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Drained peatlands used for extraction and agriculture: biogeochemical status with special attention to greenhouse gas fluxes and rewetting

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Many peatlands previously drained for peat extraction or utilized for agriculture (directly or after partial cutoff) are left abandoned during last decades in Europe, and especially in its eastern part. In the European part of Russia alone, several million hectares of peatlands have been modified for peat extraction and agriculture by direct water level draw-down and nowadays are not under use by economic reasons. This makes up one of the most serious and urgent problems of wise use and management of peatlands in these regions with serious feedback to people, environment and economy (Quick Scan of Peatlands in Central and Eastern Europe, 2009). Drainage for agriculture leads to peat oxidation resulting in substantial emissions of greenhouse gases (carbon dioxide and sometimes nitrous oxide) to the atmosphere. Together with peat fires this is the most significant negative input of peatland degradation to climate change (Assessment on Peatlands Biodiversity and Climate Change, 2008; Peatlands and Climate Change, 2008). Besides that, dehydrated peatlands often release methane. Starting from 2003, the effect of drainage and subsequent utilization of peatlands on the emissions of carbon dioxide and methane was studied in Tomsk region (West Siberia) during the summer-fall periods (Glagolev et al. 2008). The measurements were conducted by chamber method at peatlands drained for use as croplands (now partly being fallows) and peat cutting (currently abandoned or reclaimed for forest planting, haying, or pasturing), as well as at a wide range of undrained oligotrophic, mesotrophic, and eutrophic mires and burnt mire areas of different regeneration stages. The statistical analysis of data from a large number of study sites indicated a higher release of carbon dioxide from disturbed peatlands compared to undrained ones. At the same time some drained peatlands had considerable methane emission rates, additionally enhanced by the intensive efflux from the surface of drainage ditches. The findings were supported by the studies conducted from 2005 at drained peatland sites in Moscow region (European part of Russia) which are used for peat extraction or as hayfield (Chistotin et al., 2006). Unexpected transient methane fluxes were observed at the inter-ditch surfaces in two types of sites: milled peat extraction area and used as a hay field after partial peat extraction. Under warm and wet conditions methane was released even from peat stockpiles. Microbiological studies showed not lower and near to twice higher genomic diversity of methanogens in extracted sites and in a hayfield as compared to virgin mire. We suppose that well-developed plant roots at the grassland provide a source of fresh organic material used for CH_4 production. To test this hypothesis, a pot experiment with mesocosms which model three succession stages (bare peat, grass sowing, and developed grassland) under permanently high or fluctuating wetness was conducted. Methane efflux from peat under developed grassland was higher as compared to the other treatments. Under permanently high water supply the methane emission was 1 to 2 orders of magnitude higher. The obtained results clearly showed that plant organic matter can be an additional source of methane after rewetting which is obviously needed for abandoned peatland sites not used for agriculture any more. To mitigate the emissions, such management options as removal of the surface peat layer before rewetting could be applied. This practice could have additional benefits achieved by bringing day surface closer to ground water table level and forming more favorable soil conditions for mire species.