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GEOECOLOGY OF THE BLACK SEA COAST OF GEORGIA

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Abstract: The combined geoecological works carried out within the bounds of Black Sea coastline (Georgian Section) in 2008 gave the following results: Contamination of sea water surface with oil products does not exceed the regulatory values; Hydrochemical parameters of sea and the rivers discharging into the sea were determined. High concentrations of magnesium and arsenic were observed in the bottom sediments of sea and Rioni River in Poti water area; the composition of copper, lead, zinc, magnesium and arsenic highly exceed the Dutch norms in some samples of toposoils taken along the agricultural terrain and motor road. As a result of radiation measurements carried out in the Black Sea coastline the sites are allotted where radiation is higher than the accepted norms; the concentration of magnesium in the biosamples (tea and eucalyptus) highly exceeds the maximum permissible concentration.

Keywords: Ecology, Geochemistry, Georgia, Black Sea, Radiation, Water Pollution.

A small, but important part of the World Ocean – the Black Sea – borders six countries: Bulgaria, Georgia, Romania, Russia, Turkey and Ukraine, with a total population of 165-167 million. During its history, the Black Sea has sometimes been a lake and sometimes a sea. 250-40 million years ago, it was at the edge of Tetis, which connected the present Atlantic and Pacific Oceans. In the area of the present Black, Caspian and Aral Seas there was formed a landlocked freshwater Sarmat sea-lake. It existed for 2-5 million years, and during this period developed freshwater flora and fauna, remains of which can be tracked up to date.
The shape of the Black Sea is changing: slowly, but firmly taking up its coast. The increase of the Black Sea level compared to its coastal marks has been tracked for as long as there are having been ongoing scientific observations. The ecosystem of the Black Sea has been closed for many thousands of years and slightly opened just seven thousand years ago. This ecosystem is still far from being in equilibrium and is very vulnerable to external factors. That is why changes of the biological structure of the Black Sea still take place.

In order to maintain acceptable water quality of the Black Sea, the main types of possible man-made pollutants need to be examined. One such pollutant is sewage sludge that after being treated is discharged into the sea. This type of liquid waste is usually treated beforehand and possible hazardous components are removed. However, in many cases sewage sludge is discharged into the sea without any treatment. There are cases when the ground that is generated during excavation works (for deepening passage for ships), feces and chemical wastes are discharged in the open sea. Additionally, the solid waste from ships and ballast waters containing petroleum are discharged into the sea. There are other ways for pollutants to enter the sea. The particles of pesticides used from the chimneys, and the exhaust from vehicles and planes enter the sea from the air. From the painted ships, small amounts of toxins are released into the sea. The paint is used in order to avoid ships being overgrown by algae and crustaceans. As a result of forest fires, a large amount of ashes and metal oxides enter the ocean. This particular type of pollution is caused by the accidents of tankers carrying petroleum.

The most significant pollution of the sea is one in which atypical chemicals, such as gaseous and aerosol pollutants, come from the industries and households. The amount of carbonic acid in the air is increasing as well. Further development of this process may result in the unfavorable tendency of increasing the average sea level on the Earth. The pollution of the world ocean with petroleum products is also alarming. Nowadays, 1/5 of the World Ocean's surface is polluted. Such scale of the pollution with the petroleum may result in significant disturbances in the exchange of gas and water between the hydrosphere and atmosphere. Without a doubt, chemical pollution of soils with pesticides and its increased acidity that result in the collapse of the ecosystems is very significant. Thus, all the above mentioned factors those have polluting characteristics have a significant influence on the processes taking place in the biosphere.

Hydrochemical and climatic characteristics of the Black Sea as well as its socio-economic aspects influence the character of shelf flora.

While making decisions about the realization of certain projects mainly connected with transportation of goods, the transnational corporations mostly focus on profit. Quite often, the governments of states behave the same way and do not always bother themselves with assessing the consequences of the project.

The main problem is the absence of a mechanism for calculating material damage to the state treasury and to the region's population. A population's well being significantly depends on the development of tourism as a result of constructing pipelines and petrol terminals in the coastal zone.

In the beginning of 1980, the world community realized that the environmental crises may become a threat for its existence. During that period, the international mechanisms addressing environmental problems and common usage of natural resources were developed. The special institution – Global Environmental Facility (GEF) – was established to implement the projects related to the global changes in the biosphere. During the conference in Rio de Janeiro in 1992, a number of conventions were adopted that became important instruments for solving existing global problems.

