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Problems of Regional Water-Bodies' Pollution

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ABSTRACT

Paradoxically, while water is a vital substance on Earth, it remains one of the least studied compounds in nature. Its complexity poses challenges for scientists, making it difficult to understand fully. Although the chemical composition of water is stable, its effects on organisms vary depending on environmental conditions.

Going forward, we face significant threats related to water that will require considerable attention. One alarming concern, recognized globally, is the potential emergence of a widespread issue in our water supply systems and recreational reservoirs. Labeled by some as the "plague of the 21st century," this problem is linked to the evolving nature of certain microorganisms—some of the oldest life forms on Earth—but now becoming harmful due to chemical pollution. Research from the Gamaleya Scientific Research Institute indicates that these microorganisms can develop new, dangerous strains that show effects over time, functioning like a "slow-acting mine." They produce substances with carcinogenic, mutagenic, and immunosuppressive properties, notably seen with "blue-green" algae or cyanobacteria.

This article highlights the critical issue of harmful algal blooms (HABs), particularly in the Tbilisi reservoir, predicting eutrophication in the Zhinvali reservoir due to human activities. Such insights can be applied globally, emphasizing the urgent need for action to protect our water resources and public health.

The article addresses the issue of harmful algal blooms (HABs), focusing on the production and occurrence of cyan-bacteria in different water bodies, including the Tbilisi reservoir. It predicts that eutrophication will occur in the Zhinvali reservoir as a result of human activities. This approach can be applied broadly for forecasting similar phenomena in water bodies around the world.

Keywords*: phytoplankton, eutrophycation, biogenic elements, treatment, water body.*

Introduction

Anthropogenic eutrophication of water bodies refers to the increase in biogenic substances in aquatic environments due to human economic activities. This process often leads to excessive growth of phytoplankton. As this excess biomass decomposes, it can release harmful substances such as hydrogen sulfide, which can be toxic. Consequently, this may cause the death of aquatic life (zoocenoses) in the water and render it unsafe for drinking. Additionally, many species of planktonic algae can release toxins during their life processes.

Due to human activity, the natural evolution of water bodies is being accelerated, alongside the intense economic development of these bodies and their surrounding catchments. This phenomenon is primarily caused by the introduction of biogenic elements, such as nitrogen and phosphorus, into water bodies. These elements often come from wastewater discharged by industrial facilities, urban areas, and agricultural land through runoff. The excessive presence of biogenic elements results in rapid phytoplankton growth, which deteriorates water quality and disrupts its gas dynamic[1-3].

The increase in biogenic elements in the upper layers of water leads to a rise in phytoplankton populations in this area. As a result, water transparency often decreases, and sunlight penetration becomes shallower, which can cause underwater plants to die due to insufficient light. Eventually, dead organisms sink to the bottom of the reservoir, where they undergo decomposition. This anaerobic decomposition occurs in the oxygen-depleted sediment and produces harmful substances such as phenols and hydrogen sulfide. Consequently, the eutrophication process can severely impact most species of flora and fauna in the reservoir, significantly degrading the water's sanitary and hygienic properties. This degradation makes the water unsuitable for swimming and drinking, as well as for the living conditions of aquatic organisms, leading to a decline in biota's living conditions, due to which biota die.

Materials and methods

This article briefly examines pollution cases in major regional water bodies, based on research conducted by a group of authors. It also analyzes the characteristics and findings presented in various scientific papers and manuscripts.

Results and their discussion

Water pollution originates from various sources. Primarily, it comes from municipal and industrial runoff in cities. In recent years, these sources have been competing with agricultural runoff from irrigation. For instance, in the 1980s, approximately 160 cubic kilometers of runoff entered water bodies from the countries of the former Soviet Union. Out of this, 7 cubic kilometers was untreated, and 9 cubic kilometers was incompletely purified.

Additionally, water bodies are increasingly affected by pollution from acid rain, which is caused by industrial emissions into the atmosphere. Changes—whether natural or artificial—in the hydrological regimes of rivers and lakes also contribute to the deterioration of water quality.

Industrial runoff, particularly from chemical industries, contains a high concentration of phenols. These compounds not only alter the smell of water but also disrupt the balance of biological processes in the ecosystems. Recently, the presence of synthetic substances in this runoff has significantly reduced the water's ability to naturally purify itself biochemically [4-5].

Every year, more than 500 million tons of nitrogen oxides, 200 million tons of carbon oxides, up to 150 million tons of sulfur dioxide, 200-250 million tons of dust, and 120 million tons of ash enter the atmosphere from industrial emissions. Air masses carry these particles over long and short distances, which, along the way, hit the water surface. Gaseous emissions, being diluted with water particles in the atmosphere, return to the Earth, including water bodies, many hundreds of kilometers from their place of origin, in the form of acid rain [6-8].

