SUMMARY FOR POLICYMAKERS
"WISE USE OF PEATLANDS AND CLIMATE CHANGE"

I. Global extent of peat and peatlands

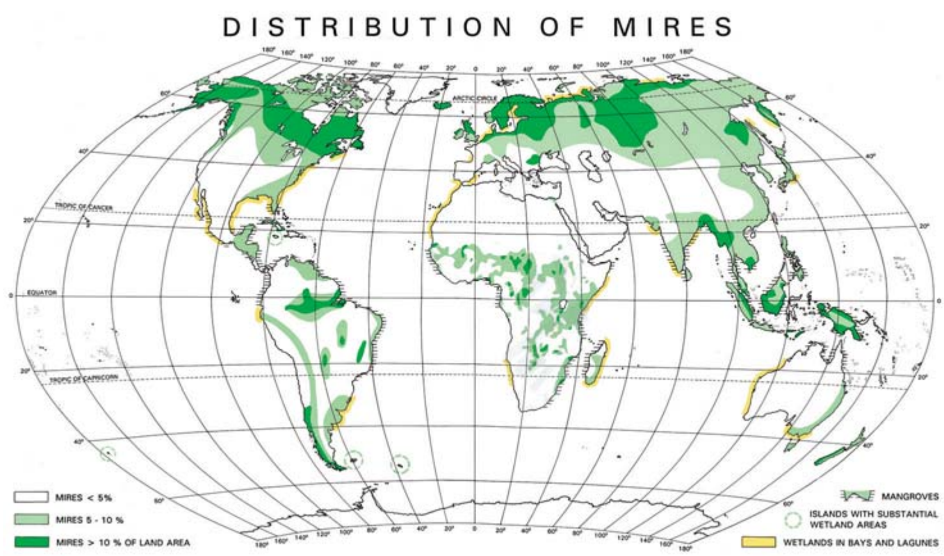
Peatlands cover an estimated area ca. 400 million ha equivalent to 3% of the Earth's land surface (Figure 0.1). Most (about 350 million ha) are in the northern hemisphere, covering large areas in North America, Russia and Europe. Tropical peatlands occur in mainland East Asia, Southeast Asia, the Caribbean and Central America, South America and southern Africa where the current estimate of undisturbed peatland is in the range 30-45 million ha accounting for 10-12% of the global peatland resource.

II. Global peat carbon store

Currently, peatlands globally represent a major store of soil carbon, sink for carbon dioxide and source of atmospheric methane. In general, nitrous oxide (N_2O) emissions are low from natural peatlands but there is evidence that those used for agriculture and receiving nitrogen fertilisers, are releasing significant amounts of this very potent greenhouse gas. The change in peatland C storage results from changes in the balance between net exchange of CO_2, emission of CH_4, and hydrological losses of carbon (e.g. dissolved organic and inorganic C and particulate organic C).

Northern peatlands store around 450 billion metric tons (Bt = 10^{15} 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. In tropical peatlands both the vegetation and underlying peat constitute a large and highly concentrated carbon

Figure 0–1 Distribution of mires
Source: International Peat Society, Available www.peatsociety.fi.



pool amounting to about 60 Bt. The current annual carbon storage rate in the world's peatlands is approximately 100 million tonnes (Mt), which is equivalent to approximately 370 Mt CO_2 yr^{-1} but this has varied greatly throughout millennia depending mainly on climate and sea level. Conversely, however, pristine peatlands (mires), especially those in boreal and temperate zones, emit methane (ca. 20 Mt yr^{-1}), which is a potent greenhouse gas.

In terms of GHG management, the maintenance of large stores of C in undisturbed peatlands should be a priority.

III. Carbon accumulation and greenhouse gas exchange in undisturbed peatlands

Regardless of variability, when considering the role of peatlands in atmospheric GHG balances, it is important to consider that they have taken up and released GHGs continuously since their formation and thus their influence must be modelled over time. When this is considered, the effect of sequestering CO_2 in peat outweighs CH_4 emissions. Thus, peatlands have been net GHG sinks for thousands of years.

