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STRATIGRAPHIC AND GEOCHEMICAL DIFFERENTIATION OF ORGANOGENIC SEDIMENTS IN THE RIVER VALLEY OF CIEMIĘGA AS A RESULT OF ANTHROPOGENIC ALTERATIONS IN THE AREA OF THE RIVER BASIN IN THE HOLOCENE

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A b s t r a c t. Anthropogenic alterations of the recent millennia of our era, in the loess areas of the Lublin Upland are clearly visible in the composition and character of the sediments that fill river valleys. This paper is an attempt to review this issue on the example of a small river valley that runs through the loess relief regions near Lublin. Samples were taken from deep drilling (up to 6 m) in the three cross-sections of the valley (Ożarów, Jastków, Snopków). A total of 172 samples taken from 5 drillings were investigated.

The results obtained allow to conclude that delluvial processes dominated in the course of sediment formation that filled the Ciemięga river valley. Those delluvial processes started in the Neolyth by climatic changes and cutting down forests for the incoming agriculture - and have been intensified since the Middle Ages up till now. It is seen in a clear correlation between the growing part of ash components and mineral interbeddings in the peat deposits, as well as in the presence of cereal grains and weed pollen from cultivated fields in the investigated samples. In the chemical composition of the sediments, anthropogenic enrichment of K, P, Fe, Mn, Pb, Cr, Cu, Zn, and Co is observed

K e y w o r d s: Lublin Upland, loess areas, Ciemięga river valley, sediment stratigraphy, anthropogenic influence.

INTRODUCTION

River valleys with specific characteristics in which the sediment gathered is a clear reflection of the changing conditions of their accumulation at various stages of the Holocene period, can be found in the loess regions of the Lublin Upland [4,5,7,9].

Alluvial material carried by river waters, interbedded by strongly silted-up peat inputs, was covered with a delluvial silty sediment derived from the eroded loess slopes in some places during the final stage [2-4].

Few results of research carried out within some river valleys of the Lublin Upland point to the important role of the anthropogenic factor in the process of their formation [8].

This paper is an attempt to examine this issue on the example of a small valley of the Ciemięga river that runs through loess relief near Lublin (Fig. 1).

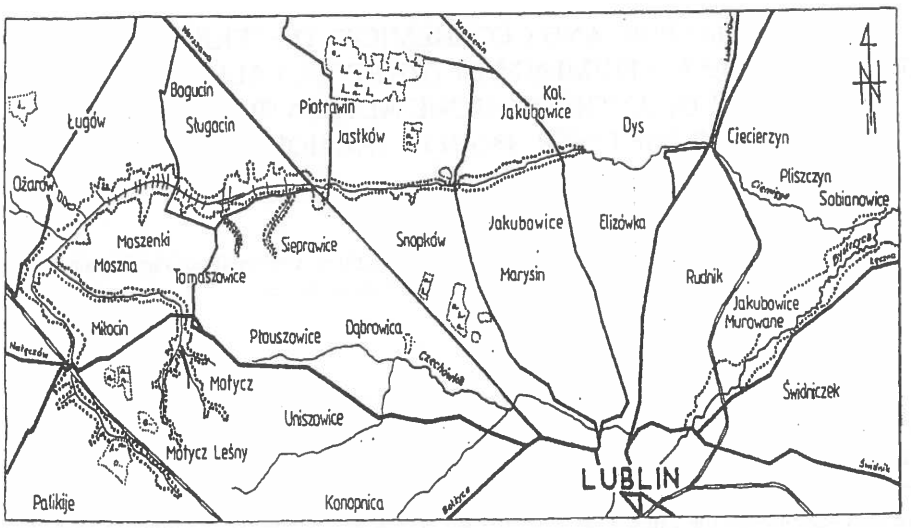


Fig. 1. Sketch map of the Ciemięga river valley.

RESEARCH AREA AND METHODS

The Ciemięga valley chosen for the present research that surrounds Lublin in the north and west, cuts in, in some places, very deeply to Quaternary sediments (loess) and underlying Cretaceous formations [1,4].

