Journal of International Scientific Publications: Ecology and Safety

Volume 8, ISSN 1314-7234 (Online), Published at: http://www.scientific-publications.net

THE SPATIAL VARIABILITY OF SOIL CONDITIONS IN THE DRY POLDER OF BESA (SLOVAKIA)

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Abstract

Polder of Besa is non-regularly flooded area that is the largest dry polder in the middle Europe. This paper is oriented to evaluate soil conditions situated in studied area. Soil samples for determination the physical and biological properties were taken from four depth profiles of 0.0 – 0.6 m at 0.2 m. From the physical properties, grain size and bulk density of the biological properties of the activity of urease, acid and alkaline phosphatise were investigated. Experimental data were evaluated by statistical methods. Content of clay particles was in the range 22.28 – 78.89% what tells us about the high difference in their minimum and maximum content. The average bulk density in individual depths of soil profile was in the range from 1.110 to 1.787 kg m^{-3}. Spatial variability was also demonstrated in terms of individual enzyme activities. The results confirm the prediction of marked heterogeneity of soil conditions in Eastern Slovak lowland.

Key words: *soil textures, physical properties, enzymes of soil*

1. INTRODUCTION

The soil is greatly influenced by soil properties. Different soils have different physical, chemical and biological characteristics. In principle, each locality can be characterized by different soil type which is typical with its properties and different from other soil types. However, it is necessary to determine their properties.

In the East Slovak lowland, the dry polder of Besa (48°31'23.906"N 21°56'57.371"E) is situated for retention of flood water in the river of Bodrog catchment. The polder is saturated only exceptionally at special flood situations, when no-keeping the agreement of maximum flow and water-table of the river of Bodrog is possible in the area of Streda nad Bodrogom (48°22'16.488"N; 21°45'51.178"E). The polder is discharge after the decreasing of water-table of the river of Laborec and after drying of this area before flooded plots may be cultivated.

Non-regularly flooded area of dry polder of Besa is reflected in changes of the physical, biological and hydro-physical properties of soil and it contributes to their overall deterioration. The area of the Eastern Slovak lowland is characterized by complex geology, which causes large soil heterogeneity. According to Vilček (1998, 2005) a territory is characterized by alternation of various soil textures on short distances.

2. MATERIALS AND METHODS

Polder of Besa (Fig. 1) is the dry reservoir, created under the village of Besa on the right side of the river of Latorica and the left side of the river of Laborec above its inflow into the river of Latorica in the former inundation space. Its construction was necessitated by the flood situations on the rivers of the Eastern lowlands.

Volume 8, ISSN 1314-7234 (Online), Published at: http://www.scientific-publications.net

