

# Justification for the necessity of regional environmental quality standards for water bodies: the Ilek River basin, Kazakhstan

Bauyrzhan Kapsalyamov, Gulzat Zholmuratova\*

L.N. Gumilyov Eurasian National University, Astana, Kazakhstan;  
[kapsalyamov\\_ba@enu.kz](mailto:kapsalyamov_ba@enu.kz), [zholmuratova.enu@mail.ru](mailto:zholmuratova.enu@mail.ru)

\*Correspondence: [zholmuratova.enu@mail.ru](mailto:zholmuratova.enu@mail.ru)

**Abstract.** In arid and semi-arid regions, unified national water quality standards do not always ensure effective regulation of anthropogenic pressure on surface waters and may lead to inconsistencies in permissible discharge standards (PDS) calculations. This study substantiates the need for regional environmental quality standards using the Ilek River basin, one of the most impacted transboundary systems in Western Kazakhstan, as a case study.

The research applies a mass-balance approach to PDS calculation and evaluates the influence of background pollutant concentrations and hydrological variability on regulatory outcomes. Boron and hexavalent chromium (Cr(VI)), typical for the natural and technogenic conditions of the basin, were selected as key indicator substances. Long-term hydrochemical and hydrological data were analyzed to assess spatial and temporal variability under different discharge scenarios.

The results show that elevated background concentrations, especially of boron, significantly affect calculated PDS values. Under such conditions, unified standards may produce negative PDS values, formally indicating the impossibility of discharge regulation regardless of actual anthropogenic input. This reveals the limitations of uniform regulatory approaches in hydrologically variable and environmentally heterogeneous regions.

The findings demonstrate that regionalized environmental quality standards, accounting for climatic conditions, background levels, hydrological regime, and ecosystem stability, are essential for scientifically sound discharge regulation and sustainable water resource management.

The practical significance of the study lies in the applicability of the proposed approach for improving environmental regulation and water management practices.

**Keywords:** environmental quality standards; regionalization; permissible discharge standards; boron; hexavalent chromium (Cr(VI)); arid regions; Ilek River.

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## 1. Introduction

Environmental regulation of water bodies in the Republic of Kazakhstan has historically been based on the application of unified maximum permissible concentrations (MPCs) of pollutants, developed primarily within a sanitary–hygienic framework. These standards are

aimed at protecting human health and, as a rule, do not take into account regional natural and climatic conditions, hydrological variability, or the geochemical characteristics of river basins, which are especially pronounced in arid and semi-arid regions of Central Asia (Chapman, 1996; Vörösmarty et al., 2010).

In practical water protection management, MPC values are used as the basic criterion for calculating permissible discharge standards (PDS), which represent one of the key instruments for regulating anthropogenic pressure on water bodies. According to the current methodology, PDS is defined as the maximum allowable mass of a pollutant that may enter a water body without violating established water quality standards at the downstream control section (United Nations Economic Commission for Europe, 2019; World Health Organization, 2017). In simplified form, the PDS calculation can be expressed as:

$$PDS = (C_{perm} - C_{bg}) \cdot Q \cdot K \quad (1)$$

$C_{perm}$  - is the permissible concentration of a pollutant in the water body (water quality standard),

$C_{bg}$  - is the background concentration upstream,

$Q$  - is the river discharge at the control section,

$K$  - is the dilution and transformation coefficient.

The key parameter in this equation is  $C_{perm}$ , since its value directly determines the possibility or impossibility of regulated wastewater discharge.

In the baseline approximation,  $K = 1$  was assumed.

