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ENVIRONMENTAL ASSESSMENT OF THE IMPACT OF TECHNOGENIC FACTORS ON THE SOIL MESOFAUNA OF THE SOUTH-EAST OF KAZAKHSTAN AND DEVELOPMENT BIOINDICATIVE AND INDICATIVE FACTORS

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ABSTRACT

A lot of research is devoted to soil fauna, which is especially harmful on cultivated lands, and its changes with different methods of cultivating cultivated plants. The patterns of changes in the mesofauna on the dry and irrigated lands were studied. The experiment, in contrast to the available works in the scientific literature, will be based on the study of the impact of technogenic factors on the mesofauna of soils in southeast Kazakhstan. Studying the soil mesofauna will make it possible to solve many cardinal problems of systematics, phylogeny, evolutionary patterns, and other issues of soil zoology. The abundance and distribution of individual groups of the soil population is significantly affected by such indicators of the soil environment as the thickness of the litter and the content of humus in the soil. There is a tendency to positively correlate the characteristics of soil zoocenosis with soil moisture. pH and soil temperature, but their influence is significant only for certain groups of mesofauna, such as earthworms of the genus *Lumbricus*, larvae of dessert beetles, weevils and clickers. The significance of all factors considered is different for different representatives of soil invertebrates. The results showed accumulation of heavy metals (Zn, Pb, Cd, Cu) in the soil of southeastern Kazakhstan (Saimasai village) that cadmium representatives of the soil mesofauna accumulate in these quantities in the smallest amounts. The revealed features of the accumulation of HM in soil in the territory of the village of Saimasai indicate that the lead-zinc association is characteristic of the residential area, and the lead-cadmium association is characteristic of Sadovaya and Rysbekov streets, Pb (residential and Rysbekov) and Cd (Sadovaya) occupy a leading position. The geochemical series (Kc) of the accumulation of toxic elements of hazard classes 1 and 2 in the soil of the Saimasai village was established: Pb30> Cd20> Zn15.8> Cu1.7. Thus, the conclusion is made that the absence of the overall Saimasai soil pollution coefficient (64.5) reflects a high level of pollution in accordance with the generally accepted gradation of urban pollution, that is, dangerous levels of pollutants, in particular heavy metals.

Keywords: bio indicators, environment, macrofauna, mesofauna, soil.

INTRODUCTION

Soil fauna is studied in detail by scientists Y. Jianga *et al*. (2018). Extensive research is available on the distribution of selected groups of soil animals by foreign researchers G. Xu *et al*. (2020). N. Yorkina (2016) studied the impact of technogenic pollution of urban environment on vitality indicators of urban biota. Bioindicative assessment of the ecological condition of the urban ecosystem was performed based on viability parameters of epiphytic lichen flora, soil mesofauna, and freshwater mollusk fauna. Analyzing the toxic effects of various pollutants on living organisms and tolerance of some bioindicator species under anthropogenic pressure it was found that the amount of zoophages increases and homogenization of anamorphoscope composition of major mesopedobionts groups with the dominance of individual species is observed in anthropogenically transformed areas. In alkaline soil functional zones of the urban ecosystem is marked by the predominance of calcicole species such as millipedes, mollusks, gastropod mollusks, which allows their use as indicators of alkalinity of soils.

D. García-Segura *et al.* (2018) investigated the impact of total petroleum hydrocarbons contamination on the soil fauna comparing the macro and mesofauna from a non-contaminated soil to a moderately and highly polluted soil caused by oil extraction. Mesofauna density was considerably higher in temperately polluted soil than in the control soil and the macrofauna were more slightly abundant at the most polluted areas. Both meso- and macrofauna were more diverse in moderately contaminated soil in the diversity indices. The mesofauna groups were more sensitive to TPH as there was a strong change of their proportions from non-contaminated soil to highly-contaminated soil.

