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Integrated geochemical assessment of sediments from Plungė Municipal sewage outfall and sediments from Mažoji Sruoja Stream, Lithuania

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Modern river sediments are complex systems of mechanical, mineral and chemical composition that are sensitive to changes in the physical and chemical conditions of the surrounding environment. Thus, more complex studies on the organic matter, grain-size fractions, chemical and mineralogical composition of the surrounding soil and sediments are necessary for the reliable interpretation of results. The composite samples from the Plungė Town sewage outlet and the Mažoji Sruoja River of topsoil and stream sediments were studied. The major goal of the study was to evaluate the contamination of topsoil and stream sediments. The mineralogical, grain-size fraction, organic matter and chemical composition of topsoil and stream sediments were determined. The results obtained have revealed that none of the topsoil samples were contaminated. Some of the elements like Cu, Pb, Zn, Cr, As and Mo in stream sediments have values of the coefficient of concentration exceeding 1 and could be considered as potential contaminants. However, there was no any strong relationship between organic matter, clay, silt particles and chemical composition.

Keywords: stream sediments, topsoil, geochemistry, environment, contamination assessment

INTRODUCTION

Modern river sediments are complex systems of mechanical, mineral and chemical composition that are sensitive to changes in the physical and chemical conditions of the surrounding environment [1]. In recent decades, human industrial and economic activities have become a particularly important factor influencing the macro- and trace element composition of river sediments [2]. All living organisms require only very small amounts of some naturally occurring elements, and any increase in their concentrations in the environment poses a significant threat to both the environment and humans. Domestic wastewater is identified as one of the main sources of technogenic pollution. Although wastewater treatment technologies have improved rapidly in recent years and have received increasing attention, wastewater treatment companies cannot guarantee 100% treatment efficiency, which is important because trace elements released into the environment do not degrade in the natural environment. Treated wastewater is discharged back into the environment, usually into rivers, which are home to a wide variety of life forms. Previous studies carried out at the site have shown that, although the wastewater is treated effectively, it has an impact on the water quality of Mažoji Sruoja [3]. It has also been found that certain elemental associations can be linked to technogenic pollution [4], but more complex studies on the chemical composition of the surrounding soil and sediments are necessary for reliable results.

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EXPERIMENTAL

Study location

The site is located in the western part of Lithuania, in the centre of the Plungė District, in the Village of Varkaliai near the Town of Plungė (Fig. 1). The length of the Mažoji Sruoja River in the Cadastre of Rivers, Lakes and Ponds of the Republic of Lithuania is 8.8 km and the catchment area is 15.2 km^2. The stream has two tributaries, the Sraujelė and the Mergvagis. The villages of Varkaliai and Pakeriai are located near the Mažoji Sruoja. It is a right tributary of the Minija River, which is important because it flows into the Minija Ichthyological Reserve, an important spawning ground.

Brief geological history of the Quaternary of the study area

The Quaternary sediments in the area were laid down during the last half a million years, when the Dainava, Žemaitija and Nemunas glaciers covered the area. The Quaternary sediments consist of five moraine layers and the fine-grained laminated sediments separating them. Two of the moraine layers were deposited by the earliest and middle glaciers and three layers by the glaciers of the last glacial period. The last two glaciers (Žemaitija, Nemunas) were particularly rich in material. The climate during this period was cold and dry, with a mixed vegetation of arctic steppe and tundra. The Nemunas Ice Age is associated with the surface relief of Lithuania, with the formation of highlands, lowlands and plains. The glacier covered most of the territory of Lithuania, except for the Medininkai Upland and the Eišiškės Plateau [5]. The moraine loams, sands and pebbles that they left behind cover the surface of the area today and form the foundation of the Plungė District's relief, and these deposits formed the soils. During the glaciation of the Nemunas, in the Baltic Stage, ice melt streams in the area deposited glacial deposits (moraine loam, sandy loam), as well as fluvio-glacial deposits – mainly various sands. Later, during the Holocene, alluvium (fine sand) and, in some places, peat formed as a result of swamping.

Research methods

Sampling of topsoil and stream sediment

The number of samples of topsoil and stream sediments, 5 and 19, respectively, were taken during the autumn of 2023. One single and four composite topsoil samples formed from two and three subsamples were taken close to the sewage outlet. Each composite sample of stream sediments was made of samples taken from the 10–15 m interval. For a location and coordinates of the samples refer to Fig. 1 and

