# QUALITY CRITERIA OF NATURAL WATERS: CHEMICAL ASPECTS OF USE IN IRRIGATION AND FERTIGATION (A CASE STUDY OF MOHYLIV-PODILSKYI DISTRICT, VINNYTSIA REGION)

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*A study of water bodies in the Mohyliv-Podilskyi district of the Vinnytsia region was conducted to assess the suitability of water for irrigation purposes. The research covered local water sources, including surface water, catchment systems, a pond, and the Kotlubaivka and Dniester rivers (both upstream and downstream of wastewater treatment facilities). The analyses were conducted in a certified laboratory at the National University of Life and Environmental Sciences of Ukraine. The research included an assessment of the chemical composition of water in terms of macro- and microelements, as well as quality parameters such as pH, mineralization, and temperature. Analytical and statistical methods were used, along with calculating water quality indicators such as SAR (Sodium Adsorption Ratio), Stebler's irrigation coefficient A, and the Water Quality Index (WQI) using the Harrington function. Significant fluctuations were observed in the concentrations of cations ($Na^+$, $Ca^{2+}$, $Mg^{2+}$), anions ($Cl^-$, $SO_4^{2-}$, $NO_3^-$, $HCO_3^-$), and heavy metals ($Cd^{2+}$, $Zn^{2+}$, $Pb^{2+}$, $Cu^{2+}$, $Fe^{2+}$), some of which approached maximum permissible concentrations. It was found that, according to the SAR index, sources No. 2 and 5 demonstrated the highest water quality, while source No. 6 was deemed unsuitable due to the risk of soil salinization. The empirical irrigation coefficient A confirmed good to satisfactory water quality for most sources, except for sources No. 6 and 8. According to the Harrington water quality index, the most favorable source was the Dniester River (No. 7) upstream of the treatment facilities (59.9 %), with sources No. 2 and 5 serving as alternative options. The obtained results support the relevance of applying integrated assessment approaches for determining water suitability for irrigation and fertigation, taking into account chemical composition, environmental risks, and technical feasibility. The findings form a basis for future sustainable water use and environmental monitoring measures.*

***Keywords***: *Harrington Index, irrigation, natural waters, water quality, water use.*

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## 1. Introduction

Under climate change conditions, the availability of irrigation is one of the key requirements for adequate agricultural production (Yang et al, 2024). Moreover, the use of fertigation — a practice that combines irrigation with the foliar application of macro- and micronutrients to crops during critical stages of plant ontogenesis — is expanding (Brez, 2010). Special considerations must be considered when using natural waters for irrigating greenhouse soils, including low-volume substrates (Ávalos-Sánchez at al., 2022).

According to an analytical report by the World Bank (Ranu at al. 2024), before the onset of the Russian invasion, only 1.6 % of Ukraine's arable land was irrigated, with the majority (up to 90 %) located in the southern regions. The most water-dependent crops, which consumed 56 % of irrigation water, were soybeans and corn, accounting for 32 % and 16 % of irrigated areas, respectively. After the outbreak of war in 2022, the area of irrigated land decreased by 13 %. The destruction of the Kakhovka Dam resulted in an almost complete loss of irrigation capacity in the southern regions. Consequently, crop yields fell by 14 % for corn, 30 % for wheat and barley, and 21 % for sunflower. Therefore, Ukraine's post-war recovery plan must include the development of a new irrigation strategy that incorporates cutting-edge global advances in agricultural production, including comprehensive water quality assessment that considers soil characteristics, crop type, environmental factors, and technical requirements.

Accordingly, the Irrigation and Drainage Strategy in Ukraine for the period up to 2030, adopted in 2019 (Strategy, 2019), requires a fundamental revision in light of the new realities and the need for a substantiated methodology for integrated assessment of water resources for various types of irrigation and fertigation.

Requirements for the composition and properties of irrigation water are typically divided into agronomic, environmental, and technical categories. Agronomic requirements (DSTU 2730) are based on preventing soil salinization and phytotoxic effects — environmental requirements (DSTU 7286) concern accumulating environmental pollutants through irrigation water. Special attention must be paid to the compliance of water composition with technical standards in methods such as drip irrigation, particularly when combined with fertigation or intelligent irrigation systems, for which separate requirements have been established (DSTU 7591, Yara fertigation manual, 2020). According to (Sela, 2019), 90 % or 250 million hectares of global irrigated land rely on surface irrigation, which is associated with considerable unproductive water losses and a high risk of soil salinization. Therefore, irrigation technologies in Ukraine should gradually transition toward sprinkler systems, sub-irrigation, drip irrigation, micro-irrigation in greenhouses, and fertigation. These intelligent irrigation methods place exceptionally high technical demands on water quality due to the increased risk of equipment failure.

