DISPERSION OF POLLUTANTS IN SOIL

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Abstract

This paper analyzes the dispersion of soil pollutants from the sewage treatment mud from Tomesti, Iasi. The results were obtained by sampling soil samples from different depths (0-20 cm, 20-40 cm and 40-60 cm). The soil material, consisting of urban sludge, at all samples collected on the 0-20 cm depth shows well-developed structural aggregates, having a structure that varies from grain to sub-lime polyhedra with a medium development degree. The material exhibits hydrophysical properties - mechanical and hydric stability, consistency being moderately dry in a dry, moderately glue-like state, with macroporous, medium and large macroporous, resulting in good aeration porosity and optimum aerohydric regime. In the range of 20-40 cm the soil material is relatively well structured, with smaller structural aggregates, the lack of groundwater causing an increase in consistency, plasticity and reduction of interspaces between aggregates. For the depth between 40-60 cm the soil is well structured, with medium-sized aggregates with a grainy structure in the first part, subangular polyhedral in the sub-surface, micro and meso-good activity. The study area is the sludge dumps from Tomeşti from Iaşi. It was built in 1994 by removing the soil layer on an area of 9.1 hectares of land and the construction of surrounding and separating dams. Around the warehouse was made a drainage channel that ensures the drainage of the deposit. The warehouse is located in the major river bed of the Bahlui River, on its right side. The straight line to the Iaşi Wastewater Treatment Plant is about 2000 m. The sludge from the process of the Iasi wastewater treatment plant was transported to the warehouse through a pumping station and a discharge pipeline.

Key words: dispersion, soil polution, sludge

In this article the study area is the sludge deposit in Tomeşti from Iaşi. It was built in 1994 by removing the soil layer from an area of 9.1 hectares of land and the construction of surrounding and separating dikes (Negulescu M., 1997). Around the deposit there was a drainage channel that ensures the drainage of the deposit (Smith S.R., 2000). The warehouse is located in the major river bed of the Bahlui River, on its right side (*figure 1*). The straight line to the Iaşi Wastewater Treatment Plant is about 2000 m (Dima M., *et al*, 2002).

The sludge from the Iasi wastewater treatment plant, one of the largest in the country, was stored for 10 years, between 1995 and 2006, in the 18,920 m² pool area, concessioned from the local council of the commune of Tomeşti (Cojocaru Paula *et al*, 2010).

The sludge was transported to the repository via a pumping station and a discharge pipeline (Stevens J.L. *et al*, 2003).

The storage was divided into 11 compartments (*figure 2*) with different surfaces. There are water and sludge slides between the compartments. The depth of the sludge deposition layer was 1.5-1.8 m. The total deposit volume is 225,000 cubic meters (Lăcatuşu R. *et al*, 2005).

The concentration of sludge resulted from the treatment process carried out in the Iaşi Wastewater Treatment Plant and deposited in the Sludge Battle is presented in *table 1* (Neag G, 1997).

Figure 1 **Aerial View**

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Figure 2 **The sludge deposit in Tomești**

In the enclosure, significant areas can be identified in which grasses such as: *Agropyron cristatum* - FD survey/drilling, foxtail (*Alopecurus arundinaceus*) - S1 survey, field grass (*Agrostis stolonifera*) - S2 and lolium survey *Lolium remotum*) - the S4 survey, are very well represented (Wang Y. *et al*, 2007).

The tendency to spread on these increasingly large areas of herbaceous plants is their tendency to occupy lands or wetlands, often marred and weakly salinized (Lăcatușu R. *et al*, 2012).

The deposited material, consisting of city sludge, further facilitates the presence and development of nitrofile, mesophyte or mesohigrophite species, such as nettle (*Urtica dioica*) - S2, S4 and FD surveys, *Amaranthus retroflexus,* S4 and S5 surveys, (*Polygonum hydropiper*) - S5 survey, *Xanthium italicum* - S5 survey, sometimes on cone area and conium maculatum, in the drainage area within the battlements of the battalion, while the hygrophic species, the reed (*Phragmites australis*) - polls S1, S2, S3 and S4, and lesser rush (*Typha angustifolia*) are mainly found in areas where groundwater is very close to the surface (Strategia națională de gestionare a nămolurilor).

