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UP-SCALING POSSIBILITIES OF ENVIRONMENTAL CHANGES ON LONG-TERM PEATLAND MANAGEMENT AT PORLA MIRE

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SUMMARY

Landscape study of 116 ha Porla mire showed a drastic changes on 77% of the mire total land cover since 1864. Water supply for the rewetting is telmatic and the water of the lake outlets having rather small changes during ten year inundation in comparison of the water formed in poor-fen. However, the annual outlet quantities seem to be lowered due to the increased part of the opened water surfaces. The coverage of the most GHG emitting part constitutes about 40% or 46 ha from contemporary peatland area. Only about 8 ha of the lakes water surface and 3 ha from the non-managed poor-fen part could be referred to the low GHG emitters, outside the tree or other plant covered area.

KEYWORDS: cut-over peatland, after-use, mapping, hydro-ecological development

INTRODUCTION

Wetland ecosystems (including peatlands) are ecologically and functionally significant elements of the water environment and they have an important role in achievement of sustainable river basin management by contributing to the abatement of the impact of pollution, as well as mitigation the effects of droughts and floods and promoting groundwater recharge (Maltby et al., 2003). Anthropogenic pressures on wetlands via their physical modification or pollution can result in impact on ecological status of wetland depending surface water bodies. Wetland creation and enhancement can in appropriate circumstances offer sustainable, cost effective and socially acceptable mechanisms for helping to achieve the environmental objectives of the Water Framework Directive (WFD).

Essential for wetland management is baseline data that establishes the range of natural variation in components, processes and services at each site within a given time frame, to which changes can be assessed (Ramsar, 2005). Hereby the ecosystem approach provides a methodological framework for integration of wetland management alongside meeting economic and sustainable development objectives. Challenge of ecosystem approach aggregate the site-based functional analysis of wetlands to the landscape or catchment-scale outputs (Maltby, 2008), called also as an up-scaling approach (Lode et al., 2011).

The simplest up-scaling approach begin from the point of understanding certain physical processes, and combining these with data to build a representation of a system (Eastaugh et al., 2011) while the top-down approach could infer from spatial data more detailed ground level information. Very often the combination of both approaches should be applied (Lode et al., 2011).

Up-scaling needed for fifteen year mire landscape study followed by the site-, transect and point level field recordings and investigations; resulted in varying sequence and concentrations of investigation results.

MATERIALS AND METHODS

The Porla mire landscape (located in south-central Sweden, E 14°40'; N 59°00, at an elevation of about 85 m.a.s.l.), was chosen for up-scaling of the landscape cover changes since 1880. Study was performed on the base of available electronic orthophotos from 2007 and other map data (historical maps), provided by the Swedish Lantmäteriet.

Based on down-scaled information from orthophoto, e.g. modification of orthophoto to the principal component layers and unsupervised classification of study area in the frame of different study polygons, the generalized ground-level study results applied to the GIS defined ecotope polygons.

The Porla mire was originally a poor fen, where peat cutting for peat litter started in 1880-ies. The peat cutting terminated 1998 and a man-made rewetted area was initiated in 1999.
The borderline between the lakeshore and littoral zones is defined by the several year maximum inundation extensions toward the upslope mounded peat or road beds.

RESULTS

The GIS based study of Porla mire orthophotos showed that from its natural extension (116 ha) about 27 ha (23%) is remained non-managed by the peat cutting. About 55 ha (48%) of the mire has a clear milled peat-cutting field pattern with well reflected net of the drainage ditches on the area. Tree coverage, mainly spruce and pine covers 34 ha (29%) of the previous mire extension. Due to different water conditions on contemporary peatland the surface land cover is fragmented and varying in details. Currently about 35% (19 ha) of cut-over peatland is rewetted, including the beaver inundation on about 5 ha (Fig. 1). Man-made rewetting forms two artificial lakes on the area: the southern Lake B (9.35 ha) and the northern Lake A (4.43 ha) together with corresponding temporary inundated littoral zones (Fig. 1; Table 1). Due to swelled and float residual peat the peat surfaces coverage in the Lake areas constitutes 25% for the Lake A and 49% for the Lake B, whereas half of these surfaces is covered by plants. Although the floating peat mats cover only 25% of the man-made pond surface, the plant coverage of those peat mats is 61% (Table 1).