These documents were signed by the countries of Black Sea region as well. These countries also signed the Bucharest Convention on the protection of the Black Sea from pollutants and the Odessa Declaration. In 1996, two documents were adopted in the framework of the Black Sea Environmental Program (BSEP): "Transboundary diagnostic analysis of the Black Sea" and "Strategic Action Plan on Rehabilitation and Protection of the Black Sea". According to these documents, the states of the Black Sea region took on the obligation to develop a joint strategy on the protection and rehabilitation of the Black Sea and on the management of its coastline and marine resources for the coming 20 years.

Fourteen years have already passed, but none of the states has met its obligations. Besides, there are unimplemented provisions of the Bucharest Convention on the creation of the Istanbul Commission and Black Sea Environmental Fund. Measures set in the Bucharest Convention and the Odessa Declaration regarding saving the Black Sea remain unrealized. Mean-while, the situation has drastically worsened. Plans for using resources of Black Sea are mainly worked out in the countries far away from the region. However, the coast for maintenancy of the management and the rehabilitation and protection works of the sea are to be covered by the states of the Black Sea basin.

The radiation pollution caused by humans is related to the accident at the Chernobyl Atomic Power Station. During those days in 1986, radiation was deposited on some area of the Black Sea coastline. According to the radiometric measuring in 1987-1989, strong pollution by radioactive nuclides was determined. On some sections of the coastline the level of radiation was from 30-60 to 90-225 μR/h with the maximum acceptable norm of 10 μR/h. Unfortunately, due to the political and economic cataclysms in Georgia by the end of the century, the monitoring of the radiological and geoecological conditions of the coastline was cut down. Its resumption is very important for the well being of the population and proper functioning of economy of the states of the Black Sea region.

The analysis of the ecological data (Kvinikadze at al. 2006) shows that a large part of the territory of Georgia exposes from geochemical, hydrochemical and biochemical pollution related to the increased man-made waste. This process also concerned the Black Sea coastline. A special concern is raised in relation to the cities and populated sites with the developed industrial activities. In this regard, the port cities of Batumi, Poti and Sukhumi should be mentioned. The negative impact on the environment in these places is caused by the trade and military ships that violate environmental laws. As a result, the Black Sea water was polluted with the petroleum.

Large amount of pollutants are discharged into the Black Sea from the rivers Rioni, Bzib, Enguri, Psou, Choloki, Mzimta, Kodori, Supsa and others. Various mining, metallurgic, chemical or agricultural plants that are located within the basin of these rivers annually discharge into the rivers and as a consequence – into the Black Sea.

