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***Research Article***

# ECOLOGICAL AND HYDROGEOLOGICAL CONDITIONS OF THE CITY OF NUKUS

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## ABSTRACT
The article presents the results of ecological and hydrogeological studies of the city of Nukus. The results of observations of changes in the groundwater level of the city are presented. It has been established that an increase in the water level leads to additional salinization of soils, which worsens the ecological situation of the city, negatively affects green spaces and reduces the longevity of plants. Based on the results of research using GIS technologies, maps-schemes of salinization of the groundwater of the city were compiled. Studies have shown that the groundwater of Nukus is salted mainly with chloride and sulfate salts.

## INTRODUCTION
The city of Nukus is located in the southern part of Karakalpakstan (Uzbekistan) on the right bank of the Amu Darya, 800 km northwest of Tashkent (1255 km by road).
The southern and eastern parts of the city are surrounded by the Kyzylkum Desert. The northern part of the city borders the Amu Darya Delta. The Kyzketken main canal (Doslyk) and the Tas arna Canal (Kattagar) pass through the city. The area of the city is 222 square kilometers, the population is 317.3 thousand people.
One of the ecological features of the city of Nukus is the salinity of groundwater. Studies show that increased salinity of groundwater and soils has a negative impact on the ecological situation of the city and reduces the survival rate of seedlings, inhibits vegetation growth. For example, studies show that due to the increased salinity of groundwater and soils of Karakalpakstan, the longevity of woody and shrubby plants decreases and the ecological balance is disturbed. This is observed throughout the territory of Karakalpakstan (Aimbetov and Bekimbetov 2021; Rafikov *et al.*, 1982).
An analysis of the existing literature shows that the salinity of urban soils has been studied mainly in relation to solving construction problems (Aimbetov and Bekimbetov 2021; Rafikov *et al.*, 1982; Agudo *et al.*, 2007; Angeli *et al.*, 2007; Li *et al.*, 2007; Min *et al.*, 2016; Naeiny *et al.*, 2011)
Gardening of Nukus is one of the topical tasks, the solution of which will help to mitigate the influence of a hot climate. In order to increase the survival rate of seedlings and the effective implementation of landscaping activities in the city, it is necessary to have information about the nature and patterns of changes in the hydrogeological conditions of the territory of Nukus. This information will make it possible to effectively apply methods to reduce the level of mineralization and depth of groundwater, choose the type of plants for landscaping depending on the salinity of groundwater and soils.

### *The Purpose of the Work*
To make a series of maps-schemes of salinization of underground waters of Nukus using GIS technologies, which are necessary for the development of measures to reduce the depth and level of mineralization of groundwater in the city of Nukus.

## MATERIALS AND METHODS
The results of the research show that there is an increase in the groundwater level in Nukus (Fig.1). Analysis of the graph shown in Fig.1 shows that there is a change in the groundwater level over the years.

