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Urban soils in Timisoara city

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Abstract: Urban soils is a term with no very precise definition, used to designate soils of areas covered with streets and buildings or occupied by parks, gardens, recreation areas, sport grounds and industrial production activities. The original soil of such areas has been strongly modified or even completely removed or replaced with other materials. In the Romanian Soil Taxonomy System (S.R.T.S-2012), "Urban Soils" are included in the Class "Antrisols", as soil types – Tehnosol and Antrosol. Because of their diversified origin, urban soils may contain pollutants in special heavy metals, like Pb, Cd, Ni, Zn. In the suburban area, the main soil types are Chernozems, in the N-NW part of Timisoara, Cambisols and Fluvisols, in the central part of Timisoara and Vertisols in the south part of the periurban zone. The greatest content of heavy metals of the parks are in the "Cathedral Park" and "Justice Park", with 1,63-1,77 ppm Cd, and 105-132 ppm Pb. Heavy metals tend to accumulate, also, in garden soils, and in general their concentration is on average twice that in agricultural soils, probably because of the input of various amendments and pesticides. The use at burning of the inferior fuel inside the thermo-electric power station (CET), as well as the powders dissipated from the waste dumps loaded with heavy metals, has a great impact upon soils, waters and vegetation (cultivated and spontaneous). Heavy metals are found except a few cases, in the interval that don't indicate a risk of pollution, above the "admissible limit".

Keywords: soil, taxonomy, urban, pollution, remediation.

1. INTRODUCTION

Soils in urban and suburban area are transformed by human activities.

Manipulation and modification of the environment was a characteristic of many societies from their very inception. Long before the advent of earth-moving machines and toxic chemicals even before the advent of agriculture, humans began to affect the land and its biota in ways that tended to destabilize natural ecosystems.

Urban soils are used for many purposes, including urban and industrial activities, forestry and agriculture. They are characterized by a strong spatial heterogeneity resulting from the various inputs of exogenous materials and the mixing of original soil material. The evolution of urban soils is controlled by the same factors as natural soils, but the human factor imposes extremely rapid transformation cycles in comparison with those dominant under natural conditions.

They often hold pollutants that may be a threat to human health.

Industrialized societies annually release large quantities of synthetic chemicals both intentionally in the case of pesticides and inadvertently, through the production, transport, refining and combustion of fossil fuels, waste streams from manufacturing, chemical spills, disposal of products by consumers and discharges from a wide variety of other sources.

Currently, there are more than 75000 chemicals registered [3].

The "pollution" term is often used, but seldom defined. A search of the literature reveals that it is often used synonymously with term "contamination".

Pollution has been defined [7] as the man-made or man-induced alteration of the physical, biological, chemical and radiological integrity of soil, water and other media.

US EPA gives a definition of the term "contamination" as "Introduction of microorganisms, chemical, toxic substances, wastes or wastewater in a concentration that makes the medium unfit for its next intended use".

So although a few authors have tried to distinguish between pollution and contamination, here, the focus will be on the addition of chemical substances to soil that affect its use or affect other parts of the environment through soil.

The European Environment Agency considers that most cases of soil contamination arise from the following industries: chemicals, metals, energy, mining, oil, electronics, glass, ceramics, stone, textile, leather, wood, paper, food, trade and traffic. Many thousands of pollutants have been dispersed in the environment by human activities, some for a long time.

For example, in the UK it is estimated that 300000ha of land are affected to some extent by contamination left by industrial activities [8]. Groundwater contamination presently comprises one of the major global concerns.

In developing countries, groundwater is subject to contamination mainly due to poor sanitation associated with high rates of population growth. In rural areas of developed countries, groundwater contamination is mainly attributed to fertilization, use of pesticides, and inappropriate habits of irrigation

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from the point of view of amounts of groundwater pumping and water quantities used for irrigation. In the European Union a limit of 50mgl^{-1} of nitrate (equivalent to 11.3 mgl^{-1} of nitrate-N) has been imposed on any ground – or surface – water to be used as a source of drinking water and any surface water where eutrophication is considered to be a risk.

