Ecology and restoration of drained mires in the Sumava National Park (Czech Republic)

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Summary

Almost 70% of peatlands in the Sumava Mts. (Czech Republic) have been influenced by drainage in the past. In 1999, a Programme of Peatland Restoration started to be implemented in the area with the aim to restore disturbed hydrology and to stop mire degradation caused by drainage. The main restoration technique used was blocking of drainage ditches by set of board dams. In 2005, both drained and intact peatlands were selected in the area to study degradation changes induced by disturbed hydrology and to evaluate the success of restoration. Water table fluctuation, hydrochemistry of groundwater, peat soil chemistry, amount of precipitation, vegetation on permanent plots (57) and runoff from small catchments were monitored. Three years of pre-restoration monitoring show that the water table is maintained in a lower position than a natural system and exhibits higher fluctuations in direct relation to the amount of precipitation received on drained sites. The pH of groundwater had lower values in general on drained bogs. Recession of hollow and lawn vegetation and expansion of competitive grasses (*Molinia caerulea*) or trees (*Picea abies*) towards the bog expanse were recorded on drained sites. Restoration of monitored drained sites will be performed in 2008 with the same monitoring design following.

Key index words: drained mires, hydrochemistry, vegetation, restoration

Introduction

Sumava National Park (700 km²) located in the southwest part of the Czech Republic belongs to important peatland regions in the Central Europe. More than 6000 ha of peatlands occur from about 700 to 1200 m a.s.l. Both ombrotrophic peatbogs and minerotrophic mires are developed especially on central plateau and flat river valleys (Svobodová and Soukupová, 2000). Ombrotrophic mires include both patterned mires from higher altitudes and valley raised bogs covered by bog pine forest with *Pinus rotundata* from river floodplains. Transitional sedge mires and extensive waterlogged spruce forests are also frequent (Soukupová, 1996).

In spite of relatively late colonisation (Beneš, 1996), peatlands have been influenced here by various human activities in the past. Among them, drainage represents one of the most important threats. Peatlands have been drained for forestry, agriculture and peat extraction purposes since 19th century (Schreiber, 1924). Almost 70% of peatlands were found to be influenced by drainage. However, intensity of disturbances caused by drainage varies largely across the area. Shallow surface ditches from the turn of 19th and 20th century are widely spread but they don´t represent the most severe impact. By contrast, only the occasional but very intensive drainage made in 70s and 80s of the last century is among serious conservation problems at present.

Peatlands, and especially ombrotrophic bogs, have been traditionally protected in the Sumava Mts. as strictly protected areas where non-intervention management was preffered (Nature Reserves, 1st Zone of the Sumava National Park). Current degradation impacts on disturbed peatlands, however, have induced needs for more active approach to ensure the conservation of these peatlands in the long term. As a result of that, a long-term project 'Programme of Peatland Restoration' primarily focused on restoration of disturbed hydrology started to be implemented in the area in 1999.

Since 2005, the restoration project has been coupled with a research monitoring program aiming to study of degradation changes caused by drainage and to evaluate the success of restoration efforts. In 2007, a three year pre-restoration phase ended and results comparing intact and drained sites are presented.

Materials and methods

Study area

The study sites are located on the central plateau of the Sumava Mts. harboring frequent patterned mires and extensive waterlogged spruce forests at an average altitude about 1100m a.s.l. The plateau has a cold and humid climate, characterised by total precipitation attaining 1337 mm and mean annual temperature of 3,2°C. Peatlands have been drained here namely for forestry purposes since 19th century (Schreiber, 1924) with local intensive drainage made during the last 50 years. Drained ombrotrophic bogs are