Fig. 1. Study location. For samples coordinates see Table 1

Table 1. **Sample abbreviation, description and coordinates**

Sample ID	Description	Coordinates	
		x	*y*
1	Composite topsoil of 3 sub-samples	55.8784602	21.8042960
2	Composite topsoil of 2 sub-samples	55.8785178	21.8046085
3	Single sample (clay)	55.8784697	21.8047463
4	Composite topsoil of 3 sub-samples (clay)	55.8783980	21.8051550
5	Composite topsoil of 3 sub-samples	55.8785528	21.8057608
6	Composite stream sediment from a concrete sewage outlet	55.8785313	21.8046289
7	Composite stream sediment from a concrete sewage outlet	55.8785588	21.8051530
8	Composite stream sediment from a concrete sewage outlet	55.8785866	21.8061192
9	Composite stream sediment from a concrete sewage outlet	55.8785977	21.8063288
10	Composite stream sediment from a concrete sewage outlet	55.8786274	21.8070701
11	Composite stream sediment from a concrete sewage outlet	55.8786555	21.8079934
12	Composite stream sediment from a concrete sewage outlet	55.8787856	21.8091136
13	Stream sediment sample located out of a concrete sewage outlet kerb	55.8787681	21.8092484
14	Stream sediment sample	55.8786622	21.8098089
15	Stream sediment sample	55.8786625	21.8098092
16	Composite stream sediment sample	55.8785552	21.8106327
17	Composite stream sediment sample	55.8784185	21.8112647
18	Composite stream sediment sample	55.8784319	21.8122595
19	Composite stream sediment sample from the Mažoji Sruoja River	55.8784413	21.8123990
20	Composite stream sediment sample from the Mažoji Sruoja River	55.8788084	21.8124462
21	Composite stream sediment sample from the Mažoji Sruoja River	55.8797414	21.8126501
22	Composite stream sediment sample from the Mažoji Sruoja River	55.8782126	21.8125961
23	Composite stream sediment sample from the Mažoji Sruoja River	55.8777864	21.8129381
24	Composite stream sediment sample from the Mažoji Sruoja River	55.8771667	21.8136304

Table 1. The soil samples were collected using a plastic shovel, while the stream sediment samples were collected using a nylon scoop to avoid the cross-contamination of the samples. The samples of ~1 kg weight each were put in the plastic bags and carried to the Department of Geology and Mineralogy of the Institute of Geosciences of Vilnius University, Lithuania. The samples were dried at the room temperature in the laboratory.

Grain size

The sample preparation for laboratory analysis was carried out according to the methodology provided in the European Geochemical Atlas [6]. The stream sediment samples were sieved through a nylon sieve with a mesh size of 150 μm, with part of the sieved sample set aside for archiving and the other part thoroughly ground using an agate mortar and pestle, then sieved through a nylon sieve with a mesh size of 63 μm. Topsoil samples were prepared in the same manner, but initially sieved through a 2 mm nylon sieve. The clay size particles (<2 μm) were determined using a laser particle sizer Fritsch Analysette 22 Micro Tes plus at the Nature Research Centre, Vilnius, Lithuania. Each sample was placed into a small laboratory container and a small amount of distilled water was added. The samples were then stirred for about 5 min to separate the smallest particles that may have clumped together and analysed.

Qualitative (general) mineralogy by X-ray diffraction (XRD)

For general mineralogical composition determination using XRD, grain size <2 and <63 μm fractions were used. All analyses were performed using a Rigaku Miniflex II (Bragg–Brentano θ–2θ geometry), using Cu Kα radiation (λ = 1.542). The data was recorded at 5° per min, at a step size of 0.01°, 2θ interval from 5° to 65°. The obtained data was analysed using the licensed Match! software. The analysis was done at the Institute of Chemistry, Faculty of Chemistry and Geosciences of Vilnius University.

Organic matter content

The determination of organic matter content in topsoil and stream sediment samples was conducted at the Institute of Geosciences of the Faculty of Chemistry and Geosciences, Vilnius University. Initially, the samples were sieved through a 2 mm sieve. Each sample of about 5 g was weighted and grinded using an agate pestle. Then the empty crucible was weighted and the sample was added. The crucible with the sample was placed in a SNOL furnace at temperature of 440°C and heated for four hours. After heating, the crucibles were weighted and the organic matter was calculated.

Chemical composition

Prior to chemical analysis, the stream sediment samples were dried at room temperature, sieved through a nylon 150 μm sieve and powdered using an agate mortar. Having done this, the samples were sieved through a 63 μm nylon sieve. The topsoil samples were dried at room temperature, initially sieved through a 2 mm nylon sieve, then, after powdering, additionally sieved through a 63 μm nylon sieve.

Atomic absorption spectroscopy (AAS)

The samples were examined using atomic absorption spectroscopy at the Institute of Chemistry of the Faculty of Chemistry and Geosciences, Vilnius University. The concentrations of chemical elements were determined using a flame atomic absorption spectrometer Hitachi 170–50 (Japan) with hollow cathode lamps. A total of 8 chemical elements were quantified in the samples: magnesium (Mg), calcium (Ca), copper (Cu), lead (Pb), zinc (Zn), strontium (Sr), nickel (Ni) and cadmium (Cd). Double-distilled water and analytic-grade reagents were used in all the experiments. The samples of soil and stream sediments (2 g each) were dissolved in 10 ml of a mixture of HCl and HNO_3 (3:1 ratio). After the dissolution was carried out, the samples were digested by the addition of 10 ml of concentrated HCl, evaporated to a minimum size (3 ml), filtred and diluted to 50 ml with double-distilled water. The atomic absorption of metals in the obtained solutions was measured, and using a calibration curve, the quantities of metals in soil and stream sediments were calculated.