R.J. Payne *et al*. (2012) examined the response of groups of microfauna (*testate amoebae*), mesofauna (*enchytraeid worms*) and plants to ammonium nitrate application in the long-term experiment. The data showed significant differences between treatments, in particular described by a loss of bryophytes in nitrogen-treated sites, on the contrary *enchytraeids* showed a non-significant increase in abundance in response to treatment. *Testate amoebae* showed no significant changes in abundance or inferred biomass but significant changes in community structure with a reduced abundance of *Corythiondubium*, interpreted as a response to the loss of bryophytes.

Authors suggested that simple indices of plant community may have value for bioindication while the bioindication value of testate amoebae and enchytraeids is not clearly demonstrated.

Assessment of soil biological degradation using mesofauna were conducted by comparing the deviation of one multivariate and two univariate indicators in intensely used arable sites from benchmark sites by J. Bedano *et al.* (2011). According to authors three bioindicators were efficient to assess soil biological degradation. Particularly, the OM/PA ([Oribatida + Mesostigmata]/[Prostigmata + Astigmata]) index and the multivariate indicator were effective in discriminating between the benchmark and the intensively managed sites and in distinguishing soil degradation levels among intensively managed sites.

J. Wahl *et al.* (2012) used soil mesofauna as bioindicators to assess environmental disturbance at a platinum mine in South Africa. The tailings material containing high levels of Cu, Ni and Cr had the greatest influence on the MP (*Mycophagous group*), SO (*Saprophagous Omnivorous*) and MBM (*Mycophagous Bacteriophagous Microalgaevorous*) functional groups of soil mesofauna. The factors such as the lack of high concentration of Co found in the surrounding soils, very low organic matter content and a very uniform structure in the surrounding soils not only make it different from the surrounding natural soils, also make it inhospitable for soil mesofauna to colonize. The authors concluded that mesofauna communities could therefore be used as bioindicators to assess environmental disturbances in South Africa based on the number of species and organisms present in the soil.

S. Yan *et al.* (2012) developed a soil quality index that takes into account the abundance and is not limited to microarthropods. The described index, which they called FAI, is based on taxonomic diversity and functional features. To develop the FAI estimate, they used both simulated and real data sets from different geographical regions and selected two valuable taxonomic independent functional features: morphological adaptive differentiation and niche width. In conditions of intensive environmental impact, including on the soil, human production activity becomes important for predicting changes in ecosystems caused by it, in particular the course of the soil formation process. Using data from soil and Zoological studies, it is possible to determine the degree of impact on ecosystems during agricultural and forestry activities and assess the impact of environmental pollution from industrial waste, heavy metals, pesticides and radionuclides.

Soil mesofauna for assessment of soil ecosystem and biodiagnosis were studied by Z. Tukenova *et al.* (2018), soils were carried out by us according to a classification based on the trophic connection and habitat of soil invertebrates. The investigated soils have a different level of biological activity, are determined by the amount of invertase and dehydrogenase and are located in the following series: black earth low-humus = dark chestnut> grey earth ordinary.

The novelty of our research in contrast to the existing works in the scientific literature will be based on the study of the impact of anthropogenic factors on the mesofauna of soils of South-East Kazakhstan. The study of the soil mesofauna will make it possible to solve many fundamental issues of systematics, phylogeny, evolutionary laws and other issues of soil zoology.

The aim of the research is to study the impact of anthropogenic factors on the dynamics of soil mesofauna in the South-East of Kazakhstan with the development of biodiagnostic and indicative indicators.

EXPERIMENTAL PART

To achieve this goal, the following research methods were used:

- work on the inventory of technogenic factors in the South-East of Kazakhstan (Almalybak village, Saimasai village, Almaty region).
- determination of soil contamination by physico-chemical methods with heavy metals and POPs).
- determination of accumulation and migration of pollutants in the soil and in the body of representatives of the mesofauna (according to C. Menta (2012)).

The comparative analytical method will allow to establish the peculiarities of the formation and migration of soil fauna along the soil profile in the conjugate connection with changes in other soil properties. The combination of relatively geographical and comparative analytical methods will reveal the features of the profile distribution of soil mesofauna in the physical and geographical aspect.