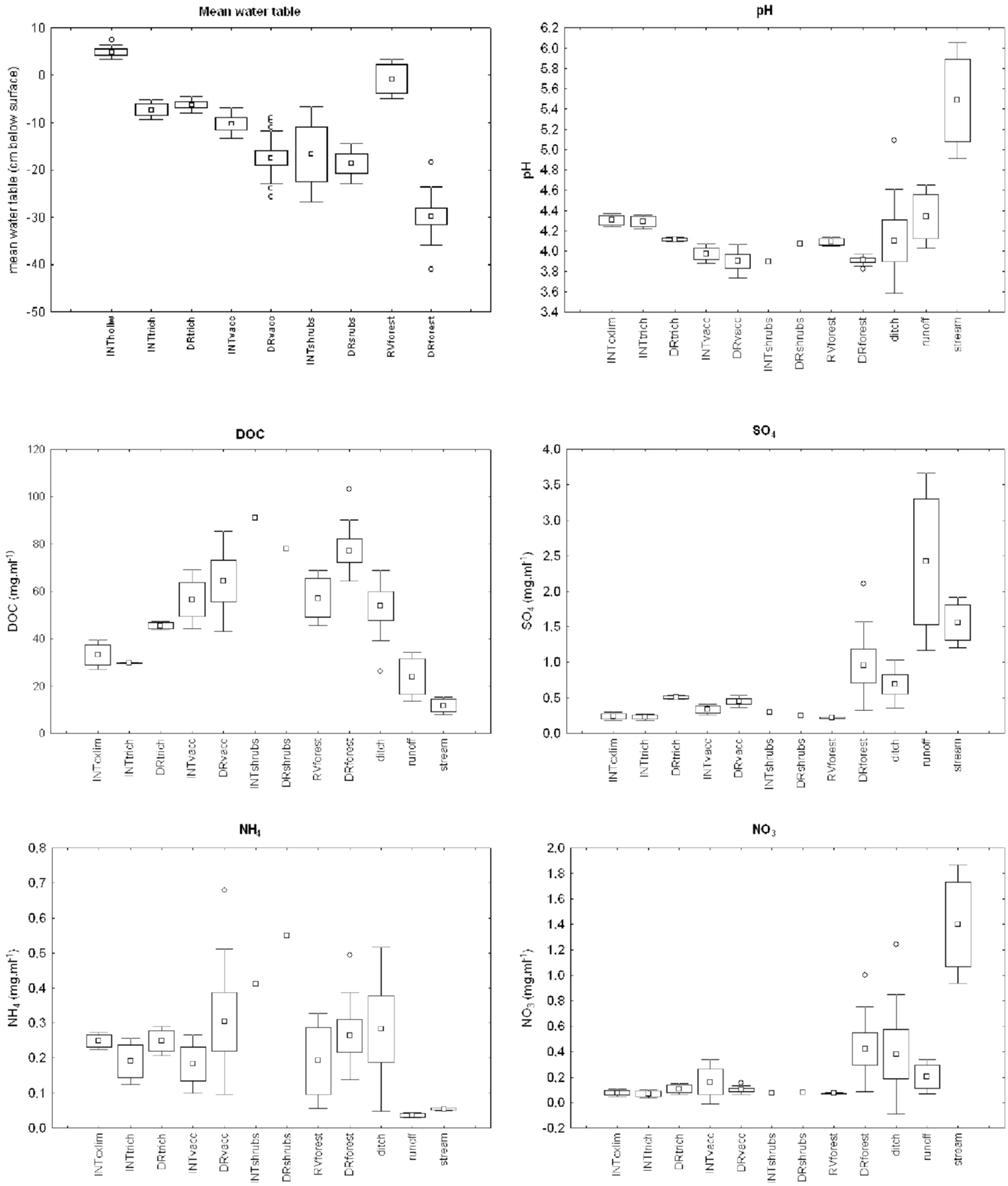

Figure 1. Mean groundwater table in boreholes and mean concentrations of selected ions, DOC and pH of monitored sites in 2007.

Legend:

INTcxlim - hollows with vegetation of all *Leuco-Scheuchzerion* in intact bog,
INTtrich - lawns with *Trichophorum caespitosum* in intact bog,
DRtrich - lawns with *Trichophorum caespitosum* in drained bogs,
INTvacc - dwarf shrub vegetation in intact bog,
DRvacc - dwarf shrub vegetation in drained bogs,
INTshrubs - marginal shrub vegetation in intact bog,
DRshrubs - marginal shrub vegetation in drained bogs,
RVforest - restored waterlogged spruce forest of as. *Sphagno-Piceetum,*
DRforest - drained waterlogged spruce forest of as. *Mastigobryo-Piceetum,*
ditch - surface water in ditches crossing ombrotrophic bogs,
runoff - runoff surface water from drained catchments,
stream - surface water in larger stream naturally draining studied part of the upland area.

crossed by several ditches linked with net of peripheral ditches in surrounding waterlogged spruce forests. Surface ditches are of considerable size with depth reaching up to 2 m and width as much as 3,5 m. Distance between ditches is ranging from 25 to 40 m.

