

Monitoring of Cadmium Contaminated Soil in Kvemo Kartli Region (Republic of Georgia)

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Abstract

Environmental pollution increases from year to year and concentrations of pollutants reach a colossal point, which ultimately affects the health of the living organisms. Industrial pollution and old mining methods are one of the sources of harmful agents in the environment. It is important to study and monitor environmental pollution in dynamics. During several years we have been researching heavy metals distribution in soils in the South East part of Georgia. “RMG Gold and Copper” mine in Kazreti is one of the biggest enterprises in Georgia. As a result of open-cast mining aerosols containing heavy metals are ejected which causes harmful effects of the environment. Within this research 21 villages in Bolnisi and Dmanisi municipalities were investigated; analysis of agricultural soils showed that the concentration of cadmium in the vicinity of the enterprise was significantly increased and exceeded maximum allowed concentrations. Through the wind, cadmium-containing dust spreads out to the 22 kilometers radius which leads to the soil contamination in the whole region.

Keywords

Cadmium, Distribution, Soil, Contamination, Gold Mine

1. Introduction

Intensive mining processes pollute the environment so much that nutrition

products growing on the soil near the mining area are often very harmful to human health [1] [2] [3]. Heavy metals and radionuclides are the most dangerous environmental chemical contaminants. Their inclusion in the biochemical cycle with high concentrations is a threat for living organism. They are hardly excreted from the body and cause pathological changes [4] [5] [6]. From this point of view, one of the most important areas in Kazreti is RMG Gold and Copper mine, located in Bolnisi region on the right and left banks of the river Mashavera [1] [7] [8] [9].

Gold-barite-copper-polymetallic ores of hydrothermal sedimentary genesis (VMS type) of Madneuli deposits [10] are extracted by open quarry type, which leads to intense pollution of the environment by toxic metals. Many researches show that soil and water pollution in the region exceeds the admissible norms quite highly in recent years [1] [8] [11] [12] [13].

It is important to mention that such a fundamental research was not conducted in this region before 2017.

2. Research Area and Methodology

Within the frames of the project “Green Political Analysis of Industrial Pollution in Kvemo Kartli Region”, financed by Heinrich Boell Foundation South Caucasus regional office, implemented by Green Policy Public and Scientific-Research Platforms in collaboration with Elephter Andronikashvili Institute of Physics, Ivane Javakhishvili Tbilisi State University, the research process began with the revision and assessment of the researches carried out before about this problem. Based on the existing data, a possible soil pollution map with heavy metals was created using GIS. As a result of our research 42 sampling areas were defined in 21 villages in Bolnisi and Dmanisi municipality, around the mining territories they were taken from A and B horizons, overall 42 samples. **Table 1** shows GPS coordinates of those places where samples were taken. The following types of soils are represented in the investigated region and adjacent territories: Cinnamonic Soils, Grey Cinnamonic Soils, Brown Forest Soils, Raw Humus Calcareous Soils, Mountain Chernozems and Alluvial Calcareous Soils [2] [13]. Soil samples were taken according to the methodology of the United States Environmental Protection Agency (the United States Environmental Protection Agency, 2006). The samples were taken by AMS Soil Step Probes. The investigated territory was divided into 1000 × 1000 m sections, where the samples were taken from 5 points and mixed into a single sample. The samples were dried at a temperature of 105 °C for 24 hours, crushed and sieved through a 0.18 mm sieve. To determine the concentration of metals, 5 ml of 65% HNO₃ was added to 1000 g of the soil sample. The flasks were then put on steam (100 °C) for 2 hours, and after 15 minutes cooling at room temperature, filtered through What man paper (0.45 μm) in 50 ml tubes. The filtered solutions are filled with 50 ml of distilled water. Soil samples were analyzed on the AAS (Atomic Absorption Spectroscopy) and determined cadmium concentration in them.

Table 1. Soil sampling locations coordinates in 2017.

