

**BUFFERING PROPERTIES OF THE SOILS DEVELOPED FROM  
MILL-POND DEPOSITS IN THE VALLEY  
OF THE JAROSŁAWIANKA CREEK**

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**Abstract**

Buffering properties, their spatial and vertical variability and factors influencing them, were studied in the soils of mill-pond basin in the valley of the Jarosławianka Creek (northern Poland). Layered, mud-alluvial deposits were accumulated on the bed of buried bog soils from 1351 until the mid of the twentieth century, and during the last few decades, along the creek channel, were covered by overbank deposits. Three soil profiles located in the upper, central and lower parts of mill-pond basin were studied. Buffering capacity of the soils was among low and medium values compare to the data for different soil types in Poland. In the horizons developed from pond deposits buffering area of alkali (P-NaOH) ranged from 13.5 to 57.4 cm<sup>2</sup>, and buffering area of acids (P-HCl) from 6.4 to 40.8 cm<sup>2</sup>. In horizons developed from overbank deposits it was 3.4-58.6 cm<sup>2</sup> and 5.6-36.8 cm<sup>2</sup> respectively. An increasing in P-HCl and decreasing in P-NaOH trends were observed down the pond basin. P-NaOH was positively related to the content of TOC and P-HCl positively related to the content of clay fraction, carbonates and TOC, specific surface area, pH, CEC and BS.

**Key words:** bog soils, buffer capacity, mill-ponds, riparian buffers

**INTRODUCTION**

Water mills were the common element of Polish rural landscape from the late Middle Ages until the beginning of the twentieth century. These objects, located usually in central and lower courses of small rivers, streams and creeks were powered by dammed in mill-pond waters. During their functioning layered mineral and organic deposits were accumulated in mill-pond basins. Textural and geochemical features of the deposits, contained in them plant and animal remains, and sometimes artifacts of human activity, constitute a record of environmental evolution in the catchment within

the time of their sedimentation (Szwarczewski 2003, Podgórski 2004, Madeyski and Tarnawski 2006, Niska 2013, Mendyk and Sykuła 2014). Accumulated in shallow, usually eutrophic water reservoirs with lush vegetation, deposits may also be considered as underwater mud-alluvial soils. Results of the preliminary studies carried out by the author, show large spatial (along the mill-pond basin) and vertical variability of chemical and physical properties of these soils. The variability is affected by spatiotemporal dynamics of fluvial processes in the catchment, physical, chemical and biological processes running in the pond and periodic emptying of the reservoir (Jonczak and Florek 2013). These interesting, anthropogenically affected soils, are very poor recognized. Meanwhile, their studies are important for at least two reasons. First, they can play important role in the geosystems of river catchments, as geochemical barriers. Secondly, from several decades a progressing degradation (erosion) of the soils is observed due to abandonment of water mills, and subsequent degradation of water damming facilities. Bearing in mind these facts, the studies on genesis, evolution and properties of the soils developed from mill-pond deposits in the valley of the Jarosławianka Creek were carried out. In this paper are presented results of the studies on buffering properties, including their variability along the pond basin and analysis of physical and chemical properties influencing them.

## **MATERIAL AND METHODS**

### **Characteristics of the studied object**

The Jarosławianka Creek is the left bank tributary of the lower Wieprza River with an area of the catchment 5.92 km<sup>2</sup>. It is located in a coastal zone of the Baltic Sea characterizing by relatively mild climate, with average annual air temperatures 7.5°C for the period 1861-2007 and annual sum of precipitation 483-1013 mm (average 714 mm) (Kirschenstein and Baranowski 2009). The valley of the Jarosławianka Creek is located on fluvio-lacustrine area of the Sławno Plain, north from the Sławno town. Valley of the creek is deep incised in superficial glacial deposits of Gardno phase of the Vistulian glaciation and lying beneath them older gray calcareous tills. Deep incision of the valley is an effect of rapid outflow of lacustrine lake at the close of the Pleistocene. During the Holocene bottom of the valley has been partially filled with alluvial and deluvial deposits, however their thickness rarely exceed 1 meter. Spring waters exuding along valley slopes and periodically surface flows and drainage water are the basic sources of waters supplying the creek (Florek et al. 2009, Jonczak 2010a).