Theoretical principles for assessing irrigation water quality based on risk levels, ranging from 1 to 5, are presented in Fig. 1.

It should be noted that regulatory documents include a comprehensive set of indicators of water quality and composition for irrigation, which in practice is rarely fully monitored due to technical and financial constraints. Therefore, practitioners and agronomists often create their so-called checklists of water parameters and properties, which they assess before designing a fertigation project and continue monitoring during operation. The recommended optimal checklist includes the following:

1. Field measurements of water electrical conductivity and pH;
2. Determination of the primary ion content to calculate the SAR (Sodium Absorption Ratio), which is a widely accepted criterion for assessing salinity and the phytotoxicity of irrigation water (Jamei at al., 2024);
3. Analysis of suspended particles (e.g., sand, algae) that can be filtered out;
4. Determination of specific cations and anions that may precipitate when present together, for example, $Ca^{2+}$ and $PO_4^{3-}$, $CO_3^{2-}$ ions;

Detection of heavy metals ability to bioaccumulation (e.g., $Pb^{2+}$, $Cd^{2+}$).

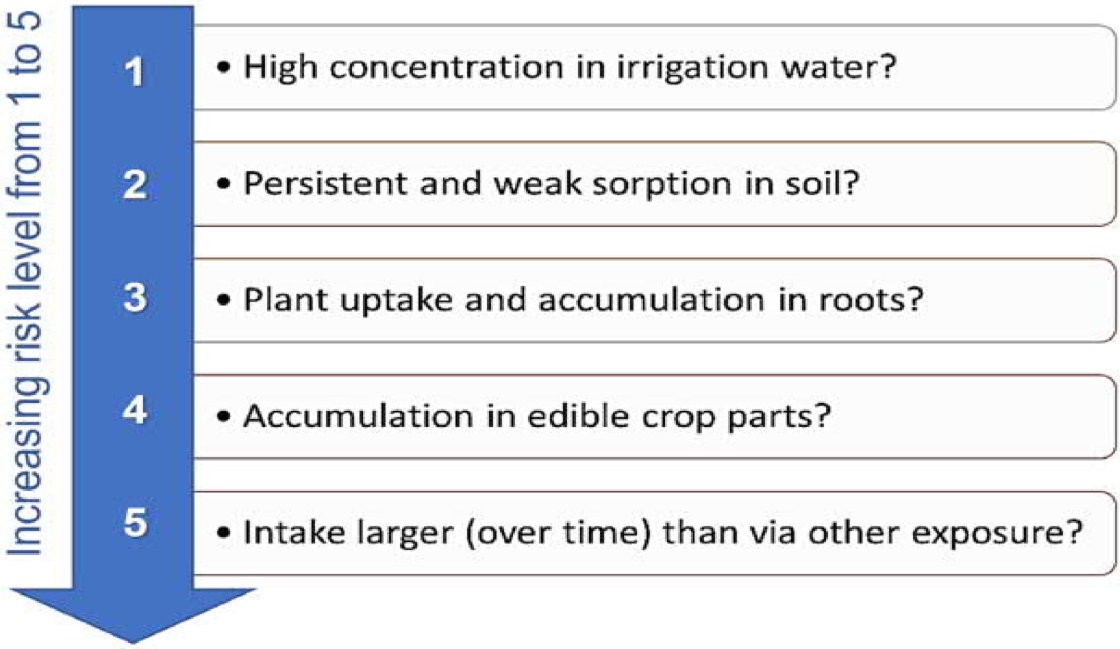


***Fig. 1****. Principles of theoretical assessment of the impact of water composition and properties for irrigation and fertigation (Drechsel at al., 2023, p. 58)*

Based on the test results, designers determine the type of water source suitable for use according to the salt composition and heavy metal content. To remove excess suspended particles, filters of the appropriate type are installed (for example, 120–200 mesh, corresponding to particle sizes greater than 0.125 mm and 0.075 mm, respectively). If the pH level falls outside the optimal range (5.5–7.0) for fertigation, an acidification unit using sulfuric acid is implemented to adjust it to the ideal value, preventing deposit formation.

