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The Impact of Some Uncontrolled Landfill Sites on the Ecosystems of Surrounding Areas of Eastern and Western Parts of Georgia

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Abstract

The most visible uncontrolled landfill sites were selected in the western and eastern parts of the territory of Georgia. Particularly, in eastern Georgia the regions of Mtskheta-Mtianeti and Kvemo Kartli have been researched; and in western Georgia Imereti and Samtskhe-Javakheti correspondingly. Both chemical and microbiological analyses were conducted in the samples taken from their adjacent territories. In case the landfill site is located near the river, during field works using portable equipment main physical-chemical indicators of surface waters were determined. After processing of the obtained results the corresponding estimations were provided. The risks due to the environmental pollution and negative impacts on population health were assessed.

Keywords

Pollution, Waste Management, Heavy Metals, Uncontrolled Landfills, Maximum Permissible Concentrations

1. Introduction

In Georgia, especially in those regions, where the representatives of local self-government don't meet the requirements and respectively are not able to supply the population with the necessary equipment, uncontrolled landfill sites are presented. Uncontrolled landfills have undesired pollution impact on the environment of the adjacent territories. Unfortunately, they are basically located in the valleys (near the rivers), close to pastures and populated places that creates important risk factors related to the population health. It should be mentioned

that in Georgia do not exist landfills (disposal sites) for hazardous wastes that means that any type of hazardous waste can be found on uncontrolled landfills.

During the study the field works were carried out in the most part of Georgia, namely, in the western and eastern territories of Georgia. In the research regions the inventory of uncontrolled landfill sites was developed. From the territories adjacent to the most visible landfills the analysis samples (soil, water) were taken and chemical (Pb, Cd, Zn, Cu, Hg) and microbiological (total coliforms, fecal streptococci and E-coli) analyses were carried out [1]-[6]. Under field conditions the physical-chemical indicators of surface waters (pH, water temperature, electric conductivity, quantity of dissolved oxygen in the water, salinity) were determined. Based on the outputs the uncontrolled landfills impact on their adjacent territories was assessed and the probability of the negative impact on population health was estimated.

2. The Purpose of the Research and the Methods Used

The goal of the research is caring out of the inventory of uncontrolled landfill sites existing in the main regions of Georgia, to conduct the chemical and microbiological analyses of samples taken from surrounding areas and assessment of ecological state of these territories. The complex chemical, physical-chemical and microbiological study of the research objects were carried [7] [8] [9] [10] [11]. For these purposes the following methods and equipment were used:

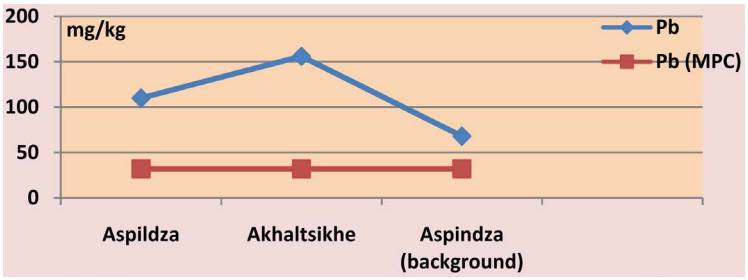
1) Ion-selective chromatograph (ICS-100) ISO 100304-1:2007
2) Spectrophotometer SPECORD 205 ISO 7150-1:2010
3) Membrane filtration ISO 9308-1, ISO 7899-2
4) Plasma-emission spectrometer ICP-MS
5) Field portable device.

In order to properly assess the role and significance of landfill sites impact in the contamination of adjacent territories the background points were selected for results comparison with the investigation points. In some cases, the obtained results were compared to the maximum permissible concentrations (MPC), as well as the comparison was provided with approximate permissible concentrations (APC).