Soil-forming invertebrates are an important link in soil-forming processes and carry out mainly primary processing of organic matter. In addition, due to their activity aeration of soil is improved; its moisture permeability increases and other processes important for soil formation are stimulated. The study of soil mesofauna is important for diagnostic purposes and provides a unique opportunity to judge the evolution or degradation of soils under the influence of human activities.

Soil samples for physicochemical, physical properties and biological studies were selected in layers by a continuous column of 10 cm to a depth of 40 cm. Below 40 cm there is a lack of soil-forming invertebrates, which determined the lower limit of sampling.

In terms of experiments, soil samples are selected in layers at depths of 0-10; 10-20; 20-30; 30-40 cm in three terms (spring-May; summer-July; autumn-September). Soil samples determination by conventional methods - moisture - by the gravimetric method, total humus - by O. Zaiets and R.M. Poch (2016); specific gravity - by the pycnometric method; bulk mass using Kachinsky drill; general porosity - by the calculation method, to determine biological indicators: soil mesofauna - the method of manual disassembly (Gilyarov 1965).

In soil samples, the determination was carried out according to generally accepted methods: humidity - by the gravimetric method; total humus; specific gravity - by

the pycnometric method; bulk weight using Kachinsky drill; total porosity - by calculation method; for the determination of biological indicators: soil mesofauna (Gilyarov 1965).

The importance of the work lies in the fact that data on the assessment of the current state of the ecosystems and soil mesofauna of the South-East of Kazakhstan can serve to maintain the soil structure with the participation of soil fauna, which is especially important in restoring degraded soils and disturbed ecosystems.

RESULTS AND DISCUSSIONS

Soil invertebrates play an important role in the decomposition of plant residues, the transformation of organic material, the formation of the humus horizon and the improvement of soil structure, the cycle of nutrients and the maintenance of homeostasis of the soil biota as a whole. As bioindicators, it is especially convenient to use large soil invertebrates (mesofauna), which can be easily taken into account by manual disassembly of soil samples. It is not by chance that in recent years, works on the inventory of the biodiversity of the soil mesofauna, the study of its taxonomic and species diversity, population structure, spatial and temporal dynamics and resistance to various factors began to appear more often.

In Kazakhstan, mesofaunistic studies are fragmented, while scientific knowledge of the problem of managing modern soil-forming processes and increasing soil fertility in Kazakhstan requires a systematic study of soil fauna in conjunction with physiographic, pedo-ecological and human factors.

The poor knowledge of the soil mesofauna of the soils of the southeastern Almaty region, the enormous role of soil invertebrates in the utilization of organic matter and humus formation, maintaining the circulation of biogenic elements, and the possibility of using them as bioindicators of the state of soil biota largely determined the goals and objectives of our research. Most of the Almaty region belongs to the subzone of chestnut soils.

Meadow-chestnut soils are (Saimasai village), in the overwhelming majority of light mechanical composition, mainly light loamy and sandy loam, and in the southern region sandy.

Light-chestnut soils are (Almalybak village) light mechanical composition up to sandy, or crushed and undeveloped.

The peculiarity of the soil cover of the region, consisting in the predominance of soils of light mechanical composition contributed to the development of the phenomena of wind erosion. At present, due to the massive use of soil-protection farming systems these phenomena are largely prevented.

Soil formation occurs here on rough alluvium, representing the result of weathering of ancient bedrock of various ages.

The essence of the process of soil formation is the transformation of the movement of substances and energy in the soil column, occurring under the influence of organisms, as well as factors of the hydrosphere and atmosphere. As a result, a soil profile is formed with different levels of natural fertility.

Soil Mesofauna Distribution in the South-East of Kazakhstan

Soil richness by soil invertebrate depends on the type and variety of soil, on natural conditions and human activities. Their role in soil formation is exceptional great. They are the active factor, the activity of which involves the processes of decomposition of organic substances and their transformation into soil humus. Soil invertebrates assimilate atmospheric nitrogen. They secrete biological substances necessary for the synthesis of enzymes and proteins, which are the most active factor in the biological circulation of substances. Their activity affects the supply of plant nutrients to the soil solution and, consequently, soil fertility.

