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INFLUENCE OF AGROMETEOROLOGICAL FACTORS ON THE GROUNDWATER REGIME (BASED ON HYDROMETEOROLOGICAL OBSERVATION DATA)

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Abstract: This article analyzes the influence of agrometeorological factors on the groundwater regime based on observation data from a hydrometeorological station. The study evaluates air temperature, precipitation, relative humidity, soil moisture, and seasonal dynamics of agricultural practices. Comparative analysis, statistical data processing, and agrometeorological monitoring methods were used to analyze the data.

The results of the study revealed that seasonal agrometeorological factors have a significant influence on the groundwater regime. In spring, the onset of irrigation activities contributed to an increase in soil moisture and the intensification of the groundwater regime. In summer, high air temperatures and decreasing relative humidity intensified evaporation processes, increasing the potential for capillary rise of groundwater and the risk of secondary soil salinization. In autumn, a decrease in temperature and a reduction in irrigation activities resulted in the relative stabilization of the groundwater regime.

The results obtained are of scientific and practical significance for assessing the groundwater regime using agrometeorological monitoring data, promoting the rational use of water resources, planning reclamation measures, and improving irrigation efficiency in agriculture.

Keywords: agrometeorological factors, groundwater, hydrometeorological station, air temperature, relative humidity, soil moisture, irrigation, agrometeorological monitoring, seasonal dynamics, Karakalpakstan.

Introduction

In recent years, global climate change, limited water resources, and increasing anthropogenic pressure have further increased the relevance of comprehensive studies of hydrogeological processes in arid and semi-arid regions [1, 2]. In particular, the Republic of Karakalpakstan, located in the Aral Sea region, is characterized by a sharply continental climate, low precipitation, high air temperatures during the summer months, and intensive evaporation. Under such conditions, agrometeorological factors have a significant influence on the groundwater regime, soil moisture conditions, and reclamation processes [6].

The groundwater regime is one of the important hydrogeological indicators used to assess the reclamation status of agricultural lands [7]. Seasonal changes in groundwater levels are closely related to air temperature, precipitation, relative humidity, soil moisture, and irrigation regimes, and their interaction contributes to the formation of soil moisture and salinity regimes.

The approach of groundwater to the land surface can intensify capillary rise and, under the influence of evaporation, may lead to secondary soil salinization [9].

In the Republic of Karakalpakstan, the analysis of agrometeorological observation results together with hydrogeological data is of considerable scientific and practical importance for the rational use of water resources, improvement of the reclamation status of agricultural lands, and effective management of the groundwater regime [2]. Such comprehensive analyses make it possible to assess the influence of agrometeorological factors on groundwater dynamics, identify patterns in the formation of the water and salt regime, and scientifically substantiate the planning of reclamation measures.

Data obtained from hydrometeorological observations, including air temperature, precipitation, relative humidity, available soil moisture, soil texture, and the phenological development stages of agricultural crops, constitute a reliable source of information for assessing the main factors affecting the groundwater regime. Comprehensive analysis of these data helps to reveal the seasonal characteristics of hydrogeological processes occurring in the study area [4].

The aim of the study was to assess the influence of agrometeorological factors on the groundwater regime based on hydrometeorological observation data, identify patterns in their seasonal variations, and scientifically substantiate the relationship between agrometeorological indicators and groundwater dynamics.

Materials and methods

The study was conducted based on hydrometeorological observation data and the results of groundwater monitoring. The study used agrometeorological observation materials collected within the system of the Hydrometeorological Service of the Republic of Uzbekistan, groundwater-level monitoring data, and official reports on the water and salt balance [5].

The study objects included hydrometeorological observations conducted in the territory of the Republic of Karakalpakstan, agrometeorological indicators of agricultural areas, and data related to the groundwater regime. During the analysis, observation results for air temperature (maximum, minimum, and mean values), precipitation, relative humidity, available soil moisture, soil texture, phenological development stages of agricultural crops, and agricultural practices were summarized. In addition, seasonal changes in groundwater levels (GWL) and water and salt balance indicators were comparatively analyzed.

