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Changes in the water regime and the state of water resources of the Chudniv irrigation system in the context of climate change

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SUMMARY

Water scarcity and drought are becoming an increasingly serious problem. Climate change makes significant adjustments in the distribution of water resources in space and time, which, in turn, leads to a large-scale increase in the frequency of manifestations of dangerous natural phenomena. The paper considers the issue of changing the state of the underground hydrosphere within the Chudniv irrigation system. Changes occur as a result of disruption of the irrigation system - land unbundling, the introduction of paid water use, the emergence of new methods and installations of irrigation. And not the last role in such changes is played by climatic factors. The changes of the groundwater regime according to the regime wells were investigated and it was established that against the background of practically no irrigation within the system and decrease of precipitation the decrease of groundwater levels within the Chudniv irrigation system is observed. Undoubtedly, in the context of adaptation to climate change at the basin level, the issues of greatest interest are directly related to the aquatic environment, changes in water regime and the state of water resources. It is expected that such changes will lead to a deterioration in water quality. This will lead to the loss of sources of drinking water for the population.

Introduction

Irrigated agriculture in the steppe regions of Ukraine was accompanied by changes in the groundwater regime (especially the first from the surface of the aquifer) and often negative processes. The most significant is the flooding of agricultural lands due to the disturbance, due to irrigation, the balance of the active water exchange zone. The amount of water supplied to irrigated areas was usually not fully used for crop water consumption. Much of the water in the form of filtration losses entered the aeration zone, reached the level of groundwater, increasing their supply. As a result, the groundwater level rose: the amplitude of the increase depended on the depth of groundwater, the intensity of irrigation, the distance from irrigation canals, the method of irrigation, and so on.

With intensive irrigation (up to 2000), the replenishment of groundwater reserves due to filtration losses during irrigation averaged (at a groundwater depth of 1 to 5 m) - 40-10 mm, respectively (Baer et al., 1979).

Analyzing the reasons for the rise of groundwater under the influence of irrigation, it is necessary to note their complex nature: construction of a cascade of Dniester reservoirs, creation of large irrigation and economic canals, intensive diversified economic activities that were not accompanied by precautionary measures. taking into account the hydrogeological conditions of reservoirs, ponds, settling tanks and a number of other reasons.

Since the beginning of the XXI century, the approach to the irrigation system has changed. There was a land unbundling, the introduction of paid water use, the emergence of new methods and installations of irrigation, changes in weather and climatic conditions and, as a consequence, a significant reduction in actual irrigated areas. This, in turn, was reflected in the level of groundwater and changes in the hydrogeological and reclamation status of lands.

In addition to the above factors that had and have an impact on the level of groundwater, the priority can be given to changing weather and climatic conditions. Especially abnormal weather situation occurs in recent years. The central, northern and western regions of Ukraine suffer from heavy rains, which in turn manifest themselves in the form of floods. At the same time, the southern and eastern regions of the country are "dying" from drought, water scarcity and rainfall shortages (Miedviedieva and Dyniak, 2020). For example, in 2019, the average annual rainfall in Ukraine was 490 mm (84% of the norm), the lowest it was in Odessa, Cherkasy, Vinnytsia, Chernihiv, Ternopil regions - 50-65% of the annual norm. Thus, the lowest amount of precipitation was recorded in Izmail (Odessa region) - 223 mm (Forecast Groundwater Level, 2020).

According to the National Ecological Council of Ukraine, catastrophic dehydration has been observed for the last four years. Reservoirs are filled to a maximum of 80% of normal, and in some places even less. This leads to a change in their hydrological cycle (Depletion of resources, 2019).

The current hydrological drought in Ukraine poses risks in the following areas: reduction of groundwater levels in catchment lands, unprecedented "blooming" of water, food crisis and loss of soil fertility (Hydrological drought, 2020).

Method

The task of assessing the hydrogeological and reclamation condition of irrigated lands is to determine the contours of areas that require reclamation measures on the basis of general information about the importance of soil, salt, hydrochemical, hydrodynamic, water management and other indicators and parameters. Thus, groundwater levels in this assessment are the main indicator.

The groundwater level was measured on the grid of the regime-monitoring network, which also suffered losses - there was a significant reduction due to the destruction of observation points by economic entities.

This paper proposes an approach to determining the level of groundwater and their trend with a relatively small number of observation wells.

Examples

The research was performed for the territory of Chudniv irrigation system, which is located in the Izmail district of Odessa region. The area of the system is 383 hectares, it borders the Danube River to the south, Lake Cahul to the north, and the Rusky water supply canal to the east.

