

## THE RESEARCH OF WATER SUPPORT QUALITY IN KHERSON REGION

***Annotation.** A study of water supply sources in the Kherson region has been carried out. It is substantiated that the state of health of the population of the region depends, among other things, on the quality of drinking water. Since at present most of the samples show no compliance with the standard and a significant excess of the norm, it is necessary to carry out studies on modeling and forecasting the processes of deterioration of the quality of drinking water.*

***Keywords:** correlation sequence, population, groundwater quality.*

### Introduction

Water is 60 percent of the body weight of a person. The most intelligent part of our body - the brain - consists of water by 84 percent, kidneys consists of water by 83, heart and lungs consists of water by 7 percent, and so on. Even with the loss of one to two percent of the water available in the body, a person experiences thirst, a loss of 10 percent of moisture leads to a disorder of the mental apparatus, and a loss of 14 to 15 percent of water leads to the death of the body. On average, a healthy person is drinking to 2.5 liters of moisture per day, therefore, in order to maintain the water balance in the body, he must consume the same amount of water [1].

### The purpose

For 60 years of life, a person drinks a whole cistern - 50 tons. It is estimated that the world's population consumes 7 billion cubic meters of water per day. The water cycle in nature provides a sufficient amount of water for the present population of the globe, but in the process of circulation the water becomes more and more polluted. In other words: there is no water problem on the Earth, there is a problem of clean water. It is believed that more than two billion people on Earth are practically unable to use clean drinking water. According to the World Health Organization, almost 80 percent of all diseases are caused by poor quality drinking water. Hence it is clear that the problem of water purification will be one of the main problems of mankind in the XXI century [2].

In our work, we investigate the quality of water supply sources, in particular, the quality of drinking water in the Kherson region.

### The main material

Caring for obtaining a sufficient amount of water, suitable for drinking and to meet the cultural and everyday needs of the population in water, accompanies humanity throughout all periods of its existence. At the same time, the nature and forms of water supply of the population changed along with socio-economic conditions. At present, the satisfaction of the needs of populated areas in the water is carried out mainly by centralized water supply systems, i.e. household and drinking water pipelines, the main source of which in Kherson and Kherson region are groundwater. In total, there are more than 2.500 wells in the region and only 55% of them supply water in accordance with the requirements, which was approved in 1982 and has not been changed since then, despite a significant deterioration in the ecological situation in Ukraine [3,4].

On the territory of the Kherson region there are 9 cities, 30 urban-type settlements and 675 rural settlements (Figure 1). Centralized water supply is provided to all cities and towns of urban type and 611 rural settlements. Water supply to the settlements of the region is carried out from 58 communal, 362 departmental and 792 rural water pipelines. All in all, 1213 water pipes are used for water supply of the population, which is 3 more than last year due to open two water pipes in Kherson (bakery, CJSC "Micon") and one on bunkering ships in Kherson port.

The main sources of water supply for water pipes are more than 2.5 thousand artesian wells. 88 wells, 4 facilities for the use of groundwater and 13 artesian wells, and 105 sources of decentralized water supply are additionally used for water supply to the rural population [3,4].



Fig.1 The map of the Kherson region

Over the past 20 years, the city has almost no new sources of water supply [5]. The situation with water supply and sanitation in the city is critical (Table 1).

Table 1

## Status of water supply sources

Districts and cities	Number of water pipes that do not meet sanitary standards	Total number of wells	Total number of wells with a broken fence	%
<i>Ivanivka district</i>	20	75	20	26,7
<i>Bilozerka district</i>	-	141	3	2,1
<i>Beryslav district</i>	3	187	76	40,6
<i>Velyka Oleksandrivka district</i>	19	93	19	20,4
<i>Velyka Lepetykha District</i>	9	113	9	7,9
<i>Verkhniy Rohachyk District</i>	10	65	29	44,6
<i>Vysokopillia district</i>	11	48	15	31,2
<i>Henichesk district</i>	3	230	3	31,2
<i>Hola Prystan district</i>	-	195	-	-
<i>Hornostaivka district</i>	6	118	6	5,1
<i>Kalanchak district</i>	6	64	6	5,1
<i>Kakhovka district</i>	4	89	8	9,0
<i>Nyzhni Sirohozy District</i>	4	129	16	12,4
<i>Nova Kakhovka</i>	2	100	2	2,0
<i>Novovorontsovka District</i>	2	62	25	72
<i>Novotroitske district</i>	16	143	16	11,2
<i>Skadovsk district</i>	10	188	10	5,3
<i>Oleshky district</i>	10	124	10	8,1
<i>Chaplynka district</i>	3	183	60	42,3
<i>Kherson</i>	11	234	-	-