A significant source of water pollution is the wastewater generated by settlements. This communal runoff includes fecal matter, which contains helminthes eggs that pose risks to human health, as well as disease-causing microbes and viruses. Additionally, it carries many hazardous compounds from various sources, including the food industry, motor transport, food services, and medical or pharmaceutical organizations.

Household runoff alone contributes to 42% of the total volume of mineral substances and 58% of organic substances. Moreover, sediment able and activated substances, along with suspensions, account for 20% of the runoff, while colloids make up 10% and diluted substances constitute 50% [9-11].

It is noteworthy that more than half of the detergents used by housewives contain such a substance dangerous to water bodies as sodium tri-polyphosphate (NTF). It's content in washing powder ranges from 15-40%. When washing, it softens water and improves the washing quality of the powder; it skillfully passes through all, even the most technologically advanced purification systems. When this detergent enters a water body, it plays the role of the most active fertilizer [10-12]. Due to its action, the number of algae in reservoirs increases not by days, but by hours. One gram of NTF stimulates the release of 5-10 kilograms of algae. Unfortunately, we do not have accurate data on the use of such detergents in Georgia. It is only known that in 1987, 1.5 million tons were used throughout the Soviet Union. Despite the cold and murky water, large and small rivers of Russia, including the Riv.Volga, "thrived" from such phosphate-containing powder. The poison of one box of powder slowly but surely affects the environment. If in 1965 there were 50 grams of microorganisms in one cubic meter of water in the Black Sea, today their number is 20 times higher. Scientists attribute this to the influence of NTF. Phosphates also stimulate the growth and development of plankton. The presence of various substances in water bodies decreases their usefulness as sources for recreation or drinking water. Unlike municipal runoff, much of the runoff from populated areas, which can cover between 100 to 1000 square kilometers, often goes untreated. As a result, it can contain high levels of oil and organic materials, which ultimately reach reservoirs during the spring snowmelt and prolonged periods of heavy rain [13-16].

Agricultural activity is one of the major sources of pollution. The primary pollutants found in surface runoff include soil particles, organic matter, humus, various types of pesticides and fertilizers, and harmful microorganisms. These contaminants ultimately make their way into rivers and reservoirs. Research shows that even from slightly sloping areas, 20% of nitrogen fertilizers, 2-5% of phosphorus, and 10-70% of potassium can be washed away. The amount of toxic chemicals released can range from 1% to 20%. It's alarming to note that 1 billion tons of animal's waste are produced by livestock complexes and private farms, which is comparable to the biogenic pollution caused by a human population of around 300 million[17].

We will no longer focus on the negative impact of other anthropogenic factors on water quality (mineral extraction, water transport development, recreational industry, timber processing, etc.).

Global warming, along with pollution, has led to excessive eutrophication of water bodies. For example, global warming has led to water blooms in European lakes. Swiss scientists have found that the growing explosions of blue-green algae (cyanobacteria), which cause water blooms in European lakes, are associated with the effects of global warming. The researchers studied data on the temperature regime of Lake Zurich and the reproduction of the cyanobacterium Lanktothrix rubescens in it and found that over the past 40 years, the temperature of the surface layer of water in the lake has increased by an average of 0.6 to 1.2 degrees. As a result, the waters of Lake Zurich began to mix less, causing favorable conditions for more intensive reproduction of blue-green algae [18].

Phytoplankton serves as an important ecological and biological indicator for evaluating the sanitary, hygienic, and pollution conditions of reservoirs, as well as addressing large-scale water usage issues. Polluted river waters promote the growth of phytoplankton, which can lead to algal blooms in reservoirs. This phenomenon occurs because the water becomes enriched with easily digestible organic substances that accelerate the growth of bacterioplankton. As a result, oxygen consumption in the water increases, leading to hypoxic conditions and potentially causing anaerobiosis.

In summary, studying phytoplankton enables an assessment of reservoirs regarding their suitability for various purposes, their current sanitary, hydrobiological, and ecological status, as well as their future conditions.

Pollution and eutrophication are closely interconnected in their effects on water systems, often causing one another. This interaction leads to an overload of the ecosystem, disrupts sustainability, reduces beneficial biological production, and deteriorates water quality. The decay of organisms associated with eutrophication, often referred to as "bloom," leads to further biological pollution of water bodies. Scientific research has shown that "bloom" occurs in all types of water bodies [19-20].

Eutrophication can be observed in reservoirs and lakes that experience stable hydrological and hydrodynamic characteristics. For instance, in the United States, algal blooms in Lake Erie, which is over 12,000 years old, began to emerge only in the second half of the 20th century. The significant development and spread of algae have been noted in various lakes, including those in mountainous regions of Switzerland, Sweden, and Yakutia, all of which are situated in northern latitudes [21].

