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Detecting Parameters of Impact Assessment of SDW Landfill Sites On Water Bodies (On The Example of The Samosyrovsk Land Fill, Kazan, Russia).

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ABSTRACT

Annually in Russia there not less than 3,5 billions tones of wastes are produced, from which only a quarter is processed, the rest is burned or removed to special landfills. Most of landfills is situated directly nearby built-up and natural areas. The objective of investigation in this work is revelation of parameters for impact assessment of Samosyrovsk landfill in Kazan on water bodies on the example of the river Krutovka. The main tasks of investigation are: gathering and analyzing data about Samosyrovsk landfill in Kazan; hydrochemical analysis of water samples of the river Krutovka and waste waters of the Samosyrovsk landfill on chemical elements content in it; hydrobiological investigation of the river Krutovka; separation of the most important parameters for further monitoring. Analyses were made on the basis of the international laboratory of the urban explorations of the Institute of social investigations on modernization of society and department of nature development and water use of KFU. It has been analyzed the existing monitoring system of landfills. The ecological state of the river Krutovka on hydrochemical and hydrobiological parameters has been assessed. It has been revealed chloride, copper, magnesium, calcium pollution of the stream. It has been shown parameters of zoobenthos allowing to more precisely assess the state of the water body. Such indicators are: aspectual content, ratio of quantity and biomasses of the basic groups of organisms, calculation of Shannon and Simpson indices, account of presence chironomidae organisms in assays.

Keywords: Impact assessment, monitoring, zoobenthos, small rivers, parameters of pollution, hydrochemistry.

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INTRODUCTION

Nowadays the area of dumps and landfills for burial of waste has reached in Russia 107 thousand ha, 1 million ha [1, 2]. Dumps exert a negative influence on atmospheric air, ground and surface water, soils, though aquatic environment is exposed to maximum impact. .

In the interests of population safety and environmental pollution control it is necessary to constantly monitor the existing landfills [3, 4]. The monitoring system covers a number of environmental components [5, 6], making analyses expensive, and the monitoring itself economically inefficient. Thus, to optimize the system of pollution control it is necessary to separate significant parameters for each of environmental components.

The brook situated near the landfill has been investigated. The brook Krutovka originates from the region of Pestretsy of the RF and falls into the lake of Bogorodsky, the length of the river of Krutovka in the area of influence of Samosyrovsk dump is 8,5 km. The sources of anthropogenic effect , located on drain area of the river are: the Samosyrovsk dump and agricultural lands. The investigations have been conducted on 5 stations, located along the streamway. Station 1 is situated in the zone of surface flow from the gathering pond of the landfill filtrate. On the eastern bank side, nearby stations 1 and 2, there is the woodland that separates the water body from agricultural lands. On the western bank side there is Samosyrovsk dump and the storage ponds of waste water. Station 3 is surrounded from both sides by the forest. Station 4 is located in the zone of surface yield from agricultural fields. On station 5 the stream turns to the west and forms the water-marsh complex. Also there the woodland, meadows and water-marsh holdings are situated.

MATERIALS AND METHODS

The characteristic of Samosyrovsk dump is from literary data and materials of ecoauditors' report of the landfill of SDW. Investigation of the river of Krutovka was conducted at 5 stations (picture 1), in August 2014 in hot dry weather in absence of rains and in September 2014 after abundant rainfalls. The stations are located near the tract of Akulovka at the distance of 1km from the headstream (picture 1).

Picture 1: The investigation district, the location of station

The water was analyzed with the help of hydrochemical, hydrophysical and hydrobiological indices. Hydrochemical analysis samples were taken from the surface manually and analyzed in the accredited laboratory. A number of hydrophysical measurements were carried out on the spot: temperature, water clarity, electric conductivity, dissolved oxygen content. It was used a thermometer, the Secchi disk, the

conductometer DiST HI 98312 and the oxygen analyzer Mark 302E, respectively. The analyses were performed according to the standard methods with three repeatabilities. To estimate water quality it is used a method being widely applicable in water protection practice which consists in comparing the results of chemical analysis of the water body, determining physical and other water characteristic with regulatory values of MPC, provided for fish holding use.

