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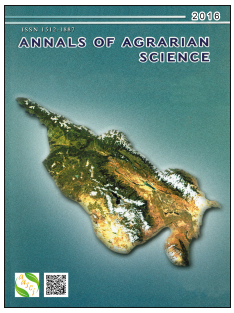

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Determination of Cu, Zn and Cd in Soil, Water and Food Products in the Vicinity of RMG Gold and Cupper Mine, Kazreti, Georgia

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A B S T R A C T

Functioning of polymetallic factories are considerable harming the ecological systems in the environment. Operation of RMG Gold and Cupper Mine in the SE part of Georgia causes severe ecological problems in the region. It is vital that conducted monitoring near the areas where industrial activities are underway. The study is aimed at eco-monitoring of the Bolnisi municipality, Georgia. The monitoring was conducted of heavy metals (Cu, Zn, Cd) in system "water-soil-plant" in the area of Kazreti (Madneuli) – villages: Balichi, Ratevani, Naxiduri, Xidiskhuri. According to the results obtained in the soil, content of heavy metals are significantly higher than the allowable concentration limit. In spite of this in crops of the plants which were grown on this soil, content of Cu and Zn does not exceed the allowed concentration limits, Cd content was not found. Study plants were green been, mauhroom, green walnut, green pepper, cucumber, cherry, potato, tomato, walnut, garlic, dry been and corn. Study water were rivers Kazretula and Mashavera's water. Rivers Kazretula and Mashavera water content Zn and Cd concentration.

Keywords: Soil-water-crop pollution, Monitoring, Heavy metals, Mining contamination.

Introduction

One of the dangerous type of environmental chemical pollution is pollution with heavy metals (Cu, Zn, Cd, Pb) [1]. High concentrations of heavy metals are dangerous for living organisms, they can be accumulated inside of the organism and causes a severe form of poisoning [2, 3]. Environment intensive contamination with heavy metals can be caused by the ore layer treatment [4]. Mining activities have adverse affect on the environment [5, 6]. Nowadays many aerosols are spit out in the environment as a result of intensive explosions of layer [7, 8]. All this explosions are very dangerous for inhabitants (meant health) [9]. Our monitoring shows that, factory causes soil, water and plants pollution with heavy metals [10,11].

It is noteworthy that environment pollutioning with wastewaters is as important problem as pollution with aerosols, which are split out after explosions of layers [12,13]. In the samples of Mashavera river, which are used for irrigation, heavy metals contentment is not as high as in soil samples. As for the waste water, Kazretula river is very contaminated with zinc, copper, cadmium and iron [14]. This river is dead with sewage waters. Kazretula river pollutes Mashavera river, which is used to irrigate lands in Bolnisi district [15].

Objectives and methods

Madneuli factory has been functioning since 1975 year, it is located in Bolnisi district, particular in the borough of Kazreti, which is located approximately 80 km southeast of Tbilisi, on the bank of rivers Mashavera and Kazretula. RMG gold and copper mine, which carries out open-pit mining method, causes intensive pollution of the environment with toxic metals such as Zn, Cu, Cd. Open-pit mining method is very important source to contaminate the environment by heavy metals [16].

Soil samples were collected in ten villages in Bolnisi region, the villages are located at different distances from the gold mine. Village Balichi (distance from the site - 4 km), Naxiduri (30 km) and Ratevani (15 km). Water samples were collected from both Mashavera and Kazretula rivers, near the gold and copper mine sites. Water samples were taken from six sites, three from the Kazretula river and three from the Mashavera river. Plant species: potatoes, dry beans, walnuts, Corn, tomatoes and garlic which were grown on this soils were taken from Balichi, Ratevani and Naxiduri villages.

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Soil sampling

Each sample represents a surface soil aliquot taken at 0-5 cm from the surface and 30-35 cm from the depth. The study area was divided in regular grids of 1000 x 1000 m, where samples were collected at five points, mechanically mixed and a composite sample was prepared. The soil samples were oven dried at 105°C for 24 h, followed by grinding and sieving using 0.18 mm sieve. In order to determine the concentrations of metals, 5 ml of 65% HNO_3 (trace metal grade) were added to 1.000 g of soil in a 50 ml volumetric flask. The flask was being

heated in a water bath (100°C) for 2 hours and then filtered with a Whatman 0.45 μm paper filter in to a 50 ml volumetric flask. These solutions were analyzed for Cd, Cu, and Zn by Atomic Absorption Spectrophotometers (AAS).

