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CHANGES IN CHEMICAL PROPERTIES IN TWO SLOVAK PEATLANDS AFTER 10 YEARS MONITORING PERIOD

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Abstract

Presented contribution brings a comparison of changes in basic chemicals parameters with emphasis on organic carbon (OC) on two different Slovak peatlands, Belianske lúky fen – Histosol (Alcalic) and Rudné bog – Histosol (Gleyic) and their near surroundings. OC concentration in peat profile on Rudné bog is higher as on Belianske lúky fen. On both peatlands fresh plant residues, such as cellulose and lignin dominate in peat organic matter and the degree of aromaticity of peat organic matter on both monitored peatlands is very low. Great differences also in pH and nitrogen content were found. Rudné bog is extremely acid with low content of nitrogen, and pH values; Belianske lúky fen is located in the alkaline region, and nitrogen content compared to Rudné bog is much higher. On both peatlands very low concentration of available phosphorus was determined. On Belianske lúky fen above-limit arsenic content, which comes from carbonate rocks of Belianske Tatras, was detected. Because the above-limit concentration of Cd and Pb only in the upper part of Rudné bog was found we assume that this may be anthropogenic contamination. During the 10 years monitoring period OC concentration on both peatlands increased but a significant increase in OC mainly on Belianske lúky fen was found due to renewal management. The changes in the another chemical parameters on peatlands were not so prominent.

Keywords: peatland, soil, organic carbon, pH, nutrients, inorganic contaminants

INTRODUCTION

Peatlands and organic soils cover about 3% of the world terrestrial area but they consist of 30% world carbon stock in terrestrial ecosystem and they provide many ecosystem services for example: water regulation, biodiversity conservation, carbon sequestration and accumulation (Schumann & Joosten 2008). In Slovakia peatlands represent a very small area however their meaning from the ecological point of view far exceeds their real extent. Although peatlands have considerable potential for carbon sequestration from the atmosphere (Mitsch *et al.* 2013), they can easily become its source, as these ecosystems are very sensitive to environmental change. Peatlands are under threat due to drainage which leads to mineralization of soil organic matter to CO_2 (Wittnebel *et al.* 2021). Decrease of groundwater level caused by the use of peatlands for agricultural purposes, resp. peat extraction (Xioang *et al.* 2014), or changing climatic conditions may accelerate aerobic peat mineralization (Joosten & Clarke 2002), which may lead to secondary peat decomposition (Heller & Zeitz 2012) caused by chemical and physical transformation processes.

Peat is the organic soil and according to IPPC (IPPC 2008) an organic soil must meet of the following conditions:

a) thickness of organic horizon 10 cm or more. A horizon less than 20 cm thick must have 12% or more organic carbon when mixed to a depth of 20% organic carbon;

b) the soil is never saturated with water for more than a few days and contains more than 10% organic carbon;
c) the soil is subject to water saturation episodes and has either:
   1. at least 12% organic carbon if it has no clay, or
   2. at least 18% organic carbon if it has > 60% clay, or
   3. an intermediate, proportional amount of organic carbon for intermediate amounts of clay.

Peatlands are ecosystems that arise in areas permanently wet by rainwater, surface water or groundwater. Under conditions of limited air access, dead organic residues accumulate in various degrees of decomposition, which produces peat. The peat contains more than 50% of combustible organic substances in dry matter (Viceníková 2000).

Based on their hydrological, bioclimatic and chemical conditions, peatlands are divided into two main types, bogs and fens (Charman 2002). The Slovak typology of peatlands is based on vegetation and three main types of peatland are distinguished: ombotrophic bog dominated by Sphagnum mosses, minetrophic fen dominated by Cyperaceae and bryophytes and transition mire, which represent intermediate between ombotrophic and minetrophic (Hájek & Rybníček, 2000). Ombotrophic peat is supplied only by rainwater and minetrophic is supplied mainly by ground orsurface water (Šeferová Stanová & Hájek 2017).

In Slovakia, peatlands are considered very rare, often relict communities that belong to the most endangered ecosystems in our country. In the National List of Peatlands, which was created in 2001 – 2009 by the DAPHNE (Institute of Applied Ecology) in cooperation with the State Nature Conservation, 1522 small peatlands with a total area of 3057 ha were recorded (Šefferová Stanová 2012). Despite the relatively small area of occurrence of peatlands in Slovakia, these localities have an irreplaceable place in terms of carbon sequestration and their importance in terms of ecological functions far exceeds their real area. From this reason, it was decided to include typical peatlands in the Partial Monitoring System – Soil. In the period 2008 – 2014, seven peatlands were thoroughly pedologically characterized, while the emphasis in the selection of sites was placed primarily on the high environmental value, rarity and uniqueness of sites. Selected localities include different types of peatland in different climatic-geographic conditions of all Slovak area (Barančíková *et al.* 2018).

Representative of fens is locality Belianske lúky, one of the oldest, largest and best-protected fens of European importance in Slovakia (Šeferová Stanová & Hájek 2017). The Belianske lúky fen is characterized as a calcareous fen typical of the southern foothills of the High Tatras and Belianske Tatras (Gojdičová 2000). Since 2003, Belianske lúky fen has been a national nature reservation and is classified by the NATURA 2000 system among the Territories of European Importance (NATURA 2000a).