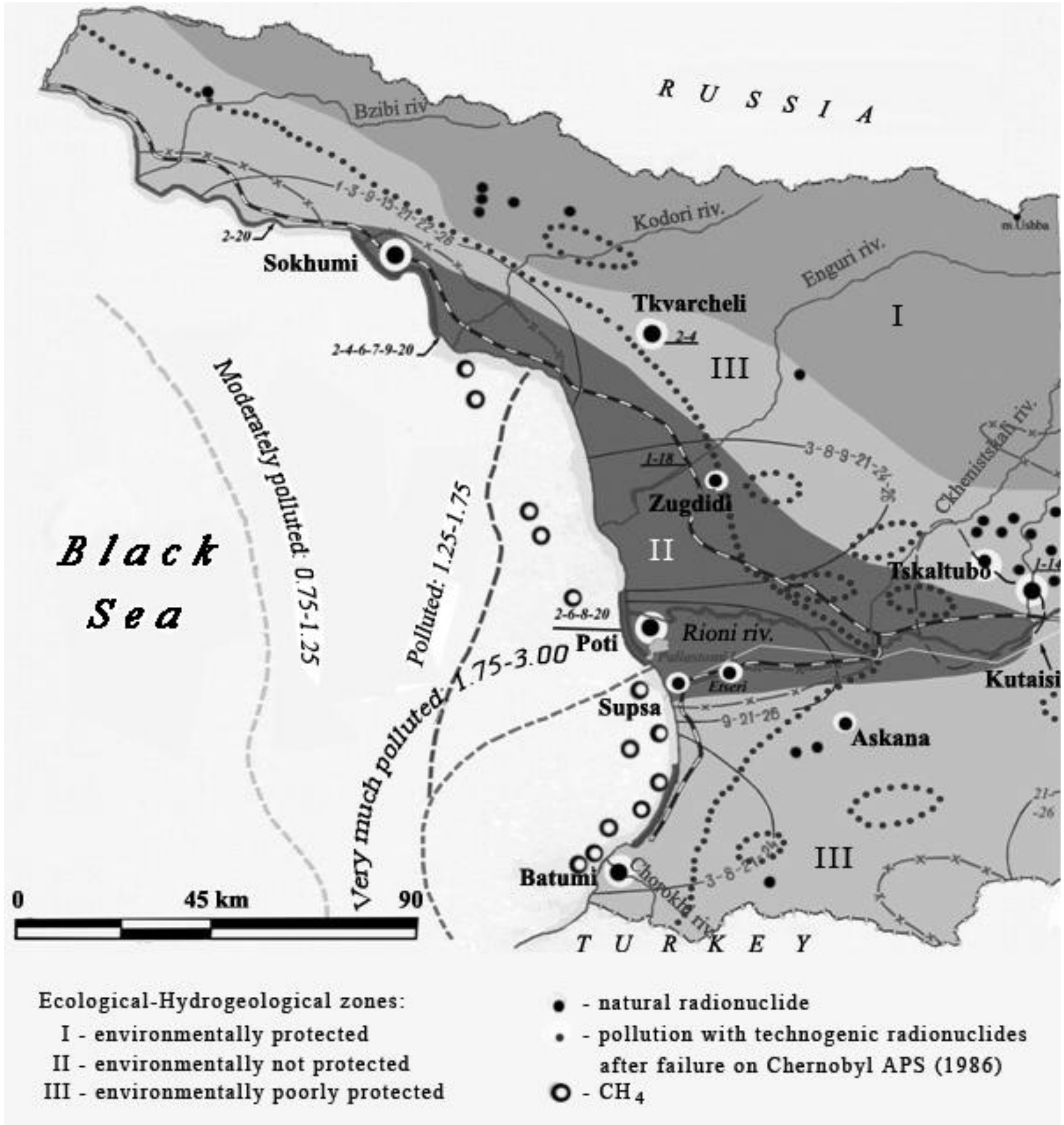

Fig.1. Geoecological map of the Black Sea coast of Georgia. The characters indicates high (in comparison with maximum allowable concentration MAC) contents of chemical elements concentration in underground water: 1-Phenol; 2-Biological need of oxygen; 3-Petroleum; 4-Chloride; 5-Sulfate; 6-Acids; 7-Cyanide; 8-Mn; 9-Fe; 10-Cu; 11-Zn; 12-Pb; 13-Ni; 14-As; 15-Ba; 16-Co; 17-Ag; 18-S; 19-V; 20-Bacterias and feces; 21-Ammonium; 22-Bromine; 23-Flint; 24-Dust;25-Li; 26-NO_2; 27-Synthetic superficially active substances; 28-Cd.

Considering all the above mentioned and based on literary and archive materials the geological map of Black Sea and coastline was developed illustrating actual data of 80-90’s of the last century (Fig. 1). Research in the last several years has determined that on the territory of Georgia there are natural radiation anomalies belonging to the group U-Ra-Th-K (Kvinikadze at al. 2007). They are connected to the Paleozoic granites and Mid-Jurassic coal-beds. It was set that unfortunately, 20 years ago, radiation anomalies were located near the settlements.

Today to assess the geoecolgical condition of the Black Sea section of Georgia the following items have to be studied:

- Contamination degree of sea water and coastline by petroleum products;
- Determination of industrial waste qualitative and quantitative contamination parameters of the waters discharging into sea (rivers);
- Contamination of coastline by technogenic origin radiation nuclides – remains of Chernobyl Atomic Power Station accident;

- Contamination of Black Sea and coastline by household waste, toxin-chemicals, fecal waters and etc.

In order to specify these issues in 2008 the integrated geoecological works were carried out in the southern part of Black Sea coastline, the results of which are given in the article. Black Sea water surface, bottom sediments of the surface and the waters discharging into the sea with their hydrochemical parameters has been studied. Also the topsoil used in the agriculture as well as the surface topsoil layers existing along the motor roads have been studied under the present project.

