Peatland ecosystem and global change

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Extent and importance

Peatlands cover an estimated area of 400 million ha, equivalent to 3% of the Earth's land surface. Most (c. 350 million ha) are in the northern hemisphere, covering large areas in North America, Russia and Europe.

Peatlands globally represent a major store of soil carbon, sink for carbon dioxide and source of atmospheric methane. Northern peatlands store around 450 billion metric tons (Bt = 1015 g = Pg = 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. However, pristine peatlands (mires), especially those in boreal and temperate zones, emit large quantities of methane (ca. 20 Mt yr^{-1}).

Impact of climatic warming

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 CO_2. On the other hand, development of vegetation towards shrub-dominated communities may lead to higher primary production, compensating soil C losses. The larger unsaturated zone will lead to reduced CH_4 emissions and some dry sites may become small CH_4 sinks.

Evidence from the Holocene suggests that climate warming results in permafrost melting and release of greenhouse gases (GHG) from northern peatlands but this is compensated to some degree by extension of forests northwards.

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.

Impacts of land-use change

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

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. In many European countries, GHG emissions from agricultural peatlands dominate national emissions of greenhouse gases from peat sources.

Drainage increases the emissions of CO_2 and N_2O but decreases the emission of CH_4. The emission rates of the greenhouse gases depend on many factors including peat temperature, groundwater level and peat moisture content.

Conversion to forestry

The utilization of peatlands for forestry is concentrated in Nordic countries (Norway, Sweden, and Finland) and Russia, where over 10 million ha of peatlands have been drained for this purpose. In addition, peatland forestry has some importance in the United Kingdom, Ireland, Canada, the United States and Southeast Asia.

Drainage of peatlands for forestry changes the plant community to one dominated by tree stands and forest flora. The effect is that despite the replacement of common mire-forming plants, perennial plant cover remains. 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.

Methane emissions always decrease after establishment of the drainage network. If the entire site is effectively drained, CH_4 emissions may cease across the site except from ditches. On the other hand drainage increases N_2O emissions.

Peat in energy production

The main greenhouse gas released as a result of peat fuel extraction and burning is CO_2 but CH_4 and N_2O are also emitted. In the process of peat extraction, the GHG sink function of the peatland is lost. Emissions also arise in the preparation of the surface for extraction of peat, and its storage and transportation, combustion and after-treatment of the cutaway area. Combustion accounts for more than 90% of the greenhouse gas emissions.

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 utilisation chain can be significantly reduced. Examples of such peat resources are cultivated peatlands and forestry drained peatlands.

Mitigation of climatic impact of land-use

Peatland management generally involves lowering the water table, GHG emissions result from decomposition of stored organic matter and, particularly as has been observed in tropical peatlands, an increase in fire susceptibility. The most efficient method for reducing GHG emissions from peatland is to prevent future land-use change although this is not always economically, socially or politically possible. If this is the case, land management strategies should focus on preventing degradation of additional peatlands where possible, and adjusting management practices on drained peatlands in order to reduce GHG impacts.