It is widely recognized that negative effects in reservoirs begin when algae biomass reaches concentrations between 500 to 5000 g/m^3. An excessive algal bloom indicates the accumulation of organic matter in the water, which poses a risk of secondary pollution and eutrophication. Furthermore, it is important to note that algae can accumulate significant amounts of heavy metals, including mercury, iron, copper, zinc, molybdenum, lead, aluminum, boron, manganese, and cadmium. When these plants die, the heavy metals are released into the water in their free form.

The Caspian Sea is the largest enclosed body of water on our planet. Its salty waters border five countries, including Kazakhstan and Russia, and it is rich in natural resources such as oil. What makes the Caspian Sea unique is its diverse marine life, home to over 120 species, including sturgeon, urchins, wrasses, and many other animals. The maximum depth of the Caspian Sea reaches 1,025 meters, and it stretches approximately 1,200 kilometers from north to south, earning it the nickname "sea."

However, the ecological state of the Caspian Sea is deteriorating and approaching a catastrophe. Various industrial waste water is flowing into the sea, leading to the inevitable decline of fish, crustaceans, Caspian seals, and other marine inhabitants. Oil slicks are increasingly appearing on the water's surface. Samples taken from the seabed indicate contamination with hazardous substances, including lead, mercury, cadmium, arsenic, zinc, nickel, and vanadium. The levels of these pollutants exceed the established safety limits for such bodies of water by several times. [22]

Mingachaur Reservoir, also known as the Mingachevir Sea, is a large reservoir on the Kura River in northwestern Azerbaijan. It supplies water to the Upper Karabakh and Upper Shirvan channels, and is used for electricity generation, irrigation water supply, and fishing. The Mingachevir Reservoir is the largest in the Caucasus, having a length of 70 km, a width of 18 km, a maximum depth of 75 m, an average depth of 26 m, a maximum volume of 15.73 km3, a shoreline length of 247 km, and an overall area of 605 km2 . The reservoir's water level is maintained by the dam of the Mingachevir Hydro Power Plant, built near Mount Bozdağ from 1945 to 1953. It is the largest hydroelectric power station in Azerbaijan, with an installed electric capacity of 401.6 megawatts. Its dam has a length of 1,550 m, a width of 16 m, and a height of 80 m.

In the current period, the eutrophic layer in the reservoir has been deepened. Thus, it is known that during the formation of the eutrophication process in the Mingechaur reservoir, along with the intensive development of phytoplankton, the area of their assimilation the eutrophic layer in the reservoir has deepened in recent times. Research indicates that the eutrophication process in the Mingechaur reservoir has led to significant phytoplankton growth, which has subsequently expanded and deepened their assimilation area. Over the past 50 years, the continuation of eutrophication in the Mingechaur reservoir has been increasingly noticeable, especially during the summer months.

It is noteworthy that the primary phytoplankton product in the Mingechaur reservoir has increased 11 times over the past 53 years. Interestingly that the dynamics of the phytoplankton initial primary product of reproduction by seasons of the year has been preserved, since in previous years the productivity on the entire area of the reservoir sharply decreased on the right bank. This is due to increased erosion along the coast. Depending on the seasons of the year, the formation of the primary product - the harvest - continues intensively in spring, summer, and autumn, except for the winter period.

In modern times, there have been significant changes in the physico-chemical properties of the waters of the Mingechaur reservoir. For the same reason, the intensity in the process of forming the biological productivity of the Mingechaur reservoir differs. The Mingechaur reservoir is a typical eutrophic reservoir of trophic type. It should be noted that in the last 25-30 years reservoirs have been created in the course of the three main rivers –Kur, Araz, Gabyrra, flowing into the Mingechaur reservoir, and unlike previous years, biogenic solid sediments are not discharged directly into the basin. However, the average annual amount of primary organic matter synthesized by phytoplankton in the Mingechaur reservoir is higher than the indicators defined in the eutrophic type and anthropogenic eutrophication continues without weakening [22].

Sevan' lake. By the mid-1990s, the water level of Lake Sevan had dropped by about 19 meters, eutrophication (excessive accumulation of plant nutrients) began, and the concentration of phosphorus, nitrogen, and other plant nutrients increased. To restore the balance and prevent a catastrophe, the almost 50-kilometer Arpa-Sevan tunnel was built. In the 1980s, the water level stabilized at about 1,897 meters. As of July 2021, the lake is located at an altitude of 1,900.75 m above sea level and contains a volume of water of 38 cubic kilometers [23-25].