### 1.1. Problems associated with the use of unified MPCs in PDS calculations

In the river basins of Kazakhstan, situations frequently occur in which background concentrations of certain pollutants exceed established MPC values. This is particularly typical for substances with a pronounced natural or natural–technogenic origin, such as boron, sulfates, chlorides, and, in some areas, chromium compounds (United Nations Environment Programme, 2019; World Bank, 2021; Asian Development Bank, 2020). In such cases, the following condition is observed:  $C_{bg} \geq C_{perm}$

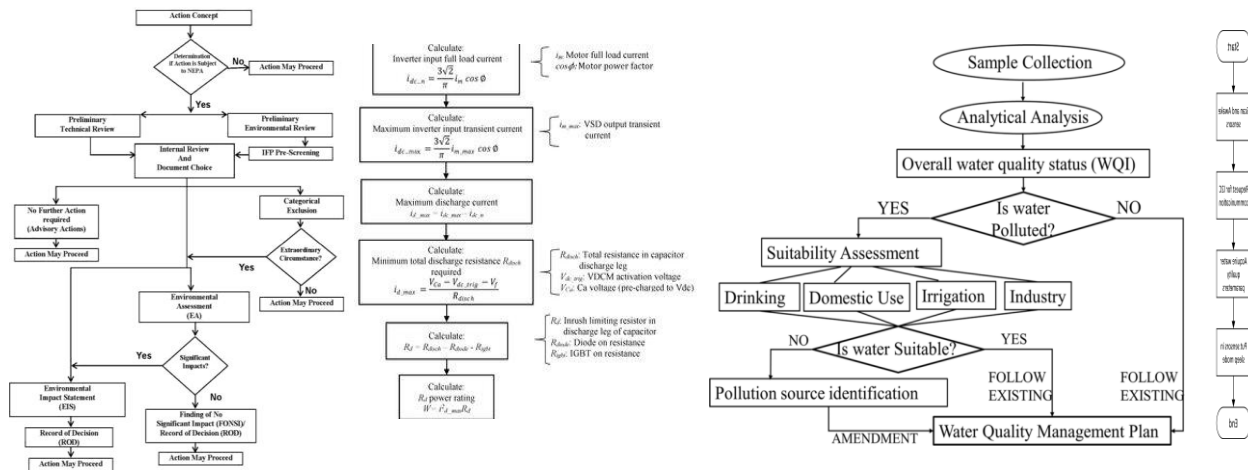
which results in zero or negative PDS values:  $PDS \leq 0$

From a management perspective, this outcome implies a formal prohibition of discharge regardless of the actual presence or absence of an anthropogenic pollution source. As a result, the PDS mechanism loses its primary function - regulation of incremental anthropogenic load - and is transformed into an instrument of formal non-compliance.

Figure 1 illustrates the formation of a “management deadlock” in PDS calculations:

When the condition  $C_{bg} \geq C_{perm}$  is fulfilled, PDS calculations yield negative values, making normative regulation of anthropogenic pressure on the water body practically impossible.

$MPC < \text{background concentration} \rightarrow \text{negative PDS} \rightarrow \text{impossibility of regulatory control}$



**Figure 1.** Conceptual scheme of interactions between hydrological regime, water quality, and discharge regulation (Source: authors ’own elaboration)

1.2. Arid conditions as a factor of systematic errors in water quality regulation

A significant part of the territory of Kazakhstan is characterized by:

- high evaporation rates,
- prolonged low-flow periods,
- concentration of dissolved substances,
- a substantial contribution of groundwater inflow and saline geological formations (Falkenmark and Rockström, 2004; Vörösmarty et al., 2010; World Bank, 2021).

Under such conditions, unified MPC values that are not adjusted to regional background levels cease to reflect actual ecological risks. This problem is especially evident in the Ilek River basin - a transboundary water body subjected to long-term technogenic impact and characterized by complex natural and geochemical conditions (Berdenov et al., 2022; Utepov et al., 2021; Dyussebayeva et al., 2023; Solodova et al., 2021; RSE Kazhydromet, 2024).

A comparison of unified water quality standards and background concentrations for priority pollutants (boron, Cr(VI), mineralization, sulfates, and chlorides) in the Ilek River basin is presented in Table 1.

