ON THE EFFECTS OF A WASTE PLATFORM ON SOIL POLLUTION NEAR THE CITY OF CLUJ-NAPOCA (ROMANIA)

EFECTELE RAMPEI DE DEŞEURI ASUPRA POLUĂRII SOLURILOR DIN JURUL MUNICIPIULUI CLUJ-NAPOCA (ROMÂNIA)

H. CACOVEAN*, T. RUSU, M. BUTA****

**O.S.PA.-Cluj, Cluj-Napoca, Romania*
***Agricultural and Veterinary University, Cluj-Napoca, Romania*
Corresponding author: H.CACOVEAN, e-mai: turda75@yahoo.com

Abstract: *In this paper we studied the influence of waste platform on soil properties of his vicinity. Export of NPS pollution from this area is receiving increasing attention due to concerns regarding excessive nutrient enrichment and eutrophication in streams. Each horizon of nine types of soils was analyzed for establishing the level of the pollution and to offer some solution of mitigation this kind of problems.*

Rezumat: *În această lucrare este studiată influenţa rampei de deşeuri industriale şi casnice asupra proprietăţilor solurilor din apropierea ei. Exportul de surse de poluare difuze din acest sector a cunoscut o atenţie deosebită datorită creşterii excesului de nutrienţi şi a apariţia procesului de eutrofizare a cursurilor de apă. Pentru aceasta a fost analizat fiecare orizont ale celor nouă tipuri de sol în scopul determinării nivelului de poluare şi de a oferii unele soluţii de reducere a acestora.*

Key words:*waste platform, soil pollution*
Cuvinte cheie:*rampa de deţeuri, poluarea solului*

INTRODUCTION

Nonpoint source pollution (NPS) is a major cause of surface water and soils near a waste platform. The chemical composition of the waste platform situated in eastern part of Cluj-Napoca (Cluj County) has been analyzed to describe the environmental load of some toxic elements that we can find in soils system. Surface soil samples were collected from 7 locations throughout the waste platform and in its vicinity. Natural background concentrations were determined in samples of the local parent material. Soil profiles show different concentrations of elements reflecting the influence of the waste platform. The most important sources of this urban soil pollution are probably city wastes, industrial and domestic waste, etc. In this paper different approaches have been used to describe the relationship between soil pollution and waste platform.

Good waste management is essential to ensure a healthy environment. Population with local administration have obligations under legislation to ensure that their waste do not impact on the environment of this region. This study tries to present some benefits by preventing: 1) contamination impacting on the value of the land; 2) contamination of the land and water on the whole region; 3) breeding sites for diseases spreading mosquitoes, pest animals and predators; 4) stock injury, disease or death. Pollution prevention represents a broader term that includes waste minimization. It is defined by the EPA as measures that reduces the generation of non-hazardous and hazardous waste that prevents deterioration of the earth's atmosphere, water, land and biota caused by pollution. Pollution prevention also includes spill prevention measures and resource conservation through sustainable design and environmentally-preferred purchasing measures. Pollution prevention hierarchy represents the measures to prevent pollution, ranked by desirability:

1. Reduce the generation of waste through improvements in the design, manufacture,

processing, purchasing, or use material (such as equipment, products and packaging) to prevent the generation of a waste or to reduce the amount and/ or toxicity of the waste generated;

2. Reuse potential waste that cannot be eliminated, in a manner that is similar to its original use or for an alternative use without creating additional pollution;
3. Recycle waste that cannot be reused, using discarded material as raw material for producing new products. Complete recycling consists of three major components: segregating and collecting materials, using the material as raw material to make new products, and purchasing the recycled products;
4. Treat waste that cannot be recycled through any operation that changes or is designed to change the physical, chemical, or biological character to remove or reduce its hazardous characteristics.

The purpose of this study was to determine the properties of the waste platform and the surrounding native soils, so as to obtain a realistic picture of the type, level and extent of soils affected by the pollution.

The catchment of Zãpodiei where is situated the so-called *Pata-Rât waste platform* are in the eastern part of the city of Cluj-Napoca, an area characterized by steeply rolling hills and not so well-developed drainage. Basin characteristics of Zăpodiei Valley are very similar with others of Someşan Tableland and make them well-suited for a paired catchment design. The predominant soils types in this region are Haplic Phaeozems, Luvic Phaeozems and Calcaric Fluvisols. Soils texture consists mainly of sand loams, silty clay loams, silt loams, or clay loams formed in Sarmatian and Badenian geological formations with many soils characterized by moderate to high erosion potential. The study area is in a humid, continental region with average annual precipitation of around 700mm. Highest monthly rainfall totals typically occur in May and June, although large storms occurring throughout the summer can lead to rapid rises in discharge.