Designers follow the mnemonic rule “WATER” (see Fig. 2), which should be adhered to when preparing macro- and micronutrient mixtures for fertigation. It ensures consideration of the water phase composition and helps avoid undesirable chemical reactions in the solution that can form insoluble compounds.

In cases where multiple water sources are available for potential use in irrigation or fertigation, the issue arises of assessing their quality comparatively. A direct comparison between a measured parameter and its corresponding maximum permissible concentration (MPC) is not informative in this case since water quality must be evaluated based on a combination of parameters that differ in their physical and chemical nature, units of measurement, and associated risk classes depending on the soil type, crop species, and other factors.


***Fig.2****. WATER Rule for Fertigation Solution Preparation (Granberry et al., 2023)*

Therefore, this study incorporates the principles of integrated water quality assessment specifically for irrigation and fertigation purposes. Foliar application of fertilizers, biostimulants, or nanomaterials through the leaf surface requires special attention to the water quality used as a carrier medium. Unlike root irrigation, where salt load and toxic elements are of primary concern, foliar application depends heavily on the chemical, physicochemical, and biological properties of the water, which affect the stability of formulations, their permeability through stomata and the epidermis, as well as the potential for phytotoxic effects.

Thus, the objective of our study is to evaluate the suitability of local water sources located in the Mohyliv-Podilskyi district of Vinnytsia region based on integrated indicators for irrigation and foliar fertigation through the application of micronutrients in the form of nanoparticles, to promote environmentally safe agricultural practice.

## 2. Objects and Methods of Research.

The research was conducted in the southern part of Vinnytsia region, specifically in the Mohyliv-Podilskyi district, which, in terms of moisture availability and thermal support during the growing season, belongs to the southern warm agro-climatic zone.

The objects of the study were water bodies located in the southern part of the Mohyliv-Podilskyi district (Table 1), precisely surface sources (No. 1, 3), catchment (spring) sources used for drinking purposes with a depth of 3 meters (No. 2, 5), a pond (No. 4), the Kotlubaivka River (No. 6), and the Dniester River before and after the wastewater treatment facilities (No. 7, 8). All these sites are important water supply sources in the studied region; therefore, the sources were numbered according to the priority and accessibility of water for local farms.

***Table 1.*** *Water Sampling Points*

| **Name of Water Source** | **Coordinates; Elevation above sea level** |
|---|---|
| № 1 - Surface water source used by local farms for irrigation and watering, with a 10 m³ storage basin | 48.416509, 27.946925; 206 m |
| № 2 - Captured spring, 3 m deep, formerly used for drinking and cattle watering; has an 18 m³ storage basin | 48.418698, 27.946925; 210 m |
| № 3 – Surface water source used for spraying and irrigation, equipped with a storage basin with a capacity of 7 m³. | 48.420692, 27.946228; 210 m |
| № 4 – Pond used for fish farming and irrigation | 48.420488, 27.961963; 206 m |
| № 5 – Captive spring, 2 meters deep, used for drinking water supply | 48.407162, 27.933393; 213 m |
| № 6 – Kotlubaivka River (Left tributary of the Dniester) | 48.411774, 27.899355; 78 m |
| № 7 – Dniester River before the wastewater treatment facilities of Mohyliv-Podilskyi | 48.395314, 27.880756; 56 m |
| № 8 – Dniester River after the wastewater treatment facilities of Mohyliv-Podilskyi | 48.385218, 27.879106, 55 m |

Water sampling was carried out in accordance with the requirements of DSTU ISO 5667-6:2009. The research was conducted at the certified measurement laboratory for surface water quality and agricultural water use facilities of the Department of Analytical and Bioinorganic Chemistry and Water Quality at the National University of Life and Environmental Sciences of Ukraine (NUBiP), accredited by Ukrmetrteststandart.

The subject of the study was the indicators of water composition, based on which a comprehensive irrigation assessment of water quality can be obtained. The main research methods were analytical – to determine the chemical composition of water samples using standardized procedures; and statistical – to establish the reliability of measurement results and to provide a generalized assessment of water quality.

The composition of water samples during the spring-summer period of 2024 was determined based on the content of macro- and microelements, including the cations $K^{+}$, $Na^{+}$, $Ca^{2+}$, $Mg^{2+}$, $Cu^{2+}$, $Zn^{2+}$, $Cd^{2+}$, $Pb^{2+}$, $NH_4^{+}$, total Fe, and the anions $Cl^{-}$, $SO_4^{2-}$, $NO_3^{-}$, and $HCO_3^{-}$. Water temperature was also studied as an important indicator for assessing the potential impact on irrigated crops.