Available soil moisture was assessed in the 0–3, 4–6, 7–10, 11–15, 16–20, 21–30, and 31–50 cm soil layers. The soil texture was characterized as loam. The groundwater regime was assessed based on data from observation wells, and its seasonal dynamics were analyzed in relation to agrometeorological factors [5].

Comparative analysis, statistical analysis, agrometeorological monitoring, and graphical-analytical methods were used to process the collected data. All indicators were systematized by season, and the relationship between agrometeorological factors and the groundwater regime was assessed. The study results were summarized in tables and diagrams and analyzed scientifically.

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Results and discussion

Analysis of the hydrometeorological observation data showed a close relationship between agrometeorological factors and the groundwater regime. Changes in air temperature, precipitation, relative humidity, and available soil moisture observed during the seasons directly affect the formation of the groundwater regime.

In spring, as air temperature gradually increases, the soil warms up, and irrigation activities begin, the soil moisture regime becomes more active. During this period, seasonal changes in groundwater levels are also observed. With the onset of the growing season, an increase in irrigation volumes increases moisture reserves in the upper soil layers and strengthens the hydraulic connection between groundwater and the soil.

In summer, the rise in air temperature to high values and the decrease in relative humidity increase the intensity of evaporation. Under conditions of low precipitation, the water requirements of crops are mainly met through irrigation. This may cause groundwater levels to approach the land surface in some areas. At the same time, under the influence of high evaporation, capillary rise processes intensify, creating conditions for the accumulation of dissolved salts in the upper soil layers.

In autumn, with the decrease in air temperature and the completion of vegetation processes, irrigation activities are reduced. During this period, the groundwater regime becomes relatively stable; however, the effect of salts accumulated in the soil on subsequent reclamation conditions persists. Therefore, regular monitoring of agrometeorological factors is of great importance for the effective management of the groundwater regime and the water and salt balance.

Table 1. Seasonal Influence of Agrometeorological Factors on the Groundwater Regime

Season	Air temperature	Precipitation	Relative humidity	Agricultural practices	Impact on the groundwater regime
Spring (March–May)	Gradually increases	Low to moderate	Moderate	Beginning of irrigation, planting, soil tillage	Groundwater levels begin to rise due to irrigation, and soil moisture increases.
Summer (June–August)	Reaches the highest levels	Very low	Low	Intensive irrigation, cultivation, and topping	Evaporation intensifies, capillary rise becomes more active, and the risk of secondary soil salinization increases.
Autumn (September-November)	Begins to decrease.	Low	Increases	Harvesting, reduction of irrigation	The groundwater regime stabilizes, and water consumption decreases.

The data presented in Table 1 show that agrometeorological factors have different effects on the groundwater regime throughout the year. In spring, the onset of irrigation activities leads to an increase in soil moisture and a rise in groundwater levels. In summer, high temperatures and intensive evaporation

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intensify capillary rise processes, thereby increasing the risk of secondary soil salinization. In autumn, the decrease in air temperature and reduction in irrigation activities result in the relative stabilization of the groundwater regime.

Table 2. Seasonal Dynamics of Agrometeorological Indicators and Their Influence on the Groundwater Regime

No.	**Month**	**Air temperature, °C (max.)**	**Precipitation, mm**	**Relative humidity, %**	**Influence on the Groundwater Regime**
1	March	30.4	3.6	20–40	The onset of the growing season and irrigation cause groundwater levels to begin to rise.
2	April	33.9	6.4	14–40	Soil moisture increases, and the groundwater regime begins to become more active.
3	May	36.5	3.5	18–35	Seasonal changes in groundwater levels are observed under the influence of intensive irrigation.
4	June	37.5	2.7	13–31	High temperatures and evaporation intensify the capillary rise of groundwater.
5	July	39.2	1.8	15–28	Evaporation is high, and the risk of salinization increases.
6	August	41.1	3.1	13–45	The hottest period; evaporation reaches its maximum level, increasing the influence on the groundwater regime.
7	September	29.7	3.9	31–58	Air temperature decreases, and the groundwater regime begins to stabilize.
8	October	28.0	3.1	45–60	Irrigation decreases, and groundwater levels become stable.
9	November	23.0	4.2	55–70	The growing season ends, and the groundwater regime shifts to its autumn state.