During the entire process of filling the valley with sediments, the process of boggy peat formation played a similar, important part as alluvial-delluvial gathering of mineral warps rich in calcium compounds ($CaCO_3$).

The result of those very different processes is an exceptionally differentiated composition and construction of the material that fills the valley, both in the vertical and the horizontal system. Stronger marked and more uniform, in terms of composition, peat deposits occur in places, where the valley widens in the upper course of the river (Fig. 1). However, great silting-up of peat and occurrence of mineral interbeddings was also present.

In the direction of the river estuary, the bottom of the valley becomes narrower and deeper, while the array and the character of the sediments change. There is less and less peat lens and peat interbeddings, and the content of mineral parts increases. The area covered with weakly permeable delluvial warp also grows.

Samples were taken for analysis from deep (up to 6 m) drillings in three cross-sections localized in the most characteristic places of the valley (Ożarów, Jastków, Snopków). A total of 172 soil and sediment samples were taken from 5 drillings. Beside pollen analysis, the following parameters were determined in the selected samples: content of organic substance, $CaCO_3$, and the content of P, K, Na, Ca, Mg, Fe, Al, Mn. Samples were also analysed for heavy metals (Table 1).

RESULTS AND DISCUSSION

Comparison of graphic pictures from the elaborated sections on the background of the included map of the valley (Figs 1-4), clearly shows vertical and horizontal differentiation in the stratigraphy of the accumulated sediments in various part of the valley.

In the upper course of the river, in the place where there probably was a shallow lake with a water flow supplied by numerous springs, the cross-section shows a deposit of low peat enriched with mineral material at the edges (loess silt with $CaCO_3$).

In the deeper layers there are deposits of the lake gythia covered with a thin layer of calcareous gythia (Fig. 2). Higher there is a material formed in a typical boggy process, i.e. mainly in the shape of moss-sedge peat with a medium degree of decomposition (approx. 30 %) and high ash content. In the roof layers (except the edges mentioned above), there is no clear delluvial cover, and the moorsh-peat top is the soil itself.

In the middle part, which is a clear breaking point, a narrow and deep cut into the valley (up to 10 m) is filled mainly with peaty material rich in mineral parts (silty parts plus $CaCO_3$). The peat inputs (interbeddings) are relatively few there (Fig. 3), and mineral-organic gythia (lower parts) is in abundance. Moving closer to the surface, warps with delluvial material become more numerous with the decreasing depth. They form a weakly permeable gley layer derived from clayes silt on the surface.

In the line of the third section made in the narrowest part of the valley (Fig. 4), sediment stratigraphy is, generally speaking, similar to the previous one. Nevertheless, the content of organic-mineral gythia deposits is definitely increasing

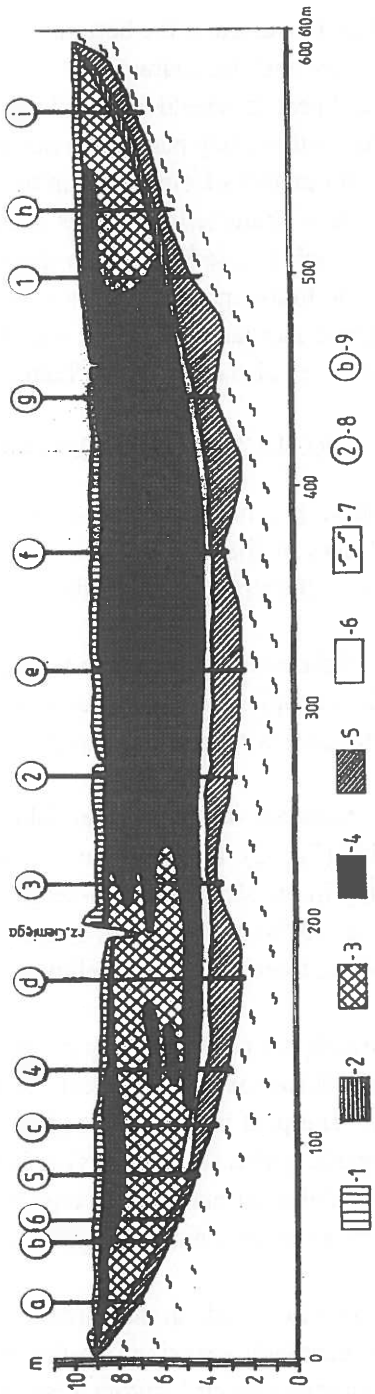


Fig. 2. Stratigraphic cross-section through the Ciemięga valley in Ożarów: 1-soil, 2-mineral-organic alluvial, 3-peat with $CaCO_3$, 4-peat, 5-mineral-organic gythia, 6-carbonate gythia, 7-silt loam, 8-basic drillings numbers, 9-supplementary drillings numbers.