**Table 1.** Comparison of unified water quality standards and background concentrations in the Ilek River basin

Parameter	Range of background concentrations, (Cbg), mg/L	Unified water quality standard (MPC), mg/L	Relationship between Cbg and MPC	Environmental and management interpretation
Boron (B)	0.6 – 1.2	0.5	$C_{bg} \geq MPC$	Background concentrations frequently exceed the MPC, resulting in negative PDS values and a formal prohibition of discharges

Hexavalent chromium (Cr(VI))	0.0005 – 0.003	0.01	Cbg < MPC	PDS can be formally calculated; however, migration forms and redox transformation Cr(VI) → Cr(III) are not considered
Total mineralization (total dissolved solids)	800 – 1500	1000	Cbg ≈ MPC	High natural mineralization of arid rivers leads to recurrent borderline exceedances
Sulfates (SO <sub>4</sub> <sup>2-</sup> )	250 – 600	500	Cbg ≤/≥MPC	Pronounced seasonal variability; concentrations increase during low-flow periods

Note. The ranges of background concentrations presented in the table are based on published hydrochemical monitoring data for the Ilek River basin and adjacent arid territories of Western Kazakhstan. Unified water quality standards (MPCs) are given in accordance with the currently applicable sanitary–hygienic and water protection regulations of the Republic of Kazakhstan. The relationship between background concentrations Cbg and MPC values determines the sign and magnitude of the concentration difference  $\Delta C = C_{perm} - C_{bg}$ , which is used in the calculation of permissible discharge standards (PDS).

1.3. Inconsistency of the sanitary-based approach with ecosystem requirements

International practice in environmental regulation over recent decades demonstrates a gradual transition from the sanitary–hygienic concept toward ecosystem-based and risk-oriented approaches. Within this framework, Environmental Quality Standards (EQS):

- are established with consideration of the sensitivity of aquatic organisms;
- are adapted to regional environmental conditions;

are used as target indicators of ecosystem status (European Commission, 2000; European Environment Agency, 2018; U.S. Environmental Protection Agency, 2016; United Nations Environment Programme, 2018; Hering et al., 2010).

In contrast, the application of unified maximum permissible concentrations (MPCs) without regional adaptation within the permissible discharge standards (PDS) system:

- distorts the assessment of anthropogenic contributions;
- complicates the implementation of environmental protection measures;
- creates conflicts between regulatory authorities and water users;
- reduces confidence in environmental monitoring results.

A comparison of water quality regulation concepts - MPCs (sanitary-based approach) versus EQS (ecosystem-based approach) - is presented in Table 2.

**Table 2.** Comparison of the sanitary–hygienic water quality regulation concept (MPC) and the ecosystem-based approach using Environmental Quality Standards (EQS)

MPC (sanitary-based approach)	EQS (ecosystem-based approach)
Objective: Protection of human health	Objective: Conservation of aquatic ecosystems
Regulatory object: Water as a resource	Regulatory object: Aquatic ecosystem
Primary criterion: Unified concentration values (without regional adaptation)	Primary criterion: Ecological risk and sensitivity of aquatic biota

Consideration of background concentrations: Formal or absent	Consideration of background concentrations: Mandatory
Hydrology and climate: Practically not considered	Hydrology and climate: Considered (seasonality, aridity)
Link with PDS: PDS values may be $\leq 0$	Link with PDS: PDS values are controllable and achievable
Management outcome: Formal control and conflicts with water users	Management outcome: Effective load management and reduction of ecological risk

It is shown that the use of unified maximum permissible concentrations (MPCs) without consideration of regional natural conditions and background concentrations limits the possibility of correct calculation of permissible discharge standards (PDS). In contrast, the ecosystem-based approach ensures the controllability of anthropogenic loads and establishes a direct link between water quality regulation and ecological risk.

The comparative analysis of water quality regulation concepts (Table 2) demonstrates that the transition from the sanitary–hygienic MPC model to ecosystem-oriented Environmental Quality Standards (EQS) represents a key prerequisite for eliminating methodological inconsistencies in PDS calculations in arid river basins.

