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Issue Article

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ECOSYSTEM STUDIES AND REMEDIATION OPPORTUNITIES

Abstract: *In Georgia, as well as in the South Caucasus region as a whole, it is an urgent necessity to conduct environmental and eco-expert studies according to threats and challengesusing respective utilizing and neutralizing systems. Agricultural soils of the Kakheti region were studied, which implies the classification of soil structure, mechanical division of organic matter by its percentage content, investigation of the cation exchange capacity (CEC), mobile, soluble forms of heavy metals and nutrients. A liquid stimulator was used, which ensured the binding-accumulation process of excessive heavy metals in the soil up to the maximum allowable contamination (MAC). The soils of the Kakheti region were found to be moderately and heavily clayey, and black soil types with the medium and high fertility growth rate. Their excessive content of calcium, iron, sodium, nitrogen and phosphorus can be supposedly explained by the overuse of chemical fertilizers. It is established that mobile-soluble forms of heavy metals (lead, copper, zinc) in the soil exceed MAC. Research work was carried out using such physic-chemical research methods as atomic-absorption, X-ray fluorescence, the EPA TCLP and WET test standards, and quantitative-chemical analysis.*

Key words: *ecotoxicology, heavy metals, TLV, research methods, remediation, pesticide, leaching.*

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Introduction

The modern scale and pace of anthropogenic changes in nature can initiate irreversible processes in the environment, which can be avoided only if we know all the processes taking place in ecological systems.In addition to ecological monitoring, ecological expertise and ecological modeling are used in the provision of environmental systems. Ecological expertise is a special type of ecological research and is aimed at assessing the impact of industrial-economic and other types of facilities on the environment, natural resources, and human health. Eco-expertise, as a systematic study of the problem, is equal to 1 percent of the export value, but these costs are incomparably small compared to the costs that the country bears to eliminate the consequences of wrong decisions, as well as those that threaten people's lives and health [1].

Experimental part

The basis of our research was a comprehensive survey of the agricultural soil of one territory of Georgia, the Kakheti region, in order to determine what threats and challenges faced thisterritory distinguished by amazingly abundant harvests.38 percent of Georgia's agricultural land is in Kakheti, where arable lands and pastures occupy the largest area. Climate: generally, dry subtropical. Soils: pH=6-7; mostly carbonated humus with moderate, amorphous iron content; salting and carbonation are also characteristic of them. Harvest: cereals – maize/corn; vegetables –potatoes, cucumbers, tomatoes; fruit – grapes, strawberries. Up to 20 soil samples on agricultural land plots of different purposes of the private sector have been studied. It is known that the ratio of air and water creates the structure of the soil. Degraded humus indicates a hardened layer of formed in the upper part of humic substances (HS), a violation of the soil structure. If the water permeability, moisture, aeration of the soil is disturbed, the soil is found exhausted (C: N=25-30:1).

As a result of studying the soils of Kakheti, the classification of the soil structure (acidity, total organic matter, humus, density, type, porosity, moisture content) has been established. By the composition, the soils of Kakheti region represent moderately and heavily clayey, and black soil types with the medium and high fertility growth rate, without the risk of degradation. Organic substances in the soil were determined by mechanical division - percentage contents of sand, silt, clay, silt, which is one of the components for determining the soil type.The study of cation exchange capacity (CEC) in the soil plays a very important role. It is a very important soil property influencing soil structure stability, nutrient availability, soil pH and the soil's reaction to fertilizers and other ameliorants.

The soils of Kakheti have also been found to contain excess calcium, iron, and sodium. An excess of nitrogen and phosphorus was also revealed during the NPK study [2; 3]. In terms of agro-ecotoxicology, the EPA TCLP and WET test methods were used, which means the processing of mobile-soluble forms of heavy metals in the soil, for their further instrumental determination.As a result of the research, the content of heavy metals exceeding MAC (lead - 3 times, copper - 0.6 times, zinc - 1.5 times) has been determined. Based on the liquid stimulator produced by us, the content of heavy metals can be reduced to MAC, which excludes the risk of their transfer from soil to the green cover and plant products.