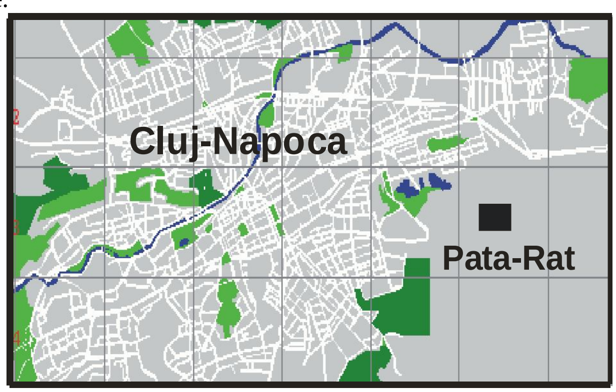

Fig.1. Location of Pata-Rât waste platform

Urbanization is a global process and Cluj-Napoca area is no exception. Urbanization is considered to be one of the most important human activities in the recent history of this region. In the late 1975s Cluj-Napoca area began a period of rapid urbanization while undergoing rapid economic development. The urban population of the city of Cluj-Napoca has increased to about 30% and represented the fastest urbanizing area in Transylvania. Rapid urbanization has caused many social environmental problems including a clear loss of soil quality.

MATERIAL AND METHODS

Soil characterization was achieved in two steps: firstly a general soil survey was carried out; secondly representative samples were collected and analyzed into a laboratory.

The soil survey was done by means of a manual Dutch auger with a length of 120 cm and a minimum density of ten observations was made. The site characteristics (location, elevation, exposition, slope, stoniness, drainage, parent material) and the soil properties of the profiles (horizon sequence, moisture, texture, carbonates and reaction) were noted following the methodology elaborated by R.I.S.S.A. Bucharest. The researches were carried out on the field and within soil analysis laboratories of the Soil Survey bureau Cluj County and University of Agricultural Sciences and Veterinary Medicine at Cluj-Napoca. In order to characterize soil types we made direct readings on the spot within main and secondary profiles.

These samples were prepared for physical and chemical analyses in accordance to standard norms observed by all laboratories of the kind in Romania. Soil samples were dried, crushed and sieved at 2 mm for chemical and physical analyses. Particle size distribution was determined by densimetric method after treatment of samples with H_2O_2 in order to destroy the organic matter and dispersion by suspension in 5% Na-hexametaphosphate for 2 hours. Particles sizes are those recommended by the I.C.P.A. Bucharest. Soil pH (1:2.5) was obtained with a glass electrode. Organic carbon, Nitrogen, were obtained by the Walkley-Black, Kjeldahl methods, Potassium with a solution of acetate lactate ammonium, Phosphorus by flame photometry method, Nitric Nitrogen by colorimetric methods and Cl^- by Mohr method.

RESULTS ABD DISCUSSION

Pollution hazard is defined as the combined effect of runoff and deep percolation (P) and is determined by the Buffer capacity for deep percolation (B), runoff (R), the land utilization type (LUT) and the level of input (I). Hence the following pollution hazard index can be developed:

$$P = f(B, R, LUT, I)$$

In order to judge values for deep percolation (B) at a regional scale, agro-chemicals were divided in three groups: 1) a group of very mobile, water soluble substances mainly represented by nitrate; 2) a group of relatively immobile elements such as phosphates and 3) cations.

The dominant shape of the Zãpodiei Valley permits to accumulate a large quantity of urban wastes which are frequently deposed on large soil surface of this region. The site studied exhibited differences in sloping patterns and these terrain attributes could impact soil properties, nutrient availability and trace elements production by the waste platform. The characteristics of this large valley admit of elements deposition northward, for a long distance from this platform (more then 200m) because of the wind intensity. This study showed weakly differences concerning the intensity of air and soil pollution with mention that a quantity of urban garbage was detected at the same level of slopes with the top of the waste platform without is transported to the bottom the valley. At different distances from the waste platform (150-200m) two soil pits (Aluviosol Calcaric) were determined with a high quantity of sodium chloride because of salt deposits.

