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Ecological and Economic Consequences of Water Pollution

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***Abstract*: Modern society is witnessing the emergence of one of the most acute problems - the protection of natural waters from pollution. In the conditions of the scientific and technological revolution, the human impact on the environment has become so significant that the question of the guarantees of the existence of life on Earth seriously arises. Nature is no longer able to compensate for violations caused by industrial and other human activities without human help.**

Pollution of surface and groundwater is one of the most harmful and dangerous negative effects of human activity on water object, which leads not only to irreversible adverse changes in the quality of water and aquatic ecosystems, but also directly affects all living organisms on our planet.

The problem of protecting surface water from pollution over the past few decades remains one of the most acute environmental problems of the Russian Federation, representing a very difficult socio-economic and scientific-technical problem.

The frivolous attitude of society and the state towards the environment, the actual priority of the economy over ecology in public policy led to a significant deterioration in the quality of the environment, which is especially pronounced in the state of many water objects in the Russian Federation, as evidenced by official state monitoring.

***Keywords*: Water Supply, River Watersheds, Water Resources, GroundwaterResources, Surface Water Resources, Zoning, Artificial Groundwater Recharge, Human Activities.**

I. INTRODUCTION

Water pollution occurs as a result of domestic and industrial effluents, as well as by the seepage of water in landfill areas.

Long-term observations prove that the main sources of pollution of surface water objects are insufficiently treated wastewater of industrial enterprises and surface runoff from the territory of settlements of the region. In rural areas, surface water objects are subject to pollution, especially during the flood period, by drains from fields, farms, garden plots, and in cities, motor vehicles and unauthorized garbage dumps occupy a large place among pollution sources [1-2].

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Observations of the state of surface water quality were carried out at 40 hydrochemical river gauges, and groundwater from 1166 water samples.

The results of the analysis of surface water quality of the main water objects in the Kursk region were obtained on the basis of statistical processing of data obtained on the hydrochemical network of the Kurskgeomonitoring Territorial Center for the most characteristic indicators for each water object.

II. METHODOLOGY

The work proposes a methodological approach, which is based on violation of the groundwater regime and the quality of water resources in regions with intensive human activities.

It is recommended to carry out water control measures on the catchments of small and medium rivers, where there is a close relationship between groundwater and surface runoff. When substantiating these measures, it is recommended to take into account the natural conditions of the region and anthropogenic impacts, which allows for the typification of river catchments according to the conditions of water supply, to identify violations of the regime and pollution of water resources in regions with intensive human activities.

III. DISCUSSION

The topic is the subject of analysis by a fairly limited number of scientists. Kosinova N.A. investigated natural and anthropogenic indicators and their impact on environmental quality, LM Korytny River basin as a geosystem, F. Kotlov Change in the geological environment under the influence of human activity, V. Golberag Assessment of groundwater protection conditions and construction of protection maps.

Studies of this publication are based on the works of A.A. Dubyansky, A.N. Semikhatov, N.A. Plotnikov, F.A. Makarenko, N.K. Ignatovich, Z.A. Makeeva, Yu.V. Mukhina, L.A. Ostrovsky, L.N. Dolgova, V.M. Smolyaninova, L.A. Vasilevskaya and others [26-37].

IV. RESULTS

Monitoring of surface water pollution using hydrochemical indicators was carried out at 11 water objects, sampling at 40 gauges. As a result, data on surface water quality obtained from 1998 to 2018 were used.

Assessment of the degree of pollution of water bodies is carried out by the value of maximum permissible concentrations (MPC) and the pollution index of the water object (WPI).

The quality of water resources is significantly affected by enterprises discharging wastewater into surface water objects [3-4].

Table 1 presents the dynamics of changes in the mass of pollutants discharged into the reservoirs of the Kursk region from 2005 to 2018.

The most common pollutants of surface water in the Kursk region are iron compounds (to a greater extent - a natural factor), organic substances (according to BOD5), nitrates, phosphates, ammonia nitrogen, and petroleum products. The oxygen regime is satisfactory.

So, there was a decrease in the mass of pollutants discharged into the reservoirs of the Kursk region of such ingredients as BOD pol., Phosphates, nitrates, copper, zinc, fluorine; increase - suspended solids, sulfates, nitrites, iron [5].