Below are the results of the soil sample analysis in the form of a table.

Table 1. Results of analysis of agricultural soils

Kakheti Region	**Classification of soil structure**								
	Overal organic matter,%	**Hunus, %**	**Density, cm^3**	**Soil type**	**Porosity, %**	**Water-holding**			
	10,12	**4,70**	**1,5-2,0**	**Moderately & heavily clayey**	**45-50**	**60**			
	Percentage of organic matter in soil								
	Sand %		**Fiane sand %**		**Clay %**		**Silt %**		
	9,9		**10,10**		**61,5**		**18,12**		
	CEC								
	Ca mg/100	**Mg mg/100**	**Na mg/100**	**Total:**	**From the sum of adsorbed bases, %**				
					Ca	**Mg**	**Na**		
	15,7	**7,0**	**1,35**	**24,05**	**66,0**	**33,0**	**5,6**		
	Content of nutrients in the soil								
	pH	**N mg/100**	**P_2O_5 mg/100**	**K_20 mg/100**	**Fe %**	**S %**			
	6.5	**6**	**5**	**26**	**6**	**0.02**			
	Heavy metalsmg/kg								
	Pb	**Cd**	**Cu**	**Zn**	**Mn**	**Ni**	**Ti**	**As**	**Sb**
	0.6	**Trace**	**40**	**4**	**0,01**	**0,08**	**0,05**	**----**	**----**

The presented table clearly shows that the soils of the Kakheti region of Georgia are quite fertile and not endangered with degradation. The irregularities found in the soils are subject for discussion and can be easily corrected [4].

Results and discussion

As a result of our research, a complete picture of agricultural soils in the Kakheti region is presented.As a result of soil structure classification, the soil type has been found to be medium and heavy clayey.

Given that a soil's CEC is being determined by the clay and organic matter present, it implies the soil buffering - the volume fraction of organic substances with the CEC. For example, nitrogen (NH_4-N), K, Ca, and Mg, stick to negatively charged particles, as a result of which the soil becomes a reservoir of plant nutrients. The soil is rich in calcium and sodium. If we consider the content of nutrients, the contents of NPK, Fe, S twice exceed MAC, which could be explained by the overuse of chemical fertilizers [5] (Table 1). In terms of agro-ecotoxicology, the EPA TCLP and WET test methods were used, which implies the processing of mobile-soluble forms of heavy metals in the soil, for their further determination, using atomic absorption spectrophotometer (AAS).

According to TCLP, a 1:20 buffer was added to a 20 g soil sample under constant stirring using a magnetic stirrer for 24 hours at a temperature of 30 ^{0}C. According to the WET test method, a buffer solution in the ratio of 1:10 was added to the 20g soil sample under the same conditions for only 48 hrs.The mobile, soluble forms of heavy metals in the soil exceeded the MAC value (Pb – 3 times, Cu – 6 times, Zn - 1.5 times). Most likely the excess Pb should have been caused by the anti-hail device containing a lead-containing preparation. As for excessive content of Cu, it should have been introduced into the soil as a Bordeaux mixture pesticide.

The dynamics of accumulation of heavy metals in the soil is presented below (Fig. 1).