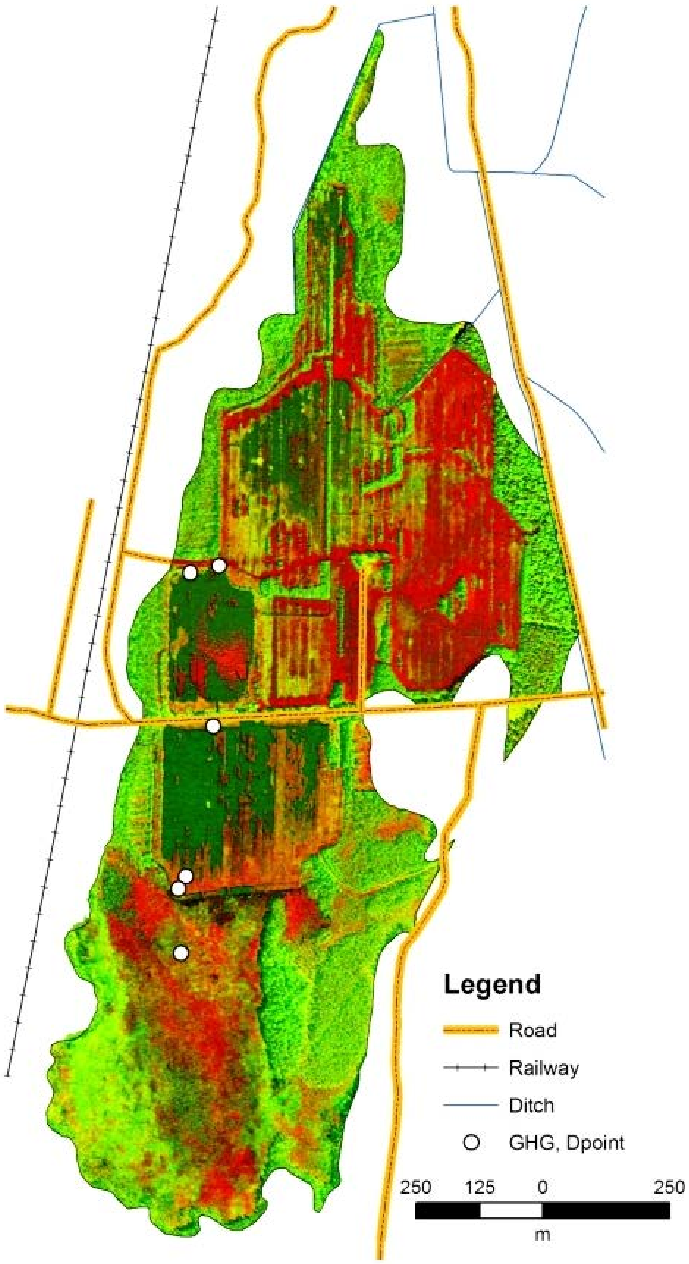

Fig. 1. Visualised Porla mire in the frame of it natural extension (116 ha), where the southernmost GHG, D point in the figure presents the greenhouse gas measurement (GHG) point on non-managed part of the poor-fen (27 ha). Next GHG, D point toward the north are for the non-inundated shore of the rewetted 9 ha Porla B Lake. Two closest points to the Lake B open water area on the southern and northern side present the temporary inundated lateral zone. The southern point of the two northern GHG, D points belongs to the GHG point on lateral zone of rewetted 4 ha Porla A Lake. The most northern GHG, D points of the Lake B and A are also a discharge measurement points of Porla rewettings. On the cut-over part of the mire the dark green areas are the open water and the dark red areas are the bear peat surface. On the poor-fen part the red pattern is the reflection of drier and higher ecotopes and the light solid green are the wetter and lower parts. Dotted green pattern over all area is the reflection from different tree species.