From the Sarpi area, including Rioni River, almost along the total coastline we have conducted radiation measurements. The concentration of the heavy metals in the biological specimens was determined in the plants that are used as food products (corn, nut, mandarin, tea and others).

The radiation measurements have been carried out in Sarpi (Georgian-Turkish Border)–Poti (Sea Port of Georgia) section. As it is known, as a result of Chernobyl accident Black Sea coastline and particularly this section of Georgia was contaminated with radiation nuclides. The measurements made in 2008 (Fig. 2) show that, today in comparison

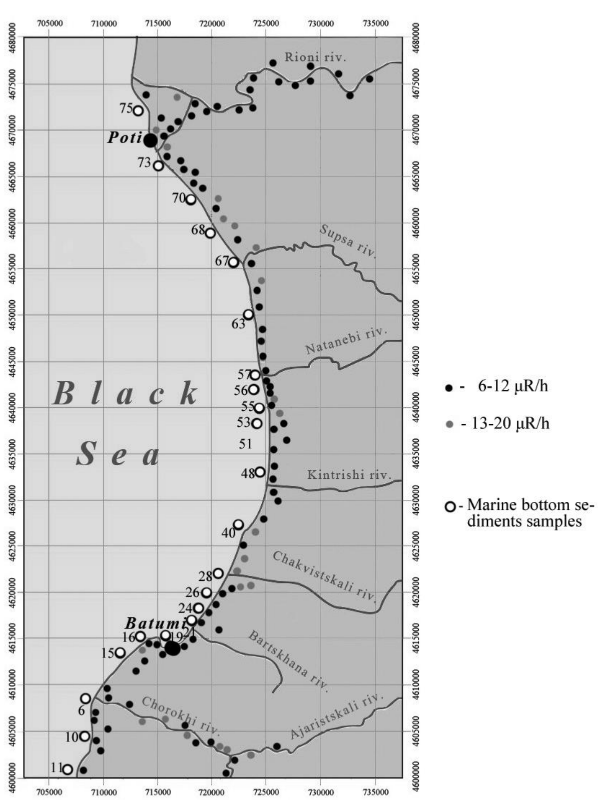

Fig.2 Radiation measurements and marine bottom sediment specimens.

with the established background of radiation in Georgia (8-10 μR/h), high levels of radiation (20 μR/h) were observed only in the plants of Mtsvane Kontskhi (particularly in the tea plantations) and in Batumi and Poti ports adjacent territories (lawns). In some canyon of the rivers (for example Adjaristskali River) and its tributaries the radiation elevations slightly were more than they are permitted (14-17 μR/h). In our opinion the existence of high levels of radiation background are stipulated by peculiarity of topsoil's (where there is high radiation level, the topsoil layers have clay features). As regards to Sea coastline itself (sand of the beach) the radiation background meets all the acceptable values and sometimes is even less.

As the studies show, the distribution of carbohydrate in Black Sea surface water samples does not exceed the acceptable norms. Their existence is observed as a form of trace. Therefore the composition of petroleum products in Black Sea water quite meets the acceptable norms ($\leq$0.04 mg/l). It has to be mentioned that these sea samples were taken in September of 2008, when due to August events (Georgian-Russian conflict) travel by sea was almost stopped.

Besides the petroleum products, the bottom sediments of sea coastline were studied on heavy metals. As it is shown in figure 3, in the area of Poti, where Rioni River joins the Sea, the concentration of manganese (Mn), zinc (Zn) and, in single instances, arsenic (As) is high in the collected marine samples. The analogical type of the samples was taken from all the rivers discharging into the Black Sea.

As figure 4 shows high concentration of heavy metals (copper and zinc) is observed in some samples that were taken from the rivers Kintrishi and Chorokhi. In the bottom sediments of Rioni River analogically in the bottom sediments of the Sea, the composition of manganese and arsenic is high. This fact is very easy to explain as Chiatura manganese and Lukhumi arsenic mines are located at the basin of the above mentioned rivers.

While survey of topsoil two types of topsoil were revealed (Table 1) - topsoil used for pastures located along the roads and topsoil used in the agriculture.

In the second type of the topsoil (used in the agriculture) heavy metals' abnormal data are noted in unit samples. There is high concentration of manganese (11800 mg/kg) and arsenic (25.9 mg/kg) in

Chaladidi (Rioni River right embankment) and Mtsvane Kontskhi (Chakvistskali River) topsoil.

