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QUALITY ASSESSMENT OF DRINKING WATER FROM DIFFERENT WATER SUPPLY SOURCES IN VYNNYKY (LVIV REGION)

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Abstract. A thorough evaluation of drinking water quality was performed for several sources in Vynnyky, Lviv region, including springs on B. Khmelnytsky and M. Kypriyan Streets, a well located at 17 K. Hrynevycheva Street, and tap water from the centralized supply system at 14 V . Sukhomlynskyi Street. The parameters analyzed encompassed total hardness, pH level, overall mineral content, as well as concentrations of chlorides, sulfates, iron, ammonium, nitrates, nitrites, and electrical conductivity The analysis revealed that water from the well at 17 K. Hrynevycheva Street had the most parameters exceeding acceptable limits. Notably elevated levels of total hardness, nitrates, and overall mineralization were identified, rendering this source inappropriate for drinking without prior purification The water sample from the spring on B. Khmelnytsky Street showed an elevated iron concentration, which negatively affects the sensory qualities of the water – such as its taste and appearance – and could potentially endanger human health if consumed over an extended period. Water obtained from natural sources exhibited elevated electrical conductivity and total dissolved solids, surpassing the thresholds established by European water quality regulations. In two of the samples – specifically, the spring on M. Kipriyan Street and the well – the nitrate levels were found to be 3 to 5 times higher than the allowable values outlined in Sanitary and Epidemiological Norms 2.2.4-171-10 for drinking water. Although tap water showed the smallest deviations among the tested sources, it still failed to comply with the standards of Council Directive 98/83/EC due to excessive mineral content and high electrical conductivity.

Keywords: drinking water, natural sources, well, centralized water supply, physical and chemical parameters.

1. Introduction

The quality of potable water plays a crucial role in maintaining public health and supporting the stability of ecosystems. In the context of the growing anthropogenic impact on the environment, increasing urbanization, and the usage of natural resources for economic and recreational purposes, the issue of systematic monitoring of water sources is becoming particularly relevant. Specifically, local water sources used without centralized treatment may be subject to contamination with nitrogen compounds, metals, and excess mineral components, which creates potential risks to human health (Klimchyk, 2019).

The issue of drinking water quality in Western Ukraine is addressed through a comprehensive assessment of physical, chemical, sanitary, hygienic, and

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microbiological indicators. In particular, in the Sambir territorial community, where the main source of water supply is wells (the study focused on wells located in the settlements of Chernikiv, Ralivka, and Novy Kalyniv, in the village of Kruzhiky), significant excesses of ammonium ion concentrations were detected – in some samples up to 4.1 mg/dm^3 while maximum permissible level is 0.5 mg/dm^3. Nitrate levels (11.3–18 mg/dm^3) remained within the norm (≤50 mg/dm^3), but their presence in water is a sign of potential fertilizer contamination. Increased water mineralization was also detected – up to 980 mg/dm^3, which is close to the limit value, and the total hardness ranged from 5.9 to 8.2 mmol/dm³, exceeding the hygienic standard in some samples. The amount of phosphates and nitrites ranged from 0.073 mg/dm^3 to 0.082 mg/dm^3, respectively, indicating a systemic violation of drinking water quality in the region, which poses a risk to the health of the population, especially vulnerable groups (Bryndzia et al., 2025).

Similar negative trends were observed in a long-term study of changes in water quality in private wells in the village of Bryukhovychi (Lviv region) for the period 2011–2023. A significant increase in mineralization has been detected: while at the beginning of the observations the water was classified as fresh (<500 mg/dm^3), by 2023 the indicators approached or exceeded 1000 mg/dm³, indicating a transition to a weakly mineralized type. Water hardness has also increased significantly, which may be the result of both natural and man-made factors. Ammonium, nitrates, and nitrites content has increased at most water sampling points, with many indicators exceeding the standards. The overall water quality for the period 2011–2023 has significantly deteriorated, making such water undesirable for regular consumption without additional purification (Kalmyk et al., 2024).

In a study (Stepova et al., 2019) of natural springs in Lviv, located in the Vysokyi Zamok and Pohulyanka parks, in Vynnyky, and green space near Lviv State University of Life Safety, it was found that all analyzed samples significantly exceeded the limit concentrations of calcium and magnesium, which determine the hardness of water at a level of more than 10 mmol/dm^3. The content of nitrates, nitrites, sulfates, ammonium, and lead in these samples also exceeds the relevant hygiene standards.