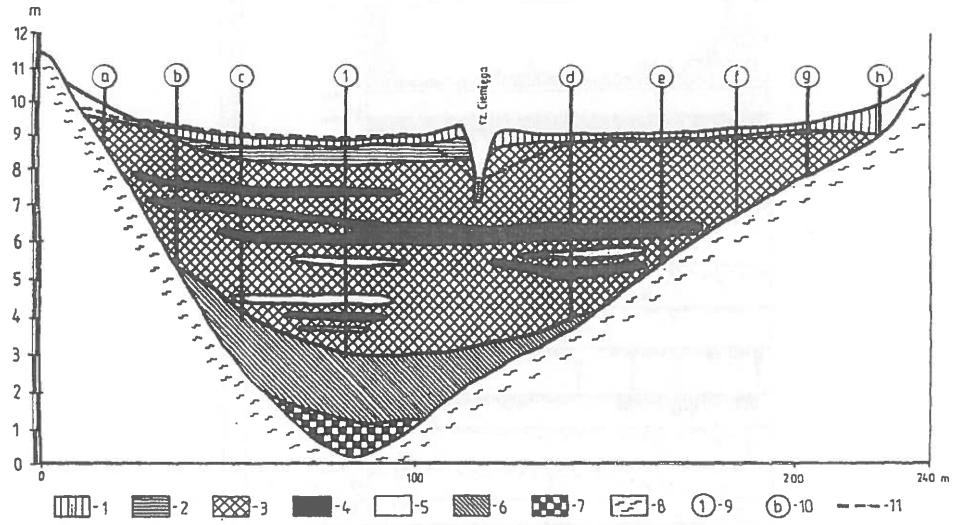


Fig. 3. Stratigraphic cross-section through the Ciemięga valley in Jastków: 1-soil, 2-mineral-organic alluvial, 3-peat with $CaCO_3$, 4-peat, 5-carbonate gythia, 6-mineral-organic gythia, 7- loam, 8-silt loam, 9-basic drillings numbers, 10-supplementary drillings numbers, 11-ground water level.

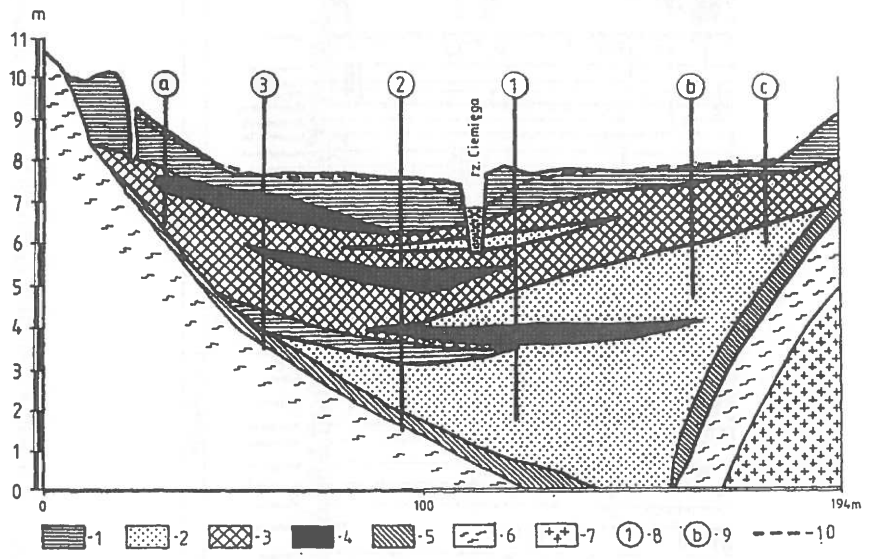


Fig. 4. Stratigraphic cross-section through the Ciemięga valley in Snopków: 1-soil, 2-mineral-organic gythia, 3-peat with $CaCO_3$, 4-peat, 5-mineral-organic alluvial, 6-silt loam, 7-medium sand, 8-basic drillings numbers, 9-supplementary drillings numbers, 10-ground water level.