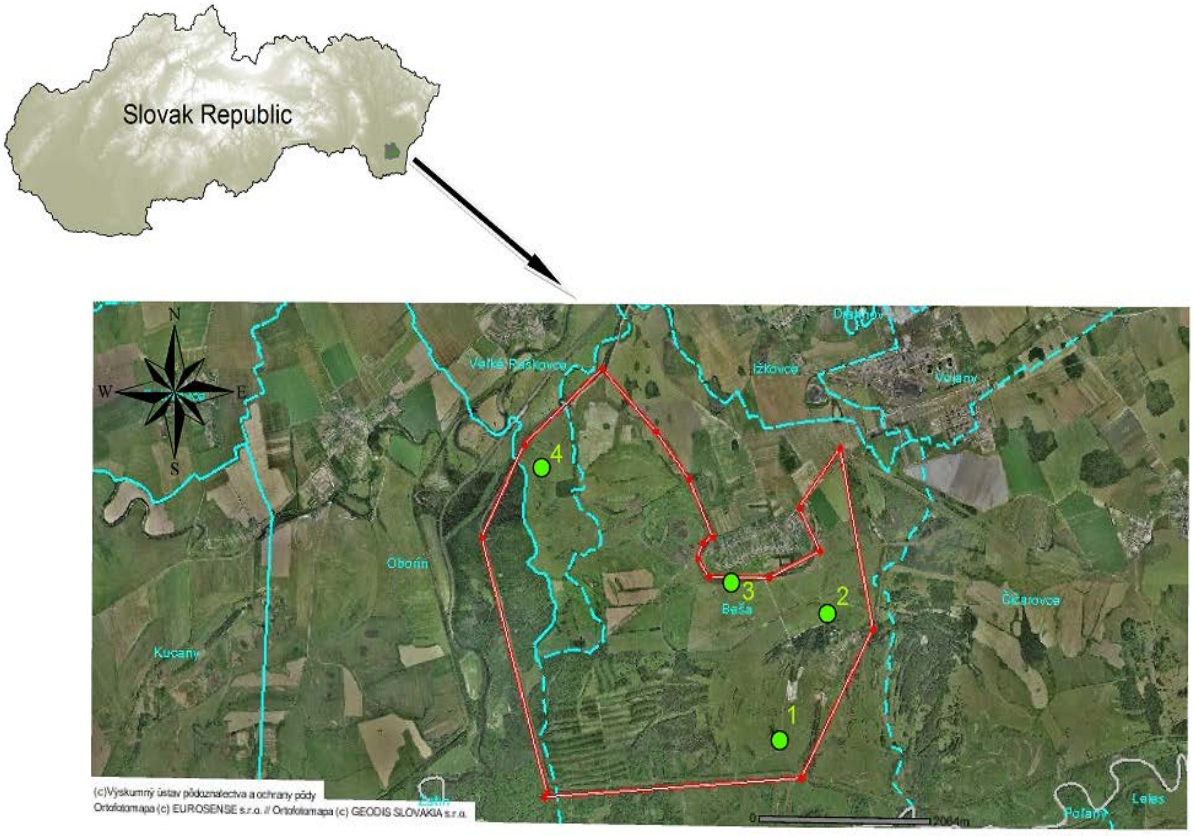


Fig. 1. Boundary and the experimental soil profiles of the dry polder of Besa (Slovakia)

The field survey was realized in 2012 on four soil profiles which represent more extended soil textures in the polder. The characteristic of the examined soil profiles is shown in Table 1. Soil samples for determination of the physical and biological soil properties were taken from the depth 0.0 – 0.2; 0.2-0.4; 0.4-0.6 meter in four soil profiles (profile 1 - profile 4) in the spring.

Table 1. Characteristics of sampling profiles in the dry polder of Besa

Profile	Description profile	Type of soil	GPS	
			latitude	longitude
1.	arable soil, north part	FMG (fluvisol gleyic)	48°34′13″N	21°58′20″E
2.	grassland, north part	RMa (rendzina arenic)	48°32′39″	21°55′30″
3.	very waterlogged, eastern part	FMG – FMp (Fluvisol gleyic - Fluvisol vertic)	48°31′36″	21°59′57″
4.	waterlogged, western part	GL (haplic gleysols)	48°31′50″	21°56′57″

From the physical properties of soil, in taken samples bulk density, ρd [kg.m^{-3}] and porosity, Pc [%] were investigated (Hrivňáková, et al., 2010, Kondrlová, et al., 2013). By pipette method, were determined following grain size fractions: 1 fraction - clay, <0.001 mm; 2 fraction - medium and fine dust, 0.001 to 0.01 mm; 3 fraction - coarse dust, 0.01 to 0.05 mm; 4 fraction - fine sand, 0.05 to 0.25 mm; 5 fraction - medium sand, 0.25 to 2.00 mm; Category I - clayey particles <0.01 mm. From the biological properties, the activity of urease according to Galstjana (Chazijev, 1976), activity of acid and alkaline phosphatase according to Chazijeva's

modified method of Grejtovský (1991) were investigated. The results were evaluated by mathematical - statistical methods by using the statistical program STATISTICA 10.

4. RESULTS AND DISCUSSION

The experimental soil profiles were taken by presence of soil textures and soil types located in the area. Basic categories of soil textures are based on Novakova's rating scale of granularity (Fulajtár, 2006, Zaujec et al., 2009, Igaz, et al., 2008) taking into account the content of clay particles (<0.01 mm).

Basic classification of granularity fractions according to Kutílek (1978) describes four categories of soil particle sizes: category I. - clay particles, category II. - dust, category III. - powdery sand, category IV. - sand. For each category different grain average is characterized. The granulometric composition of individual soil profiles in the dry polder of Besa is shown in Table 2.