A study of the Lviv municipal system of water supply for 2009–2015 was analyzed, which showed the following results: 5.3–6.4 % of samples were not in compliance with sanitary standards, and 2.1–5.5 % were not in compliance with microbiological standards. In most cases, the problems are related to the high level of equipment wear (over 65–70 %), the lack of effective disinfection systems (often only chlorination is used), and the lack of sanitation protection zones around water intakes. In 50 % of rural water supply systems, sanitary protection projects have not been implemented at all. This creates conditions for the recontamination of already purified water during its transportation, and thus reduces its sanitary safety even in a centralized system (Krupa & Lototska-Dudyk, 2016).

The sources analyzed demonstrate a systematic degradation of potable water quality in the region of Western Ukraine. In decentralized systems (wells, springs), significant exceedances of permissible concentrations of ammonium, heavy metals (lead), nitrates, and increased hardness have been detected, making such water unfit for consumption without additional treatment. A gradual increase in mineralization and salt supersaturation has also been recorded in sources previously considered as safe. Although centralized water supply is of better quality, it is also vulnerable due to the technical deterioration of networks, inefficient purification technologies, and low levels of sanitary control. The data obtained indicate a critical need to upgrade water treatment systems, introduce modern disinfection methods, and create an effective monitoring system of water quality (Lotochka et al., 2019).

The town of Vynnyky, located 6 km east of Lviv, was selected for the study of drinking water quality. It is part of the Lviv city community and has an area of 6.67 km^2 with a population of about 20.000 people. The city is distinguished by its recreational resources, in particular Vynnyky Lake, a reservoir with running water. The Emily Resort sports and recreation complex and the Football Academy are located near the lake. The Marunka River, a left tributary of the Bilka River, which is part of the Western Bug River basin, also flows through the city. Its length is 14 km, and the basin area is 65 km^2 (Khromiak & Vorobets, 2025).

The objective of the study is to analyze the physical and chemical indicators of drinking water quality from various water sources in the city of Vynnyky, Lviv region.

2. Experimental part

The samples were taken from water sources in Vynnyky, located on B. Khmelnytsky Street (near the Emily Resort recreation complex) and M. Kipriyan

Street, to investigate their chemical content. The distance between them is 2.8 km. Also, for comparison, water samples were taken from a well on K. Hrynevychova Street, 17, and tap water (V. Sukhomlynsky Street, 14). Water samples were taken in February 2025.

The analysis of water samples war conducted at the research laboratory of environmental safety at Lviv State University of Life Safety. The following indicators were analyzed: total hardness, pH, total salt content, concentration of chlorides, sulfates, iron, ammonium, nitrates, nitrites, and electrical conductivity.

The methods used for determination of these indicators are standard and comply with the current requirements for water quality analysis. The study was based on the requirements of DSTU EN 1420-1:2004, DSTU ISO 7887:2003, DSTU 4077-2001, DSTU ISO 15923-1:2018, and DSTU ISO 6059:2003 (DSTU EN 1420-1:2004, 2004; DSTU ISO 6059:2003, 2003; DSTU ISO 7887:2003, 2003; DSTU ISO 1 5923-1:2018, 2018; DSTU 4077-2001, 2001).

At the sampling site, an analysis of organoleptic indicators was carried out, including smell and the general appearance of the sample (characteristic color, turbidity, sediment), and transparency.

3. Results and Discussion

Total water hardness (Fig. 1) is one of the key physical and chemical parameters that determines the calcium and magnesium content in water, which, in high concentrations, not only change its organoleptic properties, but can also have an adverse effect on human health and the functioning of household appliances.