Table 1

Sludge concentration

Dry substance	Dry matter	Maximum admissible concentrations for use in agriculture mg/kg s.u. (O.M. 344/2004)
Amount of sludge (tons)	5566	
Degree of humidity (%)	78	
Organic substance (%)	51	
Total nitrogen (%)	3.83	
Total phosphorus	0.7	
Copper (mg/kg)	234.15	500
Chromium (mg/kg)	74.91	500
Nickel (mg/kg)	41.54	300
Lead (mg/kg)	41.89	300
Zinc (mg/kg)	274.33	2000
Cadmium (mg/kg)	<1.36	10

MATERIAL AND METHOD

Soil sampling was carried out as follows:

- soil samples in the frame: 5 surveys (coded S1, S2,..., S5) and a drill (coded FD). The sampling was done on three standardized depths (0-20, 20-40, 40-60), while the drilling was performed from 20 cm to 20 cm to a depth of 140 cm.

- ground probes in the vicinity of the battalion: 5 polls (coded SE1, SE2,..., SE5), (*figure 3*) plus drilling (FM encoded). The sampling of the outdoor surveys was carried out in the same way as in the battalion, on three standardized depths (0-20, 20-40, 40-60), and in the case of drilling, the same as for drilling in the pitch, starting from 0 cm (from 20 cm in 20 cm) to 140 cm deep.

The soil material constituted from urban sludge at all samples (S1, S2, S3, S4, S5, FD) on the 0-20 cm depth, presents well-developed structural aggregates with a structure ranging from grain to subangular polyhedrons, with an average development level. The material exhibits hydrophysical properties - mechanical and hydronic stability, the consistency being moderate cohesive in dry, moderately adhesive, loose, with frequent macroporous, medium and large dimensions, resulting in good aeration porosity and optimal aerohydric regime. In the case of the S2 and S4 surveys, where the layer of material from the city sludge is well drained and without a phreatic intake between it and the upper horizon of the soil prior to deposition, as well as in the FD drilling (where the groundwater occurs at approximately 70 cm) were able to identify traces of mesopaunistic activity in tension, especially of earthworms. In the 0-20 cm trough and even below this depth, the soil material is relatively well structured, with smaller structural aggregates, lack of groundwater causing an increase in consistency, plasticity, and reduction in aggregate troweling. At the base of the last sampling segment (40-60 cm), but also in the case of drilling (which continues to a depth of 140 cm), the soil material is still under the influence of water, the hydromorphism influencing the degree of aggregation and structuring of its material particles, which is moderate or even low, plasticity being reduced, while soil material or the upper horizon of the soil is still gleaned.

In the rest of the samples collected from the basin (S1, S3 and S5) the presence of water at approximately 25-30 cm from the surface and in the second half of the FD drilling (from 70 cm) continues to determine a relatively structured soil material, but which with the appearance of water becomes from very poor cohesive to non-tacking, sometimes non-plastic, very adherent to the depth of harvesting in the water.

The samples collected from the battalion (FM, SE1, SE2, SE3, SE4, SE5) did not show water in the control section, with visible glue traces being identified on the basis of these (40-60 cm). The soil was presented as well structured, medium-sized aggregates with a grainy structure in the first part, sub-angular polyhedral in the sub-surface, micro and meso-good activity.

Figure 3 **Map of sampling points**

RESULTS AND DISCUSSIONS

The sewage sludge contains pollutants from some heavy metals but the fact that the reaction of the environment in which this material is found is neutral - poorly alkaline causes a poor mobilization (solubilization) of the chemical elements in question, without affecting the normal development of some plant species suitable for the environment consisting of sewage sludge. The heavy metal content of the sewage sludge found in the Tomeşti, Iaşi basin is shown in *table 2*.