The construction of the Podstepne's water intake that was started is suspended due to design deficiencies, and the construction of a water intake from the Dnipro river due to a shortage of funds in the budget of

the city and the region. From year to year, it was planned to continue the construction of the second stage of the Antonovka's water intake with a capacity of 8-10 thousand m<sup>3</sup> of high-quality drinking water per day, but again because of lack of funds in the local budget construction was not conducted. For this reason, there is a constant shortage of drinking water in Kherson in 30-40 thousand m<sup>3</sup> per day especially in the summer, hot period.

A special situation is observed at the first site of the water pipeline, where the ammonium and nitrate contamination of groundwater has assumed alarming proportions: the nitrate content of the exploited wells is 72.9 -248 mg/dm<sup>3</sup>. Pollution of this area with nitrogen compounds is associated with the activities of the Kherson seaport. In the observed well № 982, located five meters from the seaport area towards the water intake facilities, the mineralization increased 18 times (up to 9.22 g/dm<sup>3</sup>) after corrosion, the sulfate content increased by 284 times (up to 5105 mg/dm<sup>3</sup>), which indicates the presence of nearby halo of groundwater pollution.

The ecological condition of the territory of the region is affected by a huge number of abandoned wells, the presence of which is the result of the reorganization of enterprises and farms in the region. Even in the worst condition are the sewer networks and facilities of the city. Out of a total of 282 km, 49% are completely worn out. Particular danger is created by emergency pressure and gravity sewage pipelines of large diameter from 300 to 1200 mm, accidents leading to the discharge of untreated sewage into the environment and the Dnipro river basin. In total, in 2009, 1646 minor accidents and 38 major accidents were eliminated on the sewerage networks of Kherson [4,5]. More than 300 km of emergency sewer networks are operated. Thus, the main pressure collector, which takes waste water from the city of Skadovsk and the entire health zone, is completely worn out. Particularly alarming are the rural water pipelines with an underdeveloped street network, as well as a low level of technical and preventive maintenance. Every year, the length of depreciated networks increases, the number of accidents and breakthroughs that are not eliminated for 2-3 weeks [4,5].

The work of household and drinking water pipelines and sources of decentralized water supply is under the control of the sanitary epidemiological service of the region. In the current survey of water pipes,

16066 drinking samples were taken for microbiological testing, 9487 samples were taken for sanitary-epidemiological indicators. 482 samples from the total number of samples that were examined for microbiological indicators did not meet the requirements of the state standard. This amounted to 2.6%. 1849 samples from the total number of samples that were examined for chemical indicators did not meet the requirements of the state standard. This amounted to 15.2% [5].

Intensive use of groundwater in the past (excess of predicted operational reserves) has become one of the causes of chemical contamination of groundwater in the main Neogene aquifer complex in the south-eastern region of the region. Long-term use of underground sources of water supply leads to their contamination by more mineralized waters below the located underground aquifers, so 45% of artesian wells supply water that does not meet the sanitary requirements for indicators: mineralization, dry residue, stiffness, nitrates, sulfates, chlorides (Figure 2).