Table 1 - Discharge of pollutants in the wastewater into surface water objects of the Kursk region

Name of pollutants	Dimension	2005	2006	2010	2018
Biochemical oxygen consumption	thousand tons	0.259	0.248	0.25	0.24
Oil products	thousand tons	0	0	0	0
Suspended matter	thousand tons	0.37	0.40	0.37	0.41
Dry residue	thousand tons	35.5	34.48	32.57	35.49
Sulphates	thousand tons	4.62	4.68	4.57	5.06
Chlorides	thousand tons	5.42	5.25	4.92	5.16
Phosphates (P)	tons	55.5	59.9	47.93	41.47
Nitrogen ammonium	tons	161	229	239.47	234.28
Nitrates	tons	731	829	751.10	652.29
Nitrite	tons	19.2	20.7	24.95	23.28
Synthetic surfactants	tons	2.7	3.0	2.55	2.73
Fats, oils	tons	0.1	0.1	0.38	0.06
Iron	tons	10.0	10.1	10.01	11.12
Copper	tons	0.1	0.1	0.14	0.10
Zinc	tons	0.8	1.0	0.98	0.90
Nickel	tons	0	0	0	0
Chrome	tons	0	0	0	0
Lead	tons	0	0	0	0
Fluorine	tons	0.2	0.2	0.12	0.03

Kurskgeomonitoring Territorial Service monitored the status of water objects in places of 10 large water intakes on the Seym, Tuskar and Swapa rivers. Water taken from surface sources is mainly used to feed water recycling systems, equipment cooling, and boiler room needs.

A general chemical analysis of water samples, determination of the content of oil products and phenols was carried out in the laboratories of the Kurskgeomonitoring Territorial Service and the Federal Public Health Institution Center for Hygiene and Epidemiology of the Kursk Region, and the total α-β activity in groundwater was determined in the laboratory of the Center for Hygiene and Epidemiology of the Kursk Region, determination of the content of microcomponents in groundwater by atomic emission and mass spectral analyzes at the Analytical Certification Center of the Institute of Problems of Microelectronics Technology and especially pure materials RAS.

The determination of helium content in groundwater was carried out by the method of ionometric analysis at the State Technical Scientific-Industrial Enterprise "GeotechVims" FSUE All-Russian Scientific Research Institute of Mineral Raw Materials named after N.N. Fedorkovsky. "

It was found that the quality of groundwater depends on the degree of protection of the aquifer, the area of its distribution, the depth [6-8].

So, in the Kursk region it is possible to allocate areas: with insufficient and poor geological protection of groundwater.

1. Insufficiently good security conditions are noted in the central regions of the Kursk region. The main aquifer is the Cenomanian-Albian. The topography is 1.2 km / km2. The amount of atmospheric precipitation infiltration is from 3 to 7%. Aquifers are well protected from pollution only on the watersheds, where Paleogene clays, chalks, marls and cover loams lie in their roof. In river valleys and gullies, these horizons are often completely devoid of cover of poorly permeable rocks, which creates the conditions for the penetration of pollutants into them.

2. Poor security conditions exist in the north-west and south of the Kursk region.

The main aquifers: Upper Cretaceous, Cenomanian-Albian, Jurassic-Devonian.

The topography of the relief is 1.6 km / km2; precipitation infiltration up to 8%. In most of the area of its distribution, aquifers are deprived of cover of poorly permeable rocks; especially in river valleys, gullies, and on the slopes of watersheds. Thus, the groundwater of the main aquifers in a significant part of the Kursk region is poorly protected from pollution. Underground water of the Upper Cretaceous aquifer under the natural conditions on the territory of the Kursk region in terms of their chemical composition is hydrocarbonate calcium water or hydrocarbonate calcium-magnesium [9-10]. The chemical composition of the Upper Cretaceous aquifer for many years remains stable, only sometimes, in some years, the content of elements such as ammonium, iron and the total hardness indicator change, exceeding the MPC requirements. In general, groundwater meets the requirements of SanPiN 2.1.4.1074-01 "Drinking Water". Of the microcomponents in the water, the presence of manganese, fluorine, copper, lead, molybdenum, arsenic, zinc, aluminum and oil products is noted. But their number is insignificant and does not exceed the requirements of sanitary standards. According to the prevailing chemical composition, the groundwater of the Cenomanian-Albian aquifer under natural conditions is calcium carbonate, less often calcium-magnesium or calcium-sodium with a salinity of 0.35-0.6 g / dm3. According to the hydrogen indicator, groundwater is from acidic to alkaline (pH-3.0–9.0), and from hardness it is from moderately hard to hard with a total hardness of 2.5 to 8.0 mEq / dm3. When determining the content of microcomponents in groundwater by mass spectral analysis, it was found that the content of microcomponents such as silicon (total) up to 1.2 MPC, molybdenum up to 5.9 MPC, bromine up to 1.05 MPC (Kursk, Zheleznogorsk) [11-13].