Representative of bogs is nature reserve Rudné. Rudné is characterized as a highland peat bog located in the territory of Upper Orava. Rudné represents a very valuable fragment of actively raised bog habitat. The Rudné bog is unique not only in Slovakia but also in the whole Central Europe (NATURA, 2000b).

A detailed description of the plant composition, morphogenetic description of soil profiles and basic chemical parameters of studied soils of the Belianske lúky fen and Rudné bog and their surroundings is given in our previous publication (Barančíková *et al.* 2018).

This study aims to compare changes in chemical parameters, with emphasis on changes in organic carbon, on the Belianske lúky fen and Rudné bog as well as their surrounding areas after the 10 years monitoring period.

MATERIAL AND METHODS

Characteristics of studied area

Belianske lúky fen (Fig. 1) is located in the Poprad part of Spišská kotlina basin in the cadaster of the Spišská Belá town at an altitude of 670 – 695 m a.s.l. Locality Belianske lúky is situated in a cold, very humid climatic area, with an average temperature of 14 – 16 °C in July and -5 °C in January. Annual rainfall represents 600 – 750 mm (Lapin 2002). The hydrological area is drained by the river Poprad with its tributaries (Marek 2007).

Figure 1 Belianske lúky fen

The Belianske lúky fen arose before more than 10,000 years ago and it is one of the oldest peatland in Slovakia.

Rudné bog represents a fragment of one of the most important bogs not only in Slovakia but also in Central Europe (Trnka 2000). On this locality, an excavation of peat was started in 1956 accompanied by massive drainage and vegetation clearance over the whole bog surface (Šeferová Stanová & Hájek 2017). To preserve at least part of this important peat bog, the Horná Orava Protected Landscape Area Administration prepared a proposal for the declaration of the Rudné Nature Reserve, which was implemented in 1986 (Trnka 2000).

Rudné bog (Fig. 2) is located in the north-eastern part of Orava region in the Oravská kotlina basin at an altitude 740 m a.s.l. The locality of the Rudné bog in the cadastral area of the village Suchá Hora belongs to a cold, very humid climatic area. The average temperature in July reaches between 12 – 14 °C and -5 to -6 °C in January. The annual total precipitation is in the range of 800 – 900 mm (Lapin 2002).

Figure 2 Rudné bog

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Sampling and Analyses

After terrain reconnaissance, appropriate points were selected to characterize the terrain profile of peat, soil profile between the peatland and the agricultural land (transition area) and the soil profile of the outlying agricultural land that is used as permanent grassland. Plant vegetation cover helped in the selection of the location of the probe. Soil sampling was performed according to Uniform procedures for soil analysis (Kobza *et al.* 2011).

Belianske lúky fen was classified as Histosol (Alcalic) (IUSS Working Group WRB 2015) Fig. 3a). The soil fen on the transition area (at a distance from the fen point 95 m) is classified as Rendzic Leptosol (Fig. 3b). Agricultural land outside the fen (at a distance from fen point 118 m) in the Belianske lúky locality is represented by Leptosol (Gleyic) (Fig. 3c).

Depths of sampling were specified on the base visual (morphological) changes in the peat profile. In the first sampling (2008) on the fen Belianske lúky the fen profile was filled with lateral water immediately after excavation. For this reason, in the first sampling (2008) samples only in 2 depths: 5 – 15, 20 – 30 cm were taken (Fig. 3a).

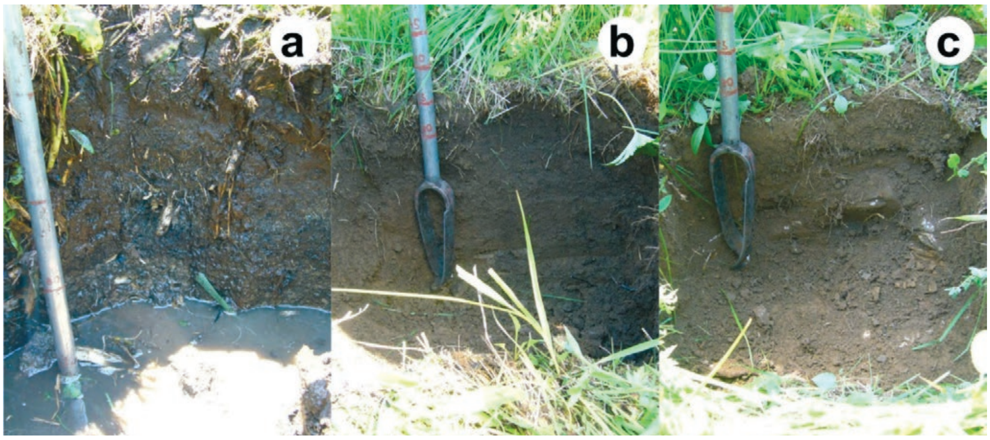

Figure 3 Fen and soils profile from the first sampling 2008
Figure 3a Upper part of fen profile Belianske lúky, under 0,3 m profile filled with lateral water
Figure 3b Soil profile on transition area – Rendzic Leptosol
Figure 3c Soil profile on grassland – Leptosol (Gleyic)

