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SOME PROBLEMS ON ENHANCING THE EFFICIENCY OF WATER UTILIZATION IN A CLIMATE CHANGE IN THE REPUBLICS OF ARMENIA AND ARTSAKH

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Abstract

The 6th of the UN Sustainable Development Goals refers to water under a heading «Clean Water - Sanitation». The goal is set by 2030 to ensure safe and equal access to drinking water for everyone in the world, to improve water quality by reducing pollution, to eliminate hazardous chemicals and to halve the discharge of untreated wastewater into water reservoirs, to increase the amount of wastewater recycling and reuse. The implementation of water supply based on the principles of sustainable development will increase the efficiency of water utilization and solve the problem of sustainable water supply in conditions of water scarcity, will carry out comprehensive management of water resources at all levels including through cross-border cooperation. Expanding of international cooperation will support water supply and sanitation projects (water intake, land desalination, water conservation, drinking water treatment, wastewater treatment including water treatment, development and application of reusable technologies, etc.). The present article refers to the identification of a number of problems in increasing the efficiency of utilization of water resources and community involvement in water supply and sanitation management in Armenia and Artsakh in the context of global climate change.

Key words: water, water intake, water saving, sustainable development, aquatic ecosystem, water pollution, wastewater treatment.

Introduction

197 countries adopted the Paris Agreement (Paris Declaration) at the 2015 UN Summit in Paris on December 12, 2015 to fight climate change and its negative effects. The agreement, which came into force a year later, aims to significantly reduce global greenhouse gas emissions and to limit rising temperatures to 2^0C by the end of this century. Global climate change makes the reproduction of freshwater resources more vulnerable. Climate change is an urgent global challenge that transcends national borders. This challenge requires coordinated decision-making at all levels and international cooperation. UN 2015 Article 7 (7) (c) of the Paris Summit Declaration stipulates that the deepening of climate knowledge, as well as the monitoring of climate change and the introduction of an early forecasting system is a necessary precondition for the creation of an appropriate information system that will facilitate the process of decision-making [1].

Article 8, Clause 1 of the Paris Declaration states that the Parties shall apply the solutions imposed by the situation and warnings of possible harmful effects of climate change, including

extreme weather events and slow-moving natural processes. They should be aimed at ensuring sustainable development reducing the risks of loss and damage.

It is necessary to activate the actions, in particular, in the following directions:

a) introduction of rapid response systems;

b) preparedness for possible emergencies;

c) monitoring of slow processes;

d) risk management, development and implementation of measures to prevent the development of phenomena that pose a risk of irreversible consequences and large losses;

e) ensuring access to information on global climate change.

Article 12 of the Paris Declaration envisages intensification of cooperation between the parties in the field of education. In this regard, we propose to include relevant new subjects in technology-oriented secondary and higher educational institutions.

At the 2019 Madrid Conference, the parties to the Paris Declaration managed to integrate approaches to the prevention or reduction of losses and the elimination of damage and the mobilization of available resources [2, Clauses 17, 30, 34]. At the same conference, the parties underlined the need of intensifying measures related to the slow-moving processes and non-economic losses [2, Clause 24]. According to the UN Climate Change Mechanism in Warsaw, these problems can only be solved by achieving a synergistic effect [3, point 11].

In September 2015 the UN 2030 Sustainable Development Agenda set 17 goals consisting of 169 targets. Objectives include basic issues of effective management of the environment including water resources. Countries are expected to consolidate their efforts to eradicate poverty in all its forms, to fight inequality and to address climate change challenges while pursuing the motto “no one should be ignored”.

The Government of the Republic of Armenia has established the Council for Sustainable Development Goals to define the priorities and directions for nationalization of the UN Sustainable Development Goals in the country, to fix them in the national strategic programs and to ensure systemization and monitoring of comprehensive implementation of the Sustainable Development Goals by 2030 [4].