The catchment of the Jarosławianka Creek is settled by man from many centuries, which is confirmed by the presence of early Middle Ages fortified settlement and many archeological finds from different ages (Rączkowski and Banaszek 2013). In the year 1351, in the lower course of the creek Joannites built water mill (Rosenow 1934), which functioned until the mid of the 20<sup>th</sup> century. Foundations, parts of wooden sluice, earth dam and deposits filling mill-pond basin remained to the present day after the mill. Contemporary the deposits are intensively eroded by creek and spring waters. Age of their bottom was estimated with radiocarbon method on 590±40 years BP (Jonczak and Florek

2013). However, it is difficult to say whether deposits constitute full chronosequence, whether were disturbed in the past in a result of dredging or other works.

### Soil sampling and analysis

Field studies were conducted during the year 2010. Soil pits were located along the pond basin, and in its cross-sections. Three soil profiles, located in upper, middle and lower parts of mill-pond basin (Fig. 1) were selected for the purposes of the studies on buffering properties. The soils were described after Polish Soil Classification (Marcinek et al. 2011). Soil samples were collected from each soil horizons/sedimentation layers as volumetric samples using 100 cm<sup>3</sup> steel rings and as disturbed samples. The following properties have been analyzed:

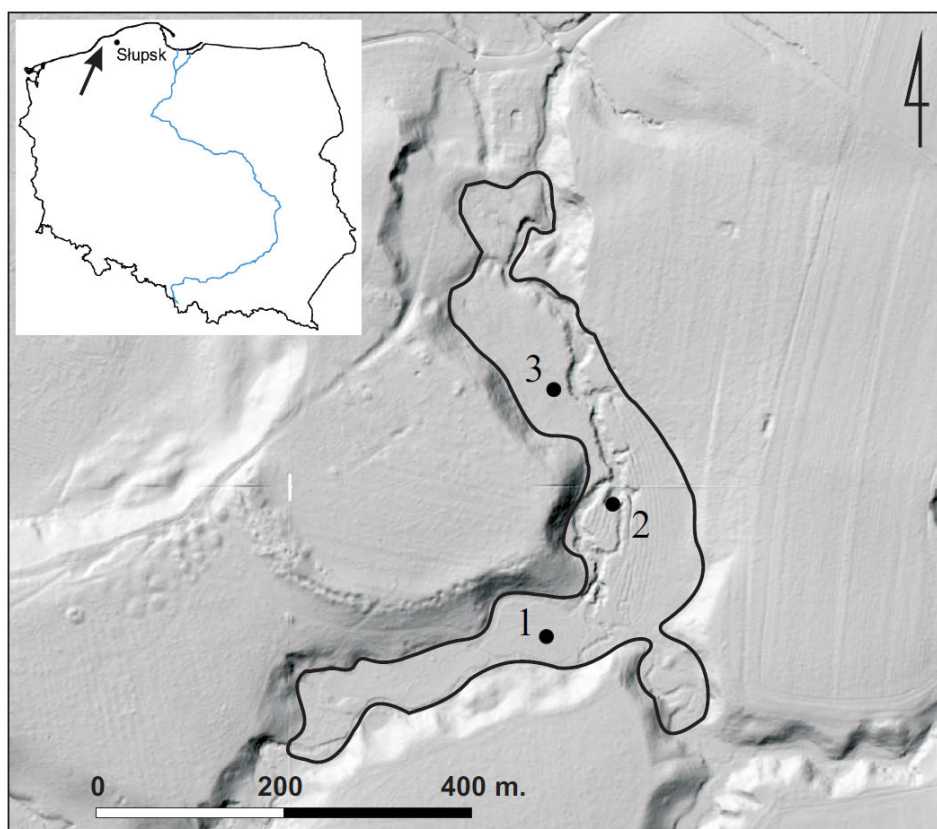


Fig. 1. Locations of the soil pits (1-3) and the range of mill-pond basin (black line) in the valley of the Jarosławianka Creek

