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Research Article

STUDY AND ASSESSMENT OF THE STATE OF GROUNDWATER IN THE BUKHARA OASIS

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ABSTRACT
This article presents the research work carried out by geologo-hydrogeological specialists on the study of the state of groundwater in the Bukhara Oasis and their results. In addition, research work on the study of the groundwater regime, balance sheet in the Bukhara Oasis, analysis and assessment of the current state of groundwater is covered.

Keywords: *Zarafshan River, Experimental Filtration Works, Wells, Water Consumption, Fresh And Slightly Saline Groundwater, Assessment Of Its Current State, Monitoring, Underground Water Mine, Hydro-Reclamation, Arid Region*

INTRODUCTION

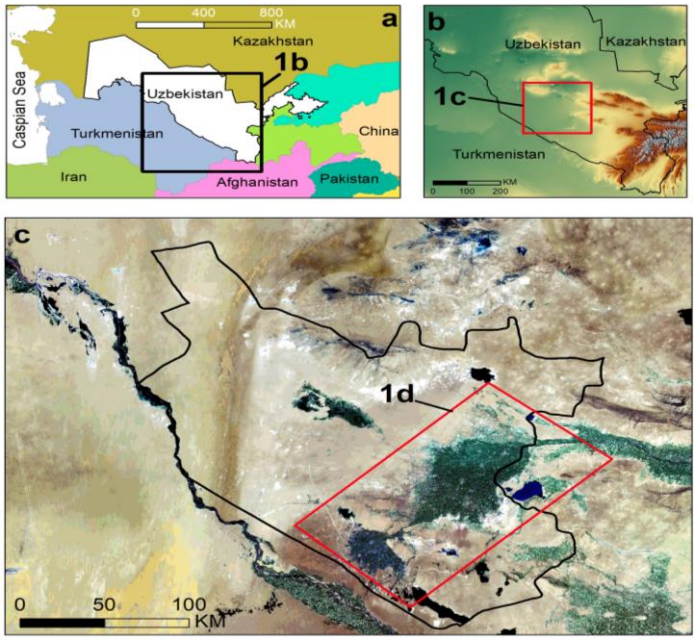
The world is one of the priority areas to assess the change in the regime of groundwater in miqiyos and the impact of other natural – man-made processes on it. It follows that state programs are being implemented by developed countries of the world aimed at identifying the reasons for the change in the groundwater regime, as well as reducing its negative consequences.

Bukhara region is located in the southwest of Uzbekistan, in the lower Zarafshan River, in the south and southeast of the Kyzylkum Desert, with uncomplicated borders. The province is bordered to the Southwest and South by the Republic of Turkmenistan in part through Amudarya, and the rest on land through the sandigliqum, Kemirakqum deserts. It is bordered to the west by the Khorezm region and the Republic of Karakalpakstan through the southwestern parts of Kyzylkum, to the North and Northeast by the Navoi region through the Jongeldi, gasy Heights, the southern foothills of Quljuktag, footpaths and Karakata swamps, to the East and Southeast by the Kashkadarya region through the cliff plateau, Karnob, Karshi and Sandigliqum deserts (Picture 1).

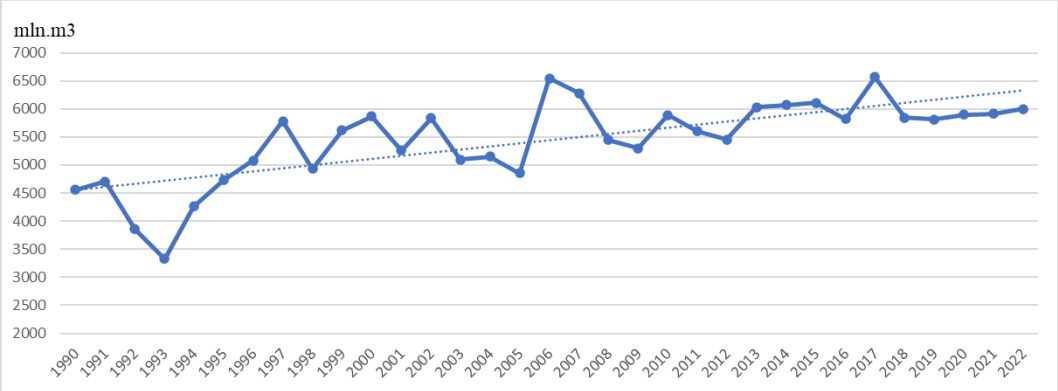
The territory of the Bukhara region is located in an arid climatic region, and it is the typical desert region the characteristic signs are observed. The territory consists of two large natural complexes, which are sharply different from each other in natural geography-the Bukhara and Karakul oases, formed by the Southern Kyzylkum steppe and the Zarafshan River [Soliev *et al.*, 2021].

