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The Impact of Anthropogenic Activities on The Indicators of Environmental Pollution

Rostislav Dmitrievich Magomet and Natalia Aleksandrovna Mironenkova

National mineral resources university (university of mines),
Russia , Saint-Petersburg, Vasiljevsky island, 21st line 2.

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The article aims at studying the impact of anthropogenic activities on the environment and presents the results from the analysis of soil samples in the area of industrial waste landfills. The industrial environment of the Bryansk region of the Russian Federation is considered as an example. Monitoring of the soils, groundwater bodies and the air in the area of the possible impact of industrial waste landfill has been conducted. Monitoring was carried out for 5 year period. Oil pollution, a significant excess of maximum permissible concentration of chromium, zinc, and nickel salts show pronounced technological environmental impact of industrial enterprises.

Key words: Technological environmental pollution,
Soil analysis, Excess in concentrations, industrial waste landfill.

The Zhukovski Region of the Russian Federation is located in the north of the Bryansk Region in the basin of the Desna, Vetma, and Ugost rivers, and is one of the most economically developed industrial centers of the Bryansk Region [Ahromeev, 2000, 2007]. The Zhukovski Region occupies the area of 111.458 hectares. Half of the area is covered by forests, mainly coniferous. Soils are dominated by sod weak podzol and mezopodzol. The climate is temperate continental. Summers are warm, while winters are moderately cold. Zhukovski Region represents diversified industry, wood processing, food and processing industry, intense forestry, and agricultural production. Industrial and domestic wastes, as well as landfills contribute to pollution and unsustainable use of land, creating a real threat of pollution of the atmosphere, surface and groundwater, as well as increasing transport costs and irretrievable loss of valuable materials and substances (Barishnikov & Bor, 1992). Just during 2010 the Region has produced more than 4.000 tons of waste (Bastrakov & Bor, 2009) from the following sources:

a) Individual residential and high-rise buildings;
b) Economic and cultural institutions, shops, and gas stations;
c) Utilities (housebreaking and construction of buildings, street scavenging, amenity planting, parks, beaches, residues from waste incineration and recycling, water supply and sanitation);
d) Schools, childcare settings, and hospitals;
e) Industry;
f) Agriculture.

Morphological composition of municipal solid wastes generated in the Zhukovski Region is quite

* To whom all correspondence should be addressed.

diverse. Construction waste includes 20% of polymer waste, 15% of glass scrap, 10% of the metal scrap, 40% of polymeric material, 8% of sand, and 7% of stones, crushed stone, gravel and others.

A significant amount of wood waste is part of the household waste, generated in the city and disposed at the landfill. A distinctive feature of construction waste is its low bulk density and large amounts that lead to congestion of landfills and significant consumption of fuel and lubricants due to the necessity to involve a large number of vehicles.

The city purification scheme against construction waste provides recycling of part of the waste into secondary raw materials. The landfills accept construction waste related to hazard class 4, which, according to regulatory documents, can be accepted by municipal solid waste landfills without restriction and used as an insulating material (Bryansk region. The scheme of territorial planning, 2008).

Methods

Environmental monitoring of the waste disposal sites represents a system of discrete and continuous observations of the natural environment status and its evaluation. This allows duly identification and elimination of the negative anthropogenic processes, as well as the development and implementation of a set of effective environmental protection measures on the basis of operational and medium-term forecasts of changes in the indicators of the environmental status.

Describing the extent of the environmental pollution sources (Bastrakov & Bor, 2007) and their intensity on a hierarchical basis and spatio-temporal level, the monitoring of environmental factors at the waste processing and landfilling sites refers to a local or impact one, as it is associated with specific objects of pollution sources (municipal, industrial, and agricultural waste processing and landfilling sites). Characteristic proportions of landscape and hydro-chemical redistribution of contaminants at the places interfacing with various components of the natural environment are important indicators for this type of human intervention on the environment. Natural and human-caused processes on waste disposal sites are related to slow phenomena; in this connection, it is advisable to carry out periodical observation of these processes.

In order to eliminate the possibility of unauthorized storage of waste containing radionuclides, landfill staff carries out radiological control on a day-to-day basis when receiving and discharging waste.