It was determined that the cause of anthropogenic eutrophication of the lake is the combined action of two leading factors: restructuring of processes within the reservoir, disruption of the natural dynamic balance in the "water and sediment" system, and excessive inflow of biogenic substances from the catchment area. Currently, the water level of the lake is gradually increasing (by 6 m by 2030), however, this increase, like the previous decrease, is accompanied by water pollution as a result of intensive development of the banks, pollution of the coastal strip, point and diffuse pollution, and the deterioration of water quality indicators of the reservoirs - Martuni, Vardenis - leads to periodic "blooming" of the lake, changes in biodiversity, and other negative consequences. The main cause of Sevan eutrophication in 2018 was an increase in the number of algae in the reservoir, which was first observed in 1964 . According to the Ministry of Environmental Protection, the bloom was caused by wastewater entering the lake, including household and agricultural waste. Out of 400 business facilities in the coastal areas of the lake, only 14 treat wastewater. Pollutants are salts of heavy metals and the heavy metals themselves. The problem of pollution of the lake with heavy metals is more complex. Excessive levels of heavy metal ions have been periodically detected in the lake, such as: V- 5-6 times, Cr- 2 times, Se- 2-3 times, Cu- in some areas 2-3 times, Mg- 1.2-1.4 times [31-33]

Several environmental factors have significantly contributed to the decline in the ecological condition of the lake. These include a reduction in water levels, rising temperatures, an increase in cyanobacteria, a decrease in lake fauna, and the discharge of wastewater from cottages, hotels, restaurants, and residential buildings along the shore. In many villages and settlements, homes are either not connected to the sewage network or the networks are poorly maintained.

The unrestricted flow of fecal and domestic wastewater into the rivers that feed into the lake raises serious concerns about water quality. This is particularly evident in the varying water quality observed in both large and small rivers at their confluences, especially near populated areas. The findings indicate that water is clean at its source; however, there is a significant increase in E. coli levels and other pathogenic microorganisms near the settlements.

Fig. 1. The polluted water surface of Lake Sevan.

A sharp increase in eutrophication levels has been observed in the Aparan and Azati reservoirs. The flow of the rivers Kasakhi and Gegharot is regulated in the Aparan reservoir, which has a basin area of 7.6 km². The Azati reservoir, with a basin area of 3.2 km², regulates the flow of the Azati River. The average water levels in these reservoirs are 1835 m and 2620 m, respectively.

Both reservoirs are filled during the flood period. During this time, water losses due to filtration greatly exceed the design values, resulting in a significant layer of alluvial material being deposited in the central part of the reservoirs. Eutrophication is primarily linked to the use of nitrogen and phosphorus fertilizers, phosphorus-containing pesticides, livestock waste, and water from irrigation reservoirs. Additionally, the water quality is compromised by untreated domestic and industrial wastewater from nearby cities and villages before the river flow is regulated.

Positive trends are currently being observed in the Lake Sevan biosphere. Measures continue to be taken to prevent poaching, and activities aimed at boosting the fish population are ongoing. In 2022, the number of crayfish amounted to 100 tons. The overall increase in the fish population was also influenced by the artificial reproduction of fries; in May 2023, 130 thousand “Ishkhani” fries - Sevan trout (weight 10 g) were released in the Karchakhpur district.

Black Sea.Due to its limited connection with the ocean, the Black Sea is very sensitive to anthropogenic impacts. As a result of human activity, the Black Sea has become one of the most degraded regional seas on the planet in recent decades. According to a report prepared by the Black Sea Commission, the Black Sea ecosystem was severely damaged in the 1970s-1980s, when large amounts of biogenic substances were introduced into the sea by rivers, leading to eutrophication of the sea. These processes were especially pronounced and intensively expressed on the northwestern coast of the sea, although eutrophication is also observed on the eastern coastal waters of Georgia.