Soil conditions in polder are variable and the area is characterized by significant heterogeneity (Zaujec et. al. 2009). In the area, heavy and very heavy soils dominate. In the sampled profile, by the granulometric composition analysed in 2012, soils are characterized as sandy-loamy (1. profile), clay-loamy (2. profile), dusty-clay (3. profile) and clayey (4. profile) which are shown in Fig. 2.

Table 2. The granulometric composition of soils in the polder of Besa

Soil profile	Ø particles [mm]						Soil textures
	< 0.001 clay	0.001–0.01 fine &middle dust	0.01–0.05 coarse dust	0.05–0.25 fine sand	0.25–2.00 middle sand	< 0.01 I.cat. Clay	
1.	14.24	10.64	18.91	40.42	15.79	24.88	sandy loam
2.	26.50	27.41	26.06	16.93	3.11	53.91	clay-loam
3.	34.06	33.69	18.81	10.68	2.75	67.76	clayley
4.	52.32	25.73	11.03	10.43	0.79	78.05	clay



sandy-loam soil (profile 1)



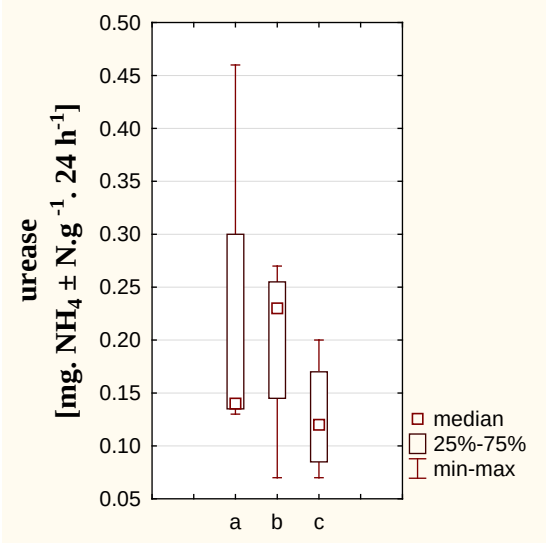
clay-loam soil (profile 2)



clayey (profile 3) clay (profile 4)

Fig. 2. Sampling profiles of the dry polder of Besa

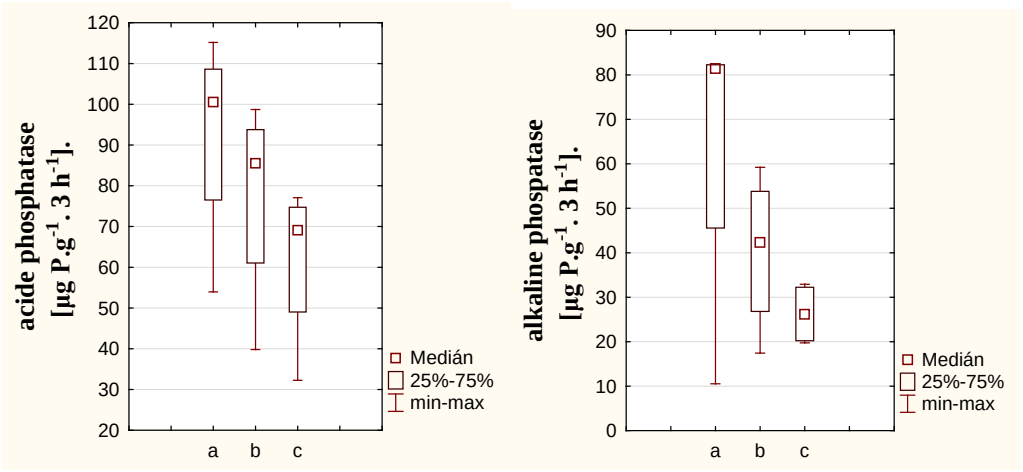
Values of activity urease are ranged from 0.07 to 0.46 mg NH_4 ± N g^{-1} 24 h^{-1} (Table 4). We found that the activity of urease was decreased with an increase of soil depth, what was shown by studies of several authors Hoffmann (1959), Myers and McGarity (1968), Ross and Roberts (1968), Skujins, (1967) (Fig. 3). On clay soil, which is used as permanent grassland (profile 4) we found the largest variance of activity of soil urease (Fig. 5). Observed fact complies with the published data of Dharmakeerthi, Thenabadu (1996).