3. Received Results and Discussions

The analyses were conducted in the internationally certified laboratory of the Environmental Pollution Monitoring Department of the National Environmental Agency. The results obtained for uncontrolled landfill sites of Samtskhe-Javakheti region, namely for cities Akhaltsikhe and Aspindza are presented in **Table 1** and **Figure 1**.

The high lead concentrations were registered both in c. Aspindza and c. Akhaltsikhe soil samples, and their contents are equal to 3 and 5 MPC, respectively. Zinc and copper contents in the analysis samples insignificantly exceed the values of APC. It should be noted as well that in case of lead the background points



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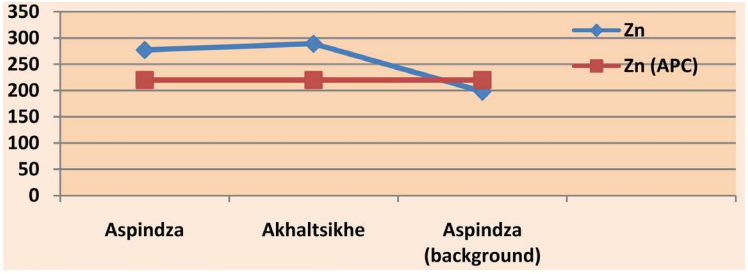

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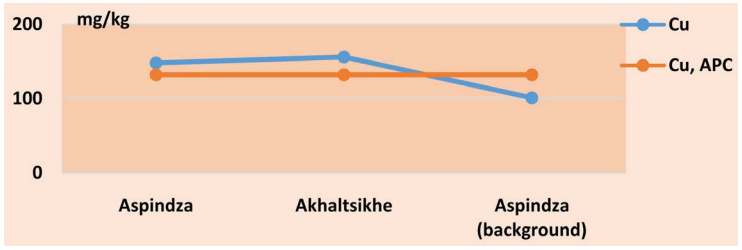

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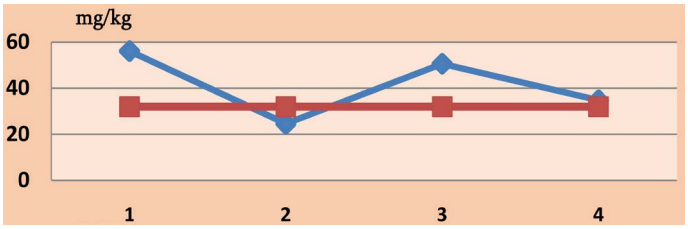
Figure 1. The lead (a), zinc (b) and copper (c) concentrations in the soil samples collected in Samtskhe-Javakheti Region.

Table 1. The heavy metals concentrations in the soil samples collected from the surrounding areas of the uncontrolled landfill sites in Samtskhe-Javakheti Region.

Sampling location	Sampling time	Pb	Cd	Zn	Cu	Hg
		mg/kg				
#1 Akhaltsikhe	25.04-28.04. 2017	156	N.D.	289	156	N.D.
#2 Aspindza (landfill)	25.04-28.04. 2017	110	N.D.	277	148	N.D.
#3 Aspindza (background)	25.04-28.04. 2017	68	N.D.	198	101	N.D.
MPC		32	2			
APC				220	132	

turned out to be overloaded by lead (2 MPC). In all cases the concentration of each heavy metal in the soil samples proved to be higher compared to background points. As for cadmium and mercury, their contents in the soil were not fixed (see Table 1).

The results of works conducted in Imereti region (Villages Chognari and Kukhi, River Gubistskhali) are presented in Tables 2-4 and Figure 2.



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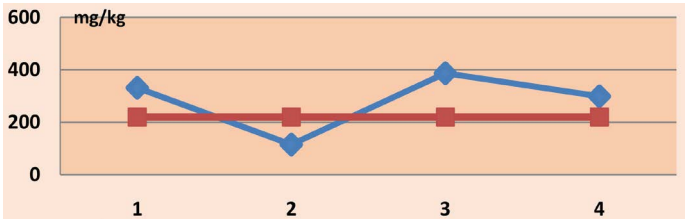

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Figure 2. The lead (a) and zinc (b) concentrations in the soil samples collected in Imereti Region. 1—v. Chognari lead and zinc concentrations correspondingly; 2—v. Chognari (background) Pb-MPC and Zn-APC correspondingly; 3—v. Kukhi; 4—v. Kukhi (background).

