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Urbanization Impact on the Ecological State of Soil in Uralsk Town

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Annotation

Inclusion of new micro districts to town, formal enlargement of green space, as well as increase of cars during the last decade caused degradation and deformation in the ecological state of Uralsk town's soil. With the aim of soil ecological state diagnostics soil samples were retrieved in the zone of roads, service stations. Samples were selected from the depth of about 0-20 sm, as urban soil is characterized as anthropogenically transformed and has communication wires.

Urban soil was researched on heavy metals, petroleum products presence, pH and the biological activity of the soil. Cellulosolic activity of the soil was determined by the rate of degradation of the linen tissue. Heavy metals were determined by atomic absorption and oil products by fluorometric methods. Measurements of topical acidity of soils were determined by potentiometric methods.

Based on several factors, analysis of the urban soil identified its typical technological distribution: compaction, gravel and anthropogenic inclusions, the content of the pollutants above the permissible values. Negative impact of technogenesis on the urban soils is reflected in the biological activity reduction and increased concentration of heavy metals and petroleum products. Marked excess is occured in the level of lead, zinc and cobalt. Soil far away from highways and potential contamination sources do not exceed maximum permissible concentrations.

The credibility of the integral indicator - soil biological activity between the studied values showed the possibility of using this parameter as a reliable criterion for predicting their condition.

Keywords: Urbanized cities, heavy metals, Lead (Pb), Soil-ecological parameters, anthropogenic impact

Introduction

Intensive rise of anthropogenic capacity reflected in construction, new micro district inclusion, increased cars negatively affects natural environment condition. People living in cities depend on the sustainable management of urban ecosystems and are especially confronted with current social challenges such as climate change, increased resource consumption and sustaining ecosystem services (Elmqvist et al., 2013, Ernstson et al., 2010). Among the reasons for determining the city as a driving force of ecological problems are world population growth and intensive anthropogenic activity. The level of urbanization has now reached 50%. The United Nation Organisation predicts urbanization will rise for 60 % in 30 years (UN, 2006). The risks of environmental harms associated with depositions of urban pollutants may be indicated by the extent of ecosystem services (Faber and Wensem, 2012, Galic et al., 2012, Nienstedt et al., 2012, Pataki et al., 2011, Thomsen et al., 2012). Road networks and industries are the two main sources of heavy metal emissions in cities. (Chen et al. 2010; Dayaniand Mohammadi 2010; Wongetal. 2006). The effects of urbanization are profound and pervasive from the local to the global scale. Cities now account for about 60% of all residential water use, 75% of energy use, 80% of the wood used for industrial purposes, and 80% of human greenhouse gas emissions (Grimm et al., 2008, Newman et al., 2009). Heavy metals enter soil in the various forms of chemical compounds and accumulate till high rate and pose a significant risk to the normal functioning of the soil biota. Emissions of heavy metals from precipitation can occur in peri-urban and rural soils. (Wei and Yang 2010; Wu et al. 2010). The incidence of heavy metal contamination from both natural and anthropogenic sources has increased concern about possible health effects. Natural and anthropogenic sources of soil contamination are widespread and variable (Tahir et al., 2007). At high concentration, metals can exert toxic effects on plants and human health (Srinivasa et al., 2010; Duong and Lee, 2011; Liu et al., 2012; Massas et al., 2013). There is a large body of evidence in the literature of the negative impact of heavy metals soil contamination on soil biota. When the chemical

equilibrium is disturbed, the soil is under stress. The urbanization processes drastically affect the indigenous soil ecological template (Kaye et al., 2006, Pavao-Zuckerman, 2008).

The aim of this work is examination of anthropogenically transformed urban soil, which is constantly under technogenic influence.

The object of the research is occured to be soils and soil-like formations located within the city limits, in various functional zones: recreation, the area of service stations and roads.

Methods

Sample preparation. Samples were retrieved in different areas: recreation, the area of service stations and roads. Urban soil is situated in the zone of communication infrastructure, so samples were collected from the topsoil (0-20 cm). Each sample was an average amount of 5 single sample combinations within 100 м^2.

The investigation was carried out in 5 districts of Uralsk town: Для исследования выбрали пять районов города Уральск: River Ural embankment (Stella), J.Moldagulov square, gasoline station (along Zhangir khan street), Isatai and Mahambet Square, Kirov park (control).

