

An aerial photograph of a peatland ecosystem. The landscape is a mosaic of green and brown patches, representing different types of peatland vegetation and open areas. Several distinct, elongated patches of dense evergreen forest are scattered across the peatland. The overall terrain appears flat and expansive.

Peatland Ecosystem and Global Change

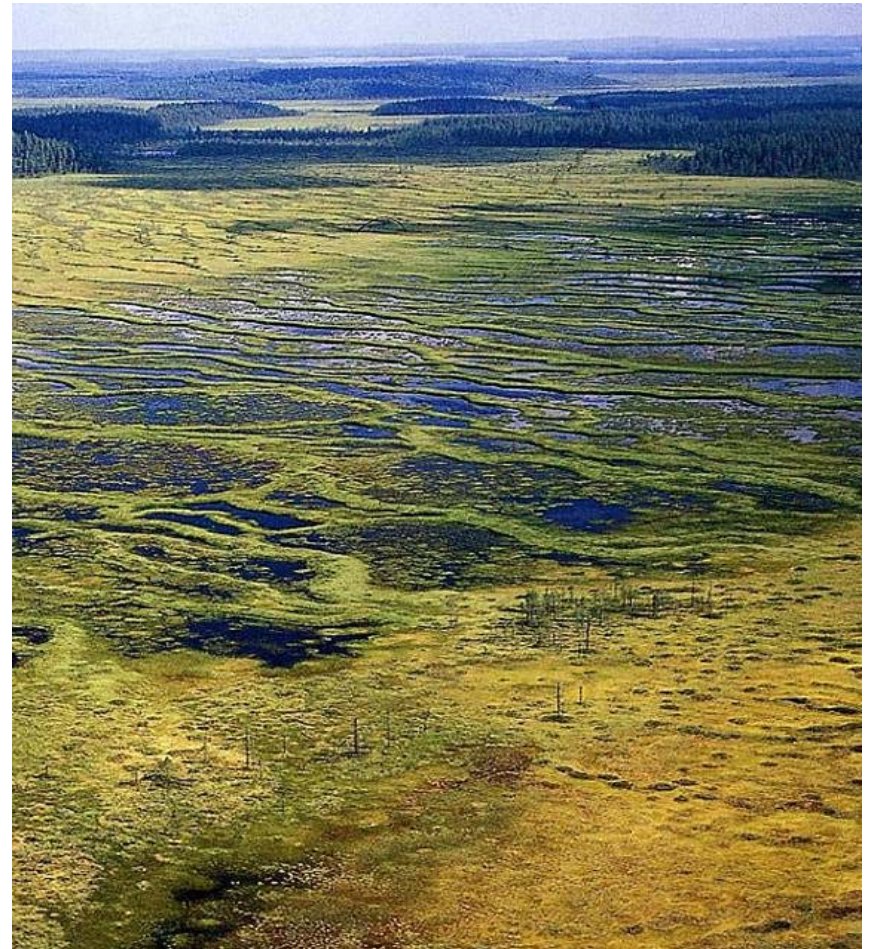
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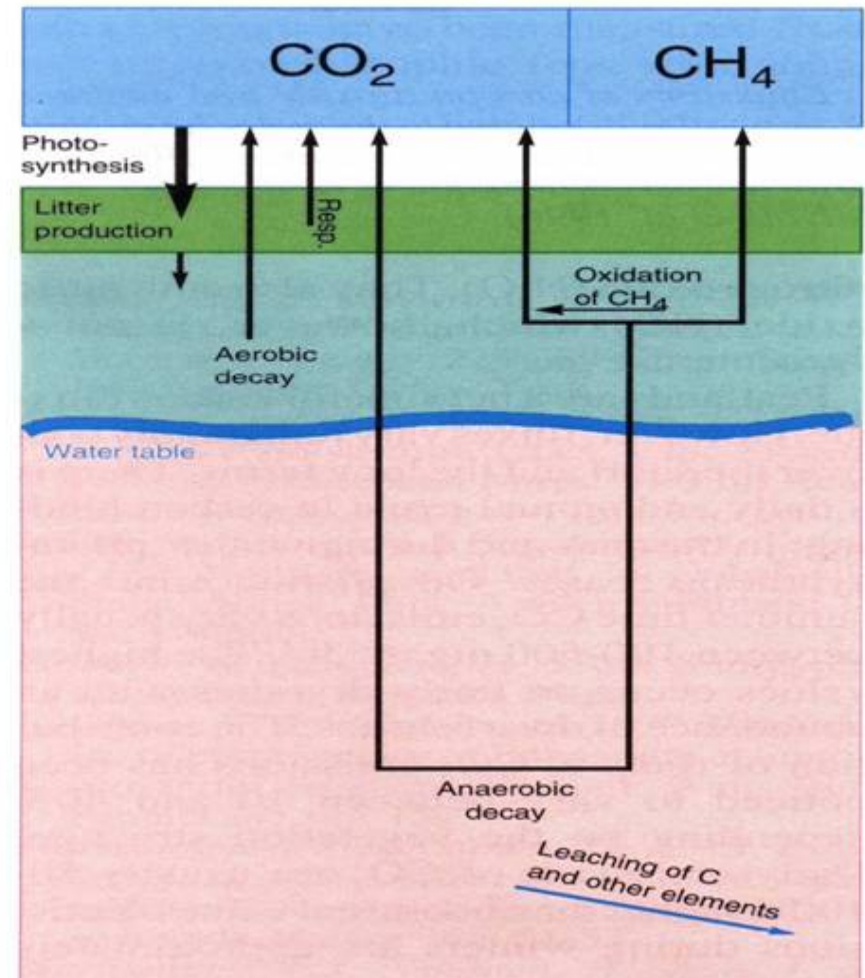
Extent and importance