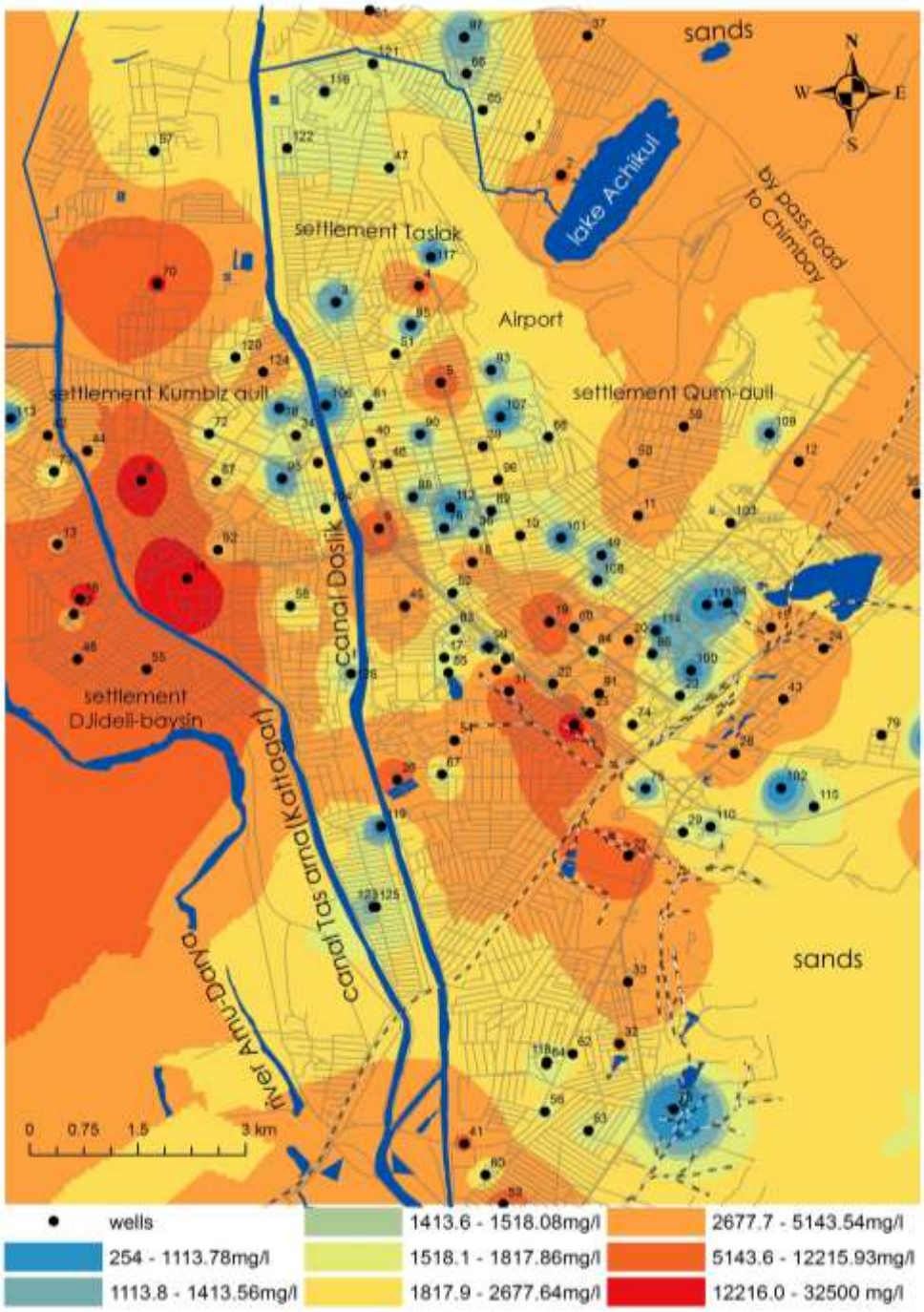


**Figure 1: Map-scheme of salinization of underground waters of the city of Nukus with water-soluble salts (by dense residue).**

This is primarily due to the irrigation of this territory and the filtration of water from the irrigation system, the main channels flowing through the city, as well as the insufficiency of the drainage system of the city. Analysis of archival materials of local survey organizations showed that in 1970, at the groundwater level of 2-5m, the mineralization of groundwater was 1.7 g/l. In 1986, the groundwater level rose to 0.3-2 m, and mineralization on average reached 18 g/l, in some cases up to 32 g/l [1].

This circumstance indicates an increase in the aggressiveness of groundwater, which contributes to the oppression of green spaces. At the same time, the city of Nukus is insufficiently provided with a drainage system.

To prevent the aggressive effect of salts on green spaces, it is necessary to assess the pattern of salinization of soils and groundwater in the city of Nukus.

To assess the nature of the distribution of salts and to determine the types of salts in groundwater that have a depressing effect on green spaces, maps of salinization of ground waters of Nukus were compiled. At the same time, conclusions were used to assess the engineering and geological conditions of the building construction site. As a rule, the reports of engineering and geological surveys contain the results of chemical analysis of groundwater to assess salinity, which are used to prevent destructive effects on the underground parts of buildings and structures. To assess the ecological situation of the salinity of the territory of the city of Nukus, data from existing reports of engineering and geological surveys of the sites of the projected buildings compiled by local engineering and geological survey organizations were used. To assess the patterns of salt distribution, coordinates of points were plotted on a digitized map at a scale of 1:50,000 to determine the salinity of soils to the groundwater level. The maps are compiled using the ArcGIS computer program. When drawing up maps, the results of determining the salinity of the groundwater of 113 workings were processed. The research area is 153.6 sq.km. When making maps, a map on a scale of 1:50,000 was used as a basis.