The water supply of irrigated areas of the Bukhara Oasis is carried from Amudarya through the Amu-Bukhara and Amu-Karakol canals, and in the spring months through the Zarafshan River. To irrigate land in the region in 2018 - 5843.1 million.m^3; in 2019 -5816 million.m3; in 2020 -5901 million.m3 in 2021 - 5917.5 million.m3 water was obtained. From this, the irrigated period is 60-70% from May to December, the non-irrigated period is 30-40% of surface water used from January to April.

Water resources were imported into the Bukhara oasis from the 70 years of the last century through the Amu-Bukhara canal in the amount of 4.5 -6.5 km3 per year. Previously, the Zarafshan River began to have a man-made effect on groundwater resources, water resources with a different chemical composition, entering natural conditions along its territory. Through the Amu-Bukhara main canal, we can see that the amount of Water received from the Amudarya in the period from 1990 to 2022 regularly increased, and after 2017 it decreased slightly as a result of the reforms carried out in the agriculture and water economy in our Republic (Picture 2) [Rakhimov *et al.*, 2021].



Picture 1. Survey map of the research area. a) on a continental scale, b) on regional scale based on a digital elevation model, c) location of the study area the local level based on the Landsat satellite image, d) the contour of research.



Picture 2. Graph of the amount of perennial water obtained through the Amu-Bukhara canal.(1990-2022)

MATERIALS AND METHODS

Within the territory under consideration, two types of relief are distinguished: a structural elevated plain and an alluvial plain.

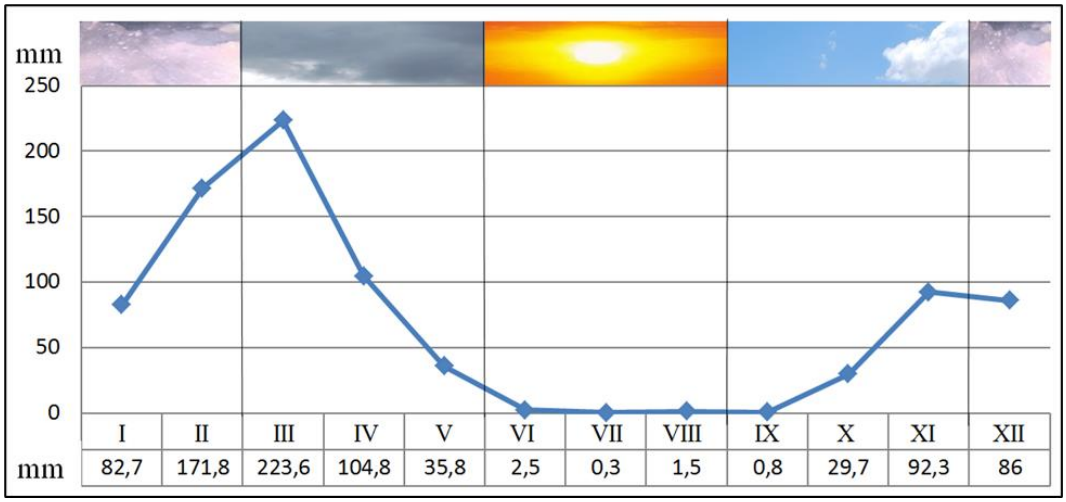
The first type of relief is located in the southwestern and western parts of the study area and is a slightly undulating plain with a slope towards the alluvial plain. The absolute marks vary between 217-230m and they rise above the surface of the alluvial plain by 3-5m [Tolibov *et al.*, 2014].