Sample selection of macrozoobenthos was carried out in 3 repeatabilities, in littoral area with a scrapper of 20 x 20 sm. In selecting samples the point data of sampling, biotope characteristic, width and depth of the stream, its transparence were recorded (table 1).

Table 1: The characteristic of sampling places

Station, №	Distance between stations,m	Width, m	Depth, m	Transparence, m	Ground
St.1	1000 m from the head of the river Krutovka	0,5	0,05	to the bottom	sandy, chemical smell.
St. 2	500	3,5	0,5	0,1	Slimy.
St. 3	315	1,5	0,15	to the bottom	Sandy slimy
St. 4	200	0,5	0,05	to the bottom	Earthy, chemical smell.
St. 5	200	1	0,15	to the bottom	Sandy slimy

The analysis of zoobenthos samples was carried out according to generally accepted hydrobiological methods (Manual.., 1983). The preliminary preparation of zoobenthos sample (washing off formalin, sorting out, species calculating) was made. Then it was determined taxonomy of organisms, species composition, the biomass and number indices were calculated. To estimate the quality of water it was used Shannon and Simpson indices, Woodiwiss index.

RESULTS

The analysis of physicochemical characteristic of the river Krutovka

The length of the river Krutovka– 8,52 km, the width at the analyzed stations ranged from 0,3 to3,5 m, the depth ranged from 0,05 m to 0,5m, the drain area – 12,5 square kms. The water type of the stream ranges from sweet water at stations 1 and 2, located upstream, to saltish water at station №5 (table 2).

Table 2: Physicochemical characteristics of the river Krutovka

Stations, №	Temperature, ^{o}C	S, ms	Oxygen content, mg O/l
St.1	18,9	0,36	11,1
St. 2	23,5	0,37	11,3
St. 3	19,2	0,68	11,6
St. 4	17,3	0,73	7,23
St. 5	16,6	1,62	8,29

With increasing electrical conduction the quantity of dissolved oxygen decreases and reaches minimum value at stations №4 and 5 (7,23mg O/l and 8,29 mg O/l, respectively). Increasing electrical conduction of stream water at stations 4 and 5 is, possibly, connected with ingress of polluted ground waters into the river of Krutovka or impoundment here of dirt, permeating from surface.

The analysis of waste water composition of the Samosyrovsk dump.

To detect the pollutants incoming from the Samosytovsk dump to environment it has been analyzed the waste waters from filtration storage pond located near the west slope of the tract Akulovka. Organoleptic properties of water revealed it as utterly polluted. The colour of water – black, the smell – 5 points (of 5), putrid. The chemical analysis of the drain detects the exceeding content of biogenic substances

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(ammonium, nitrate, nitrite); contaminating compounds (Aspan, petroleum derivatives, chlorides); heavy metals (iron), table 3.

Table 3: The content of pollutants in waste waters of the Samosyrovsk dump

	Ingredients	MPC_{rh}	The results of analysis, C±Δ, (P=0,95 n=2)		
1	pH, pH unit	6,5-7,5	7,94	±	0,45
2	BOD_5, mgO_2/dm^3	4	8,5	±	1,1
3	COD*, mg/dm^3	30	554	±	133
4	Ammonium ion mg/dm^3	0,5	37,9	±	8,0
5	Nitrites, mg/dm^3	0,08	40,4	±	5,7
6	Nitrates, mg/dm^3	40	41,6	±	6,2
8	Chlorides, mg/dm^3	300	603	±	90
10	Petrochemicals, mg/dm^3	0,05	0,143	±	0,034
11	Aspan*, mg/dm^3	0,5	0,56	±	0,12
12	Iron, mg/dm^3	0,1	0,457	±	0,091
16	Phenols, mg/dm^3	0,001	0,0062	±	0,0016
17	Solid residual, mg/dm^3	1000	1712	±	154

The Analysis of Hydrochemical Data of the River Krutovka

The hydrochemical analysis revealed the exceeding content of various chemical compounds in the stream. The type of the water variates the course of the river from the hydrocarbonate at the head (the 1st station) to chloride- hydrocarbonate (the 5th station).