Table 2. The heavy metals concentrations in the soil samples collected from the surrounding areas of the uncontrolled landfill sites in Imereti Region.

Sampling location	Pb	Cd	Zn	Cu	Hg
			mg/kg		
V. Chognari, (landfill)	56.11	N.D.	331.4	82.8	N.D.
V. Chognari, (background)	24.6	N.D.	115.2	66.7	N.D.
V. Kukhi (landfill)	50.6	N.D.	386.9	50.19	N.D.
V. Kukhi (background)	34.78	N.D.	299	42.4	N.D.
MPC (mg/kg)	32	2			
APC (mg/kg)			220	132	

Table 3. The results of chemical and microbiological analyses of the water samples collected from the River Gubistskhali.

#	Parameters	Units	Measurement results	MPC	Methods
1	Ammonium	mgN/I	0.554	0.39	ISO 7150-1:2010
2	Nitrite	mgN/I	0.122	1.0	ISO 10304-1:2007
3	Nitrate	mgN/I	0.727	10.0	ISO 10304-1:2007
4	Phospate	mg/I	0.192	3.5	ISO 10304-1:2007
5	Sulfate	mg/I	48.25	500	ISO 10304-1:2007
6	CI^-	mg/I	4.79	350	ISO 10304-1:2007
7	Br^-	mg/I	0.082	0.2	ISO 10304-1:2007
8	F^-	mg/I	0.115		ISO 10304-1:2007
9	E-coli	Iiter	3500	5000	Membran filtration
10	Total coliforms	Iiter	8200		Membran filtration
11	Fecali streptococci	Iiter	550		Membran filtration

Table 4. The results of physical-chemical analysis of the water samples collected from the Gubistskali River.

Sampling location	pH	Conductivity msm/sm	Salinity (%)	Dissolved oxygen in water, mg/I	t, °C
Gubistskali river (landfill)	7.9	224	0.1	7.8	13.8
Gubistskali river (300 meters away from the landfill)	7.95	210	0.1	7.6	13.6

According to obtained results, a lead concentration in the soil samples taken from territories adjacent to Chognari landfill exceeded MPC values 1.8-times, while in Kukhi samples its content reached 1.5 MPC. Relatively less increased concentrations were registered in the case of zinc (Figure 2(a) and Figure 2(b)). It should be also noted that Hg and Cd concentration were not registered in sampling locations.

The results of hydro-chemical, physical-chemical and microbiological analyzes of Gubistskali river (Kukhi village) point at the fact that the uncontrolled landfill located in its proximity has no significant impact on the quality of its water and there are no extraordinary unsanitary conditions there, though ammonia ion concentration in the vicinity of the landfill is slightly increased in the water compared to its MPC (Table 3 and Table 4).

The results of analyzes conducted in the Mtskheta-Mtianeti region are presented in Tables 5-7 and Figure 3.

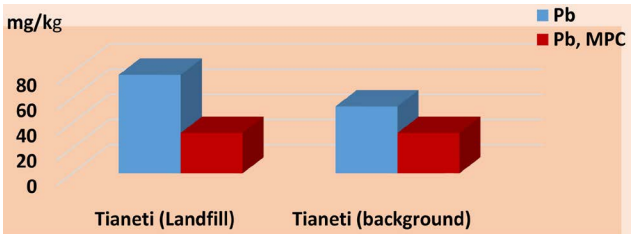
It is noteworthy that the territory adjacent to uncontrolled landfill situated in Tianeti turned out to be polluted by lead, copper and zinc as well (see Diagr. 6 - 8). Their concentrations exceed not only MPC, but also background values, too. Though there was neither cadmium nor mercury in the analysis samples (Table 5).