2. MATERIALS AND METHODS

In order to solve this study, we have used a detailed soil survey effectuated in the years 2000-2003th and there were taken soil samples on the depth of 0-20cm, samples of the phreatic water and of vegetables from areas situated in the town or round the town Timisoara.

The main physical, chemical characteristics and heavy metals content have been determined with respect the national standard (A.S.Ro).

In the urban and suburban area studied in Timisoara municipium, soils provide support for infrastructure (buildings, roads, railways, parking lots, bridges), shelter for cables (electricity, telephone, television) and pipes of various size and composition (drinking water, wastewater, gas) and substrate for plants (insolated trees along streets, trees in public parks and ornamental and edible plants in public and private gardens).

They are also used for agricultural (horticulture, suburban agriculture, gardening) and industrial production activities, and for recreation (stadium, playgrounds). For centuries, the regions surrounding residential areas have been used for provision of construction materials and domestic waste disposal. Therefore, soils differ according to the degree of human transformation.

3. RESULTS AND DISCUSSIONS

The configuration of the relief within the limits of the city is much blurred by the anthropic activities developed throughout the centuries. In the north-west of the city lies the only area that has not been affected by the excess of water.

This strip of higher land (99m) is continued in the north of the city, but it winds a lot and it is penetrated by numerous sand banks and areas of small depressions or low plain gulf, formed by the present day movements of local subsidence.

The old meanders and the secondary streams of the rivers Bega and Timis, can be observed only in unbuilt areas.

The southern and central part of the city is covered with a thick cover of alluvial deposits. In the central and the western part of the region, the phreatic level oscillated between 0.5 and 2.0 meters depending on the configuration of the minor landforms and on the granulometric characteristics of the rocks [10].

The distribution of soil types in the suburban area reflects the soil-forming factors (table 1).

Table 1 The main sol types from suburban area Timisoara

SRTS-2012	WRB-SR	Timisoara	Dumbrăvita	Ghiroda	Giroc
Aluviosol	Fluvisols	352.8	-	193.9	458.4
Cernoziom	Chernozems	2356.8	1026.5	-	-
Eutricambosol	Cambisols	1190.7	477.7	131.8	2982.5
Preluvosol	Luvisols	-	145.7	1354.9	-
Vertosol	Vertisols	1783.6	-	314.5	53.2
Gleiosol	Gleysols	561.1	44.0	266.7	493.6
Solonet	Solonetz	49.6	-	19.9	-
Soil complex	Soil complex	1914.9	-	474.8	521.2
Total		8229.5	1693.9	2756.6	4569.0

SRTS-2012	WRB-SR	Mosnita	Săcălaz	Sânmihai Român	Area ha
Aluviosol	Fluvisols	1311.9	676.2	1456.1	4449.3
Cernoziom	Chernozems	-	3978.2	774.0	8135.5
Eutricambosol	Cambisols	2605.6	838.3	177.2	8403.8
Preluvosol	Luvisols	-	-	-	1500.6
Vertosol	Vertisols	1117.7	4027.2	2023.9	9320.3
Gleiosol	Gleysols	451.1	518.3	131.8	2466.7
Solonet	Solonetz	13.2	276.2	64.7	423.6
Soil complex	Soil complex	240.6	350.9	2224.1	5746.5
Total		5740.1	10665.3	6851.1	40446.3

The oldest land, situated in the high plain, is covered by Cambisols and Luvisols.

On the lands with loess, Chernozems have different stage of gleysation and salinization. In the eastern and southern areas of the perimeter, predominant are Vertisols and Fluvisols.

In general artificiality increases from the periphery to the center of the city, where original soils are often removed and replaced by anthropogenic materials.