To determine the hydrochemical composition of the waters of the river Krutovka it has been revealed that at station 5 it exceeds the chloride content (figure2) and water hardness (more than 2 MPC_{r-h}, makes up 5,3 mg-Eq./l).

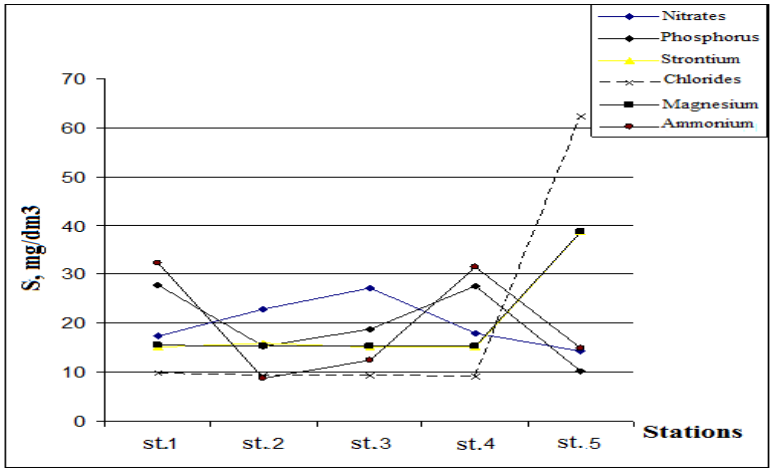

Figure 2: The content of chemicals in the river Krutovka (August, 2014)

The concentration of biogenic substances (nitrogen and phosphorus compounds) increases at stations 3 and 4; stations 3 and 4 are located on the open area, the slopes of ravine are not wooded. Possibly, it is caused by wash out by surface waters of nitric and phosphatic manures that are used for farming grounds situated up the slope (figures 3, 4).

The exceeding content of copper (incoming heavy metal from landfill waste waters) is detected at station 4, the excess accounts to 4 MPC_{r-h}, на станции 5 – 3 $MPC_{r-h.}$ At stations 1, 2, 3 copper in the water has not been detected. The water-logged ground is situated between stations 4 and 5. It is known that organic and peaty soils decrease the concentration of copper, it gets bound in insoluble organic complex

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and is taken up by hydrophytes. At that, the excessive content of phosphates in the water blocks up the copper absorbing by plants (that occurred at station 4). Natural purification of the water of copper is explained by flow of the stream through water-logged complex at stations 1, 2, 3, and also by reduction of phosphates station 5 (figure 5). Correlation coefficient (r) between the content of copper and phosphates equals 0,89.