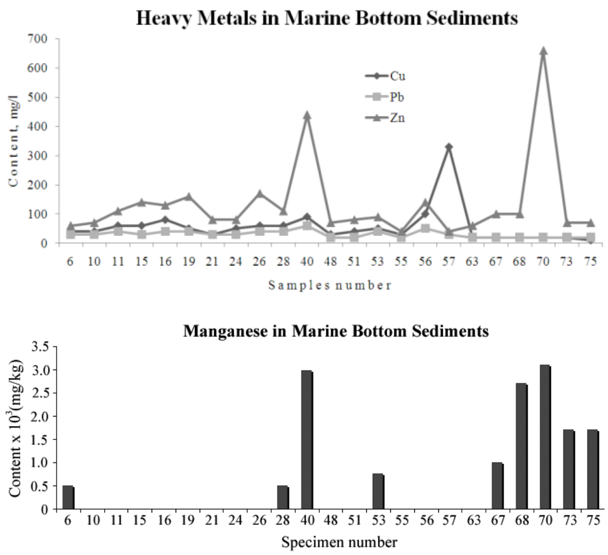

Fig. 3. Heavy metals and manganese contents in the marine bottom sediments (Specimen numbers see on Fig. 1.)

The existence of toxin-chemicals was observed in some samples as a form of large amount of copper. The high concentration of copper is revealed in some samples taken along the motor road. As in the bottom sediments of the sea and rivers, manganese and arsenic concentrations are very high also in the bottom sediments of the topsoil taken in Poti areas.

The plants that are food products are basically used as biosamples. The data in Table 2 show that the manganese in biological samples submitted as a dominant element. In some cases its composition is very high. For example, for the eucalyptus it is 232-255 mg/kg, but for the tea leaves 632 mg/kg. It has to be noted that the species of these both plants are located at the territory of Mtsvane Kontskhi (Chakvistskali river), where the quantitative indications of such elements are very high.

As regards to biological contamination, it basically concerns the waters of Rioni river and Chorokhi river as it is clearly illustrated on the map developed by us (Fig.1). In our opinion this is caused by high coefficient of the settlement in these rivers' basins, so the large amount of household and fecal waters enters these rivers: Chorokhi and Rioni and by means of them the toxic waste joins the Black Sea water.