Table 1. Surface cover patchiness developed at inundated part of cut-over peatland of the Porla mire (Fig. 1). Identification is made from orthophoto 2007 of Swedish Lantmäteriet

Surface cover	**Lakes**				**Shore zones**				**Ponds**	
	Southern Lake A		Northern Lake B		Southern Lake A		Northern Lake B			
	ha	%	ha	%	ha	%	ha	%	ha	%
Open water	3.33	75.2	4.85	51.9					0.09	25.6
Peat surface	0.54	12.1	2.19	23.4	0.41	26.2	0.38	9.6	0.05	13.1
Plant cover	0.56	12.7	2.30	24.6					0.22	61.4
Tree shade					0.35	22.5	1.27	31.9		
Trees, lower plants					0.80	51.2	2.33	58.5		
Stones			0.00	0.0	0.00	0.2				
Total	4.43	100	9.35	100	1.57	100	3.98	100	0.36	100

During the ten year field survey we had six years with reliable annual discharge recordings at the outlets of Porla man-made lakes, i.e. from 2000 up to 2002, and from 2007 up to 2009. The average precipitation amount for those six years was 803 mm and runoff was 218 mm. Results of discharge analyses showed the lower high peaks and fewer low flow events during the inundation period (Nilsson et al. in current proceedings).

The ten year inundation shows unchanged pH in outlet discharges of the Lake B, accompanied with water quality changes towards less organic content, with slight increase in P_{tot} concentrations and decreased nitrogen (N) (Table 2). However, according to water chemistry results of the Porla man-made lakes (Lundin et al., in current proceedings), these lakes could be classified to the small standing water bodies with organic rich and dark water (WFD, 2000).
In general the type of new grown plant species and the peat moisture conditions funished the crucial factors influencing the GHG fluxes on rewetted part of cut-over peatland (Jordan et al., in current proceedings).

Table 2. Water chemistry of the Lake B outlet at inundated part of cut-over peatland of the Porla mire (Fig. 1), where before rewetting equals to the years of 1997-1999, and periods I, II and III equals to the inundation periods of 2000-2003, 2004-2006 and 2007-2010 correspondingly

Ingredient	**Before rewetting**	**During rewetting**		
		period I	period II	period III
pH	5.4	4.9	5.0	5.0
El. cond., µS/cm	41	34	32	28
Colour, mgPt/l	236	257	261	260
DOC, mg/l	39	37	37	35
N_{org}, mg/l	1.07	0.75	0.86	0.73
N_{tot}, mg/l	1.69	1.54	1.45	1.09
P_{tot}, mg/l	0.016	0.024	0.017	0.026

CONCLUSIONS

Up-scaled land-cover results showed that from 116 ha Porla mire origin the 55 ha have been managed for peat cutting. Although the extension of the man-made lake areas is 14 ha, only 8 ha (i.e. 57%) of lake surface could be defined as a clear water, without floating peat mats or swelling peat surfaces. The spontaneous tree and plant growth took place on 34 ha, and beavers caused inundation on 5 ha. On the ground level hardly recognisable disturbances (tree invasion) took place at least on 30% of the 27 ha part of the poor-fen.

Water supply for the rewetting is telmatic and the water of the lake outlets having rather small changes during the ten-year inundation period in comparison of the water formed in poor-fen. However, the annual outlet quantities seem to be lowered due to the increased part of the opened water surfaces.

Although there is a big variation in GHG fluxes from different ecotopes with different plant cover and wetness conditions, the coverage of the most GHG emitting part constitutes about 40% or 46 ha from contemporary peatland area (e.g. non-inundated peat surface from extraction, littoral and shore zones of the lakes). Only about 8 ha of the lakes water surface and 3 ha from the non-managed poor-fen part could be referred to the low GHG emitters, outside the tree or other plant-covered area.

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