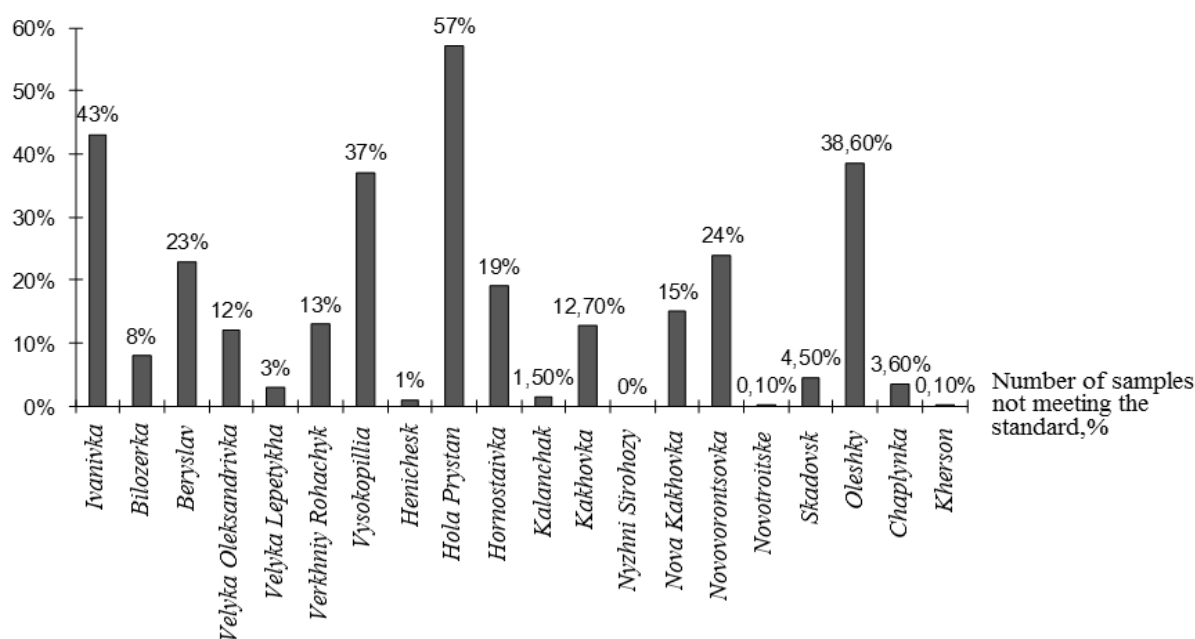


Fig. 2. The number of drinking water samples that do not comply with the state standard, out of the total number of samples in percentage

In spring and summer, a large part of the population of Belozerka, Berislav, Vysokopilla, B.Aleksandrovka, Genichesk, Kakhovka and Chaplynka districts remains without water.

Figure 3 shows the dynamics of deterioration of water quality in the region on a dry residue for the period 2000-2017. As we can see, with the

norm of the dry residue of 1000 units, at the present time the overwhelming majority of samples show an excess of this indicator.

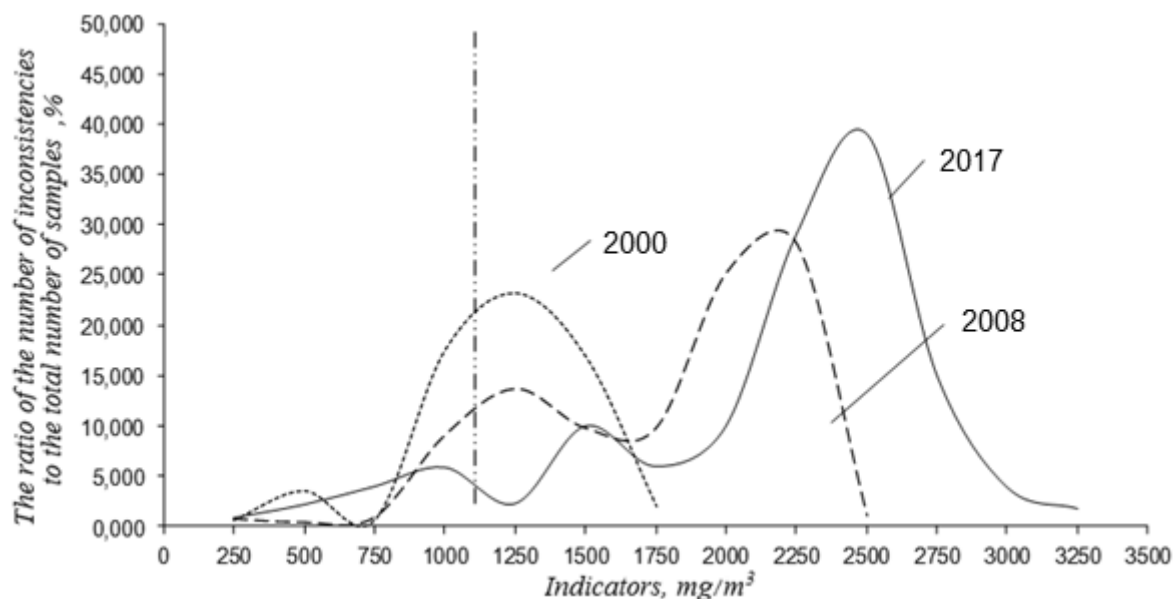


Fig.3. Dynamics of water quality deterioration on dry residue

According to the Berislav district, a correlative dependence was constructed showing that the cardiovascular system in this region is 84% determined by the quality of drinking water [3]. In addition, the effect of a temporary lag was noticed: the incidence in the current year is determined by the quality of water two years later. This indicates that the disease develops gradually: a year later the disease develops, and two years later the patient turns to the doctor.