Most contemporary peatlands began accumulating peat following the last glacial period and have continued to do so throughout the Holocene, approximately the last 10,000 years. Some peatlands in tropical Southeast Asia, however, started to form towards the end of the Pleistocene more than 20,000 years ago. Carbon accumulation rates have varied over this period in relation to stage of peatland development and climate; average long-term C accumulation rates for northern bogs are 20-30 g m^{-2} yr^{-1}, while a tropical peat core has yielded a long-term average C accumulation rate of over 50 g m^{-2} yr^{-1}.

Contemporary C exchange in peatlands exhibits great spatial variability related to regional and local difference in ecology, hydrology, and climate. Studies of net ecosystem exchange of CO_2 in northern peatlands provide values ranging from uptake of over 220 g CO_2 m^{-2} yr^{-1} to release of 310 g CO_2 m^{-2} yr^{-1}. Accumulation rates in tropical peatlands are also variable, yet they probably accumulate more carbon per unit area than northern peatlands. Present net C uptake may be in the range of 500 g C m^{-2} yr^{-1} (~1800 g CO_2 m^{-2} yr^{-1}). Temporal studies of peatlands reveal that they may act as CO_2 sinks in some years and sources in others, depending on climate. Emissions of CH_4 and N_2O are similarly variable in space and time.

IV. Climate change impact on peatland carbon stocks and greenhouse gas exchange

Owing to the spatial diversity of peatlands, the variability of the response of peatland GHG exchange to climate change is likely to be large. Some peatlands will emit more CO_2 to the atmosphere and change from net C sinks to become sources; other peatlands may exhibit increased CO_2 sequestration owing to elevated water tables. In terms of the stability of peatland C stocks, non-permafrost peatlands will be most at risk because not only are these likely to release CO_2 as a result of peat oxidation under dry conditions, but they will also face increased risk of fire.

Climate variability throughout the Holocene, especially in boreal and temperate zones, has had a major effect on C accumulation rates in peatlands. Increased peat accumulation reflects periods of a more positive precipitation-evaporation balance, which is supported by data on lake level fluctuations from these regions. In contrast, drier periods correspond to lower C accumulation rates. Evidence from the Holocene suggests that climate warming results in permafrost melting and release of GHGs from northern peatlands but this is compensated to some degree by extension of forests northwards. Future climate change may also result in accelerated rates of permafrost degradation, displacing tree communities, and creating water saturated open fens. C accumulation at these sites will be higher than neighbouring permafrost peatlands but CH_4 emissions will be enhanced owing to increased vegetation productivity and waterlogged conditions.

In contrast, climate change scenarios predict that some peatlands will experience lowered water tables, leading to increased dryness and unsaturated, oxic conditions at their surface, resulting in aerobic decomposition (oxidation) 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 bogs may become CH_4 sinks. Over time, peat subsidence combined with increased ecosystem productivity may keep some peatlands (e.g. fens, bog pools and hollows) wet, maintaining or enhancing C storage although CH_4 emissions may increase under these conditions.

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 or anthropogenic activities. Fire will continue to play an important role in the fate of global peatland C stocks.

V. Land-use change impacts on peatland carbon stocks and greenhouse gas exchange

Agriculture, forestry and peat extraction for fuel and horticultural use are the major causes of peatland disturbance. As these types of land-use change require alteration of peatland hydrology, peat oxidation results and the greenhouse gas balance of the peatland is altered (Table 0.1).

V.1 Peatland utilised for 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. For agricultural use, fens and raised bogs have to be drained in order to regulate the air and water conditions in the soil to meet the requirements of cultivated or pasture plants. In many European countries, GHG emissions from agricultural peatlands dominate national emissions of GHGs from peat sources.