The second type of relief occupies almost the entire area of the study area.

In the cross-section of the alluvial-delta valley, three terraces of the r. Zarafshan, including understanding. The first floodplain terrace is traced in the form of separate outliers along the modern riverbed. The surface of the terrace rises 0.5-1.0 m above the water horizon in the river. the width of the terrace reaches 0.3-0.5 km.

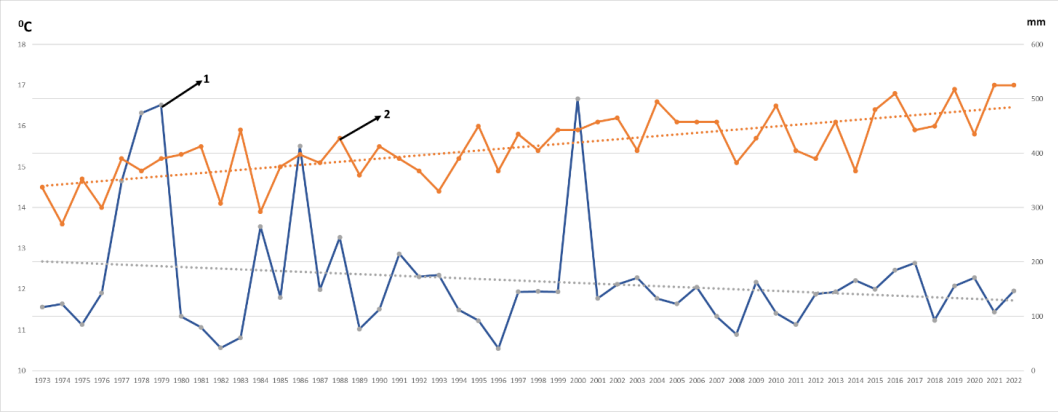
The second terrace is traced in separate parts along the floodplain and rises 0.4-1.5 m above the floodplain.

The third terrace borders on the second terrace, a floodplain and rises 2-5 m above the water level in the river. The third terrace has a significant distribution and represents the entire alluvial plain of the study area, with the exception of the areas of the first and second terraces.
The general slope of the plain is observed from northeast to southwest with local slopes towards the river. The absolute marks of the surface range from 220-242m. The surface is flat and mostly occupied by cotton and wheat crops. The area of the terrace is crossed by a dense network of irrigation and drainage systems, there are various mounds and hills with a height of 3-15m, sometimes up to 20m. General slope (0.0003-0.0004) to the southwest.
The climatic conditions of the work area are typical arid ones, due to the proximity to the Kyzyl Kum desert zone. The climate is sharply continental with large fluctuations in temperature throughout the year and day.
Summers are long, hot, dry; winters are short and relatively cold. Precipitation falls in insignificant amounts. Low air humidity and high volatility are noted. Data on the main climatic factors characterizing the climate are taken from the meteorological station located in Bukhara. The main data of climatic characteristics are given in charts. (Picture 3,4)



	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
mm	82,7	171,8	223,6	104,8	35,8	2,5	0,3	1,5	0,8	29,7	92,3	86

Picture 3. Graph of the change in the amount of annual precipitation in the Bukhara meteostancy.



Picture 4. Bukhara meteorostancy data. 1-average perennial atmospheric precipitation (mm) graph, 2-average perennial temperature (^{0}C) graph. (1973-2022)

Analyzing the data of the multi-year meteostancy, the average atmospheric precipitation trend line is falling, and the average annual temperature trend line is rising.
The Bukhara Oasis has arid climatic conditions, with a perennial average January air temperature of-2ºC to +1ºC, with an absolute minimum of-26ºC, winter lasts 1-2 months. The average air temperature in July

is around 29.5-36ºC, with the highest air temperature going up to 45-46ºc. The duration of the year when the sun shines is 2800-3000 hours.