A comprehensive water quality assessment can be performed using various methodologies (Pusatli at al., 2009). One of the most widely used approaches is the classification developed by the United States Department of Agriculture (USDA). This system is broadly applied worldwide due to its accessibility and the limited number of indicators required for evaluating irrigation-related risks. A key parameter in this classification is the Sodium Adsorption Ratio (SAR), which assesses the risk of soil sodicity resulting from irrigation practices. The SAR (Sodium Adsorption Ratio) value is calculated using the formula:

$$xSAR = \frac{\mathrm{Na}}{\sqrt{\frac{Ca+Mg}{2}}} * (1 - 8{,}4 - pHc(1),$$

where Na, Ca, Mg – are the concentrations of the respective cations in milliequivalents per liter (meq/L); pHc – is the calculated value that functions as a parameter depending on the sum of concentrations of ($Ca^{2+}$ + $Mg^{2+}$) and ($CO_3^{2-}$ + $HCO_3^{-}$), determined by the formula:

$$pH_c = (PK_2\text{-}PK_0)+P(Ca+Mg)+P_{Alk.}(2).$$

Based on the SAR value, irrigation water quality can be classified as follows: less than 3 – excellent quality; 3 to 6 – good; 6 to 12 – fair; 12 to 20 – poor; and 20 or more – very poor.

The method of irrigation water quality assessment was also used, based on the classification of natural waters by Alekin, in the form of an empirical irrigation coefficient A, proposed by Stebler. The formula for calculating the value of A depends on the ratio of the equivalent concentrations of sodium, chlorides, and sulfates in the irrigation water. The procedure for assessing the quality of irrigation water according to this method includes the following sequence: 1. The concentration of water components is converted from mg/dm³ to mmol/dm³; 2. Based on the ratio determined in step 1, the appropriate formula is chosen for calculating A:

Item 1. If $rNa^{+} < rCl^{-}$, that is, if the sodium ion forms only chlorides,

$$A = \frac{288}{5rCl} (3).$$

Item 2. If $rCl^{-} < rNa^{+} < (rCl^{-} + rSO_4^{2-})$, when sodium is present as both chlorides and sulfates,

$$A = \frac{288}{\mathrm{rNa+4rCl}} \ (4).$$

Item 3. If $rNa^{+} > (rCl^{-} + rSO_4^{2-})$, that is, when bicarbonates and carbonates of sodium appear in the solution:

$$\mathrm{A} = \frac{288}{\mathrm{10rNa-5rCl-9}rSO_4}(5),$$

where A is the irrigation coefficient; 288 is a dimensionless empirical coefficient; $rNa^{+}$,

$rCl^-$, and $rSO_4^{2-}$ are the equivalent concentrations of sodium, chloride, and sulfate ions, respectively, expressed in mmol/dm³.

Depending on the irrigation coefficient (A) value, water quality is assessed according to the criteria provided in (Tanji, 1990).

For the comprehensive assessment of water quality, the method of calculating the Water Quality Index (WQI) was used based on the Harrington logistic function. This method allows the integration of studied parameters of water composition and properties for various types of water use (Voitenko L., 2017).

The aggregation of partial desirability values di, determined for each i-th parameter, is performed using the so-called overall desirability function according to the formula:

$$D_{agr.} = \sqrt[n]{\prod_{i=1}^{n} d_i}. (6).$$

The desirability scale belongs to the class of psychophysical scales, transforming a physical parameter into a dimensionless value, such as the function value *d*, interpreted as follows: 1.00–0.80 – very good; 0.80–0.63 – good; 0.63–0.37 – satisfactory; 0.37–0.30 – poor; 0.20–0.00 – very poor. For each parameter, it is necessary to determine the type of constraints—either one-sided or two-sided. Most water quality parameters relevant to irrigation are subject to one-sided constraints, except parameters such as pH, temperature, total mineralization, and SAR (Sodium Adsorption Ratio), which require two-sided evaluation.

