Carbon emissions from degraded tropical peat – does hydrological restoration cut down gaseous C-losses?

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Tropical peat swamp forest forms one of the most efficient carbon-sequestering ecosystems and important carbon stores. Some peatlands, even in a natural condition, are in a steady-state and no longer accumulating peat. Others, especially drained peatlands, are undergoing degradation and form a marked C-source. One most important abiotic factors influencing on peatland C-balance is hydrology. Rainfall in excess of evaporation forms predominant peat hydrology-regulating parameter because evaporation and (groundwater) outflow are fairly constant in tropical peat. Peat drainage decreases water holding capacity, and thus speeds up creation of oxic condition and surface peat stored carbon oxidation.

Temporal and cumulative CO_2 and CH_4 fluxes were studied in selectively logged and clear felled tropical peatland sites affected by drainage. The work included, in fact one of the very first, practical hydrological restoration efforts in tropical peat. Large drainage canals, excavated in mid 1990's, were blocked by dams in 2005in an area outlining ~13 km^2. Construction of dams was done in order to see; i.) how water flow retarding attempt influences peat hydrology, and ii.) what is the potential effect on peat CO_2 and CH_4 emissions. Gas flux regression models were tested by applying *in situ* collected water level (WL) data in periods before and after the establishment of dams, and by applying hypothetical peat WL data.

Higher annual minimum water levels prevailed on both sites, open site WL prevailed considerably longer near the peat surface, and forest WL was a longer period in the topmost 30 cm peat profile after dam establishment. Carbon dioxide flux rates and cumulative emissions were clearly higher in comparison to CH_4, and were clearly higher in the forest floor in comparison to open site. Soil in both sites could reverse from CH_4-sink to -source depending on the WL in peat. Actual and conceivable raise of WL was noted to have a minor effect on cumulative CO_2 emissions in the forest floor but cause decreasing trend in emissions of the clear felled site.

Micrometeorological observations of CH_4 and N_2O at a managed fen meadow in the Netherlands.

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Global atmospheric concentrations of CO_2, CH_4 and N_2O have increased markedly as a result of human activities since 1750 (30%, 150% and 17% respectively). The global increases in carbon dioxide concentration are primarily due to fossil fuel and land-use change, while those of methane and nitrous oxide are primarily due to agriculture (IPCC, 2007). Our research is part of the BSIK ME1 project that has its main focus on fen meadow ecosystems in the western part of the Netherlands. Since the 19th century these areas have been a strong net source of carbon dioxide as a result of increased peat oxidation caused by drainage. To understand the effect of natural changes and management on the green house gas emission and uptake in the areas an integral assessment of the greenhouse gases balance in these areas is required. Three experimental sites have been selected for this purpose: a restored nature reserve with relatively high ground water level and no agricultural activities (Horstermeer) a site under extensive agricultural exploitation where the ground water level will be raised in the coming years (Stein) and a site under intensive agricultural exploitation with low a ground water level (Oukoop).

However, there are significant uncertainties in the estimated CH_4 and N_2O fluxes, mainly due to a combination of complexity of the source (i.e. spatial and temporal variation) and instrument limitations. High-frequency micrometeorological methods are an option to obtain integrated emission estimates on a hectare scale that also has continuous coverage in time. In this study, a quantum cascade laser spectrometer (Aerodyne Research Inc.) is used for eddy covariance measurements of CH_4 and N_2O. The system has been running continuously in Oukoop since August 2006. An automatic liquid nitrogen filling system is employed for unattended operation of the system. A sampling frequency of 10 Hz is obtained using a 1.0 GHz PC system. A precision of 2.6 and 0.3 ppb $Hz^{-1/2}$ is obtained for CH_4 and N_2O, respectively. However, it proved to be important to calibrate the equipment frequently using a low and a high standard. Drift in the system is removed using a 120 s running mean filter. Average fluxes and standard deviations in these averages of 461 ± 485 ngC $m^{-2}s^{-1}$ (2.21 ± 2.33 mg $m^{-2}hr^{-1}$) and 38 ± 64 ngN $m^{-2}s^{-1}$ (0.22 ± 0.36 mg $m^{-2}hr^{-1}$) were observed over the period August 17th to November 6th 2006. About 40% of this total N_2O emission was due to a fertilizing event. Besides these observed emissions, uptake of CH_4 and N_2O occurred in short events lasting at most a few hours.

CO_2 and CH_4 flux dynamics in an Irish lowland blanket bog.

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Pristine peatlands affect the atmospheric concentration of greenhouse gases by acting as a small sink for carbon dioxide (CO_2) and a source of methane (CH_4). Large spatial variation has been observed in the flux rates within and between peatlands, which is linked to water level and vegetation characteristics. Strong temporal variation has also been observed, with the annual C balance oscillating from positive to negative according to weather conditions. While a number of C exchange studies have been carried out in boreal and continental peatlands, maritime blanket bogs have received less attention. In this study, CO_2 and CH_4 exchange were studied in an Irish lowland blanket bog from July 2003 to September 2005. The study area was characterized by temperate maritime climate (precipitation > 2000 mm yr^{-1}, average temperature in July 14.6 ºC and in February 6.1ºC) and a patterned surface structure. Chamber methods were used to measure fluxes and non-linear regression models combined with environmental data were used to integrate the fluxes over the study period. Fluxes were measured in four different vegetation communities along a water level gradient, namely hummocks, high lawns, low lawns and hollows. Gas exchange followed the water level gradient, with gross photosynthesis, ecosystem respiration and net ecosystem exchange (NEE) being highest in hummocks and lowest in hollows. Contrastingly, CH_4 fluxes were highest in hollows and lowest in hummock. The spatial variation in fluxes was primarily controlled by the water level. The seasonal dynamics in the gas fluxes followed the changes in temperature and vegetation cover. Flux rates were lowest, but still noteworthy, during winter and highest during the second half of the summer. The bog acted as a moderate C sink for the duration of the study. Annual NEE was 65 g CO_2 -C m^{-2} y^{r-1} and CH_4 efflux 4.7 g CH_4-C m^{-2} yr^{-1}.