PROBLEMS OF GROUNDWATER POLLUTION

Pipko Polina Alexandrovna, Isengalieva Gulya Amirzhanovna

Aktobe Regional University named after K. Zhubanov,
Aktobe, Republic of Kazakhstan
polina.mey23@gmail.com

Abstract:
This article discusses groundwater pollution and the main aspects of its correct use. Groundwater pollution poses a critical challenge to water resource management in Kazakhstan, a vast country in Central Asia with diverse geological conditions. This article delves into the sustainable management of groundwater, focusing on Kazakhstan's efforts to minimize the use of underground water and proposing potential solutions. As a nation located in the heart of Eurasia, Kazakhstan relies on various water resources, including rivers, lakes, and underground water. Groundwater, found at depths ranging from 50 to 500 meters, plays a pivotal role in providing drinking water and meeting agricultural needs, serving as the primary water source for many settlements and irrigation.

Kazakhstan exhibits distinct groundwater horizons, primarily comprising Paleogene and Mesozoic deposits, as well as carbonate rocks. However, regional variations in groundwater levels present challenges, such as surface-reaching groundwater in Southern Kazakhstan leading to flooding and soil salinization. Moreover, high mineralization is a notable characteristic, rendering some groundwater unsuitable for drinking and irrigation due to excessive salt content.

The state of Kazakhstan's groundwater significantly impacts the country's ecosystem, as overexploitation can lead to decreased groundwater levels, negatively affecting vegetation and wildlife. Various factors contribute to groundwater pollution, including industrial emissions from factories and mines, agricultural activities employing pesticides and fertilizers, oil and gas operations causing leaks, and uncontrolled wastewater discharge in the absence of effective treatment systems.

This comprehensive exploration of Kazakhstan's groundwater situation emphasizes the need for sustainable practices to address pollution sources and protect this vital resource. The article sheds light on the interconnectedness of groundwater management, environmental conservation, and the well-being of both human and natural systems in the region.

Keywords: Kazakhstan, groundwater pollution, water resource management, sustainable groundwater use, Paleogene and Mesozoic deposits, carbonate rocks, mineralization, environmental impact, ecosystem, industrial emissions, agriculture, pesticides, fertilizers, oil and gas operations, wastewater discharge, Central Asia.

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Introduction:

"Kazakhstan, as a large country in Central Asia, faces serious challenges in water resource management. One important aspect is the sustainable management of groundwater. In this article, we will explore the issue of minimizing the use of underground water in Kazakhstan and possible solutions. The country, located in the heart of Eurasia, is characterized by diverse geological conditions. Kazakhstan's water resources include rivers, lakes, and underground water [1].

Groundwater plays a crucial role in providing drinking water and meeting the agricultural needs of the country. They serve as the primary source of drinking water for many settlements and are used for irrigation.

The main groundwater horizons in Kazakhstan are found at depths ranging from 50 to 500 meters. The major aquifers include Paleogene and Mesozoic deposits, as well as carbonate rocks.

The groundwater level can vary significantly in different regions of Kazakhstan. For instance, in some areas of Southern Kazakhstan, the groundwater level reaches the surface, leading to problems of flooding and soil salinization.

A notable characteristic of Kazakhstan's groundwater is its high mineralization. In some regions, the salt content in groundwater exceeds permissible limits, making it unsuitable for drinking and irrigation.

The state of Kazakhstan's groundwater also impacts the country's ecosystem. Excessive exploitation of groundwater can lead to a decrease in the groundwater level, negatively affecting vegetation and wildlife [2].

Causes of Groundwater Pollution:

1. Industrial emissions: The region hosts numerous industrial facilities, including factories and mines, generating industrial waste and chemicals that pollute water resources.
2. Agriculture: The use of pesticides and fertilizers in agriculture can lead to the transport of these chemicals into groundwater.
3. Oil and gas operations: The extraction and transportation of oil and gas in the region can result in leaks and contamination of groundwater.
4. Uncontrolled wastewater discharge: Lack of effective sewage and wastewater treatment systems can lead to groundwater pollution with untreated effluents.

Consequences of Groundwater Pollution:

1. Deterioration of water quality: Groundwater pollution degrades the quality of drinking water and may contain toxic substances harmful to human health.
2. Environmental damage: Groundwater pollution can poison plants and animals, as well as disrupt ecosystems.