Along the entire area of the system there is a horizontal open drainage with a depth of drainage of -1.5-2.5 m, which was designed to reduce the level of groundwater and drain the natural excess of groundwater and the excess formed as a result of irrigation. The system is equipped with a pumping station for water drainage, equipped with water meters, which are annually leveled. Measurements are carried out daily and are mediated (Figure 1). In addition, there are two observation wells left on the system, where groundwater levels are measured monthly (Figure 2).

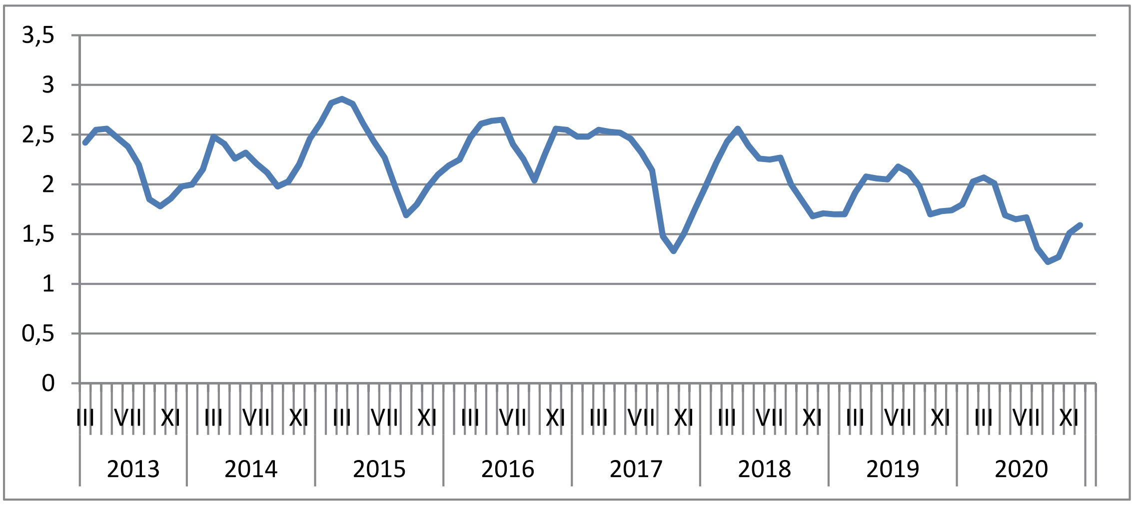

Figure 1 *The level of water measurements in the pre-chamber according to the drainage and pumping system (m)*

In order to establish changes in the state of groundwater, the results of level measurements on the Chudniv irrigation system were analyzed. Data for the last eight years (2013-2020) on groundwater levels in observation wells №1 and №5 were taken for analysis; and measurement data at the pump station level in the pre-chamber; data on the amount of precipitation at the meteorological station "Reni" (Figure 3).

The work showed that against the background of virtually no irrigation in the system and reducing rainfall and their redistribution, when prolonged rainfall with low intensity changes to sudden downpours, there is a trend to reduce the amount of surface water and groundwater level. Thus, at depths where the groundwater level was in the range of 0.5-1.0 m becomes more than 1.0 m; 2.5-3.0 m - about 4.0 m.