The groundwater of the Upper Devonian aquifer under natural conditions shows chemical composition of the water is close to the waters of the overlying Cenomanian-Albian aquifer and have a calcium carbonate type, sometimes they become hydrocarbonate-sulfate (Zolotukhino settlement) with a salinity of 0.3-0.6 g / dm3.

The total hardness ranges from 0.35-0.65 mEq / L. According to the hydrogen indicator of water, slightly alkaline pH-7.3-7.5.

Of the microcomponents, sometimes in isolated cases an excess of the maximum permissible concentration of boron (total) is noted at 1.08 times, barium (total) at 3.4 times, iron at 1.1 times. The content of total α-β activity in groundwater mainly corresponds to sanitary standards, but in some cases (Fatezhsky, Shchigrovsky districts), the content of α-activity up to 6.6 MPC is noted [14-16; 38-44].

In general, in terms of their physicochemical and bacteriological characteristics, the underground waters of the Upper Devonian aquifer meet the requirements of SanPiN 2.1.4.1074-01 “Drinking Water” and no significant changes in water quality are observed over time.

The disturbed groundwater regime was formed under the influence of water withdrawal by large group water intakes of the cities of Kursk, Zheleznogorsk, Kurchatov and other industrial district centers. These aquifers are located in the zone of active water exchange, the depression funnels in them have local dimensions.

Large water intakes of the city of Kursk: “Kievsky”, “Zorinsky”, “Ryshkovsky”, “Severny” are located outside the city limits at a distance of 0.5-4.0 km from consumers and have a linear arrangement of wells. They exploit the Cenomanian-Albian aquifer [17-19; 45-51].

During operation, the actual decrease in the groundwater level at these intakes is less than the permissible decreases (Table 2).

Table 2. Groundwater Levels of the Cenomanian-Albian Aquifer at the Intakes of the Kursk Region, 2018.

№	Name of water intake	Absolute mark static level, m	Absolute mark dynamic level, м	Decrease		Intakes of Kursk thousand.m³/s
				Approved reserves	Permissible factual	
Water intakes of Kursk						
1.	Voroshnevsky	163.9	no information	21.8	no information	9.1
2.	Ryshkovsky (Eastern target)	154.0	152.5	12	1.5	60.9
3.	Zorinsky	149.6-154.0	149.5-152.4	12-15	0.1-1.6	66.1
4.	Kiev	154.5	150.7	10	3.8	98.6
5.	Northern	157.0	156.0	11	1.0	15
6.	Maisky	169.1	158.5	25.0	10.6	5.6
7.	«NVA»	179	175.8	21.0	3.2	5.6
8.	«Upper zone»	170.0	162.2	13.7	7.8	5.0
Water intakes of Zheleznogorsk						
11.	Berezovsky	148.0	144.8	18	3.2	79.8
Water intakes of Kurchatov						
9.	Kurchatovsky	153.0	137.8	40	15.2	10.5
10.	Dychnyansky	148.5	147.0-141.7	14	1.5-6.8	18.2

The following industrial enterprises have a huge technogenic impact on groundwater: Kursk Oil Depot, CJSC Kurskrezinotekhnika, CJSC Kursk Plant Accumulator, Kursk Thermal Power Station - 1, OJSC SAN Interbrew branch in Kursk, LLC Energoservis, etc. As a result of this at the intakes of these enterprises there was a pollution of groundwater with oil products, phenols.

In the area of the Mikhailovsky iron ore deposit, the groundwater level regime is influenced by: abstraction by existing water intakes, drainage measures at the Mikhailovsky quarry, filtration from hydraulic structures, and leakage of process water at industrial sites.

For the period from 1962 to 2018 near the quarry, a steady decrease in the level to 5 meters is noted. For 2018, there is a slight increase in the level of 0.1 - 0.2 m.

Groundwater level decrease from static for the period 1959-2018. is 77.9 m at the Pogarshchina water intake (Table 3).