Another main feature of urban soils is the high frequency of usage change with time.

An example is the conversion of farmer industrial sites to new activities, including residential, public and recreational activities, and that may cause possible soil contamination.

The influence of the "human factor" makes the soil-forming processes very rapid.

Digging for new buildings, bringing in material from large distances for landscaping, disposing of rubbish, debris and topsoil for leveling and preparing the land for a new use.

Soil compaction and leakage of drinking or waste water from pipes may induce locally strong changes in redox and water flux conditions.

Because of their diversified origin, urban soils may contain pollutants and must be established properly for future land use.

For example, urban horticulture provides food supply to large populations.

Also, in urban areas children are often in direct contact with soil material, and soil quality in playgrounds may affect their health.

Table 2 Heavy metals in the parks of Timisoara, ppm [14]

Park	Cd	Pb	Co	Cu	Mo
Central	0.64	99	12	39	7
Libertătii	0.77	95	10	67	1.5
Copiilor	0.82	19	8	13	1.4
Rozelor	0.63	18	12	46	1.3
Catedralei	1.63	105	17	15	10.1
Justitiei	1.77	132	26	23	3.9
Civic	1.61	24	14	10	3.9
Botanic	1.64	23	10	3	3.7
Alpinet	1.87	24	9	3	2.8
Regina Maria	1.70	21	8	2	1.4
Doina	0.86	18	8	9	1.1
Normal values	1	20	15	20	2
Admissible limits	3	100	30	100	10

Park	Zn	Cr	Ni	Mn	Fe
Central	1668	67	62	487	22100
Libertătii	1133	80	1902	433	22200
Copiilor	534	80	92	467	20000
Rozelor	578	83	77	498	20000
Catedralei	1675	111	1060	667	21200
Justitiei	1250	199	62	667	20070
Civic	374	161	85	467	20300
Botanic	106	205	92	467	20600
Alpinet	138	186	93	433	21300
Regina Maria	124	109	101	367	21200
Doina	789	231	98	167	22400
Normal values	100	30	20	900	-
Admissible limits	300	100	50	1500	-

Heavy metals tend to accumulate in garden soils and, in general their concentration is on average twice that in agricultural soils, probably because of the input of various amendments, pesticides, to the garden soils.

In urbanized areas, the presence of mortar, concrete, and asphalt, roots of trees are often sequestered in a restricted space; lateral room space is hindered, with a narrow strip, often less than 2m, of poor-quality soil sandwiched between building foundations and highly compact road material.

The use at burning of the inferior fuel inside of the CET, situated in the south area of Timisoara, imposes the storing of great among of ashes, on a 50 hectares area.

The emissions from the thermoelectric power station's chimney, as well as the powders dissipated from the waste dumps loaded with heavy metals, have favoured the dust-fall on a big area, with a great impact upon soils, waters and vegetation.

Table 3 Heavy metals (ppm) in the soils, near the spoil bank - CET

Site	Arable, 519		Arable, 524		Arable, 614		Pasture, 614		Norma
Depth, cm	0-20	-40	0-20	-40	0-20	-40	0-20	-40	values
Cu	35,0	42,5	42,5	45,0	37,5	40,0	50,0	51,0	20
Zn	80	55	55	85	55	45	30	55	100
Mn	575	475	900	975	775	850	1175	1225	900
Co	62,5	67,5	50,5	62,5	25,0	30,0	42,5	35,0	15
Cr	56,1	52,3	49,2	55,5	61,8	72,1	56,6	63,2	30
Ni	16	25	5	5	21	20	23	21	20
Pb	30	22,5	105	4,0	30	22,5	62,5	70	20
Cd	1,5	1,3	1,4	1,3	1,1	1,4	1,4	1,3	1

Table 4 Heavy metals (ppm) in the plants, near the spoil bank - CET

Site	Arable, 519	Arable, 614	Pasture, 614	Remark
Cu	22,25**	15,5*	21,25**	*critical concentration **toxicity
Zn	92,5	72,5	93,7	
Mn	61,0	325*	102,5	
Co	2,5	7,5	10,0*	
Ni	10,0	<5	<5	
Pb	2,8	2,8	2,8	
Cd	0,2	0,3	0,3	

The heavy metals are found, except a few cases, in the interval that don't indicate necessity of intervention.