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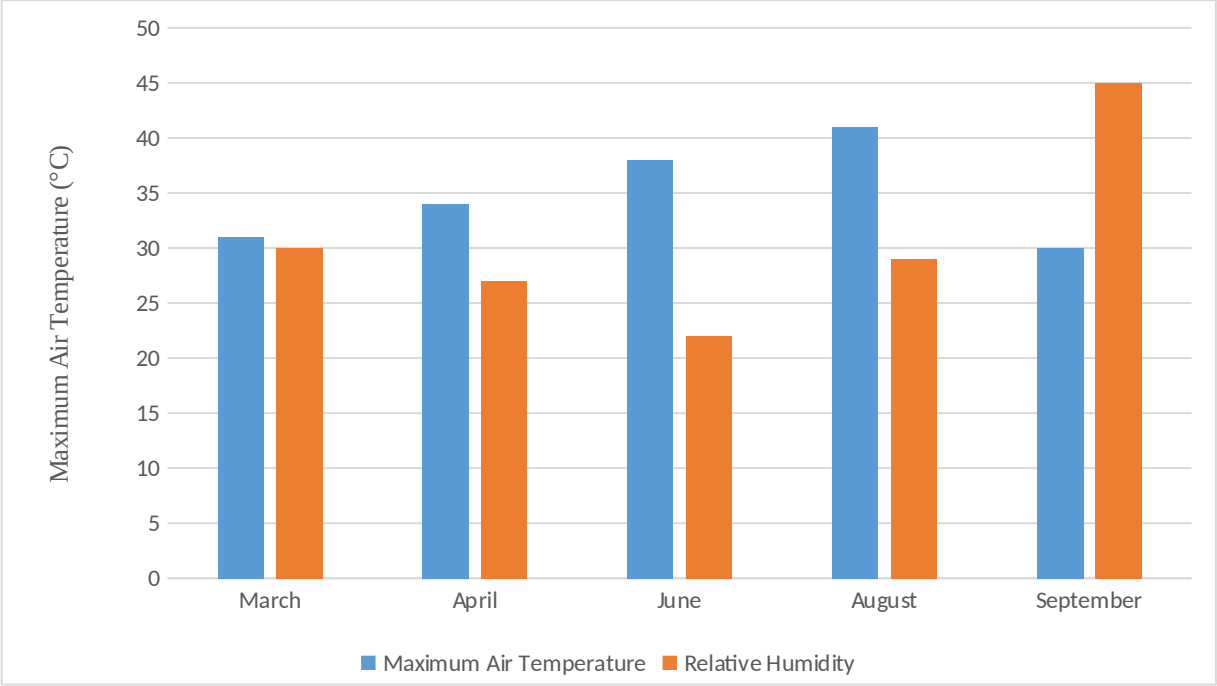

Figure 1. Monthly Variation in Maximum Air Temperature and Relative Humidity in the Republic of Karakalpakstan in 2024

Observations conducted at the hydrometeorological station showed a close relationship between agrometeorological factors and the groundwater regime. It was found that seasonal changes in air temperature, relative humidity, and agricultural practices significantly affect the soil moisture regime and groundwater conditions.

In spring, the gradual increase in air temperature and the onset of irrigation activities resulted in an increase in soil moisture reserves, while seasonal changes in groundwater levels were observed. During this period, favorable conditions for active plant growth developed, and the soil water regime remained relatively stable.

In summer, the rise in air temperature to high levels and the decrease in relative humidity intensified evaporation processes. As shown in the diagram, maximum air temperature reached its highest value in August, while relative humidity remained at a low level during most of the growing season. Under these conditions, the importance of irrigation increased further, and maintaining soil moisture served as an important factor for the normal growth of agricultural crops.

In autumn, the decrease in air temperature and increase in relative humidity resulted in a reduction in evaporation intensity. The reduction in irrigation activities contributed to the relative stabilization of the groundwater regime. At the same time, redistribution of soil moisture was observed, and the formation of the water regime for the subsequent season began.

Overall, the observation results showed that the influence of agrometeorological factors on the groundwater regime varies considerably depending on the season. While an increase in air temperature intensifies evaporation processes, irrigation activities play an important role in maintaining soil moisture conditions and stabilizing the groundwater regime. This indicates the

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need to use agrometeorological monitoring data for water resource management and the development of efficient irrigation regimes in agriculture.