Table 3 Groundwater levels of the Jurassic-Devonian aquifer within the Kursk metropolitan area and the Mikhailovsky mining district, 2018.

№	Name of water intake (depression center)	Absolute mark of the static level, m	Absolute mark of the dynamic level, m	Decrease, m		Approved reserves, thousand m³ / day
				allowable	actual	
1.	Agricultural Institute (Kursk)	165	92.3	100	72.7	3.2
2.	Sorokovaya (Kursk)	165	88.9	100	76.1	12.2
3.	Kievsky (Kursk)	165	100.5	100	64.5	9.0
4.	Zorinsky (Kursk)	165	96.6	104	68.4	-
5.	Peski (Kursk)	165	89.0	100	76.0	18.0
6.	Poharshina (Zheleznogorsk)	165.0	87.1	180	77.9	18.0
7.	Podzemny DK (Zheleznogorsk)	165.0	80.9	180	84.1	48.7

It can be assumed that the same situation in the groundwater of the Jurassic-Devonian aquifer under disturbed conditions will continue for the coming years.

The presence of the Mikhailovsky GOK sludge storage facility led to an increase in the level of the aquifer in the area of its location and the formation of flood zones in the villages of Pasherkovo and Volkovo.In areas of large cities of the region (the cities of Kursk, Zheleznogorsk, Kurchatov) underground waters are exploited through large group and single water intakes. In the area of these water intakes, a peculiar hydrochemical regime of groundwater has developed. Kursk city agglomeration. Within the agglomeration, the hydrodynamic and hydrochemical regime of groundwater has an intense technogenic effect. Groundwater is operated by a number of both group and single water intakes.

The hydrochemical regime of groundwater within the agglomeration directly depends on the degree of protection of aquifers and the intensity of anthropogenic impact [20].

According to the hydrogen index of water from slightly acidic to alkaline (pH 4.5-8.5), the total hardness ranges from 3.0 to 8.0 mEq / dm3. Of the nitrogen-containing compounds in the waters, nitrites and nitrates are present in small quantities. Of the microcomponents, zinc is present (up to 0.02 mg / dm), copper (up to 0.002 mg / dm). In general, the water in its physicochemical parameters complies with the requirements of SanPiN 2.1.4.1074-01 "Drinking Water" and for several years its quality has remained stable. The exception is the increased iron content, the amount of which varies from 1.62 to 6.3 mg / dm3, which exceeds the MPC for the Kursk region by 1.6-6.3 times.

The worst situation with groundwater quality has developed in groundwater intakes located in the river valleys of the river. Diet (water withdrawals "Kiev", "Zorinsky", "Ryshkovsky" and others) and p. Tuskar (water intake "Northern").

The presence of sulfate nitrate anions and magnesium cations is also noted in groundwater. Due to the mismatch of groundwater with sanitary standards, a number of water intakes in the industrial zone of the city were closed by sanitary authorities. All this significantly worsened the situation with the water supply of the city of Kursk and raises the question of finding additional sources of water supply for the population and enterprises of the city [21-22].

The Mikhailovsky mining and industrial area is confined to the zone of technogenic impact on the geological environment of the Mikhailovsky GOK.

In the Mikhailovsky mining and industrial area, the Cenomanian-Albian aquifer is most prone to pollution.

In this area, the Cenomanian-Albian aquifer in most of the territory is the first exploited aquifer from the surface [52-68]. The drainage system of the mining and processing complex, tailing dump and sludge dumping have the hydrochemical regime of groundwater.

So, in a number of water intake and observation wells, there is an increased content of ammonium nitrogen (up to 2.5 MAC), nitrates (up to 2.2 MAC), and total hardness (up to 1.5 MAC). Almost everywhere there is iron (up to 3 maximum concentration limits), oil products (up to 80 maximum concentration limits).

Often groundwater does not meet sanitary standards for its organoleptic properties (color, smell, taste).

In terms of their chemical composition, the groundwater of the Cenomanian-Albian aquifer, mainly hydrocarbonate calcium-magnesium or hydrocarbonate-chloride calcium-magnesium with a salinity of 0.7-0.8 mg / dm3. For several years, this chemical composition of groundwater Cenomanian The Albanian aquifer remains unstable and there are prerequisites for the deterioration of its quality [23; 69-74].