***Table 2.*** *Two-sided Constraints of Parameters for Calculating Harrington's Desirability Function in Irrigation Water Quality Assessment*

| **Indicators of Composition and Units of Measurement** | **Values of the Partial Dimensionless Desirability Function $d_i$** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0-0.2 Very poor | 0.2-0.37 poor | 0.37-0.63 Satisfactory | 0.63-0.8 Good | 0.8 – 1 Very good e | 1 – 0.8 Very good | 0.8 – 0.63 Good | 0.63 – 0.37 Satisfactory | 0.37 – 0.2 Poor | 0.2 – 0 Very poor |
| Dry residue (total mineralization) – mg/L | 0-80 | 80-100 | 100-150 | 150-320 | 320-400 | 400-480 | 480-1000 | 1000-3500 | 3500-5000 | 5000-10000 |
| Temperature – °C | 0-8 | 8-10 | 10-12 | 12-15 | 16-18 | 18-22 | 22-25 | 25-29 | 29-32 | 32-45 |
| Hydrogen index (pH) – pH units | 4.5-5 | 5-5.4 | 5.5-6 | 6-6.5 | 6.5-6.8 | 6.8-7.2 | 7.2-7.5 | 7.5-8.5 | 8.5-9 | 9-10.5 |
| SAR (Sodium Adsorption Ratio) – *dimensionless* | 0.1-0.8 | 0.9-1.2 | 1.2-1.5 | 1.5-2 | 2-2.5 | 2.5-3 | 3-6 | 6-12 | 12-20 | 20-40 |

***Table 3.*** *One-sided parameter constraints for calculating Harrington's desirability function in the assessment of irrigation water quality*

| **Indicators of composition, units of measurement** | **Values of the Partial Dimensionless Desirability Function $d_i$** | | | | |
|---|---|---|---|---|---|
| | 1 – 0.8<br>Very good | 0.8 – 0.63<br>Good | 0.63 – 0.37<br>Satisfactory | 0.37 – 0.2<br>Poor | 0.2 – 0<br>Very poor |
| Irrigation coefficient by Stebler, A | 25-18 | 18-6 | 6-4 | 4-1.2 | 1.2-0.2 |
| Permanganate oxidizability, mg $O_2$/L | 0-10 | 10-15 | 15-30 | 30-50 | 50-200 |
| Turbidity, NTU | 0-5 | 5-10 | 10-50 | 50-200 | 200-5000 |
| Nitrate nitrogen, N-$NO_3$, mg N/L | 0-4 | 5-15 | 16-20 | 21-30 | 30-1000 |
| Total iron, Fe(total), mg/L | 0-0.05 | 0.05-0.2 | 0.2-1 | 1-5 | 5-20 |

Tables 2 and 3 present examples of generalized water quality assessment scales for irrigation, applied to indicators with two-sided desirability constraints (i.e., those that have an optimal value range) and one-sided constraints (evaluated according to the "the lower, the better" principle).

For the determination of the values of these ranges, the complete list of regulatory and methodological documents in the field of water quality standards for irrigation was used.

## 3. Research Results

For the comprehensive analysis of the studied water sources for agricultural use during 2022–2024, the indicators of pH, total mineralization, and temperature were used, as presented in the previous article (Chobotar, 2024).

Additionally, for the comprehensive assessment in the next stage of the research, the content of cations and anions in the water sources was analyzed. The results of water quality from various water supply sources during the spring–summer period of 2022–2024 for the studied sites are presented in Fig. 3.

Based on the presented data, the chemical composition of the water indicates varying levels of suitability for irrigation, and the difficulty of assessment based on individual parameters depends on the content of the main cations and anions. Therefore, the approaches to integrated water quality assessment for irrigation and fertigation purposes are described below.