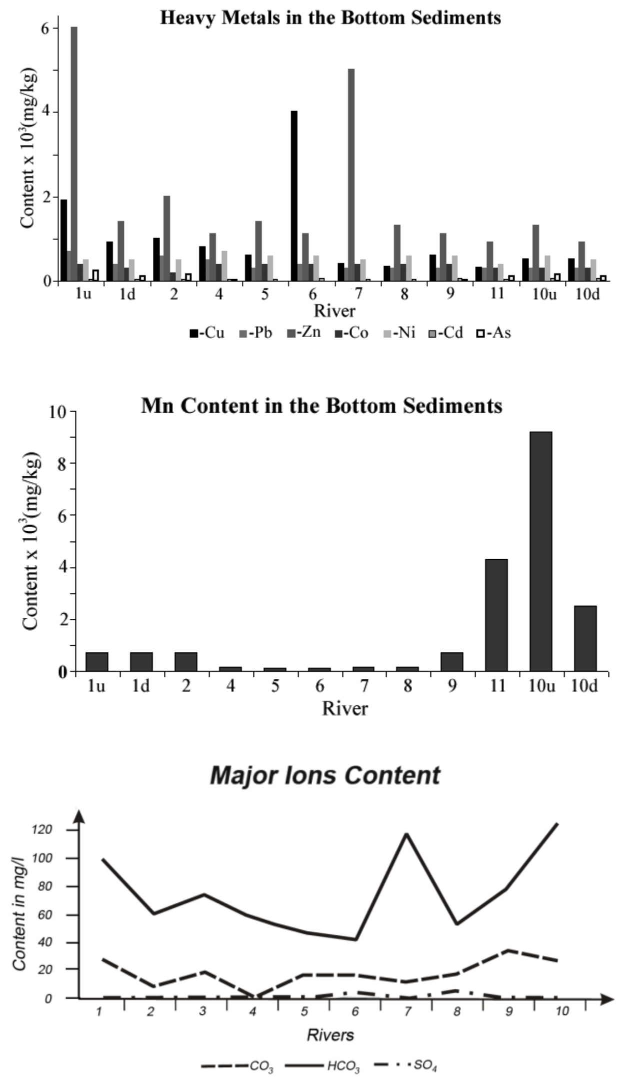

Fig. 4 Heavy metals and manganese contents in the rivers bottom sediments and major ions content in the river water. Rivers: 1-Choroki; 2-Ajaristskali; 3-Bartskana; 4-Korolistskali; 5-Chakvistskali; 6-Kintrishi; 7-Choloki; 8-Natanebi; 9-Supsa; 10-Rioni; 11-Maltakva (u-upstream, d-downstream)

Conclusions

1. The high concentration of manganese and arsenic in the bottom sediments of the sea, river and agricultural topsoils is observed in Poti areas that are due to the precipitation coming from the manganese and arsenic mines located at Rioni River basin.
2. The high concentration of copper, lead and zinc is observed in the topsoils existing along the motor road, what in our opinion is due to the sedimentation processes of vehicles' exhausting gases.

Table 1. Heavy Metals Content in Topsoil along the Roads and Used in Agriculture.

Coordinates		Content (mg/kg)							
N	EO	Cu	Pb	Zn	Co	Ni	Cd	Mn	As
*		36	85	140	20	35	0.8	1500	2.9
Topsoil Along the Roads									
41º 34′ 11.60″	41º 33′ 57.20″	130	70	250	30	40	5.0	-	-
41º 31′ 16.00″	41º 32′ 59.00″	150	70	140	50	120	7.0	-	-
41º 38′ 08.40″	41º 36′ 26.76″	80	50	250	30	40	5.0	-	-
41º 38′ 34.98″	41º 37′ 01.80″	80	40	140	30	30	4.0	-	-
41º 39′ 09.24″	41º 38′ 0.42″	500	60	150	60	50	6.0	-	-
41º 38′ 57.90″	41º 38′ 39.60″	80	60	130	30	60	3.0	-	-
41º 40′ 09.00″	41º 41′ 15.06″	150	80	380	40	60	4.0	-	-
41º 41′ 04.68″	41º 42′ 03.96″	130	70	670	20	50	4.0	-	-
41º 41′ 42.12″	41º 42′ 35.10″	100	60	90	40	50	6.0	990	-
41º 41′ 56.40″	41º 43′ 00.96″	120	70	180	40	60	7.0	940	-
41º 42′ 13.02″	41º 43′ 15.42″	60	40	100	40	40	5.0	2350	
41º 41′ 22.92″	41º 42′ 56.70″	150	40	230	30	30	4.0	-	-
41º 38′ 46.02″	41º 38′ 23.28″	130	110	200	40	50	5.0	1190	-
41º 38′ 13.62″	41º 37′ 05.94″	120	80	1130	30	40	5.0	-	-
41º 43′ 02.76″	41º 43′ 59.82″	60	30	140	40	60	5.0	-	-
41º 44′ 07.80″	41º 44′ 02.34″	100	80	350	500	60	6.0	2270	-
41º 45′ 01.86″	41º 44′ 39.42″	150	60	270	50	60	7.0	-	-
41º 45′ 31.08″	41º 45′ 35.40″	500	70	330	50	150	7.0	-	-
41º 46′ 11.94″	41º 45′ 20.70″	130	60	100	40	40	5.0	1340	-
41º 47′ 15.12″	41º 46′ 00.36″	400	40	1700	30	50	5.0	-	-
41º 49′ 30.72″	41º 46′ 33.48″	500	1400	300	30	60	5.0	-	-
41º 51′ 33.72″	41º 46′ 46.86″	50	40	270	20	60	5.0	-	-
41º 52′ 38.46″	41º 46′ 32.82″	40	30	230	30	110	4.0	-	-
41º 52′ 38.46″	41º 46′ 32.82″	30	20	40	20	50	4.0	-	-
41º 53′ 42.84″	41º 46′ 24.12″	100	50	140	30	40	4.0	-	-
41º 56′ 07.02″	41º 46′ 19.14″	20	20	70	30	60	4.0	-	-
41º 58′ 47.58″	41º 46′ 57.78″	20	30	110	30	60	5.0	-	-
42º 04′ 23.34″	41º 42′ 57.48″	40	130	430	30	60	4.0	1000	6.4
42º 04′ 23.34″	41º 42′ 57.48″	30	30	80	30	50	5.0	1100	8.0
42º 04′ 50.76″	41º 42′ 42.04″	40	30	110	30	400	5.0	900	11.2
42º 06′ 12.90″	41º 42′ 02.46″	20	40	400	30	60	5.0	1200	<1.6
42º 09′ 09.18″	41º 39′ 19.62″	80	40	140	30	60	5.0	1300	8.0
42º 12′ 48.12″	41º 48′ 01.98″	20	20	70	20	40	5.0	-	8.0
42º 10′ 41.04″	41º 41′ 14.70″	60	50	150	30	50	7.0	1700	<1.6
42º 09′ 00.60″	41º 40′ 18.96″	360	150	300	30	50	7.0	4600	8.0
42º 08′ 10.02″	41º 46′ 32.82″	20	30	80	30	40	5.0	1800	14.4
Topsoil Used in the Agriculture									
41º 35′ 43.22″	41º 38′ 31.57″	600	60	330	30	60	5.0	-	-
41º 32′ 50.70″	41º 33′ 51.60″	120	50	120	40	40	5.0	-	-
41º 32′ 50.70″	41º 33′ 51.60″	110	50	150	40	40	5.0	1000	-
41º 38′ 58.74″	41º 39′ 55.10″	50	60	430	30	40	5.0	-	-
41º 41′ 31.44″	41º 42′ 55.74″	150	90	50	30	40	7.0	11800	<1.6
41º 42′ 30.18″	41º 43′ 26.10″	40	60	10	30	40	6.0	-	-
41º 42′ 07.68″	41º 43′ 58.98″	50	40	50	30	80	7.0	-	-
41º 48′ 16.74″	41º 46′ 34.74	700	80	580	40	60	6.0	-	-
41º 50′ 21.00″	41º 46′ 43.20″	400	70	600	30	60	5.0	-	-
41º 50′ 21.00″	41º 46′ 43.20″	50	30	120	30	60	4.0	-	-
41º 56′ 42.60″	41º 46′ 14.58″	40	40	90	40	85	5.0	-	-
41º 57′ 17.70″	41º 46′ 16.50″	60	40	80	30	50	5.0	-	-
42º 12′ 48.12″	41º 48′ 01.98″	50	50	160	30	40	6.0	-	25.6

