Soil as an archive for anthropogenic influence and pollution

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Abstract
Soil can be regarded as an archive for anthropogenic action and influence on the landscape.
The paper presents geochemical analysis of the soil in the flood terrace in the riverbed of the Vistula. The soil was investigated in a Nature Reserve Forest, called Las Bielanski located to the north of Warsaw, Poland.
The distribution of elements within individual soil properties depends on long-term quaternary, geological processes. This accounts for the composition of soil parent materials and the formation of the terraces. Medium-term processes, such as weathering and soil formations led to chemical differentiation of soil. Anthropogenic activity, as short-term processes influence the soil properties in different ways. Soils in the Central Europe area are the result of a long process of development. Formation and distribution patterns allow conclusions on changes of climate and environmental conditions. Soils are thus important evidence of the natural and landscape history of a region. Urban soils are documenting the settlement and management activities of a community and hence represent an archive from which one may reconstruct the cultural history of inhabited areas. Already the recent paper of Fetzner et al. presents, that soil can be regarded as an archive of natural and cultural history (1).
Some parts of the investigated forest are transformed by anthropogenic activities: notably the traces of military quarters, and several excavations, heaps and trenches. The disposal of refuses and ruins, the dewatering of the habitat, air pollution by traffic and waste, human recreational activity; and crows' fecal pollution as synanthropogenic pollution have also left their traces in the soil.
Soil samples were taken in May 2000 and were analyzed for soil particle size distribution, content of K^+,Na^+,Mg^{2+},Ca^{2+}, total content of nitrogen and carbon, pH-value, content of phosphorus as well as the content of the heavy metals lead (Pb) and cadmium (Cd).
Although the forest is encircled by high-traffic urban streets and is close to a non-ferrous steel work, the soil pollution with lead (Pb) and cadmium (Cd) is quite low. The min-max value of lead is 18,92 to 55,16 mg /kg soil and the min-max value of cadmium is 0,05 to 0,42 mg /kg soil.
But two special points with higher charge of Cadmium and Lead were found in the area. A tannery is assumed to be located in this part of the forest about 50 years ago.

Introduction
Soil can be regarded as an archive for the influence of anthropogenic action on the landscape.
Soils in Central Europe area are the result of a long development process. Formation and distribution patterns allow us to draw conclusions about changes in climatic and environmental conditions. Soils thus provide important evidence of the natural and landscape history of a region. Urban soils document the settlement and management activities of a community, and hence represent an archive from which one may reconstruct the cultural history of inhabited areas (1). G. Kele et al. present in their survey of heavy metal contamination in the flood area of the river Tisza in Hungary (2), that the pollution in the flood area result from that contamination by human intervention for serveral centuries, like intensive long-term metal mining for several centuries.

Different authors have written about the threat by heavy metal pollution for the health and the economy. Soil is the most important renewable resource and its productivity is essential for crop production. Prof. Al. Spassovan et al. present in their Health-Ecological study on soil pollution with heavy metals and arsenic in an endemic region (3), the danger of high polluted soil for the inhabitants of polluted regions. Also V. Stanescu et al. reveals in their paperthat the increased concentration of sulphate and heavy metals in soils have resulted in distinct biological changes of the local environment (4).
The paper presents a geochemical analysis of the soil in the flood terrace in the riverbed of the Vistula. The soil was investigated in a Nature Reserve Forest, Las Bielanski, located to the north of Warsaw, Poland.

Methods
The 80 soil samples were collected in May 2000 in the Las Bielanski Reserve, whose geographical localization is 52°11`N, 21°1`E (Fig. 1). The area is divided into three geological terraces. The flood terrace, the overflood terrace and the dune terrace (Fig. 2), whereas the flood terrace is overgrown by the plant community of Ficario-Ulmetum campestris, the overflood- and the dune-terraces are covered with Tilio-Carpinetum