On the territory of the Bukhara region, natural humidity is very low, the annual fat content is around 95-125 mm and possible evaporation from the surface of the Earth is 2000 mm. It reaches up to, and the territory of the region is included in the zone with an extremely arid - arid climate. Precipitation is not evenly distributed throughout the year, with the spring season being the most fertile, with 45-55% of the annual precipitation falling during this season. The summer season is extremely dry, precipitation practically does not fall, and the relative humidity of the air decreases by 10-20%. In the area, the snow cover will not be thick and will not remain insoluble for a long time.

The high air temperature in the summer will cause extreme dryness of the air, which will lead to a large lack of moisture. Maximum relative humidity of up to 86% is observed in December-January, with a minimum of 25-35% in June-July [Rakhimov, Davitov *et al.*, 2021].

Dry heat i.e. insufficient air humidity during the summer months causes strong evaporation and an increase of 10 times the amount of precipitation is observed. The maximum value of evaporation is up to 200 mm, observed in June-August.

The main water sources of the region are the Zarafshan River and Amudarya, which start from the territory of neighboring Republics. The water supply of the region is carried out mainly from Amudarya, through the AMU-Bukhara and Amu-Karakol canals. Amudarya water is supplied to the AMU-Bukhara and Amu-Karakul channels for use using the Hamza I and Hamza II pumping stations.

The water of the Zarafshan River is divided into more than 50 trunk ditches (Konimex, Shofirkon, Vobkentdarya, Romiton, Shohrud, etc.) in the territory of the region and is spent on irrigation. The water in the canals comes mainly from the Amu-Bukhara Canal and the Zarafshan River.

In ancient times, the Zarafshan River was absorbed in the dunes without reaching 20 km to Amudarya. The mineralization of the river waters varies on average from 1.3 to 1.8 g/l as a result of the confluence of the Zarafshan river waters (coming from Samarkand and Nawai) with the waters of the Amu-Bukhara canal. The Zarafshan River brings very little water to the province. Its average annual water consumption is 14.3 m^3/second in Karakol (155 m^3/second in the mountainous part). The part of the Zarafshan River that passes through the Bukhara Oasis is known as the central Bukhara drainage, which currently serves as a drainage of effluents.

For irrigation purposes, lower Zarafshan (Korakul, Olot, Jondor, Romitan, Bukhara and Kogon cities) received Amudarya water through the Amu-Karakul canal, 55 km long, in 1962, and the Amu-Bukhara canal, 268 km long, in 1965. At the head of the Amu-Karakol Canal, the water consumption is 48 m^3/second, and at the Amu-Bukhara canal, it is 235 m^3/second. Olot, Karakol and Hamza pumping stations on the Amu-Bukhara canal have a capacity of 66 m of Amudarya water. ga will pick it up. The ditches released from this canal lead Amudaryo water to the lower and Tudakul reservoir during the winter months when water is not needed for irrigation. In order to provide irrigation and water to the population in the region, Tudakul, and the lower reservoir were built on the Zarafshan and Amu-Bukhara canals. The Tudakul is located in a natural swamp. It is currently used as a reservoir. The water capacity is 1.0 km^3 when the dam is full of water.

In order to provide irrigation and water to the population on the territory of the Bukhara region, Todakul and Quaymazar reservoirs were built on Zarafshan and the Amu-Bukhara canal. The Tudakul is located in a natural swamp. It is currently used as a reservoir.

RESULTS AND DISCUSSION

Groundwater is a vital natural resource that has an increasing impact on climate change and human activities. We know that we must monitor it to properly use and protect invisible groundwater. It is impossible to assess and predict the qualitative and quantitative displacement of groundwater without accurate and retrospective information.

The study of the natural-historical conditions of Central Asia, including the Bukhara region, began in the first half of the XIX century. Special hydrogeological studies on the reconstruction and hydro-reclamation of the irrigation network of the irrigated area of the Bukhara Oasis M.I. Reshetkin, S.V. Luasky, A.N. Witte (1952-1953yy.) and A.A. Khudoyberdiev (1957y.). The last two authors gave information about the