Water and sanitation are focused upon the sustainable development. Safe drinking water and wastewater disposal, as well as personal hygiene are the cornerstones of human health and well-being. In addition to household use, water is required for food, energy production and industry. These are highly interrelated and potentially conflicting uses. Water consumption results in wastewater, which, if not properly treated, can lead to pollution. Water provides universal flexibility during anthropogenic and natural changes. The climate system is linked to nature and the socio-economic system by water and as a result of climatic changes there often occur deviations in water availability - water scarcity in some areas and flooding in others. Consequently, water is one of the main risk management factors for women, epidemics, migration, inequality, political instability and natural disasters. Comprehensive water management is irreplaceable for both synergy strengthening and managing possible trade and economic relations which will ensure that everyone has access to water and sanitation [5].

Despite significant progress in improving access to safe drinking water, billions of people, mostly in rural areas still suffer from the lack of stable water supply.

One of three people in the world today do not have access to safe drinking water, and sixty percent do not receive sustainable sanitation. According to the United Nations about 890 million people continue practicing open defecation.

In 80 per cent of households, women are responsible for collecting water in the absence of a stable water supply.

Water scarcity is an urgent problem for more than 40 per cent of the world's population. There are all preconditions that the situation will go from bad to worse. Currently 1,7 billion people live in river basins where the demand for water significantly exceeds its self-cleaning capacity. More than 80 percent of the world's wastewater is discharged into rivers or seas without treatment.

COVID-19 epidemic has become imperative to ensure a stable supply of sanitation, hygiene and clean drinking water. Regular hand washing is one of the most effective steps a person can take to reduce the spread of pathogens and prevent infections.

Conflict setting

Taking into consideration that effects of global climate change include, among other things, a significant reduction in freshwater amounts in the near future and as a result a sharp increase in water prices in the international market, Armenia and Artsakh can set a long-term aim to become one of main exporters of drinking water.

Research results

The management of water resources cannot be done properly without paying attention to water quality. In particular, a link should be established between planning and management of water resources, processes of water utilization and water pollution bench mark.

The main steps in establishing an effective monitoring system of water pollution are:

- Detection of water pollution and preliminary analysis of related problems, including identification and classification of problems and determination of primary problems.
- Definition of a long-term management and short-term goals, including assessment of existing capacities, determination of necessary measures as a part of the management process and definition of realistic short-term, mid-term and long-term goals.
- Defining and implementing the necessary measures, levers and mechanisms for effective water management including planning legal reforms, making necessary changes to existing legal documents; implementation of legal acts, development of a monitoring system, definition of measures, training of bodies involved in the process, definition and implementation of exchange of information and mechanisms of dissemination.

Mechanisms of pollution control have been developed in almost all countries of the world to ensure the protection of the environment, in particular, water resources. According to such mechanisms, companies are obliged to comply with the mandatory environmental standards set by the legal acts of the country, as well as to develop and implement environmental monitoring programs if necessary. Companies carrying out polluting activities are also obliged to comply with the norms set out by international agreements and protocols.

Together with setting of pollution-limiting regulations it is important to develop mechanisms that encourage pollution reduction for the development of the economy which will allow the sustainable use of natural resources including water. The use of such levers provides a number of decisive advantages.

In particular, they force companies to refrain from making investments into environmentally harmful production. Pollution control mechanisms encourage companies to explore, localize and implement technologies that can prevent or reduce pollution as well as apply methods that use natural resources wisely and efficiently.

The use of pollution charge as a control mechanism is often conditioned by the institutional and administrative capacities of the existing system in the country. In other words, you can either invest in a separate type of payment or combine it with another, already existing payment. Obviously, using the

second option can simplify the process of collecting pollution pays.

At present, in order to reduce the level of pollution of water resources, a number of pollution control mechanisms are used worldwide which are related to the principle of "polluter pays". According to it, the polluter must reimburse the costs of cleaning up his emissions, pay fines and penalties in case of pollution, violation of environmental standards, as well as the damage caused by the pollution and elimination of its consequences. There is also a second principle – "the user pays" according to which the users of services must pay the costs of using the natural resources used to receive the product and for their further recovery. In providing pollution control the most applicable mechanisms to be introduced are [6]:

- **Water pollution payment** is calculated based on the amount of pollutants emitted by companies into the environment. Moreover, the amount of payment depends on the number of units of each pollutant emitted into the environment. Moreover, the amount of payment may differ depending on the hazards of the pollutants, the place of discharge and the properties of the pollutants. The variety of pollution sources and their large number make the calculation of the payment for water pollution and its use almost impossible for many materials, which is conditioned by the limited resources required for the organization of monitoring and control. The best pollution payment scheme includes a simple, straightforward calculation approach and is applied for a limited number of pollutants.
- **Fines for violating the standards** are levied on companies if the level of pollution caused by them exceeds the values set by the relevant regulations or permits. Moreover, in order to ensure the efficiency of this mechanism, it is necessary to meet the following conditions:
  - ✓ fines should be set at a fairly high value level which will force polluters to actually meet requirements of standards, rather than just pay the appropriate fine,
  - ✓ the amount of the fine should depend on the extent of exceeding the permitted level of pollution and the frequency of such violations,
  - ✓ the monitoring system of the supervising authority should be sufficiently reliable and efficient to detect violations of the standards in a timely manner.
- **Enforcement of targeted commitments** enables companies to create and introduce a system of environmental protection. Experience has shown that companies which pollute environment tend to reduce their harmful emissions by monitoring their polluting activities if they are clearly aware of the significant amounts of the fine to be paid in case they cause damage to the environment. In case of application of obligations, the field is regulated by the judicial system, and the obligation enters into force after recording the fact of damage caused to the environment. At the same time, it should be noted that the target commitments are difficult to realize in practice, as the polluting company may not have sufficient financial resources to pay the court-ordered liabilities at the time of the damage assessment, or may choose the suspension of its activities. Moreover, in order to ensure the efficiency of this mechanism, the following conditions must be met:
  - ✓ the charge for the damage caused to the environment should be set so high as to oblige the polluting company to comply with the requirements of the established standards in the future,
  - ✓ the fee should depend on the size of damage done to nature,
  - ✓ the information system of the supervising body must be sufficiently reliable and efficient to detect, measure and assess the damage caused on the environment,
  - ✓ citizens and self-governing bodies need to be informed about their rights in the sphere of nature preservation.

- **Guarantees of fulfillment of contractual obligations** are given to the supervisory or regulatory body prior to such an activity carried out by a company that may result in potential pollution. Guarantee payments are refunded to the company upon completion of the project if the regulatory body confirms compliance with the accepted environmental standards. If the company does not comply with environmental standards, the guarantee amount is retained and used to implement measures to eliminate pollution caused by the company.

Sources of water pollution are various. One of the most dangerous sources of water pollution is mining industry which has a negative impact on the whole environment, changes the qualitative composition of air (dust), water and soil. The Subsoil Law aims to ensure that mining waste is properly managed to avoid damaging the environment. It contains provisions on mining waste, which require the miner to ensure the processing, assessment, neutralization and reduction of mining waste while maintaining the norms and rules of waste collection, transportation, storage, processing and burial.

Heavy metal Contamination of soil is a serious health concern in recent years. Heavy metals from mining waste contaminate drinking water, soil, fodder and food. They negatively affect the characteristics of the soil, leading to the limitation of its productive and vital functions. The inclusion of heavy metals in the main group of environmental pollutants is conditioned by their stability and biological accumulation capacity. Their accumulation leads to the emergence of toxic effects on ecological systems that are already clearly visible.

Wastes such as acid mine drainage have a significant harmful effect on water composition. Metal waste promotes the penetration of metallic materials into large waterways, dams, spreads through food chains, appears in hazardous quantities in food and affects the biodiversity of ecosystems.

Of major mining wastes are tailings, waste materials left after the target mineral is extracted from ore. They consist of crushed rock, water, trace quantities of metals and additives used in processing. To store mining wastes conventional tailings dams are built.

The waste technical profile is performed during the Environmental Impact Assessment (EIA) prior to final approval of the project. Structures such as landfills and tailings dams should be planned, designed and operated in such a way that geotechnical risks and environmental impacts are properly assessed and managed throughout mining operations and after mine closure. The subsoil company should develop a monitoring program, subsoil waste management and recycling plan.

In this regard, it is necessary to study the impact of the Kashen mining complex on the surrounding aquatic environment. This problem can be solved by using the method of calculating the filtration in the homogeneous soil dam body of the tailings dam proposed by L.V.Tokmajyan [7]. There are cases of inflow of groundwater contaminated as a result of the penetration of fertilizers, pesticides, domestic and industrial wastewater into the reservoir.