In modern environmental regulation systems, large industrial enterprises are increasingly regulated through integrated environmental permits based on Best Available Techniques (BAT). However, even under BAT-based regulation, the calculation of permissible discharge standards remains dependent on the applied environmental quality standards. If unified standards do not reflect regional natural background concentrations, regulatory inconsistencies may arise even when advanced treatment technologies are applied. Therefore, the development of regional environmental quality standards may complement existing regulatory instruments and improve the practical implementation of integrated environmental permitting systems. In recent years, the environmental regulatory framework in the Republic of Kazakhstan has been undergoing significant modernization. In accordance with the new Environmental Code of the Republic of Kazakhstan (2021), the Ministry of Ecology and Natural Resources has initiated the development of environmental quality standards for environmental components, including surface water bodies. In addition, environmental regulation for Category I enterprises is currently implemented through integrated environmental permits based on the principles of Best Available Techniques (BAT). These regulatory developments highlight the growing importance of regionally adapted environmental quality standards in Kazakhstan.

Scientific novelty of the study lies in the methodological justification of the necessity of regional environmental quality standards for water bodies in arid regions. Unlike traditional regulatory approaches based on unified maximum permissible concentrations, the proposed framework demonstrates how elevated natural background concentrations may lead to negative permissible discharge standards and create a regulatory management deadlock. The study shows that the regionalization of environmental quality standards allows the restoration of the physical and managerial meaning of permissible discharge calculations under conditions of hydrological variability and natural geochemical specificity of river basins.

#### 1.4. Aim and objectives of the study

The aim of this study is to substantiate the necessity of developing regional environmental water quality standards using the Ilek River basin as a case study, as a tool for ensuring the correct calculation of permissible discharge standards and sustainable water resource management.

To achieve this aim, the following objectives were addressed:

1. To analyze the influence of background pollutant concentrations and hydrological variability on permissible discharge standard calculations.

2. To perform demonstrative PDS calculations for boron and hexavalent chromium under different river discharge scenarios.
3. To identify methodological limitations associated with the use of unified water quality standards.
4. To justify the advantages of regional environmental quality standards from ecological and management perspectives.

## 2. Materials and Methods

### 2.1. Study area and conceptual framework

The object of the study is the Ilek River basin (Republic of Kazakhstan), for which unified environmental water quality standards without regional adaptation are traditionally applied in water protection practice. The methodological basis of this study is to demonstrate how the selection of a unified water quality standard ( $C_{perm}$ ) in comparison with a regionally adapted standard affects the results of permissible discharge standard (PDS) calculations under conditions of elevated background pollutant concentrations ( $C_{bg}$ )

The calculations were performed using a mass-balance approach for a control section located downstream of the discharge point. This approach corresponds to the commonly applied practice of discharge regulation and surface water quality management.

### 2.2. Input parameters and river discharge scenarios

To account for hydrological variability typical of steppe and arid rivers, three river discharge scenarios were considered in the calculations:

$$Q \in \{Q_{low}, Q_{avg}, Q_{high}\} = \{3, 5, 7\} \text{ m}^3/\text{s} \quad (2)$$

The following substances were selected as priority pollutants:

boron (B) - an element with a pronounced natural and natural–technogenic origin in the Ilek River basin;

hexavalent chromium (Cr(VI)) — a highly toxic pollutant characteristic of technogenically impacted areas.

The selection of these substances is justified by their environmental significance and their frequent use as indicator pollutants in regional water quality assessments.

### 2.3. Method for calculating permissible discharge standards (PDS)

#### 2.3.1. Concentration difference as a determining parameter

The main calculation parameter in determining permissible discharge standards is the difference between the permissible and background concentrations:

$$\Delta C = C_{perm} - C_{bg} \quad (3)$$

where  $C_{perm}$  - is the permissible concentration of a pollutant in the water body (either a unified or a regionally adapted water quality standard);  $C_{bg}$  - is the background concentration upstream of the discharge point.

When the condition  $\Delta C < 0$  is satisfied, the PDS calculation yields negative values, indicating the impossibility of normative discharge regulation within the framework of the applied water quality standard.

#### 2.3.2. Mass-based form of PDS calculation

Under the assumption of complete mixing of wastewater and river water at the control section and in the absence of explicit consideration of pollutant transformation processes, the basic formula for calculating permissible discharge standards is expressed as:

$$\text{PDS} = \Delta C \cdot Q \cdot K \quad (4)$$

Q is the river discharge at the control section (m<sup>3</sup>/s); K - is an integrated coefficient accounting for dilution, transformation, and self-purification processes.