alluvial lithology of the Oasis, they made a map of the mineralization of the territory from the surface of the wastewater and conducted hydrogeological and reclamation zoning.
In 1958-1960, V. P. Semenov carried out hydrogeological work in the Zarafshan River Valley in order to find sources of water supply for the city of Bukhara, and as a result, a plot of Shakhrud was proposed, according to the author's conclusion, the reserves of grunt waters were estimated and recommended for further research.
In 1959-1961, Work was carried out on the results of hydrogeological research work by F. M. Farmanov (hydrogeological party of Kokhcha). The exploitation reserves of the grunt waters for the author's irrigation purposes and the reserves of groundwater corresponding to Category B were considered.
In 1961, V.P. Volkov and L.V. Podlyavskov the purposes of domestic and drinking water supply of the Bukhara region by the operational accounting books of the fresh groundwater and their corresponding Class B water intake, were approved.
In 1965, G.M. Mcelskoy and S.Sh Mirzaev made a territorial estimate of the exploitation reserves of groundwater in the areas of Konimex-Karmana, Bukhara Karakol, and blueberry groundwater deposits, the salinity of which is up to 1.5 g/l.
In 1968-1973, I.E.Shtamm The strain worked on fields on sheets K-41-XXXIV, K-41-XXXV, J-41-V, J-41-X, J-41-XII, searching and hydrogeological exploration in the Bukhara region in order to find fresh groundwater and select promising areas for settlements. As a result, a hydrogeological map was compiled on the above sheets, calculated the full thickness of the Neogene period, and proposals were made for drilling groundwater with the separation of promising areas [Shtamm *et al.*, 1972]
Hydrogeological and engineering-geological surveys on a scale of 1: 50,000 were carried out by specialists of the West-Uzbekistan GGE, including in 1967-1969 B. Burkhanov (Karakul IGP) in karakul Oasis, 1970-1972 I.V. Vasiev (Romitan IGP) in the central part of Bukhara Oasis, 1971-1975 D.U. Ashirmatov (Shofirkon IGP). (Gishtin IGP) in the northeastern part of Bukhara Oasis, 1979-1982 G.S.Eshonkulov As a result of work carried out by Eshonkulov (Qoraulbazar IGP) in the southern part of the Bukhara Oasis and the western part of the Karshi desert, in the period 1980-1983 (Varakhsha IGP) in the southwestern part of the Bukhara Oasis, corresponding maps were compiled on a scale of 1:50,000, and areas of fresh groundwater with a depth of up to 100 M were determined [Ashirmatov, Utiev et al.,1980, Burkhanov, Karabaev *et al.*, 1969]
In 1978-1980 V. Shutko and V.E. Kvon (Zhilvon hydrogeological party) conducted a general search for fresh groundwater for water supply in rural settlements of Bukhara Oasis, as a result of which Kanimex, Narpay, Gijduvon, Zhilvon, Vobkent and other areas with groundwater salinity of 1.5 g/l were allocated for supplying water to rural settlements. At the same time, work was carried out along all the major channels of the Bukhara region.[Shutko, Kvon et al.,1980]
The entire research area is 1: 200 000 (B.R. Ruziev and N. Akhmadkulov, Gijduvon hydrogeological party, sheets K-41-XXXV) on the basis of a state survey on scale. Conditional hydrogeological maps of 1: 200 000 scale were drawn up and recommendations were made on the need for special hydrogeological work on the identified promising fields.
In 1998-2000, specialists of the hydrogeological party II-Shirinkuduq (T.M.Zinoveva, I.R. Ruziev) studied the groundwater of the upper Pliocene and quaternary deposits in the northeastern part of the Bukhara mine to supply water to the rural settlements of the Bukhara region. According to the results of the work carried out in the research area, 3 promising areas were identified and allocated according to the categories of operational reserves: reserve by Categories A, B, C1 [Zinovieva, Riziev *et al.*, 2000].
In 1998-2000, in the western part of the territory of the saritash hydrogeological party under the West-Uzbekistan GGE, R.R. Aytmatov settlements of Bukhara region by aitmetov carried out a search for fresh and low-salt groundwater in the Neogene and chalk sediments of the Western Kashkadarya underground water mine for internal water supply of the Karaulbazar district. As a result of the work carried out, promising fields have been identified for further hydrogeological research.
In 1999-2002 in the GGE part of West-Uzbekistan in the territory of the hydrogeological party III-Duoba (P.B. Navruzov and V.P. Morozov) conducted a search at the underground water Mine in the Duoba plot for the supply of fresh and poorly saline groundwater to rural settlements in the Kiziltepa district, Navoi region, Gijduvon and Shofirkon districts. According to the results of intelligence work on 01.06.2002, 9