- bulk density and actual moisture by drying-weight method in volumetric samples,
- particle density by burette method,
- total porosity was calculated based on bulk and particle densities,

- particle-size distribution with mixed pipette and sieve methods. Polish Soil Science Society classification on granulometric fractions and groups (PTG 2009) has been applied,
- average diameter of mineral particles ( $M_z$ ) was calculated after Folk and Ward (1957) using GRADISTAT software,
- specific surface area by glycerine vapors adsorption,
- pH by potentiometric method in a suspension with water and  $1 \text{ mol}\cdot\text{dm}^{-3}$  solution of KCl,
- the content of carbonates by Scheibler method,
- the content of total organic carbon (TOC) by Tiurin method,
- the content of total nitrogen (TN) by Kjeldahl method,
- cation exchange capacity (CEC), as a sum of exchangeable basis (extracted with  $1 \text{ mol}\cdot\text{dm}^{-3}$  solution of  $\text{CH}_3\text{COONH}_4$ , pH 7.0) and exchangeable acidity (analyzed by Sokolov method),
- base saturation (BS) was calculated based on the content of exchangeable basis and exchangeable acidity,
- buffering areas of alkali (P-NaOH) and acids (P-HCl) by Arrhenius' method (Bednarek et al. 2004).

Spearman's linear correlations between buffering areas of alkali and acids and some properties of the soils were calculated using Statistica software.

## RESULTS AND DISCUSSION

### Soil physical and chemical properties

The deposits filling mill-pond basin in the valley of the Jarosławianka Creek have been accumulated on the bed of buried bog soils during the last more than 600 years. Their thickness increase from upper to the lower part of the pond, up to about 2 m. Along the creek channel pond deposits are covered by up to 60 cm layers of overbank deposits, accumulated during the last few decades. The presence of overbank deposits prove occurrence of periodic floods in the lower course of the valley, which is also confirmed by the studies of Florek et al. (2009). The soils developed from pond sediments has mud-alluvial character and have been classified as muddy-gleyic (Jonczak and Florek 2013). They are not described in Polish Soil Classification (Marcinek et al. 2011).

The studied soils are spatially and vertically varied in their physical and chemical properties. The variability is affected by spatiotemporal dynamics of fluvial processes in the catchment, physical, chemical and biological processes running in the pond, as well as human activity, e.g. periodic emptying of the reservoir, dredging, etc. (Podgórski 2004, Borówka 2007, Jonczak and Florek 2013). Decreasing water flow speed along the pond is reflected in decreasing average diameters of mineral particles ( $M_z$ ) in pond deposits (Table 1). In the upper part of the pond deposits have a texture of fine and very fine loamy sands, whereas in the central and lower parts very fine sandy loams with layers of loamy silts dominate. Soil horizons developed from overbank deposits have a texture of fine and very fine sandy loams. The con-

tent of clay in the investigated soils is not high, ranging from 0.2 to 10.8% in pond deposits and from 0.2 to 3.3% in overbank deposits.