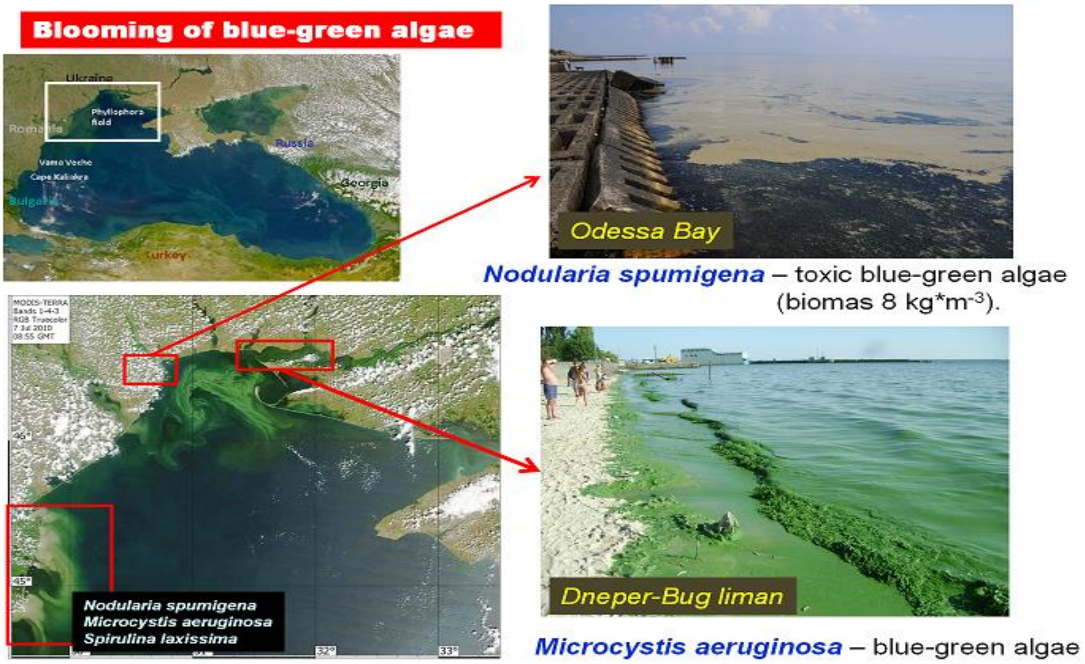

Fig. 2. The polluted water surfaces of the northwestern coasts of the Black Sea

The issue concerns the waters of the Ambassador Islands complex under construction, where three rivers Bartskhana, Kubistskali and Korolistskali, bring various types of pollutants that have caused the rapid generation, growth, and reproduction of cyan-bacteria [26].

It is noteworthy that phytoplankton in the ecosystem of the Black Sea, Georgia's coast, is quite diverse and is represented by six main groups of algae: Limestone ***(Bacillariophyta)*** 73%, dinoflagellates ***(Dinophyta)***-57%, green ***(Chlorophyta)***-2-3%, Golden ***(Chromophyta)***-6%, blew-green ***(Cyanophyta)***-16% and Yellow-green ***(Xanthophyta)***-%5, algae, among which the group of diatoms ***(Bacillariophyta)*** stands out for its species and quantitative superiority.

It is important to note that in certain study areas, such as the River Chorokhi, Batumi, and Supsa, local or point eutrophication occurs during the warmer months of the year. The aquatic waters of the River Supsa are particularly noteworthy, as they display a significant presence of blue-green algae (which contain especially toxic metabolites) and yellow-green algae. Additionally, one of the phagotrophic species of dinoflagellates**,** ***Noctiluca scintillans***—commonly known as "sea glow"—dominates the estuaries of the Chorokhi and Supsa rivers, serving as an indicator of local eutrophication.

The total number of phytoplankton in the Georgian Black Sea coastline usually experiences seasonal fluctuations and in spring and summer, precisely during the recreational period, it reaches an average of 1400 to 2300 million units/m^3, which negatively affects the health of vacationers, and in autumn and winter it varies from 1000 to 200 million units/m^3. According to the Black Sea Strategic Action Plans, in addition to eutrophication, the causes of environmental degradation in the Black Sea are chemical pollution of water (including as a result of oil spills), excessive fishing of marine fauna and the invasion of alien species into the sea [27].

Based on the analysis of the information obtained as a result of monitoring, it can be said that the main causes of water pollution in the Black Sea region of Georgia are water-using enterprises (especially communal ones), where a complete technological regime for wastewater treatment has not been implemented or water treatment facilities are operating inefficiently. Besides, it is also worth noting that 20 European countries discharge their wastes into the Black Sea, including through the Danube, Prut, and Dnieper rivers, with the main load falling on its relatively shallow northwestern part, where 65% of all living organisms are conceived, and the main spawning grounds are located.

The Tbilisi reservoir ecology. The reservoir is located in the northeastern part of Tbilisi. It has an elongated shape from northwest to southeast. The length of the coastline is 23.9 km, the surface area is 11.8 km2, the total volume of water is 308 and the usable volume is 155 million cubic meters, respectively; the average depth is 26.6 m, the maximum - 45 m; the maximum water level is 548 m, and the minimum - 333 m. The natural inflow of the reservoir is insignificant. The reservoir is supplied with water both from the Zhinvali reservoir, with a gravitational flow of Q = 12.5 m^3/s, of which 12.0 m^3/s is considered the city's water supply, and 0.5 m^3/s for irrigation of agricultural lands in Samgori, and from the Sioni reservoir, through the Zemo Samgori main canal, with a water flow of 6 m^3/s, of which an average of 2/3 is used for irrigation. The remaining volume of water accumulated in the reservoir is used for drinking water .

It is worth noting that, according to hydro-chemical characteristics, the surface waters of the Aragvi, Zhinvali, and Tbilisi reservoir basins are suitable for drinking water supply. Nevertheless, it is advisable to allocate such local areas that are potentially dangerous to any extreme events (damage to sewage systems of settlements and industrial facilities, failure of treatment plants, etc.), and in the future, due to increased anthropogenic load, in terms of chemical pollution. In such areas, it is desirable to carry out preventive water protection measures, which in these cases will create a reliable guarantee of protecting the quality of drinking water.