X-ray fluorescence (XRF)

The X-ray fluorescence analysis of the samples was carried out at the Geological Survey of Lithuania using the SPECTRO XEPOS analyzer to determine the concentrations of 20 chemical elements: magnesium (Mg), aluminum (Al), sulfur (S), potassium (K), calcium (Ca), vanadium (V), chromium (Cr), manganese (Mn), iron (Fe) and nickel (Ni), copper (Cu), zinc (Zn), arsenic (As), selenium (Se), strontium (Sr), molybdenum (Mo), cadmium (Cd), barium (Ba), mercury (Hg) and lead (Pb). Firstly, 10 g of the sample was crushed using a ball mill Fritsch Pulverisette 6. The milling process lasted for 45 min. Then, the resulting powder was mixed with Cereox Licowax C wax powder in a ratio of 3.12 g of the sample and 0.70 g of the binder and blended until a homogeneous mixture was obtained. From this mixture, 1.91 g was weighed out for capsule preparation. A laboratory press, MP250M, was used to manufacture the capsule. The sample was compressed into 20 mm diameter tablets for 10 s using a force of 15 t. After the tablets were produced, they were placed into an X-ray fluorescence analysis device. Each sample was analysed for 12 min.

Topsoil and stream sediment contamination evaluation

There are no specific environmental protection requirements for lake, pond and river sediments. However, these results of the analysis of these sediments can be compared with the Lithuanian Hygienic Standard HN 60:2015 'Hazardous Chemical Substances Limit Values for Hazardous Substances in Soil' [7] and apply the limit values presented in the Chemical Environmental Protection Requirements for the Management of Chemically Contaminated Sites. The results obtained are also compared with the median trace element levels found in some rivers stream sediments [8]. Topsoil contamination by heavy metals was determined according to the adjusted ***limit value*** (LV_a) which was calculated according to the formula

$$LV_a = LV^*[(A + (B^*M\ (\%)) +$$
$$+ (C^*OM\ (\%))] / [A + (B^*10) + (C + 3)],$$

where M (%) is the percentage of clay particles (less than 0.002 mm) in the soil. In cases where the determined soil clay particle content is more than 50% or less than 10%, the values 50 or 10%, respectively, shall be entered in the formula; OM (%) is the soil organic matter content (%). In cases where the soil organic matter content determined is more than 10% or less than 3%, the values 10 or 3%, respectively, shall be entered in the formula. A, B, C are the coefficients with values depending on heavy metals. In addition, we compared our results with the median values of the Minija River basin stream sediments. The median values of elements in the stream sediments of the Minija River basin for comparison were taken from the Geochemical Atlas of Lithuania (Table 14) [8]. The coefficients of concentration (Cc) were calculated according to the formula

$$Cc = Cx/Cb,$$

where Cx is the element content in the stream sediment sample, and Cb is the median value of element in the Minija stream sediment.

RESULTS

The results of grain-size, organic matter and chemical composition (ppm) for topsoil and stream sediments (SS) are summarised and presented in the Table below.

Table 2. **Median values of grain-size, organic matter and chemical composition (ppm) for topsoil and stream sediments (SS). For group description look in the text. Samples of the group are in brackets**

Analysis/sampling media	Topsoil (1–5)	SS 2 (6–13)	SS 3 (14–18)	SS 4 (19–21)	SS 5 (22–24)
Organic matter, %	6.0	2.8	2.1	1.7	1.3
Clay (<0.002 mm), %	2.1	0.4	0.6	0.5	0.7
Coarse-grained sand (2–0.2 mm), %	32.7	68.9	56.0	62.4	55.7
Fine-grained sand (0.2–0.02 mm), %	52.0	29.1	42.0	35.5	40.4
Silt (0.002–0.02 mm), %	10.7	1.6	1.7	1.7	1.4
Cu*	8	9	7	4	4
Pb*	23	10	7	5	6
Zn*	48	77	77	51	49
Sr*	5	7	14	17	18
Mg*	2956	1948	2899	3662	3263
Ca*	1672	6124	8283	12350	11433
Ni*	27	11	16	19	12
Mg	3999	2973	3243	3600	4250
Al	47840	22527	23699	24753	27661
S	429	966	1029	696	412
K	21319	17482	19592	17594	19628
Ca	8958	11528	13617	27138	22015
V	51	12	13	10	13
Cr	32	23	17	16	22
Mn	369	573	418	549	338
Fe	25296	11238	10100	15566	12681
Ni	24	12	10	8	9
Cu	12	13	10	7	8
Zn	46	83	70	47	46
As	4	1	1	3	1
Sr	104	90	92	101	102
Mo	0.04	2	2	1	3
Ba	373	325	324	335	323
Pb	21	11	10	10	10

* analysis by AAS, the rest by XRF.