The width of the infiltration area can be determined by considering the general case of the filtration process, when there is a h_o deep water flow on the opposite side of the reservoir slope (Fig. 1).

The depth in reservoir varies with respect to Eq.(1).

$$h(\tau) = B_1 - B_2 \cos 2\pi\tau\,, \tag{1}$$

where $B_1 = \frac{h_{\max} + h_{\min}}{2}$, $B_2 = \frac{h_{\max} - h_{\min}}{2}$, $\tau = \frac{t}{T}$, $h_{\max}$ is the maximum water depth in the reservoir, $h_{\min}$ is the depth corresponding to the dead volume of the reservoir, t is the time variable, and T is

the observed total time.

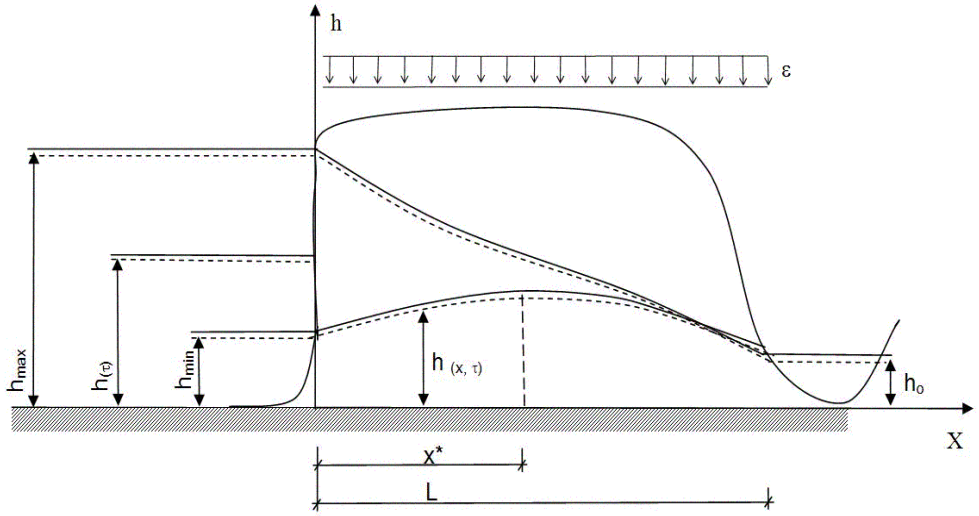

Fig. 1 Filtration through the reservoir homogeneous body

$$\bar{h}(\bar{x},\tau)=(1-\bar{x})\bar{h}(\tau)+\bar{h}_0(x)+v_1(\bar{x},\tau)+v_2(\bar{x},\tau) \quad (0\le\bar{x}\le 1,\ 0\le\tau\le 1), \tag{2}$$

where

$$\bar{x}=\frac{x}{L},\bar{h}(\bar{x},\tau)=h(\bar{x}L,\tau)/L,\bar{h}(\tau)=h(\tau)/L,\bar{g}(\bar{x})=g(\bar{x}L)/L,\bar{h}_0=h_0/h,\overline{h_+}=h_{\max}/L,\overline{h_-}=h_{\min}/L,$$

$$B_1=B_1/L=(\overline{h_+}+\overline{h_-})/2,\overline{B_2}=B_2/L=(\overline{h_+}-\overline{h_-})/2,\bar{p}^2=aT/L^2,\bar{f}=\varepsilon T/\mu L,$$

$0\le\bar{x}\le 1, 0\le\tau\le 1$:

$v_1(\bar{x},\tau)$ ..... $v_2(\bar{x},\tau)$ functions are determined by the following formulas.