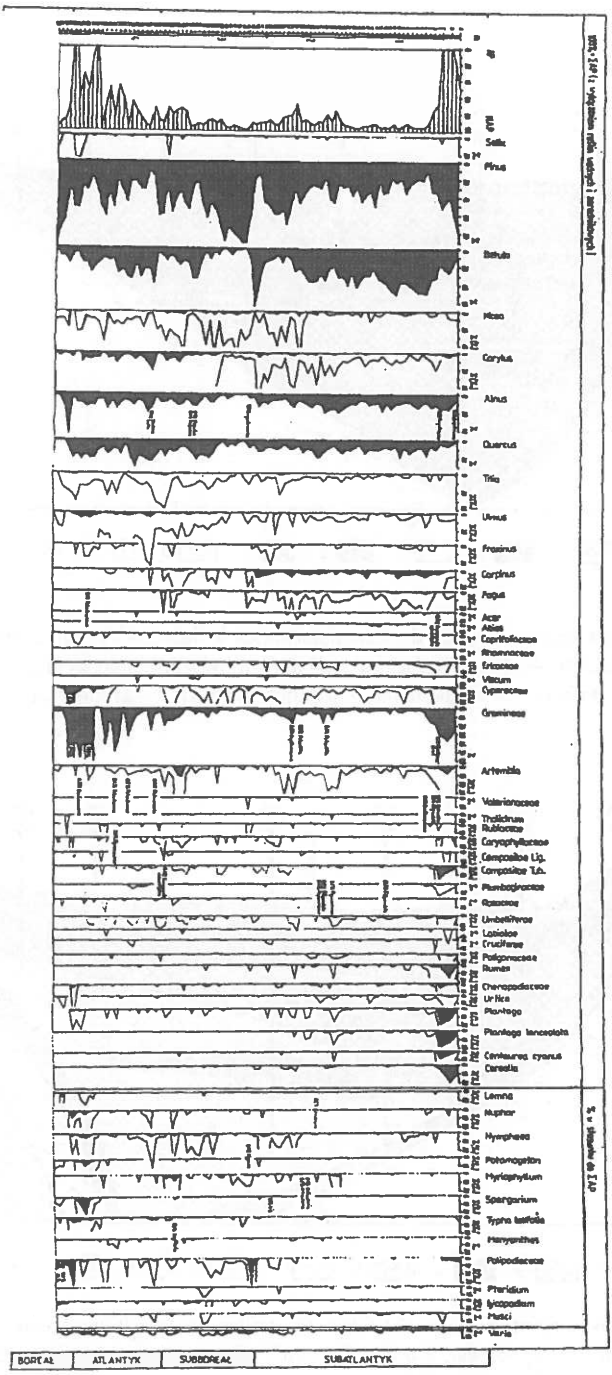


Fig. 5. Diagram of pollen analysis in sediments from cross-section No. 3 in Ożarów.

