Л.Н. Гумилев атындағы Еуразия ұлттық университетінің ХАБАРШЫСЫ.
ISSN: 2616-7034. eISSN: 2663-130X

БИОЛОГИЯЛЫҚ ҒЫЛЫМДАР СЕРИЯСЫ/
BIOSCIENCE SERIES / СЕРИЯ БИОЛОГИЧЕСКИЕ НАУКИ

IRSTI 34.35.33
Scientific article

DOI:https://doi.org//10.32523/2616-7034-2024-147-2-120-136

Research on chlorophyll-a concentrations in freshwater lakes of Pavlodar region

Zh.K. Samenova[1], N.T. Yerzhanov[1], M.B. Uruzalinova[1]*, M. Kravka[2]

[1]*Toraighyrov University, Pavlodar, Kazakhstan*
[2]*Czech University of Life Sciences, Prague, Czech Republic*

**Corresponding author: meruertmaj@mail.ru*

Abstract. Freshwater ecosystems play a crucial role in maintaining ecological balance and ensuring human well-being. However, these ecosystems are increasingly threatened by anthropogenic activities. Pavlodar region has undergone rapid industrialization and urbanization, impacting its pristine lakes.

This article is part of a doctoral study on lakes located equidistant from each other, aimed at determining the chlorophyll-A levels in the lakes of Pavlodar region.

Seven lakes were purposefully selected from the numerous lakes in the region, considering various anthropogenic impacts. Water samples were collected in the spring of 2022.

A comparative assessment revealed significant differences in chlorophyll levels observed in several water bodies. The study identified polluted water basins in the region, highlighting critical areas that require urgent attention for environmental conservation.

The conducted analyses indicate possible processes of vegetation degradation and flooding, leading to a decrease in dissolved oxygen and potential environmental consequences. The obtained results underscore the importance of continuous monitoring and effective management strategies to preserve the ecological integrity of the studied water bodies.

This study provides valuable information on the ecological status of lakes in Pavlodar region and highlights the impact of both natural and anthropogenic factors on water quality. The findings underscore the need for targeted environmental efforts.

Keywords: fresh, origin, lake, water pollution, chlorophyll-a.

Introduction

Currently, environmental issues have taken precedence in terms of importance [1].

The environment is subjected to significant anthropogenic impacts [2]. Gleick argues that the most crucial water-related problem is its inability to meet basic human needs [3]. Human activities, such as excessive groundwater extraction and widespread surface water pollution, have outpaced nature's capacity to replenish water resources [4]. As a result, natural sources of freshwater are experiencing immense strain, necessitating the monitoring of water quality [5].

Lakes are valuable resources that provide a wide range of environmental services. However, their ecological functions are threatened by eutrophication [6,7,8]. While monitoring and research on lake water are systematically conducted primarily in large reservoirs [9,10,11], the study of shallow lakes has become a priority.

In freshwater ecosystems, algae serve as the foundational element of the trophic pyramid. Their primary ecological function encompasses the generation of oxygen and the photosynthetic production of autochthonous organic matter. This organic matter, constituting the energy foundation, sustains organisms at higher trophic levels and plays a crucial role in all subsequent stages of the production process within extensive lakes and reservoirs [12].

Chlorophyll-a is the primary pigment in green plants, including unicellular algae (phytoplankton). Among the numerous pigments present in the photosynthetic apparatus of algae, chlorophyll-a plays a pivotal role in the process of photosynthesis. Information regarding the concentration of chlorophyll-a and its variability in aquatic environments serves as a criterion for assessing the biomass reserves of phytoplankton and its production, as well as an indicator of water pollution. Together with other measurements of active biomass, determining the concentration of chlorophyll-a provides insights into the quantity and potential activity of algal photosynthesis. The concentration of chlorophyll-a is indicative of the degree of trophication in surface waters [13].

A central challenge in the management of lake eutrophication lies in the substantial variability observed in the nutrient-chlorophyll a (Chl-a) relationship, stemming from diverse factors such as lake depth, trophic status, and latitude. To address the variability arising from spatial heterogeneity, a robust and comprehensive understanding of the nutrient Chl-a relationship can be attained by employing probabilistic methods for the analysis of data aggregated across an extensive spatial scale [14].