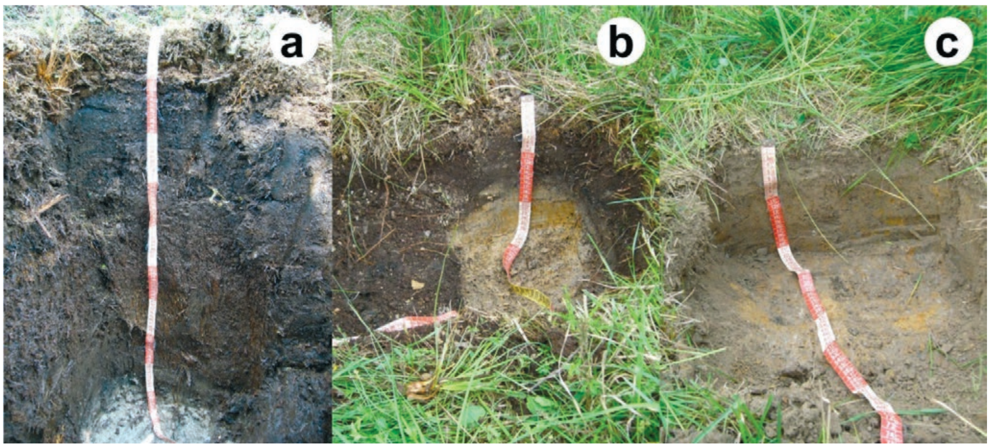

Figure 4 Bog and soils profile from the first sampling 2008
Figure 4a Soil profile of Rudné bog – Histosol (Gleyic)
Figure 4b Soil profile on transition area– Stagnic Cambisol
Figure 4c Soil profile on the grassland – Gleyic Stagnosol (Clayic)

In second sampling (2018) samples from fen profile from 5 – 15, 20 – 30, 40 – 50 and 58 – 68 cm depth were taken. The Rudné bog was classified as Histosol (Gleyic) (Fig. 4a), the soil on the transition area (at a distance from the bog point 145 m) as Stagnic Cambisol (Fig. 4b), and the agricultural soil outside the bog (at a distance from the bog point 177 m) as Gleyic Stagnosol (Clayic) (Fig. 4c) (IUSS Working Group WRB 2015). In the first (2008) and second sampling (2018) samples in bog profile from depth of 0 – 10, 15 – 25, 35 – 45 cm were taken.

At all individual depths of fen and bog and also at the first depth from transition area (soil between peatland and agricultural soil), and agricultural soil near peatlands these attributes were determined: the content of organic carbon (OC), total nitrogen (Nt), soil reaction (pH/KCl), available phosphorus (P), available potassium (K) and selected risk elements (As, Cs, Co, Cr, Cu, Ni, Pb, Zn) from both sampling (2008, 2018). The methods for determination the individual parameters are listed in the Uniform working procedures of soil analysis (Kobza *et al.* 2011).

Total organic carbon and nitrogen were determined on a Euro 3000 elemental analyser in CN configuration (Eurovector Instruments & Software, Milano, Italy). The OC content was calculated from the total carbon content after correction for carbonates. The soil reaction was determined as the exchange soil reaction in 1M KCl potentiometrically. For the available potassium analyse an extracting the soil with Mehlich III extraction solution by atomic absorption spectrometry was used. The available phosphorus was determined by extracting the soil with Mehlich III extraction solution by SKALAR instrument. The risk elements (Cd, As, Co, Cu, Cr, Ni, Pb and Zn) were analysed by the microwave decomposition method. Content of Cd, Co, Cu, Cr, Ni, Pb and Zn were determined by the AAS method and content of As by hydrogen arsenic gas generation technique after previous reduction. Solid state 13C NMR spectra were measured by NMR spectrometer (Varian/Agilent VNMRS 600 MHz) to determine the detailed chemical structure in the first depth of peats in the first sampling (2008). Subdivision of the spectrum into characteristic regions has been made by the commonly used scheme of Malcolm (1990). The composition of peat was determined by quantifying the signal areas of the chemical shift regions of the ^{13}C NMR spectra. The degree of aromaticity of peat was calculated by: $\alpha = Carom/(Carom + Caliph) \times 100$ (%).

RESULTS AND DISCUSSION

Organic carbon content

Organic carbon is a key element of the whole biomass and organic matter is the most important supply of organic carbon in biosphere. The first information about organic carbon content on locality Belianske lúky fen comes from the General soil survey of agricultural land (Němeček *et al.* 1967). In 1967 concentration of OC in the depth 0 – 30 cm on fen Belianske lúky represent almost 50% OC (Fig. 5). In this period Belianske lúky fen was used as a mowed meadow. In 2008 the Belianske lúky fen was selected for the soil monitoring network of Slovakia peatlands and OC concentration has been rapidly decreased (Fig. 5). For more than the 40-years Belianske lúky fen was unmown and overgrown with trees, which may be one of the reason for the significant reduction in OC in this locality, as according to Šeferová Stanová *et al.* (2015), afforestation also has an impact on peat drying. Another possible cause may be the drainage of adjacent areas (Wiitnebel *et al.* 2021), which reduced the groundwater level in the fen, which is located near the drained area. After the 10 years monitoring cycle (2018) OC concentration significantly has increased (Fig. 5).