Kurchatov industrial region. This area includes the territory adjacent to the Kursk NPP and the city of Kurchatov, with an area of approximately 400 km2. The aquifers of the Cenomanian-Albian and Upper Cretaceous sediments, associated with sands, chalks and marls, are ubiquitous in the region. The main exploited aquifer is the Cenomanian-Albian and, to a lesser extent, Upper Cretaceous.

The hydrochemical regime of groundwater in the Kurchatov industrial region is influenced by such factors as the presence of a cooling pond in the Kursk NPP, the impact on potential and obvious sources of pollution on the groundwater (MSW landfill, Lukashevskaya oil depot and a number of other industrial enterprises).

The main consumer of groundwater is the city of Kurchatov, the water supply of which is based on the exploitation of groundwater of the Cenomanian-Albian aquifer. There are two water intakes in the city - Dychnyansky, 7.5 km away from the city and Kurchatovsky, located within the urban area [24].

As a result of close occurrence to the day surface and poor protection against pollution, the underground waters of the Upper Cretaceous aquifer are most susceptible to pollution. Over the years, groundwater has been characterized by an increased content of total hardness up to 12.5 mEq / dm3 (MPC for the Kursk region 10 mEq / dm3), odor, iron up to 6.3 MPC, ammonium nitrogen up to 40.3 MPC. In the area of Lukashevskaya oil depot in the underground waters of the Upper Cretaceous aquifer, the presence of oil products in water up to 2000 MPC is noted.

During the observation period (1998-2018), groundwater in the area of Kurchatov remains permanently polluted.

The environment, including groundwater, which in the area of the reservoir rupture are unprotected due to the low-power aeration zone, represented by well permeable sand, were at risk of pollution [75- 84].

The groundwater quality characteristics we obtained in the area of the filtration fields allow us to draw the following conclusions: the first aquifers from the surface experience anthropogenic stress: Upper Cretaceous, Cenomanian-Albian; with continuous operation of the filtration fields, pollution is sustainable: water quality indicators exceeding the MPC are constant, only their quantitative content changes; upon elimination of the source of pollution or temporary absence of wastewater discharges, secondary foci of groundwater pollution remain. They are soil and aeration zone, contaminated during filtration of wastewater from storage during their operation. In the absence of discharges, a decrease in the concentration of pollutants is noted within the wastewater storage facilities. Both the process of self-purification of groundwater and the transfer of pollutants along the aquifer by spreading from the source of pollution under the influence of the natural flow of groundwater and pulling them to the intake structures occur [25].

V. CONCLUSION

The most common pollutants of surface water in the Kursk region are iron compounds (to a greater extent - a natural factor), organic substances (according to BOD5), nitrates, phosphates, ammonia nitrogen, and petroleum products. The oxygen regime is satisfactory.

The chemical composition of groundwater in the Kursk region was studied using 1166 water samples.

Under natural conditions, the underground waters of the Kursk region have a hydrocarbon-calcium composition, and their mineralization does not exceed 1 g / l. Such waters fully satisfy the requirements of GOST “Drinking Water”.

Groundwater quality in areas with intensive human activities is unfavorable. So, the Kursk agglomeration is characterized by an increased iron content (up to 10 MAC), general hardness (up to 1.5 MAC). At the Kievsky and Ryshkovsky water intakes, manganese content (up to 2.4 MPC), odor up to 1.5 MPC, turbidity up to 1.6 MPC, ammonium nitrogen up to 2.3 MPC are also noted in groundwater. In the southern and southwestern part of Kursk there are petroleum products (up to 10 and more MAC), phenols (up to 50 MAC). Over the years, this chemical composition of the waters has remained unstable and there are prerequisites for its deterioration in its quality.

In the Zheleznogorsk district, there is an increased content of ammonium nitrogen (up to 2.5 MAC), nitrates (up to 2.2 MAC), general hardness (up to 1.5 MAC). Almost everywhere there is iron (up to 3 maximum concentration limits), oil products (up to 80 maximum concentration limits).

In the Kurchatov region, there is an increased content of total hardness up to 12.5 mEq / dm3 (MPC for the Kursk region 10 mEq / dm3), odor up to 2.5 MAC, iron up to 6.3 MAC, ammonium nitrogen up to 40.3 MPC. In the area of Lukashevskaya oil depot in the underground waters of the Upper Cretaceous aquifer, the presence of oil products in the water is up to 2000 MPC, manganese up to 0.92 mg / dm3 (MPC - 0.5 mg / dm3). During the observation period, groundwater in the area of Kurchatov remains constant polluted.

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