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INFLUENCE OF DITCHING ON THE HYDROLOGY OF MIRE LAKES

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SUMMARY

The effects of ditching on water levels and water quality in mire lakes were studied on seven mires located close to peat production areas, six of which possessed a mire lake. The work was carried out chiefly in 2006–2007, although some monitoring results covering several years were included in the data. Groundwater gauges were installed on transects across two mires in order to assess the distance over which ditching affected the mire surface. This parameter was studied more precisely in the case of one of the lakes, Lake Vähä-Karsikkolampi. Water levels were measured in the six lakes, water samples were taken and precipitation was measured throughout the period concerned. Conditions were particularly suitable for such research, as summer 2006 proved to be exceptionally dry.

The results indicate that although the influence of ditching on the surface horizons of the mire extended between 24 m – 38 m from the ditching site, no permanent lowering of the water level could be detected in any of the lakes. Water levels in the lakes and on the mires dropped during summer 2006 on account of the general groundwater situation, but returned to normal with the heavy rains in the autumn. The observations bore witness to the high water retention capacity of peat. No appreciable changes in the water quality of Lake Vähä-Karsikkolampi were detected over the period of peat production.

KEYWORDS: ditching of mires, mire lakes, peat production, water quality

INTRODUCTION

Small lakes, representing the remnants of earlier larger lakes that have been filled in with vegetation in the course of time, are an essential part of Finnish mire landscapes. These lakes are nowadays protected areas and no work should be carried out in their surroundings that would alter their water balance or water quality. On the other hand, there is no precise information available to peat production companies or the authorities regarding the manner in which the depth of ditching and the distance between the ditches and the lake might affect these parameters. A mire is normally dried by ditching for 3–5 years before peat production commences, and the protection of mire lakes is taken into account in the environmental licences issued for peat production, by insisting on buffer zones of a certain width between the ditched area and any lakes and providing for monitoring of water levels and water quality in the lakes throughout the duration of peat production. As noted by Mäkelä (1988), the hydrology of many peat production and mire restoration areas has been studied but there are very few published results available. The majority of related publications are concerned with the loading of waterway systems from peat production areas, in addition to which there have been a few studies of the effects of peat production on the groundwater table in Finnish mire areas (Hillebrand et al. 1996, Mäkelä 1988). We thus set out here to study the influence of the ditching of mires for peat production on variations in water levels and water quality in mire lakes.

MATERIAL AND METHODS

The research was focused on Lake Vähä-Karsikkolampi, a lake lying close to the peat production mire of Pikarineva in Northern Ostrobothnia, Finland (25°26'20"E–64°32'50"N), and took place over the period 15.5.2006–19.1.2007. Five groundwater gauges for monitoring water levels in the lake and the mire were installed on a 119 m transect setting out from the production area, the first being located between the isolating ditch and the collecting ditch. The gauges were placed closer together at the end nearer to the production area, in order to assess the effects of the ditching in an outward direction. The positions of the water level in the lake and the groundwater levels in the gauges were determined on 15.5.2006 by precise levelling by reference to a known point on a tree and regular measurements were made and water samples taken from that time on, the last being on 19.1.2007 (Tables 1 and 2).

RESULTS

Variations in the groundwater table on the Vähä-Karsikkolampi transect

The water level in Lake Vähä-Karsikkolampi on 15.5.2006 was 54.73 m a.s.l., i.e. 10 cm higher than it had been in mid-May a year earlier, and the groundwater table along the transect varied very little from this height, so that the total range was only 8 cm (Table 1 and Figure 1). The June measurements were practically the same as in May, but water levels at all the measurement points had fallen markedly by the beginning of July, at which time the water level at the nearest gauge of the peat production site itself had dropped by 35 cm. The declines in water level were less marked towards the mire lake, however, and the level in the lake itself had dropped by only 16 cm. This trend then continued, so that the water level near in the production area was 69 cm below the baseline reading by 8.8.2006 and that in the lake 43 cm below the baseline. The groundwater table rose once again as autumn set in, so that the reading at the point 9 m from the production area was already 30 cm above the August level by 8.11.2006 and the readings at the other points were consistent with this, while the water level in the lake had risen by 18 cm over the same period. By the time of the last measurement, on 19.1.2007, the groundwater table at the points 38 m and further from the production area had regained the May 2006 level.

The summer of 2006 was an exceptionally dry one, as may be seen by comparing the rainfall in June–August with the means for the normal period 1971-2000, as in Figure 2, while precipitation in October–January was higher than normal. Thus the groundwater table dropped markedly throughout Finland in the course of the summer and rose again as winter approached. The corresponding situation at the official meteorological station at Turtakangas in Ruukki, about 30 km west of Lake Vähä-Karsikkolampi, is shown in Figure 3, demonstrating that the groundwater table in the mineral soil of that site behaved in the same manner as was observed along the transect, except that it continued to fall until November, by which time water levels in the mire had begun to rise again. The water table at Turtakangas had returned to the spring 2006 level by January 2007 in the same way as that in the surroundings of Lake Vähä-Karsikkolampi.