operational water extraction facilities of the Neogene-quaternary age of the Blue ground water mine in the Duoba plot were evaluated and approved category B [Navruzov, Morozov *et al.*, 2002].
In 2007-2010, regional hydrogeological studies were carried out by the Shurabad GGP on the reevaluation of the upper Pliocene deposits in the northern part of the Bukhara region and the predicted freshwater underground resources in the southern part of the groundwater mine with the attitude of changing water management conditions and appropriating new land for irrigation farming. According to the results of the study, the predicted freshwater resources of the upper Pliocene aquifer were calculated.
In 2010-2014, P.B. Navruzov In order to provide rural settlements with domestic drinking water in the Gijduvan and Vobkent districts of the Bukhara region, carried out an assessment of fresh and low-saline groundwater in the areas adjacent to it. According to the results of the work carried out, the exploitation reserve of groundwater was approved.[Navruzov *et al.*, 2014]
In 2011-2015, o.Ya. Tolibov and Z.X. Kholikov (Peshku GGP) conducted regional hydrogeological studies on the development of new lands within the Peshkowa Romitan regions in order to reevaluate the predicted resources of fresh groundwater in the upper Pliocene deposits in the western part of the Bukhara groundwater deposit and for farming on irrigated land. As a result of the work carried out, the predictive resources of fresh and poorly saline groundwater of the complex of upper Pliocene aquifers were calculated. According to the results of the work, freshwater and low-saline groundwater were detected in an area of 232 km2, including fresh water in an area of 90 km2 and low-saline groundwater in an area of 142 km2, with an average thickness of water layers in areas with a minelayer of up to 1.5 g/l of 35 m. Natural reserves in the area have been assessed.
It is mentioned that work will be carried out throughout the research area to study the regime and balance of groundwater and control their reduction and protection from pollution, and it is established that this task will be carried out within the framework of the Bukhara GGS.
The predicted groundwater resources for the Bukhara and Kokhcha deposits were calculated only for the Quaternary aquifer. The estimated groundwater resources for the upper Pliocene aquifer have not been calculated.
At the same time, the quality of the aquifers in the Quaternary and upper Pliocene deposits has changed, the assessment of which and the development of proposals for rational use in perspective are important tasks.
In the conditions of a sharp shortage of irrigation sources in the development of new lands in the Bukhara region, it is important to reevaluate the predicted resources of low-saline groundwater in the Quaternary and upper Pliocene aquifers in relation to irrigation conditions, which will help improve the irrigation conditions of new lands in the Bukhara region.
In 2017-2020. Z. Kholikov and other specialists (Zhuynav GGP) in order to identify the sources of water supply of rural settlements of Shofirkon District of Bukhara region, the purpose of assessing the reserves of fresh and low-saline groundwater in promising areas of the northern and northwestern part of the Bukhara mine is to determine the sources of water supply. formed kilib. In the area where the work was carried out, groundwater enters the upper Pliocene deposits from the northeast side.[Kholikov *et al.*, 2020]
N.N. Khodzhibaev, Yu.S. Kovalev (1977.) Collected and analyzed data on Bukhara and Karakul Oasis, according to the data, the irrigated area of Bukhara Oasis is 178 thousand hectares (1973 year). Groundwater lies at a depth of 0.5-1.0 to 2.5 m (sometimes slightly deeper), with mineralization ranging from 1-3 to 5-10 g/L and higher. 90-95% saturation is associated with irrigated waters (filtration in fields and irrigation channels). The groundwater flow to the Oasis was estimated by hydrogeologists to be 0.6 m3/sec. The reclamation situation in the Oasis is considered complex, according to natural drainage conditions, the main part of the territory belongs to dry and very poorly drained zones (D.M. Kats). According to regional balances carried out by the enterprise" Uzbekhydrogeology", groundwater flow by 1970 is characterized by the following data (m3/sec):
- underground output outside the Oasis-0.5;-0.5;
- drainage collector and drainage systems -14;
- water supply and water intake for irrigation-1;
- total evaporation-15.5.