In the present study, a baseline approximation with K = 1 was adopted. Considering that 1 mg/L is equivalent to 1 g/m<sup>3</sup>, the daily permissible discharge standard was calculated using the following expression:

$$\text{PDS}_{\text{day}} \text{ (kg day}^{-1}\text{)} = 86.4 \cdot (C_{\text{perm}} - C_{\text{bg}}) \cdot Q \cdot K \quad (5)$$

#### 2.4. Assumptions and limitations of the method

Since the objective of this study is to provide a methodological justification for the necessity of regional water quality standards, the following assumptions were adopted in the calculations:

- complete mixing of wastewater and river water at the control section (single-box model);
- stationary hydrological conditions for each discharge scenario;
- absence of explicit consideration of pollutant transformation and decay processes (K = 1);
- background concentrations represent natural and natural–technogenic conditions upstream of the discharge point;
- for hexavalent chromium, redox transformations (Cr(VI) → Cr(III)) were not considered and are regarded as a subject for further research.

The adopted assumptions are sufficient to identify the fundamental dependence of permissible discharge standards on the relationship between permissible (C<sub>perm</sub>) and background (C<sub>bg</sub>) concentrations.

It should also be noted that the calculations presented in this study are conceptual and intended to demonstrate the regulatory implications of the relationship between background concentrations and applied water quality standards. The model does not include detailed hydrodynamic processes, pollutant transformation kinetics, or spatial heterogeneity of river systems. These aspects may be considered in future studies using more complex hydrochemical and ecological modeling approaches.

#### 2.5. Input data table

Table 3 presents the input parameters and boundary conditions applied in the PDS calculation framework.

**Table 3.** Input parameters used for permissible discharge standard (PDS) calculations in the Ilek River basin

Parameter	Symbol	Unit	Value	Notes
River discharge (low flow)	$Q_{\text{low}}$	m <sup>3</sup> /s	3	Low-flow scenario
River discharge (average)	$Q_{\text{avg}}$	m <sup>3</sup> /s	5	Baseline scenario
River discharge (high)	$Q_{\text{high}}$	m <sup>3</sup> /s	7	Conditionally high-flow scenario
Background boron concentration	$C_{\text{bg}}(B)$	mg/L	0.8	Elevated regional background
Unified boron standard	$C_{\text{perm}}(B)$	mg/L	0.5	MPC

Regional boron standard	$C_{perm,reg}(B)$	mg/L	1.0	Demonstrative value
Background Cr(VI) concentration	$C_{bg}(Cr(VI))$	mg/L	0.001	Low background level

2.6. Output calculation parameters

For each pollutant and for each river discharge scenario, the following parameters were determined:

- concentration difference,  $\Delta C$  (mg/L);
- daily permissible discharge standard, PDS<sub>day</sub> (kg/day);
- sign and magnitude of PDS values as indicators of the validity of normative discharge regulation.

3. Results

3.1. Results of permissible discharge standard (PDS) calculations

Based on the mass-balance equation for permissible discharge standard calculation:

$$PDS_{day} \text{ (kg day}^{-1}\text{)} = 86.4 \cdot (C_{perm} - C_{bg}) \cdot Q \cdot K \tag{6}$$

Daily permissible discharge standards were calculated for boron (B) and hexavalent chromium (Cr(VI)) under three river discharge scenarios ( $Q=3, 5, 7 \text{ m}^3/\text{s}$ ).

The calculations were performed using a transformation coefficient of  $K = 1$ , which corresponds to the baseline assumption of complete mixing and the absence of explicit consideration of pollutant transformation processes.

The calculated PDS values for the considered discharge scenarios are summarized in Table 4.

