Policy Implications of Warming Permafrost

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http://www.unep.org/pdf/permafrost.pdf

Carbon dioxide (CO2) and methane emissions from thawing permafrost could amplify warming due to anthropogenic greenhouse gas emissions. This amplification is called the permafrost carbon feedback. Permafrost contains ~1700 gigatonnes (Gt) of carbon in the form of frozen organic matter, almost twice as much carbon as currently in the atmosphere. If the permafrost thaws, the organic matter will thaw and decay, potentially releasing large amounts of CO2 and methane into the atmosphere. This organic material was buried and frozen thousands of years ago and its release into the atmosphere is irreversible on human time scales. Thawing permafrost could emit 43 to 135 Gt of CO2 equivalent by 2100 and 246 to 415 Gt of CO2 equivalent by 2200. ***Uncertainties are large, but emissions from thawing permafrost could start within the next few decades and continue for several centuries, influencing both short-term climate (before 2100) and long-term climate (after 2100).***

Below are specific policy recommendations to address the potential economic, social and environmental impacts of permafrost degradation in a warming climate:

1) Commission a Special Report on Permafrost Emissions: The Intergovernmental Panel on Climate Change. (IPCC) may consider preparing a special assessment report on how CO2 and methane emissions from thawing permafrost would influence global climate to support climate change policy discussions and treaty negotiations. All climate projections in the IPCC Fifth Assessment Report, due for release in 2013-14, are likely to be biased on the low side relative to global temperature because the models did not include the permafrost carbon feedback. Consequently, targets for anthropogenic greenhouse gas emissions based on these climate projections would be biased high. The treaty in negotiation sets a global target warming of 2°C above pre-industrial temperatures by 2100. If anthropogenic greenhouse gas emissions targets do not account for CO2 and methane emissions from thawing permafrost, the world may overshoot this target.

2) Create National Permafrost Monitoring Networks: To adequately monitor permafrost globally,

3) Plan for Adaptation: Nations with substantial presence of permafrost may consider developing plans evaluating the potential risks, damage and costs of permafrost degradation to critical infrastructure.

Carbon feedback additional warming

How much additional warming could carbon feedback add by 2100

At issue is not only ignored permafrost carbon, but ignored carbon feedback as a whole.

GEWX-LEAPS conference Melbourne 2009 provides the estimates of the experts.

From a risk perspective we conclude the potential of another **5.5°C warming by 2100.**

Vulnerable carbon pools and feedbacks by 2100
Estimates are for A2 scenario.

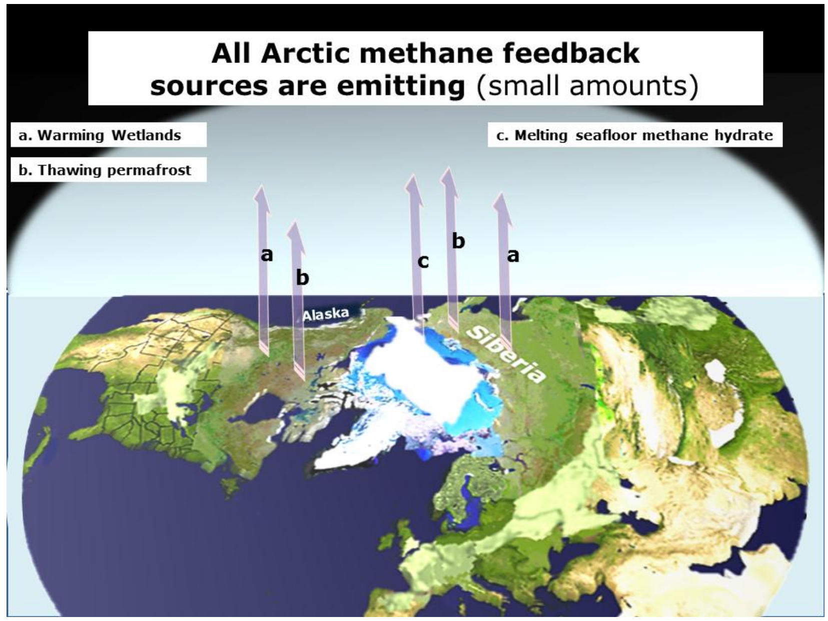
The world economy is tracking A1FI which is 0.6°C higher than A2 by 2100.

RISK

There is no question that vulnerable (to warming) carbon pools are massive and may lead to planetary catastrophe. This applies to permafrost alone and methane hydrate alone.

In the Arctic there are three large pools of carbon vulnerable to global warming, and right now they are all emitting additional carbon as methane to the atmosphere, as the Arctic warms rapidly- several times faster than the rest of the planet.

1. Warming peat rich wetlands
2. Thawing permafrost.
3. Arctic sea floor frozen solid methane gas hydrate.



Therefore assessing the greatest risk applies for policy rather than so called *most likely* estimates.

Permafrost contains an estimated double atmospheric carbon and so may Arctic methane hydrate. Recent research suggests methane hydrate outside of the Arctic may be vulnerable to warming.

Emissions from both can trigger irreversible increasing emissions.