The Karakol delta of the Zarafshan River occupies the lowest hypsometric position and has a very weak natural drainage. A distinctive feature of the deposits is their high primary salinity; undoubtedly, their natural drainage has been low throughout the geological history of the formation of the Karakol Delta. The state of groundwater lies at a depth of 1-3 m. the composition of water varies from strong salinity (5-10 g/l) to saline (40-50 g/l). The formation of groundwater is ensured by the infiltration of 95% irrigation. Water output from the Oasis is reported to reach 18,000 m3 per year.[Khodjibaev, Kovalev *et al.*, 1977]
G.A. Mavlyanov, K.G. Ganiev (1983.) Bukhara and Karakul Oasis collected perennial regime data of groundwater, and in Bukhara Oasis in 1936-1976 the amplitude of the change in groundwater level was 0.63-2.79 m. The maximum was in 1943, 1954, and 1965, and the minimum was in 1940, 1948, 1963, and 1972. Karakol Oasis the average annual depth of groundwater is 1.93-2.37 m, and the amplitude of vibration is 0.25-0.86 m. maximum periods-1949, 1954, 1959, 1963, minimum periods-1948, 1957, 1961, 1967 are reflected.[Mavlyanov, Ganiev *et al.*, 1983]
O.V. Mudrova (1988.) in his dissertation, made maps on the reclamation of the Syrdarya region, hydrodynamic, and hydrochemical States of grunt waters based on hydroreism data. As a scientific innovation in this dissertation, a statistical analysis of the groundwater regime is presented.[Mudrova *et al.*, 1988]
The following summary of the Bukhara Oasis has been collected and analyzed. These, in the lower part of the Zarafshan River Basin, are distinguished by two main aquifers: the upper part – groundwater distributed only in the irrigated zone of Bukhara and Karakol oases, and the lower part-pressure water distributed in the upper chalk sandstone, which developed from the Kuljuqtau mountains to Amudaryo. Groundwater in oases occurs at a depth of 1.5-3.0 m. [Mirzaev *et al.*, 1967]
In the example of Syrdarya, the current state of the Paleoallyuvian and freshwater deposits was assessed. In this case, mainly in terms of the state of fresh groundwater, the previous and current states were compared and grouped into groups, and areas of unsurpassed, partially changed, dangerous states were marked on the map. The main source was the analysis of the data from steam wells, water intake facilities, rivers, and canals [Nagevich, Chebotareva *et al.*, 2017]

CONCLUSION

Hydrogeological research in the region is carried out systematically, it is necessary to conduct scientific practical work on the rational use and control of groundwater to trace new groundwater deposits and determine their reserves. Currently, the population in the world is increasing demand for clean drinking water. From this point of view, conducting hydrogelogical research and assessing the current state of groundwater deposits is one of the urgent tasks. Research work performed by several scientists on groundwater assessment has been studied. As a conclusion, the above scientists evaluated the data of the hydroelecim and surface water according to the first aquifer (Quaternary period), based on the population's demand for drinking water. The results of work on the assessment and search of mainly fresh groundwater reserves in foreign countries, their quality status, degree of protection against anthropogenic impact have been analyzed, pollution-repellent work has been carried out. Those who have proposed a number of measures aimed at optimizing work on the search and evaluation of groundwater deposits, their geological and economic assessment, monitoring the current state, rational use and the creation of a monitoring system for protection against pollution. In conclusion from the research work, the assessment of the current state of groundwater deposits in the Bukhara Oasis was calculated for Quaternary aquifers. And we are P.P. Nagevich also had a.V. Based on the methodology developed on the assessment of the current state of the Paleoallyuvian and fresh groundwater deposit on the example of the Syrdarya of the chebotaryovas, we consider it advisable to assess the current state of groundwater deposits in the Bukhara Oasis using modern programs, as well as create a database and use them wisely in perspective.

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