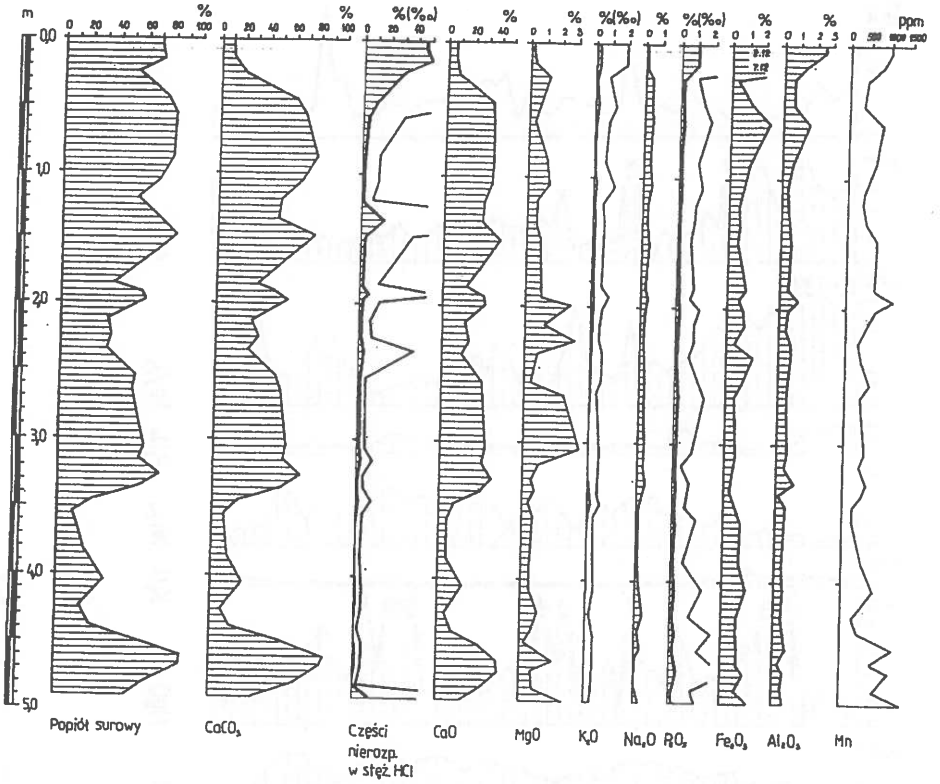


Fig. 6. Chemical composition of sediments from cross-section No. 3 in Ożarów.

there. The main mass is heavily silted-up peat material with a little content of peat input without silting-up. However, the most characteristic feature of this part of the valley is a thicker (up to 1 m at places) overlying mineral material, which is decisive for the actual system of water relations in the valley.

The results obtained in the present research supported by the data from literature [3,4] allow to conclude that delluvial processes started in the Neolyth by climatic changes and cutting down forests for the incoming agriculture that has been intesified since early Middle Ages until today, played a dominat role in the course of deposit formation that filled the Ciemięga river valley [7,9].

The elaborated diagram of pollen analysis (Fig. 5), as well as the showing chemism graphs of the gathered sediments (Figs 6-8) allow to trace changes in the indices of the vertical system (in time), and indirectly, relations between those changes in the natural and anthropogenic alterations at various stages of Holocene [4,8].