The elevated chlorophyll-a concentration in the lake foreshadows various consequences, including eutrophication driven by an excess of phosphorus and nitrogen. This can lead to the accelerated proliferation of algae and oxygen desorption, resulting in the degradation of the aquatic ecosystem. This process significantly impacts the biomass and production of phytoplankton and serves as an indicator of water quality challenges, underscoring the imperative for systematic monitoring to comprehend and manage ecological changes in the lake environment [15].

Aquatic contamination is another significant issue affecting the utilization of available water reserves in Kazakhstan. Currently, 50-70 % of land water in the country is assessed as “polluted” or “highly polluted” in relation to environmental standards [16].

The data from the specialized scientific technical program "The assessment of resources and forecast of the use of natural waters in Kazakhstan in conditions of anthropogenic and climatically determined changes" developed by the Institute of Geography with the support of the Secretariat of the Security Council and the Ministry of Education and Science, indicates that the country faces a comprehensive range of hydrological threats associated with water pollution and scarcity [17].

The primary objective of this study is to identify the chlorophyll-a concentration in lakes in Pavlodar region of Kazakhstan to assess the extent of eutrophication impact on the freshwater lake in Pavlodar region.

Methodology

One of the methods for assessing trophic levels is based on determining the concentration of chlorophyll-a, which has been employed in comprehensive studies assessing the ecological condition of water bodies in Pavlodar region.

The study was conducted in the Pavlodar region of Kazakhstan, which covers an area of 124,8 thousand km^2. This region is situated in the suture zone between the Central Kazakhstan hillocky area and the West Siberian lowland, with the Irtysh River dividing it into two unequal parts from southeast to northwest (Figure 1) [18].

The left bank of the region is predominantly occupied by the Central Kazakhstan hillocky area, characterized by low-hill terrains with decreasing absolute elevations from south to north and northeast, ranging from 1056 to 150 meters. The slopes of the hillocky area graduall y flatten, and they are covered by sandy-clay deposits from the Mesozoic-Cenozoic Irtysh cavity in the West Siberian lowland. The Irtysh plain is notable for its lack of drainage and the abundance of saline and saltish lakes. Most of the lakes in this area are formed as a result of snowwater filling various depressions [18].

In terms of precipitation, the Pavlodar region falls within an insufficient moisture zone. Precipitation is highly uneven both spatially and throughout the year. There is a slight increase in precipitation in the lowlands (280-300 mm/year), the extreme northeast and southeast (300-360 mm/year), where birch-aspen groves and pine forests grow. In the vast territory of the region, precipitation ranges from 200 to 250 mm. Winter receives the least amount of precipitation, accounting for 24-32 % of the annual total. The snow cover height varies from 10-20 cm in the open steppe to 30-40 cm in forested areas. By early spring snowmelt, the moisture reserve in the snow ranges from 10 to 70 mm, with an average of 40 mm. The average long-term evaporation from open water surfaces is 700-800 mm, and evaporation from the soil reaches 250-300 mm per year [18].

The region is home to approximately 1200 lakes [19]. Table 1 provides information on the size and salinity classification of these lakes.