No.	Village	North	East
1	Nakhiduri	X 0474246	Y 4590064
2	Mtskneti	X 0470949	Y 4588293
3	Foladauri	X 0458174	Y 4576250
4	Kvemo Bolnisi	X 0457393	Y 4578535
5	Rateveni	X 0458875	Y 4588651
6	Musheveni	X 0455643	Y 4586077
7	Akaurta	X 0451949	Y 4585549
8	Gomareti	X0422928	Y 4593580
9	Gantiadi	X 0437889	Y 4577110
10	Vardisubani	X 0445796	Y 4577567
11	Mamishlo	X 0440166	Y 4572386
12	PataraDmanisi	X 0445628	Y 4576533
13	Abulbuki	X 0448991	Y 4581087
14	Balichi	X 0449059	Y 4580986
15	Tandzia	X 0447779	Y 4589467
16	Darbazi	X 0442143	Y 4584364
17	Fotskhveriani	X 0449200	Y 4588065
18	Kazreti	X 0450748	Y 4582642
19	Balichi 2	X 0450188	Y 4580713
20	Balichi 3	X 044972	Y 4579984
21	Balichi 4	X 0449731	Y 4579564

3. Results

The results of the research showed that cadmium is especially increased in the village Ratevani, However, in almost all samples Cd concentration was higher than the maximum permissible concentration. Cd concentration is also high in the village Balichi (**Figure 1**).

Balichi is the closest village to the Sakdrisi-Kachagiani open quarries where agricultural farms are located and local population grow crops, vegetables and other food products The distance to the nearest populated area is 1 km [1].

According to our research village Ratevani is contaminated as by air as well as by polluted waters, while the village Nakhiduri soils are contaminated only by the polluted waters released from the mine, near the mining area the river Mashaver a flows [3] [4] [13]. Mining process contaminates Mashavera River. Population of Bolnisi Municipality uses the river Mashavera which contaminates agricultural soils through the irrigation system [1] [2]. Studies revealed that most of the territories from Bolnisi municipality and huge part of Dmanisi municipality are contaminated with Cd due to the mining activities of the RMG (**Figure 2**).

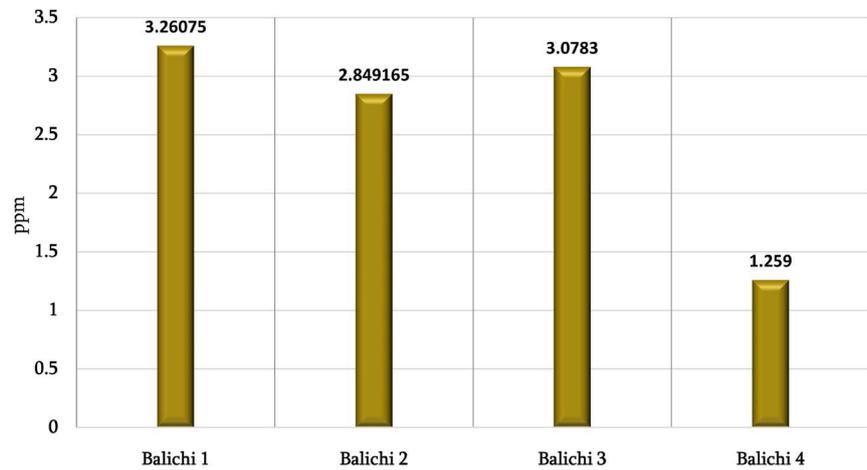


Figure 1. Cd concentration in the soil of village Balichi.

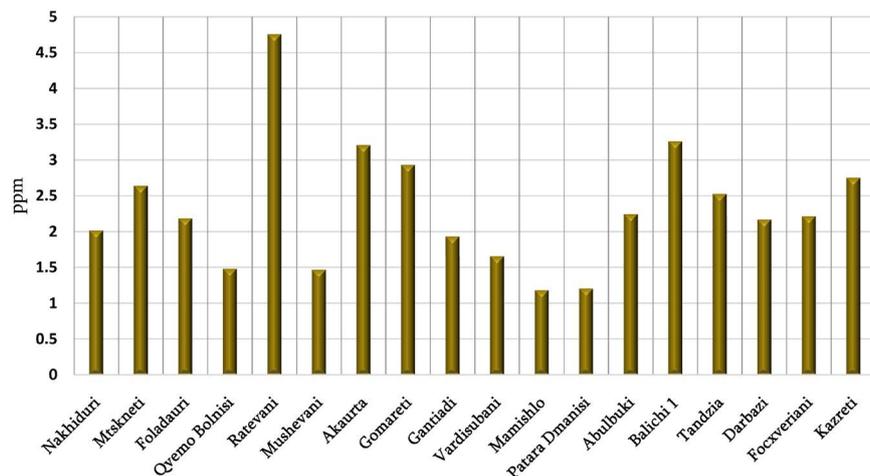


Figure 2. Distribution of Cd concentration in the Bolnisi and Dmanisi municipalities, 2017.