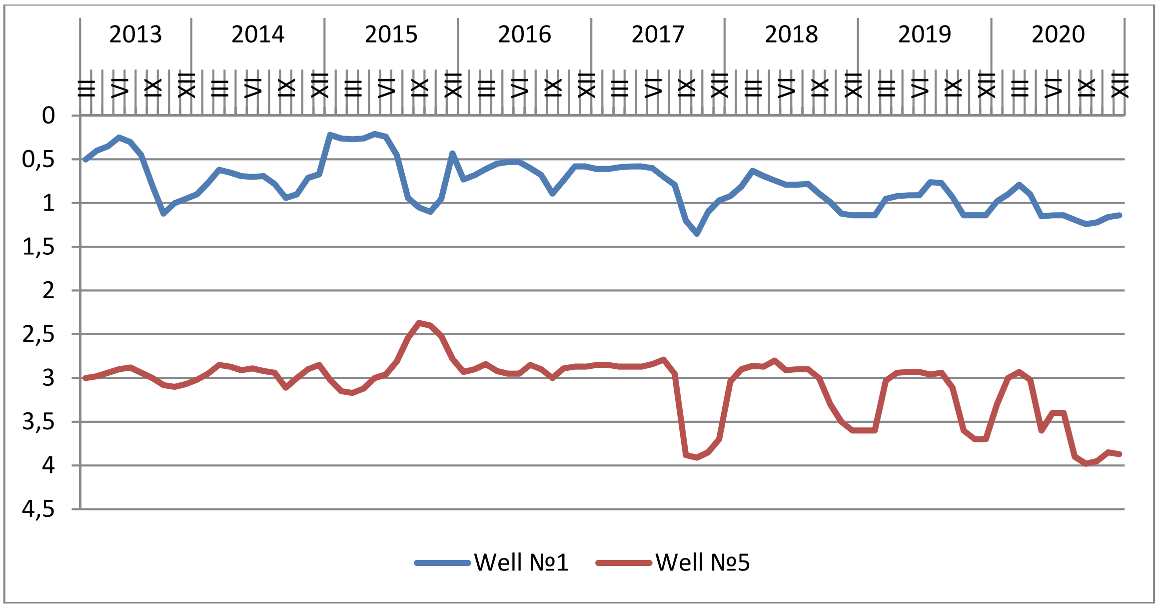

Figure 2 *Groundwater level in observation wells №1 and №5*

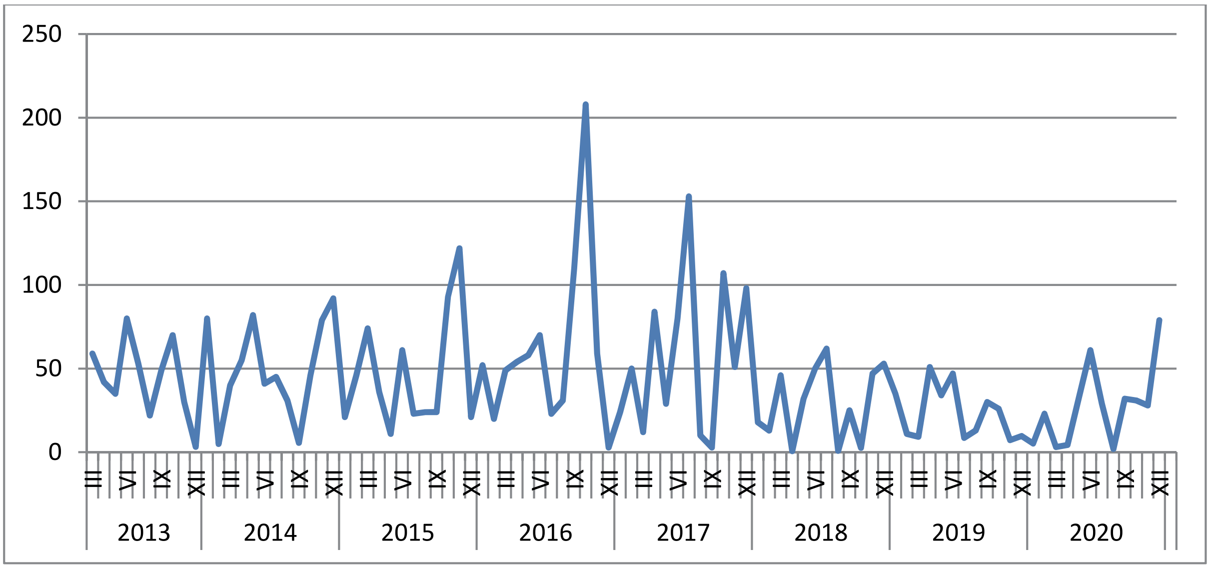

Figure 3 *Precipitation (in mm) according to the meteorological station "Reni"*

There is also a tendency to reduce rainfall. If in 2016 the lowest average monthly rainfall was observed in February and March - 20mm and 49mm, respectively, the highest in September and October - 110mm and 208mm, in 2019 and 2020 the marks decreased significantly: in March 2019 - 9.2mm, in March 2020 - 3.4 mm; September-October in both years have marks of 29-30 mm, which is almost 7 times less than in previous years.

Conclusions

Active depletion of water horizons harms both the environment and people who use groundwater. When reserves are replenished more slowly than water is extracted, aquifers are depleted. If the problem becomes large-scale, it can have serious economic and humanitarian consequences.

Groundwater depletion leads to changes in the water balance of the territory. The long-term consequence of this is the degradation of natural ecosystems. There is a risk of losing water sources for the population that consumes groundwater as drinking water. Lack of water is an artificial phenomenon. This is a periodic imbalance that occurs as a result of excessive use of water resources, caused by a significant excess of consumption over the natural renewable resource. Water scarcity can be exacerbated by water pollution (reducing the suitability for different uses of water) and during droughts. And this, unfortunately, will hit the most vulnerable and vulnerable communities - the rural population.

To minimize the consequences, it is necessary to introduce sustainable forms of agriculture and farming, maximum protection of ecosystems with high buffer water capacity, to maintain the ability of aquatic ecosystems to self-healing. That is why in most EU countries the protection of groundwater is a key priority.

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