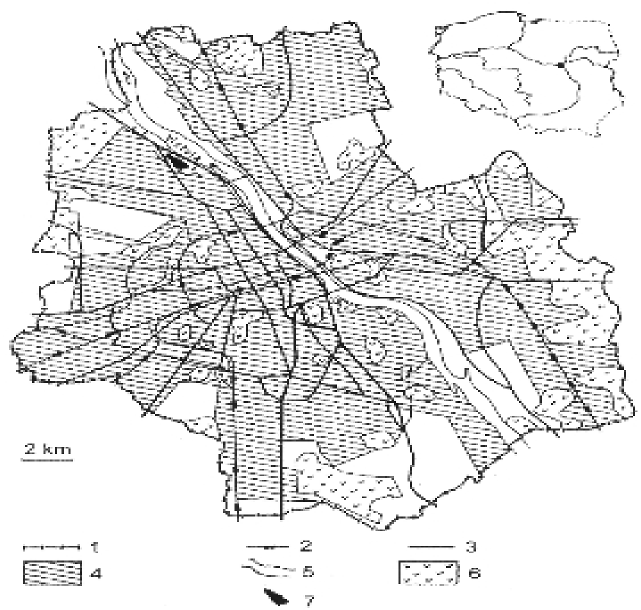

Fig. 1: Location of the Las Bielanski Reserve.
1. Warsaw boundary; 2. railways; 3. main streeets;
4. build up areas; 5. Vistula river; 6. parks
7. Las Bielanski

The soil samples were collected from depths of 0-15 cm in the Ah horizon. Each time 15 – 20 individual samples were taken, thus providing a mean mixed sample about
1 kg of soil. The soil was dried in room temperature. The samples were handled in different ways according to their disposition:

- The percentage content of total nitrogen in soil was determined by the Kjedahl method
- The percentage content of carbonate in soil was determined by the Tiurin method.
- The percentage content of the heavy metals in soil (Pb and Cd) was determined by the ASA method.

Results and Discussion
The investigated area is divides into three different terraces; the flood-, the overflood- and the dune terrace. The map of study side with different terrace types is presented in Figure 2. There it is obvious,

that the altitude of the flood terrace, located next to the Vistula river is three to five times lower than the dune terrace.
According to the different plant communities at the terraces (Fig. 3) the data of soil analyses of flood-, overflood- and dune terrace is summarized into two parts. The part, which is overgrown by the plant association of *Tilio-Carpinetum* (overflood and dune terrace) and the part covered by *Ficario-Ulmetum* (flood terrace).