Today, attention will be focused on the territory of Western Kazakhstan. Groundwater pollution is a serious problem that requires immediate action. Collaborative efforts of government agencies, businesses, and non-governmental organizations can help minimize pollution and ensure sustainable management of this crucial natural resource.

Minimizing the use of groundwater in Kazakhstan is a path to Sustainable Water Management. Problems of groundwater use in Western Kazakhstan:

1. Overpopulation and agriculture: Agriculture in Kazakhstan is a major consumer of groundwater used for irrigation. Increasing population and water consumption in agriculture create pressure on groundwater resources.
2. Leaks and losses: Outdated water supply and irrigation systems can lead to leaks and water losses, exacerbating pressure on groundwater.
3. Drying up water bodies: Excessive use of groundwater can cause rivers, lakes, and other surface water bodies to dry up, negatively impacting ecosystems and aquatic resources.

In Western Kazakhstan, over 140 potential sources of groundwater pollution have been identified, with more than 50 documented as currently hazardous and moderately hazardous pollutants of water for domestic use. Thus, anthropogenic impact is comprehensive, leading to changes in the atmosphere, surface and groundwater regimes, landscape transformation, and the creation of geochemical and thermal anomalies, disrupting the internal balance of the subsoil.

The ecologist from Taraz, R. Sabitov, has been addressing the issue of groundwater pollution from human activities for 20 years. Factories and plants pollute water with their discharges, and the private sector contributes through livestock waste and ubiquitous toilets. In his opinion, all of this affects the quality of drinking water, which eventually enters our bodies.

Experts suggest that over decades, water literally becomes toxic. The lack of statistics and specialized research in this area only exacerbates the situation.

The main consumers of underground and surface waters are Uralsk and Aksai, as well as the settlements of Burlin, Derkul, Zachagansk, and Krugloozernoye. Water extraction from natural water sources over the past 11 years has a general tendency to decrease. For example, in 2003 compared to 1993, water extraction decreased by more than 51% (Figure 1.1). A similar situation is observed with water consumption in the region, which has decreased by almost 73% over the same period. Industrial and agricultural facilities using water in the production cycle discharge it onto fields for evaporation and filtration, and sometimes into water bodies. In the oil and gas industry, spent waters are usually injected into underground formations
[2]."

In the West Kazakhstan region, more than 25 sources of groundwater intended for domestic and industrial use have been researched and approved, with total reserves of up to 367.3 thousand m3/day. The following sources of groundwater pollution have been identified in the region: industrial facilities such as oil depots in the Chapaev settlement, Burlin, and the city of Aksai, as well as oil and gas fields and municipal utilities. Agricultural facilities, including poultry farms and pig complexes in Rostoshi, Shchanogo, Zhelaeva, Volodarskoye, Darinskoye, Ozeroye, Bol. Chagan, Podstepnoye, and others, are also sources of pollution. Other sources of groundwater pollution include wastewater filtration in Darinsk, Novenkiy, Fedorovka, Burlin, and Peremetnoye settlements.

The primary pollutants in groundwater are phenols, petroleum products, aluminum, manganese, iron, nitrates, and nitrites. In 2002, groundwater pollution with manganese (exceeding 2-8 MPC), aluminum (exceeding 2-10 MPC), and nitrates (exceeding 1-2 MPC) was detected in the Ural, Serebryakovskoye, Kushum, Darinskoye, Tokpai, and Urdinskoye fields, classified as the third class of pollution hazard. Groundwater pollution from the Zharsuat field with manganese and iron falls into the fourth class of hazard. Therefore, groundwater pollution is observed in the Burlin, Bokeyordinsky, Teretinsky, and Zelenovsky regions [3].

Pollution from extractive industries in the West Kazakhstan region can be caused by lime, industrial dust, and waste rock. Some enterprises also show the presence of heavy metals as major pollutants. However, despite this, effective measures are not taken in the region to prevent the spread of industrial and household waste by air currents, leading to the expansion of areas with contaminated soil and, consequently, water pollution. To prevent groundwater pollution in the western part of the region, it is necessary to strictly adhere to environmental standards and take precautionary measures at all levels of enterprises and organizations. Local authorities and environmental protection agencies should monitor compliance with these norms and conduct water resource monitoring to respond timely to potential threats and ensure the safety of groundwater.