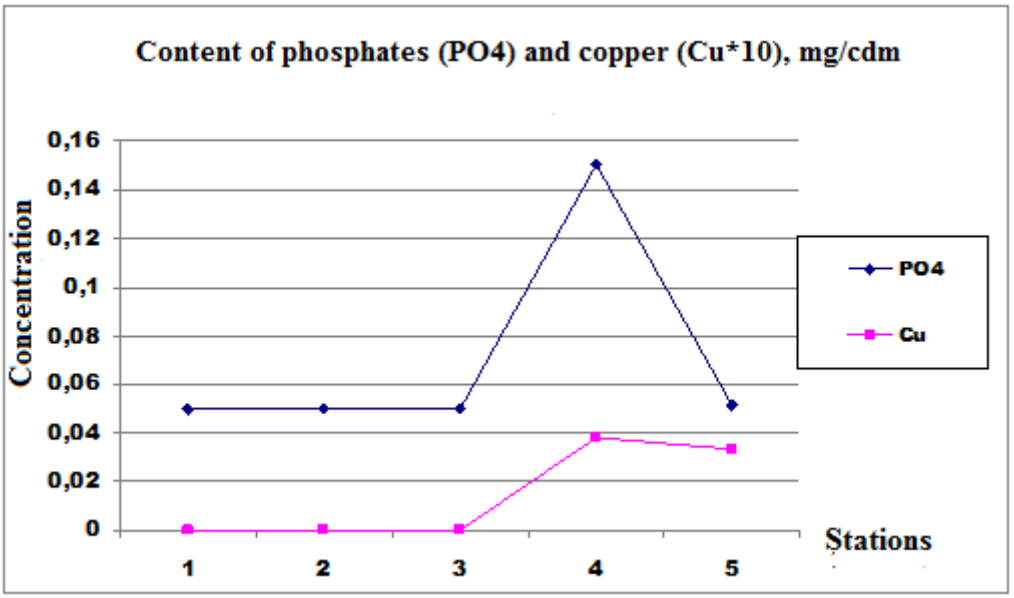

Figure 5: Content of phosphates and copper in the river Krutovka (September, 2014).

Water pollution index for station 4 accounts to 2,7, and for station for 5 – 2,5, that corresponds to class 4 of the water quality, polluted waters. Correlation coefficients between the content of chlorides, magnesium and sodium in the water have been calculated, the correlation coefficient equals 0,99.

Major portion of polluting substances revealed in the waters of the stream is there in the waste waters of storage pond of filtration drain of the Samosyrovsk dump. Thus, by further investigating and monitoring it should be preliminarily tested a filtrate and analyzed compounds in the water detected while analyzing.

Analysis of hydrobiological data

Table 4: Quantitative characteristics of macrozoobenthos of the river Krutovka

	St.1		St.2		St.3		St.4		St.5	
	Ncp.,sp./m^2	Bcp., g/m^2	Ncp.,sp./m^2	Bcp., g/m^2	Ncp.,sp./m^2	Bcp., k/m^2	Ncp.,sp./m^2	Bcp., g/m^2	Ncp.,sp./m^2	Bcp., g/m^2
Chironomids	63	0,09	592	1,05	483	1	117	0,32	116	1,08
Caddis flies	0	0	0	0	75	0,61	8	0,1	17	1,63
Dayflies	0	0	0	0	17	0,08	8	0,02	0	0
The other insects	113	0	0	0	0	0	38	0,19	0	0
Mollusks	0	0	17	0	0	0	0	0,58	50	0
Beetles	0		0		0		25		0	
The number of species in 3 repeatabilities	8		5		4		9		6	
Shannon index	1,26		0,69		0,86		0		0	
Simpson index	0,47		0,55		0,37		0		0	
Woodiwiss index	2		4,33		2,67		0		0	