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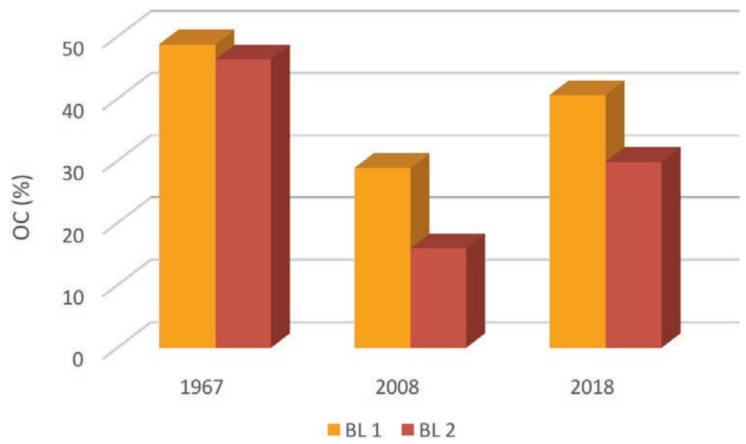

Figure 5 Changes in organic carbon (OC %) on fen Belianske lúky
BL – Belianske lúky BL1 – depth 5 – 15 cm
BL2 – depth 20 – 30 cm

One of the reasons for the increase in OC may be renewal management, which has been applied to Belianske lúky fen since 2009. The trees on Belianske lúky fen have been felled, fen has been mulched and mowing has started by light mechanization. At present, mowing by light mechanization is carried out on Belianske lúky fen every year. According to Šeferová Stanová *et al.* (2015) regeneration of fen is relatively fast, which may result in an increase in the concentration of organic carbon in this managed fen.

The changes in OC concentration reflect also in OC stock. The same trend as in OC concentration changes, also in OC stock in 0 – 30 cm fen depth were found (Fig. 6).

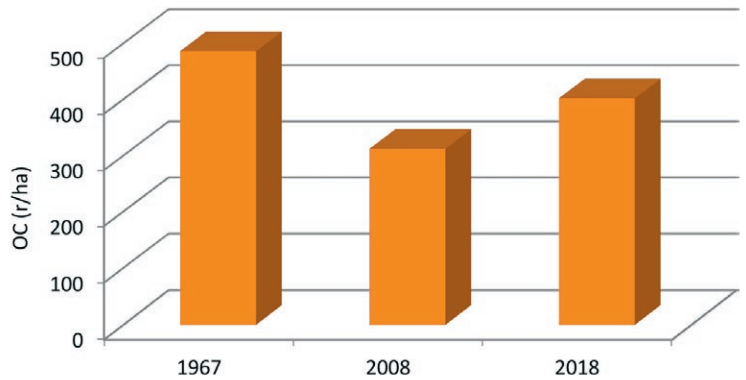

Figure 6 Changes in OC stock in 0 – 30 cm fen Belianske lúky depth

As can be seen in the Fig. 7 OC concentration in fen profile continually decrease.

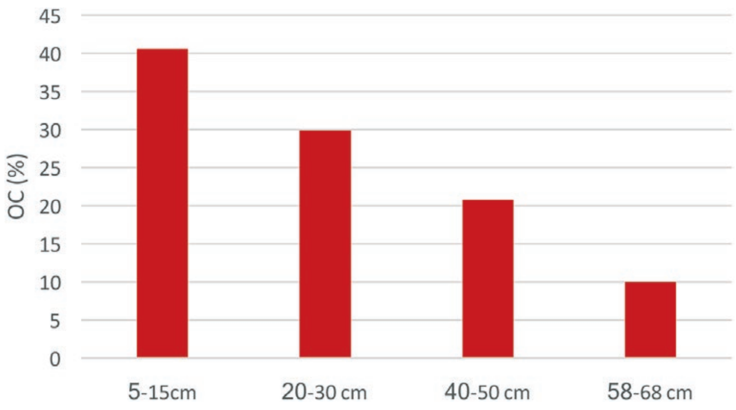

Figure 7 Concentration of organic carbon (OC %) in fen Belianske lúky profile (2018)

A gradual decrease in OC concentration was observed within the distance from peat (Fig. 8). During the 10 years monitoring period OC concentration increased not only on the upper 5 – 15 cm of Belianske lúky fen but also on soil on transition area between fen and meadow. The concentration of OC on a meadow in comparison to fen is very low and during the 10 years monitoring period no change in OC concentration on meadow topsoil was recorded (Fig. 8).