Meadow-Chestnut Soil (Saimasai Village, Almaty Region)

Meadow-chestnut soils in comparison with light-chestnut soils have maximum mesofauna activity, which is associated with relatively high humus content, microflora richness, favorable water physical properties of the soil, in particular, high water strength, structure and porosity. The decrease in mesofauna in the lower horizons is associated with the distribution of the profile, as well as high carbonation and alkaline reaction of the medium, which suppresses the vital activity of soil organisms.

In the study of the mesofauna of soils, we have established a height-zonal pattern in the formation of a complex of soil-inhabiting invertebrates expressed in an increase in the number and group composition of the mesofauna when moving from light chestnut to meadow chestnut.

So, the dominant species on meadow-chestnut soils are the earthworms *Lumbricus* and the ants *Formicidae*. The most numerous are larvae from the families *Carabidae, Tenebrionidae*. Small amounts are from the family of lamellar *Scarabaeidae* and staphylinide *Staphylinidae*.

Light Chestnut Soils (Almalybak, Almaty Region)

Light chestnut soils on biological activity occupy the second place after meadow-chestnut soils. It should be noted that in light chestnut soils there is a slight decrease in the activity of mesofauna in comparison with meadow-chestnut soils, which is associated with a longer summer drying of the soil at high temperature and aeration. The greatest activity of the mesofauna is observed in the upper layers, decreases with depth. While in meadow-chestnut soils, the decrease in the number and group composition of the mesofauna proceeds gradually, in light-chestnut soils it decreases dramatically, this is due to the fact that light chestnut soils are less rich in organic matter than meadow-chestnut, so the number and species composition of the mesofauna in them decreases.

There are the same groups of soil invertebrates as in black soil, but in smaller quantities. Earthworms *Lumbricus* (80 ind./m^2) as in the chestnut meadow

dominate. Scarabs *Scarabeidae,* click beetles *Elateridae,* darkling beetles *Tenebrionidae* are subdominate. Among the weevil larvae Curculionidae prevail Sitona F. (12 copies m^2).

The results of our research have shown that the common species are insectlarvae from the family - *Carabidae, Scarabaeidae, Elateridae, Formicidae*, since these species have plasticity (ability to dwell in various biotopes). The dominant species are insect larvae - *Formicidae, Scarabaeidae.*

It is revealed that soil animals act as an indicator of the ecological state of the soil. If at least one condition changes in the range of conditions of an ecological standard of a species, the species immediately reacts to this by changing the number of individuals, which can be fixed by simplest methods.

Species that are part of a particular eco-group behave differently with respect to individual soil properties. And, therefore, the presence in one part of the catena (a chain, a continuous series, a regular sequence) of a specific set of species is determined by their adaptability to any common leading factor. This makes it possible to use pedobionts in the biological indication of soil types.

Thus, the larvae family *Staphylinidae* are rather hygrophilic, and therefore soil moisture is a factor limiting its distribution in xerophytic conditions, namely in the area of technogenically polluted lands.

Wireworms from thespecies of the genus *Tenebrionidae* are found only on meadow-chestnut soils. Their high abundance in the soil correlates with a high content of humus and a good structured soil, which is not observed in the area of technologically polluted lands.

Determination of the Accumulation and Migration of Pollutants in the Soil and in the Body of Representatives of the Soil Mesofauna of South-East Kazakhstan

The main source of threat to the environment are thermal power plants using outdated technologies of dust and gas cleaning, highways and much more. The main pollutants of the air basin of Almalybak village are emissions of the boiler house; emissions from the operation of road equipment; emissions associated with electricity consumption.

Anthropogenic stressors occur at such a rate that biological systems do not have time to adapt to them (Israel 2004), however, their biological characteristics change under the influence of all factors (Kozlov 2000; Krivolutsky *et al*. 2002). One of the most toxic substances that enter the biosphere in the results of human production activities can be attributed to heavy metals. In small quantities, they can be found in every body, but a significant increase in their concentration can lead to death of animals. Heavy metals accumulating in the soil and litter, in plants and animals, also in the human body, causes poisoning and disease (Motyl 2007). The role of animals in biogenic migration of substances in terrestrial ecosystems has not been sufficiently studied. The activity of animals in biogeocoenosiscan be considered as a factor regulating this biogenic cycle (Payne *et al.* 2012).

