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ARTICLE

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DETERMINATION OF THE LEVEL OF POLLUTION OF WATER RESOURCES

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Summary. *The based on the data of laboratory studies, an integrated assessment of the quality of water resources the village of Mala Belozerka. Analytical researches have search character of an integrated estimation of level of pollution of district and are executed by a method which is offered by researchers Kryzhanovsky E.M. and Davydov I.V., is of a recommended nature and based on the algorithm of the officially approved methodology of the KND 211.1.1.106 "Organization and implementation of observations of surface water pollution (in the system of the Ministry of Energy)". According to the results of the calculation of the total pollution rate, it was found that the local water resources are characterized as dirty, despite the relatively high quality of groundwater, which is used as a source for drinking water supply to the rural population.*

Keywords: *integrated assessment, pollution coefficient, and surface, groundwater quality, hydrochemical parameters.*

Drinking water shortages are linked to the effects of climate change, human activities that reduce water resources due to pollution of freshwater ecosystems, and the effects of urbanization and land use change.

According to statistics, almost 1/5 of the world's population lives in areas where there is a serious shortage of clean drinking water. In addition, 1/4 of the population lives in developing countries, which lack due to the lack of infrastructure needed to collect water from aquifers and rivers. One of the main problems is the problem of fresh water pollution, which significantly reduces existing reserves. This pollution is promoted by industrial emissions and drains, washing away of fertilizers from fields, and also penetration of salt water in coastal zones into aquifers because of pumping out of ground waters.

The problems of water protection and the provision of sufficient water of adequate quality to meet all needs, especially of the rural population, as defined in Directive 2000/60 / EC of the European Parliament and of the Council on the establishment of a Community framework for water policy, are becoming relevant. in the Law of Ukraine "On the Basic Principles (Strategy) of the State Environmental

Policy of Ukraine for the period up to 2030", as well as in the previous Law of Ukraine "On the Basic Principles (Strategy) of the State Environmental Policy of Ukraine for the period up to 2020" [1-3].

Assessment of surface and groundwater quality will be considered on the example the village of Mala Belozerka, which is located at a distance of about 4.4 km from PRAT "Zaporizhzhya Iron Ore Plant" (Fig. 1). The extraction of iron ore underground can further lead to lower groundwater levels and, consequently, to a shortage of water resources. Today, groundwater is used to meet the needs of the rural population.

To compare the compliance of hydrochemical parameters of water resources the village of Mala Belozerka to the requirements of current national standards were taken surface water samples from the pond located within the rural settlement, and groundwater samples from wells № 1-3 (conditional numbering) 19.10.2020, and from well № 1 previously - 01.10 .2019 (Fig. 1) in accordance with DSTU ISO 5667-2: 2003

Fig. 1. Location of surface and groundwater sampling points. Symbols: well 1, well 2, well 3 - well № 1-3 (conditional numbering)

Chemical analysis of selected water samples was determined in the laboratory of hydroecology of the Dnieper State Agrarian and Economic University (Fig. 2). Determination of water mineralization was performed using a portable TDS-meter (hold) AquaKut.The reliability of the obtained results with the help of a portable device is evidenced by their comparison with the data of laboratory studies on the example of a sample of water taken from a well № 2.

According to the results of laboratory studies, it is found that the mineralization of groundwater mainly meets the requirements for sources of drinking water supply according to the national standard SanPiN 2.2.4-171-10 or is characterized by slightly higher values compared to low quality surface waters:1) mineralization of water from the pond in the village of Mala Belozerka exceeds 11.4 times the requirements of SanPiN 2.1.5.980-00 (recreation, irrigation);2) mineralization of groundwater from well № 1, depth ≤ 50 m, and which is located near agricultural land within the village of Mala Belozerka, at the beginning of operation in 2019 was 750 mg / dm3 and met