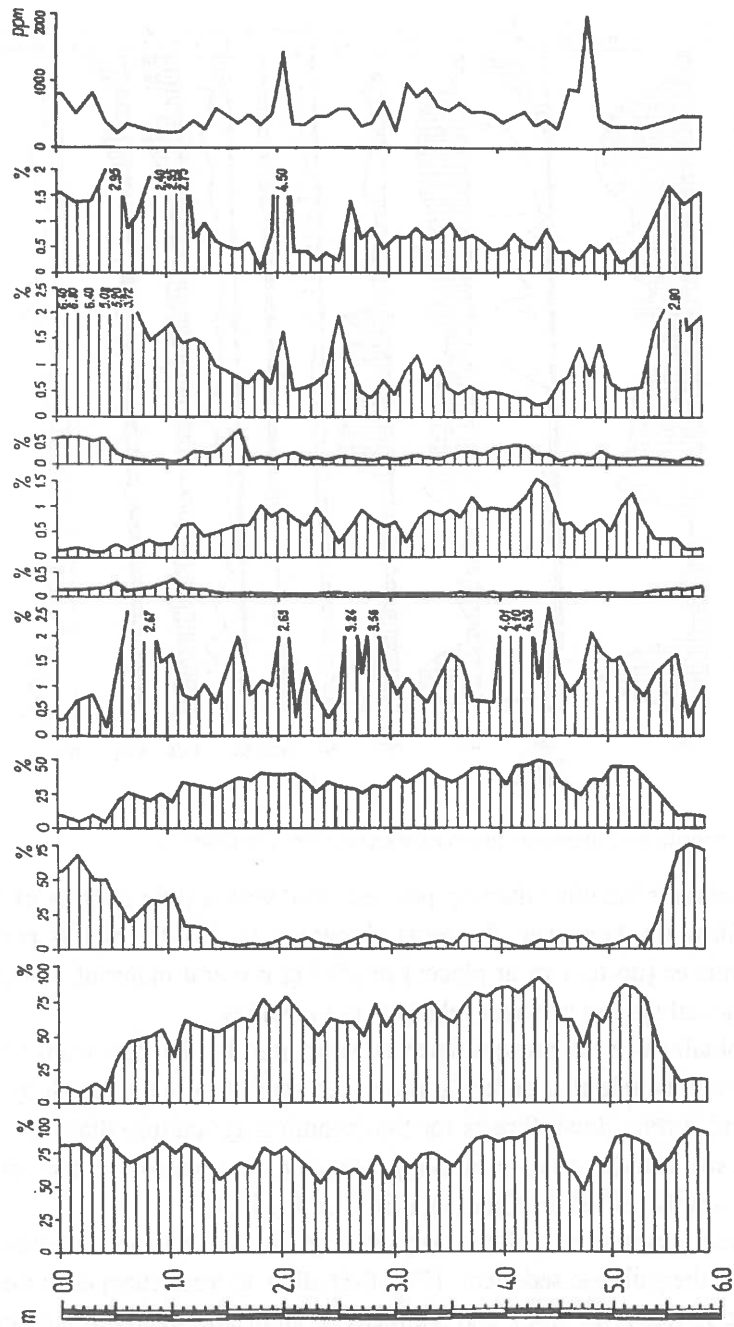


Fig. 7. Chemical composition of sediments from cross-section No. 1 in Jastków.