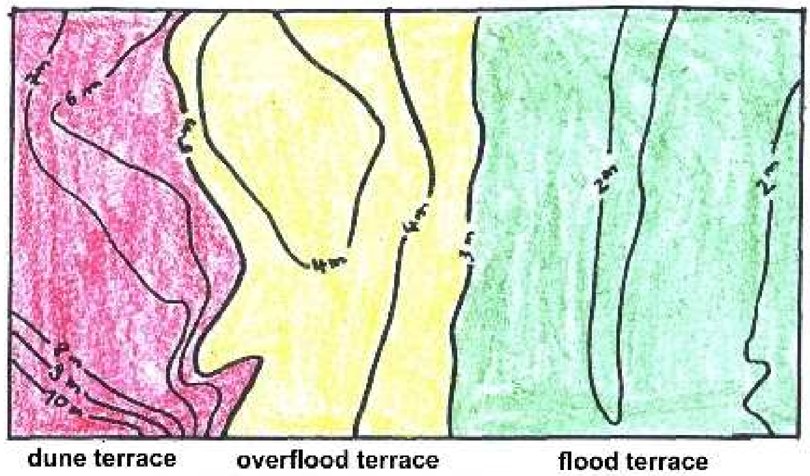

Fig. 1: The map of study side with different terrace types

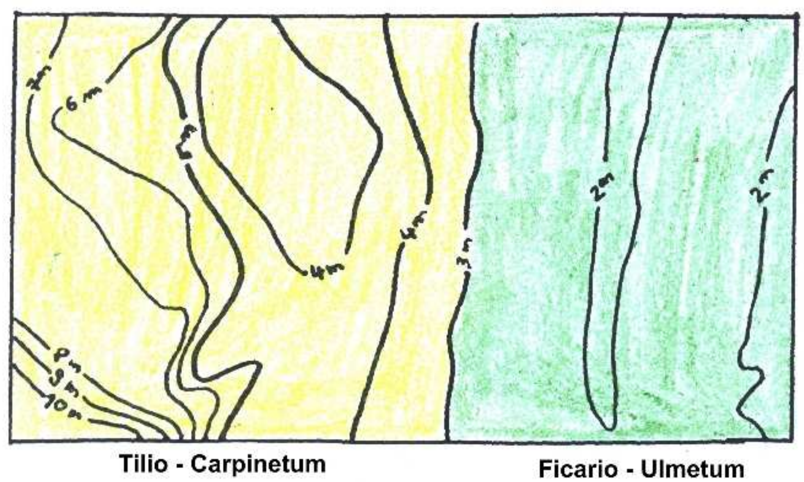

Fig. 3: The map of different plant communities in the study side

Table 1 presents the different minimum, maximum and median values of the different soil particels as well as the geochemical compounds and heavy metal contamination. The different demands of the two plant community types are perceptible in different soil particle values. The plant community of *Tilio-Carpinetum* is not able to exist in such moisture conditions like in the flood terrace, it demands more sandy and drier soil conditions.
Figure 4 presents the C/N factor distribution [%] in the study side. The flood terrace is more fertile than the other two. The fertility factor in the *Ficario-Ulmetum* has a median value of 10.2, whereas the C/N ratio in the higher parts has a median value of 13.3 (Table 1). This advantage of the fertility of soil explains the higher biomass production as well as the higher number of plant species in the *Ficario-Ulmetum*.