Table 1

## Selected physical properties of the studied soils

Soil horizon	Depth [cm]	% of fraction			$M_z$ $\Phi$	Textural group	Water content [% v/v]	Total porosity [%]	Specific surface area [m <sup>2</sup> ·g <sup>-1</sup> ]
		sand	silt	clay					
Profile 1									
Acg	0-31	70.6	28.3	1.1	2.63	gp dr	59.0	63.6	48.9
2Lc1	31-66	83.5	16.0	0.5	2.16	pg dr	49.6	49.5	21.3
2Lc2	66-90	80.2	19.6	0.2	2.25	pg dr	50.1	52.3	23.8
2Lc3	90-190	72.6	26.3	1.1	2.68	pg bdr	54.2	55.5	56.2
3G	190-200	81.0	13.3	5.7	2.04	pg dr	34.8	35.8	15.4
Profile 2									
Ag	0-24	69.7	28.8	1.5	4.04	gp bdr	43.7	63.2	62.8
ACcg	24-40	67.6	30.6	1.8	3.85	gp dr	42.9	51.3	52.1
ACg	40-60	71.1	27.3	1.6	3.68	gp dr	51.9	57.7	30.7
2Lc1	60-69	63.7	34.3	2.0	4.38	gp bdr	63.3	71.5	77.3
2Lc2	69-81	63.0	34.1	2.9	4.60	gp bdr	70.7	75.8	81.8
2Lc3	81-99	62.5	34.8	2.7	4.61	gp bdr	72.9	77.8	100.4
2Lc4	99-110	56.2	40.9	2.9	4.73	gp bdr	74.3	76.1	97.7
2Lc5	110-121	67.9	30.3	1.8	4.35	gp bdr	68.2	70.5	100.1
2Lc6	121-131	61.3	36.9	1.8	4.57	gp bdr	70.9	72.4	60.5
2Lc7	131-140	57.3	38.9	3.8	4.82	gp bdr	69.2	73.8	84.5
2Lc8	140-150	51.0	43.9	5.1	5.01	gp bdr	75.0	79.4	72.0
2Lc9	150-161	22.3	67.4	10.3	6.04	pyg	76.2	79.5	80.1
2Lc10	161-175	24.7	64.5	10.8	5.97	pyg	73.6	75.4	109.7
2Lc11	175-180	94.9	4.4	0.7	2.35	pl dr	46.1	50.0	19.9
3Ab1	180-192	80.3	18.8	0.9	3.59	pg dr	70.4	79.2	69.9
3Ab2	192-200	77.8	20.6	1.6	3.63	pg dr	55.4	55.6	65.8
3Ab3	200-230	76.3	22.3	1.4	3.57	pg dr	66.7	70.2	14.2
3G	230-260	97.4	2.1	0.5	1.82	pl sr	-	-	8.0
Profile 3									
Ag	0-30	59.5	37.2	3.3	4.58	gp bdr	67.6	69.5	80.4
Cg1	30-42	84.4	14.9	0.7	3.13	pg dr	54.0	55.7	43.3
Cg2	42-57	99.0	0.8	0.2	2.05	pl sr	29.0	43.0	4.6
2Lc1	57-71	60.1	37.1	2.8	4.50	gp bdr	67.5	72.0	106.4
2Lc2	71-81	59.2	37.8	3.0	4.68	gp bdr	70.7	71.4	49.7
2Lc3	81-91	57.3	38.2	4.5	4.78	gp bdr	78.1	81.0	112.3
2Lc4	91-120	61.6	35.3	3.1	4.34	gp bdr	75.8	77.3	94.2

gp dr – fine sandy loam; pg dr – fine loamy sand; pg bdr – very fine loamy sand; gp bdr – very fine sandy loam; pyg – loamy silt; pl dr – fine sand; pl sr – medium sand

The studied soils are very highly porous, especially in mud-alluvial horizons, where total porosity is 49.5-81.0%. The pores are almost completely saturated with water (Table 1). In general, highly porous are also horizons formed from overbank depos-

its – from 43.0 to 69.5%. Specific surface area in mud-alluvial horizons ranged from 19.9 to 112.3 m<sup>2</sup>·g<sup>-1</sup> and in the horizons formed from overbank deposits from 4.6 to 80.4 m<sup>2</sup>·g<sup>-1</sup>. Soil pH changes from strongly acid and acid in the upper part of the pond to neutral and alkaline in its central and lower parts, where pond deposits contain up to 5.6% carbonates (Table 2).