## RESULTS AND DISCUSSION

Figure 1 shows a schematic map of salinization of groundwater with water-soluble salts in the city of Nukus. As shown in Figure 1, the content of water-soluble salts varies from 254 mg/l to 32500 mg/l. At the same time, the greatest blockage is observed between the Duslyk and Taras na channels. Only a small area of the right bank of the Duslyk Canal has a salinity from 5143.6 mg/l to 12215 mg/l. The largest part of the city's groundwater contains 2677.7-5143.54 mg/l of salts. On an area of about 20 percent, groundwater contains salts of 1518-1817 mg/l. Small individual areas have a minimum salinity of 254-1113 mg/l. The different salinity of groundwater can be explained by different filtration properties, the presence of a drainage system and natural drainage.

The climate of Nukus is sharply continental. The maximum temperature in summer reaches 50 ° C. In order to create comfortable conditions in hot weather for residents of the city, it is necessary to carry out landscaping of the city. To choose the type of green spaces, information is needed on the content of various types of salts in groundwater. In this regard, maps-schemes of groundwater were built for the content of chloride, sulfate and bicarbonate salts.

Figures 2-4 show the maps-schemes of salinization of the underground waters of the city of Nukus according to the content of chloride, sulfate and bicarbonate salts in them. As can be seen from Figures 2.7-2.9, the highest salinity in terms of the content of chloride, sulfate and bicarbonate ions is observed on the right bank of the Tas Arna canal. This is due to the peculiarity of the lithological composition and salinity of the soils lying at depth. This territory is located in an irrigation zone where there are no collector-drainage networks. Due to the migration of salts from deeper Cretaceous sediments, additional salinization of groundwater and soils occurs during capillary uplift of groundwater.

Figure 5 shows a graph describing the change in the average groundwater level over the years, the analysis of which shows that the deepest groundwater level was observed in 2001, when there was little water in the Amu Darya River.

Figure 6 shows a graph of seasonal changes in the groundwater level of the city of Nukus in different years. As can be seen from this figure, the maximum deep groundwater level is observed mainly in winter and autumn, the minimum (high) groundwater level falls during the growing season from April to August. Seasonal changes in the groundwater level are associated with changes in water flow in the Duslyk canal, which is designed to deliver irrigation water to the northern regions of Karakalpakstan, located on the right bank of the Amu Darya.