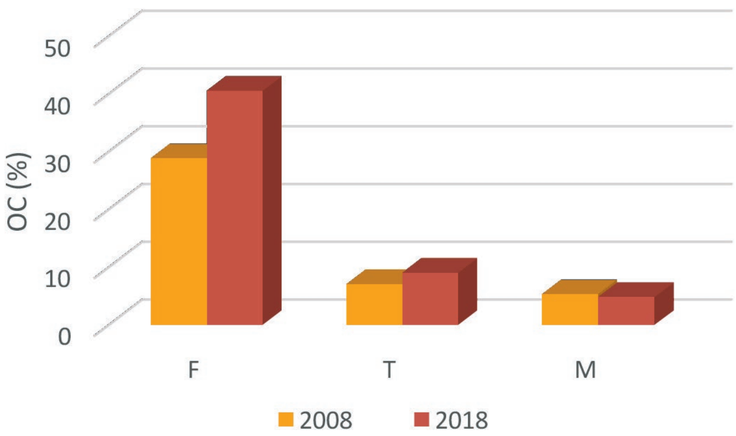

Figure 8 Changes in OC concentration in the depth 5 – 15 cm on fen Belianske lúky (F), on transition area (between fen and meadow) (T) and on the meadow (M) near fen Belianske lúky F – fen, T – transition area between fen and meadow, M – meadow

The concentration of organic carbon in the bog profile of Rudné is considerable higher compare to Belianske lúky fen mainly in the deeper part of bog horizon (Fig. 9, 7). On Rudné bog OC concentration also in the deeper part of the bog profile is approximately the same as in the upper the first depth (Fig. 9) in contrast to fen Belianske lúky, where the concentration of organic carbon decreases in the deeper parts of the fen profile (Fig. 6).

After the 10 years monitoring period (2018) OC concentration in throughout bog profile of Rudné increased but the increase was not as significant as in the fen Belianske lúky (Fig. 6, 9).

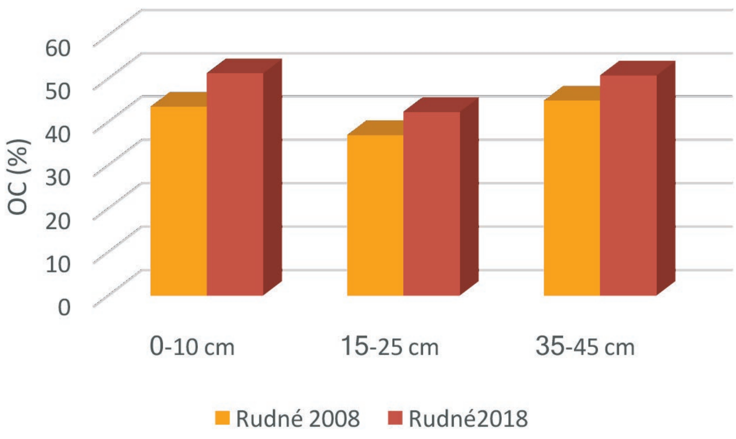

Figure 9 Changes in organic carbon (OC %) on bog Rudné

Increase was found also in OC stock on Rudné bog in 0 – 30 cm depth (Fig.10).

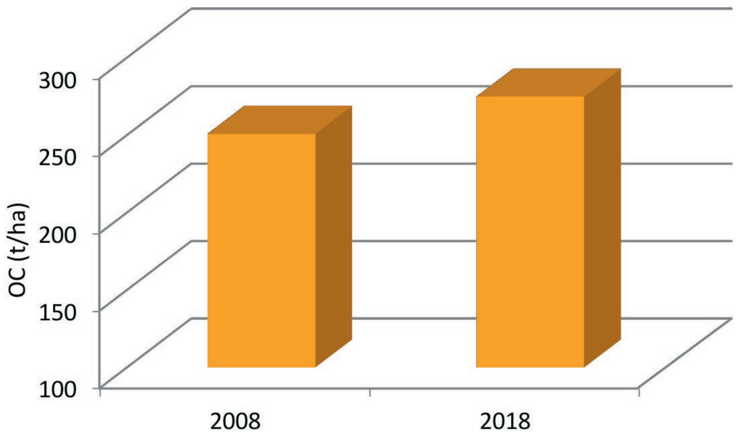

Fig.10. Changes in OC stock in 0 – 30 cm bog Rudné depth

On locality Rudné bog no management was carried out and the character of Rudné locality did not change at all after10 years, in contrast to Belianske lúky fen, where the character of the locality has changed significantly. A slight increase in OC concentration and stock at this site may be due to a natural increase in organic matter, but a positive role could also play the fact that peat extraction, which was carried out before this period near the protected area of Rudné bog, was stopped. As in the same case of Belianske lúky fen OC concentration decrease with distance from the Rudné bog (Fig. 11).

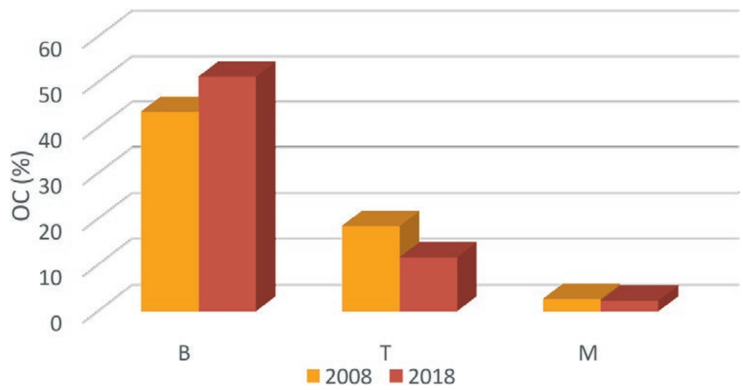

Figure 11 Changes in OC concentration in depth 0 – 10 cm on bog Rudné (B), on the transition area (between fen and meadow) (T) and on the meadow (M) near the bog Rudné

On the transition area OC concentration was higher compared to Belianske lúky fen but on meadow near Rudné bog content of organic carbon was lower (Fig. 8, 11). Differences between OC concentration on Rudné and Belianske lúky meadow can be explained by different soil types. On meadow near fen Belianske Lúky soil type is Rendzic Leptosol, which has a higher OC content compared to Gleyic Stagnosol – soil type on meadow near bog Rudné. Average OC concentration on Leptosol is higher as than on Stagnosol (Kobza *et al.* 2019).