The main monitoring objects at the disposal and landfilling sites are the atmosphere, surface and ground waters, soil, biota, urban environment, and the population (Magometa & Bor, 2008, 2009).

Prioritized environmental indicators include the level of soil salinity by easily soluble salts, heavy metal pollution, the presence of organic pollutants, and the reaction of environment (Shkotova & Bor, 2010).

Monitoring of the soils, groundwater bodies and the air status in the area of the possible impact of the landfill is defined by the availability of SO_4^{2-}, CI^{2-}, HCO^{3-}, Ca^{2+}, Mg^{2+}, Na^+ ions in aqueous extracts.

Control over radiological parameters in terms of availability of heavy metals, such as Ni, Pb, Zn, Cr, V, Kd, Zr and others is performed by landfill staff on a day-to-day basis when receiving and discharging waste.

Small amounts of heavy metals, available in soils, serve minor-nutrient elements necessary for plants life. Heavy metals in amounts exceeding the maximum allowable concentrations are highly toxic pollutants, which adversely affect plants. For example, zinc reduces the intensity of the organic matter transformation processes in the soil, facilitates change in physical and physicochemical properties of the soil; at that it is absorbed by plants quite easily.

It is also necessary to note the impact of lead, which also adversely affects the biological activity in the soil, inhibiting the activity of biological catalysts and violating microorganisms' metabolism. Lead is well absorbed and stored by plants that slows their growth and leads to gradual destruction. Using an animal feed, containing 3 mg or more of lead per 1 kg of dry weight, results in its accumulation in animal tissues (Scherbo, 2002; Chusovitina, 2010).

Chemical characteristics of the soil include also content of chromium, manganese, nickel, zinc, copper, phosphorus, chloride, sulfur, oil products, exchangeable ammonium, nitrates, as well as pH value (pH of salt extract and pH of the aqueous extract) (Middleton, 1997; Towards Sustainable Development, 1998).

Main part

Soil sampling was carried out taking into account its vertical structure, heterogeneity of soil cover, topography and area climate, as well as with regard to the specifics of pollutants or organisms in the sample plots (Wilhelmson & Bor, 1998; World population prospects, 1996). Soil samples were taken at the following points: the sample #1 was taken from the surface of the landfill, while the sample #2 – beyond the secondary containment of the landfill, and the sample #3 (ambient concentration) – 200 meters from the landfill. Sample #3 was investigated only in terms of the oil content.

Samples were collected in following order: point samples were taken at the test site from one or more layers or horizons by envelope method, cornerwise, in such a manner that each sample represented the soil portion, typical for genetic horizons or layers of the given soil type. Then point samples were taken by filling knife from small trench and soil sampling tube. Afterwards, the

Table 1. The results of chemical analysis of the soil from solid municipal waste landfill for the period of 2002-2009. (Sample #1 is taken from the solid municipal waste landfill)

Indicators	Admissible concentration limit, mg/kg	Research results					
		2002	2003	2004	2006	2007	2009
Hydrogen index (pH of salt extract)	_	7.42	7.46	7.47	8.06	5.1	7.37
Phosphorus (labile form)	200.0	549	436	247	306	0	0
Copper (labile form)	3.0	223	111	19.7	11.9	198	11.9
Zinc (labile form)	23.0	226	96.8	15.6	50.3	376	50.3
Nitrates	130.0	5.15	8.69	7.25	3.5	3.5	3.5
Petroleum products	15.0	13.7	26.7	457	80	41	80
Sulfur (labile form)	160.0	566	473	350	0	0	0
Nickel (labile form)	4.0	801	466	214	25.2	205	25.2
Manganese (labile form)	1500.0	299	312	291	0	0	0
Chrome	6.0	11	10.2	9.6	0	0	0
Lead (labile form)	6.0	0	0	0	6.0	37	13

Table 2. The results of chemical analysis of the soil from solid municipal waste landfill for the period of 2002-2009. (Sample #2 is taken beyond the secondary containment of the landfill)