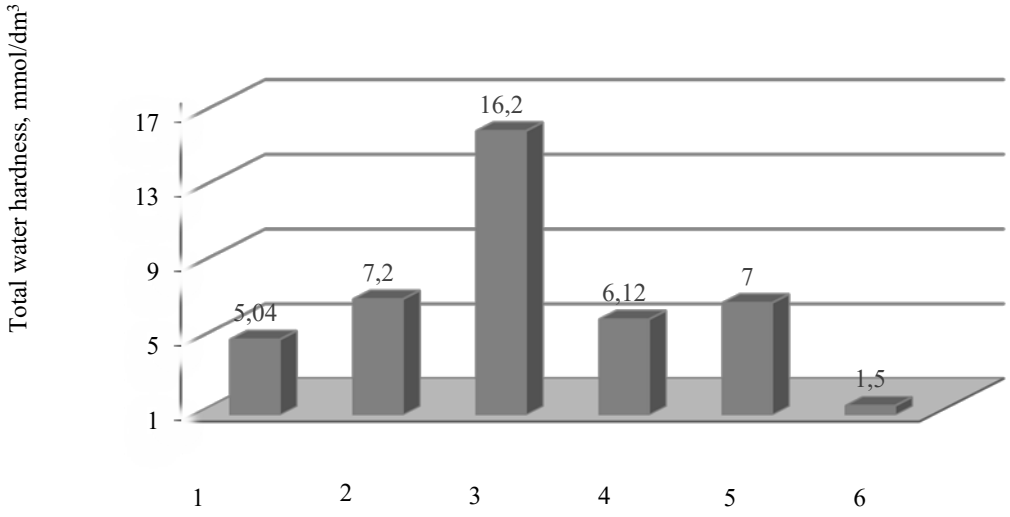

Fig. 1. Total water hardness: 1 – spring on M. Kipriyan Street; 2 – spring on B. Khmelnytsky Street; 3 – well on K. Grynevychova Street, 17; 4 – tap water on Sukhomlynskoho Street 14; 5 – drinking water requirements according to DSanPiN 2.2.4-171-10; 6 – drinking water requirements according to Directive 98/83/EC

According to the results in Fig. 1, it was found that the highest level of total hardness was recorded in the sample from the well on K. Grynevycha, 17 (16.2 mmol/dm^3), which exceeds the hygienic standards established by DSanPiN 2.2.4-171-10 (7.0 mmol/dm^3) twice (DSanPiN 2.2.4-171-10, 2010) and the requirements of Directive 98/83/EC more than thrice (Directive 98/83/EC of the Council, 1998). This indicates excessive water hardness, which requires pre-treatment of water before consumption.

Water from the spring on B. Khmelnytsky Street is also characterized by increased hardness (7.3 mmol/dm^3). In samples from the spring on M. Kipriyan Street (4.5 mmol/dm^3) and tap water (3.9 mmol/dm^3), the total hardness does not exceed the limits, which indicates their conditional suitability for consumption in terms of this indicator.

An important indicator affecting the quality of drinking water is the hydrogen index (pH) (Fig. 2).

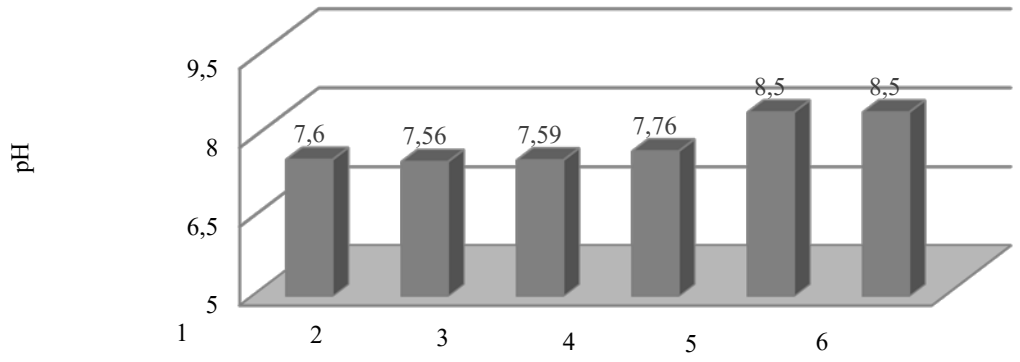

Fig. 2. Hydrogen index (pH): 1 – spring on M. Kipriyan Street; 2 – spring on B. Khmelnitsky Street; 3 – well on K. Grynevychova Street, 17; 4 – tap water on Sukhomlynskoho Street, 14; 5 – requirements for drinking water according to DSanPiN 2.2.4-171-10; 6 – requirements for drinking water according to Directive 98/83/EC

In all s amples, the hydrogen index is within normal limits. The optimal pH of drinking water ranges from 6.5 to 8.5. It should be noted that a low pH in water creates an acidic medium in the body, which leads to thickening of the blood, saliva, and lymph, hindering the enrichment of cells with oxygen and the removal of toxins, and leading to the blood clots formation and parasites promoting. All people with cancer have acidification of the organism (low pH) (Bardov et al., 2020).