Table 2

## Selected chemical properties of the studied soils

Soil horizon	Depth [cm]	pH <sub>H2O</sub>	pH <sub>KCl</sub>	CaCO <sub>3</sub> [%]	TOC [g·kg <sup>-1</sup> ]	TN [g·kg <sup>-1</sup> ]	TOC/TN	CEC [cmol(+)·kg <sup>-1</sup> ]	BS [%]
Profile 1									
Acg	0-31	5.90	4.98	0.0	28.83	2.77	10.4	2.64	96.9
2Lc1	31-66	4.45	3.80	0.0	11.36	1.13	10.0	1.73	27.9
2Lc2	66-90	4.67	3.93	0.0	14.01	1.21	11.6	1.63	36.0
2Lc3	90-190	5.04	4.44	0.0	72.42	4.98	14.5	4.45	79.8
3G	190-200	5.17	3.73	0.0	-	-	-	1.40	30.3
Profile 2									
Ag	0-24	5.32	4.11	0.0	31.93	3.34	9.6	6.58	14.9
ACcg	24-40	5.30	4.13	0.0	13.88	1.19	11.6	1.59	74.8
ACg	40-60	5.30	4.15	0.0	16.64	1.60	10.4	1.67	71.9
2Lc1	60-69	5.93	5.00	0.1	53.22	4.69	11.3	3.66	95.4
2Lc2	69-81	7.52	6.90	3.3	77.26	5.54	14.0	10.58	98.8
2Lc3	81-99	7.52	7.01	4.7	79.45	5.51	14.4	9.28	98.0
2Lc4	99-110	7.50	6.99	5.9	64.11	4.77	13.4	9.65	98.5
2Lc5	110-121	6.98	6.58	1.3	64.48	5.70	11.3	8.69	98.1
2Lc6	121-131	6.95	6.56	0.8	64.83	5.79	11.2	8.91	97.7
2Lc7	131-140	7.24	6.75	1.5	61.59	5.36	11.5	9.15	98.5
2Lc8	140-150	7.42	6.80	2.7	59.06	5.30	11.1	9.91	97.9
2Lc9	150-161	7.50	6.90	3.4	55.60	5.67	9.8	10.58	98.4
2Lc10	161-175	7.27	6.78	3.0	62.99	4.67	13.5	9.61	98.3
2Lc11	175-180	6.35	5.79	0.0	6.85	0.46	14.8	0.74	88.5
3Ab1	180-192	5.61	5.07	0.0	56.68	4.82	11.8	3.61	94.3
3Ab2	192-200	5.75	5.11	0.0	36.96	3.19	11.6	2.56	94.1
3Ab3	200-230	5.85	5.19	0.0	50.00	4.37	11.5	3.43	93.8
3G	230-260	6.96	6.47	0.0	-	-	-	0.31	84.5
Profile 3									
Ag	0-30	7.26	6.76	0.3	56.85	4.80	11.8	5.98	98.5
Cg1	30-42	6.81	6.09	0.0	36.16	2.18	16.6	2.55	98.5
Cg2	42-57	6.79	6.12	0.0	0.94	-	-	0.14	100.0
2Lc1	57-71	7.47	7.13	2.0	64.67	3.87	16.7	7.03	100.0
2Lc2	71-81	7.90	7.36	5.6	49.03	3.47	14.1	6.53	100.0
2Lc3	81-91	7.49	7.21	5.0	72.69	5.31	13.7	10.46	100.0
2Lc4	91-120	7.88	7.37	4.8	56.27	4.08	13.8	8.94	100.0

The content of TOC in mud-alluvial horizons ranged from 6.90 to 79.50 g·kg<sup>-1</sup>, and in horizons formed from overbank deposits from 0.94 to 56.85 g·kg<sup>-1</sup>. The soils are in general rich in TN, which content is 0.46-5.79 g·kg<sup>-1</sup> and 1.19-4.80 g·kg<sup>-1</sup> respec-

tively. High abundance in nitrogen is reflected in narrow TOC:TN ratios (Table 2). Despite the high content of organic matter, CEC is not high and ranged between 0.74 and 10.58  $\text{cmol}_{(+)}\cdot\text{kg}^{-1}$  in mud-alluvial horizons and between 0.14 and 6.58  $\text{cmol}_{(+)}\cdot\text{kg}^{-1}$  in horizons formed from overbank deposits. The percentage of basis in soil sorptive complex increase along the pond.