Indicators	Admissible concentration limit, mg/kg	Research results					
		2002	2003	2004	2006	2007	2009
Hydrogen index (pH of salt extract)	_	5.02	5	5.13	6.58	5.15	5.44
Phosphorus (labile form)	200.0	270	259	211	92.3	0	0
Copper (labile form)	3.0	7.2	7	5.3	0.1	13.8	0.1
Zinc (labile form)	23.0	1.66	1.6	1.6	0.3	53.3	0.3
Nitrates	130.0	1.94	2	1.96	3.5	3.5	3.5
Petroleum products	15.0	6.1	106	173	15.5	33.5	15.5
Sulfur (labile form)	160.0	4.74	4	3.2	0	0	0
Nickel (labile form)	4.0	15.3	9.6	4	1	57.6	1
Manganese (labile form)	1500.0	49.3	50.1	49.7	0	0	0
Chrome	6.0	6.9	6	4.2	0	0	0
Lead (labile form)	6.0	0	0	0	6.9	4.1	0.4

combined sample was prepared by mixing point samples taken at the same test site. The combined sample for chemical analysis consisted of at least five point samples taken from the same test site. The weight of such combined sample was at least 1 kg. Point samples to control substances, extending over the surface, such as oil, oil products, heavy metals and others, were taken layer by layer from the depth of 0-5 and 5-20 cm, and weighed not more than 200 g each. Possibility of secondary pollution when selecting point samples and integrating combined sample, was excluded. Soil point samples for detecting heavy metals were taken by tools containing no metals. Prior to the selection of point samples, the wall of the small trench and the surface of the drill sample were protected by plastic filling knife.

Nitrates detection technique was based on the detection of nitronic acid when reacting of nitrates with phenoldisulfonic acid, which, when interacting with the alkali, forms compounds, giving the solution yellow color.

The zinc content in the soil was determined by the photometric method: labile zinc compounds were extracted from the soil by acetate ammonium standard buffer with pH of 4.8 and further were defined by photometry with dithizon.

Detection of phosphorus was carried out using method, based on formation of molybdenum blue by reacting of phosphate ions with ammonium Mb in the presence of a reducing agent.

Manganese was determined by extracting the labile Mn compounds from soil with sulfuric acid with concentration of (1/2 H_2SO_4) = 0.1 mol/ dm^3.

Chromium detecting method was based on the extraction of chromium from the soil and measurement of the chromium atomic absorption using a full-cathode lamps at 15 mA current and the wavelength of 357.94 m.

To detect copper, labile copper compounds were extracted from the soil by acetate ammonium standard buffer with pH of 4.8, and were detected by means of atomic absorption or photometric method with lead diethyldithiocarbomate.

The research results are given in Tables 1 and 2 (State report "On the sanitary 2008, 2009; State report on the status 2007, 2008, 2009).

In 2002, in the sample #1, taken from the landfill, the concentration of phosphorus exceeded the maximum permissible concentration by 2.7 times, copper – by 74.2 times, zinc - by 9.8 times, oil products – by 9.2 times, sulfur (labile) – by 3.5 times, nickel – by 205.3 times, and chromium – by 1.8 times. In sample #2, taken from secondary

Table 3. Indicators of discharged waste water

Substances and composition indicators	Concentration of a substance above the disposal site , mg/l	Concentration of a substance in sewage disposal (disposal #1)	Concentration of a substance in sewage disposal (disposal #2)	Concentration of a substance below the disposal site , mg/l
pH	7.6	-	-	7.6
Dissolved substances	255	400	300	265
Weighted substances	8.5	12	10	9
Biochemical oxygen demand (BOD)	2.48	12	3	2.48
Oil products	-	0.05	0.05	-
Chlorides	9.8	70	40	9.8
Iron	0.24	0.25	0.2	0.26
Dissolved $_2$	8.6	-	-	8.5
Sulfates	7.2	70	40	7.2
Nitrate nitrogen	0.28	6.5	-	0.34
Nitrite nitrogen	0.007	0.05	-	0.008
Ammonia nitrogen	0.14	10	0.25	0.17
Phosphates	0.46	5	0.3	0.47
Copper	0.001	0.003	0.003	0.001

containment of the landfill, the phosphorus content exceeded the maximum permissible concentration by 1.4 times, copper – by 2.4 times, nickel – by 3.8 times, chromium by – 1.2 times, oil products – by 4.1 times. The oil products content in the sample #3 (ambient concentration) did not exceed the maximum permissible concentration.