Next, we performed the following experiment: to the deviation in the chemical composition of water this year added 15% of the value of the previous year. On the example of statistics of diseases of the Henichesk district (Fig. 4) we showed how the residual phenomena of previous years affect the incidence of today (cumulation effect). The correlation sequence in the original case is described by equation:

$$Y_s = 422,9 + 3,69x. \quad (1)$$

Correlation sequence in the case of adding 15% of the values of the previous year is described by equation:

$$Y_s = 328,41 + 6,59x. \quad (2)$$

The coefficient of multiple determination  $R^2$  in this case increased from 4% to 59%, and the standard error  $\sigma$  decreased from 87.5 to 38.4.

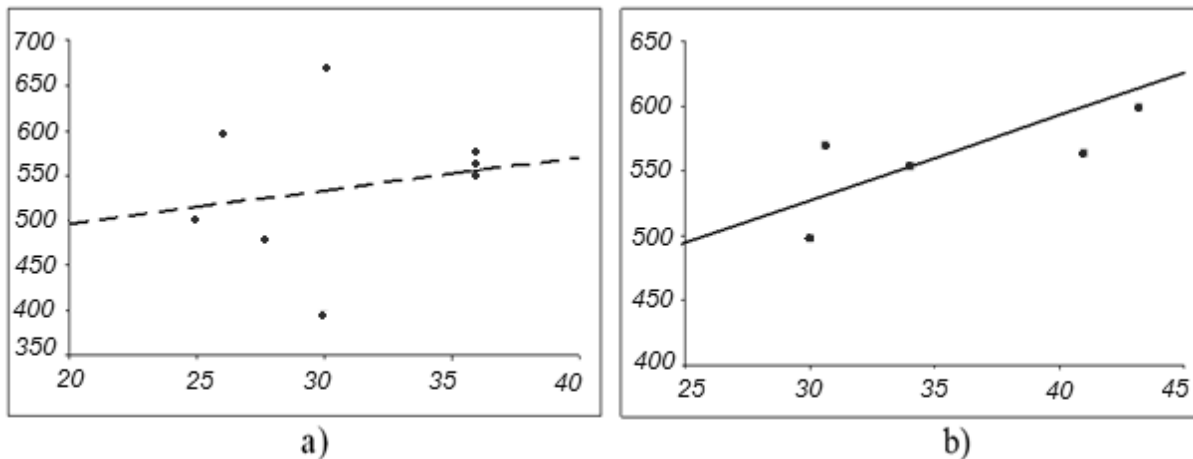


Fig.4. Dependence of diseases of the cardiovascular system of a person on the water quality of the Henichesk district: a) with the initial regression; b) with a shift of two years + 15% from the previous year

Among the total number of samples that do not comply with the standard, two most significant parameters (chlorides and total hardness) were identified, which determine the main percentage of nonconformities. On these two indicators, a two - factor model of the dependence of diseases of the gastrointestinal tract on the number of drinking water samples that do not correspond to the norm on chlorides and the general rigidity is constructed. Based on the statistics of the Berislav district. It is linear in rigidity and non-linear in chloride, that is, the incidence increases with decreasing water hardness and increases square with increasing chloride content in water. The same studies were conducted in Belozerka, Genichesk, Vysokopilla, Gornostaevka, Novotroitsk and Chaplynka districts, where the growth of diseases is confirmed against the background of deteriorating water quality.

The incidence in many cases depends solely on the sanitary condition of settlements, the hygienic living conditions of the population, the state of the environment. One possible solution is to predict this problematic situation. Studies are needed to model these processes, as well as their consequences, namely, the health status of the population; modeling situations, thanks to the current state of affairs with water supply; the modeling of the way out of the situation at the moment of its transformation into a critical one.

### Conclusion

A study of water supply sources in the Kherson region has been carried out. It is substantiated that the state of health of the population

of the region depends, among other things, on the quality of drinking water. Since at present most of the samples show no compliance with the standard and a significant excess of the norm, it is necessary to carry out studies on modeling and forecasting the processes of deterioration of the quality of drinking water.

For this, it is necessary to develop algorithms, programs and information technologies based on the achievements of modern mathematical science and computer facilities.

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