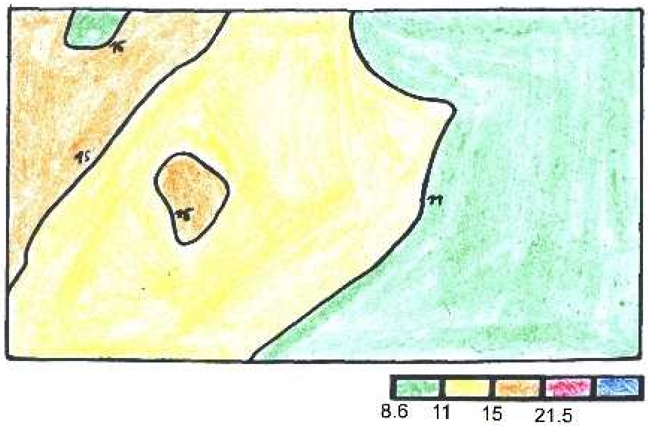

Fig. 4: The map of C/N - factor [%] distribution in the study side

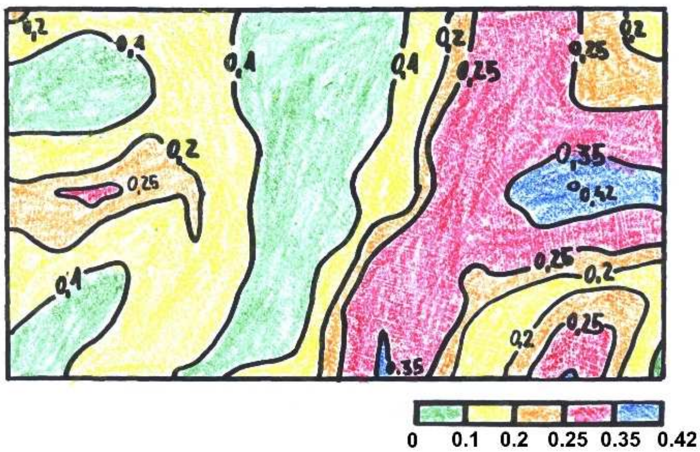

Fig. 5: The map of cadmium (Cd) distribution [mg/kg soil] in the study side

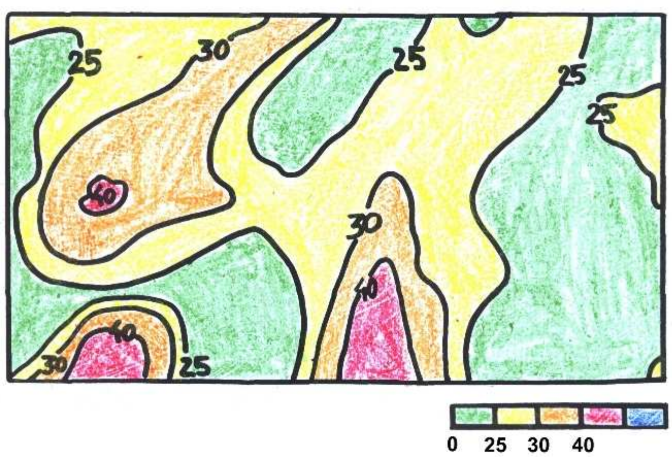

Fig. 6: The map of lead (Pb) distribution [mg/kg soil] in the study side

Figure 5 and 6 present maps of cadmium (Cd) and lead (Pb) distribution [mg/kg soil] in the study side. There is one special point in both maps, at the bottom of the investigated area, which shows a higher value of cadmium (0.35 mg/kg soil) and lead (40 mg/kg soil), compared to the rest of the area. In Figure 5 there is a noticeably higher pollution with cadmium in the flood terrace. The median value of cadmium content is 0,24 mg/kg soil, and the maximum value is 0,42 mg/kg soil (Table 1).

The investigation of the values of pollution has shown, that the soil in the forest is not highly polluted. In this investigation only the heavy metals (cadmium and lead) were regarded and the highest pollution was observed in the flood and overflood terrace. A tannery is assumed to be located in this part of the forest about 50 years ago.
The Mazowsze region and Warszawa is not very much industrialised, because of the lack of commodities in this area. So the pollution in this region is not very high, although a non-ferrous steelworks is located in the boundary of Warszawa.

Conclusion

1. It was found that the soil pollution with lead (Pb) and cadmium (Cd) is quite low, although the forest is encircled by high-traffic urban streets and is close to a non-ferrous steel work. The min-max values of lead range from 18,92 to 55,16 mg/kg soil and the min-max values of cadmium range from 0,05 to 0,42 mg/kg soil.

2. The highest content of lead (Pb 55 mg/kg of soil) and cadmium (Cd 0.42 mg/kg of soil) was observed in the flood and overflood terraces. It is assumed that a tannery was located in this area about 50 years ago.

3. The geochemical analyses of soil in the Las Bielanski Reserve show that the “chemical marks” of human activity can be found decades later even in abandoned landscapes. Soil can be regarded as an archive for the influence of anthropogenic action on the landscape.

References

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study sites	statistics	skeleton %	coarse sand %	medium sand %	fine sand %	silt %	clay %
Flood terrace	Minimum	0,1	0,2	0,5	9,9	8	13
	Median	0,45	0,8	1,8	21	34	38
	Maximum	2,8	12,5	37,5	33,6	46	53
	Std.Dev.	0,7	4,15	12,54	7,32	12	12,4
Overflood and dune terraces	Minimum	0,1	0,8	11,7	13,1	5	7
	Median	1,3	8,2	20,1	45,3	12	10
	Maximum	6,9	29,3	39,6	70	25	40
	Std.Dev.	1,77	6,89	8,98	17,81	4,5	6,69

study sites	statistics	S	H	T	N	C
Flood terrace	Minimum	2,6	11,4	15,7	11,3	0,2
	Median	16,6	17,15	31,85	49,55	0,3
	Maximum	30,2	35,6	46,2	71,4	32
	Std.Dev.	6,72	6,18	7,68	15,91	7,1
Overflood and Dune terraces	Minimum	1,1	8,3	13,8	6,8	0,1
	Median	3,1	18,1	20,7	14,9	0,2
	Maximum	16,7	35,6	46,2	46,3	0,6
	Std.Dev.	3,34	6,63	8,74	9,69	0,1

study sites	statistics	C/N	pH- value	P_2O_5	Pb	Cd
Flood terrace	Minimum	2	5	0,42	18,92	0,1
	Median	2,89	5,5	10,48	25,27	0,2
	Maximum	7,1	7	30,98	55,16	0,4
	Std.Dev.	1,37	2,1	10,75	8,5	0,1
Overflood and Dune terraces	Minimum	2	4	2,43	20,31	0
	Median	2,78	5,2	9,26	25,72	0,1
	Maximum	7,1	6,7	31,95	55,16	0,4
	Std.Dev.	1,52	3,74	10,85	9,52	0,1

S - sum of exchangeable cations [cmol/ (+) kg soil]
H - hydrolytic acitity [cmol/ (+) kg soil]
T - cation exchange capacity (CEC) [cmol/ (+) kg soil]
N - content of nitrogen [%]
C - content of carbon [%]
C/N ratio - fertility factor
pH - value
P2O5 - content of phosphor [mg/ 100g soil]
Pb - the total content of lead [mg/ kg soil]
Cd - the total content of cadmium [mg/ kg soil]