Grain size

The highest median percentage of stream sediments is coarse-grained sand exceeding 50%, while fine-grained sand (0.2–0.02 mm) dominates topsoil (52%) (Table 2). The median clay content in both stream sediments and topsoil is low: it does not exceed 1% for stream sediments and is 2.1% for topsoil. The silt, which usually is a carrier of the heavy minerals phase, is also relatively low in the stream sediments and does not exceed 2%. The silt content, however, is much higher in the topsoil, i.e. 10.7% (Table 2). The content of clay fraction (<0.002 mm) in stream sediments is below 1%. Only in two samples from the sewage outlet (17 and 18) it is above 1% (Fig. 2).

Organic matter content

The organic matter median is highest in the topsoil reaching 6% (Table 2). There is a stable median percentage of the organic matter decrease from the concrete sewage outlet through out of the concrete sewage outlet kerb and the stream sediment sample from the Mažoji Sruoja River (Table 2). The highest organic matter content, i.e. more than 3%, is observed in a concreate sewage outlet and sewage outlet, samples 11, 12, 13 and 14, 15, respectively (Fig. 3).

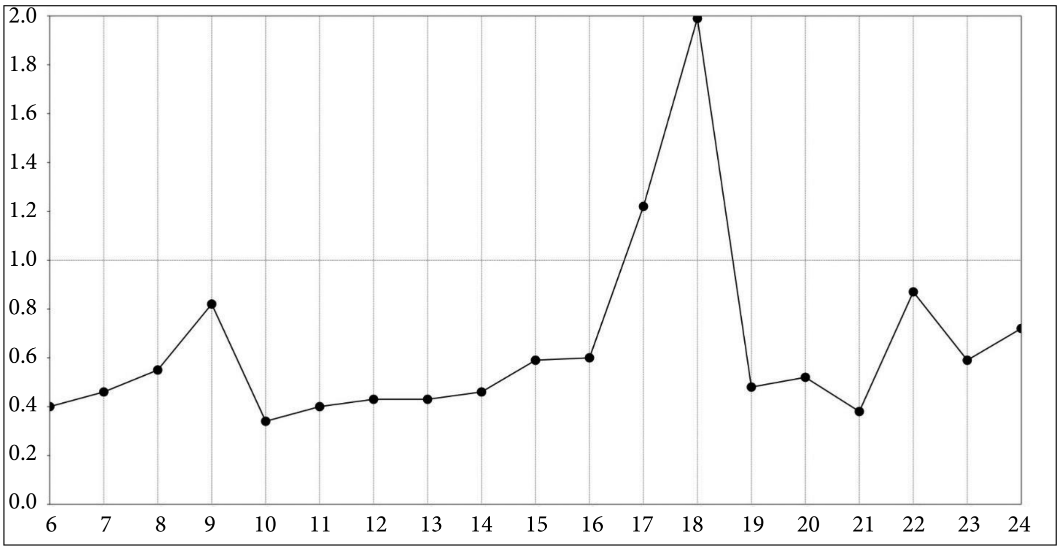

Fig. 2. Clay (<0.002 mm) particles content (%) variation in stream sediments of a concrete sewage outlet (samples from 6 to 13), sewage outlet (14–18) and the Mažoji Sruoja River – 19–21 upstream and 22–24 downstream