Methane emissions from permafrost and methane hydrate will last many hundreds to thousands of years. Therefore to protect humanity we need estimates of carbon feedback emissions over many centuries, but this is not done.

We should be taking the worst case possibility from the research available. We are not, instead means are taken. However means of a range of results are not even policy relevant, because the goal of policy is to protect human populations and humanity.

Terrestrial carbon feedbacks 1.5°C

Terrestrial carbon feedbacks exclude peat lands, methane emitting water bodies, thawing permafrost and melting methane hydrate.

Range 0.1 to 1.5°C. The 1.5°C is from Peter Cox 2000 and includes Amazon die back. Amazon research since 2000 indicates die back. The IPCC 2007 estimated 1.5°C for A2 *Warming tends to reduce land and ocean uptake of atmospheric carbon dioxide, increasing the fraction of anthropogenic emissions that remains in the atmosphere. For the A2 scenario, for example, the climate-carbon cycle feedback increases the corresponding global average warming at 2100 by more than 1°C* (from year 2000). So we take 1.5°C.

Methane from frozen soils 2.0°C

Range 0.2 to 2.0°C.

Thawing permafrost according to D Lawrence by generating its own internal heat can be self accelerating with respect to irreversible emissions of methane. Sergei Zimov says the same. Siberian coastal permafrost is collapsing into the sea releasing large amounts of carbon. Therefore we take the 2.0C.

Tropical peatlands 0.2°C

Range 0.1 to 0.2

Methane hydrate 1.5°C

Arctic sea floor frozen solid methane gas hydrate

There is very little published David Archer in *Methane hydrate stability and anthropogenic climate change 2007* said *The potential climate impact in the coming century from hydrate methane release is speculative but could be comparable to climate feedbacks from the terrestrial biosphere and from peat, significant but not catastrophic.* That would be more than 1.5°C.

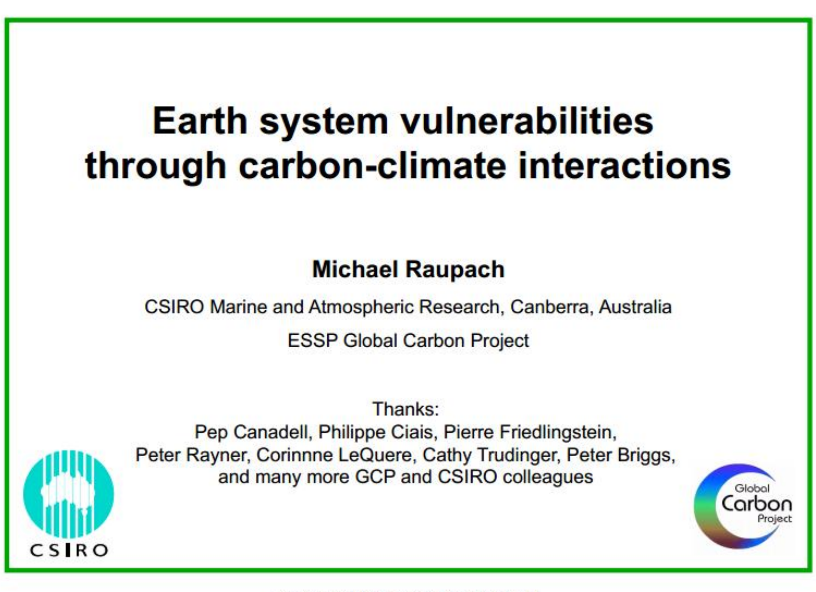
The Danny Harvy 1995 estimate *Global warming increases by 10–25% compared to the case without clathrate destabilization for our scenarios using what, in many respects, are worst case assumption is still valid and the only estimate that considers a risk approach.*

A1F1 at 2100 is 4.5°C without carbon feedbacks which is 6.0°C with IPCC terrestrial carbon feedbacks. That gives us 1.5°C for methane hydrate

Evaluation of the potential impact of methane clathrate destabilization on future global warming L. D. Danny Harvey

This is a total 5.5°C from carbon feedback by 2100 or just over double warming without carbon feedback.

This estimate list of vulnerable carbon does not include global wetlands or Arctic peat lands.



Summary of carbon-climate vulnerabilities

- GHG emissions: (B1, A1T, B2, A1B, A2, A1FI)
  ΔT_A (1750 to 2100) = (2.4, 3.0, 3.0, 3.4, 4.1, 4.6) K
  IPCC AR4 (2007)

- Vulnerabilities from additional feedbacks and forcings (for A2 scenario):
  - Feedbacks on land and ocean C sinks extra ΔT_A ~ 0.5K (0.1 to 1.5)
    Friedlingstein et al (2006), Sitch et al (2008)
  - Methane from frozen soils extra ΔT_A ~ 0.5K (?) (0.2 to 2)
    (Assume sensitivity of methane to temperature = 0.5 to 4 PgC/K)
  - Release of C in tropical peatlands extra ΔT_A ~ 0.15K (0.1 to 0.2)
    (New emission; assume release of 50 PgC)
  - Release of aerosol brake extra ΔT_A ~ 0.7K (0.4 to 1.5)
    Ramanathan and Feng (2008, PNAS)