### Soil buffering properties

Buffering properties, as a mechanism of soil pH stabilization under conditions of the inflow from external and internal sources of acidifying and alkalizing substances, are affected by the presence of different buffer systems characterizing with limited, varied in space and through time capacities in relation to acidifying and alkalizing substances (Ulrich 1981, Kowalkowski 2002). Functioning of the various buffer systems ensure maintenance of soil pH on relatively stable level, in the range characteristic for particular buffer systems, until exhaustion of buffering substances. Because at a given moment one buffer system play a dominant role, it can be easily identified based on the current values of soil pH. Based on pH values and buffering ranges after Ulrich (1981), has been established, that ion-exchange, silicate and carbonate buffer systems are basic active buffers in the investigated soils (Table 3). Functioning of ion-exchange buffer system, which is based on adsorption of acidic ions by mineral and organic colloids, ensure the maintenance of soil pH at the level  $>4.2 - \leq 5.0$ . This buffer system is active in the top of pond deposits in profile 1 (horizons 2Lc1 and 2Lc2). In the remaining horizons of the profile, as well as in horizons formed from overbank deposits in the profile 2 and in buried soils in the same profile, active is silicate buffer system, maintaining pH on the level  $>5.0 - \geq 6.3$ . Neutralization of acidic ions by the buffer system is realized by their binding by products of primary silicates weathering. The dominant buffer system in soil horizons formed from mill-pond deposits in the middle and lower parts of mill-pond basin is carbonate buffer system. Its importance is growing along the pond basin, with increasing pH and the content of carbonates.

Buffering abilities of acidifying and alkalizing substances are affected by the capacity of particular buffer systems, which is directly related to the complex of specific for each of them soil properties. Thus, the capacity of carbonate buffer system is affected by the content of carbonates, the capacity of silicate buffer system by the content of primary silicates and the capacity of ion-exchange buffer system by CEC and BS. However, the total buffer capacity of alkali and acids is usually considered and its measure is buffering area of alkali (P-NaOH) and acids (P-HCl) expressed in  $\text{cm}^2$ . P-NaOH is usually positively related to the content of soil organic matter and soil organic carbon, whereas P-HCl to the content of clay fraction and carbonates, pH, CEC and BS (Skłodowski 1995, Malczyk 1998, Malczyk et al. 2008, Walenczak et al. 2009, Jonczak 2010b, Bągiel 2012). Soil buffer capacity is varied through time in a result of the inflow of alkalizing and acidifying substances, as an effect of natural processes and human activities (Marschner and Noble 2000, Ludwig et al. 2001, Dorland et al. 2004, Lieb et al. 2011, Tanikawa et al. 2014).

Buffering capacity of the soils located along the studied transect in mill-pond basin in the valley of the Jarosławianka Creek is varied both spatially and vertically. The variability is affected by the character of particular horizons (mud or alluvial) and their physical and chemical (Table 3). P-NaOH in horizons developed from pond

Table 3

Basic active buffers after Ulrich (1981) and buffering areas of alkali (P-NaOH) and acids (P-HCl)