Table 1

Number of lakes in Pavlodar region

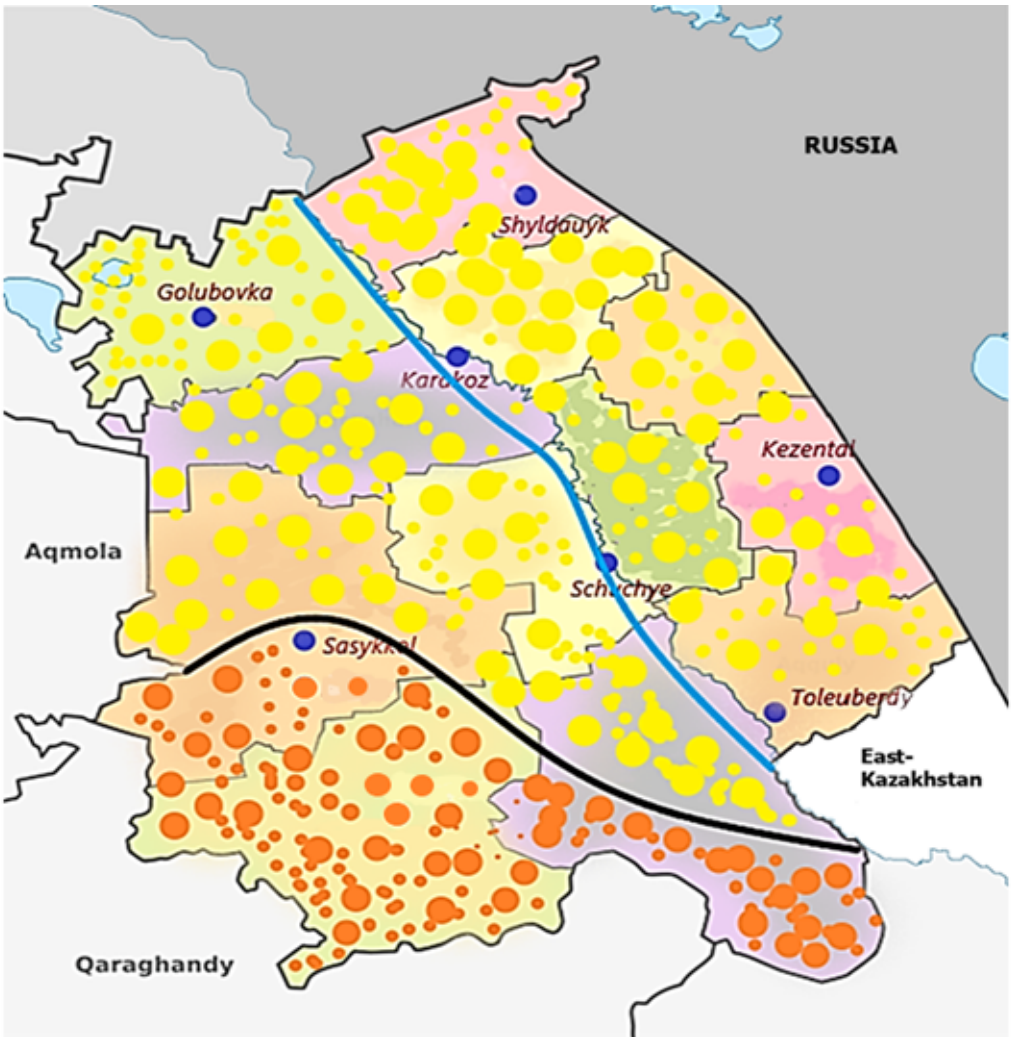
Lake surface area, км^2	Fresh		Saline		Total	
	Number	% of total	Number	% of total	Number	% of total
to 1	297	24,6	500	41,4	797	66,0
1,1-2,0	52	4,3	136	11,3	188	15,6
2,1-5,0	27	2,2	113	9,4	140	11,6
5,1-10,0	8	0,7	45	3,7	53	4,4
10,1-50,0	0	0	25	2,0	25	2,0
more than 50	0	0	5	0,4	5	0,4
total	384	31,8	824	68,2	1208	100

In addition to natural factors, anthropogenic activities play a significant role in the Pavlodar region. The main industries in the region include mining, oil refining, chemical industry, ferrous and non-ferrous metallurgy, and energy [20,21]. One of the primary sources of pollution in the region is the thermal power plants that utilize the high-ash Ekibastuz coal technology [22]. The majority of emissions originate from industrial enterprises located in Ekibastuz city (46 %), Aksu city (26,5 %), and Pavlodar city (25,5 %), while other districts account for only about 2 % of emissions [23].