The block of soil-litter invertebrates is characterized by an early reaction to the pollution of their habitat by heavy metals. It is known that representatives of mesofauna act as their active storage (Pokarzhevskii 2005). Of particular interest is the migration of trace elements along the trophic chains of these animals and other consulates, both to determine their resistance to toxicants and to identify loads on the ecosystem as a whole (Wahl *et al*. 2012). So, for insects representatives of the mesofauna, the concentration of heavy metals in food is one of the main factors that determines their content in the body of the animal. In most cases, the absorption of toxic trace elements in it occurs through the intestines. Subsequently, there is a redistribution of all parts of the body. Studies on the accumulation of heavy metals by soil-litter vertebrates were carried out near the above pollutants.

The content of heavy metals in invertebrates was carried out using the method of atomic absorption spectrophotometry on the AAS-30 spectrophotometer according to the standard technique (Yorkina 2016). The analysis results were calculated by the formula: $C=C_oV/P$, C_o-is the element content in the test solution; V - is the volume of the solution, ml; P - sample weight, g.

Over 60 samples were prepared for atomic absorption analysis. The samples analyzed the content of elements such as Cu, Pb, Cd, Zn, which are priority pollutants for the study region. In addition, the content of heavy metals in the upper soil horizon - litter was investigated.

It is known that macro- and microelements enter the body of animals and bioaccumulate in them in the feeding process. Therefore, the features of accumulation of heavy metals in invertebrates not only at the taxonomic, but also at the trophic level are of great interest.

The structural and functional composition of the representatives of the soil mesofauna is diverse and includes representatives of zoophages, phytophages and saprophages. Representatives of each trophic group inherent in a specific way of nutrition.

Invertebrates that inhabit the upper soil horizon - litter, are closely associated with plants that, like animals, accumulate heavy metals and are the object of nutrition for representatives of phytophages. On the other hand, they are associated with litter, which performs barrier functions in the way of toxicants entering the soil, being not only the habitat of the studied group of animals, but also the object of destructive influence of saprophages. During the studies, we have registered representatives of Carabidae, Scarabaeidae, Elateridae, Formicidae in which the content of heavy metals was determined.

Representatives of each functional group accumulate heavy metals in different amounts. Certainly, the highest content in representatives of all functional groups of trace elements of biogenic originare Cu, Zn, Pb, Cd. It was revealed that such highly toxic elements as Cd, Pb accumulate in invertebrates in a much smaller amount.
There were no significant differences in the accumulation of copper by representatives of all trophic groups. Each of the three trophic groups of soil invertebrates accounts for

32.9-36.1 % of this element from its content in the studied groups of soil invertebrates. While the share in the accumulation of zinc in representatives of zoophages and saprophages is 34.4-35.1%, then phytophages in comparison with them accumulate it 1.14-1.16 times less. One of the toxic elements that have the most negative impact on the livelihoods of representatives of the mesofauna is lead. This element is accumulated in the largest quantity by representatives of zoophages- 1.14 times more than phytophages and, in turn, 1.19 times more than saprophages. Cadmium is accumulated in the largest quantity by representatives of saprophages - 54.5% of the total soil content in the mesofauna, and in the smallest one - zoophages 6.9%. A comparative analysis of the content of heavy metals in representatives of various functional groups of invertebrates shows that cadmium, compared to all trace elements, is accumulated by animals in the smallest amount (1.1-9.1 mg / kg dry weight) (Table-1).

Table-1. Table - Accumulation of heavy metals by representatives of soil invertebrates of various functional groups on the highway (mg/ kg dry weight).

Functional groups	Cu	Zn	Pb	Cd
Phytophages	492,3	1816,6	147,3	6,5
Zoophages	523,6	2058	165,8	1,7
Saprophages	571,9	2104,1	89,5	9,1

In connection with the above, the importance of these groups of invertebrates in the migration of heavy metals along food chains, including vertebrates, cannot be overestimated. In the future, it is necessary to continue monitoring studies of migration of heavy metals in biogeocenoses, including trophic networks. And also, to identify the main factors that determine the processes of bioaccumulation and biomagnification. The obtained data can be used for bioindication and monitoring studies of environmental pollution both in the region and abroad.