Soil horizon	Depth [cm]	Active buffer	P-NaOH [cm <sup>2</sup> ]	P-HCl [cm <sup>2</sup> ]	P-NaOH / P-HCl
Profile 1					
Acg	0-31	silicate	36.4	18.5	2.0
2Lc1	31-66	ion exchange	35.2	6.4	5.5
2Lc2	66-90	ion exchange	40.1	8.0	5.0
2Lc3	90-190	silicate	57.4	18.4	3.1
3G	190-200	silicate	13.6	4.9	2.8
Profile 2					
Ag	0-24	silicate	58.6	9.8	6.0
ACcg	24-40	silicate	33.5	9.8	3.4
ACg	40-60	silicate	36.1	9.3	3.9
2Lc1	60-69	silicate	43.9	19.8	2.2
2Lc2	69-81	carbonate	33.6	39.5	0.9
2Lc3	81-99	carbonate	35.1	40.1	0.9
2Lc4	99-110	carbonate	35.5	40.1	0.9
2Lc5	110-121	carbonate	41.4	37.5	1.1
2Lc6	121-131	carbonate	41.3	37.5	1.1
2Lc7	131-140	carbonate	37.6	39.0	1.0
2Lc8	140-150	carbonate	36.3	39.4	0.9
2Lc9	150-161	carbonate	34.8	40.3	0.9
2Lc10	161-175	carbonate	37.8	38.9	1.0
2Lc11	175-180	carbonate	13.5	8.6	1.6
3Ab1	180-192	silicate	51.0	20.9	2.4
3Ab2	192-200	silicate	40.5	18.6	2.2
3Ab3	200-230	silicate	45.4	21.9	2.1
3G	230-260	carbonate	2.8	7.7	0.4
Profile 3					
Ag	0-30	carbonate	36.3	36.8	1.0
Cg1	30-42	carbonate	25.1	23.6	1.1
Cg2	42-57	carbonate	3.4	5.6	0.6
2Lc1	57-71	carbonate	38.0	37.6	1.0
2Lc2	71-81	carbonate	30.5	39.5	0.8
2Lc3	81-91	carbonate	40.1	40.8	1.0
2Lc4	91-120	carbonate	34.2	39.3	0.9

deposits range from 13.5 to 57.4 cm<sup>2</sup>, and P-HCl from 6.4 to 40.8 cm<sup>2</sup>. P-NaOH trended to be higher in the soils of upper part of mill-pond basin, whereas P-HCl increase along the pond. P-NaOH is positively, statistically significant correlated with the content of TOC, and P-HCl positively, statistically significant correlated with the



content of clay, carbonates and TOC, specific surface area, pH, CEC and BS (Table 4). In most cases these are very high correlations, which confirm important role of the

Table 4

Spearman's linear correlations between buffering areas of alkali (P-NaOH) and acids (P-HCl) and some properties of soil horizons formed from mill-pond deposits

	P-NaOH	P-HCl
Clay content [%]	-0.029	0.556*
$M_z$ [ $\Phi$ ]	0.040	0.889*
Specific surface area [ $m^2 \cdot g^{-1}$ ]	0.256	0.816*
$pH_{H_2O}$	-0.300	0.915*
$pH_{KCl}$	-0.286	0.920*
$CaCO_3$ [%]	-0.198	0.751*
TOC [ $g \cdot kg^{-1}$ ]	0.483*	0.811*
CEC [ $cmol_{(+)} \cdot kg^{-1}$ ]	0.131	0.955*
BS [%]	-0.081	0.811*

\*correlations statistically significant at  $p < 0,05$ ,  $n = 18$

listed soil parameters in the shaping of their buffering properties. Soil horizons developed from overbank deposits, in relation to developed from pond deposits, characterize with comparable capacity of alkali ( $3.4$ - $58.6$   $cm^2$ ) and in general lower, but increasing down the mill-pond basin capacity of acids ( $5.6$ - $36.8$   $cm^2$ ). The noted values of P-NaOH and P-HCl are among low and medium compare to observed by other authors in different soil types of Poland (Malczyk et al. 2008, Walenczak et al. 2009, Jonczak 2010b, Raczuk 2011, Brągiel 2012).