Most lakes in the Pavlodar region exhibit variability in hydrological and hydrochemical regimes, influenced by long-term changes in climate humidification and varying groundwater inputs. Shallow lakes of suffusion origin, which have no connection with soil or confined aquifers, are more susceptible to frequent drying and sharp increases in mineralization. Deep-cut lakes, such as Zhalauly, Selety-Tengiz, Maraldy, Teke, Altybaysor, and others, represent remnants of the ancient hydrographic network. These lakes serve as local discharge areas for confined aquifers in Neogene, Paleogene, and partly Cretaceous deposits, which contributes to their relatively stable hydrological regime [18].

From a hydrogeological perspective, the Pavlodar region is situated within the second-order Irtysh artesian basin. The Irtysh artesian basin is part of the extensive first-order West Siberian basin. The remaining territory of the region falls within the hillocky area (Kokshetau-Ekibastuz hydrogeological region of the second order) [18] (Figure 1).

In the low-rise areas, a significant number of lakes are formed, although only a few have a long-standing existence. In the Bayan-Aul mountains, for instance, there are freshwater lakes that persistently occupy the deepest intermountain depressions of tectonic origin. The Bayan-Aul group of lakes comprises mountain or semi-mountain reservoirs with relatively deep waters (up to 13 meters) and clear freshwater. These lakes exhibit poor growth of aquatic vegetation within them [24].



– Irtysh artesian basin. The II order hydrological region

– Kokchetau-Ekibastuz basin. The I order hydrological region

Figure 1. Hydrogeological zoning of Pavlodar region territory

Limnological studies have revealed that several lakes in Northeast Kazakhstan, characterized by pronounced seasonal and long-term fluctuations in water levels, are subject to significant anthropogenic influence. This influence has resulted in numerous alterations to the natural landscapes, including a general decrease in the water surface level. The lakes in the region vary in size and shape, ranging from small reservoirs with diameters of a few meters to large ones.

The collection of data on the current geo-ecological state of lake geosystems in Northeast Kazakhstan covers the period from 2006 to 2013. The research was conducted using various

methods, including literary and cartographic analysis, comparative and historical approaches, route surveys, and the application of zoning and GIS (geographic information system) technologies. During the field study, distinct typological units of natural limnocomplexes were identified [25].

The lakes in the region are generally shallow, with depths rarely exceeding 1-1,5 meters. In most cases, their depth ranges from 40-50 centimeters. Many lakes experience complete drying up during the summer, transforming into sors and salt marshes [25,26].

The central floodplain of the region is characterized by a flattened topography and optimal moisture conditions. It features a multitude of saucer-like depressions, small ravines, and elongated depressions (former channels). These depressions, filled with meltwater and runoff, give rise to small reservoirs, many of which dry up in the summer [25].

Golubovka lake is located in Pavlodar region's Irtysh district of the Irtysh artesian basin of the II order hydrological region. (53°8′30″N, 74°9′18″E). Maximum distance between lake endpoints – 4,43 miles. Reservoir was formed by deflation as basin of arid zones [27]. Degree of mineralization – fresh (Fig. 2) .

Karakoz lake is located in Pavlodar region's Terenkol district of the Irtysh artesian basin of the II order hydrological region. (53°1′48″N, 76°14′22″E) Maximum distance between lake endpoints – 1,08 miles. Rhithral basin was shaped by the river [27], degree of mineralization – fresh.

Kezental is located in Pavlodar region's Shcherbakty district of the II order hydrological region Irtysh artesian basin. (52°13′31″N, 78°33′54″E). Maximum distance between lake endpoints – 0,20 miles. It is artificial type of lake [27], degree of mineralization – fresh (Fig.3) .

Sasykkol is located in Pavlodar region's Ekibastuz district of the I order Kokshetau-Ekibastuz basin hydrological district. (51°47′24″N, 75°16′17″E). Maximum distance between lake endpoints – 2,07 miles. Shallow lake formed by deflation as basins of arid zones [27], degree of *mineralization is fresh.*

Schuchye lake is located in Pavlodar region's Pavlodar district of the II order Irtysh artesian basin hydrological district. (52°9′36″N, 76°57′52″E). Maximum distance between lake endpoints – 0,98 miles. A basin was shaped by river – rhithral [27], degree of mineralization – fresh.