The loss of water from the upper peat by drainage, followed by oxidation, leads to compaction and subsidence of the surface. Drainage of peat 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. For ploughed temperate fens (arable land), in the central and north part of Europe (Sweden), annual CO_2 mean emissions of 4100 g m^{-2} can be expected, but with a high range of variation. Temperate and boreal fens converted to grassland show mean CO_2 emissions of about 700 g m^{-2} yr^{-1} (Canada) and from 1500 to 1700 g m^{-2} yr^{-1} in Central Europe (Poland, Germany, The Netherlands and Sweden). Finnish studies show average CO_2 emissions of about 2200 g m^{-2} yr^{-1} for boreal fens under grass and barley. Drained peatlands are large sources of nitrous oxide

Table 0.1: *Impact of land-use change on peatland greenhouse gas balance*

	Approximate area (10^3 km^2)	Response of greenhouse gas flux to land-use change		
		CO_2	CH_4	N_2O
Agriculture	300	**Net emission of CO_2** -decreased CO_2 uptake: removal of peatland vegetation, crop residues removed -increased CO_2 emission: lower water table, peat oxidation	**Reduced CH_4 efflux** -emission from ditches remains high	**Enhanced N_2O emission** -N mineralization at nutrient rich sites -fertilizer application
Forestry	150	**Often little change in net ecosystem balance** -increased CO_2 uptake by treestand -increased CO_2 emission from soils: peat oxidation, dependent on extent of drainage	**Reduced CH_4 efflux** -emission from ditches remains high	**Dependent on site type and fertilizer application** -increased N_2O flux on nutrient rich sites -increased N_2O flux if fertilizer applied
Peat extraction	<5 *)	**Net emission of CO_2** -loss of CO_2 via combustion (fuel) or decomposition (horticulture) -decreased CO_2 uptake: removal of peatland vegetation, crop residues removed -increased CO_2 emission: lower water table, peat oxidation	**Reduced CH_4 efflux** -emission from ditches remains high	**Little change** -some increase in N_2O efflux at nutrient rich sites

*) Area of peatland used for energy generation and production of plant growing media. Estimation of the IPS, based on the book “Wise use of Mires and Peatlands”, H. Joosten and D. Clarke, 2002 (page 8 and 33) and “Global Peat Resources”, edited by E. Lappalainen, 1996.

(N_2O) with fluxes varying between 0.2 and 5.6 g m^{-2} annually. The annual CH_4 fluxes of cultivated peat soils range from a very small sink to low emission.
The position of the water table is one of the most important factors influencing peat conditions and processes in organic soils. Consequently, precise water management for peatlands utilised for agriculture purposes is very important. Increasing the water level in peat decreases emissions of CO_2 (by up to 20%) and N_2O, but increases

emissions of CH_4. German studies showed that for lowland fens in Central Europe maintaining the ground water level at a depth of 30 cm below the surface under grass utilisation will result in 90% of the optimum plant crop yield, the peat mineralization rate will be reduced by 60-70% and the GHG emissions will be only 50-60% of those under lower water table regimes.

V.2 Peatland utilized for 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. Forestry in undrained peatlands is currently practiced primarily in Canada, the United States and Indonesia. Forestry in peatlands generally involves the same silvicultural practices (fellings, site preparation, fertilization) as conducted on mineral soils. The fundamental difference is that water management systems (i.e. drainage) are nearly always required when practicing economic forestry on these naturally wet sites.

The climatic impacts of the use of northern peatlands for forestry are smaller than those of agriculture. Subsidence of the peat surface is much smaller than in agricultural sites and the oxidation of organic matter is of less importance. 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. According to the few micrometeorological studies, the net ecosystem C exchange in northern organic soil forests varies from a loss of 800 g CO_2 m^{-2} yr^{-1} to a sink of 1000 g CO_2 m^{-2} yr^{-1}. Similar range in variation is reported in soil C balances. This variation is related to climatic conditions, site type, intensity of management and the level of drainage. Despite the possible soil C losses, ecosystem C balance may remain positive because of the increase in tree stand C stock during the first rotation.