The detailed chemical structure of organic matter in the first upper horizon was measured for Rudné bog and Belianske lúky fen by the high-resolution ^{13}C nuclear magnetic resonance technique (Fig. 12, 13) only on the beginning of the monitored period (sampling 2008). ^{13}C NMR spectra is one of the most widely used spectral techniques in the study of peat organic matter as this technique allows quantitative determination of individual carbon types in the structure of peat organic matter (Barančíková 2008, Enev 2014). The sharp are peaks for aliphatic carbons in region 0 – 50 ppm (Fig. 10, 11). It is likely that the aliphatic carbons represent refractory cuticular waxes from vascular plants, microbial lipids, long-chain hydrocarbons and fatty acids. A relatively sharp peak in region 30 ppm is specific for methylene groups of long aliphatic chains (Hammond *et al.* 1983).

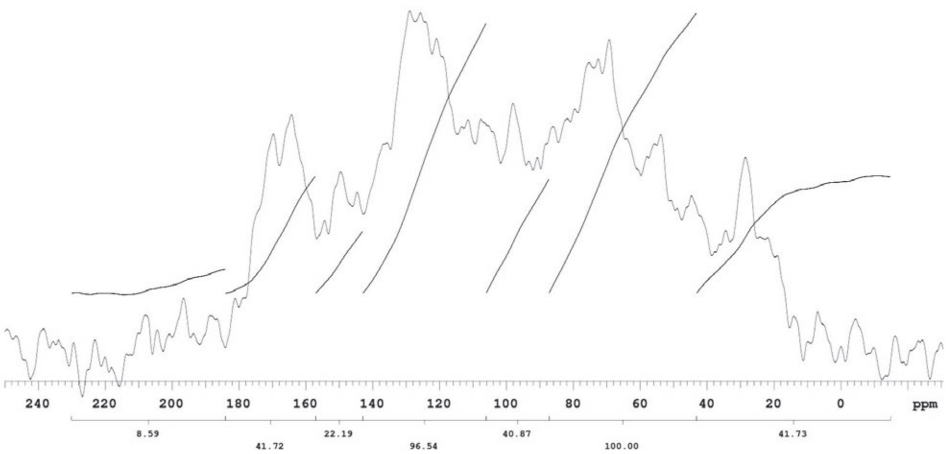

Figure 12 ^{13}C NMR spectra of the upper horizon of Belianske lúky fen

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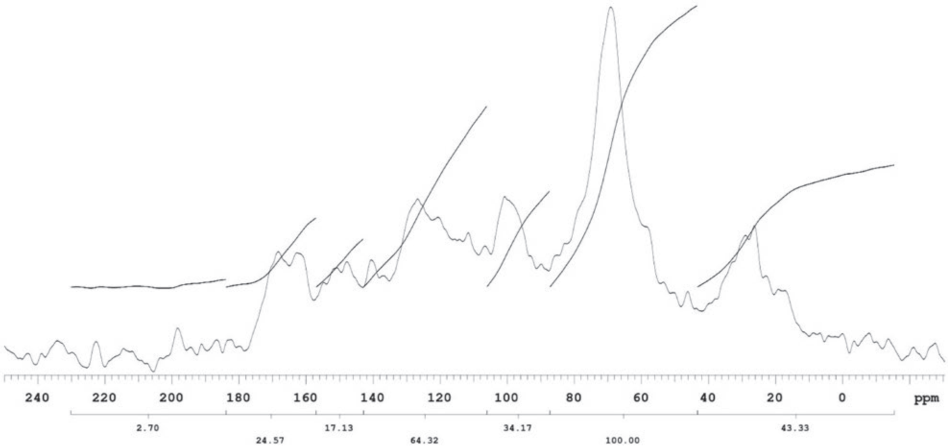

Figure 13 ^{13}C NMR spectra of the upper horizon of Rudné bog

At 75 ppm is a very intense peak which is characteristic of polysaccharides and indicates that part of the cellulose and other carbohydrates were not broken down during the peat formation process (Georgakopoulos 2003). The 160 – 100 ppm region (Fig. 12, 13) contains aromatic carbons that may be a part of the lignin, or humic substances, which are an important part of the organic matter of peat (Hammond *et al.* 1985, Georgakopoulos 2003). A distinct peak in the region of 120 – 145 ppm (Fig. 10, 11) is characteristic of non-protonated carbons (Georgakopoulos 2003). A relatively broad peak in the 175 ppm region (Fig. 12, 13) is characteristic of carboxyls, amides and carbonyl groups carbon (Schnitzer *et al.* 2006). From the parameters of ^{13}C NMR spectra can be calculated the percentage of aliphatic (Calif) and aromatic (Car) carbons, from which the degree of aromaticity α is determined. As can be seen in data in the Tab. 1, the highest percentage of relative integral intensities of fen and bog is in the aliphatic region 87 – 43 ppm which is characteristic of sp3carbon with C-O and C-N bonds.