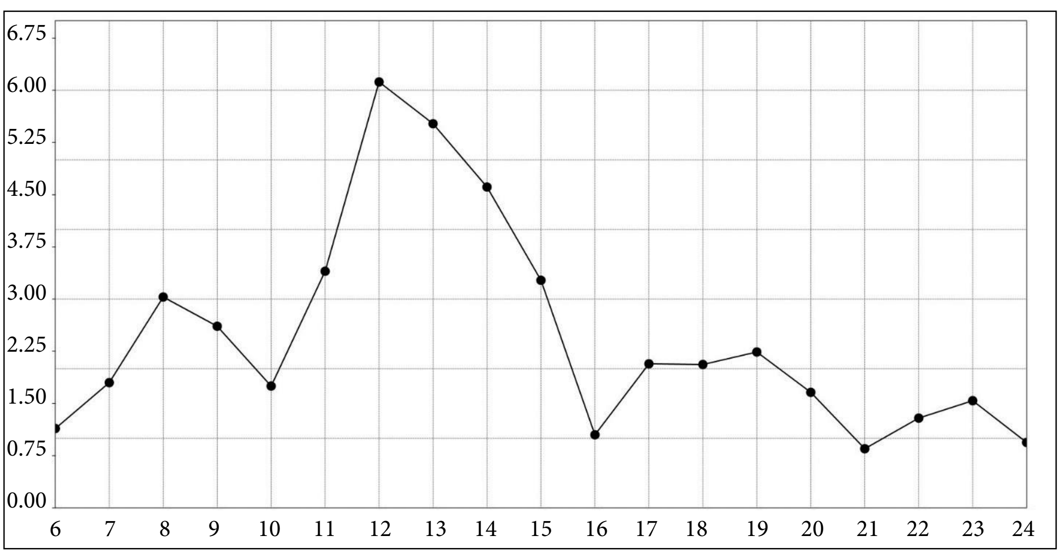

Fig. 3. Organic matter content (%) variation in stream sediments of a concrete sewage outlet (samples from 6 to 13), sewage outlet (14–18) and the Mažoji Sruoja River – 19–21 upstream and 22–24 downstream

Mineralogy

The general qualitative mineralogy was inspected by XRD analysis. The major detected phases were quartz, albite, feldspars, calcite and dolomite. There was no difference of major mineral phases in the fraction size 63 μm and 1 mm (Fig. 4).

Carbonates – calcite and dolomite – were detected in all but the 9th sample. In soil, carbonates were detected in samples 2, 4 and 5 (Fig. 5).

Chemical composition

The median values of topsoil and stream sediment chemical composition are presented in Table 2. The difference of the median percentage of XRF and AAS analysis of all samples is presented in Table 3. The difference in the AAS and XRF is discussed in the next chapter. The contents of major elements Mg, Al, K and Fe are highest in topsoil, while Ca content is highest in SS4 (XRF, 27138 ppm and AAS, 12350 ppm). Comparing the median vales of topsoil and stream sediments mobile elements, we see that Pb and Ni are clearly higher in topsoil, while Ca, Sr, Mg and Zn in stream sediments (Table 3). Total contents are higher in the topsoil of Al, K, V, Cr, Fe, Ni, As, Sr, Ba and Pb (Table 2).

AAS vs XRF

The AAS analytical technique uses a soluble phase of the sample and may be considered as a mobile phase for an element under acid environment while by XRF analytical technique a sample is analysed directly. We used the difference of XRF and AAS data as a mobile phase of the element in the sample (Table 3). The values exceeding 100% could be due to a combined analytical error. The very low value of Sr may indicate that the main carrier of Sr is rather feldspars than carbonates.

Topsoil and stream sediment contamination evaluation

Adjusted limit values of some elements were used to evaluate topsoil contamination (Table 4). None of