Trace greenhouse gas fluxes are also affected by the forest management practices. 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. Highest emissions of ca. 1 g N_2O m^{-2} yr^{-1} have been measured on the most fertile sites, while the average emission in Fennoscandian drained peatlands falls between 0.2 and 0.3 g N_2O m^{-2} yr^{-1}.

Clear felling disturbs the GHG balance of the site temporally by decreasing primary production and inducing N_2O emissions owing to liberation of nutrients in the soil. Soil preparation further disturbs the soil C dynamics. Whole-tree harvesting, especially if stumps are removed, greatly reduces the amount of C in the ecosystem compared to conventional harvesting, in which residuals are left on and in the soil. In general, the potential for soil C losses in peatlands increases with intensity of soil disturbance.

Drainage of nutrient-poor peatlands for forestry in the boreal zone typically decreases the radiative forcing of the site in the short term, since CH_4 emissions decrease and the ecosystem (soil and vegetation) usually continue to accumulate C during the first tree-stand rotation (50–100 years). At more nutrient rich sites where the soil often becomes a source of C an increase in radiative forcing is expected in the long term, as the relative impact of CH_4 emissions is decreased in comparison to that of CO_2.

V.3 Greenhouse gas impact of peat extraction for fuel and horticultural use

Peat has been used for domestic energy purposes by local communities in many parts of the world for centuries. Electricity generation, using peat as a fuel, developed in the 20th Century in some European countries and the Soviet Union. Today, Finland, Ireland, Russian Federation, Belarus and Sweden account for almost 90% of the world's production and consumption of energy peat. In terms of greenhouse gas emissions peat combustion which in Finland accounts for 7% of primary energy, is there responsible for 14% of CO_2 emissions from combustion of fossil fuels. Peat is also used in horticulture, as a growing medium, but the volume used annually is only about half that of fuel peat. Germany and Canada account for over half of horticultural peat extraction.

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 cutting (removing vegetation and ditching), 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.

In Finland and Sweden, several studies have been performed to determine the GHG fluxes from different stages of the fuel peat production supply chain and life cycle analyses have been carried out of peat fuel use and its climate impact in terms of radiative forcing. Some studies show that the extraction and combustion of peat from pristine peatland has radiative forcing 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.

As with the extraction of energy peat, horticultural peat extraction requires drainage of the peatland to accommodate machinery and facilitate drying of peat prior to extraction. This facilitates peat oxidation, increases CO_2 emissions but reduces efflux of CH_4. Although horticultural peat is not consumed instantaneously, it will decompose over time following extraction. In Canada the first life cycle analysis of greenhouse gas emissions from horticultural peat extraction has been performed. Decomposition of peat in growing media accounted for over 70% of greenhouse gas emissions. Remaining emissions arise from transportation, processing and land-use change. Although the use of peat in growing media may enhance productivity of those plants it is used to grow, leading to some increase in C storage, this is temporary and short term.

V.4 Greenhouse gas emissions from drained and degraded tropical peatlands

A peat carbon content of 50 kg C m^{-3} is considered to be representative for SE

Asian peatlands in general and, combining this value with peatland area and thickness, indicates that carbon storage in SE Asian peatlands is in the order of 58 Gt. In the late 1980s 3.7 million hectares of Indonesian peat swamp forest were utilized, leading to an 18% decrease in peat swamp forest area with a consequent reduction in the C-fixation capacity of 5-9 million t yr^{-1}. Deforestation, drainage and conversion of peatland in Indonesia and Malaysia continued throughout the 1990s and are still occurring. These changes are converting large areas of peatland from active carbon sinks to carbon sources.