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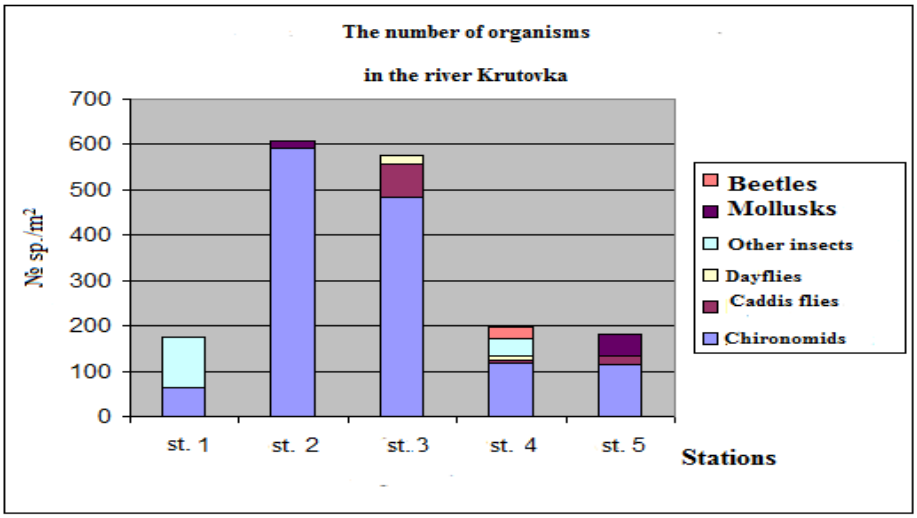
In all, in the river Krutovka there has been detected 29 zoobenthos species, of them: caddis flies – 4 species, larvae of chironomids – 14 species, mollusks – 4 species, beetles – 2 species, dayflies – 1 species, maggots of other insects – 4 species. Dayflies and caddies flies, that are the indicators of clean waters, are detected at station 3, caddies flies at stations 1, 4 and 5. In communities zoobenthos of the river Krutovka there dominate chironomids undemanding to environmental conditions. Species resources is small – from 4 species at station 3 to 9 species at station 4. At station 3 there are dayflies that are typical for clean waters.

The number of zoobenthos varied from 275 sp./m^2 at station 1 (located down filtration storage pond) to 2225 sp./m^2 at station 3 (located down farming lands and characterized by high content of biogenic substances, phosphates and ammonium). The larvae of chironomids possessed the highest number (2225 sp./m^2), the lowest – beetles (25 sp./m^2), mollusks were in eliminating condition (fig. 6).



The biomass of zoobenthos varied from 0,5 g/m^2 at station 1 (located down filtration storage pond and characterized by presence of chemical smell of the grounds) to 12,18 g/m^2 at station 4 (located down farming lands and characterized by high content of biogenic substances, phosphates and ammonium). The heaviest biomass was possessed by the beetles (1,75 g/m^2) and maggots of insects (2,55 g/m^2), including chironomids (3,26 g/m^2).

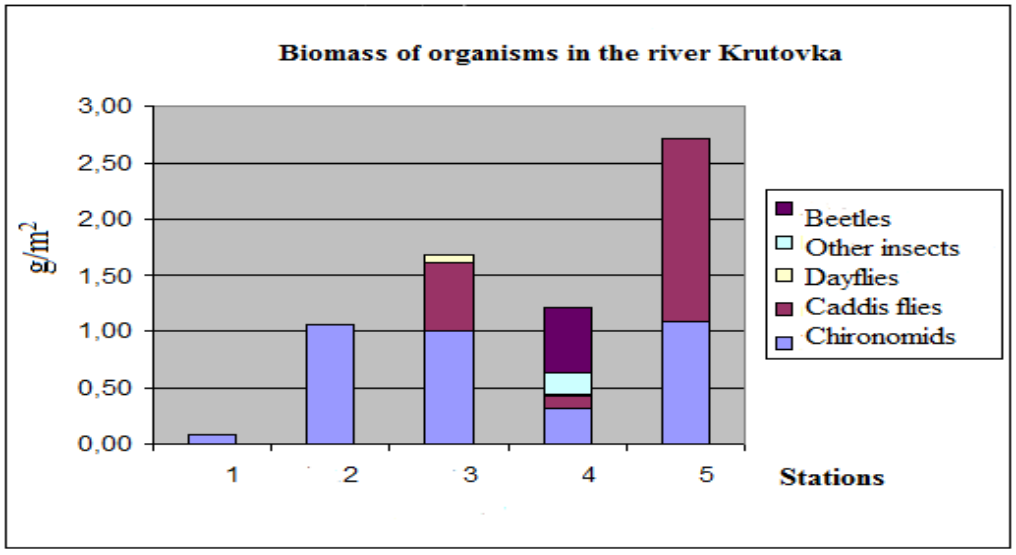


Figure 7: Zoobenthos biomass in the river Krutovka

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Indices possess minimum values at stations 1 and 2, here they equal 0, that characterize the waters as dirty. At station 1 Shannon index accounts to 0,84, that characterizes the water as dirty, Simpson index – 0,39, that is characteristic for seral communities; Woodiwiss index equals 0, that is also usual for dirty waters.