Accumulation of Heavy Metals (Zn, Pb, Cd, Cu) in Soil of South-East Kazakhstan (Saimasai Village)

This section reflects the results of the analysis (voltammetric inversion method) of heavy metals (HM) in the soils of Saimasai village. Samples were taken from two conditionally allocated residential areas: (Sadovaya St. and Rysbekov St.). The analysis revealed an uneven distribution of zinc in the soil; the data obtained are presented in Table-2. The average value of zinc accumulations in the soil of Sadovaya St. is 15.64 mg/kg; the interval is from 0.63 to 72.90 mg/kg.

Table-2. Zn content in soils of the Saimasai village of Almaty region.

Area	$\bar{x} \pm S\bar{x}$ / lim, mg/kg	V, %	Cs
Residential Area	19,7±1,1 / 1,25-72,9	105,6	19,66
Sadovaya Street	8,9±1,2 / 0,63 – 36,3	78,4	9,0
Rysbekov Street	8,9±1,4 / 1,99 -19,4	59,0	8,9
Note - lim - fluctuation limit, - arithmetic mean and its error, Cs - concentration coefficient, background - 0,99±0,05 mg/kg			

According to the magnitude of the concentration coefficient (K_c) of zinc, the studied areas in the territory of Saimasai village form the following series of decrease: residential area 19, 66>Sadovaya St. 8.93>Rysbekov St. 8,89. According to the gradation of A. Ilyin (2004) the values of K_c indicate the presence of the most specialized zinc complexes in all the examined areas. V (%) values reflect the poorly differentiated distribution of the element in the soil of Rysbekov St., differentiated - on Sadovaya St. and intensively differentiated - on residential territory.

The soil of the residential (19.66 mg / kg) zone more than doubles in Zn as compared to Sadovaya St. (8.93 mg / kg) plots. A significant excess of the background indicator is noted for all zones: residential - 20 times, ul. Sadovaya and Rysbekova - 9 times. The average excess of soil pollution in the city over the background indicator was 16 times.

Thus, the increased accumulation of zinc in the soil grounds of the Saimasai village is due to its proximity to the source of pollution and local climatic and geographical factors (terrain, rainfall, wind rose).

Accumulation of Pb in the soils of Saimasai village. The range of lead content is shown in Table-3. In the studied areas of the urban environment, the following series of decay K_c is determined: residential area $_{33.5}$> northern industrial zone$_{22.9}$> eastern industrial zone $_{18.8}$.

Table-3. Pb content in the soils of different zones of the Saimasai village of Almaty region.

Area	$\bar{x} \pm S\bar{x}$ / lim, mg/kg	V, %	C_s
Residential Area	8,1±0,9 / 0,5 – 36,2	107,2	33,5
Sadovaya Street	5,5±0,8 / 1,1 – 24,9	100,8	22,9
Rysbekov Street	4,5±0,4 / 1,0 – 11,0	78,6	18,8
Note - lim - fluctuation limit, - arithmetic mean and its error, C_s - concentration coefficient, background - 0.24±0.04 mg/kg			

The values of the coefficient of variation (V, %) reflect the poorly differentiated distribution of the element

in the soil and the intensively differentiated - over the residential area and Sadovaya Street, i.e. Lead distribution in the Saimasai village territory is uneven, spotty.

In quantitative terms the excess of lead in the soil relative to the background is maximum for the residential zone (33.5 times), lower for Sadovaya St. (22.8 times) and Rysbekova St. (18.7 times). On average, the excess of soil contamination of the residential zone by lead (8.05 mg / kg) of Sadovaya and Rysbekov Streets (4.98 mg / kg) is 2 times.

According to the value of cadmium concentration, the studied areas on the territory of Saimasai form the following series of descending: Sadovaya street 55>Rysbekov street 16> residential area 3 (Table-4).

