Effect of frequency of meadow sward use on changes in bulk density of peat-muck soil

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Introduction

Peatlands play a significant role in the regulation of greenhouse gas emissions and global climate. The organic matter of peat is used in horticulture, floriculture, forestry as well as agriculture. Unfortunately, in most regions of the world, peatlands have been irretrievably degraded. This unfavourable phenomenon has particularly affected post-boggy habitats that formed as a result of the drainage and cultivation of peatlands. Intensive agriculture has led to a number of effects including the lowering of the groundwater table as well as changes in plant communities and physicochemical properties of soil. Changes in organic soils caused by the mineralization process concern particularly the content of organic matter, water capacity as well as bulk density. Texture and structure of a soil are closely related to bulk density. Soil structure can be modified by adopting various soil management practices including aeration, tillage or drainage. The subsequent changes of the physical, chemical and hydraulic properties initiated by land amelioration for agricultural purposes are also intensified by grassland abandonment.
The aim of this paper was to determine the changes in the bulk density of peat-muck soil depending on the frequency or lack of meadow use in post-boggy habitats.

Results

The significantly differences were observed in the soil in 2008 and 2009 in comparison to 2006 and 2007 years (Fig. 2). Great changes in bulk density could caused by lower precipitation (9-30%) as well as higher mean temperatures (15%) in 2007 and 2008 in comparison to multi-year mean values. The increasing bulk density and disappearance of organic matter indicates the transformation of organic soils into mineral soil. The greatest changes were observed in the soil of the unused meadow (0A) that was characterized by the highest values of that feature in 2009 (0.56 – 1.05 g cm-3; Fig. 1). Furthermore, a low groundwater level and species indicative of mineralization of organic matter such as Linaria vulgaris and Urtica dioica were observed in that meadow. Interaction between years and frequency of use was significant but it was affected the other sites which was used a short time. The soil of the meadow that remained unused for a long time was characterized by a significantly higher bulk density (0A – 0.81; 0B – 0.38 g cm-3) in comparison to the other sites. The significantly lower values determined for the unused meadow (0B) in comparison to 0A could be connected with a higher groundwater table that limits bulk density increase. Maintaining the use of meadows is one of the methods of preventing the degradation of ecosystems.
There were no significant differences among other methods of use but the lowest bulk density occurred in the soil of 1-cut and 2-cut meadows (Fig. 2). The soil layer at the depth of 5-10 cm was characterized by a significantly higher bulk density (0.39 g cm-3) than the deeper layer (0.34 g cm-3).

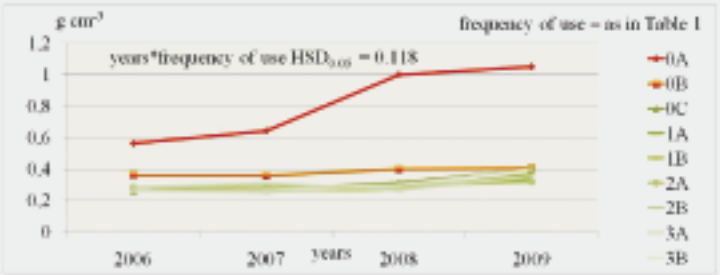

Figure 1. Bulk density of soil depending on frequency of use in 2006-2009

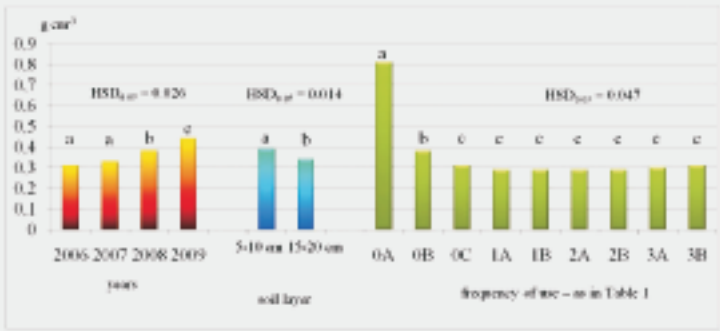

Figure 2. Mean bulk density of soil depending on various factors under study

Methods

The studies were carried out in 2006-2009 in a peatland complex in Sosnowica (the Wieprz-Krzna Channel area in eastern Poland). In the years 1964-1966, the fen was drained and the reclaimed land was put to agricultural use. At present, the soils of this grassland complex mostly belong to the muck soil type and the peat-muck soil subtype (Mt II). This complex extends over a wide area on both sides of the River Piwonia, within its middle course. This complex is part of Parczewskie Forests, a Natura 2000 site (Birds Directive). The bulk density of soil in the particular soil layers (5-10 cm; 15-20 cm) as well as the diverse frequency of meadow use were determined (Table 1). This feature was measured in 4 replications by using a cylindrical steel core with a volume of 105 cm3. Samples were dried at 105°C. Results were analyzed statistically using Statistical Analysis System (SAS ver. 9.2) by means of Tukey's Honestly Significant Difference (HSD).

Table 1. Frequency of use and characteristics of tested meadows

Site no		Frequency of use	Characteristics
0	A	Unused	degraded meadow with the predominance of *Deschampsia caespitosa* near the River Piwonia – unused for 13 years
	B		meadow with the succession of shrubby and arborescent vegetation of the genus *Salix* sp. and *Betula* sp. – unused for about 20 years
	C		meadow unused for 5 years, earlier used as a 2-cut meadow
1	A	1-cut meadow	without fertilization – used for 5 years, earlier used as a 2-cut meadow
	B		fertilization (N – 30; P – 26; K 75 kg ha^{-1} yr^{-1}) – used for 5 years, earlier used as a 2-cut meadow
2	A	2-cut meadow	(N – 30; P – 26; K - 75 kg ha^{-1} yr^{-1}) – used as a 2-cut meadow for over 25 years
	B		(N – 60; P – 26; K - 75 kg ha^{-1} yr^{-1}) – used as a 2-cut meadow for over 25 years
3	A	3-cut meadow	(N – 60; P – 26; K - 75 kg ha^{-1} yr^{-1}) – used for 5 years, earlier used as a 2-cut meadow
	B		(N – 90; P – 26; K - 75 kg ha^{-1} yr^{-1}) – used for 5 years, earlier used as a 2-cut meadow

Picture 1: Cylindrical steel core

Picture 2: Degraded meadow 0A

Conclusions

Maintaining the use of meadows is one of the methods of preventing the degradation of ecosystems. The soil of used meadows is characterized by a lower bulk density in comparison with the soil of meadows unused for a long time. On abandoned grassland, the groundwater table could be an important factor. The lowest value of this feature was observed in 1-cut and 2-cut meadows. These could be the best methods of use in post-boggy habitats. The upper stratum of organic soils is characterized by a higher bulk density.

Acknowledgements

This research is funded by a grant from Polish Ministry of Science in 2007-2010