It should be noted that the total salt content (mineralization) is an important indicator of drinking water quality, characterizing the total concentration of dissolved inorganic substances – primarily Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, SO_4^{2-}, and CO_3^{2-}. Excessive mineralization can have a negative impact on human health, in particular, increased stress on the cardiovascular system, disruption of the water-salt balance, and kidney function (Bardov et al., 2020). Fig. 3 shows a comparative assessment of the salt content in water from various sources in the city of Vynnyky, including natural springs, wells, and the water supply system, and regulatory limits according to Ukrainian and European standards (DSanPiN 2.2.4-171-10, 2010; Directive 98/83/EC of the Council, 1998).

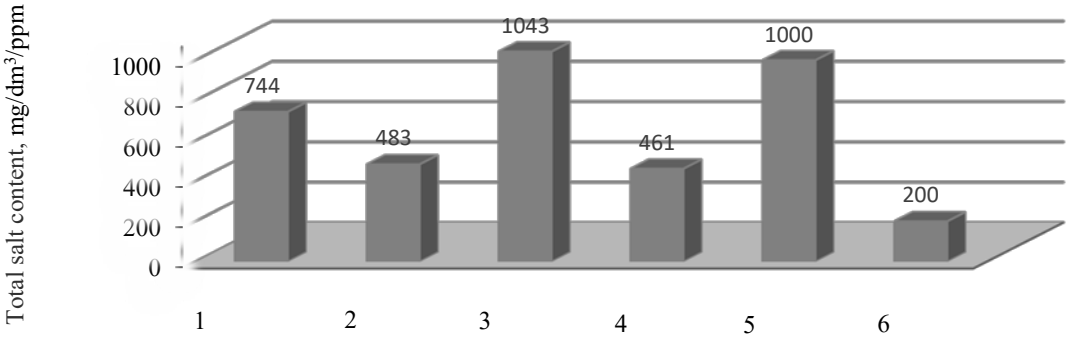

Fig. 3. Total salt content: 1 – spring on M. Kipriyan Street; 2 – spring on B. Khmelnitsky Street; 3 – well on K. Grynevychova Street, 17; 4 – tap water on Sukhomlynskoho Street, 14; 5 – requirements for drinking water according to DSanPiN 2.2.4-171-10; 6 – requirements for drinking water according to Directive 98/83/EC

According to DSanPiN 2.2.4-171-10, which are approved in Ukraine, there is practically no excess of normal limits in these samples (in sample 3 there is an insignificant increase in salt content). If these values are compared with the requirements for drinking water according to Council Directive 98/83/EC of November 3, 1998, all samples exceed the standards.

Chlorides and sulfates are important inorganic components of drinking water. Their excessive content in the drinking water can negatively affect its organoleptic properties, cause corrosion of pipelines, and disrupt human organ functions. The sources of these compounds can be both natural geological formations and anthropogenic factors, in particular domestic and industrial wastewater and the use of mineral fertilizers. Therefore, determining the content of Cl^- and SO_4^{2-} is a necessary stage in the comprehensive analysis of drinking water quality. The ions content was measured in selected water samples.

No elevated content of Cl^- and SO_4^{2-} were detected in any of the test samples analyzed. This indicates the absence of Cl^- and SO_4^{2-} contamination, which is a positive marker, since an excess of these ions can cause a bitter taste, have a negative impact on human health, and cause pipeline corrosion.

Iron is one of the quality indicators of drinking water. High iron content can change the color, smell, and taste of water, cause sediment, and, with long-term consumption, lead to iron accumulation in the body, which negatively affects the liver, pancreas, and cardiovascular system (Bardov et al., 2020). Fig. 4 shows the iron content in water from different sources in the city of Vynnyky.