Apart from logging, the development of palm oil and timber plantations, which require intensive drainage and cause the highest CO_2 emissions of all land uses, are major drivers of peatland deforestation and increases in CO_2 emissions. A large proportion (27%) of palm oil concessions (i.e. existing and planned plantations) in Indonesia is on peatlands; a similar percentage is expected to apply in Malaysia. These plantations are expanding at a rapid rate, driven in part by the increasing demand for palm oil as a biofuel in developed countries. Land use change from peat swamp forest to agriculture or plantations affects C sequestration markedly because the tree biomass is removed and replaced with non-peat forming crop plants. Agriculture requires drainage which creates permanent oxic conditions in the surface peat down to the minimum water table required for optimum crop growth; this results in increased CO_2 emissions.

Comparative studies show that CO_2 emissions from drained forest and recovering sites (undergoing succession to secondary forest) are slightly higher than those from undrained forest probably owing to higher autotrophic respiration from tree roots and enhanced peat oxidation as a result of drainage. The highest annual CO_2 emission (4000 g CO_2 m^{-2} yr^{-1}) occurs in drained forest whilst recovering forest has slightly lower emissions than undrained peat swamp forest. The highest CO_2 emission rates in drainage affected sites occur where channels (ditches) are deepest. Annual CO_2 emissions from a drained agricultural site are considerably lower than at all other sites (ca. 500 g CO_2 m^{-2} yr^{-1}) because there are no trees to provide a supply of litter to peat surface decomposers and the replacement vegetation root biomass is small and produces much less respiratory CO_2 than rain forest trees.

Present and future emissions from natural and drained peatlands in Indonesia have been quantified recently using data on peat extent and depth, present and projected land uses and water management practices, decomposition rates and fire emissions. It is difficult to determine accurately the net CO_2 and CH_4 fluxes in natural peat swamp forest because of the uncertainty in measuring gas fluxes into and out of tree leaves in a multi-layered canopy up to 45 metres in height. Most studies of this ecosystem are carried out of gas exchange at the peat surface and measure CO_2 released in autotrophic and heterotrophic respiration of roots and bacteria and CH_4 evolution from anaerobic decomposition. These values tend to be high for CO_2 and misrepresent the true CO_2 balance of the ecosystem.

Current CO_2 emissions (2005) caused by decomposition of drained peatlands are estimated to be ca. 630 million t yr^{-1} (range 350 – 870 million t yr^{-1}), which will increase in coming decades, and will continue well beyond the 21st century, unless land management practices and peatland development plans are changed. In addition, between 1997 and 2006 an estimated average of 1400 Mt yr^{-1} of CO_2 emissions was caused by fires associated with peatland drainage and degradation.

The total current CO_2 emissions from tropical peatland of approximately 2000 Mt yr^{-1} equal almost 8% of global emissions from fossil fuel burning. Emissions are likely to increase every year for the first decades after 2000. As shallow peat deposits become depleted, however, and the drained peatland area diminishes, peat oxidation emissions are predicted to peak sometime between 2015 and 2035 at between 560 and 980 Mt yr^{-1} and will decline steadily thereafter. As the deeper peat deposits will take much longer to be depleted, significant CO_2 emission will continue beyond 2100.

Overall, methane emissions from tropical peatland are very low irrespective of whether it is natural peat swamp forest or drained and degraded or used for agriculture. Annual CH_4 emissions are highest in drainage affected forest and recovering forest sites, both of which are subjected to periodical waterlogging and receive inputs of easily decomposable litter from the canopy (providing substrates for methanogenic bacteria). Peak CH_4 emissions occur when the water table is near to or above the peat surface; oxic conditions increase considerably, however, following deep drainage and the potential for CH_4 oxidation by methanotrophic bacteria is much greater. Cleared but uncultivated peatland has a CH_4 emission of almost zero at all peat water table depths owing to the permanently low water table following drainage to grow crops.

N_2O emissions from natural tropical peatlands are low but evidence is emerging that suggests that these increase following land use change and fire.

