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Monitoring the quality of groundwater from wells in the Pokrovsk District of Donetsk region

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SUMMARY

In Donetsk region, which has always suffered from a shortage of surface water, groundwater is a strategic water resource. In Pokrovsky District, under martial law, when water channels, pumping stations, treatment facilities and water supply networks were destroyed, groundwater became the only alternative solution to the water supply problem. This article is based on the data obtained as a result of the analysis of quality parameters from 151 active wells, located in the city of Pokrovsk and nearby areas of Donetsk region. During the monitoring, borehole water studies were carried out in Pokrovsk District according to 9 indicators: Salinity, Total Hardness, Alkalinity, pH, Turbidity, Total Iron content, content of Nitrates, Nitrites, Phosphates. It was found that 20% of water samples exceeded the standard for Salinity by 300-400%, and for Total Hardness - by 400-500%. Half of all samples exceed the water quality standard by 5-6 times. Monitoring of groundwater from wells in Pokrovsk District showed that this water cannot be used as drinking water without preliminary purification. It was found that the standard indicators of drinking water quality were exceeded many times, especially Salinity (100% of samples), Total Hardness (96.1% of samples), Nitrate content (80.6% of samples). Groundwater from wells in Pokrovsky District does not meet the requirements of both Ukrainian and European water quality standards for most quality indicators. The main causes of pollution of this water are anthropogenic and geological conditions.



Introduction

For many countries, groundwater is one of the most important water resources that ensure the livelihoods of the population, the functioning of industry and agriculture. Groundwater provides more than half of all water for drinking and irrigation worldwide (Gregorya *et al.*, 2024). Groundwater plays a crucial role in maintaining ecological balance and regulating the water balance in the environment. However, in many regions of the world, human activities such as agriculture, industry, and urbanization directly or indirectly threaten this valuable natural resource through depletion and deterioration of water quality (Famiglietti, 2014; Burri *et al.*, 2019). Compared to surface water quality, large scale assessments for groundwater quality are still scarce and often rely on inadequate data sets (Lapworth *et al.*, 2022). The lack of detailed information about local groundwater resources and insufficient monitoring initiatives are major challenges undermining groundwater resources management (Cooper and Hiscock, 2024). Groundwater resource depletion requires groundwater quality monitoring and awareness raising among all stakeholders (Singhal *et al.*, 2020).

In eastern Ukraine, groundwater is a critically important drinking water resource. In Donetsk region, which has always suffered from a shortage of surface water, groundwater is a strategic water resource (Starovoit *et al.*, 2021). With the beginning of the Russian aggression, the problem of providing the population with drinking water has significantly worsened. Water canals, pumping stations, water treatment facilities, and water mains were destroyed (Zbykovskyy *et al.*, 2024). In the cities and towns of Pokrovsk District, centralized drinking water supply was absent for almost six months at some times. The local population was forced to look for alternative sources of drinking and technical water for daily life. In this region, groundwater is the only alternative solution to the water supply problem.

Under martial law, local authorities allowed the population to drill water wells independently. At the same time, local authorities did not monitor compliance with technical conditions for drilling and operating wells. Measures were not taken to prevent contamination of aquifers, casings were not sealed, and regulations regarding sanitary protection zones around wells were not observed. The population did not have information about the quality of groundwater and the rules for its use. Over the years of operation of the wells, the quality of groundwater deteriorated, which was fixed visually.

Method

This article is based on the data obtained as a result of the analysis of quality parameters from 151 active wells, located in the city of Pokrovsk and nearby areas of Donetsk region. Studies of water samples from wells were carried out in the Water Laboratory by scientists of Donetsk National Technical University. The task of these studies is to monitor the quality of groundwater from wells in households of residents of Pokrovsk District.

Results

During the monitoring, borehole water studies were carried out in Pokrovsk District according to 9 indicators: Salinity, Total Hardness, Alkalinity, pH, Turbidity, Total Iron content, content of Nitrates, Nitrites, Phosphates. As experience shows, this number of water quality indicators is sufficient for its initial assessment (Venkatesh *et al.*, 2024). Figure 1 shows the geographical location of the wells with the values of the six indicators that were measured.