As for Iori river, as we can see there is no impact of the landfill on it. Both hydrochemical and microbiological analyses show that the key indicators are within the norm. According to physical-chemical indicators we can say that there is no significant pollution or discharge to the river in the given period (Table 6 and Table 7).

The results of field works conducted in Kvemo Kartli are presented in Table 8 and Figure 4.

According to obtained data the concentrations of all three metals (Pb, Cu, Zn) exceeded MPC and APC in the analysis samples of Marneuli soil. Such carcinogenic elements, as mercury and cadmium, were not observed in the analysis samples (Figure 4). As for Gardabani, the territory adjacent to the landfill site was polluted by lead only (Table 8).

Their concentrations frequently exceed their MPC, and the territories adjacent to the uncontrolled landfill sites quite often are in unsanitary conditions as well. Proceeding from this fact we can say that they make definite contribution to the pollution processes on the adjacent territories and respectively create a hazard



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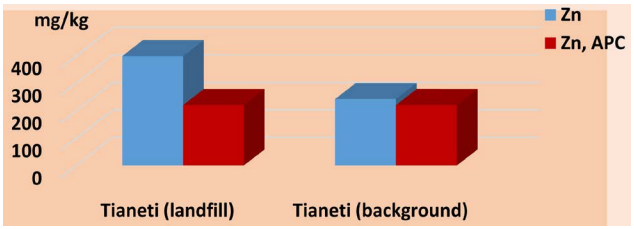

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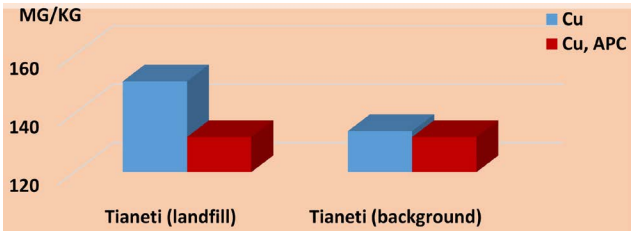

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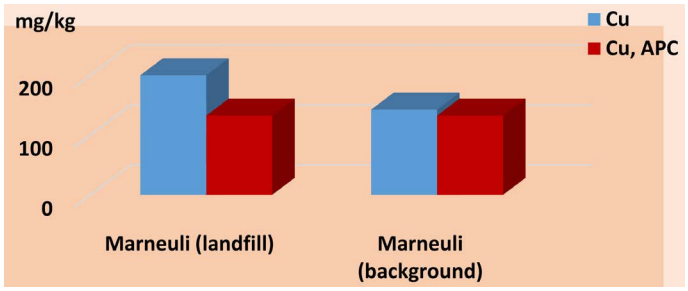
Figure 3. The lead (a), zinc (b) and copper (c) concentrations in the soil samples collected in Mtsketa-Tianeti Region.

Table 5. The heavy metals concentrations in the soil samples collected from the surrounding areas of the uncontrolled landfill sites in Mtskheta-Mtianeti Region.

Sampling location	Cu	Zn	Pb	Cd	Hg
			mg/kg		
Tianeti (landfill)	151	398	78	<2.0	-
Tianeti (background)	134	242	53	<2.0	-

Table 6. The results of chemical and microbiological analyses of the water samples collected from the River Iori.