**Table 4.** Results of permissible discharge standard (PDS) calculations for priority pollutants in the Ilek River basin

Pollutant	Water quality standard	Q, m <sup>3</sup> /s	$\Delta C=C_{perm}- C_{bg}$ , mg/L	PDS <sub>day</sub> , kg/day
Boron (B)	Unified (MPC = 0.5 mg/L)	3	-0.3	-77.76
		5	-0.3	-129.60
		7	-0.3	-181.44
Boron (B)	Regional (1.0 mg/L)	3	+0.2	51.84
		5	+0.2	86.40
		7	+0.2	120.96
Cr(VI)	Unified (0.01 mg/L)	3	+0.009	2.33
		5	+0.009	3.89
		7	+0.009	5.44

3.2. Interpretation of calculation results

The calculation results demonstrate fundamentally different PDS behavior for the analyzed pollutants depending on the relationship between background concentrations and water quality standards.

For boron, when the unified water quality standard (MPC = 0.5 mg/L) is applied, the concentration difference  $\Delta C$  takes negative values under all river discharge scenarios. This leads to



so-called «management deadlock» zone within the system of environmental regulation of water bodies. This zone arises when background pollutant concentrations exceed unified water quality standards (MPCs), resulting in the condition  $C_{bg} > C_{perm}$  and, consequently, in negative PDS values.

As shown in Figure 1, under such conditions, the calculation of permissible discharge standards loses its managerial meaning: instead of limiting the incremental anthropogenic load, a formal prohibition of discharges is imposed regardless of the actual contribution of the water user. The negative PDS<sub>day</sub> values obtained for boron across the entire range of river discharge scenarios ( $Q = 3\text{--}7 \text{ m}^3/\text{s}$ ) demonstrate that an increase in river water availability does not remove the system from the management deadlock zone, but only increases the absolute magnitude of the negative calculated standard.

Thus, the hydrological factor alone is unable to compensate for the methodological inconsistency between unified water quality standards and the regional natural–geochemical background (Chapman, 1996; Meybeck and Helmer, 1989; Falkenmark and Rockström, 2004).

#### 4.2. Relationship between the management deadlock zone and hydrological variability

The conceptual scheme presented in Figure 2 makes it possible to consider the management deadlock zone within a broader context of interactions between the hydrological regime, water quality, and the environmental management system. Hydrological variability - expressed through low-flow, average, and high-flow conditions - characteristic of arid and semi-arid regions, directly affects the dilution capacity of river systems and the magnitude of permissible pollutant loads (Vörösmarty et al., 2010; United Nations Economic Commission for Europe, 2019; World Health Organization, 2017). However, as demonstrated by the calculation results, this mechanism is not fully realized when unified MPC values are applied.

Under conditions of elevated background concentrations - typical for steppe rivers with intense evaporation, significant groundwater contribution, and specific geochemical characteristics of catchments - the regulation system becomes insensitive to changes in river discharge. This contradicts the fundamental logic of water resources management, according to which an increase in water availability should be accompanied by an increase in permissible anthropogenic load under unchanged ecological risk (United Nations Environment Programme, 2019; World Bank, 2021).

Thus, the management deadlock zone represents a mismatch between hydrological reality and the normative model used for permissible discharge standard calculations.

Similar challenges associated with elevated background concentrations and water quality regulation have also been reported in other arid and semi-arid river systems worldwide. Studies of rivers in Central Asia, Australia, and parts of the western United States demonstrate that natural mineralization and geochemical background often exceed unified regulatory thresholds. These examples further support the necessity of regional environmental quality standards adapted to local hydrochemical conditions.

#### 4.3. Management implications of negative PDS values

From a management perspective, negative permissible discharge standard values indicate:

- the impossibility of establishing an allowable discharge limit;
- the absence of differentiation between natural background and anthropogenic contributions;
- the formalization of environmental requirements without linkage to actual ecological effects.

Within this zone, environmental regulation is transformed from a water quality management instrument into a mechanism for recording normative non-compliance. This leads to an increase in conflicts between regulatory authorities and water users, as well as a decline in confidence in monitoring results and calculation procedures (Asian Development Bank, 2020; Berdenov et al., 2022).

#### *4.4. Role of regional water quality standards in overcoming the management deadlock*

A comparison of permissible discharge standard calculations for boron using unified and regionally adapted water quality standards (Table 4) demonstrates that the regionalization of standards allows the system to be removed from the management deadlock zone. When a regional standard ( $C_{perm, reg}$ ) is applied, the concentration difference  $\Delta C$  becomes positive, and PDS values exhibit a linear dependence on river discharge. This behavior corresponds to the mass-balance logic of the calculation and restores the physical meaning of discharge regulation.