Table 1

Relative integral intensities (% of total area) solid state 13C NMR spectra of Belianske lúky fen (F) and Rudné bog (B)

Peat	230 – 184	184 – 157	157 – 143	143 – 106	106 – 87	87 – 43	43 – 15	Calif (%)	Car (%)	α (%)
								15 – 106	106 – 230	
F 5 – 15 cm	2,44	11,86	6,31	27,45	11,62	28,44	11,88	51,.94	33,76	39,00
B 0 – 10 cm	0,94	8,58	5,99	22,47	11,94	34,94	15,14	62,02	28,46	31,45

The fen Belianske lúky and also bog Rudné have a significantly higher proportion of aliphatic carbons (spectral region 15 – 106 ppm) compared to aromatic carbons (spectral region 106 – 157) which express the degree of aromaticityα. More aliphatic structures are in bog Rudné, which is expressed by a lower degree of aromaticity (Tab. 1). A large amounts of aliphatic compounds in non-undrained peat can be explained by selective protection due to anaerobic conditions (Heller *et al.* 2015). A higher proportion of anomeric carbohydrate carbons mainly in Rudné bog (spectral region 87 – 43 ppm) is characteristic for organic matter with a higher part of fresh plant residues such as cellulose (Segnini *et al.* 2013). Compare to the organic matter of Slovak soil types, where the values of the degree of aromaticity are in the range 34 – 60% (Barančíková & Makovníková 2003, Kobza *et al.* 2019), the values of the evaluated peats are low mainly on Rudné bog.

Contents of nutrients, soil reaction and risk elements

In the first upper horizon of fen and bog, on transition area and meadows near studied peatlands contents of nutrients, risk elements and pH were monitored.

Nitrogen content on Belianske lúky fen is substantially higher compared to Rudné bog (Tab. 2, 3). This finding is consistent with Davis and Anderson (Davis &Anderson, 1991) and Szajda (Szajda *et al.* 2020), who report a high concentration of Nt on fens and extremely low on bogs.

Table 2

Changes in C, Nt, C/N, pH, P, K, on Belianske lúky fen (F), on transition area (T) between fen and meadow and meadow (M) near Belianske lúky fen

	C (%)	Nt (g/kg)	C/N	pH/KCl	P (mg/kg)	K (mg/kg)	As (mg/kg)
2008 F	28,9	20,2	14,3	7,3	<0.4	377,0	113,0
2018 F	40,6	27,8	14,6	7,0	9,3	161,0	33,8
2008 T	7,1	7,3	9,7	7,2	<0,4	103,0	8,4
2018 T	9,1	9,5	9,6	7,2	3,1	94,9	10,6
2008 M	5,4	5,3	10,1	6,6	1,8	104,0	13,3
2018 M	4,9	5,1	9,6	6,5	4,0	102,0	8,2

Table 3

Changes in C, Nt, C/N, pH, P, K, on Rudné bog (B), on transition area (T) between bog and meadow and meadow (M) near Rudné bog

	C (%)	Nt (g/kg)	C/N	pH/KCl	P (mg/kg)	K (mg/kg)	Cd (mg/kg)	Pb (mg/kg)
2008 B	43,6	14,3	30,5	3,1	94,5	636,0	0.5	28,6
2018 B	51,3	13,9	36,9	2,7	80,7	648,0	2.6	13,4
2008 T	18,5	8,4	22,1	3,4	3,5	180,0	0,60	44,6
2018 T	11,7	6,0	19,6	3,9	23,6	46,4	0,60	18,1
2008 M	2,7	2,3	11,7	4,0	30,5	61,7	<0.2	18,2
2018 M	2,4	1,7	13,6	3,4	11,9	93,1	0.70	36,6

Compared to the peatlands, on the both studied localities, Nt concentration on the transition area is lower and the lowest Nt concentration on meadows near peatlands were determined. After 10 years of the monitoring period on the locality Belianske lúky fen and the transition area near fen Nt increase, similar to OC, but on the meadow near fen Nt concentration decrease (Tab. 1). On the locality Rudné decrease of Nt concentration after 10 years of the monitoring period on the bog, the transition area and also on the meadow near bog was detected (Tab. 2).

Because almost 95% nitrogen is bound in organic matter (Knops & Bradley 2009) on both studied localities significant linear correlation (R=0,99**) between total nitrogen and organic carbon was found. Values of total nitrogen on meadows near peatlands area are within range of values of this parameter for soil type Leptosol and Stagnosol (Kobza *et al.* 2019).

The nitrogen supply of organic matter is assessed based on of the C/N ratio (Tobiašová *et al.* 2018). The high concentration of OC and low Nt on the Rudné bog is reflected in very high values of the C/N parameter (Tab. 3). A high C/N value on Rudné bog indicates low nitrogen stock on bog organic matter (Tobiašová *et al.* 2018). Substantially lower C/N value on Belianske lúky fen indicates higher nitrogen stock on the fen compared to the bog (Tab. 2, 3). The C/N values on the transition area and on the meadow near peatlands on both studied localities indicate higher Nt supply on soil compared to peat (both, fen and bog). After 10-years changes in C/N values on fen and bog and also on the nearby area were negligible (Tab. 2, 3).