#	parameters	units	Measurement results	MPC	methods
1	Ammonium	mgN/I	0.345	0.39	ISO 7150-1:2010
2	Nitrite	mgN/I	0.022	1.0	
3	Nitrate	mgN/I	0.147	10.0	
4	Phospate	mg/I	0.172	3.5	
5	Sulfate	mg/I	22.18	500	ISO 10304-1:2007
6	CI^-	mg/I	2.28	350	
7	Br^-	mg/I	0.099	0.2	
8	F^-	mg/I	0.088		
9	E-coli	1Iiter	1120	5000	
10	Total coliforms	1Iiter	1200		Membran filtration
11	Fecali streptococci	1Iiter	250		



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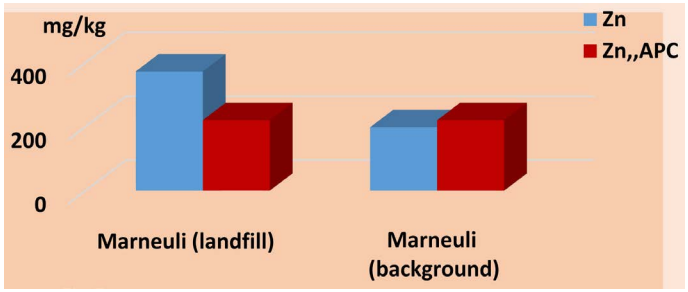

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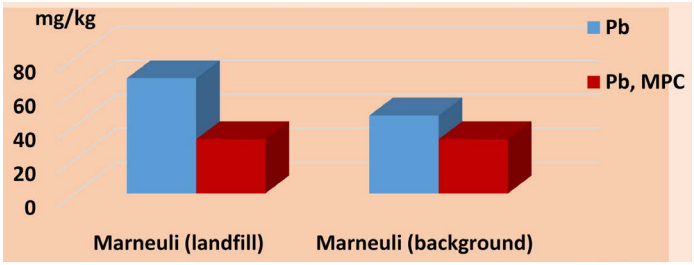

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Figure 4. The copper (a), Zn (b) and lead (c) concentrations in the soil samples collected in Kvemo Kartli Region.

Table 7. The results of physical and chemical analysis of the water samples collected from the River Iori.

Sampling location	pH	Conductivity, μSm/sm	Salinity, %	DO, mg/l (disolved oxigen in water)	t, ˚C
R. Iori (landfill)	8.22	213	0.015	8.0	3.8
R. Iori (background)	8.18	211	0.015	8.1	3.2

Table 8. The heavy metals concentrations in the soil samples collected from the surrounding areas of the uncontrolled landfill sites in Kvemo Kartli Region.

Sampling location	Cu	Zn	Pb	Cd	Hg
	Mg/kg				
Marneuli (landfill)	199	372	68	<2.0	-
Marneuli (background)	142	198	46	<2.0	-
Gardabani (landfill)	66	118	54	<2.0	-
Gardabani (background)	54	104	35	<2.0	-

of deterioration of population health resident there and all of this leads to the whole range of negative processes. In order to avoid this situation, the local self-government has to create the respective conditions for population that first of all implies the delivery of needed services (necessary amount of containers, increase of garbage trucks amount etc.) and on the other part, carrying-out of the whole range of measures in order to increase the awareness level of humans living there.

4. Conclusions

It is worth mentioning that the first time in Georgia the special research regarding the study of the negative impact of uncontrolled landfills on the ecological situation of the surrounding territories were carried out. The impact of these landfill sites on the surrounding areas and water bodies is determined. In particular, uncontrolled landfill sites contaminate the surrounding territories with such toxic components as lead, copper and zinc.

In most cases these pollutants concentrations exceed MPC and the territories adjacent to the uncontrolled landfill sites quite often are the areas whose conditions are insanitary. Consequently, it can be concluded that these landfills contribute to the contamination of the surrounding territories and thus create a threat to the population health that leads to a number of negative processes.

However, it should be noted that the impact of uncontrolled landfill sites on the ecological conditions of rivers is negligible.

To summarize, in order to eliminate the risks due to the environmental pollution and negative impacts on population health the local self-governments have to create the respective conditions for population that first implies on the delivery of needed services (necessary amount of containers, increase of garbage trucks amount etc.) and on the other part, carrying-out of the whole range of measures in order to increase the awareness level of humans there.

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Conflicts of Interest

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

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