The soil of the park zone, which is the least susceptible to anthropogenic impacts, was studied as a control for comparison. For the determination of biological activity, linen tissue was fixed to the glass plate using the application method «cottonstripassay». Cellulose materials were stored in the soil for 30 days, and during assessing cellulose activity of the soil the following scale was used, as proposed by D. G. Zwigantsevy: very weak 10%, weak 10-30%, average 30-50%, strong 50-80%, very strong > 80%.

Chemical analysis. The samples were tested on presence of heavy metals, petroleum products, actual acidity and the biological activity. The measurement of actual acidity was measured potentiometrically in the upstream liquid of the suspension, prepared at a soil ratio of 1:2.5. The mass fraction of petroleum products in soil samples was measured on the liquid analyzer «Fluorite-02-2M». The fluorometric method of measuring the mass of petroleum products in soil is based on their extraction from the sample by hexane and the measurement of the intensity of the fluorescence of the purified extract. Heavy metals were were determined on an atomic absorption spectrometer (model AA140). Prior to the measurements, the spectrometer is prepared by chemical decomposition of the soil. Soil control based on measurement of maximum allowable concentrations was carried out by comparison with biological activity, since integral measurements are more informative diagnostic criteria.

Results and Discussion

Urban soil contains the horizon “urbick” UR characterized by an organic mineral layer representing the mixture of urban anthropogenic inclusions: construction and household waste, industrial waste.

With the aim of investigation of urban soil condition following indicators were used: the presence of lead, zinc, cobalt and manganese, petroleum products, pH of the water extract as well as the integral indicator of soil quality - cellulose activity.

The investigation of urban soil monitoring has shown that soil was significantly transformed for both heavy metals and their biological activities. The soil condition was particularly critical in areas of high traffic, roads of general urban importance.

In case of the investigation of actual acidity pH increase from neutral to weak alkaline was occurred in the territories less influenced to anthropogenic impact. Attention is drawn to the increasing pH of alkalinity in areas exposed to road pollution. In addition to transport, soil pH is affected by drainage water containing calcium and sodium salts.

The indication of actual acidity based on soil condition has shown an increase in pH of water extraction in areas more susceptible to man-made press. (Figure 1).