The study of samples taken from the reservoir showed that the main algae in the Tbilisi reservoir are: 1. Blue-greens – ***Cyan-bacteria***; 2. Greens - ***Cylorophyceae;*** 3. Diatoms - ***Diatomeae***; 4. Desmidiales - ***Desmidiales***; 5. Pyrophyta - ***Peridineae;*** 6. Volvox - ***Volvocales***; 7. ***Euglenineae***. They cover the water surface and float along the coastline with a width of 15-85 m. Observations conducted in the spring showed that mainly diatom algae (***Melosira, Asterionella, Fragilaria and Naviculaceae***) developed and spread, the number of cells per liter ranged from 40 to 165 thousand units [28].

During the observation, other species of algae were detected, including toxic algae represented by Anabeana. In spring, their number was 1000-3500 units/l, and in summer the concentration was approximately doubled, depending on the distance from the water inflow point and the wind direction.

The results of hydrochemical studies showed that the mineralization of the waters of the Aragvi, Zhinvali and Tbilisi reservoirs is below average, the content of biogenic elements is small, and the dichromatic oxidation is low, which indicates that chemical pollution is insignificant. The concentrations of trace elements are also low. The values of these indicators do not exceed the maximum permissible concentrations (MPC) provided for by water supply standards. In most cases, the studied waters belong to ecologically very clean - Class I waters, and only in terms of the content of phenols and oil products do they belong to Class II and III - clean and insignificantly polluted waters.

From a sanitary bacteriological point of view, the studied waters often fail to meet the requirements imposed on the water supply source. For a number of areas, there is a significant excess of coli-index concentrations over the maximum permissible norm (10,000 units/l). In the upper reaches of the Aragvi River, above the Zhinvali Reservoir, bacteriological pollution is seasonal, sharply increasing during the summer-autumn low-water period after rains, and is mainly caused by the washout of fecal pollution from pastures and livestock farms. The bacteriological pollution of the Zhinvali Reservoir is due to a sharp increase in this type of pollution in rivers; however, due to the dilution and self-cleaning processes taking place in the reservoir, the coli-index concentration values are two orders of magnitude lower than the values in the river [29].

Determination of changes in concentrations of biogenic ingredients (nitrogen, phosphorus) in Zhinvali reservoir

The equation that takes into account the changes in concentrations of various chemical elements in a reservoir has the following form [5,11]:

$$C_j = C_{0j}\, exp\left[-\left(\frac{Q_{flout}}{W} + K_j\right)t\right] + \frac{C_{trib.j}\cdot Q_{trib}}{Q_{flout} + KW}\left\{1 - exp\left[-\left(\frac{Q_{flout}}{W} + K_j\right)t\right]\right\} \quad (1)$$

(1) Here - is the initial concentration of the j-th element in the reservoir, the volume of which is W; kj - non-conservative (destruction) coefficient; $C_{trib.j}$- concentration of the j-th ingredient in the effluent Q_{trib}; C_j - concentration of the element that flows out of the reservoir $Q_{flout.}$

We calculate for the following data: $C_p = 0,01$mg/l; nitrogen $C_N = 1,75$ - mg/l; the flow of the Aragvi tributary Q_{trib} =23.2 m^3/s; Pshavi's Aragvi Q_{trib} =20.6 m^3/s;. The flow for the HPP is Q_{flout} =9.0 m^3/s. According to the formula (1), we obtain $C_P = 0,009$ mg/l for phosphorus concentration, and $C_N = 1,52$ mg/l for nitrogen concentration [5,11].

Predicting the level of Zhinvali reservoir' eutrophication. In case to determine the eutrophication of the Zhinvali reservoir, it is first necessary to determine the amount of primary products formed as a result of photosynthetic reactions in the reservoir, i.e., to determine the average annual concentrations of chlorophyll [chlor.a]. In the case when the ratio of nitrogen and phosphorus in the study waters is N : P >12, we will use the Dillon and Riegler relationship.

$$Log_{10} [clor.\mathbf{a}]=1,45log_{10} ([P] \cdot 1000)1,14 \qquad (2)$$

And in the case when the ratio of nitrogen and phosphorus is N : P <4, the following relationship

$$Log_{10} [clor.\mathbf{a}]=1,4 \ log_{10} ([N]\cdot 1000)-1,9 \qquad (3)$$

In these relationships, the concentrations of nitrogen and phosphorus are expressed in mg/l, and the concentration of chlorophyll in mkg/l. which can be used to determine the amount of primary products formed as a result of photosynthetic reactions in the reservoir, i.e.,to determine the chlorophyll-a average concentrations, one of the most important indicators of eutrophication. After determining the concentrations of biogenic substances nitrogen and phosphorus in the reservoir, since these data are essential for assessing the biomass in the reservoir, it is already possible to predict the level of the reservoir' eutrophication.

Using this method, the concentration of was determined in the Zhinvali reservoir, which is 2.31 mg / m^3.