The Map (**Figure 3**) shows the distribution of Cd in Bolnisi and Dmanisi Municipalities. In almost every village Cd concentration is higher than the maximum allowed concentration, but in the village Ratevani Cd is at the highest level than the other villages. Cadmium is a toxic element and is a threat to health as it causes calcium elimination from the organism and premature disintegration of the bones; it can also lead to the tumors and other diseases.

4. Conclusions

Thus, RMG Gold and Copper mine leads to intense pollution of the environment by such a toxic metal as Cd. During the research 42 sampling areas were in 21 villages in Bolnisi and Dmanisi municipality. All these villages are located near the RMG enterprise. Soil samples were analyzed on the AAS (Atomic Absorption Spectroscopy) and determined cadmium concentration in them.

The results showed that the cadmium was especially increased in the village Ratevani. However, in almost all samples Cd concentration was higher than the

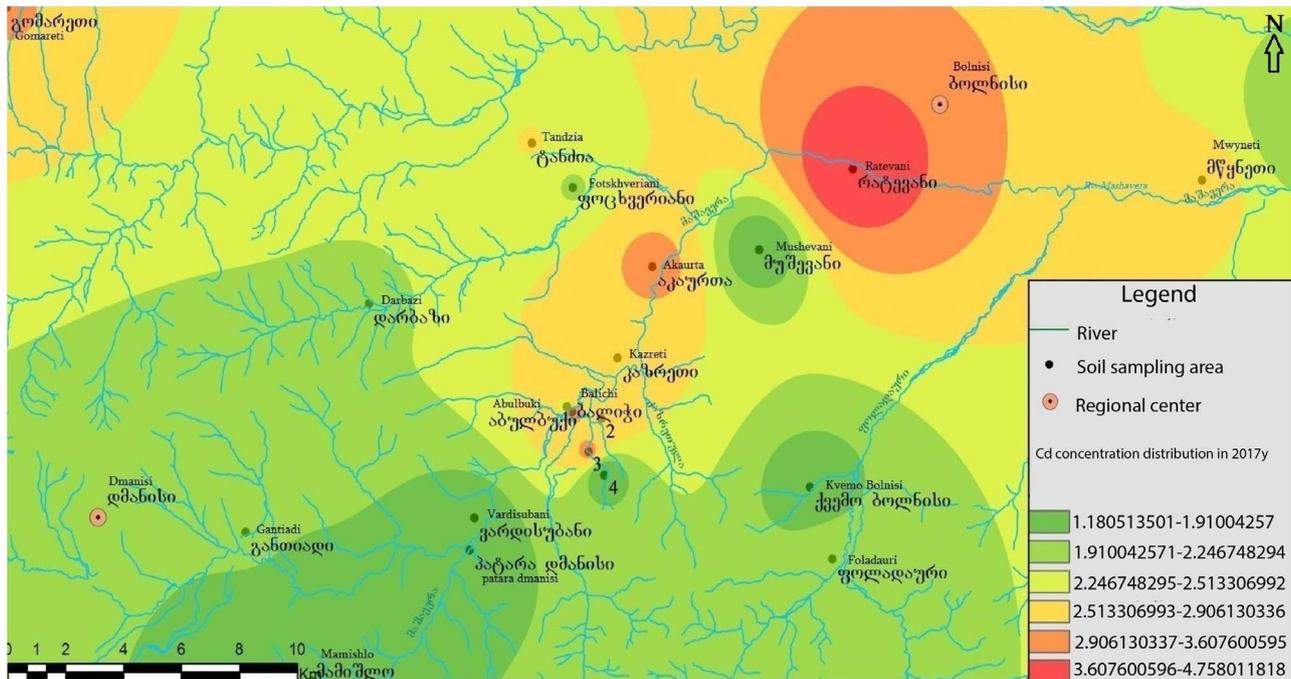


Figure 3. Cd concentration distribution map in Bolnisi and Dmanisi municipality, 2017.

maximum allowed concentration. Cd concentration is also high in the village Balichi. Hence, Cadmium is a toxic element which is a threat to the health and causes many diseases.

It should be noted that ecological condition of the region can be improved if mining company RMG will assess all environmental risks properly and implement modern environmentally safe mining methods based on modern concepts of mine waste management. But assessing highly ideologized policy of the natural resources economy in Georgia, we doubt it is possible, without strict environmental regulations and scientifically refined political involvement of the government in the field, from the perspectives of green policy.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Avkopashvili, G., Avkopashvili, M., Gongadze, A., Tsulukidze, M. and Shengelia, E.