The Cd content in the soil grounds of Sadovaya and Rysbekov streets is higher than in residential areas - by 18.3 and 5.3 times, respectively, and on average - by 11.5 times.

Table-4. The Cd content in soils of different zones of Saimasai village of Almaty region.

Area	$\bar{x} \pm S\bar{x}$ / lim, mg/kg	V,%	Cs
Residential Area	0,030±0,002 / 0,01 – 0,89	401,6	3
Sadovaya Street	0,60±0,02 / 0,01 – 8,24	274,3	55
Rysbekov Street	0,16±0,01 / 0,01 – 1,32	221,9	16
Note - lim - fluctuation limit, - arithmetic mean and its error, Cs - concentration coefficient, background - 0.01± 0.001 mg/kg			

Cu accumulation in soils on the territory of Saimasai village of Almaty region. The range of Cu content in soil is shown in Table-5. Copper accumulation in residential (6.2 mg/kg) and Rysbekov street - at the same level, but higher than on Sadovaya street (4.6 mg/kg) by 1.3 times.

The Cu content in the soils of the residential zone is higher than the average for the studied areas (Sadovaya street and Rysbekov street) (5.2 mg/kg) by 1.2 times. The coefficients of variation indicate a uniform distribution of copper in the soil of Rysbekov street and the focal nature of the accumulation of the element on Sadovaya street and residential areas.

The level of accumulation of copper in soils at investigated sites Saimasai village reflects the geochemical range: residential area$_{6,20}$> St. Rysbekov$_{5,85}$> St. Sadovaya$_{4,62}$.

Table-5. Cu content in soils of different zones of Saimasai village of Almaty region.

Area	$\bar{x} \pm S\bar{x}$ / lim, mg/kg	V, %	Cs
Residential Area	6,2±1,1 / 0,1 – 89,5	211,3	2,2
Sadovaya Street	4,60±0,06 / 0,1 – 13,2	85,9	1,6
Rysbekov Street	5,90±0,09 / 0,2 – 9,3	45,5	2,1
Note - lim - fluctuation limit, - arithmetic mean and its error, Cs - concentration coefficient, background - 2,8 ±0,25 mg/kg			

Another center of copper is located in the eastern part of the Saimasai village around the motorway. Its boundaries do not capture the residential zone.

CONCLUSIONS

Thus, the abundance and distribution of individual groups of the soil population is significantly influenced by such indicators of the soil environment as litter thickness and humus content in the soil. There is a tendency of a positive correlation of the characteristics of soil zoocenosis with soil moisture, soil pH and temperature, but their influence is significant only for certain groups of the mesofauna, such as earthworms of the genus *Lumbricus*, larvae of dessert beetles, weevils and clickers. The significance of all the factors considered is different for different representatives of soil invertebrates.

Common species are the larvae of insects from the family - *Carabidae, Formicidae*, since these species have plasticity (ability to live in a variety of biotopes).The dominant species are insect larvae - *Formicidae*, since these species have plasticity (ability to live in various biotopes).

Accumulation of heavy metals by representatives of various trophic groups of soil invertebrates is not unique. It is established that cadmium representatives of the soil mesofauna under these conditions accumulate in the smallest amounts.

The identified features of the accumulation of HM in the soil on the territory of the Saimasai village indicate: the lead-zinc association is characteristic of the residential area, and the lead-cadmium association is characteristic of Sadovaya and Rysbekov streets, Pb (residential and Rysbekov) and Cd (Sadovaya) occupy a leading position.

The geochemical lead-zinc regional specificity of soil contamination in the Saimasai village has been established, which is confirmed by a high correlation relationship (r0.75).

The geochemical series (K_c) of accumulation in the soil of the Saimasai village of toxic elements of hazard class 1 and 2 is established: Pb_{30}> Cd_{20}> $Zn_{15.8}$> $Cu_{1.7}$. The total pollution coefficient for the soil of Saimasai (64.5) reflects the high level of pollution in accordance with the

generally accepted gradation of urban pollution, i.e. hazardous levels of pollutants, in particular heavy metals.

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