On Belianske lúky fen concentration of available phosphorus was lower compared to Rudné bog (Tab. 2, 3). Low concentration of P also on transition area and meadow near fen and higher concentration of P near bog was found (Table 2, 3). However, P concentration on meadows near bog and fen according to Criteria for evaluating the results of soil analyzes is low. Kobza *et al.* (2019) reported that concentrations of available P on Slovak meadows/pastures are very low. After 10 years, changes in available P on both studied localities were slight (Tab. 2, 3).

The content of available K on the bog is higher compared to fen, however, a higher content of K in soil near Belianske lúky fen than on the Rudné bog was found (Tab. 2, 3). After 10 years monitoring period decrease of available K on Belianske lúky fen and on the transition site between fen and meadow and also and the transition site between bog and the meadow and on meadow near bog was found. Bhuiyan *et al.* (2017) in their study reported N, K and C/N values for bog and fen at a level comparable with our results.

Similar than nitrogen content also pH values depend on the type of peatlands. On Belianske lúky fen value of pH/KCl was significantly higher compare to Rudné bog (Tab. 2, 3). The value of pH/KCl on fen was neutral and on bog extremely acids. These findings are in line with literature data (Davis & Anderson 1991, Szajdak *et al.* 2020). Davis & Anderson (1991) reported that values of hydroxonium ions for fen are in the range 4 – 8 and for bog 3 – 4,5. On the surrounding area near Belianske lúky fen pH/KCl values were a little lower, however similar to fen and on surrounding area near Rudné bog values of pH/KCl were also extremely low, however a little higher than on Rudné bog (Tab. 2, 3). pH/KCl values on meadows near peatlands are in the range of soil reaction typical for soil type Leptosol (near fen) and Stagnosol (near bog) (Kobza *et al.* 2019). After10 years only small changes of pH/KCl values on peatlands (fen and bog) and also on the surrounding area were detected (Tab. 2, 3).

On both peatlands and their surrounding also risk element content (Cd, As, Co, Cu, Ni, Pb and Zn) was measured. In this paper are reported only these elements which values are the above-limit concentration according to the Act No. 220/2004 on Soil Protection.

On Belianske lúky fen very high concentration of As was found (Tab. 2). Belianske Tatras carbonate rocks can contain a high concentration of As (Hagarová *et al.* 2006). During weathering and migration to groundwater, arsenic can be immobilized in the top layer of peat, because the peat organic matter tends to bind risk elements (Sadiq 1996). Hoffman *et al.* (2013) reported interaction mechanisms between AsIII+ and natural organic matter, which play a vital role in the cycling of As in anoxic natural organic matter rich environments, such as peatlands and peaty sediments. After10 years As concentration in the upper fen horizon decreased (Tab. 2) but the concentration in the deeper horizon (not shown) remained at the same level. On transition area and on the meadow near fen changes in As concentration were negligible (Tab. 2).

On Rudné bog and its surrounding values of Cd and Pb above-limit concentration according to Act No. 220/2004 was found (Tab. 3). Because the above-limit concentration of Cd and Pb only in the upper part of Rudné bog was found we assume that this may be an anthropogenic contamination – mainly from energy and industrial activity. After 10-years on Rudné bog concentration of the Cd increase and the Pb decrease, but on the meadow near the bog concentration of Pb increased. Due to the high content of organic carbon in peat risk elements from anthropogenic sources can interact with natural organic matter such as peat (Norton 1990, Martinez-Cortizas *et al.* 1997). Increase of the Pb concentration on the meadow near bog can be explain by the movement of Pb in extremely acid soil. Soil pH and organic matter are the most important soil parameters that affect the bioavailability of risk elements in the soil (Makovníková & Barančíková 2009).

CONCLUSION

The peatlands are the largest stores of organic carbon in the world. In Slovakia peatland areas are not widespread, however the environmental value of peatland and its considerable potential for organic carbon sequestration is very high. In this paper basic chemical parameters of two different peatlands, fen and bog are described. Compare to Rudné bog, Belianske lúky fen has the thickness of peat horizon very low. In terms of organic matter quality both monitored peatlands are dominated by fresh plant residues, such as cellulose and lignin and their humification degree is very low. Between Belianske lúky fen and Rudné bog significant differences mainly in pH and nitrogen content have been found. On Belianske lúky fen value of exchangeable reaction was neutral, but on Rudné bog pH/KCl value was extremely low. Significantly higher nitrogen content was found in the organic matter of the fen, in contrast to the bog, the organic matter of which was poor in nitrogen. After the 10 years monitoring period considerable changes in organic carbon content were found. Receiving results show that peatlands are very sensitive to changes in conditions in a relatively short time period. At both monitoring sites (Belianske lúky fen and Rudné bog) there was an increase in organic carbon concentration and stock over the last 10 years. At the Belianske lúky fen increase in OC content due to proper management, which has a positive effect on increasing of OC concentration/stock in this fen can be explained. There were no changes in the character at the Rudné locality during the monitored period. A slight increase in OC concentration/stock may be due to a natural increase in organic matter, but the fact that peat extraction stopped, near the protected Rudné bog, may also play a positive role in the increased of OC content.

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