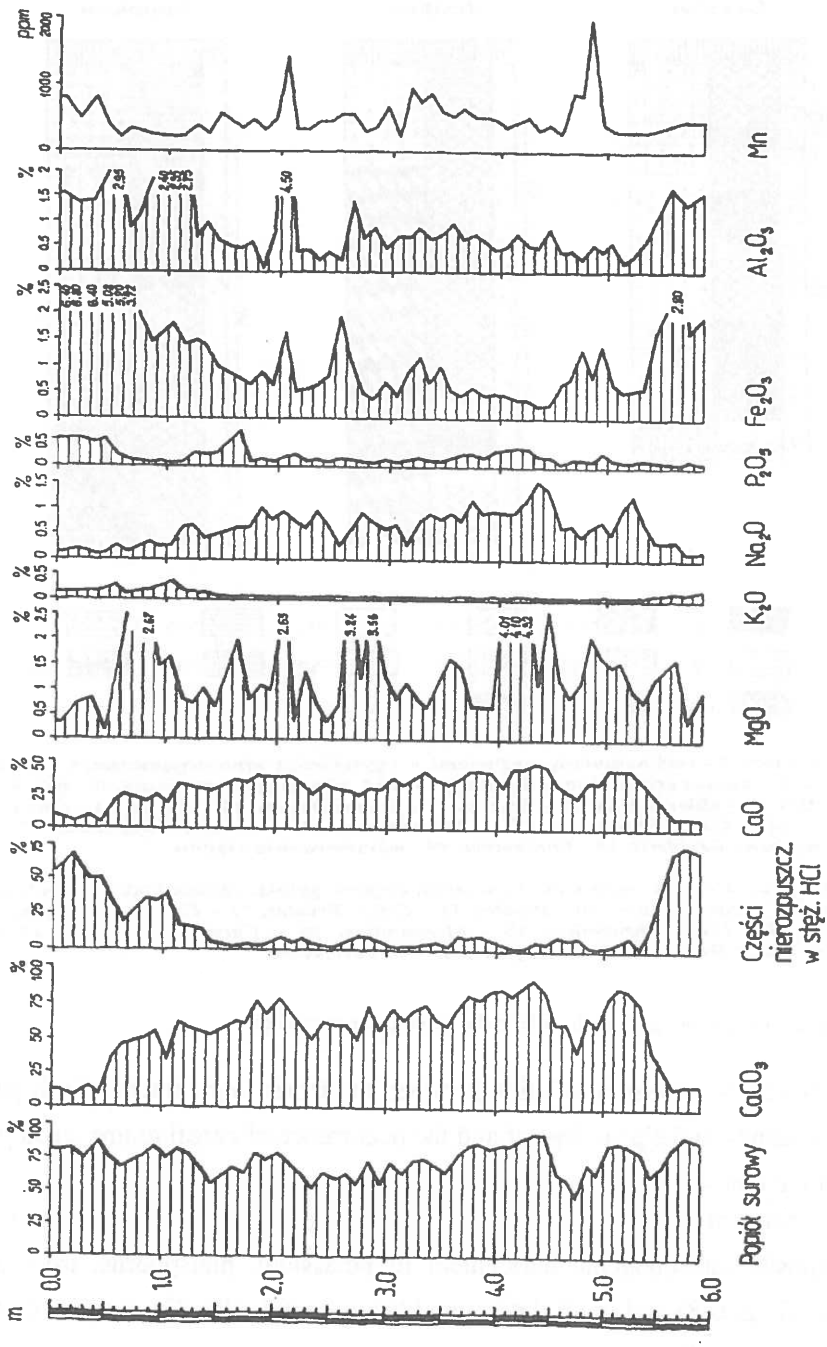
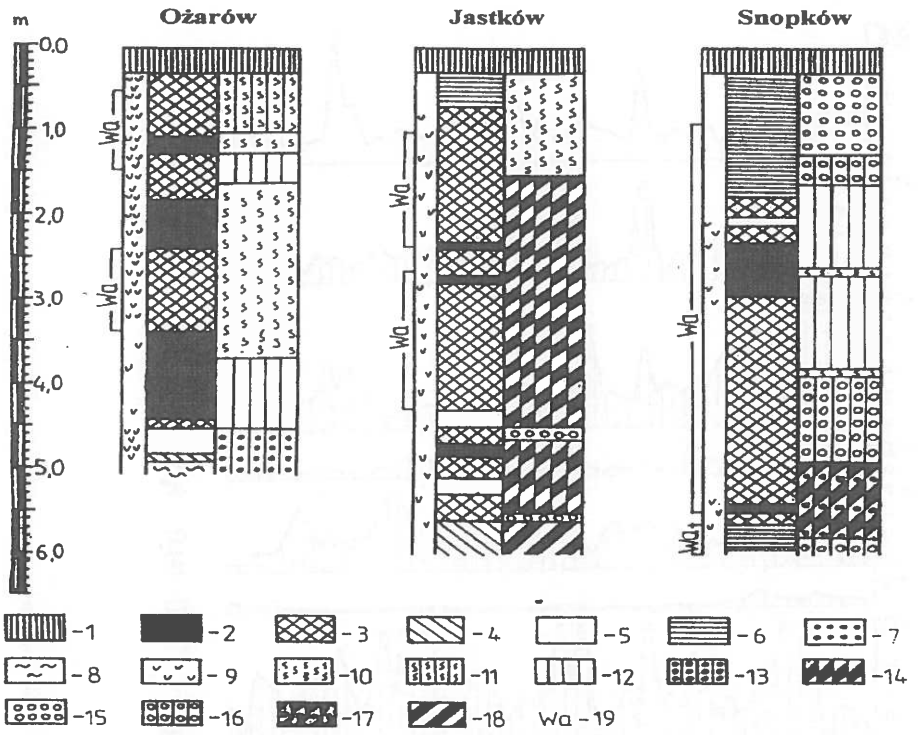


Fig. 8. Chemical composition of sediments from cross-section No. 2 in Snopków.