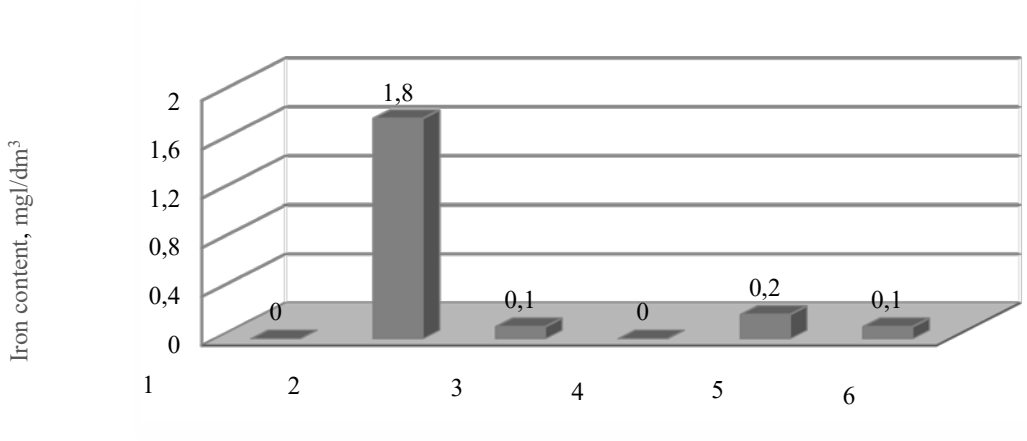

Fig. 4. Iron content: 1 – spring on M. Kipriyan Street; 2 – spring on B. Khmelnitsky Street; 3 – well on K. Grynevychova Street, 17; 4 – tap water on Sukhomlynskoho Street, 14; 5 – requirements for drinking water according to DSanPiN 2.2.4-171-10; 6 – requirements for drinking water according to Directive 98/83/EC

A significant excess of iron content was found in sample 2 (source on B. Khmelnytsky Street). Water from this source had a characteristic rusty color and a metallic taste. No excessive iron content was found in rest water samples studied.

The ammonium content in water was also examined (Fig. 5). Excessive ammonium concentration in water may indicate the organic residues or domestic sewage. These indicators are controlled in accordance with national and European water quality standards.

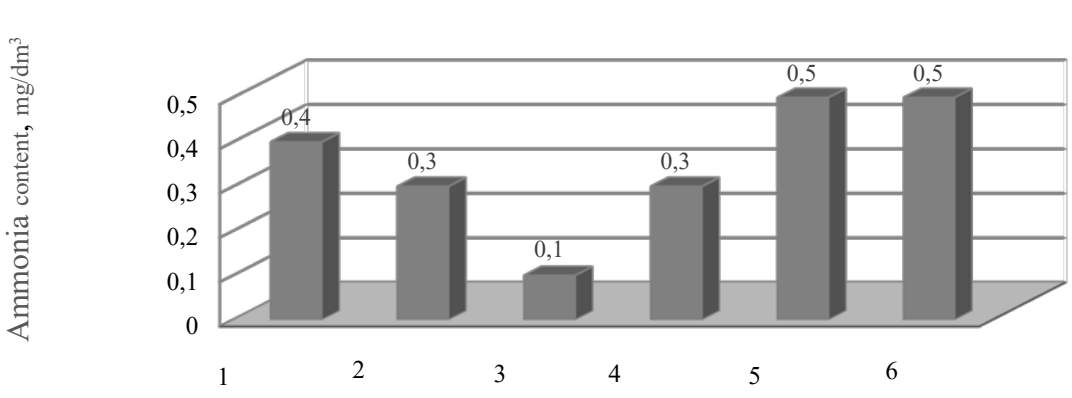

Fig. 5. Ammonia content: 1 – spring on M. Kipriyan Street; 2 – spring on B. Khmelnitsky Street; 3 – well on K. Grynevychova Street, 17; 4 – tap water on Sukhomlynskoho Street, 14; 5 – requirements for drinking water according to DSanPiN 2.2.4-171-10; 6 – requirements for drinking water according to Directive 98/83/EC

It has been established that the ammonium content in the samples doesn't exceed the limits.