Water sampling

Water samples were collected in 1000 ml (HDPE) plastic bottles, which were washed and rinsed 3 times with distilled water prior of using them. Preservation of water samples was done by adding 2 drops of concentrated HNO_3 (trace metal grade) to each sample. Water samples were filtered with Whatman 0.45 μm filter paper in a Buchner funnel. Samples were analyzed by AAS in the chemistry laboratory of the Georgian Technical University, country of Georgia.

Food Sampling

Food samples were collected in Balichi, Ratevani and Naxiduri villages, where this vegetables were growing up. The plant samples were oven dried at 105°C for 24 h, followed by grinding and sieving. In order to determine the concentrations of metals, 5 mL of 65% HNO_3 (trace metal grade) were added to 1.000 g of dry sample in a 50 ml volumetric flask. The flask was being heated in a water bath (100°C) for 2 hours and then filtered with a Whatman 0.45 μm paper filter in to a 50 ml volumetric flask. These solutions were analyzed for Cd, Cu, and Zn by Atomic Absorption Spectrophotometers (AAS).

Results and analysis

The aim of the research was eco monitoring of the villages which are located near the mining area (Madneuli). For these villages we estimated heavy metals concentrations (Cu, Zn, Cd) in the system "water-soil-plant". Table 1. Results obtained from Kazretula and Mashavera rivers.

Table 1. *Heavy metals concentration in the river water. 2010.*

Number of samples and name		Cu mg/kg	Zn mg/kg	Cd mg/kg	Fe mg/kg
Maximum admissible limit		1.0	1.0	0.00	0.3
N1	Mashavera river 0.5 km upstream the confluence with the Kazretula river	0.01	0.04	0.00	0.12
N2	Kazretula river 0.3 km upstream the confluence with the Dam water	1.4	510.2	13.2	1.1
N3	Dam water 0.3 km above the confluence between the Kazretula river and waste water	1.6	3.5	0.2	17.3

	reservoir				
N4	Kazretula river 0.3 km downstream of the confluence of Dam water and Kazretula river	1.1	324.4	9.8	9.0
N5	Mashavera river 17 km downstream of the confluence of Mashavera and Kazretula rivers	1.6	26.	0.3	18.2
N6	Mashavera river 25 km downstream of the confluence of Mashavera and Kazretula rivers	0.3	1.7	0.05	0.6

Results shows that Mashavera and Kazretula rivers are very contaminated with Zn and Cd. The given data clearly shows that the Kazretula river is highly polluted with waste water from the factory which contains large amounts of heavy metals, such as cadmium and zinc. Industrial waste water have low pH, ranging between 2 and 3 [1]. Our research results show that the water in the dam is not fully free of heavy metals.

We also studied the intensity of pollution, caused by irrigation water. Water samples were taken in the villages Ratevani and Naxiduri. The study results showed that in the samples of water, heavy metals (Cu, Zn, Cd) concentration exceeds the maximum admissible limit.

Kazreti, where RMG Gold and Cupper mine is functioning, is known as highest contaminated area in the country. RMG Gold and Copper mine, which carries out open-pit mining method, causes intensive pollution of the environment with toxic metals such as Zn, Cu, Cd, with concentrations up to 6000 mg/kg for Zn, 2000 mg/kg for Cu, 100 mg/kg Cd, respectively. Products produced on that contaminated soils harm human health, which means that this soil is practically useless for agriculture. The results is shown on table 2.

Table 2. *Heavy metals concentration in soil, in Balichi, Ratevani, Naxiduri villages. 2010.*

#	Village name	Cu		Zn		Cd	
		Mg/kg		Mg/kg		Mg/kg	
		Surface	depth	Surface	depth	Surface	depth
1.	Balichi	97.0	49.5	159.1	140.3	43.8	20.0
2.	Ratevani	2050.0	511.3	5420.0	499.0	68.7	100.3
3.	Naxiduri	231.8	285.4	3770.0	404.0	34.6	41.5

Concentrations of heavy metals in soil samples, which were taken from Balichi village, is lower than in Naxiduri and Ratevani villages. On the one hand, this result can be explained by the fact that village Balichi is using clean Mashavera river for irrigation (Mashavera river 3 km upstream the confluence with the Kazretula river) and the lands in Naxiduri village are watered with river Mashavera after the confluence Kazretula river. In Naxiduri and Ratevani villages the pollution is caused by the fact that agricultural soils are extensively irrigated with highly polluted water of Mashavera.