This result is consistent with international practice in the application of Environmental Quality Standards (EQS), within which standards are established with consideration of background concentrations, ecosystem sensitivity, and hydrological variability (Singh, 1995; U.S. Environmental Protection Agency, 1991). In this context, regional environmental water quality standards may be regarded as a key element in the transition from a sanitary–hygienic regulatory model to ecosystem-based and risk-oriented water resources management.

From an ecosystem perspective, the use of regionally adapted environmental quality standards is also important for maintaining the stability of aquatic ecosystems in arid river basins. Elevated background concentrations of certain elements, such as boron or mineralization components, may represent natural geochemical conditions rather than anthropogenic pollution. In such cases, environmental regulation based solely on unified sanitary standards may incorrectly interpret natural hydrochemical features as ecological degradation. Therefore, ecosystem-oriented standards that consider natural background levels are essential for balanced environmental management in arid regions.

#### *4.5. Summary of the Discussion*

Thus, the management deadlock zone observed in permissible discharge standard calculations is a consequence of methodological inconsistency between unified water quality standards and regional natural conditions, rather than an indicator of actual ecological degradation. Elimination of this zone is possible only through the implementation of regional environmental water quality standards that ensure consistency between the hydrological regime, background concentrations, and regulated anthropogenic loads within an integrated environmental regulation framework.

### **5. Conclusion**

The conducted analysis demonstrated that the application of unified water quality standards in permissible discharge standard calculations for the Ilek River basin leads to the formation of a management deadlock zone caused by the exceedance of background pollutant concentrations over established regulatory values. Under such conditions, PDS calculations lose their regulatory function and do not allow differentiation between natural and anthropogenic contributions to water quality formation.

The calculation results confirm that hydrological variability alone does not ensure removal from the management deadlock zone if water quality standards are not aligned with regional natural and geochemical conditions. The use of unified MPC values in arid and semi-arid basins results in a formal prohibition of discharges regardless of actual ecological risk and the level of technological wastewater treatment.

It is shown that the implementation of regional environmental water quality standards is a necessary prerequisite for restoring both the physical and managerial meaning of permissible discharge calculations. Regionalization of standards enables a transition from formal control to risk-oriented water resources management that integrates hydrological regime, background concentrations, and allowable anthropogenic load, which constitutes a key requirement for sustainable water use in the Republic of Kazakhstan.

Future research may focus on the development of quantitative methodologies for determining regional environmental quality standards and on the integration of hydrochemical monitoring with ecosystem-based assessment of water bodies.

**6. Supplementary Materials:** no supplementary materials.

### 7. Author Contributions

Conceptualization – G.Zh., B.K.; methodology – B.K.; formal analysis – G.Zh.; investigation – G.Zh.; writing – original draft preparation – G.Zh.; writing – review and editing – B.K.; supervision – B.K. All authors have read and agreed to the published version of the manuscript.

### 8. Author Information

Kapsalyamov, Bauyrzhan – doctor of technical sciences, professor, Management and Engineering in the field of environmental protection, L.N. Gumilyov Eurasian National University, Kazhymukan st., 13, Astana, Kazakhstan, 010000; [kapsalyamov\\_ba@enu.kz](mailto:kapsalyamov_ba@enu.kz), <https://orcid.org/0000-0002-3674-8200>

Zholmuratova, Gulzat – PhD student, Management and Engineering in the field of environmental protection, L.N. Gumilyov Eurasian National University, Kazhymukan st., 13, Astana, Kazakhstan, 010000; [zholmuratova.enu@mail.ru](mailto:zholmuratova.enu@mail.ru), <https://orcid.org/0009-0006-3803-7855>

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## **Су объектілерінің экологиялық сапасына арналған өңірлік стандарттардың қажеттілігі: Елек өзені алабы, Қазақстан**