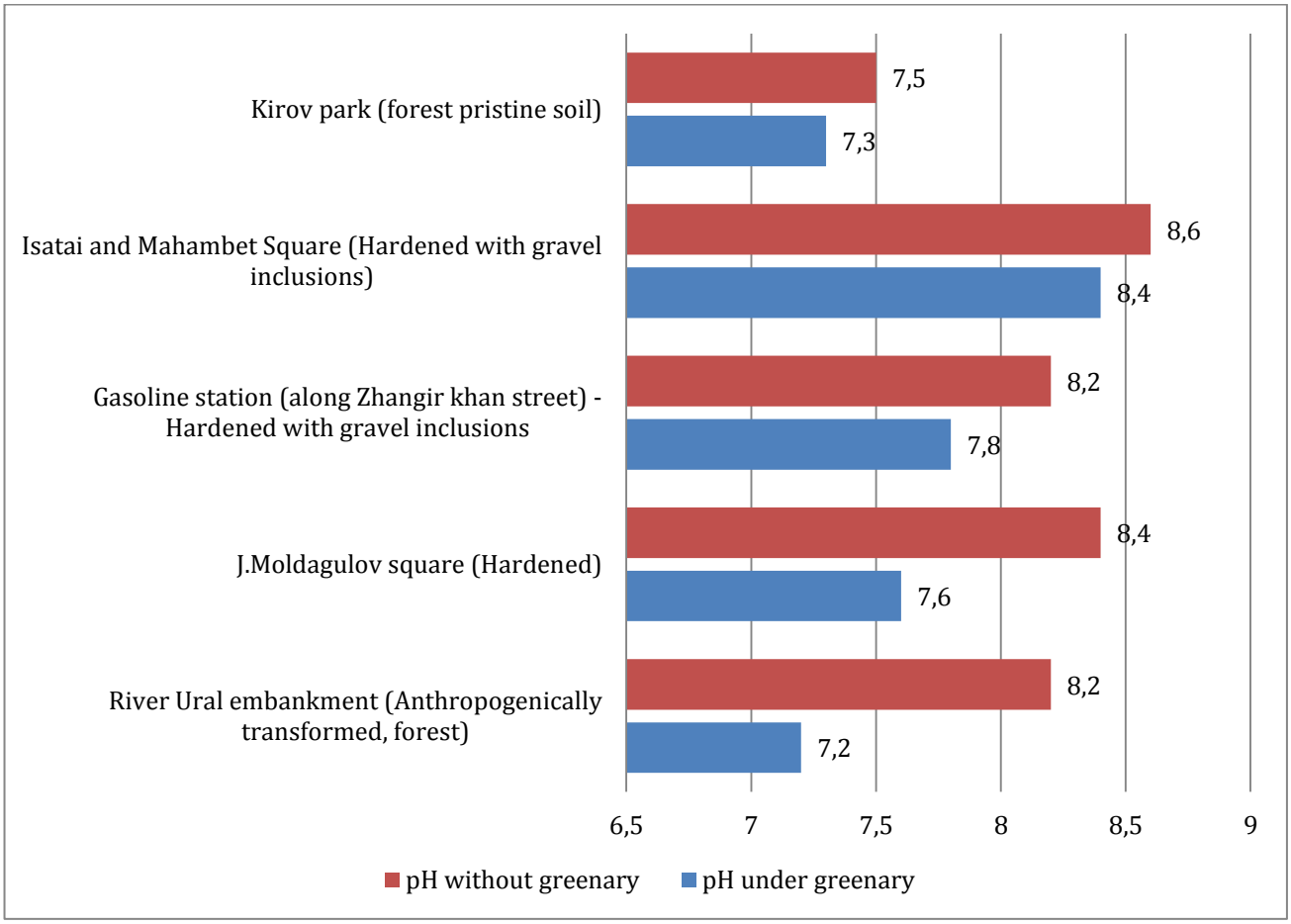

Fig.1 - Actual soil acidity

The indicators of biological activity are occurred to be highly informative in the assessment of soil condition. The indicators of biological activity are shown in figure.1

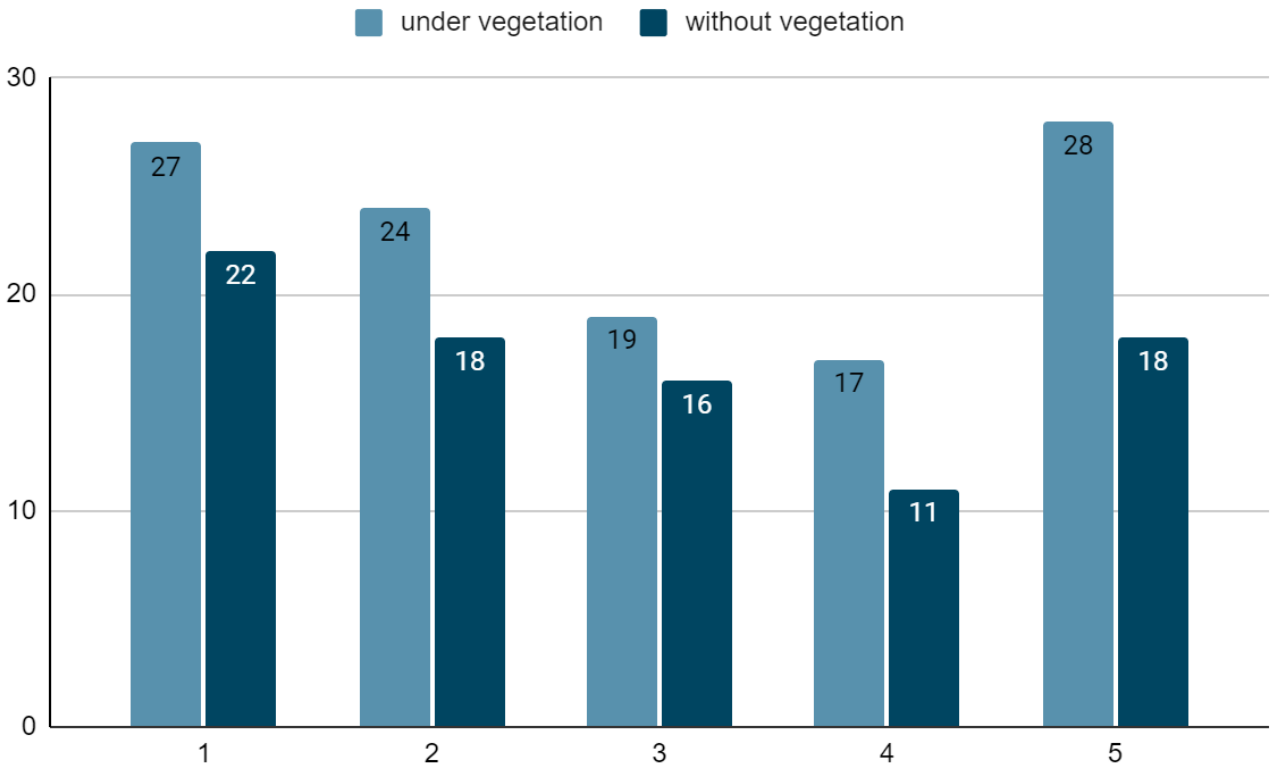

Fig.2 - Cellulose activity (change in weight of cellulose materials).% in soil layer 0-20 cm

The obtained results have shown natural increase in cellulose activity under vegetation cover. A high percentage of flax tissue decomposition was recorded in the Kirov Park, probably due to favourable conditions for nutrients.The correlation coefficient r = 0.78 shows a relatively good correlation between the values studied: cellulose soil activity and pH.