$$v_1(\bar{x},\tau)=\frac{8\bar{\varepsilon}}{\pi^3}\sum_{n=1}^{\infty}\frac{\sin[\pi(2n-1)\bar{x}]}{(2n-1)^3}e^{-\pi^2(2n-1)^2\bar{p}^2\tau} \quad (0\le\bar{x}\le 1,\ 0\le\tau\le 1): \tag{3}$$

$$v_2(\bar{x},\tau)=\frac{4\bar{f}}{\pi^3\bar{p}^2}\sum_{n=1}^{\infty}\frac{1-e^{-\pi^2(2n-1)\bar{p}^2\tau}}{(2n-1)^3}\sin[\pi(2n-1)\bar{x}]-\frac{8\bar{B}_2}{\pi}\sum_{n=1}^{\infty}\frac{\sin(\pi n\bar{x})}{n(4+\pi^2\bar{p}^2n^4)}\{e^{-\pi^2n^2\bar{p}^2\tau}+$$

$$+\frac{1}{2}[\pi\bar{p}^2n^2\sin(2\pi\tau)-2\cos(2\pi\tau)]\}$$

$$(0\le\bar{x}\le 1,\ 0\le\tau\le 1): \tag{4}$$

In this regard, it is necessary to study the impact of the Kashen mining complex on the water quality of the Tartar, including the Sarsang Reservoir built on it. Water quality can be determined by taking into account the above mentioned method changing the boundary conditions depending on the operating mode of the complex.

German geologists have studied the temperatures and pressure conditions of the formation of secondary quartzite in the Kashen deposit. Their findings show that the secondary quartzite are formed at a pressure of 110–200 bar and at a temperature of – 150–200^{0}C, i.e. in the sub-volcanic fascia. These thermodynamic parameters do not correspond to the secondary quartzite formed in the near-contact zone of granite intrusive masses of the hypabyssal fascia. Well known in Armenia masses of well-known Paleogene (pyrite quartzite of Hatsavan, Uranium-bearing quartzite of Lernadzor) and Neogene quartzites (Sulfur opalite's quartzites) are isolated from Upper Eocene-Oligocene intrusions. They are spatially associated with basaltic-andesitic volcanic formations of the Middle Eocene and Upper Miocene.

The secondary quartzite of Kashen mineral field are composed of the following minerals: quartz, sericite, kaolin, rutile, pyrite, chalcopyrite, also in the oxidized zone - iron hydroxides (geotite, limonite), oxides (hematite), minerals of propylene volcanic rocks (chlorite, celadonite) and relicts of primary rocks (plagioclase, amphibole, idiomorphic porphyry quartz) (Fig. 2) [8].

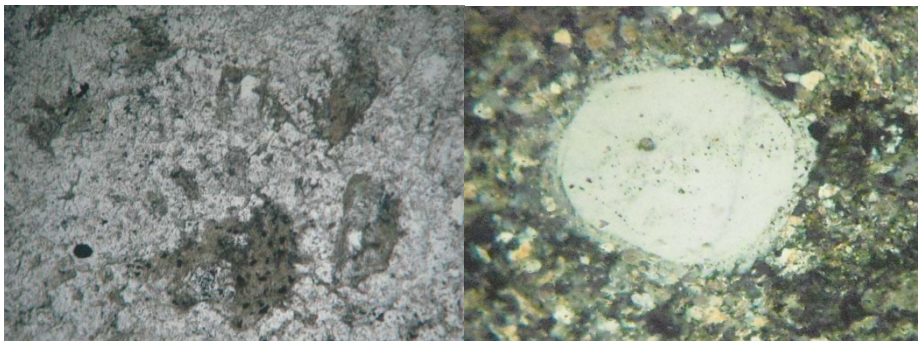

Fig. 2 Sericite quartzite-like metasomatitis

On the right, in the quartz sericite base, aggregates of chlorite from propylite with small pyrite particles are preserved. Without analyzer, d = 4.88 mm, slice 3.

On the left: Quartz relic idiomarphic phenocrystal in metasomatic rocks. With analyzer, d = 4.88 mm, slice 1.

When discussing water management issues, it should be borne in mind that significant climate change already exists in Artsakh [9]. In Stepanakert (capital of Artskh Republic), in particular, the average annual temperature rise over the last 50 years has been 1.3^0C (Fig. 3).