Due to the fact that in Balichi Village clean river water is used for irrigation, we assume, soil pollution is not caused by the river. Thus, industrial dust, which is absorbed in the soil, causes soil contamination in this village. Open pits causes atmosphere pollution and because of this soils in village Balichi are very contaminated. Uncontrolled works of the enterprise causes this condition.

Within the research agricultural food crops were collected in the villages nearby mining area. In these plant samples Cu, Zn and Cd were measured. Twelve plant species were examined, such as green bean, mushroom, green walnuts, green pepper, cucumber, cherry, potato, tomato, nuts, garlic, dried beans, corn. These food crops were harvested from Nakhiduri, Khidiskuri, Balichi and Ratevani villages. The table below shows Cu, Zn and Cd concentrations in these plants.

Table 3. Cu, Zn and Cd concentration in the green bean, mushroom, green walnut, green pepper, cucumber and cherry.

Village name	Food product name	Cu mg/kg	Zn mg/kg	Cd mg/kg
Xidiskhuri	Green been	3.7	3.8	-
Naxiduri	Mashroom	5.44	1.3	-
Balichi	Mashroom	10.8	2.4	-
Naxiduri	Green Walnut	1.7	1.8	-
Balichi	Green Walnut	1.1	1.8	-
Xidiskhuri	Green pepper	3.03	4.2	-
Naxiduri	Green pepper	2.2	5.7	-
Ratevani	Green pepper	1.3	2.3	-
Naxiduri	Cucumber	4.2	3.3	-
Xidiskhuri	Cucember	2.6	2.4	-
Naxiduri	Cherry	1.9	3.8	-
Xidskhuri	Cherry	2.6	2.4	-

On the figures 1, 2 and 3, Cu, Zn and Cd concentrations are shown in plants, which were grown in Ratevani, Naxiduri and Balichi villages.

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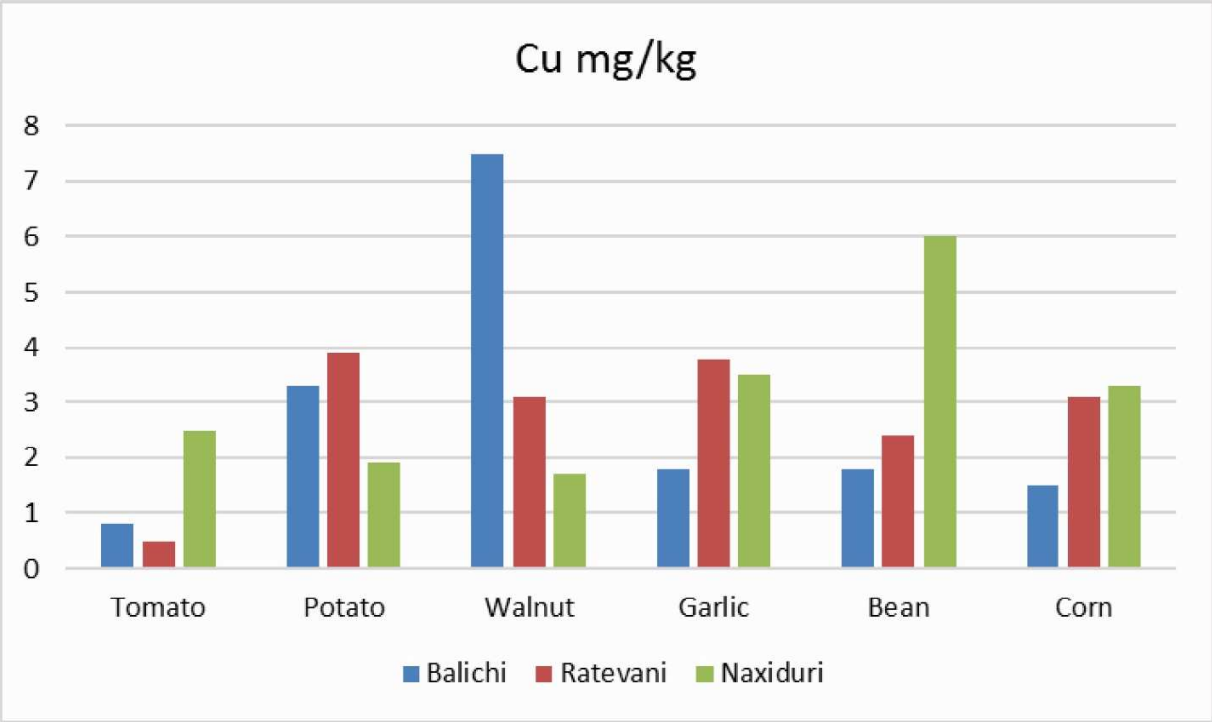