One of the main dangers is the contamination of groundwater with hazardous substances such as arsenic. For example, arsenic can enter groundwater as a result of rainwater washing away pesticides containing it, which are used in agriculture to combat plant pests, as well as during the filtration of surface runoff into the ground. The main methods for removing small amounts of arsenic from water are coagulation with aluminum and iron salts with the introduction of air into the mixer, settling, and filtration through quartz and then coal filters [4].

Ideas and Proposals - a Path to Solving the Problem of Combating Pollution.

Recently, we were introduced to the installation of an underground septic tank. This structure is designed for the mechanical purification of wastewater by settling with anaerobic digestion of the sediment. Septic tanks are used as part of autonomous sewage systems. The septic tank is not a complete treatment facility: after the septic tank, the clarified effluent is fed to an underground filtration structure, which finally purifies the effluent by soil filtration.

However, it is an integral part of modern wastewater treatment systems and has a significant impact on reducing groundwater pollution. Here are some of its main advantages:

1. Environmental Safety: The septic tank processes wastewater directly on-site, avoiding contamination of surface and groundwater and reducing the risk of harmful substances entering the environment.
2. Control of Discharges: The septic tank helps control wastewater discharges, preventing their direct release into the environment or onto the land surface. This contributes to preserving the quality of water resources and reducing the risk of waterborne diseases.
3. Durability: Well-made septic tanks have a high level of strength and durability. Properly installed and regularly maintained, a septic tank can serve for many years, providing a reliable wastewater treatment system.
4. Economically Viable: Installing a septic tank can significantly reduce costs associated with connecting to centralized sewer systems. This is especially relevant in remote areas where connecting to the city network may be problematic or costly.

All these advantages make septic tanks an essential component in sustainable wastewater management and the protection of the quality of underground water resources.

Figure 2 - Septic Tank Diagram

The approximate size of the reservoir will depend on the groundwater level.

Figure 3 - Diagram of Selecting a Treatment Facility Depending on the Groundwater Level

At first glance, it may seem that wastewater can simply be discharged into the sewer or the environment. However, this is an incorrect solution that can cause ecological problems and violate sanitary-hygienic standards. A septic tank, on the other hand, allows for the efficient and safe treatment of wastewater, its long-term storage, and prevents environmental pollution. The septic tank is a standalone wastewater treatment system that employs various treatment methods such as aeration, filtration, and sedimentation. These processes help eliminate contaminants and bacteria present in wastewater, resulting in purified water that can be safely used for irrigation or discharged into the environment.

The basis for reducing the negative anthropogenic impact on groundwater is its rational use. Knowing the water demand by regions and industries allows for differentiated water consumption based on quality: using lower-quality water for technical and production needs and reserving high-quality water only for drinking water supply. However, administrative decrees and fines, as experience shows, are not sufficient to regulate water withdrawal. One of the most effective tools for regulating the intensity of anthropogenic impact on groundwater is economic stimulation of rational water withdrawal and environmentally safe location of production. It is known that the population reacts predictably to changes in water prices. Therefore, setting optimal water user fees is a separate and highly relevant task [4]. It is also necessary to analyze alternative ways of using groundwater resources for medicinal, industrial, and reclamation purposes.

Rational use of groundwater will not only reduce the negative impact on the groundwater hydrosphere but also provide the necessary means to implement various environmental protection measures.

In conclusion, it is essential to emphasize the tremendous importance of groundwater for our planet and humanity as a whole. They are a vital source of drinking water needed to sustain human life and health, as well as for agriculture, industry, and ecosystems.

However, groundwater pollution has catastrophic consequences. Various industrial and agricultural waste, household chemicals, and toxic substances enter groundwater, leading to serious environmental problems and threatening human health. Groundwater pollution can cause various diseases, such as cancer, nervous and muscular disorders, immune system weakening, and other severe conditions. Additionally, it also affects biological diversity and ecosystems that depend on clean water for their existence.

Therefore, urgent measures must be taken to prevent groundwater pollution. This includes strict control over the discharge of harmful substances, the implementation of sustainable agricultural and industrial practices, and educating the population about the importance of preserving and protecting groundwater resources.

Only through joint efforts and responsible decisions can we protect these crucial natural resources and ensure clean and healthy drinking water for ourselves and future generations. Otherwise, the threat to nature and our own well-being will be inevitable and unpredictable.

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