**Бауыржан Капсаямов, Гүлзат Жолмуратова**

**Андатпа.** Қазақстан Республикасының қуаң және шөлейт аймақтарында су объектілерінің экологиялық сапасына қойылатын бірыңғай стандарттарды қолдану антропогендік жүктемені тиімді реттеуді әрдайым қамтамасыз ете бермейді және рұқсат етілген төгінді нормативтерін (РТН) есептеу барысында әдістемелік қайшылықтарға әкелуі мүмкін. Бұл зерттеу Батыс Қазақстандағы антропогендік әсері жоғары трансшекаралық су жүйелерінің бірі болып саналатын Елек өзені алабының мысалында су объектілері үшін өңірлік экологиялық сапа стандарттарын әзірлеу қажеттілігін негіздеуге бағытталған. Зерттеу РТН есептеудің

баланстық тәсіліне негізделіп, ластаушы заттардың фондық концентрациялары мен өзен ағынының гидрологиялық өзгергіштігінің төгінділерді реттеу нәтижелеріне әсерін талдауды қамтиды. Зерттеліп отырған алаптың табиғи-техногендік жағдайларына тән ластаушы заттар ретінде бор және алты валентті хром (Cr(VI)) басым индикаторлық заттар ретінде таңдалды. Зерттеу нәтижелері бордың табиғи және өңірлік фондық концентрациялары жоғары болған жағдайда бірыңғай экологиялық сапа стандарттарын қолдану теріс мәнді РТН көрсеткіштеріне әкелетінін, яғни экологиялық реттеу жүйесінің формалды түрде жүзеге аспайтынын көрсетеді. Алынған нәтижелер табиғи-климаттық жағдайларды, фондық концентрацияларды және су экожүйелерінің тұрақтылығын ескере отырып, экологиялық сапа стандарттарын өңірлендіру Қазақстанда экологиялық және басқарушылық тұрғыдан негізделген төгінділерді реттеу мен су ресурстарын тұрақты басқарудың қажетті алғышарттарының бірі екенін растайды. Зерттеудің практикалық маңызы ұсынылған тәсілді су ресурстарын басқару жүйесін жетілдіруде қолдану мүмкіндігімен айқындалады.

**Түйін сөздер:** экологиялық сапа стандарттары; өңірлендіру; рұқсат етілген төгінді нормативтері; бор; алты валентті хром (Cr(VI)); қуаң аймақтар; Елек өзені.

## **Обоснование необходимости региональных стандартов экологического качества водных объектов: бассейн реки Илек, Казахстан**

**Бауыржан Капсалямов, Гүлзат Жолмуратова**

**Аннотация.** В аридных и семиаридных регионах Республики Казахстан применение единых стандартов экологического качества водных объектов не всегда обеспечивает эффективное регулирование антропогенной нагрузки и может приводить к методологическим противоречиям при расчёте нормативов допустимых сбросов (НДС). Настоящее исследование направлено на обоснование необходимости разработки региональных стандартов экологического качества водных объектов на примере бассейна реки Илек - одной из наиболее антропогенно нагруженных трансграничных водных систем Западного Казахстана. Исследование основано на балансовом подходе к расчёту НДС и включает анализ влияния фоновых концентраций загрязняющих веществ и гидрологической изменчивости речного стока на результаты регулирования сбросов. В качестве приоритетных индикаторных веществ выбраны бор и шестивалентный хром (Cr(VI)), характерные для природно-техногенных условий исследуемого бассейна. Полученные результаты показывают, что при повышенных природных и региональных фоновых концентрациях бора применение единых стандартов качества воды приводит к отрицательным значениям НДС, что делает систему экологического регулирования формально невыполнимой. Сделанные выводы подтверждают, что регионализация стандартов экологического качества с учётом природно-климатических условий, фоновых концентраций и устойчивости водных экосистем является необходимым условием экологически и управленчески обоснованного регулирования сбросов и устойчивого управления водными ресурсами в Республике Казахстан. Практическая значимость работы заключается в возможности применения предложенного подхода при совершенствовании системы экологического регулирования водных ресурсов.

**Ключевые слова:** экологические стандарты качества; регионализация; нормативы допустимых сбросов; бор; шестивалентный хром (Cr(VI)); аридные регионы; река Илек.