In 2003, in the sample #1, phosphorus concentration exceeded the admissible concentration limit by 2.2 times, copper – by 36.9 times, zinc – by 4.2 times, sulfur – by 3.0 times, nickel – by 116.3 times, chromium – by 1.7 times, and oil products – by 17.8 times. In the sample #2 phosphorus content exceeded the admissible concentration limit by 1.3 times, copper – by 2.3 times, nickel – by 2.4 times, and oil products – by 7.1 times.

In 2004, in the sample #1 phosphorus concentration exceeded the admissible concentration limit by 1.2 times, copper – by 6.6 times, oil products – by 30.4 times, sulfur – by 2.2 times, nickel – by 53.6 times, and chromium – by 1.6 times. In the sample #2 phosphorus content exceeded the admissible concentration limit by 1.1 times, copper – by 1.8 times, and oil products – 11.5 times.

In 2006, in the sample #1 phosphorus concentration exceeded the admissible concentration limit by 1.5 times. In the sample #2, no excess of the admissible concentration limit was revealed.

The highest values of copper, exceeding the admissible concentration limit by 65.8 times, were found in the sample #1 in 2007. In the subsequent period there has been a 3-fold reduction of concentration exceedances. In sample #2 copper concentration exceeded the admissible limit by 4.6 times.

In 2009, copper concentration in the sample #1 exceeded the admissible concentration limit by more than 3.9 times, while in the sample #2 content of copper did not excess the admissible concentration limit.

A tendency of exceeding the admissible concentration limit of zinc in the soil still remains essential. Thus, in 2006, its concentration in the sample #1 exceeded admissible limit by factor of 2.17; about the same concentration level was typical for 2007-2009. The sample #2 showed no concentration excess during the period of 2006-2009. The year of 2007 was distinctive in terms of maximum excess of zinc concentration; thus, in the sample #1 Zink content exceeded the admissible concentration limit by 16.3 times, whereas in the sample #2 – by 2.3 times.

Years 2006 and 2009 showed the stable indicators in terms of exceeding the admissible concentration limit of petroleum products in the samples #1; here the concentration exceeded by 5.3 times, while in the samples #2 – by 2 times.

In terms of nickel content, in the samples #1 the excess of the admissible concentration limit in 2006 and 2009 was 6.3 times, while the samples #2 did not show the excess of the admissible concentration limit.

The maximum excess of nickel was recorded in 2007 in the sample #1, which was 51.2 times, and 6.3 times in the sample #2.

Subsequent years (2007 and 2009) revealed the excess of lead. In 2007, samples #1 showed the excess of lead concentration equal to 6.1 times, and in 2009 – 2.1 times. In soil samples #2 taken in secondary containment of landfill excess in lead concentration was not found.

Final part

High concentrations of zinc, chromium, and nickel in the soil is due to the fact that until 1995 the waste from electroplating shops of the Zhukovski Bicycle Factory was landfilled at the site without prior neutralization. Since 1995 the plant put into operation neutralization station with vacuum units. Currently the liquid fraction is deactivated and extracted. The resulting slurry is partly used in the construction industry according to regulatory documents. From 2002 to 2004 there was a decrease in the content of zinc, chromium, and nickel. Currently, nickel and chrome plating are not applied. Soil of the solid municipal waste landfill is characterized also by the high content of sulfur due to landfilling of electrolytes from the city enterprises. High concentration of petroleum products is due to landfilling of waste lubricants and motor oils. Nitrate content does not exceed the admissible concentration limit.

Over a long period of time, the major source of waste water contamination at the Zhukovski Bicycle Factory was electroplating shop, where degreasing, rinsing, chrome and nickel plating, and galvanizing were applied.

For drinking needs the enterprise uses

underground water from 6 artesian wells (two of them are stand-by wells), with total capacity of 122 m^3/h. For production purposes the factory uses the surface water from the Desna River. Water intake is carried out through diversion facility. Desna River is fishery reservoir of the highest quality. Its fish fauna includes pike, roach, perch, bream, carp, catfish, burbot, ide and others. At the site of the surface water intake, there are no spawning ground and fish wintering holes. This part of the river is the nursery ground of the above species. Total water consumption of the OJSC "Zhukovski Bicycle Factory" equals to:

a) 852.6 m^3/day (214.0 thousand m^3/year) for production needs;

b) 173.39 m^3/year of underground water for drinking needs;

c) 7.48 thousand m^3/year (water from the Desna River) for technical needs.