At station 4 the water quality according to the indices of species diversity corresponds to polluted waters. Shannon index accounts here to 1,6, Simpson index – to 0,55, Woodiwiss index - to 4.

At station 5 Shannon and Simpson indices characterize the waters as polluted (0,18 and 0,05, respectively), and Woodiwiss index as clean (6). In this case Woodiwiss index is not revealed, as its high value is explained by the presence of caddies flies. At the same time, the number of caddies flies compose not more than 15 % of total number. The dominating group in macrozoobenthos is here the larvae of chironomids, that are characteristic for dirty waters. The maximum value of indices was at station 3, the minimum value- at station 2.

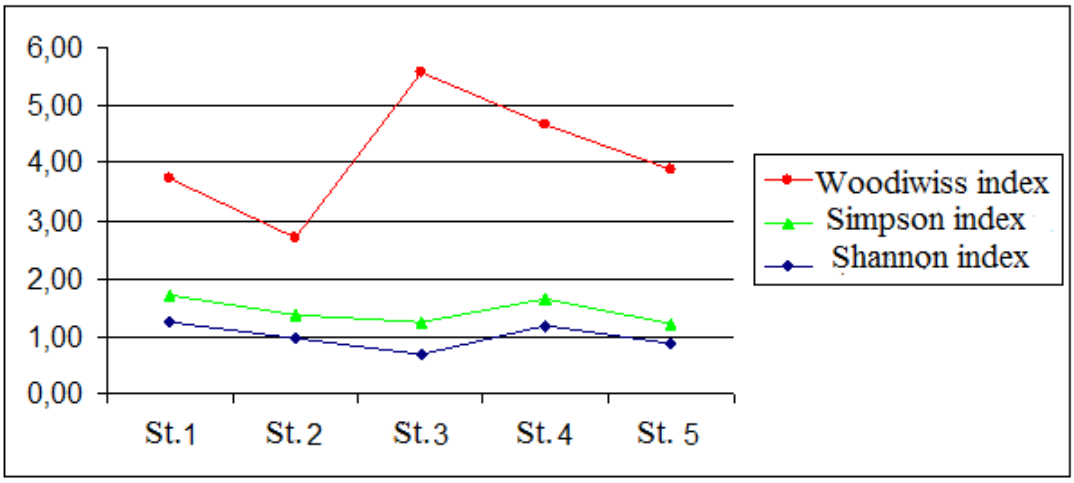

Figure 8: Indices variation of species diversity in the river Krutovka

On the whole, the waters of the river Krutovka are characterized as polluted. The larvae of chironomids, being characteristic for polluted waters, prevail in species composition. The stream residents dayflies and caddies flies are rarely met. Dayflies are observed at station 3, caddies flies – station 5. The waters at station 5 are characterized as polluted according to hydrochemical indicators. Therefore, in this case caddies flies are not indicated organisms and Woodiwiss index should not be applied for assessing the water quality.

The waters at stations 1 and 4 possess the best characteristics, the worst – are at stations 3 and 5. The third station is characterized as such with maximum composition of biogenic substances, and station 5 - of mineral, the concentration of chlorides, magnesium, calcium, strontium exceed MPC r h. at station 5. In terms of physicochemical investigations, caddis flies of the revealed species can inhabit in polluted water bodies and are not susceptible of mineral substances pollution.

The detected species of dayflies inhabits in oligosaprobic and mesosaprobic water bodies, that is also confirmed by chemical examinations of the water body. In the waters at this station there is an abundance of organic matters but their concentrations do not exceed MPC.