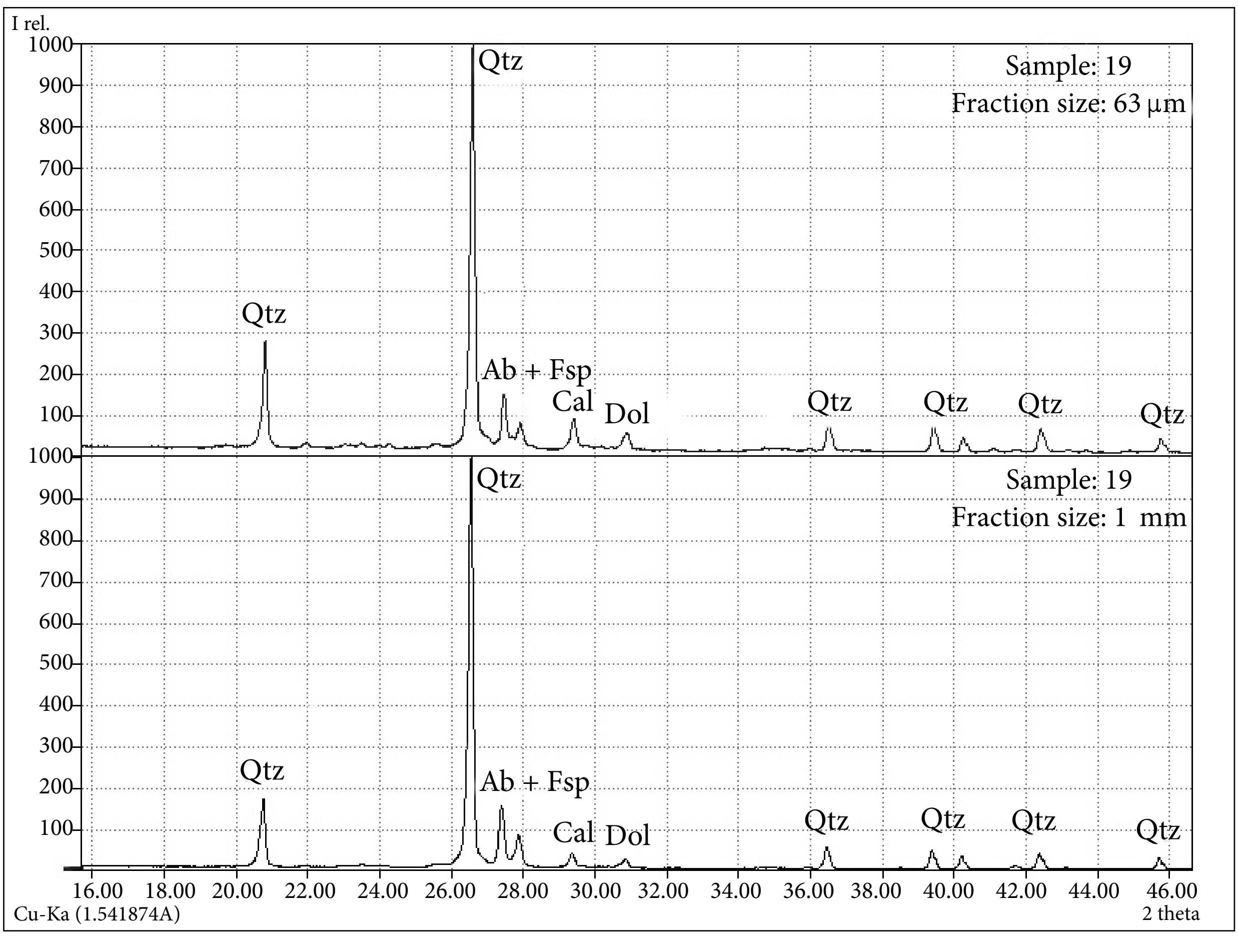

Fig. 4. The XRD of major mineral phases in different grain-size fractions. Qtz is quartz, Ab+Fsp are albite and feldspars, Cal is calcite, and Dol is dolomite

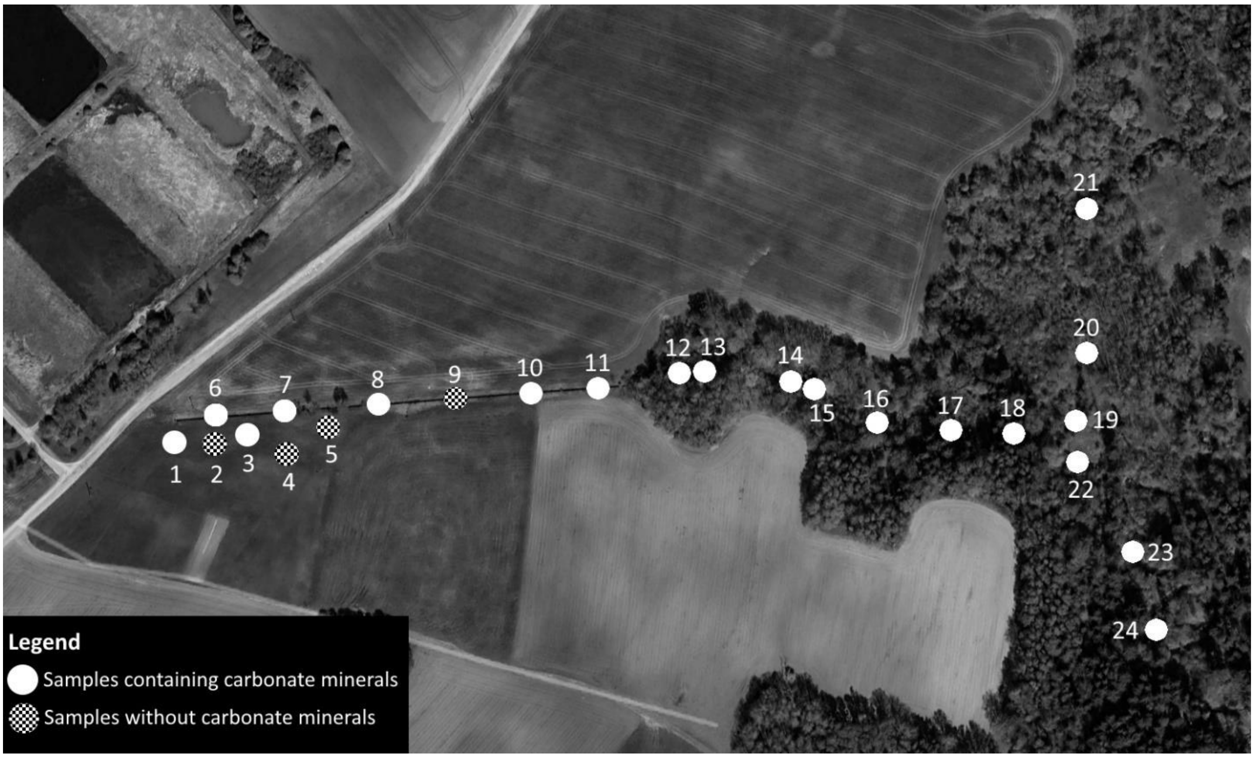

Fig. 5. Presence of carbonate minerals (calcite and dolomite) in topsoil and stream sediments based on quantitative XRD analysis