Fig.1. *Concentration of Cu in Tomato, Potato, Walnut, Carlic, Bean, Corn in village Balichi, Ratevani, Naxiduri*

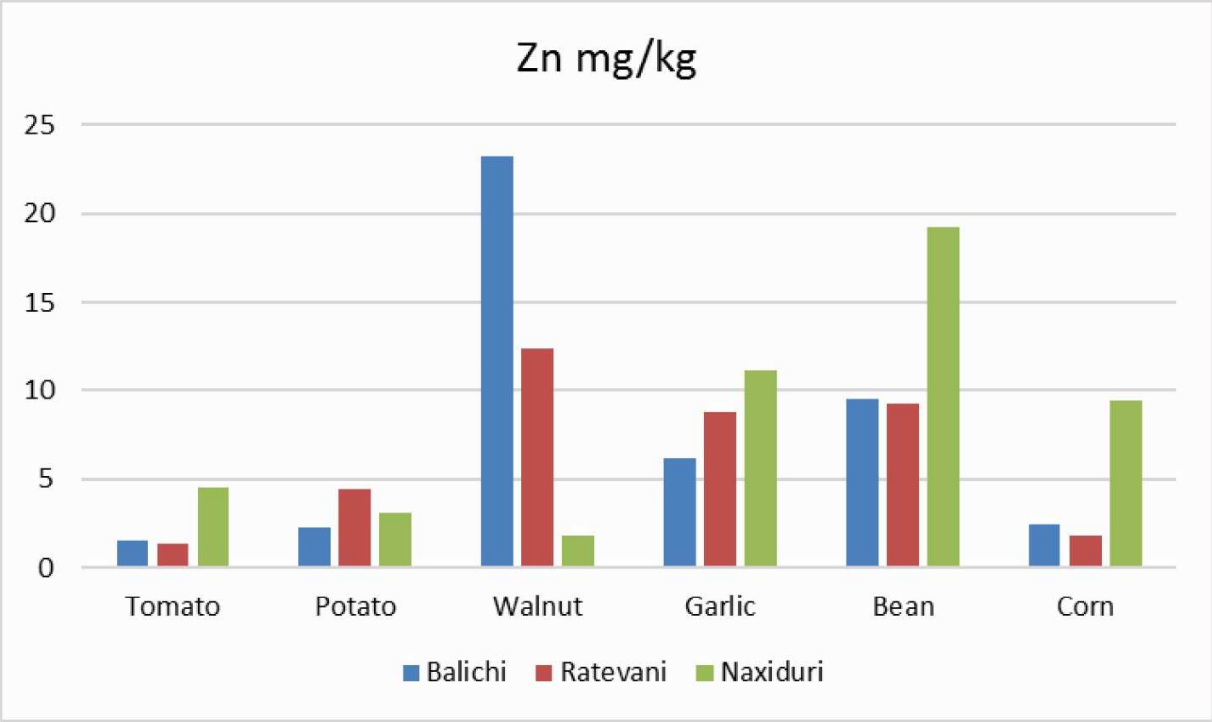

Fig.2. *Concentration of Zn in Tomato, Potato, Walnut, Carlic, Bean, Corn in village Balichi, Ratevani, Naxiduri*