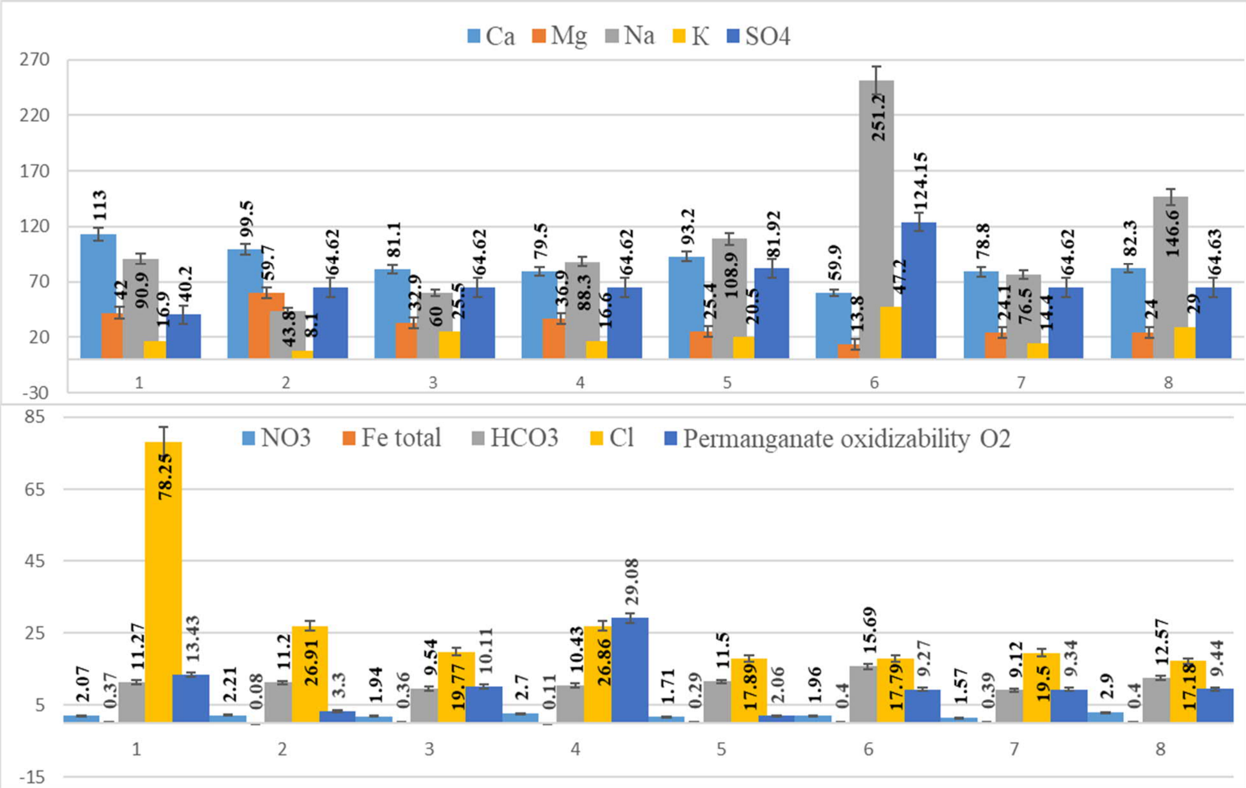


*Fig. 3 Average concentrations of cations and anions in the studied water sources during the spring–summer period of 2022–2024, mg/dm³*

At the next stage, the content of heavy metals, which pose a danger to human health and may accumulate in agricultural products, was analyzed. The data are presented in Fig. 4.

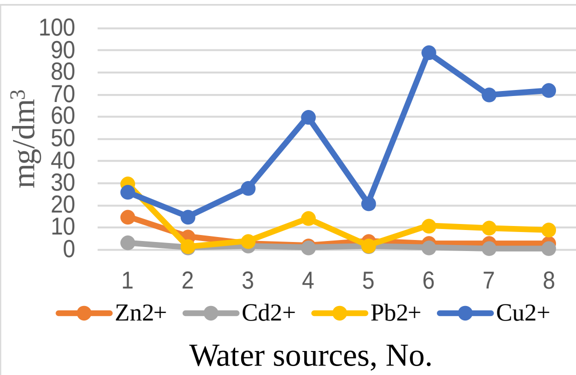


***Fig. 4*** *Content of heavy (transition)metals in water sources, mg/dm³*

As can be seen, the highest concentrations of zinc, cadmium, and lead were found in source number 1, which may indicate the influence of economic activity and the use of chemicals on the water body. The highest copper content was observed in source No. 6.

Traditional water quality assessment methods are based on comparing experimentally determined parameter values with existing guidelines.

However, integral water quality indicators represent an approach that minimizes the volume of data and significantly simplifies the expression of water quality status. The main advantage of integral water quality assessment is the effective generalization of individual criteria to evaluate the suitability of using a water source in a specific sector.