$Cl._{"a"} = 0,28P^{0,96}$, (4)

As for the Tbilisi Reservoir, there is a growing trend in bacteriological and biological pollution: the coli-index value in some cases reached 50,000 units/l. It should be noted that the determining factors of the pollution of the Tbilisi Reservoir are: water and solid sediment entering from the Zhinvali and Samgori canals, which causes siltation of the Tbilisi Reservoir, as a result of which the depths of the reservoir decrease and favorable conditions are created for the spread of phyto- and zooplankton, which is already noted; use of the reservoir for recreational purposes - swimming, tourism, fishing, etc., which results in pollution of the surrounding areas and its washing into the reservoir as a result of rains; as well as the use of the areas surrounding the reservoir as pastures and watering places for livestock belonging to the population[31].

Of course, there are direct ways to determine phytoplankton biomass directly in the laboratory, but these measurements are quite difficult, time-consuming, and not very accurate.

It is also worth noting that various economic facilities are located on the territory of the recreational zone of the Tbilisi Reservoir. Despite the fact that they are sewered, as established by a survey of the population, in a number of cases, when accidents occur in the sewage systems, polluted waters enter the Tbilisi Reservoir. According to the hydrochemical characteristics, the surface waters of the Aragvi, Zhinali and Tbilisi Reservoir basins are suitable for drinking water supply. Nevertheless, it is advisable to allocate such local areas that, in the event of any extreme event (damage to the sewage systems of settlements and industrial facilities, malfunction of treatment plants, etc.) and in the future, will be considered potentially dangerous areas in terms of chemical pollution caused by an increase in anthropogenic load. In such areas, it is desirable to carry out preventive water protection measures, which in these cases will create a reliable guarantee of protecting the quality of drinking water. Unfortunately, the Sanitary Supervision Service does not function at all in Georgia today. Even before its abolition, sanitary doctors had limited rights and could not influence such issues; they could only identify sources of pollution and could not impose administrative fines.

Conclusion*:*

Water is one of the natural resources that has been directly linked to human life from the very first moments, has an incessant connection with it, and uses it quite frequently and extensively throughout its existence.

Based on comprehensive research, it is essential to develop new approaches to water treatment before and after water abstraction. This includes creating specialized methods and recommendations for implementation in the water supply system. We need to establish complex barriers and technologies for water treatment that will significantly reduce the burden on reservoirs and water treatment plants from various pollutants. Additionally, this approach could allow for the use of safer disinfectants instead of chlorine, which poses risks to human health.

Therefore, the main problem related to the quality of river and reservoir waters is the presence of chlorinated organic compounds, pesticides, and detergent residues in them, which, after disinfection of water with chlorine, form dioxins, the analysis of which is very difficult and possible only with special expensive equipment. It is known that water is chlorinated to destroy harmful microorganisms and preserve the organoleptic properties of drinking water. As a result, the first organochlorine compounds are formed in the water, and then, under the influence of soluble oxygen, they form very toxic dioxins, which contribute to the development of cancerous tumors. Organochlorine compounds containing fluorine, chlorine, and bromine cause nephritis (kidney disease), hepatitis (liver disease), increase the number of stillbirths and toxicosis during pregnancy, congenital anomalies, mutagenic defects, weakening of immunity, and disruption of reproductive function in both men and women. It is precisely due to the subsequent formation of dioxins that mutagenic, carcinogenic, teratogenic (ugly) properties are manifested in water at concentrations of 5-10 -12 mg/l.

We strongly believe that in order to protect water resources, it is necessary to prohibit the discharge of untreated runoff into reservoirs, prohibit any activities that negatively affect water quality in water protection zones, and take various administrative measures; strengthen the self-cleaning processes of reservoirs, improve and maintain the conditions for the formation of surface and groundwater; pay special attention to the introduction of methods and technologies for improving the ecological and hygienic state of water in the direction of cleaning runoff from agricultural fields; find and attract adequate methods for cleaning and disinfecting drinking water; replace worn-out branches of the network and implement planned flushing measures; impose strict control and punitive sanctions for excessive water consumption; Tightening control over the irrational placement of industrial and various agricultural, as well as recreational facilities near water supply facilities by local government bodies, sanitary-epidemiological and water supply services .This is a current, unsolved, life-and-death problem for the whole world, to which the government of our country, healthcare and non-governmental organizations should pay special attention [31-34].

We do not allow the health of our future generation to be encroached upon by the above-mentioned horrors. A priori, it must be said that preventing the causes of an accident is cheaper than eliminating its consequences, especially an epidemic.