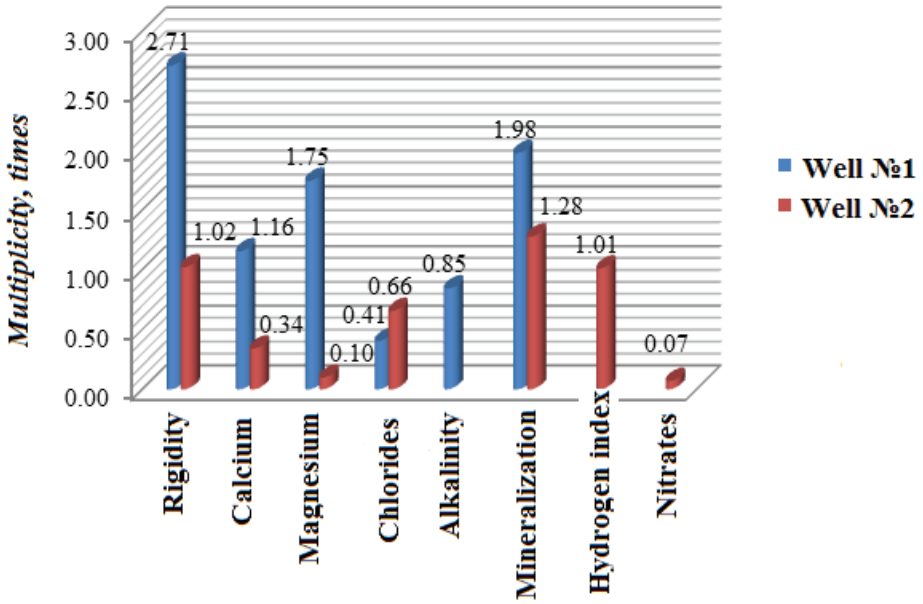

Fig. 2. Comparative characteristics of hydrochemical indicators of groundwater quality with regulatory requirements. Sources of drinking water supply: well № 1 and 2 (see Fig. 1)

the requirements of the national standard SanPiN 2.2.4-171-10 (drinking and drinking purposes, irrigation), and in 2020 - exceeded 2.0 times the standard;3) mineralization of groundwater from well № 2, depth ≤ 50 m, and located within the village of Mala Belozerka exceeds 1.3 times the standard according to SanPiN 2.2.4-171-10 (drinking and drinking purposes);4) mineralization of groundwater from well № 3, depth ≤ 500 m, and which is located near the mine, outside the village of Mala Belozerka is 198 mg / dm3 meets the requirements of SanPiN 2.2.4-171-10 (commercial and drinking purposes). Tap water in the village of Mala Belozerka, which is fed without prior treatment from well № 3, also meets the requirements of the national standard, mineralization 147 mg / dm^3.

Thus, the quality of water resources in the area the village of Mala Belozerka is variegated, which determines the expediency of forming an integrated assessment of their quality. Unfortunately, today there is no generally accepted official method for determining the index of general pollution of the territory, but there are studies in this direction and recommendations, which are reflected in a number of works by scientists [4-7].

For example, in [4] it is proposed to use the algorithm of the method KND 211.1.1.106 "Organization and implementation of observations of surface water pollution (in the system of the Ministry of Energy)" to assess the pollution of not only surface water but also groundwater, soil and atmosphere, as it is officially the adopted method does not take into account the specifics of the spread of pollutants in surface waters.

The pollution coefficient (K_p) is a generalized indicator that characterizes the level of pollution in a number of quality indicators, which are repeatedly measured in several points (sites, posts) of observations.

The level of contamination is estimated in accordance with KND 211.1.1.106 by the values of K_p, calculated by formula (1), as follows: $K_p \leq 1$ - uncontaminated (clean); K_p = (1.01 - 2.50) - slightly contaminated; K_p = (2.51 - 5.00) - moderately polluted; K_p = (5.01 - 10.0) - dirty; K_p> 10 - very dirty.

If the water body is intended for several types of water use, when calculating K_p should follow the rules that determine the greater requirements for water quality [4]. To determine the total K_p should find the average value of K_p for points (shots, posts) [4]:

$$К_{p.general} = \beta \cdot К_{p.surface\ waters} + \beta \cdot К_{p.groundwater} + \beta \cdot К_{p.atmosphere}, \quad (1)$$

where$K_{p.\ general}$ – surface water pollution coefficient; $K_{p.\ groundwater}$– coefficient of groundwater pollution; $K_{p.soil}$ – coefficient soil pollution; $K_{p.\ atmosphere}$ – coefficient pollutionatmospheres; β – the weight of the components of the pollution factor.

The sum of all weights must be equal to 1 [4]. In the absence of data on a particular component of the environment (eg soil), it is necessary to distribute the weight between the other three so that the sum is still 1.

According to the above recommendations we get:

$$К_{p.general} = \beta \cdot К_{p.surface\ waters} + \beta \cdot К_{p.groundwater}$$
$$К_{p.general} = 0{,}5 \cdot 11{,}4 + 0{,}5 \cdot 1{,}32 = 6{,}36$$

Thus, the level of pollution of water resources the village of Mala Belozerka can be assessed as dirty, despite the fact that the level of groundwater pollution is$К_{p.groundwater} = 1{,}32$ - slightly polluted.

Conclusion. On the considered example the method of an integrated estimation of levels of pollution of water resources the village of Mala Belozerka, which is of a recommended nature [4]. The obtained results testify to the expediency of further development of the method of calculation of the index of general pollution of the city or other administrative territory, which can cover the data of monitoring the condition of all components of the environment.

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