(a - 0.0-0.2 m; b - 0.2-0.4 m; c- 0.4-0.6 m)

Fig. 3. The activity of soils urease depending on the depth of the dry polder of Besa expressed by descriptive statistics

The activity of acid phosphatase ranged from 32.25 to 115.19 [µg P g^{-1} 3 $µh^{-1}$], activity of alkaline phosphatase ranged from 10.53 to 82.27 [µg P g^{-1} 3 h^{-1}]. In comparison with results of the authors Chazijev and Burangulov (1965), we found that with increasing depth a biological activity is lower (Fig. 4). We observed lowest activity of phosphatase on arable soil (profile 1), greater variability of activity of phosphatase was observed on permanent grassland (profile 2, 3, 4), Fig. 6.



(a - 0.0-0.2 m; b - 0.2-0.4 m; c- 0.4-0.6 m)

Fig. 4. The activity of soils phosphatase depending on the depth of the dry polder of Besa expressed by descriptive statistics

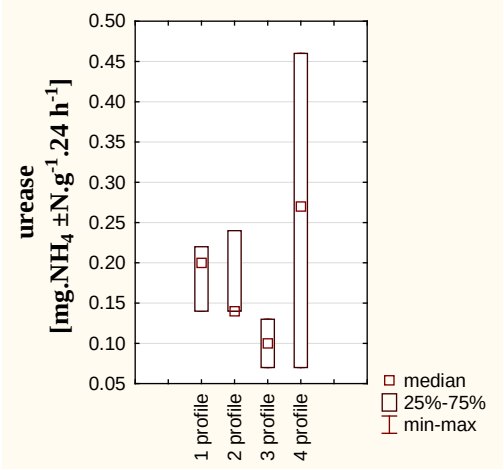


Fig. 5. The activity of urease of individual profiles in dry polder of Besa expressed by descriptive statistics

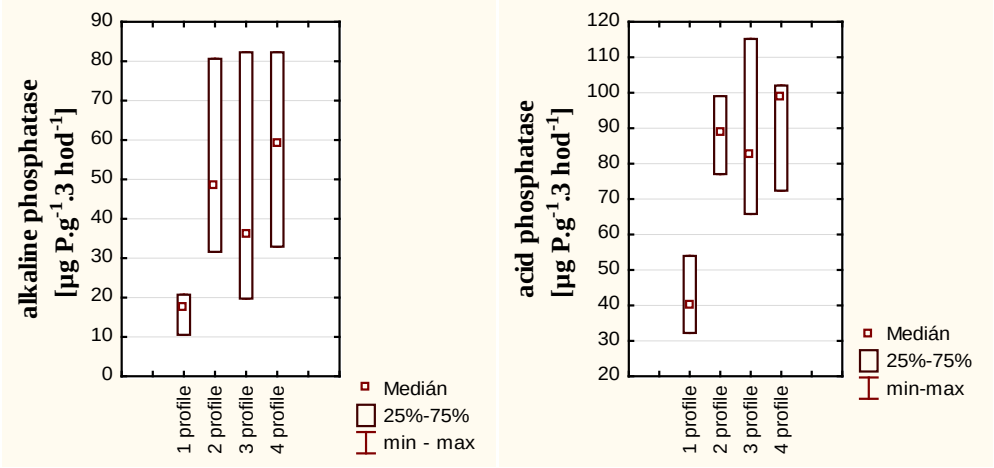


Fig. 6. The activity of phosphatase of individual profiles in the dry polder of Besa expressed by descriptive statistics

5. CONCLUSIONS

Variability of soils is a result of the impact of soil-forming factors in time and space. The properties of soil which change during the year are characterised by large spatial variability. The results of the field research in the irregularly flooded area in the dry polder of Besa confirmed that soil conditions are variable and the area is characterized by significant heterogeneity. Heavy and very heavy soils, with the content of high-clay particles in the whole profile are dominant. We also found out the variations in soil bulk density, which is related to a variety of soil textures in the selected area. The highest values were observed on arable land, where was the smallest content of clay particles. The most favourable values of the soil porosity were in the upper layers of soil. The activity of soil enzymes, as an important biological indicator of soil, showed the highest values in the upper layers of soil, the activity was higher in permanent grasslands compared to arable soil.

ACKNOWLEDGEMENT

The research was supported by the Projects APVV-0163-11, VEGA 1/0627/12 a KEGA 012 PU-4/2012.

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