1 - gleba, 2 - torf, 3 - torf namulony węglanami, 4 - gytia mineralno-organiczna, 5 - gytia węglanowa, 6 - namuł organiczno-mineralny, 7 - muł mineralno-organiczny, 8 - pył, 9 - muszelki, 10 - 18 - zbiorowiska: 10 - *Bryales*, 11 - *Carex-Bryales*, 12 - *Carex*, 13 - *Carex - Dyropteris*, 14 - *Carex-Phragmites*, 15 - *Menyanthes*, 16 - *Carex-Menyanthes*, 17 - *Phragmites-Carex-Dropteris*, 18 - *Phragmites*, 19 - warstwowanie osadów

1 - soil, 2 - peat, 3 - peat with $CaCO_3$, mineral-organic gythia, gythia $CaCO_3$, mollusc shells, 10 - 18 - communities: 10 - *Bryales*, 11 - *Carex-Bryales*, 12 - *Carex*, 13 - *Carex - Dyropteris*, 14 - *Carex-Phragmites*, 15 - *Menyanthes*, 16 - *Carex-Menyanthes*, 17 - *Phragmites-Carex-Dropteris*, 18 - *Phragmites*, 19 - stratification

Fig. 9. Stratigraphic problems of sediments in the Ciemięga river valley.

It is proved by a clear correlation between the increasing content of ash parts and interbeddings in the peat deposit and the occurrence of cereal grains weed pollen from field cultivation in the investigated samples.

In the chemical composition of the sediments, especially in the upper horizons of the deposit, anthropogenic enrichment in potassium, phosphorus, iron, and manganese (Figs 6-8) and in all determined heavy metals (Pb, Cr, Cu, Zn, Co) is worth mentioning - Table 1.

Table 1. Content of Pb, Cr, Cu, Co, Ni, Zn in soil and sediment samples

Cross-section	Depth (cm)	Content (mg/kg)					
		Pb	Cr	Cu	Co	Ni	Zn
Ożarów	0-10	104	34	17	5	5	266
	11-20	84	32	14	5	6	253
	21-30	47	30	11	7	9	tr.
	75-90	tr.	30	5	9	tr.	tr.
	195-200	tr.	29	5	6	6	tr.
	220-230	tr.	16	4	4	6	tr.
	260-270	tr.	26	4	tr.	4	tr.
	340-370	5	13	3	4	5	tr.
	380-390	tr.	12	3	3	5	tr.
	457-465	tr.	46	5	tr.	tr.	tr.
	485-495	tr.	30	11	8	13	tr.
Jastków	0-12	33	37	14	5	7	tr.
	13-25	18	18	11	5	8	tr.
	41-50	17	17	11	4	8	tr.
	81-90	21	21	8	5	11	tr.
	111-120	42	42	12	6	12	tr.
	241-250	tr.	tr.	4	tr.	tr.	tr.
	321-330	tr.	tr.	4	tr.	tr.	tr.
	411-420	tr.	tr.	9	tr.	tr.	tr.
	571-580	12	12	6	1	5	tr.
	581-600	14	14	8	2	5	tr.
Snopków	0-10	46	79	24	9	17	tr.
	21-30	34	48	16	6	10	tr.
	31-40	22	47	12	5	8	tr.
	66-74	17	38	4	10	8	tr.
	201-210	15	30	13	4	5	tr.
	280-290	11	24	5	tr.	4	tr.
	321-330	tr.	tr.	2	tr.	tr.	tr.
	371-380	11	27	9	tr.	5	tr.
	540-550	27	38	11	6	11	tr.

At the same time, there was a significant loss of calcium, magnesium, and sodium which is a clear tendency towards acidification (Figs 6-8).

CONCLUSIONS

1. The investigated Ciemięga river valley has specific stratigraphy of the deposit and a very diversified composition of the accumulated sediments.

2. The material deposited in the valley consists of alternating interbeddings of heavily silted-up moss-sedge peat and organic-mineral warp rich in carbonates.

3. The delluvial mineral overlying material (clayey silt), occurring locally in the entire section of the deposit, as well as at the edges of the valley, shapes the current system and changeability of water relations, and indirectly decides on the possibilities to use the soils in the valley.

4. Results of the present research indicate an important influence of anthropogenic alterations within the basin on the sediment stratigraphy and characteristics according to different stages of the Holocene when their accumulation took place.

5. In the chemism of the upper horizons of the investigated sediments, the influence of an anthropogenic factor is clearly visible in the enrichment in K, P, Fe, and Mn, and all the determined heavy metals (Pb, Cr, Cu, Zn, Co). Significant losses of Ca, Mg, and Na were also found as clear symptoms of soil acidification.

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