Table 3. **The median percentage of the difference of XRF and AAS analysis of all samples**

Element	Cu	Pb	Zn	Sr	Mg	Ca	Ni
Median % of mobile part	68	79	103	12	76	50	118

the sample after the comparison was concluded as contaminated. As it was mentioned, that absence of regulation for the contamination evaluation for the stream sediments, we compared the results according to the adjusted limit values of soil. Only in one stream sediment sample (No. 8), the determined Mo value was 5.17 ppm, while the adjusted value of Mo is 5 ppm. We may conclude that the stream sediments, including this one, are not contaminated by any of the compared elements.

In addition, we calculated the Cc for stream sediments to compare it to the median values of the Minija River basin sediments. Those values were considered as a median for the Minija River basin rivers to which the Mažoji Sruoja belongs. The coefficients of the concentration of elements in the stream sediment samples are given in Table 5. The elements which have values exceeding 1 could be considered as potential contaminants. Among them, Cu, Pb, Zn, Ni(?), Cr, As and Mo. It is evident that all but two samples are contaminated by Mo. The Cc is >1.5. The elements Mn, Ba, V and Ni(?) are depleted (Cc < 1) in the stream sediment samples.

Table 4. **Adjusted limit values (LVa) (ppm) for some chemical elements in topsoil**

Sample ID	Cu	Pb	Zn	Ni	Cr	V	As	Mo
1	61	80	387	65	86	137	14	5
2	69	86	422	65	86	137	16	5
3	67	84	410	65	86	137	15	5
4	63	81	396	65	86	137	15	5
5	60	79	383	65	86	137	14	5

Table 5. **The coefficients of concentration (Cc) of stream sediments. Cc > 1 in a bold font. Asterisks: Mo value below the detection limit**

Sample ID/Element	Cu	Pb	Zn	Ni	V	Cr	As	Ba	Mn	Mo
6	**1.5**	0.8	**1.6**	0.9	0.4	**2.4**	0.6	0.9	0.5	**4.0**
7	**1.3**	0.8	**1.5**	0.9	0.3	**1.7**	0.6	0.9	0.4	**1.7**
8	**1.5**	0.7	**2.0**	**1.1**	0.5	0.7	0.5	0.7	0.9	**5.7**
9	0.7	0.7	0.7	0.6	0.4	**1.1**	0.5	0.8	0.3	**3.1**
10	**1.5**	**1.5**	**2.1**	0.7	0.3	0.4	0.5	1.0	0.5	**2.2**
11	**1.9**	0.7	**2.0**	1.0	0.4	0.6	0.5	0.9	0.6	**3.0**
12	**1.3**	0.8	**1.6**	0.9	0.5	0.7	0.9	1.0	0.7	**1.8**
13	0.6	0.5	0.8	0.3	0.3	0.2	0.3	0.9	0.1	**1.6**
14	**1.1**	0.7	**1.4**	0.8	0.3	0.4	0.6	0.9	0.2	**2.5**
15	**1.7**	0.7	**2.4**	0.8	0.3	0.8	0.5	0.9	0.4	**1.7**
16	0.6	0.5	0.9	0.5	0.4	0.3	0.4	0.9	0.3	**1.7**
17	0.8	0.6	1.0	0.6	0.5	0.5	0.5	0.9	0.4	*
18	**1.1**	0.7	**1.5**	1.0	0.5	0.9	0.8	1.0	0.4	**2.5**
19	0.8	0.7	1.0	0.7	0.3	0.5	**1.1**	0.9	0.5	*
20	0.8	0.7	0.9	0.6	0.4	0.3	**1.4**	0.9	0.5	**1.6**
21	0.6	0.5	0.5	0.6	0.3	0.4	0.7	0.8	0.4	**2.2**
22	**1.2**	0.7	**1.1**	1.0	0.5	0.6	1.0	0.9	0.4	**3.3**
23	0.8	0.6	0.9	0.7	0.4	0.8	0.6	0.9	0.3	**2.6**
24	0.9	0.6	0.9	0.6	0.4	0.6	0.6	0.9	0.3	**3.4**

DISCUSSION

Anthropogenic contamination has usually a significant influence on the minor and trace element composition of stream sediments and may mask peculiarities of the natural diversity. A complex study of the sewage outfall and the stream sediments of the Mažoji Sruoja has provided a more detailed insight into the likely sources of metals. The results if based on the coefficients of concentration suggest that Cu, Zn and Mo contamination is present in the entire range of stream sediments, whereas the stream sediments of the Mažoji Sruoja are actually only contaminated by Mo, As, Zn and Cu (Table 5). Elements of the biogene-technogene association Ag–Cu–Pb–Sn–Zn and partly Cr–Ni–P are mostly related to the organic material [8]. We also analysed possible organic matter, clay and silt relationships to the total and soluble amounts of Cu, Pb, Zn and Ni. Molybdenum was included in the analysis as well, since it had its coefficients of the concentration of stream sediments exceeding 1.