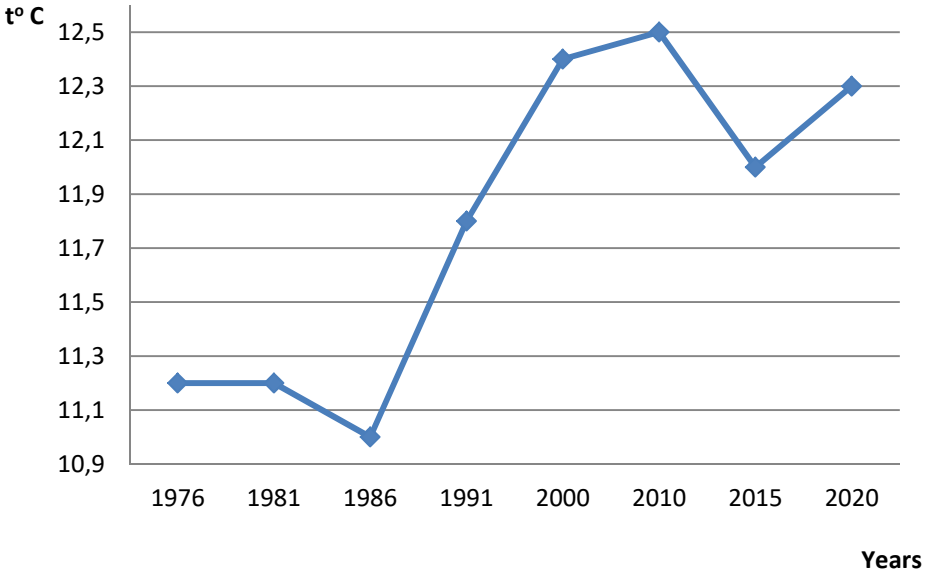

Fig. 3 Dynamics of temperature change in average annual indicators in Stepanakert

During the same period, the average monthly temperature rise in Stepanakert reached 3.2^0C (Fig. 4).

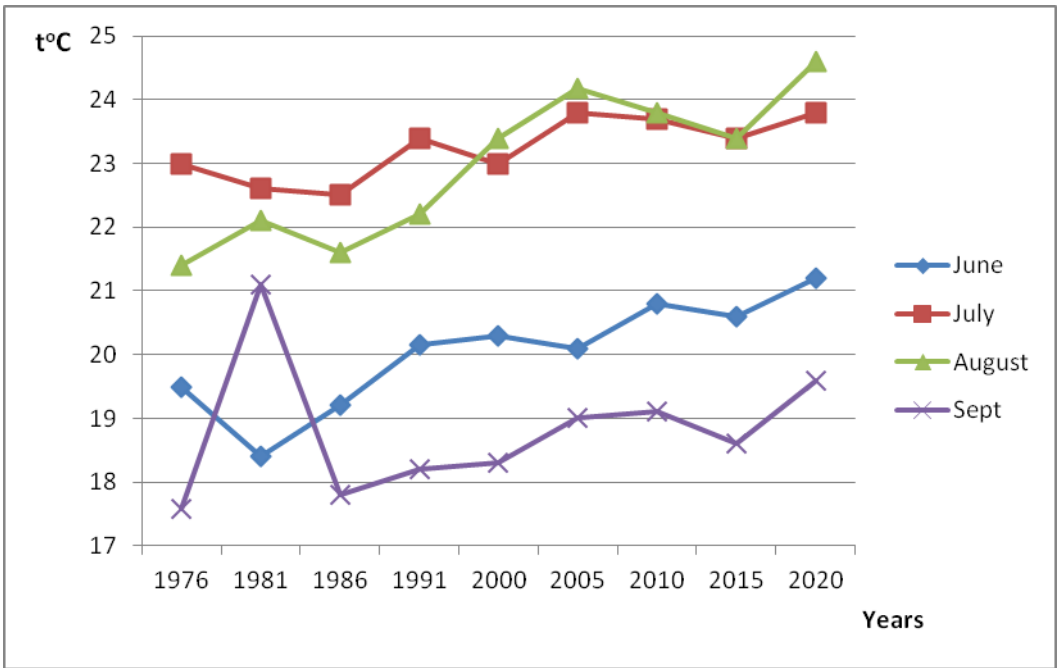

Fig. 4 Dynamics of annual change of average monthly temperature in Stepanakert

In order to increase the safety and efficiency of the use of state-owned water systems of the Republic of Artsakh, to implement a policy in the field of water systems and to ensure the implementation of the national water program, it is necessary to establish an authorized body for water systems management which should be reserved [10].