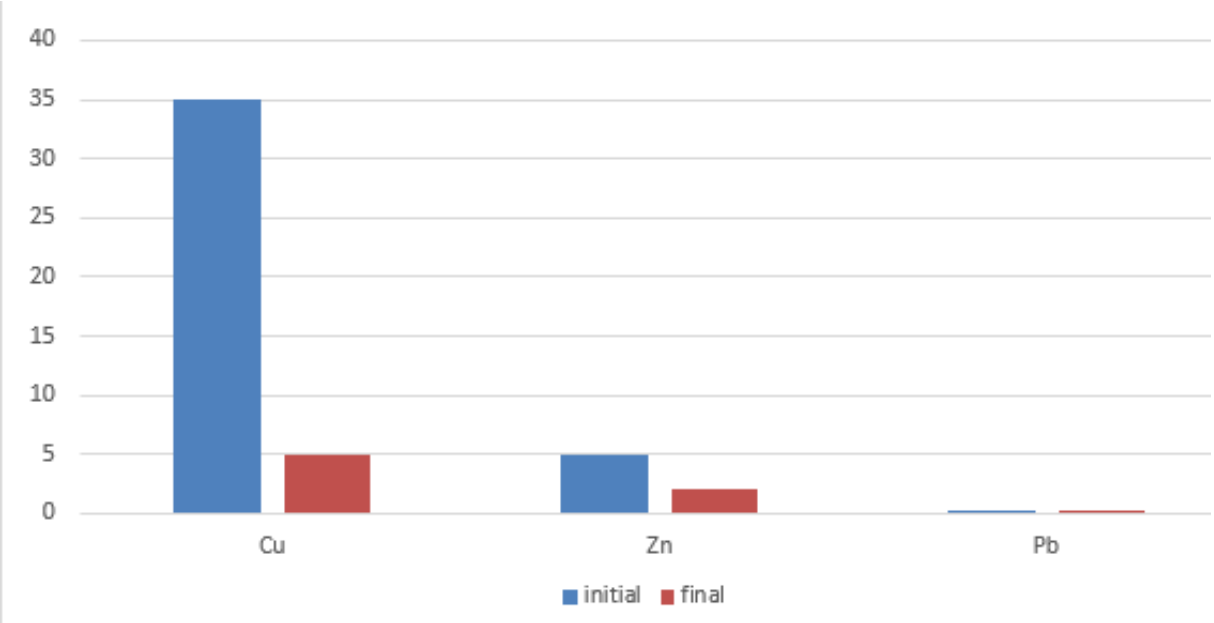

Figure 1. Dynamics of accumulation of mobile, soluble forms of heavy metals using stimulator in soil

If the mobile, soluble forms of toxic heavy metals exceed 1%, in this case phytoremediation can be carried out [6].

Conclusions

A complete survey of agricultural soils in the Kakheti region of Georgia has been carried out. Up to 20 soil samples were taken on land plots of different purposes, in A 0-20 horizontal and B 0-40 vertical directions.The classification of the soil structure has been studied, which implies the determination of pH, total organic matter, humus, density, soil type, porosity and moisture content. Organic substance sand their mechanical division, percentage contents (sand, fine sand, clay, and silt) have been studied. For a complete study of the soil, we considered it necessary to determine the exchange capacity (CEC) in the soil, as a result of which the soil becomes a reservoir of nutrients for plants. In terms of agro-ecotoxicology, mobile, soluble forms of heavy metals in the soil have been studied, using the state-of-the-art EPA TCLP (Toxicity Characteristic Leaching Procedure) and WET (Wet Extraction Test) test methods. The process of accumulation of toxic heavy metals under the action of a liquid stimulator manufactured by us has been studied. In our case, lead, copper, and zinc exceeded the MAC value. The soils of the Kakheti region were found to be moderately and heavily clayey, and black soil types with the medium and high fertility growth rate. The content of calcium, iron, sodium, nitrogen and phosphorus in them exceeds 1.2-2 times the MAC value, which is a result of the overuse of chemical fertilizers. The content of movable, soluble heavy metals has been found to exceed the MAC value: Cu – 6 times, Pb – 3 times, Zn – 1.5 times (Table 1). Based on the liquid stimulator produced by us, the content of these three metals can be reduced to MAC, which excludes the risk of their transfer from soil to the green cover and plant products. If the content of a

toxic heavy metal in the soil exceed 1%, the soil can be subject to phytoremediation.The Chinese ladder brake fern (*Pteris vittata)*is the best in this direction. For example, in an arsenic residue study, the fern absorbed 2% of the soluble form of arsenic.

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