rate		2% decay rate		5% decay rate	
	Mean	SD	Mean	SD	Mean	SD.	Mean	SD
Spring wheat – Canola – Barley – Oats	2.34	1.22	1.17	0.61	7.01	3.67	3.5	1.83
Spring wheat – Canola – Barley	2.41	1.24	1.2	0.62	7.21	3.71	3.61	1.85
Spring wheat – Canola	3.15	1.26	1.58	0.63	9.44	3.77	4.72	1.89

Key Findings

- For landowners, peatland conservation implies foregone agricultural returns, with a baseline opportunity cost of $1,700 - $2,300 CAD/ha.
- Removing BRM reduces the mean NPV by roughly 30% and increases the probability of losses from roughly 3% to 11% for the baseline 4-crop rotation.
- Under the baseline case, the break-even carbon price is below CAD 10/tCO_2e, suggesting modest incentives could prevent peatland conversion to agriculture.

Policy Implications

- Preventing peatland conversion can deliver large avoided emissions at low private cost, and even modest carbon payments could shift landowner decisions toward conservation.
- BRM programs increase the costs of conservation and may not be aligned with conservation policies.
- Alberta's Wetland Policy could explicitly incorporate peatland carbon storage and GHG impacts into wetland valuation and compensation.

Acknowledgement

- We thank Environment and Climate Change Canada (ECCC) for funding support.
- We are grateful to Scott Jeffery for constructive comments on the methodological approach and to Hongyu Wang for guidance with ArcGIS Pro.
- We also thank participants in three policy workshops for their valuable insights, as well as the many individuals who provided thoughtful feedback throughout the project. This research involving human participants was approved through the University of Alberta human ethics review process (Project "Modelling peatland in Alberta," Pro00135451).