Analyses of waste water and ambient concentrations of pollutants discharged to the Desna River is performed by the laboratory of the OJSC "Zhukovski Bicycle Factory". The research results are shown in Table 3.

As shown in Table 3, waste waters contain excess concentration of suspended substances, as well as copper, phosphate, and organic compounds.

Waste waters flow rate in disposal #1 is 3389.53 m^3/day (1237.18 thousand m^3/year). Waste waters flow rate in disposal #2 is 568.08 m^3/day (207.35 thousand m^3/year).

Water supply at the factory is carried out from 5 wells, municipal water supply network, river waterway, and in-house intake from Desna River. Total water consumption of the factory is 1077 thousand m^3/year. Excess of the water intake limits have not been identified. The factory has a separate sewerage system providing the discharge of contaminated domestic and industrial waste waters to the biological treatment facility, while partially clean water from workshops – directly into the Lanitok creek and further into the Desna River.

Contaminated waste waters containing heavy metals salts in the amount of 151 m^3/day, are fed to the neutralization station for reagent purification. First, waste waters are acidified with sulfuric acid, and then treated with reducing agents (pyrosulphite or sodium sulfate) to transfer a 6-valent chromium into 3-valent chromium. Further, to precipitate hydroxides of nickel, chromium, zinc, and iron, lime milk is added. Metal hydroxides are precipitated in the gravity clarifier. Periodically, to the extent that the sludge is accumulated, it is pumped to the slime ponds. To improve the operation of physicochemical and biological treatment facilities and to prevent pollution of water reservoirs, the factory has made repairs on the replacement of intraplant pipelines, as well as equipment in the electroplating workshop, and commissioning of two reserve capacities, 400 m^3 each. Sludge dewatering is carried out by means of vacuum filter; another vacuum filter is currently being assembled. Dewatered sludge is used to produce bricks. For this reason factory acquired the apparatus for forming bricks. From the biological treatment plant effluents are discharged to the Lanitok creek, and further to the Desna River.

According to the expert opinion of the Federal State Institution "Center of Laboratory Analysis and Technical Measurements in the Central Federal District", based on the results of quantitative chemical analysis of natural and waste waters (control chart #150-151 of July 4, 2005), oxidative processes in waste water treatment plants are mild.

The concentration of suspended substances decreases from 113.5 mg/dm^3 to 19.5 mg/dm^3, and organic compounds – from 104 mg/dm^3 to 10.5 mg/dm^3. Transparency of waste water in the purification process increases insufficiently. The phosphate concentration is not reduced substantially. Nitrification processes proceed satisfactorily and are characterized by decomposition of nitrogen by ammonium from 19.5 mg/dm^3 to 9.6 mg/dm^3 to form nitrites nitrogen in concentration of up to 0.23 mg/dm^3, and nitrates nitrogen in concentration of up to 6.1 mg/dm^3.

Waste water treatment facilities do not provide treatment of waste waters to standard indicators. Concentrations of pollutants in waste waters exceed the discharge standards in respect to fishery water bodies: in terms of suspended substances – by 1.9 times; organic compounds – by 5.2 times; ammonia nitrogen – by 24.6 times; nitrites nitrogen – by 11.5 times; phosphates – by 9.6 times; copper – by 8 times; zinc – by 19 times; nickel – by 9 times; and iron – by 7 times.