In irrigation practice in the USA and other countries, irrigation water quality is assessed based on the Sodium Adsorption Ratio (SAR). This indicator is used to evaluate the risk of soil sodicity. The research results are presented in Fig. 5:

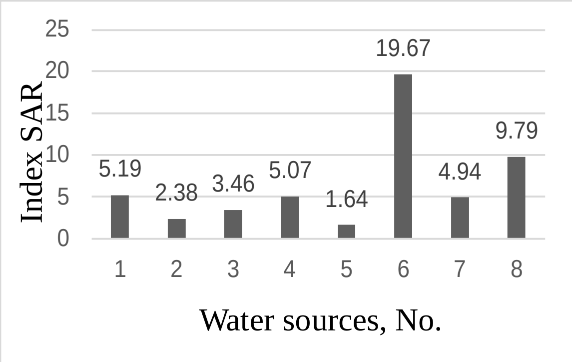


***Fig. 5*** *SAR index during the spring-summer period of 2022–2024.*

Thus, based on the research results, water samples No. 2 and 5 are classified as sources with excellent water quality, making them the most promising for irrigation use in the studied area (SAR ≤ 3). The SAR values of sources 1, 3, 4, 7, and 8 indicate that the water from these samples is suitable for irrigation. According to the results, water from the Kotlubaivka River (No. 6) cannot be used for irrigation in local farms due to the risk of soil salinization. A detailed analysis of the percentage of salts (Chobotar, 2024) suggests a risk of sodium bicarbonate salinization, making this water source unsuitable for irrigation.

At the next stage, the empirical irrigation coefficient A was calculated. The data are presented in Fig. 6.

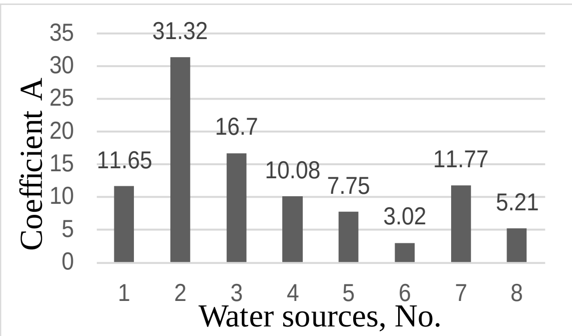


***Fig. 6*** *Indicators of the irrigation coefficient A for the spring-summer period of 2022–2024.*

According to the irrigation coefficient A indicators, all sources are suitable for irrigation without restrictions and fall into the categories of "Good" quality (source No. 2) and "Satisfactory" (sources No. 1, 3, 4, 5, 7). Exceptions are sources No. 6 and 8, as the values of the irrigation coefficient characterize the water quality as "Unsatisfactory".

The final stage of assessing water quality for irrigation was the calculation of the comprehensive Water Quality Index, which considers all the above-mentioned evaluation approaches. The Harrington index calculation data are presented in Fig. 7.

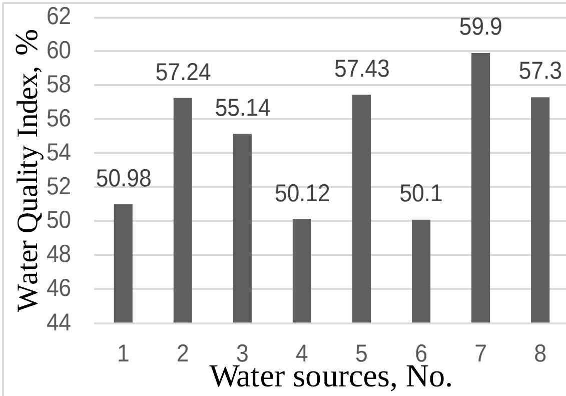


***Fig. 7*** *Water Quality Index (%) for irrigation during the spring-summer period of 2022–2024.*

The Water Quality Index (WQI) calculations showed that the most promising irrigation source, considering the key parameters specific to irrigation water, is source No. 7 (the Dniester River upstream of the treatment facilities), with a WQI of 59.9 %, classifying it as “good” for irrigation. As alternatives, surface water sources No. 2 and 5 may also be considered suitable for irrigation, with WQI values of 57.24 % and 57.43 % respectively. These values are close to the “good” threshold but still fall under the “satisfactory” category for irrigation purposes. Other sources can also be classified as “satisfactory,” with the lowest WQI observed in sources No. 1, 4, and 6, each scoring around 50 %.

## 4. Conclusions

Based on the obtained research data for the period 2022–2024, a comprehensive assessment of the quality of local water sources for irrigation and fertigation was conducted using both traditional chemical indicators and integral evaluation methodologies. The analyzed water samples demonstrated considerable variability in the concentration of key cations ($Ca^{2+}$, $Mg^{2+}$, $Na^{+}$, $K^{+}$), anions ($Cl^{-}$, $SO_4^{2-}$, $NO_3^{-}$, $HCO_3^{-}$), and physicochemical properties (pH, temperature, mineralization, and permanganate oxidizability), as well as in the levels of heavy metals ($Cd^{2+}$, $Pb^{2+}$, $Zn^{2+}$, $Cu^{2+}$, $Fe^{2+}$), which are essential for determining the suitability of the water for agricultural use.