- Peatlands cover an estimated area of 400 million ha (3% of the Earth's land surface). Most (c. 350 million ha) are in the northern hemisphere.
- Northern peatlands store around 450 billion metric tons ($Bt = 10^{15} \text{ g} = \text{Pg} = \text{Gt}$) carbon, which is equivalent to approximately one third of global soil C stocks and 75% of the pre-industrial mass of C stored in the atmosphere.
- Pristine peatlands emit large quantities of methane (ca. 20 Mt yr^{-1}).



Carbon gas exchange in pristine peatlands

- positive CO₂ balance (15 - 25 g m⁻² yr⁻¹) - accumulation of organic C
- part of the organic C further processed into methane (5 - 40 g m⁻² yr⁻¹)



Global change impacts

An aerial photograph showing a landscape that has been significantly altered. In the upper portion, there is a dense forest of evergreen trees. Below the forest, the terrain has become a vast, open area with a mix of light brown, sandy soil and patches of green and yellowish vegetation. The ground appears to be eroded or has lost its topsoil, with winding, irregular patterns of vegetation and bare earth. The overall scene suggests a major impact on the environment, such as deforestation or a large-scale natural event like a fire or drought.

- Effects of climatic warming
- Effects of land-use change

Climate change impacts

- Climate change scenarios predict that northern peatlands will experience lowered water tables, leading to increased dryness and unsaturated, oxic conditions at their surface, resulting in aerobic decomposition and larger releases of CO₂
- Development of vegetation towards shrub-dominated communities may lead to higher primary production, compensating soil C losses
- Larger unsaturated zone will lead to reduced CH₄ emissions and some dry sites may become small CH₄ sinks



Climate change impacts....

- Evidence from the Holocene suggests that climate warming results in permafrost melting and release of greenhouse gases (GHG) from northern peatlands
- In some parts of the world the peat C store is being reduced because of fire. Major increases in the area of peatland burned have been documented in recent decades and this may continue in the future if peatlands dry out as a result of climate change



Land-use change impacts

- Agriculture, forestry and peat extraction for fuel and horticultural use are globally the major causes of peatland disturbance. As these types of land-use change require intensive drainage, peat oxidation results and the greenhouse gas balance of the peatland is altered.



Conversion to agriculture

- About 14 – 20 % of peatlands in the world are currently used for agriculture and the great majority of these are used as meadows and pastures
- Intensive drainage, natural vegetation removed, tilling, fertilization etc.
- Drainage increases the emissions of CO₂ and N₂O but decreases the emission of CH₄
 - CO₂ 1500 - 2000 g m⁻² yr⁻¹
 - N₂O 1 - 2 g m⁻² yr⁻¹



Conversion to forestry

- The utilization of peatlands for forestry is concentrated in Nordic countries and Russia, where over 10 million ha of peatlands have been drained for this purpose
- Biomass and primary production increase during stand development, which thereby increases the C input to the soil. Simultaneously the organic matter decomposition rate increases primarily because of increased soil aeration and enhances outflux of C from the system.
- The combination of these changed fluxes shifts the C balance of the ecosystem with some peatlands becoming sources of C to the atmosphere, while others remain or become even stronger C sinks (CO₂ losses 0 - 500 g m⁻² yr⁻¹)
- Methane emissions decrease clearly - up to small sink



Peat in energy production

- In the process of peat extraction, the GHG sink function of the peatland is lost, but also the emissions of the site prior to harvesting are avoided. Combustion accounts for more than 90% of the greenhouse gas emissions during the energy production chain.
- Life cycle analyses have shown that the extraction and combustion of peat from pristine peatland has climatic impact similar to the combustion of coal.
- However, by extracting peat from peatlands that are large greenhouse gas sources, radiative forcing of peat utilization chain can be significantly reduced. Examples of such peat resources are cultivated peatlands and forestry drained peatlands



Interaction of climatic warming with land-use impacts

- The processes behind greenhouse gas production in peat soils are highly temperature dependent, and consequently GHG emissions from these land-uses may be greatly enhanced in the warming climate