CONCLUSIONS

The conducted analysis of the environmental status of the region under study demonstrates the situation typical for many regions of the Russian Federation, namely the intense accumulation of solid municipal wastes, which are polluting environment, if disposed improperly and untimely. Gross misconduct during operation of authorized landfills and facilities adapted for solid waste and household garbage landfilling contribute to significant and irreversible human impacts on the environment. These include the following:

a) The lack of selective collection of components suitable for use as secondary raw materials, as well as insufficient ecological monitoring of the environment at concerned sites, leading to uncontrolled pollution of soils, groundwater bodies and the air in the landfill affected zone;

b) A significant excess of admissible concentration limits on chromium, zinc, and nickel salts content is revealed that shows pronounced technological environmental impact of industrial enterprises;

c) The galvanic facility as a major source of environmental pollution in the area under study ceased its operation since 2007, though presently tangible signs of excessive contamination by copper, nickel, zinc are revealed; in comparison with the previous period their content has decreased, though still remaining significantly higher than the admissible concentration limit;

d) The identification of high concentrations of heavy metals in soil samples outside the landfills indicates a pronounced human intervention that impacts the environment;

e) The pollution of water bodies in the region under study is caused by primary and secondary load, both bacterial and chemical;

f) The discharge of untreated and inadequately treated waste waters is the primary load on the reservoir and direct toxic hazard to human health, which is caused mainly by heavy metal salts;

h) oil pollution is a typical result of human intervention impact on the environment, associated with the discharge of waste lubricants and motor oils to the landfill in violation of prevailing environmental laws.

REFERENCES

1. Akhromeev, L.M., The landscape structure, natural resources and geo-ecological problems of topology central Russia 9. Bryansk state University Press, 2007; 2-7.
2. Akhromeev, L. M. Nature Bryansk in questions and answers. Training and reference guide. - Bryansk: “Kursiv”, 2000; 165-179.
3. Barishnikov, I.I. & Musijchuk, J.I., Human health - system-forming factor in the development of ecology problems of modern cities: Medical-geographical aspects of the assessment of the level of human health and the environment. Saint-Petersburg, 1992.
4. Bastrakov, G.V. & Dolganova, M.V., Environmental monitoring of soil. Bryansk state University Press, 2009.
5. Bastrakov, G.V. & Kohanim, A. C., Applied aspects of geographical research floodplain r. Desna within the Bryansk region. Materials of scientific-practical conference of students and postgraduates of natural-geographical faculty. Bryansk, 2007.
6. Bryansk region. The scheme of territorial planning., The concept of territorial organization: CUI spatial planning. Bryansk, 2008.
7. Chusovitina, K. V., Environment and the health of the population of the Bryansk region infectious and parasitic diseases. Proceedings of the Second international scientific-practical conference “Geographical problems of balanced development of exploited regions”. Bryansk: “Kursiv”, 2010.
8. Magometa, S.D. & Magomet, R.D., The influence of environmental factors Zhukovsky district of the Bryansk region on the demographic situation and population morbidity. Proceedings of the XI International conference “Ecology and society development”, 2008.
9. Magometa, S.D. & Magomet, R.D., Influence of environmental factors on human. Proceedings of the X International scientific-practical conference of young scientists, students and postgraduate students “Analysis and forecasting systems management”, 2009.
10. Middleton, N., The Global Casino An introduction to Environmental Issues. London. Arnold, 1997.
11. State report “On the sanitary-epidemiological situation in the Bryansk region in 2008.

Bryansk.
12. State report “On the sanitary-epidemiological situation in the Bryansk region in 2009. Bryansk.
13. State report on the state of environment of the Russian Federation in M.: the Ministry of natural resources of the Russian Federation, 2007.
14. State report on the state of environment of the Russian Federation in 2008. M.: the Ministry of natural resources of the Russian Federation.
15. State report on the state of environment of the Russian Federation in 2009. M.: the Ministry of natural resources of the Russian Federation.
16. Scherbo, A.P., Environment and health: approaches to risk assessment. St. Petersburg: St. Petersburg medical Academy of postgraduate education, 2002; 20-26.
17. Shkotova, O. N. & Dolganova, M.C., Economic-geographical assessment of the effectiveness of land use on the territory of the Bryansk region. Proceedings of the Second international scientific-practical conference “Geographical problems of balanced development of exploited regions”. Bryansk: “Kursiv”, 2010.
18. Towards Sustainable Development. Environmental Indicators, 1998. Paris. OECD.
19. Wilhelmson, B. & Drettner, B. (1998). “Nasal problems in wood furniture workers. A study of symptoms and physiological variables”. Acta Oto-laryngol, 5(6), 548-555.
20. World population prospects: The 1996 revision. Annex 11,111: Demographic indicators by major area, region and country. US, 4: 353-353.