Current developments give little cause for optimism because, while deforestation rates on non-peatlands in SE Asia have decreased slightly in recent years, those on peatlands have been stable (on average) for up to 20 years. The current (2000-2005) average deforestation rate is 1.5% yr^{-1}. In 2005, 25% of all deforestation in SE Asia was on peatlands.

V.5 Potential of peatland restoration for mitigation of climate change impacts of peatland management

Peatland restoration is growing in importance in Europe and North America and is likely to remain important over the next half century. It is also gaining recognition in tropical peatland areas where some of the greatest challenges exist following inappropriate and unsuccessful development projects. While peatland restoration is primarily designed for global biodiversity protection, it can also play an important role in reducing GHG emissions.

In general, rewetting of peatlands reduces CO_2 emissions by creating anoxic, reducing conditions, although it may lead to an icrease in CH_4 efflux at least for a time. Rewetting also inhibits nitrification, resulting in reduced emission of N_2O. Some restored boreal bogs have become C sinks again following successful re-establishment of Sphagnum-dominated vegetation. In contrast, it is more difficult to re-establish the C sink function of temperate bogs and fens. In some cases, CH_4 emissions are frequently higher in rewetted peatlands, especially fens, than in pristine peatlands. Emission of CH_4 from restored peatlands can be greatly reduced if the water table is kept below (about 10 cm) the surface so that a high proportion of the CH_4 produced in the lower horizons will be oxidized in the thin, oxic surface layer.

The duration of most field investigations of peatland restoration is too short to evaluate the long-term dynamics of rewetted bogs and fens. After rewetting of peatlands, at least three phases of carbon and nitrogen cycling occur, and only in the third phase, more than 10 years after rewetting, are greenhouse gas fluxes expected to be in the range of natural peatlands. Thus, initially, restoration may result in a pulse of GHG, but in the long-term, the peatland should return to a C and GHG sink with a similar climate impact as an undisturbed peatland. More long-term studies with better spatial coverage are required to better constrain the GHG impact of peatland restoration.

VI. Reporting peat greenhouse gas emissions in international climate conventions

Peat-based GHG emissions reported under the United Nations Framework Convention on Climate Change (UNFCCC) are divided between several sectors: Energy, Agriculture and Land Use, Land-Use Change and Forestry (LULUCF). Only human-induced GHG emissions are included in reporting, therefore, emissions from undisturbed/virgin peatlands are not included.

Emissions of GHGs from peat combustion for energy and heat are reported in the Energy sector and under the 2006 IPCC Guidelines peat is classified to its own class between fossil energy sources and biomass. In the reporting, the emission calculations are, however, based only on the emissions from the combustion. In the Agriculture sector, peatlands are considered only to report N_2O emissions from organic agricultural soils. Emissions of CO_2 from organic agricultural soils are reported under LULUCF. Also under LULUCF are GHG emissions arising from peat extraction areas, biomass burning on peat soils, drained organic forest soils, disturbance and nitrogen fertilization associated with conversion of organic soils to croplands.

Although total national emissions are reported to the UNFCCC both including and excluding LULUCF from the total, the basis for emission reductions under the Kyoto Protocol is total emission excluding LULUCF. Emissions and removals of GHGs are considered only partially when assessing a country's fulfillment of their commitment under the Kyoto Protocol. Emissions or removals from afforestation, deforestation and reforestation since 1990 will be added to or subtracted from a country's assigned amount according to the Protocol, while additional emissions or removals from forest management, cropland management, grazing land management and revegetation may be considered if a country elects for their inclusion. Once a certain LULUCF activity has been added to a country's Kyoto accounting, it must be reported continuously and consistently even if a sink becomes a source.

While industrialized nations listed in Annex I of the UNFCCC submit annual GHG inventories and have emission limitation targets under the Kyoto Protocol, the heterogeneous groups of developing nations that are non-Annex I Parties are only required to provide information about GHG emissions in national communications. However, peatland fires and wetland degradation in many non-Annex I countries contribute significantly to global GHG emissions.