The distribution of heavy metals in the soil of urbanized areas of the city showed exceedance of the MAC for lead, manganese and cobalt (Figure 3).

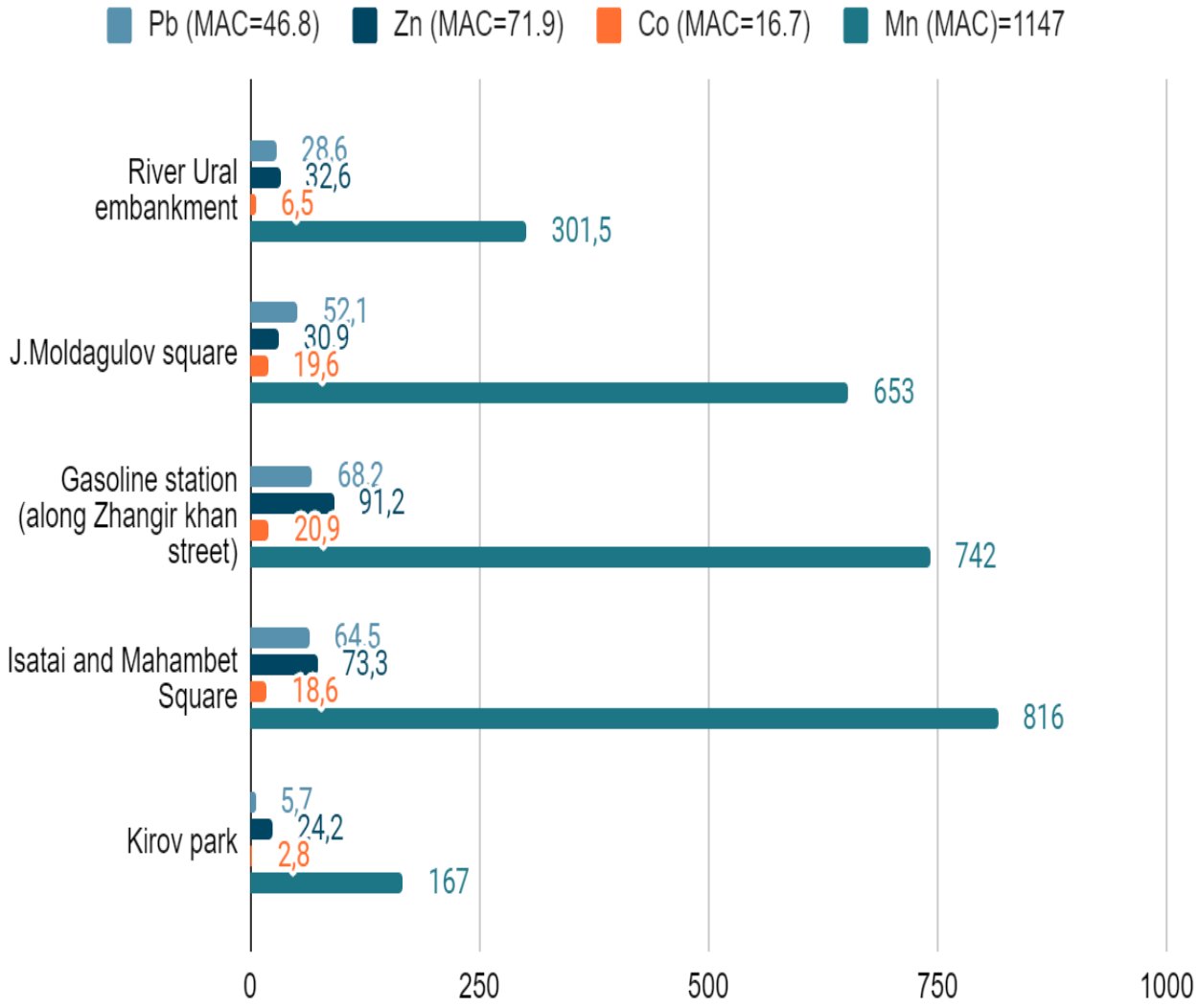

Fig. 3 - Average concentration of Lead, Manganese, Cobalt in soil

Sites close to roads and potential pollution sources showed exceedances for lead, zinc and cobalt (32%, 14% and 12% of total exceedances). There is a risk of further concentration of heavy metals at the investigated sites.