Table 1. Water levels in Lake Vähä-Karsikkolampi and along the groundwater measurement transect.

	Gauge 1	Gauge 2	Gauge 3	Gauge 4	Gauge 5	
Date	Production area	9 m	24 m	38 m	67 m	Mire lake 119 m
15.5.2006	54.76	54.75	54.77	54.81	54.8	54.73
8.6.2006	54.73	54.71	54,73	54.76	54.77	54.72
4.7.2006	54.41	54.47	54.5	54.54	54.59	54.57
8.8.2006	54.07	54.16	54.23	54.29	54.35	54,3.
8.11.2006		54.46	54.47	54.49	54.56	54.48
19.1.2007		54.55	54.65	54.79	54.75	54.77

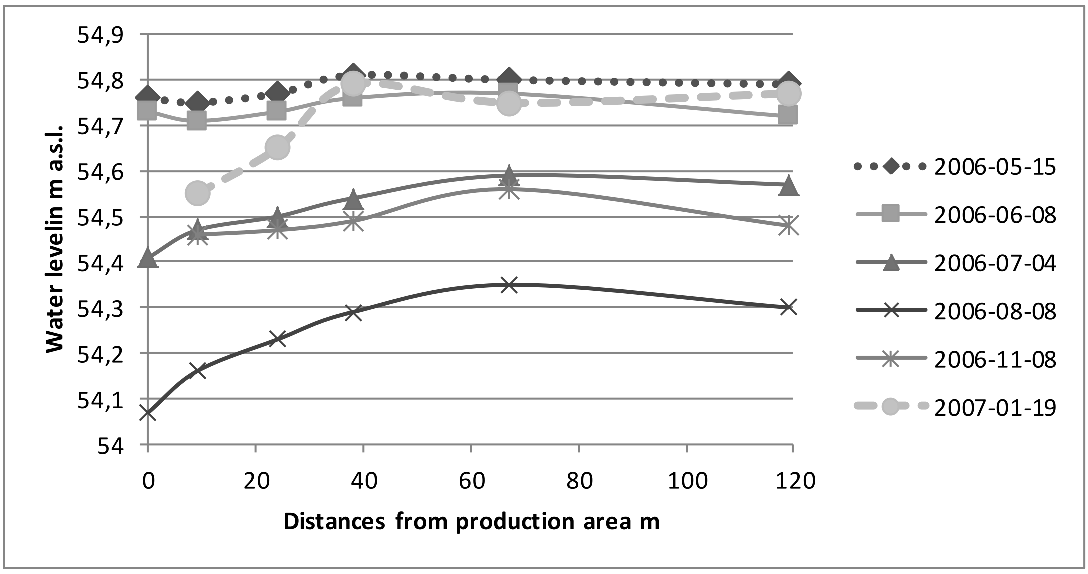

Figure 1. Water levels along the Vähä-Karsikkolampi transect in May 2006 – January 2007. Comparison of the values for the beginning and end of the period shows that ditching had an effect on the groundwater table up to a distance of 24 m from the peat production area.

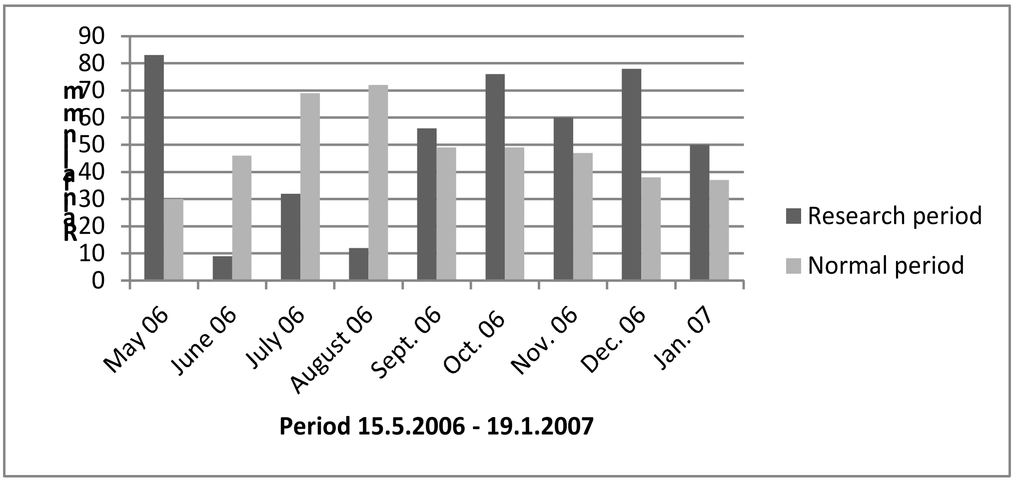

Figure 2. Rainfall at Ruukki Meteorological Station in May 2006 – January 2007 (Finish Environment Institute 2007,2008).