The Kyoto Protocol allows Annex I Parties to fulfill part of their emission reduction commitments by taking actions to reduce emissions in developing countries under the Clean Development Mechanism (CDM). For the first commitment period of the Kyoto Protocol (2008-2012) only afforestation and reforestation activities under LULUCF are eligible for CDM consideration; however, enlarging the scope of LULUCF activities considered under this mechanism could assist in mitigation of fires and degradation in peatlands helping to reduce peat-derived emissions, particularly in developing nations.

Methodologies and guidance for estimating peat-based emissions in the good practice guidelines for LULUCF and the 2006 IPCC Guidelines are relatively scarce. Default methodologies that include all anthropogenic activities likely to alter peatland hydrology, temperature regime and vegetation composition are still lacking. There is still a deficiency of data that can be applied to country, region or site-specific conditions with data availability varying for different climate regions and countries, while global scale knowledge of peat-derived emissions remains limited. Development of scientifically sound emission factors for peat soils is complicated and resource demanding owing to the variation between sites. Still, with more long-term measurements of GHG fluxes on sites with different climatic conditions and land uses, reliable emission factors for inventory purposes can be developed thereby improving the understanding of GHG impacts of different activities under given circumstances.

VII. Wise use recommendations: Peatlands and climate change

Carbon stocks in undisturbed peatlands

Peatlands represent globally significant stores of soil C that have been accumulating for millennia. Thus, these ecosystems have acted as, and continue to act as, important GHG sinks and this function should be considered alongside other functions and values when making management decisions.

Climate change may threaten C stocks in unmanaged peatlands because of drought leading to peat oxidation, permafrost melting and shifting fire regimes. Owing to the variability in environmental conditions and GHG exchange across peatlands, predicting the overall response is not simple. Research aimed at improving peatland inventories and enhancing our understanding of the links between climate, hydrology, ecology, permafrost degradation, fire regimes and GHG balances will improve our knowledge of the state of current peat resources and predict the fate of this important store of carbon.

VII.1 Mitigation of greenhouse gas emissions from managed peatlands

Since 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 developed peatlands in order to reduce GHG impacts. The incentive to mitigate GHG emissions from peatland management may come from a requirement to include emissions in national GHG inventories (as is the case for most northern peatlands) or from an attachment of an economic value to the C stock (as may soon apply to tropical peatlands).

It is essential that future land use of peatland incorporates the principles and practices of wise use in order to promote sustainable management, especially with respect to hydrology, water and carbon. Inevitably, however, every type of human intervention on peatland leads to impairment or even loss of natural resource functions (ecology, hydrology, biodiversity, carbon storage). Effective peatland management also requires engagement between scientists, policy makers and stakeholders.

Changing the management of peatlands used for agriculture and forestry, for example, reducing the extent and intensity of drainage, converting arable cultivation to grasslands and pasture, and reducing fertiliser application will reduce GHG emissions.

Life cycle analysis of peat GHG emissions from peat extraction indicates that climate impact can be reduced by using already degraded peatland sites, such as those already drained for forestry or agriculture, and reducing the time period during which the peat is extracted, followed by rapid conversion to an appropriate after-use.

New opportunities for protection of the tropical peat carbon store may arise from current negotiations on financial payments for reduced emissions from avoided deforestation and forest degradation (REDD). This could put an economic value on the remaining tropical peat swamp forests and their globally important C stores, and provide an incentive for their protection.

Afforestation following peatland cultivation or peat extraction can greatly reduce radiative forcing as C will be stored in tree biomass; however, the resulting ecosystem will likely be very different than the pre-disturbance peatland. Restoration of the site may assist not only by preventing oxidation and returning the site into a C sink, but can also reinstate other ecosystem functions such as biological diversity. Peatland restoration can be effective for millennia, leaving the work of GHG sequestration to micro-organisms and plants.