NO_3^- are among the most common chemical pollutants of natural and drinking water, which enter water sources mainly through agrochemicals, wastewater, and the decomposition of organic matter. The excessive content of nitrates in drinking water poses a great threat to human health, especially for children, as it can lead to methemoglobinemia. Monitoring nitrate content is a key part of water quality monitoring. Fig. 6 shows the nitrate content in water samples collected in the city of Vynnyky.

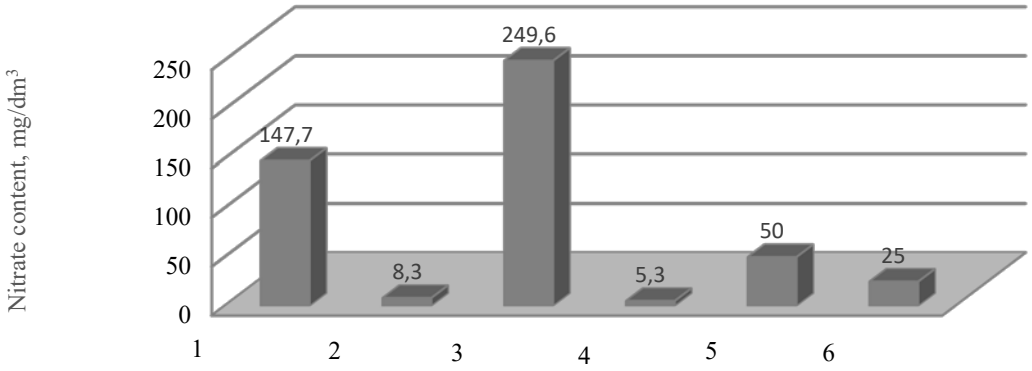

Fig. 6. Nitrate content: 1 – spring on M. Kipriyan Street; 2 – spring on B. Khmelnitsky street; 3 – well on K. Grynevychova Street, 17; 4 – tap water on Sukhomlynskoho Street, 14; 5 – requirements for drinking water according to DSanPiN 2.2.4-171-10; 6 – requirements for drinking water according to Directive 98/83/EC

The highest concentration of nitrates was found in water from a well on K. Grynevychova Street, 17, and from a spring on M. Kipriyan Street, exceeding permissible standards. Water from a spring on B. Khmelnytsky Street and tap water meet sanitary standards. The results indicate the need for purification and constant monitoring of sources with elevated nitrate levels.

Nitrates become toxic because they are partially converted into more toxic nitrites in the digestive organs, causing tissue respiration disorders. Nitrates form cancer-causing substances in the body. When water containing nitrates is consumed, there is a lack of oxygen for the respiratory organs, resulting in suffocation. It's especially dangerous for small children and infants. Nitrates are imperceptible in color, smell, and taste; on the contrary, the more nitrates there are, the more "tasty" the water feels (Bardov et al., 2020).

The studies conducted did not reveal any nitrites in the samples.

Electrical conductivity in drinking water is not regulated, but this indicator is important for protecting the water supply system. High electrical conductivity can cause corrosion. All tested samples have increased electrical conductivity.

4. Conclusions

Water from natural springs in Vynnyky, Lviv region, on B. K hmelnytsky Street and M. Kypriyan Street, and from the well (K. Hrynevych Street, 17) and tap water (V. Sukhomlynsky Street, 14) were examined. Research revealed that the water is unsuitable for consumption. It was found out that all samples contained excessive levels of various indicators.

The greatest deviations were observed in the water sample from the well (K. Hrynevychova Street, 17) where significant exceedances of the following indicators were recorded: total hardness of 16.2 mmol/dm^3, which significantly exceeds the permissible standards, the concentration of NO_3^- exceeded the sanitary permissible level by 5 times, and the total salt content (1043 mg/dm^3) exceeded the European standard (up to 200 mg/dm^3). The water from the spring on B. Khmelnytsky Street has excessive iron content, which impairs the organoleptic properties of the water and poses a potential risk to human health with prolonged consumption. All samples showed increased electrical conductivity, indicating an excessive content of dissolved impurities. At the same time, the pH, NH_4^+, Cl^-, SO_4^{2-}, and NO_2^- values remained within the established standards. The

investigation highlights the importance of pre-treatment of water before consumption, along with the implementation of continuous monitoring of water resources in the town of Vynnyky to ensure safe water supply and prevent environmental and medical-biological risks.

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