One of the most important indicators of drinking water quality is the Nitrate content (Lapworth *et al.*, 2017). The samples included well water samples with a Nitrate content of 1000 mg/l, which is 20 times higher than the maximum permissible concentration of Nitrates in drinking water of 50 mg/l. Among the well water samples, 104 samples were found to exceed the maximum permissible concentration of Nitrates in drinking water, which is 80.6% of the total number of samples. Among



the water samples, there were a lot of samples with Nitrate content exceeding the maximum permissible concentration by 6-10 times. (Table 1). These results characterize such groundwater according to only one quality indicator, as unsuitable for use as drinking water and limitedly suitable as technical water. For industrial areas, such as Pokrovsk District, this situation is no exception.

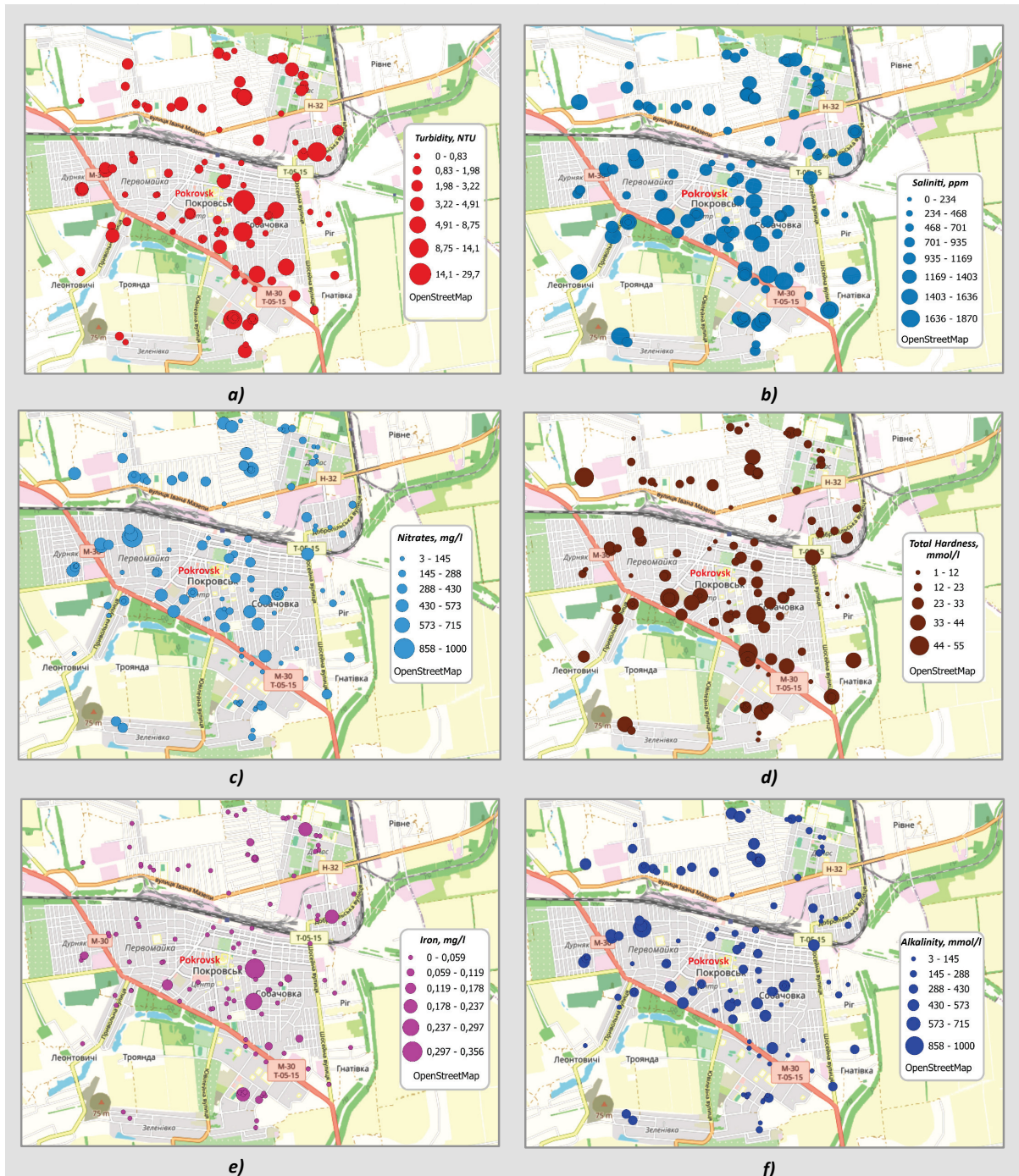


Figure 1 Geographical localization of samples and corresponding indicator values: (a) Turbidity; (b) Salinity; (c) Nitrates; (d) Total Hardness; (e) Iron; (f) Alkalinity.

The cause of groundwater pollution in Pokrovsk District is anthropogenic activity. One of the most likely sources of Nitrate pollution of groundwater may be a large industrial and livestock complex in



the city of Pokrovsk. To establish the actual causes of groundwater contamination with Nitrates, regular monitoring of well water quality is necessary. The residence time of contaminants within groundwater bodies can be anywhere from weeks to decades, depending on physic-chemical properties of compound and environmental conditions (Freitas *et al.*, 2015). The groundwater's quality varies as more water is pumped out of the sources (Venkatesh *et al.*, 2024). Determining the causes of pollution is necessary for their elimination, as well as for the stable provision of drinking water to the local population through the use of groundwater. Resolving this issue is relevant for residents of Pokrovsk, Myrnohrad and other cities in Pokrovsk District, who now are without any water supply and without any alternative sources of water supply, except for groundwater from wells.

Table 1 Maximum value of the indicator in samples and maximum permissible value according to Ukrainian Standard for drinking water quality.

Indicators	Maximum Permissible Value	Maximum value of the indicator in samples	Percentage exceeding maximum value, %	Number of samples exceeding MPV	