- (2017) Determination of Cu, Zn and Cd in Soil, Water and Food Products in the Vicinity of RMG Gold and Copper Mine, Kazreti, Georgia. *Annals of Agrarian Science*, **15**, 269-272. <https://doi.org/10.1016/j.aasci.2017.05.001>
- [2] Avkopashvili, G., Avkopashvili, M., Gongadze, A. and Gakhokidze, R. (2017) Eco-Monitoring of Georgia's Contaminated Soil and Water with Heavy Metals. *Carpathian Journal of Earth and Environmental Sciences*, **12**, 595-604.
- [3] Avkopashvili, G., Gongadze, A., Gakhokidze, R. and Avkopashvili, M. (2015) Phytoremediation of Contaminated Soils, Contaminated with Heavy Metals from Gold Mine in Georgia. *Proceedings of International Conference Applied Ecology: Problems, Innovations*, Tbilisi, 7-10 May 2015, 154-157.
- [4] Withanachchi, S.S., Ghambashidze, G., Kunchulia, I., Urushadze, T. and Ploeger, A. (2018) Water Quality in Surface Water: A Preliminary Assessment of Heavy Metal Contamination of the Mashavera River, Georgia. *International Journal of Environmental Research and Public Health*, **15**, 1-25.
- [5] Tsivtsivadze, N., Matchavariani, L., Lagidze, L., Paichadze, N. and Motsonelidze, N. (2014) Problem of Surface Water Ecology in Georgia. In: Efe, R. and Ozturk, M., Eds., *Environment and Ecology in the Mediterranean Region II*, Cambridge Scholars Publishing, Cambridge, 283-294.
- [6] Hanauer, T., Henningsen, P.F., Steffens, D., Kalandadze, B., Navrozashvili, L. and Urushadze, T. (2011) *In Situ* Stabilization of Metals (Cu, Cd, and Zn) in Contaminated Soils in the Region of Bolnisi, Georgia. *Plant and Soil*, **341**, 193-208. <https://doi.org/10.1007/s11104-010-0634-5>
- [7] Das, A. and Das, A. (2018) Heavy Metals in Common Food Items in Kolkata, India. *Euro-Mediterranean Journal for Environmental Integration*, **3**, 1. <https://doi.org/10.1007/s41207-017-0039-4>
- [8] Withanachchi, S.S., Ghambashidze, G., Kunchulia, I., Urushadze, T. and Ploeger, A. (2018) A Paradigm Shift in Water Quality Governance in a Transitional Context: A Critical Study about the Empowerment of Local Governance in Georgia. *Water*, **10**, 98. <https://doi.org/10.3390/w10020098>
- [9] Matchavariani, L., Kalandadze, B., Lagidze, L., Gokheliashvili, N., Paichadze, N. and Dvalashvili, G. (2014) Soil Quality Changes in Response to Their Pollution by Heavy Metals, Georgia. *Journal of Environmental Biology*, **36**, 85-90.
- [10] Magalashvili, A. (2002) Correlation between Volcanism and Ore Mineralization Based on Madneuli Deposits: Further Evolution of Ideas of Academician G. Dzotzenidze. *Proceedings of Geological Institute of Georgian Academy of Science, New Series*, **177**, 460-466. (In Russian)
- [11] Härmanescu, M., Alda, L.M., Bordean, D.M., Gogoășă, I. and Gergen, I. (2011) Heavy Metals Health Risk Assessment for Population via Consumption of Vegetables Grown in Old Mining Area; a Case Study: Banat County, Romania. *Chemistry Central Journal*, **5**, 64. <https://doi.org/10.1186/1752-153X-5-64>
- [12] Asanidze, L., Avkopashvili, G., Tsikarishvili, K., Lezhava, Z., Chikhradze, N., Avkopashvili, M., Samkharadze, Z. and Chartolani, G. (2017) Geocological Monitoring of Karst Water in Georgia, Caucasus (Case Study of Racha Limestone Massif). *Open Journal of Geology*, **7**, 822-829. <https://doi.org/10.4236/ojg.2017.76056>
- [13] Tsikaridze, N., Avkopashvili, G., Kazaishvili, K.H., Avkopashvili, M., Gognadze, A. and Samkharadze, Z. (2017) KvemoKartli Manufacturing Mining Pollution Analysis in Green Politics Context; Scientific Report, Green Policy Public Platform: Tbilisi, Georgia. (In Georgian) <https://greenpolicyplatform.wordpress.com>