Metals are natural components that are part of global ecosystems. Some of them are essential for the proper development of plants and organisms, others may be toxic to them, even at very low concentrations.

Metals may be present in the environment in a wide range of oxidation states and coordination numbers, these differences being correlated with their toxicity. In literature, metals are classified into two main categories: light metals and heavy metals. Of all the metallic elements in nature, 53 of them are heavy metals with a density greater than 5 g / cm3 and are often associated with pollution and toxicity, although some of these (the essential metals) are required for living organisms but in small concentrations.

The generic heavy metal designation has typically been used to designate metals and semimetals (metalloids) that have been associated with their toxicity and ecotoxicity properties. Some legal regulations in the field of the environment and human health specify hard metal lists that may differ from one set of regulations to another, and the term is used without specifying what heavy metals are involved. Therefore, the heavy metal name is often used in an inconsistent manner, generating confusions about the correct meaning of the term. There is also a tendency to consider that all elements under the generic heavy metal designation are highly toxic and ecotoxic, which can cause significant damage to areas where these metals are used, often without a real foundation.

Table 2

The heavy metal content of the sewage sludge in the battle of Tomești, Iași

Chemical elements	Depth (cm)	Minimum value	Maximum value	Average value	High values of standard deviation	Median values	Modules values	Asimetry
Zn	0-20	5.502	11.732	7.986	2.389	7.563	6.542	As
	20-40	5.468	10.182	7.553	1.744	7.700	6.780	As
	40-60	1.604	6.206	4.130	1.795	4.130	4.804	Ad
Cu	0-20	104	167	143	23	152	156	Ad
	20-40	119	176	137	22	130	131	As
	40-60	53	121	89	24	96	100	Ad
Fe	0-20	22.657	41.877	29.152	6.962	27.626	26.668	As
	20-40	22.546	34.708	26.395	4.671	25.223	25.084	As
	40-60	20.701	36.028	28.648	5.635	29.108	23.544	As
Mn	0-20	333	560	446	89	466	375	As
	20-40	374	549	443	67	431	404	As
	40-60	365	839	500	184	407	440	As
Pb	0-20	88	563	314	222	301	132	As
	20-40	51	515	307	222	314	115	As
	40-60	43	471	145	162	92	103	As
Cd	0-20	5.1	8.9	7.2	1.5	7.2	6.7	As
	20-40	5.9	9.9	7.2	1.4	6.9	6.7	As
	40-60	2.2	9.5	6.3	3.0	6.8	3.2	As
Cr	0-20	38	80	61	18	64	46	As
	20-40	40	76	62	16	67	74	Ad
	40-60	44	93	65	17	61	58	As
Co	0-20	13	21	17	3	17	14	As
	20-40	15	19	17	2	16	16	As
	40-60	2	21	15	7	17	17	Ad
Ni	0-20	29	47	39	7	40	32	As
	20-40	33	46	39	4	39	37	As
	40-60	33	52	43	7	42	41	As

Ad – right asymmetry
As – lest asymmetry

CONCLUSIONS

The average zinc content (Zn) in the 0-40 cm horizon is 7.770 mg kg^{-1}, and in the 40-60 cm horizon it reaches only 4,130 mg kg^{-1}. And the values of the average square deviation are large, which proves the variations of this chemical element both horizontally and vertically to the surface on which it is deposited.

When comparing these values with the total average soil content (50 mg kg^{-1}), it is concluded that the sludge contains 155 times more zinc than the soils. The maximum permissible limit (LMA) of zinc (300 mg kg^{-1}) is exceeded 26 times. Also, sludge contains 7 times more copper (Cu), 21 times more lead (Pb), but LMA is exceeded 3.1 times, 24 times more cadmium than in soils, and LMA is exceeded 7 times. The other chemical elements analyzed, whether found at normal content, as well as in soils (iron, manganese), either have slight increases in content compared to soil (chromium, cobalt, nickel).

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