- Management of state-owned water systems;
- Organization of irrigation and drinking water supply and drainage.
- Ensuring the implementation of redistribution of works of water resources.
- Organizing the development and expertise of investment programs in the field of water systems development;
- Development of programs aimed at increasing the efficiency of water systems management and implementation,
- Providing preliminary examination of design documents for the construction of objects affecting water systems and reconstruction works of submitting proposals.
- Safety regulation of the use of hydraulic structures and control.
- Supervision of work organization in non-competitive water supply systems.
- Ensuring the implementation of water systems inspection activities.
- Carrying out analyses in the field of water systems and monitoring.

Functions of management of water resources should be delegated to another authorized body. Tariff policy in the water sector should be implemented by an independent regulatory commission.

Utilizing the opportunities of Lake Sevan can be a crucial step in becoming a donor of drinking water in the region. For this purpose, it is necessary to raise the level of the lake to the level of the first half of the XX century which is substantiated by H.V. Tokmayan and T.S. Martirosyan [11].

Conclusion

When carrying out management of water resources and water systems in Armenia and Artsakh, it is necessary to be guided by the principles of sustainable development, taking into account that in a

climate change, the scale of fresh water scarcity will increase sharply in the near future, as for the price of fresh water it may jump dozens of times in the international market.

Desalination of ocean and sea water, basically – turning ocean or sea water into drinking fresh water is not only economically inefficient but also unpromising in terms of quality; it cannot be used for drinking in the long run. Therefore, measures to protect freshwater from pollution and depletion are now gaining special importance. Countries that can become exporters of freshwater will have real opportunities for development. In this regard, despite the fact that the water resources of Armenia and Artsakh have largely come under the control of the neighboring country, there are still serious opportunities to become one of the main players in the export of drinking water in the region. Necessary but not sufficient conditions to solve this problem are:

1. Development and implementation of measures designed to enhancing the efficiency of utilization of water resources including the identification and implementation of new methods for water conservation.
2. Implementation of an active and effective policy in the field of water under international law.
3. Protection water resources from pollution and depletion.
4. Implementation of water collection programs, including the construction of small reservoirs.
5. Utilization of Lake Sevan exclusively as a source of drinking water by raising the lake level to 1915.57 m.
6. Improvement of water legislation.
7. Ensuring safe operation of water systems.

The main risks to achieve this goal are:

1. Blocking the flow of water in the neighboring countries to Armenia and Artsakh for political purposes, including the implementation of economically inefficient and very expensive programs. The implementation of such programs in Turkey is currently estimated at more than $ 22 billion. In particular, after the construction of the Kars Reservoir is completed, the cross-border Akhuryan River will be deprived of the inflow from Turkey and we must also return to the neighboring state 50 per cent of Armenia's inflow according to the norms of international law. A possible problem for Artsakh could be the possible actions of our neighbors to direct the waters of the Tartar River to Azerbaijan.
2. Water pollution, including poisoning.
3. Maintaining high rates of water loss.
4. Irregular use of groundwater, especially for fisheries.
5. Implementing the wrong pricing policy for drinking water and irrigation.
6. Inefficient management of water systems and operation.
7. Carrying out subversive actions against water systems.

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ՀԱՅԱՍՏԱՆԻ ԵՎ ԱՐՑԱԽԻ ՀԱՆՐԱՊԵՏՈՒԹՅՈՒՆՆԵՐՈՒՄ ՋՐԱՅԻՆ ՌԵՍՈՒՐՍՆԵՐԻ ՕԳՏԱԳՈՐԾՄԱՆ ԱՐԴՅՈՒՆԱՎԵՏՈՒԹՅԱՆ ԲԱՐՁՐԱՑՄԱՆ ՄԻ ՔԱՆԻ ԽՆԴԻՐ ԿԼԻՄԱՅԻ ԳԼՈԲԱԼ ՓՈՓՈԽՈՒԹՅԱՆ ՊԱՅՄԱՆՆԵՐՈՒՄ