Conclusion

The study results, based on observations from a hydrometeorological station, demonstrated a close relationship between agrometeorological factors and the groundwater regime. It was found that seasonal changes in air temperature, precipitation, relative humidity, and agricultural practices directly affect the soil moisture regime and groundwater conditions.

In spring, the gradual increase in air temperature and the onset of irrigation activities resulted in an increase in soil moisture reserves, and the groundwater regime began to become more active. In summer, high temperatures and decreasing relative humidity intensified evaporation processes, and an increase in the capillary rise of groundwater and the risk of secondary soil salinization were observed. In autumn, the decrease in air temperature and reduction in irrigation activities resulted in the relative stabilization of the groundwater regime.

The analyzed data demonstrated the scientific and practical importance of conducting regular agrometeorological observations, assessing the groundwater regime, and ensuring the efficient use of water resources. Improving irrigation regimes with consideration of agrometeorological factors, maintaining soil moisture at an optimal level, and scientifically planning reclamation measures can contribute to improving the ecological condition of agricultural lands and maintaining a stable groundwater regime.

Future research should focus on developing an integrated monitoring system that combines hydrometeorological station data with groundwater levels, mineralization levels, and soil salinity indicators. This can provide a scientific basis for the efficient management of water resources and ensuring the sustainable development of agriculture under the conditions of the Republic of Karakalpakstan.

References

1. Zholdasov A.S., Khodzhaeva G., Umarov E.K. *The Aral Environmental Crisis and the Peculiarities of Demographic Development in Rural Areas of the Republic of Karakalpakstan*. – 2009. – P. 1–12.

2. Nauryzbaeva Z.Sh. *Analysis of Degraded Soils under the Conditions of Karakalpakstan* // *Universum: Chemistry and Biology*, 9 (87). – 2021. – P. 17–20.

3. Tleumuratova B.S., Mambetullaeva S.M., Mustafaeva R. *Modeling of Salt Removal from the Exposed Bottom of the Aral Sea and Its Consequences* // *Eurasian Scientific Association. Effective Research of Modernity*. – 2015. – No. 10. – P. 238–242.

4. Chembarisov E.I., Khojamuratova R.T., Sadiev U.A., Balliev A.I., Reymova G.B. *Features of Hydrological and Reclamation Monitoring of Irrigated Areas of the Republic of Karakalpakstan* (Monograph). – Tashkent: Lesson Press LLC, 2022. – 177 p.

5. Center of Hydrometeorological Service of the Republic of Uzbekistan (Uzhydromet). Official reports and agrometeorological observation data.

6. Allanazarova M.K. *Monitoring of Groundwater Levels and the Impact of Irrigation on Soil Condition (Case Study of Karauzak and Takhtakupyr Districts)* // *Economics and Society*, No. 2(141)-2. – 2026. – P. 474–479.

DOI 10.66073/ReFocus-Conf/0910184

7. Kawabata Y., Kawai M., Yamada M., Onwona-Agyeman S., Aparin V., Jollibekov B., Kurita T., Nagai M., Katayama Y. *Seasonal Changes in Water Quality of Rivers and Groundwater in Karakalpakstan, Uzbekistan* // *Journal of Arid Land Studies*, 22(1). – 2012. – P. 171–174.

8. Kulmatov R., Alimov A., Opp C. *Determination and Assessment of the Groundwater Table and Mineralization in Irrigated Areas (Xojeli District, Republic of Karakalpakstan)* // *BIO Web of Conferences*, Vol. 93, 04014. – 2024.

9. Otenova F.T. *Analysis of Soil Salinity Index Indicators in Different Districts of Karakalpakstan* // *Universum: Chemistry and Biology*, 1(12 (138)). – 2025. – P. 21–26.

10. Yendirboyeva M.O. *The Assessment of Groundwater Influence on Soil Fertility in the Republic of Karakalpakstan* // *American Journal of Agriculture and Horticulture Innovations*, Vol. 6. – 2026. – P. 15–18.

DOI 10.66073/ReFocus-Conf/0910184