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რეგიონული წყლის ობიექტების დაბინძურების პრობლემები

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რეზიუმე

პარადოქსულია, მაგრამ მიუხედავად იმისა, რომ წყალი დედამიწაზე სასიცოცხლოდ მნიშვნელოვან ნივთიერებას წარმოადგენს, ის ბუნებაში ერთ-ერთ ყველაზე ნაკლებად შესწავლილ ნაერთად რჩება. მისი სირთულე მეცნიერებისთვის გამოწვევებს ქმნის, რაც მის სრულად გაგებას ართულებს. მიუხედავად იმისა, რომ წყლის ქიმიური შემადგენლობა სტაბილურია, მისი გავლენა ორგანიზმებზე გარემო პირობების მიხედვით იცვლება.
მომავალში წყალთან დაკავშირებული მნიშვნელოვანი საფრთხეების წინაშე ვდგავართ, რაც მნიშვნელოვან ყურადღებას მოითხოვს. ერთ-ერთი საგანგაშო შეშფოთება, რომელიც გლობალურად არის აღიარებული, არის ფართოდ გავრცელებული პრობლემის პოტენციური გაჩენა ჩვენს წყალმომარაგების სისტემებსა და რეკრეაციულ წყალსაცავებში. ზოგიერთის მიერ „21-ე საუკუნის ჭირად" მოხსენიებული ეს პრობლემა დაკავშირებულია გარკვეული მიკროორგანიზმების - დედამიწაზე არსებული უძველესი სიცოცხლის ფორმების - ევოლუციურ ბუნებასთან, რომლებიც ამჟამად ქიმიური დაბინძურების გამო მავნე ხდება.
გამალეას სამეცნიერო-კვლევითი ინსტიტუტის კვლევა მიუთითებს, რომ ამ მიკროორგანიზმებს შეუძლიათ განავითარონ ახალი, საშიში შტამები, რომლებიც დროთა განმავლობაში ავლენენ ეფექტებს და ფუნქციონირებენ როგორც „ნელი მოქმედების მაღარო". ისინი წარმოქმნიან ნივთიერებებს კანცეროგენული, მუტაგენური და იმუნოსუპრესიული თვისებებით, რაც განსაკუთრებით შეინიშნება „ლურჯ-მწვანე" წყალმცენარეებში ან ციანობაქტერიებში.
ეს სტატია ხაზს უსვამს მავნე წყალმცენარეების აყვავების (HABs) კრიტიკულ საკითხს, განსაკუთრებით თბილისის წყალსაცავში, და პროგნოზირებს ჟინვალის წყალსაცავში ადამიანის საქმიანობით გამოწვეულ ევტროფიკაციას. ასეთი მოსაზრებების გამოყენება შესაძლებელია გლობალურადაც, რაც ხაზს უსვამს ჩვენი წყლის რესურსებისა და საზოგადოებრივი ჯანმრთელობის დასაცავად მოქმედების სასწრაფო აუცილებლობას.

საკვანძო სიტყვები: ფიტოპლანქტონი, ევტროფიკაცია, ბიოგენური ელემენტები, გასუფთავება, წყალსატევები.

Проблемы загрязнения региональных водоемов

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Резюме

Парадоксально, но, несмотря на то, что вода является жизненно важным веществом на Земле, она остается одним из наименее изученных соединений в природе. Ее сложность создает проблемы для ученых, затрудняя полное понимание ее состава. Хотя химический состав воды стабилен, ее воздействие на организмы варьируется в зависимости от условий окружающей среды.
В будущем мы столкнемся со значительными угрозами, связанными с водой, которые потребуют значительного внимания. Одна из тревожных проблем, признанных во всем мире, — это потенциальное возникновение широко распространенной проблемы в наших системах водоснабжения и водохранилищах для отдыха. Эта проблема, которую некоторые называют «чумой XXI века», связана

с эволюционирующей природой определенных микроорганизмов — одних из древнейших форм жизни на Земле, — которые теперь становятся опасными из-за химического загрязнения.
Исследования Научно-исследовательского института имени Гамалеи показывают, что эти микроорганизмы могут развивать новые, опасные штаммы, которые проявляют свои эффекты с течением времени, функционируя как «медленно действующая мина». Они производят вещества с канцерогенными, мутагенными и иммунодепрессивными свойствами, что особенно заметно у «сине-зеленых» водорослей или цианобактерий.
В данной статье освещается критическая проблема вредных цветений водорослей (ВЦВ), в частности, в Тбилисском водохранилище, и прогнозируется эвтрофикация в Жинвальском водохранилище вследствие деятельности человека. Полученные данные могут быть применены в глобальном масштабе, подчеркивая острую необходимость принятия мер по защите наших водных ресурсов и здоровья населения.
В статье рассматривается проблема вредных цветений водорослей (ВЦВ), уделяя особое внимание образованию и распространению цианобактерий в различных водоемах, включая Тбилисское водохранилище. Прогнозируется, что в Жинвальском водохранилище происходит эвтрофикация в результате деятельности человека. Этот подход может быть широко применен для прогнозирования подобных явлений в водоемах по всему миру.

Ключевые слова: Фитопланктон, эвтрофикация, биогенные элементы, очистка, водоем.