Է.Վ. Ավանեսյան
Շուշիի տեխնոլոգիական համալսարան

ՄԱԿ-ի կայուն զարգացման նպատակներից վեցերորդը վերաբերում է ջրին և ունի «Մաքուր ջուր և սանիտարական պայմաններ» անվանումը: Նպատակ է դրվում մինչև 2030թ. աշխարհում բոլորի համար ապահովել խմելու ջրի անվտանգ և հավասար հասանելիություն, բարելավել ջրի որակը՝ կրճատելով աղտոտումը, վերացնելով վտանգավոր քիմիկատներ և կիսով չափ կրճատել չմաքրվող կեղտաջրերի ջրային օբյեկտներ արտանետելը, մեծացնել կեղտաջրերի վերամշակման և բազմակի օգտագործման ծավալները: Ջրառ իրականացնել՝ ելնելով կայուն զարգացման սկզբունքներից, բարձրացնել ջրօգտագործման արդյունավետությունը, սակավաջրության պայմաններում լուծել կայուն ջրամատակարարման խնդիրը: Բոլոր մակարդակներում իրականացնել ջրային ռեսուրսների համապարփակ կառավարում, այդ թվում՝ անդրսահմանային գործակցության միջոցով: Պաշտպանել և վերականգնել ջրաէկոհամակարգերը: Ընդլայնել միջազգային գործակցությունը ուղղված օժանդակությունը ջրամատակարարման և ջրահեռացմանն առնչվող ծրագրերում (ջրառ, հողերի աղազերծում, ջրի խնայողություն, խմելու ջրի և կեղտաջրերի մաքրում, այդ թվում՝ ջրի մաքրման և բազմակի օգտագործման տեխնոլոգիաների մշակում և կիրառում, այլ): Ավելացնել համայնքների մասնակցությունը ջրամատակարարման և ջրահեռացման կառավարման բարելավման գործընթացներին: Հայաստանի և Արցախի Հանրապետություններում, կլիմայի գլոբալ փոփոխությունների պայմաններում, ջրային ռեսուրսների օգտագործման արդյունավետության բարձրացման մի շարք խնդիրների բացահայտմանն է վերաբերում ներկայավող հոդվածը:

Բանալի բառեր. ջուր, ջրառ, ջրի խնայողություն, կայուն զարգացում, ջրաէկոհամակարգ, ջրերի աղտոտում, կեղտաջրերի մաքրում:

НЕКОТОРЫЕ ПРОБЛЕМЫ ПОВЫШЕНИЯ ЭФФЕКТИВНОСТИ ИСПОЛЬЗОВАНИЯ ВОДНЫХ РЕСУРСОВ В РЕСПУБЛИКАХ АРМЕНИЯ И АРЦАХ В УСЛОВИЯХ ГЛОБАЛЬНОГО ИЗМЕНЕНИЯ КЛИМАТА

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Шестая из целей устойчивого развития ООН относится к воде и имеет название "Чистая вода и санитария".

Поставлена цель, к 2030 году для всех людей во всем мире обеспечить: безопасный и равный доступ к питьевой воде; улучшить качество воды; уменьшить ее загрязнение, уничтожить опасные химические вещества и сократить наполовину сброс неочищенных сточных вод в водные объекты; увеличить объемы переработки и многократного использования сточных вод; осуществлять водозабор, исходя из принципов устойчивого развития; повысить эффективность водопользования; решить проблему стабильного водоснабжения в условиях дефицита воды; осуществлять комплексное управление водными ресурсами на всех уровнях, в том числе посредством трансграничного сотрудничества; защищать и восстанавливать водные экосистемы; расширять международное сотрудничество, направленное на содействие в проектах водоснабжения и водоотведения (водзабор воды, рассоление почвы, очистка питьевой воды и сточных вод, в том числе разработка и применение технологий очистки воды и многократного использования и т.д.); расширить участие общин в процессах улучшения управления водоснабжением и водоотведением.

В статье делается попытка выявить ряд проблем повышения эффективности использования водных ресурсов в республиках Армения и Арцах в условиях глобального изменения климата.

***Ключевые слова*:** вода, водозабор, водосбережение, устойчивое развитие, водная экосистема, загрязнение воды, очистка сточных вод.

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