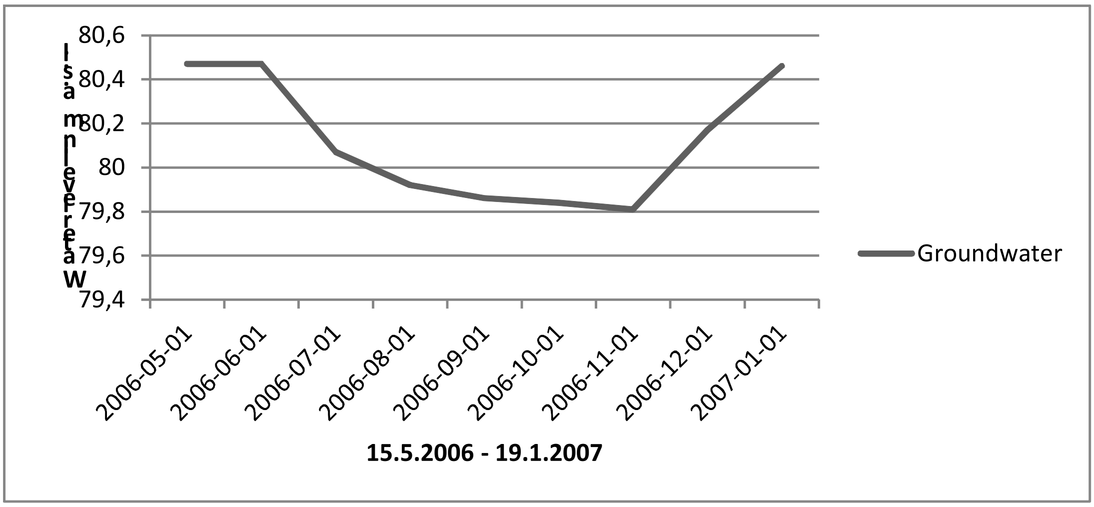

Figure 3. Heights of the groundwater table at Ruukki Meteorological Station, Turtakangas (Finnish Environment Institute 2007,2008).

Water quality in Lake Vähä-Karsikkolampi in 2006

Trends in water quality in Lake Vähä-Karsikkolampi during the summer and autumn of 2006 are shown in Table 2. There are no major differences in water quality relative to previous years, but some minor ones can be noted. One deviation is the high concentration of ammonium nitrogen in November, at which time nitrate+nitrite nitrogen was similarly elevated. It is also significant that pH values were above 6 throughout the period studied.

Table 2. Water quality in Lake Vähä-Karsikkolampi in 2006.

	15.5.2006	4.7.2006	8.8.2006	8.11.2006
Temperature ^{0}C		24.0		1.0
Oxygen mg/l	8.9	6.9		10.9
Oxygen %		82		77
pH	6.4	6.1	6.2	6.2
Electrical cond. mS/m	1.6	2.3	2.7	3.9
Alkalinity mmol/l				0.09
Suspended solids mg/l	<1	3.9	3.9	<1
Colour mg Pt/l				50
Turbidity FTU	0.6	1.7	1.4	1
Ammonium N ug/l	7	99	27	690
Total N ug/l	450	610	850	1600
Nirate+nitrite N ug/l	<3	<5	<5	19
Phosphate P ug/l	<2	3	3	
Total P ug/l	20	23	68	25
COD_{Mn} mg/l	8.4	13	16	11
Fe ug/l	480	880	720	530

CONCLUSIONS

It can be concluded from these results that the fall in the groundwater table on the Lake Vähä-Karsikkolampi transect was attributable to the exceptionally dry summer and that levels in the area around this mire lake returned to normal with the increased rainfall in autumn. The influence of ditching of the Pikarineva peat production area would appear to have extended outwards as far as the 24–38 m zone, a result that supports the findings of Mäkelä (1988: 27) on a mire in Kontiolahti known for its bird life, where ditching was likewise found to have led to a drop in the water table only in the immediate vicinity of the ditched area. Earlier research has established that the water permeability of peat is dependent on its degree of humification, with better humified peats proving less permeable (Päivänen 1973).

No attempt was made here to assess the quality of the water in the peat, but the water of Lake Vähä-Karsikkolampi can be assumed to react to the quality of that present in the peat of the surrounding mire area. Acidity appears to have increased in response to drying of the peat, and a concurrent increase can be seen in ammonium nitrogen concentrations, while a correlation can be perceived between iron and total phosphorus. The results are similar to those reported earlier (Sepponen & Haapala 1979).

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