Woodiwiss index proved also to be statistically unreliable, therefore it is not recommended to use for landfill impact assessment as it includes neither the number of species nor their biomass. Shannon and Simpson indices negatively correlated with the concentrations of biogenic matters. High value of biomass at station 5 is connected with that the dominating species of chironomids and caddis flies do not have rivals among the organisms of zoobenthos in polluted waters of the river Krutovka.

For further monitoring it is recommended to study species composition, ratio of number and biomass of the basic groups of organisms, calculation of Shannon and Simpson indices, accounting of the presence of samples of chironomids organisms.

CONCLUSION

The Samosyrovsk dump brings high polluting impact upon the water body situated near it. The water saltiness increases downstream, from 0,36 msm at the 1st station to 1,62 msm at the 5th station. Water type ranges from sweet to saltish, from hydrocarbonate-calcium to chloride-calcium. High biogenic matters (nitrates, phosphates and ammonium) have been detected at the 1st, 3d and 4th stations, MPC r. h. excess of chlorides, magnesium, strontium, calcium and copper has been revealed at station 5. Water pollution index characterizes the waters as dirty and relates them to the forth class of water quality.

Abrupt change of water type indicate the ingress of waste water and pollution. A large number of biogenic substances is revealed at stations located upstream, the metals accumulate at stations that lie down. The revealed regularity of the presence of contaminants in the waters of the river Krutovka allows to organize nonexpert monitoring system. It is recommended to analyze the content of biogenic substances nearer to the place of impact, and the content of heavy metals and sediments at a distance of 1000 m from the site of impact.

The indices of zoobenthos accepted minimum values at stations 3 and 5, here they equal 0, that characterize the waters as dirty. The maximum value of indices was registered at stations 1 and 4, the minimum values - at stations 3 and 5.

Woodiwiss index proved to be statistically unreliable, therefore, it is nit recommended to use for impact assessment of landfills as it does not include the number of species and biomass. Shannon and Simpson indices negatively correlated with concentrations of biogenic substances.

For further monitoring it is recommended to study the species composition, the ratio of number and biomass of the basic groups of organisms, the calculation of Shannon and Simpson indices, the accounting of the presence of samples of chironomids organisms.

For organization of further monitoring of water objects nearby the landfills of solid garbage it is recommended to use the complexes of analyses including hydrobiological and hydrochemical analyses. At that it is economically more effective to conduct the analysis in succession, to correlate the list of analyzed components with chemical composition of landfill filtrate.

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REFERENCES

[1] Geoecological Studies at Samosyrovsk Landfill Site //Proceedings of Kazan State University. Series: Natural Studies -2008.

[2] Toxicological Control of Ground and Surface Waters at Landfill Sites of Solid Domestic Waste of the Moscow Region (Gribanova, L., Portnova, T.G.,1993., Mineral Resources Prospecting and Conservation of. 1993, N9, p. 27-29. Russ.. RU. ISSN 0034-026X)

[3] Arkhipov, B.S., Kozlov, S.A. About Influence of Landfill Sites of Industrial and Domestic Waste on Ground Water Quality (on the example of the town of Komsomolsk near the Amur). ECWATECH-2000: the 4th International Congress "Water: Ecology and Technology". Brief outline report. M., 2000. P. 215-216.

[4] HS 2.1.5.2280-07 Maximum Permissible Concentrations (MPC) of Chemical Agents in Water of Water Bodies of Household and Community Water Use. Hygienic regulations. M.: RusRPTC and BV MH P, 2008.

[5] Shcherbo, A.P. Industrial Waste: Ecohygenic Problems. // Hygiene and sanitation. 1995. - №3. - P. 10-12.

[6] Shcherbo, A.P, Kipich, A.V. Solid Domestic Waste: Preconditions For Projecting System of Management // Environment and Human Health: Scientific Writings of International Ecological Forum. SPb.: Special literature, June 29 – July 2, 2003. 864 p.