				number of samples	%
Salinity	350 ppm	2030	480	129	100
Total Hardness	7 mmol/l	55	686	124	96,1
Iron	0,2 mg/l	0,356	78	4	3,1
Nitrates	50 mg/l	1000	1900	104	80,6
Nitrites	0,5 mg/l	10	1900	13	10,1
Phosphates	3,5 mg/l	3	0	0	0
Alkalinity	6,5 mmol/l	14,8	128	118	91,5
pH	6,5-8,5	6,3 (min); 8,1(max)	3	4	3,1
Turbidity	2,6 NTU	67,9	2512	35	27,1

During monitoring, two physic-chemical indicators were also determined for all water samples from the studied wells: Salinity and Total Hardness. These indicators are critically important for human health (Zbykovskyy *et al.*, 2024). It was found that Salinity in water from all wells does not meet the requirements of the national quality standard for well water, and in terms of Total Hardness - in more than 96% of the wells studied. It was found that 20% of water samples exceeded the standard for Salinity by 300-400%, and for Total Hardness - by 400-500%. Half of all samples exceed the water quality standard by 5-6 times. Using this water as drinking water can cause great harm to human health, causing problems with the kidneys and cardiovascular system. The use of this water as technical water without prior desalination can be very limited, as it leads to scale formation, corrosion, and soil salinization (in agriculture). Currently, there is a lack of stationary water purification stations in Pokrovsk District, and there are no mobile ones.

Conclusions

Monitoring of groundwater from wells in Pokrovsk District showed that this water cannot be used as drinking water without preliminary purification. It was found that the standard indicators of drinking water quality were exceeded many times, especially Salinity (100% of samples), Total Hardness (96.1% of samples), Nitrate content (80.6% of samples). Groundwater from wells in Pokrovsk District does not meet the requirements of both Ukrainian and European water quality standards for most quality indicators. The main causes of pollution of this water are anthropogenic and geological conditions.

In this situation, it is necessary to inform the local population about the quality of groundwater and the health risks of uncontrolled consumption, and to disseminate recommendations for the purification



and safe use of well water. After monitoring, information about the quality of groundwater in Pokrovsk District was disseminated among residents through local media.

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