* Standards, which correspond to natural background (Fomin and Fomin 2001)

Table 2. Heavy Metals Content in Biological Samples.

Biological Sample	Content, mg/kg						
	Cu	Pb	Zn	Mn	Co	Ni	Cd
Eucalyptus (leaf)	0,80	1,10	2,00	7,70	1,00	1,50	0,30
Eucalyptus (stalk)	12,00	6,60	23,00	23,00	4,00	5,00	1,30
Mandarin	3,75	3,90	6,00	6,00	2,30	2,00	0,50
Grass	12,00	8,80	33,00	56,00	6,40	5,50	1,00
Palm	4,00	3,30	14,00	77,00	1,90	2,00	0,50
Broomcorn	4,80	3,50	26,00	23,00	2,00	1,50	0,30
Walnut (foetus)	2,50	2,20	16,00	10,00	1,00	1,00	0,20
Walnut (stalk)	3,80	5,00	36,00	13,50	5,50	6,00	2,00
Walnut (leaf)	6,30	7,00	27,00	60,00	6,50	7,00	2,00
Corn (stalk)	4,50	3,50	39,00	12,00	14,00	1,50	0,25
Corn (husk)	8,50	5,50	28,00	54,00	1,00	1,50	0,70
Corn (ear)	1,50	1,65	29,00	9,50	0,90	1,50	0,30
Corn (leaf)	1,25	1,65	9,00	11,50	0,50	0,50	0,15

3. Rather high radiation data are stipulated by lithological and plant cover peculiarity of the topsoil.
4. The composition of heavy metals in the bio-samples has the selective nature and basically is defined by topsoil geochemistry.
5. Biological contamination is connected with the rivers, on which the town type settlements are located. Also it can be caused by bad working of cleaning structures' or their absence on the rivers at all.
6. In October-November of 2009 we are planning to perform the monitoring of the works carried out in 2008, which will enable us to define the received results precisely.

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