After this research we can argumentatively to establish four areas with different values of soils pollution:

- Area with a maximum value of soils pollution and who situated under the waste platform;
- Area with a mean value of pollution for the soils surrounding the waste platform

(10-20m);

- Area with a mean value of soils pollution at 50 m upstream and 150 m downstream to west part of waste platform;
- Area with a low concentration of pollution on the slopes of western part of Zãpodiei catchment (150-200m).

We want to mention these areas concern only the soil cover of the region but the research work could be enlarge to air pollution, surface water contamination, groundwater contamination because of their contribution by enlarging the areas. This study shows the changes in the water chemistry due to surface water contamination can affect all levels of an ecosystem. Depending on the geology of the catchment, groundwater may rise to the surface during the rain events and flow laterally into nearby stream. Leachate is the liquid that forms as water trickles through contaminated areas leaching out the chemicals. In this case, the leaching of landfill can result in a leachate containing a cocktail of chemicals. The movement of contaminated leachate may result in hazardous substances entering surface water, groundwater or soil.

The chemical features of all samples from the Pata-Rât area given in the table 1. Within entire deep of soil pH ranging from neural (at a distance of 200 m) to slightly alkaline. This analysis indicated that the geological influence and the airborne dust from the waste platform who influenced the soil reaction evolution to the alkaline direction. The stronger relationship at the middle of the waste platform is consistent with the observation that, at this site, the sampling points with the highest CO_2 fluxes corresponded to points with strong rates of CH_4 emission. We suppose that a kind of relationship between CO_2, CH_4 emission hasn't any influence on mineral composition of soils. This fact could be explained by the flux of wind that diffuses the atmospheric emissions for a large area.

The exchange complex is nearly completely saturated with by Ca^{++} and carbonates are always present in the soils profile and tend in some points to decrease with depth. Therefore, extractable Ca^{++} and the level of the CO_2 from the air are contributed to the carbonate dissolution. Organic carbon and nitrogen (NO_3; NO_2) show different values raging from 2.18% to 4.81%.

Knowing the bulk density, the exact depth of each layer and the stone content, total amounts of organic carbon present in the soil layers were calculated. Amounts of organic carbon were highest in the top layer of meadows than in croplands. Concentrations and vertical distribution of organic carbon and the forms of nitrogen varied widely by location and decreased with increasing soil depth for meadow and cropland. In natural ecosystems, phosphorus is commonly a limit nutrient for plant growth and is generally recycled a retained efficiently. Research over the last 30 years has shown that infiltration water is in many cases restricted to a small part of the soil volume. The soils form Pata-Rât watershed contained a very different situation between the all points. There was a strong dependency of the concentrations on the depth; the highest values were measured in the topsoil and a general decrease was observed thereafter with depth. Apart from soil type and depth, phosphorus was affected by the position relative to the stained flow paths of the Zãpodiei Valley.

Higher concentrations of total phosphorus were also observed in the stained fens nearly to the waste platform. Due to the high saturation in some points of the catchment of the exchange complex and to problems derived from the abundance of soluble salts, sodicity was estimated from the proportion of chlorides anions (Cl^-).

The proportion of chloride is shows the same values between the horizons of soils. Sodicity is basically related to the influence of the lithological material. The form of potassium (K_2O) is the element second only in the amount plants absorb. Although soils provide a great deal of K through natural processes and with the addition from the organic matter burnt who came from the waste platform. The total amount of K in soils of the area ranges from 72 to 1026 ppm (near the waste platform) while this amount seems like a lot of K, only a small amount is plant-available at any particular time. Most K is in the structural component of the soils.