The results of the SAR (Sodium Adsorption Ratio) analysis showed that sources No. 2 and 5 exhibited excellent quality (SAR $\leq$ 3), indicating minimal risk of soil sodification and confirming their high potential for irrigation use. Other sources (No. 1, 3, 4, 7, and 8) were found to be suitable with certain limitations, while water from source No. 6 (Kotlubaivka River) was deemed unsuitable due to excessive sodium content, which poses a high risk of sodium bicarbonate salinization and associated soil degradation.

The assessment based on the empirical irrigation coefficient A revealed that most sources fall into “Good” or “Satisfactory” categories, with the exception of sources No. 6 and 8, which were classified as “Unsatisfactory” due to disproportionate levels of $Na^{+}$, $Cl^{-}$, and $SO_4^{2-}$. These results confirm the importance of cation-anion balance in evaluating irrigation water quality, especially in relation to salinity and long-term soil health.

The comprehensive Water Quality Index (WQI), calculated using the Harrington function, integrated all examined chemical parameters into a single synthetic indicator of usability. The highest WQI score was recorded for source No. 7 (Dniester River upstream of the treatment plant), reaching 59.9 %, which categorizes it as “Good.” Sources No. 2 and 5 closely followed with values of 57.24 % and 57.43 %, placing them at the upper end of the “Satisfactory” range and indicating their potential as alternatives for sustainable irrigation.

Overall, the study confirms that while several sources meet minimum standards for irrigation water, only a few can be considered optimal without additional treatment. This highlights the need for a tailored water management strategy that incorporates not only chemical composition but also ecological safety and technical feasibility. The findings provide a solid foundation for informed decision-making in irrigation planning, fertigation system design, and environmental risk mitigation in the Mohyliv-Podilskyi district and similar agroecological regions.

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# КРИТЕРІЇ ЯКОСТІ ПРИРОДНИХ ВОД: ХІМІЧНІ АСПЕКТИ ВИКОРИСТАННЯ В ЗРОШЕННІ ТА ФЕРТИГАЦІЇ (НА ПРИКЛАДІ МОГИЛІВ-ПОДІЛЬСЬКОГО РАЙОНУ ВІННИЦЬКОЇ ОБЛАСТІ)

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*Проведено дослідження водних об'єктів Могилів-Подільського району Вінницької області з метою оцінки придатності води для зрошення. У дослідженні охоплено місцеві джерела: поверхневі води, каптажні системи, ставок, а також річки Котлубаївка і Дністер (до та після очисних споруд). Аналіз проводився у сертифікованій лабораторії Національного університету біоресурсів і природокористування України. Вивчено хімічний склад води за вмістом макро- і мікроелементів, а також якісні показники (pH, мінералізація, температура). Застосовано аналітичні та статистичні методи, а також обчислено індекси якості води: SAR (натрієво-адсорбційне співвідношення), іригаційний коефіцієнт A за Стеблером та індекс якості води (ІЯВ) за функцією Харрінгтона. Виявлено значні коливання концентрацій катіонів ($Na^{+}$, $Ca^{2+}$, $Mg^{2+}$), аніонів ($Cl^{-}$, $SO_4^{2-}$, $NO_3^{-}$, $HCO_3^{-}$) і важких металів ($Cd^{2+}$, $Zn^{2+}$, $Pb^{2+}$, $Cu^{2+}$, $Fe^{2+}$), деякі з яких наближались до гранично допустимих концентрацій. За індексом SAR найвищу якість продемонстрували джерела № 2 і 5, а джерело № 6 було визнано непридатним через ризик засолення ґрунтів. Іригаційний коефіцієнт A підтвердив добру та задовільну якість більшості джерел, крім № 6 і 8. За індексом Харрінгтона найкращим джерелом виявилась річка Дністер (№ 7) до очисних споруд (59,9 %), альтернативними — джерела № 2 і 5. Отримані результати підтверджують доцільність використання інтегральних підходів до оцінювання придатності води для зрошення та фертигації з урахуванням хімічного складу, екологічних ризиків і технічної доцільності. Дані дослідження є основою для подальших заходів зі сталого водокористування та екологічного моніторингу.*

***Ключові слова:*** *індекс Харрінгтона, зрошення, природні води, якість води, водокористування.*