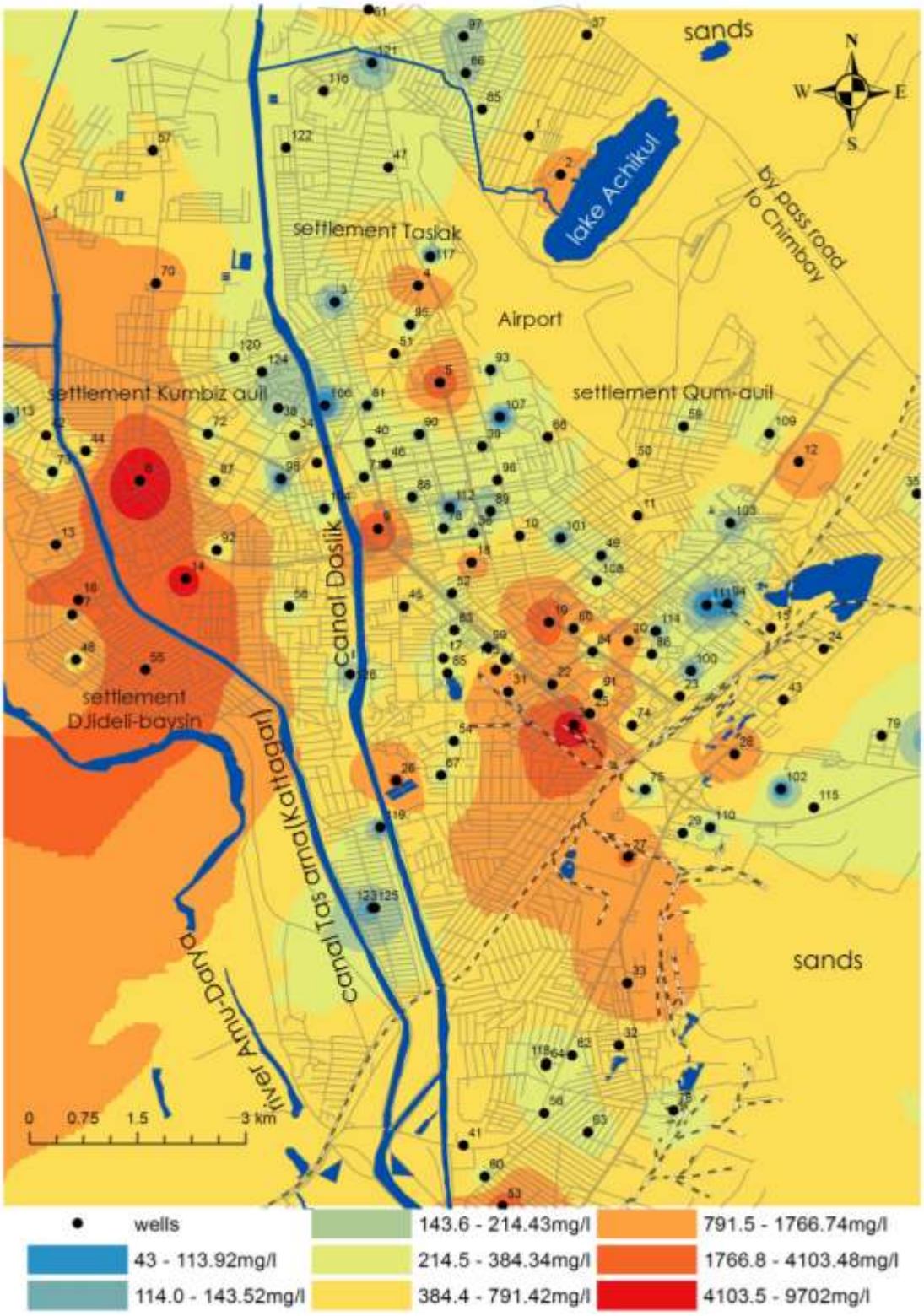


**Figure 2: Map-scheme of salinization of underground waters of the city of Nukus by the content of chloride salts**

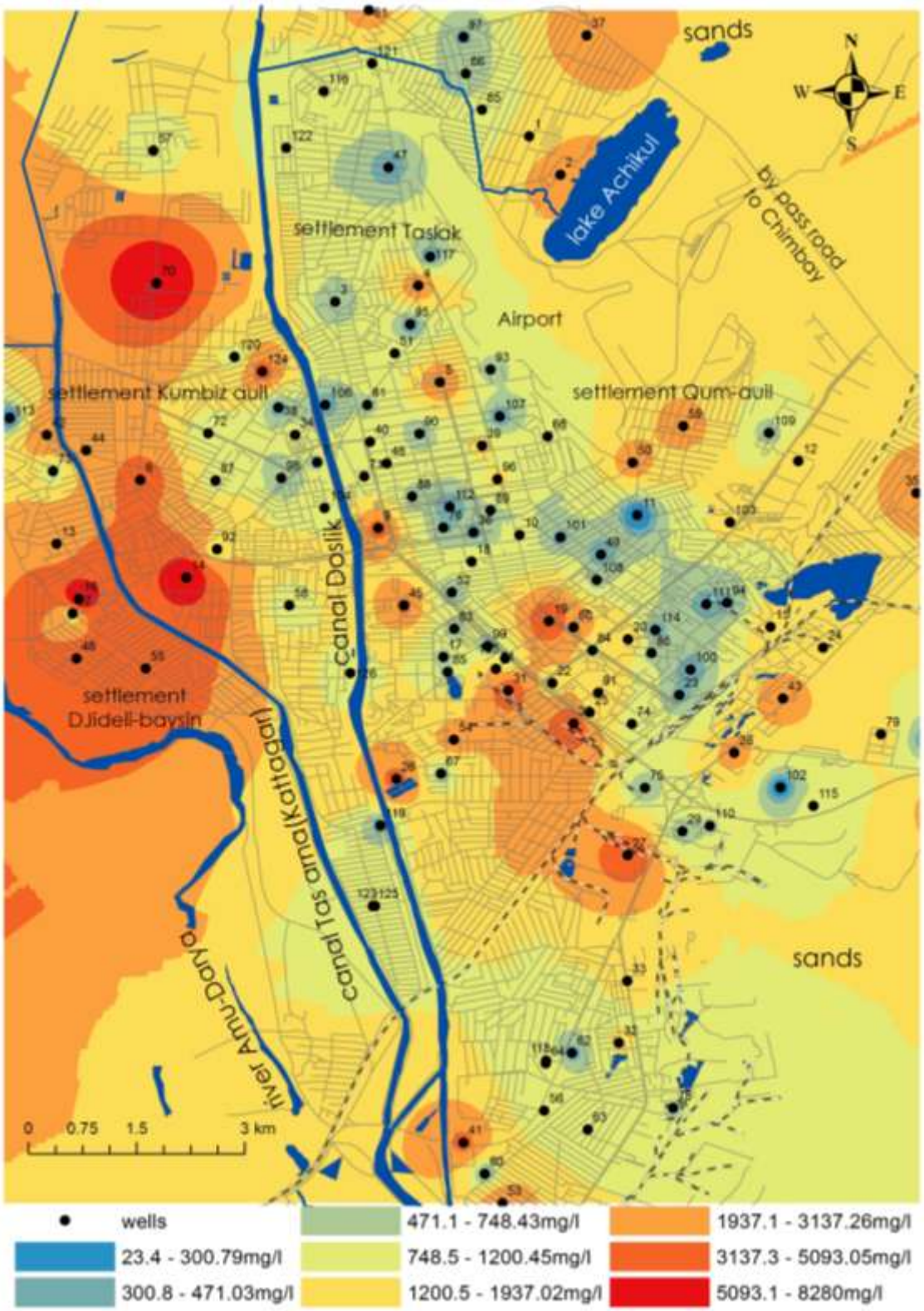


**Figure 3: Map-scheme of salinization of underground waters of the city of Nukus by the content of sulfate salts**

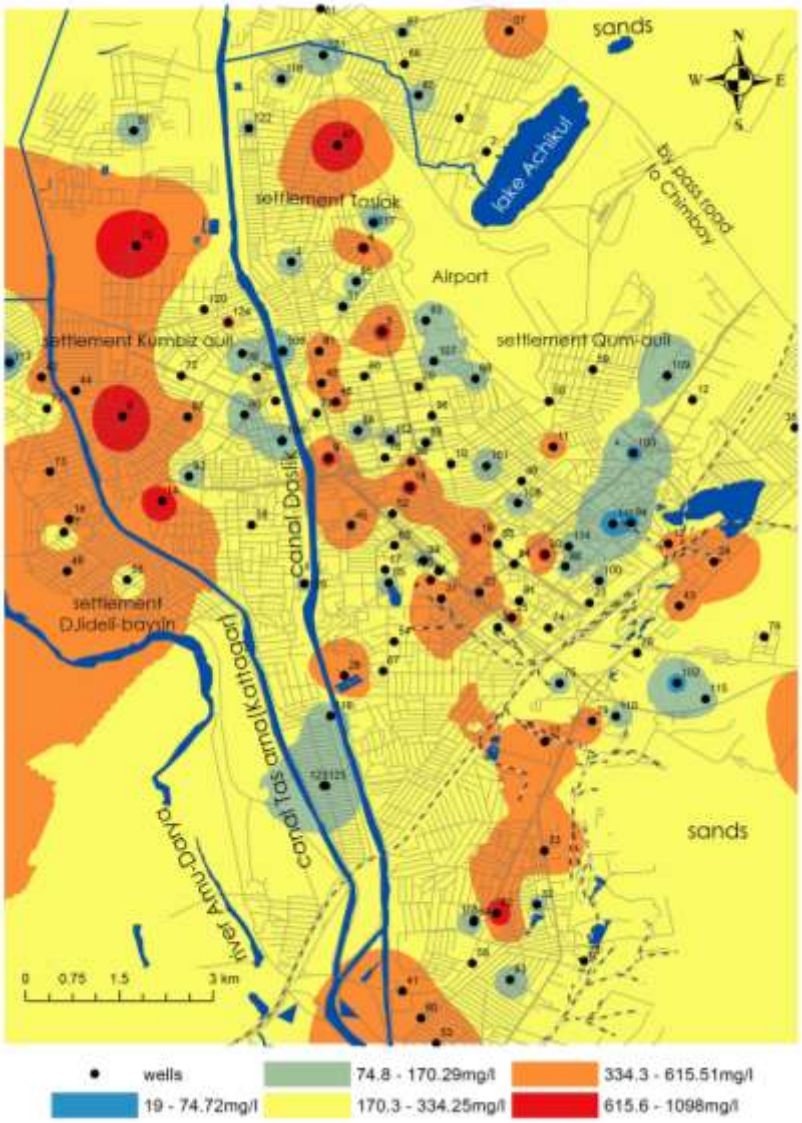


**Figure 4: Map-scheme of salinization of underground waters of the city of Nukus by the content of bicarbonate salts**

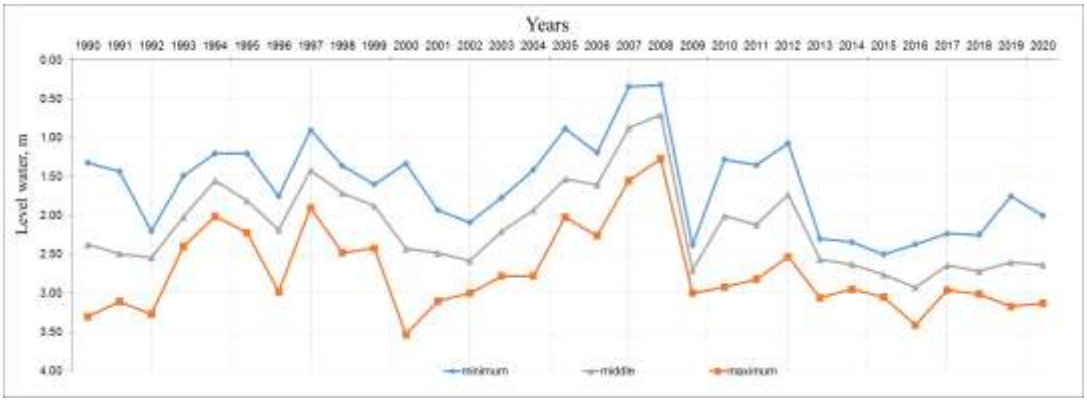


**Figure 5: Dynamics of changes in the depth of underground waters of the city of Nukus by year**

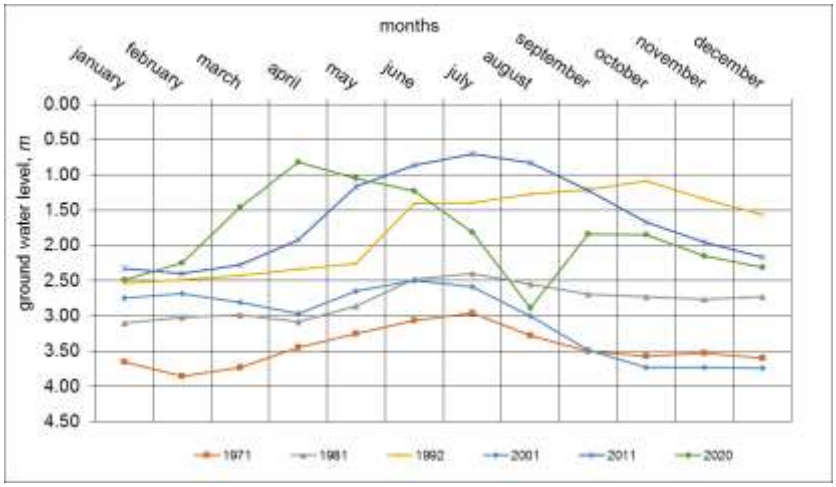


**Figure 6: Dynamics of seasonal changes in the groundwater level of the city of Nukus**

## CONCLUSION

**1.** Research results have shown that the underground waters of the city of Nukus contain mainly chloride and sulfate salts, which have a negative impact on vegetation. The content of water-soluble salts varies from 254 mg/l to 32500 mg/l. At the same time, the greatest blockage is observed between the Duslyk and Taras na channels.

2. The analysis of long-term observations of the hydrogeological conditions of the city of Nukus has shown that there is an increase in the level of groundwater in the city, which has a negative impact on the ecological situation of the city.

3. For effective landscaping of the city of Nukus, it is necessary to develop scientific recommendations on the selection and placement of tree species depending on the salinity of groundwater and soils of the city of Nukus.

4. To improve the ecological and hydrogeological situation of the city of Nukus, it is necessary to conduct research aimed at designing a new innovative drainage system.

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