Table I

Basic chemical properties of the soils of Zãpodiei catchment

No.	Horizon	Depth cm	pH	Carb. %	C_{org} %	NO_3 mgkg	NO_2 mg	P_2O_5 ppm	K_2O ppm	Cl mg	SO_4 mg
1	Ao	0-20	8.01	6.08	4.14	9.4	0.64	19	380	21.3	76.25
2	-	5	8.05	8.08	4.19	9.8	0.78	17	302	21.3	76.25
3	-	30	8.18	7.06	3.51	10.0	0.78	7	246	21.3	32.25
4	A/CGo	30-40	8.38	8.1	3.50	7.0	0.64	3	168	17.75	91.50
5	C1	50-60	8.55	8.5	1.43	6.4	1.56	3	72	10.65	76.25
6	C2	70-80	8.59	8.9	2.45	14.0	0.86	2	278	10.65	91.50
7	C3	90-100	8.56	8.4	2.58	11.6	0.32	1	262	14.2	103.7
8	-	0-5	8.12	8.6	2.67	10.4	0.78	7	374	17.75	73.2
9	-	30	8.24	8.8	2.25	10.4	0.40	5	342	10.25	91.5
10	-	0-5	7.69	8.8	1.40	10.6	0.60	52	294	14.2	274.5
11	-	30	7.75	7.5	1.71	3.8	0.44	52	254	14.2	54.9
12	-	0-5	8.24	9.9	4.23	3.8	0.70	3	342	10.65	64.05
13	-	30	8.34	14.6	4.81	3.2	0.26	0.9	246	10.65	67.10
14	-	0-5	8.08	6.2	2.18	10.4	0.60	24	270	14.2	67.10
15	-	30	8.16	6.3	3.81	9.4	0.44	10	254	14.2	667.1
16		0-5	8.07	2.5	-	7.6	0.78	32	800	114.2	27.43
17		30	8.49	4.2	-	10.0	1.88	22	858	15.62	24.4
18	Am	10-20	8.34	3.4	-	8.0	2.08	21	810	14.2	27.45
19	A/B	40-50	8.53	3.1	-	4.6	0.18	11	810	8.52	6.10
20	-	0-5	8.65	4.2	-	5.6	1.18	6	400	31.95	57.95
21	-	30	9.42	9.7	-	10.2	0.68	4	430	284.0	115.9
22	Ao	3-8	8.54	3.5	-	4.6	1.30	7	672	24.85	70.15
23	A/Csc	10-20	9.29	8.0	-	10.0	0.88	4	400	131.39	45.75
24	CGosc	35-40	9.42	9.4	-	10.4	0.84	5	564	291.1	48.8
25	-	0-5	8.25	7.7	-	5.6	1.44	10	738	21.31	9.15
26	-	30	8.27	6.7	-	5.1	0.64	10	382	14.21	9.15
27	-	5	7.65	7.8	-	16.0	0.70	23	1026	35.5	6.64

CONCLUSIONS

The result of this study shows that the presence of this waste platform have influenced the soil resources, with the better agricultural soils being the most affected. Based on our study of chemical soil properties made in Pata-Rât area, we can conclude that the milestone of our study is characterised by some unfavourable soils chemical properties, increased levels of moderate alkaline and highly reaction (pH) and high level of nitrogen forms, phosphorus and potassium. The majority of the nutrients forms (NO_2, NO_3) transfer at catchment scale is estimated to be of diffuse origin. Diffuse transfers of nutrients measured at plot and field scale from grassland can account for the amount and composition of nutrients transfer observed at the catchment scale in diffuse source dominate river of Zãpodiei, thus the transport of nutrients from soils to catchments scale in general appears to be conservative.

However, despite modern waste solid and water treatment and source-separation of organic household wastes in one of the two societies, nutrient cycling through wastes is far from being closed. Sewage sludge and compost from Pata-Rât are not recycled to agriculture and high water content in organic wastes rather than unwanted contamination is the bottleneck for equitable re-distribution. In this case, there isn't the situation where the influence of waste platform by airborne lead to a situation that soils cover of Zãpodiei catchment will never come back to agriculture use again.

In addition, some distinct soil types, with their unique physical structure and history of formation, may be in danger of elimination, likely resulting in a substantial loss of below ground and above ground biodiversity. The short vegetation growth period and rapid biomass accumulation of crops recently introduced require a much higher soil nutrient release intensity and a higher concentration than those necessary for grain production.

Traditional households efficiently used animal manure as fertilizer; however, rapid urbanization has created a big challenge for soil nutrient management and soil sustainability in Zãpodiei catchment. Such management schemes do not yet exist. This study is subject to considerable uncertainties because of the extreme complexity of nutrient cycles at regional scales. A variety of possible important nutrients sources and output have not been accounted for in the calculation, such as mineralization of organic matters and denitrification. Despite such limitations, this study provides valuable insights into soil pollution and soil sustainability in Zãpodiei catchment in the context of rapid urbanization of Cluj-Napoca area. As a result of the lack of such schemes and strategies, a variety of environmental and economic problems related to nutrient depletion and overload, such as soils and water pollution will continue to emerge around the waste platform of Pata-Rât.

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