Data collection

Three small catchments with different level of disturbance (control, drained and extensively drained) and including a large proportion of mires have been studied since 2005. The mire habitats under the program of monitoring are ombrotrophic peatbogs (*Leuco-Scheuchzerion palustris, Oxycocco-Ericion, Sphagnion medii*) and waterlogged spruce forests (*Mastigobryo-Piceetum*). Two sites with waterlogged spruce forest (*Sphagno-Piceetum*) already restored in 2005 were also included into the monitoring program. Permanent plots (57) with associated water wells were established to characterise microtopographical, vegetation and drainage patterns of the different sites. Position of water table was measured by piezometers in plastic boreholes. Water samples from boreholes, ditches and streams were taken monthly for a detailed hydrochemical analysis, including content of main cations and anions (SO_4, NO_3, NH_4, PO_4, Ca, Mg, Al, Fe), pH, conductivity and DOC. Runoff from drained catchments as well as amount of precipitation were measured continualy. Vegetation was sampled in 1x1m permanent plots around each borehole during July and August 2005. Percentage cover values for all vascular plants and bryophytes present on the permanent plots were estimated visually. Syntaxa used in the text without any citation follow Moravec (1995).

Results

Results of hydrological and hydrochemical monitoring of drained and intact sites are shown in Fig.1. Water table was maintained in lower position and exhibited higher fluctuation on dryer dwarf shrub sites prevailing on drained bogs. Fragments of *Trichophorum* lawns in centre of drained bogs exhibited a more stable water regime with water table fluctuation similar to intact bogs. pH values of groundwater were lower values on drained bogs. DOC was higher in groundwater of drained sites and in ditches and much lower in runoff water from drained catchments. Concentrations of SO_4 and NH_4 were slightly higher on drained bogs with the highest SO_4 values in runoff surface water from drained catchment. Nitrate concentrations had very low values in groundwater of both drained and intact bogs. However, they slightly increased in ditches and runoff water from drained catchments.

Large differences were recorded between drained and already restored waterlogged spruce forests. Drained forests are characterised mainly by lower and highly fluctuating water table and higher DOC and SO_4 concentrations. PO_4 concentrations were found to be highest in restored forests. However, comparison between drained and restored waterlogged spruce forests has to be used with care because of differences in hydrology as well as vegetation between both groups of monitored sites (drained *Mastigobryo-Piceetum* versus restored *Sphagno-Piceetum*).

Changes in abiotic environment of drained mires are well mirrored by their vegetation. Degradation changes include considerable recession of hollow vegetation (all. *Leuco-Scheuchzerion palustris*) and *Trichophorum caespitosum* lawns. Drainage also caused expansion of moss and lichen species adapted to lower water table (e.g. *Pleurosium schreberi, Dicranum scoparium, Polytrichum strictum, Pohlia nutans, Cladonia rangiferina, Cetraria islandica*) and expansion of well competitive graminoids (mostly *Molinia caerulea*). In drained sites, expansion of dwarf shrubs with high proportion of *Vaccinium myrtillus* at the expense of *Vaccinium uliginosum* was recorded. Intensively drained bogs are characterised by expansion of trees (*Picea abies, Pinus* x *pseudopumilio, Betula pubescens*) into the bog expanse.

Discussion and conclusion

Differences in hydrology, hydrochemistry and vegetation between drained and intact ombrotrophic mires of this study agree mostly with other results of studies performed in other central- and north european peatlands. Increased SO_4 and NH_4 concentrations in soil solution after dropping water table in blanket peatbogs have been reported for example by Adamson *et al.* (2000). Large increases in ammonium concentrations have been observed following drainage by Lundin (1991) or Miller *et al.* (1996). Higher DOC concentrations in surface water from drained catchments were found by Clausen (1980). On the other hand, Chapman *et al.* (1999) reported lower DOC in streams from drained moorland.

This collection of data for three years prior to the restoration phase on drained sites represents a good base to follow the changes of how the ecosystems will react after restoration actions. The planned restoration projects will primarily focus on re-establishment of high water tables and stable hydrology through the blocking of drainage ditches by a set of woody dams. The restoration method is based on the level of water table targeted for the different restored peat sites. Restoration will be performed in 2008.

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