Clearly defined limit concentrations for petroleum products in Kazakhstan have not been established yet. During describing the extent of pollution at the sites, approximate concentrations of petroleum products were used. The results of a survey of the oil content in the sites under investigation showed an excess of petroleum products presence at the Isatai and Mahambet gasoline station (figure 3).

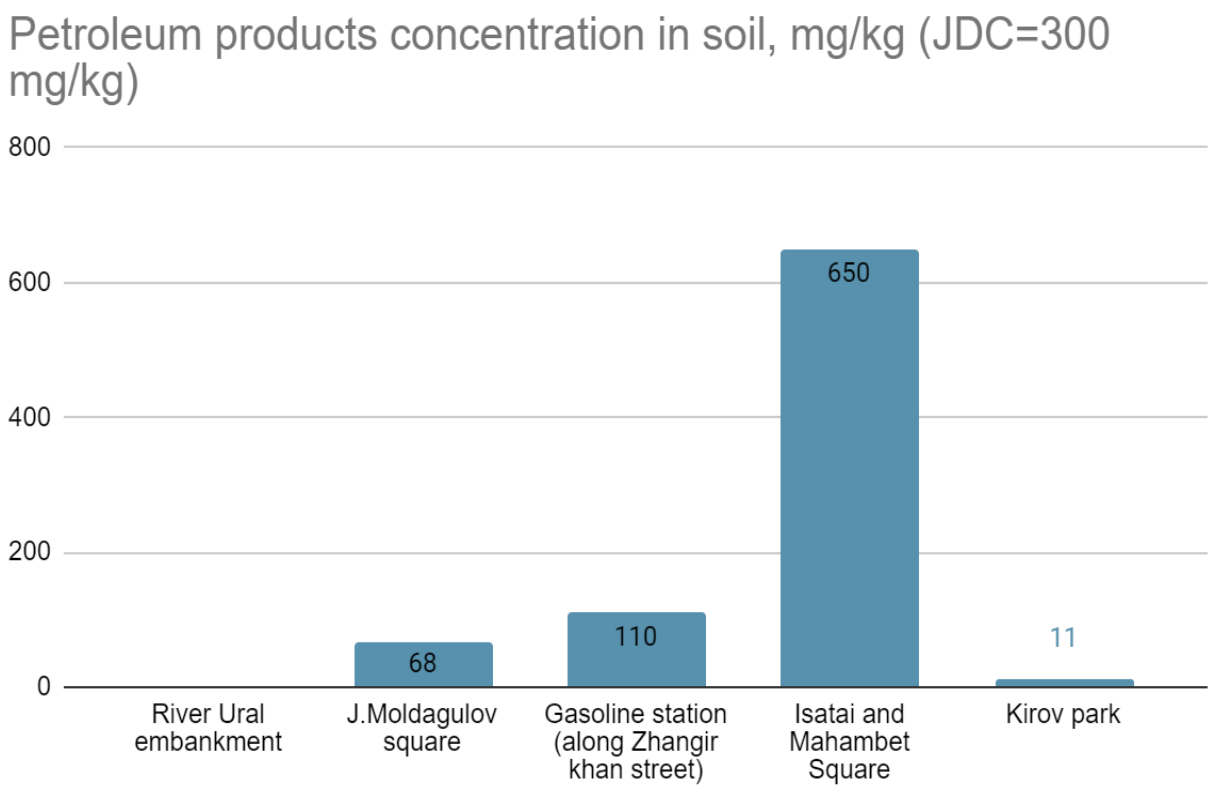

Fig. 3 - Petroleum products concentration in soil, mg/kg (JDC=300 mg/kg)

Conclusions.

1.Studies carried out in different parts of the city and experiencing long-term urban press has shown approximately the same levels of contamination;

2. Soil condition on heavy metals presence show an increase in their maximum allowable concentrations within the «urbick» layer;

3. Integrated soil biological measures are indeed highly informative and may be useful in the diagnostic of urbanized soils;

4. Areas with a smaller area than parkland areas, namely recreation squares, have proved to be more sensitive to pollution and anthropogenic pressure

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