No correlation was detected between the organic matter, clay, silt particles and both mobile (soluble) and total amounts of mentioned metals. All mentioned metals except Mo have weaker or stronger correlations and may be *pointing to the same source*? It was detected that the coefficients of the concentration of molybdenum in the stream sediments in all samples were more than 1 reaching 5.7 in sample 8 (Table 6). Molybdenum tends to follow Cu in its behaviour and is strongly complexed by organic matter [6]. The dispersion of sewage water contaminated with organic matter, carbonate and hydro carbonate colloids and metal ions has formed favourable conditions for its concentration [8]. We did not find any relationship between Mo and organic matter, clay or silt. Since carbonates are present in all but the 9th sample, the influence of carbonate content could not be evaluated. The correlation between both mobile and total part of Pb, Cu and Zn suggests a possible relationship of these elements. No relationship between those elements and organic matter as well as with the clay fraction

Table 6. **Correlation matrix of organic matter, clay and silt particles, mobile (soluble) phase and the total content of metals in stream sediments**

	OM	Clay	Silt	Cu*	Pb*	Zn*	Ni*	Ni	Cu	Zn	Pb	Mo
OM	1.00											
Clay	–0.18	1.00										
Silt	0.02	0.24	1.00									
Cu*	0.20	–0.05	–0.30	1.00								
Pb*	0.13	–0.32	–0.27	0.74	1.00							
Zn*	0.24	0.01	–0.12	0.94	0.69	1.00						
Ni*	–0.08	–0.02	0.18	0.41	0.39	0.53	1.00					
Ni	0.01	0.21	0.06	0.56	0.35	0.51	0.35	1.00				
Cu	0.21	–0.17	–0.29	0.87	0.63	0.83	0.43	0.71	1.00			
Zn	0.27	–0.09	–0.19	0.92	0.68	0.94	0.57	0.60	0.93	1.00		
Pb	–0.02	–0.22	–0.14	0.52	0.71	0.54	0.29	0.18	0.47	0.56	1.00	
Mo	–0.09	–0.08	–0.37	0.24	0.32	0.18	0.10	0.50	0.42	0.29	0.14	1.00

OM is organic matter, %; clay (<0.002 mm), %; silt (0.002–0.02 mm), %; * mobile (soluble) phase.

was determined. May it suggest that the source of these elements is of anthropogenic origin?

CONCLUSIONS

1. According to the adjusted limit values for topsoil contamination, none of the samples were contaminated.

2. The elements Cu, Pb, Zn, Cr, As and Mo in stream sediments have values of the coefficient of concentration exceeding 1 and could be considered as potential contaminants.

3. No strong relationship was detected between the organic matter, clay, silt particles and both mobile (soluble) and total amounts of mentioned metals.

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KOMPLEKSINIS PLUNGĖS MIESTO NUOTEKŲ IŠLEISTUVO IR MAŽOSIOS SRUOJOS UPELIO NUOSĖDŲ GEOCHEMINIS VERTINIMAS, LIETUVA

Santrauka
Šiuolaikinės upių nuosėdos yra sudėtingos mechaninės, mineralinės ir cheminės sudėties sistemos, kurios jautriai reaguoja į supančios aplinkos fizinių ir cheminių sąlygų pokyčius. Taigi, norint patikimai interpretuoti rezultatus, būtini sudėtingesni organinės medžiagos, granuliometrinių frakcijų, cheminės ir mineraloginės aplinkinio dirvožemio ir nuosėdų sudėties tyrimai. Buvo tiriami Plungės miesto nuotekų išleistuvo ir Mažosios Sruojos upelio viršutinio dirvožemio sluoksnio ir upelio nuosėdų sudėtiniai mėginiai. Pagrindinis tyrimo tikslas buvo įvertinti viršutinio dirvožemio sluoksnio ir nuosėdų užterštumą. Nustatyta mineralinė, granuliometrinės frakcijos, organinės medžiagos ir cheminė viršutinio dirvožemio sluoksnio ir upelio nuosėdų sudėtis. Gauti rezultatai atskleidė, kad nė vienas viršutinio dirvožemio sluoksnio mėginys nebuvo užterštas. Kai kurių elementų, pavyzdžiui, Cu, Pb, Zn, Cr, As ir Mo, koncentracijos koeficiento reikšmės upelio nuosėdose viršija 1, todėl juos galima laikyti potencialiais teršalais. Stipraus ryšio tarp organinės medžiagos, molio, dumblo dalelių ir cheminės sudėties nustatyta nebuvo.