Table 5 Forage F4 – 10.1m Sânmihaiu Român – analytical data

	08.1995	09.1996
pH	7.6*	7.6
Total hardness	18.20	29.90*
Fixed residue	475	848*
Organics substances	88.5**	15.8**
Ca	70.0	132.0
Mg	36.5	49.0
Na	31.5	80.0
K	1.5	9.2
NH_4	9.20**	1.61**
Fe	3.78**	0.22*
Mn	0.00	0.048
NO_3	5.37	0.7
NO_2	0.7**	0.06*
SO_4	110.5	392.5*
HCO_3	305.0	256.0
Chlorides	46.1	74.4
Oxygen	0.00	
Phenols	0.00	
Detergents	0.00	
Zn	0.025	0.03
Cyanide	0.00	
Extractable	0.00	
Ni	0.00	
Cu	0.00	
Pb	0.00	
Alkalinity	5.0	4.0

* - critical concentration
** - toxic concentration

In urban areas Timisoara, groundwater contamination is attributed to a variety of species (both chemical pollutants and microorganisms), originating from urban development, and domestic and industrial wastes. Table 5 provides analytical data from the phreatic aquifers. Such pollutants usually arrive at the phreatic aquifer with infiltrating runoff water or water from other sources.

In Romanian Soil Taxonomy System (SRTS-2012), "Urban soils" is a class of Antrisols, a term already used in several classification systems [13, 15].

Table 6 Corellation of the type and subtype of soils, between SRTS-2012 and WRB-2006

Type Tehnosol (SRTS-2012)	Technosols (WRB)
Tehnosol rudic	Skeletic Technosols
Tehnosol spolic	Spolic Technosols
Tehnosol garbic	Garbic Technosols
Tehnosol urbic	Urbic Technosols
Tehnosol mixic	AnthropicTechnosols
Tehnosol copertic	Humic Technosols
Tehnosol reductic	Reductic Technosols
Tehnosol antroplacic	Linic Technosols
Tehnosol litic	Lithic Technosols
Tehnosol ekranic	Ekranic Technosols
Type Antrosol (SRTS-2012)	(WRB)
Antrosol hortic	Hortic Anthrosols
Antrosol antracvic	Hydragric Anthrosols
Antrosol aric	Aric Regosols
Antrosol erodic	(eroded phases)
Antrosol decopertic	-

The intensive extension of urban land in surrounding areas often on land with soils of high quality can be meet on the north and north-west part of Timisoara, by the zone Circumvalatiunii and Calea Aradului.

4. CONCLUSIONS

"Urban soil" is a term with no very precise definition, used to designate soils of areas covered with streets and buildings or occupied by parks, recreation areas, sport grounds, etc. the original soil of such areas has been strongly modified or even completely removed or replaced with other materials. In soil classification, "Urban soil" is included in SRTS-2012 and W.R.B-2006, at Antrisols, respectively – Anthrosols and Regosols.

The soil types in Romania are designated – Tehnosols and Antrosols.

Because of their diversified origin, urban soils may contain pollutants, in special heavy metals, like Pb, Cd, Ni, Zn, but the contain is seldom above the critic value.

Coarse textures, generate great horizontal as well as vertical heterogeneity, and a great quantity of dust.

Because the heavy metals are concentrated in the upper horizon, the dust is also contaminated.

Once a need for soil remediation is recognized, the best available technology is selected according to the nature, toxicity of the contaminant, related to the physical and chemical characteristics of the soil and a cost – benefit analysis.

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