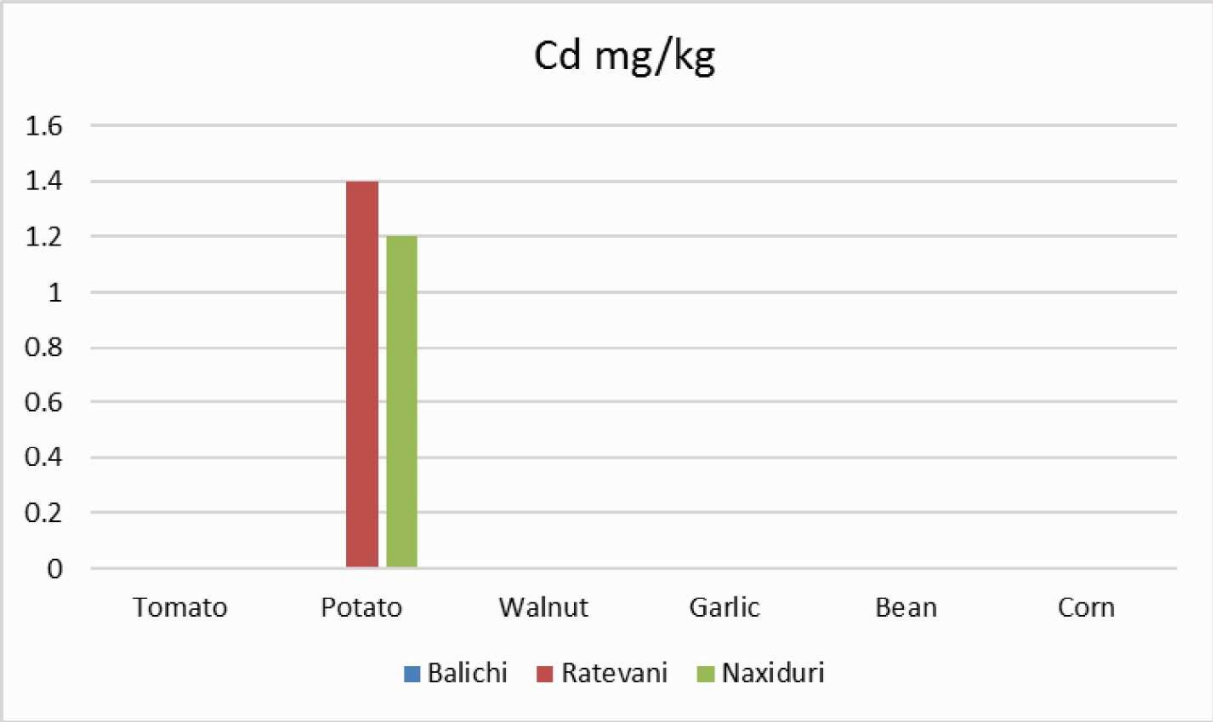

Fig.3. *Concentration of Cd in Tomato, Potato, Walnut, Carlic, Bean, Corn in village Balichi, Ratevani, Naxiduri*

Environmental monitoring has revealed that copper (Cu) and zinc (Zn) contentment in fetus of all these vegetable crops do not exceed the maximum admissible limit, but there is a growing dependence by the location of these villages. Studies were conducted in autumn. Research have examined only plant fetus. It can be assumed that, in plants which we selected, heavy metals do not absorbed in the fetus and absorbed in the stem, roots and leaves. Our research revealed high cadmium level in potatoes, harvested in Ratevani and Naxiduri villages. In the potato from Ratevani Village, cadmium concentration is higher than the admissible limit with an average of 4600%. In Naxiduri Village cadmium decreased with 4000 %. Other food products which we analyzed the cadmium concentration was not identified.

Conclusion

Our research evidence that, in Bolnisi district (South-east Georgia), environmental pollution is caused by gold and copper mining.

Uncontrolled industrial waste water discharging into the Kazretula river and leads to the death of living organisms. Likewise, Mashavera river is very contaminated with heavy metals, 60% of the population in this region use this water for irrigation.

After monitoring of the “water-soil-plant” system which was done in the area of Kazreti, we can say that soils in the villages: Balichi, Ratevani and Naxiduri are very polluted with heavy

metals (Cu, Zn, Cd), in spite of this, inside of the vegetables - tomato, walnut, garlic, bean, corn which were grown up on the polluted soils, heavy metals concentrations are not exceed environmental limits. Potatoes which were grown in the Ratevani and Naxiduri villages absorbed higher Cd concentration. It is significant to conduct intensive researches in this region and we will examine more plant species, as we consider that vegetables which was not analyzed yet may possibly uptake high concentration of heavy metals, though population does not know that and use it as a food product. So such plants should be uncovered in order to protect people from poisoning.

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