## CONCLUSIONS

Buffering capacity of the soils developed from mill pond deposits in the valley of the Jarosławianka Creek was among low and medium values as compared to the data for different soil types in Poland, and was affected by the genesis of particular soil horizons and some their physical and chemical properties. In horizons developed from mud-alluvial materials P-NaOH ranged from  $13.5$  to  $57.4$   $cm^2$ , and P-HCl from  $6.4$  to  $40.8$   $cm^2$ , whereas in horizons developed from overbank deposits  $3.4$ - $58.6$   $cm^2$  and  $5.6$ - $36.8$   $cm^2$  respectively. P-NaOH was positively related to the content of TOC and P-HCl positively related to the content of clay, carbonates and TOC, specific surface area, pH, CEC and BS. High and very high correlation coefficients confirm importance of these properties in the shaping of soil buffering properties. The basic role in the buffering of acidifying substances in the investigated soils play ion-exchange, silicate and carbonate buffers. In the upper part of the pond these are ion-exchange and silicate buffer systems. The importance of carbonate buffer system is growing down the pond. Results of the studies show effectiveness of mill-pond deposits as geochemical barriers to the migration of ionic substances in river valleys.

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## WŁAŚCIWOŚCI BUFOROWE GLEB WYKSZTAŁCONYCH Z OSADÓW STAWU MŁYŃSKIEGO W DOLINIE JAROSŁAWIANKI

### Streszczenie

W pracy przedstawiono wyniki badań właściwości buforowych antropogenicznie uwarunkowanych gleb mułowato-glejowych występujących w obrębie niecki stawu młyńskiego w dolinie Jarosławianki. Badane gleby zbudowane są z osadzonych na podłożu kopalnych gleb bagiennych, warstwowanych osadów mułowo-aluwialnych akumulowanych w stawie od roku 1351 do połowy XX wieku, kiedy nastąpiło zniszczenie urządzeń piętrzących i osuszenie stawu. Wzdłuż współczesnego koryta potoku osady te są nadbudowane kilkudziesięciocentymetrową warstwą osadów pozakorytowych. Badania przeprowadzono w trzech odkrywkach glebowych, zlokalizowanych w górnej, środkowej i dolnej części niecki stawu. Stwierdzone duże przestrzenne (wzdłuż stawu) i pionowe zróżnicowanie cech teksturalnych oraz licznych właściwości fizycznych i chemicznych badanych gleb, będące odzwierciedleniem czasoprzestrzennej dynamiki procesów fluwialnych w zlewni, a także procesów fizycznych, chemicznych i biologicznych zachodzących w stawie, znalazło odzwierciedlenie w zróżnicowanych właściwościach buforowych badanych gleb. Ich pojemność buforowa mieści się w przedziałach wartości niskich i średnich na tle danych literaturowych dla różnych typów gleb Polski. Powierzchnia buforowania zasad (P-NaOH) w poziomach zbudowanych z osadów mułowo-aluwialnych wynosi od 13,5 do 57,4 cm<sup>2</sup>, a powierzchnia buforowania kwasów (P-HCl) od 6,4 do 40,8 cm<sup>2</sup>. W poziomach zbudowanych z osadów pozakorytowych jest to odpowiednio 3,4-58,6 cm<sup>2</sup> i 5,6-36,8 cm<sup>2</sup>. P-NaOH jest istotnie statystycznie, pozytywnie skorelowana z zawartością węgla organicznego, a P-HCl również istotnie statystycznie, pozytywne skorelowana z zawartością węgla organicznego, ładu i węglanów, oraz średnią średnicą ziaren mineralnych (wyrażoną w skali  $\Phi$ ), powierzchnią właściwą, pH, pojemnością wymienną kationów i stopniem wysycenia kompleksu sorpcyjnego zasadami. Pojemność buforowa względem kwasów wykazuje wyraźną tendencję wzrostową wzdłuż stawu. Tendencja ta uwarunkowana jest gradientem wpływających na właściwości buforowe cech fizycznych i chemicznych osadów. W kwaśnych glebach górnej części stawu główną rolę w neutralizacji kwasów odgrywa bufor wymiany jonowej i krzemianowy. W dół stawu wzrasta rola buforu węglanowego.