Shyldauyk is located in Pavlodar region's Zhelezinsky distric of Irtysh artesian basin of the II order hydrological region. (53°45′25″N, 76°47′3″E). Maximum distance between lake endpoints – 0,64 miles. Shallow Lake is formed by deflation as basins of arid zones [27], degree of mineralization – fresh.

Toleuberdy is located in Pavlodar region's Akku district of the II order hydrological region of Irtysh artesian basin. Maximum distance between lake endpoints – 1,52 miles. (51°22′5″N, 78°12′28″E). Водоем природного происхождения. This lake refers to potamal type as the river carries sand and mud only [27], degree of mineralization – fresh.

Figure 2. A snippet from Google maps – Golubovka lake

Figure 3. A snippet from Google maps – Kezental lake

The method of assessing trophic status through the determination of chlorophyll-a content was employed in comprehensive studies of the ecological condition and trophic status of water bodies in the Pavlodar region, conducted from April 15 to April 20, 2022.

Seven samples from different regions of Pavlodar region were analyzed to determine the content of chlorophylle substances. The lakes included in the study are Karakoz, Schuchye, Kezental, Toleuberdy, Golubovka, and Shyldauyk. The selection of these lakes corresponds

to the hydrological regions of the first and second order. The sampling process followed recommendations and built upon the experience gained from previous studies [26,28]. To collect the samples, a bathometer was utilized.

The samples were collected from the studied reservoirs in spring of 2022. For the monitoring, the determination of chlorophyll-a indicators was conducted within 2-3 days after sampling. Spectrophotometric method was utilized for the analysis.

The monitoring was carried out within 5-7 days using analyzers that comply with international standards such as ISO-IEC (International Organization for Standardization - International Electrotechnical Commission) and EPA (Environmental Protection Agency).

Lake samples were testing through external monitoring at the Helmholtz Research Center, Chemical Laboratory, Germany (Table 2).

Discussion

The trophic status assessment of water bodies in Pavlodar region was conducted utilizing the chlorophyll-a determination method. The results are comprehensively presented in the table, encompassing absorption values for various water bodies, as well as concentrations of chlorophyll-a and its degree of coloring (DIN). The data were collected from April 15 to April 20, 2022.

Evidently, the majority of water bodies exhibit diverse levels of chlorophyll-a content, indicating fluctuations in trophic status. For instance, Shydauyk water body demonstrates a high chlorophyll-a level (29.8 mg/l), suggesting the presence of eutrophication and biological activity. In contrast, Golubovka and Schuchie exhibit more moderate values (1.9 mg/l and 25.5 mg/l, respectively).

Comparing these findings with established standards and norms for chlorophyll-a allows for the identification of potential exceedances. Values surpassing established norms, such as those in Sasykkol (72.2 mg/l) and Karakoz (82.7 mg/l), may indicate high phytoplankton activity and eutrophication.

Consequently, the research results provide crucial insights into the trophic status of water bodies and form the basis for further analyses of the impact of various factors on aquatic ecosystems in this region.

Results

Microsoft Excel 2013 software methods were used for data processing and creating a graph-association (Fig.4). The processed analytical data are presented in table 2.

Table 2

Analytical data

Object (Lake)	Absor-ption	Absor-ption	Absorp-tion (spectral)	Absorp-tion (spectral)	Filtra-tion volume	Extrac-tion volume		Vali-dity crite-rion	Chlo-rophylle-a	Cholop-hylle's degree (DIN)
			Acidity	Acidity	ml	ml	R ChlA	1 -1,7	mg/l	mg/l

	665 nm	750 nm	665 nm	750 nm						
STD 200 mg/l (from 8.07.21) in proportion 1:100. 2100 mg/l of Chlorophylle	0,1779	0,0012	0,1080	0,0010	1	1	1,65	1,65	2063,1	2063,12
Shydauyk	0,0995	0,0060	0,0726	0,0079	200	7	1,37	1,45	29,8	29,84
Golubovka	0,1289	0,0111	0,1270	0,0110	200	7	1,01	1,02	1,9	1,86
Schuchie	0,1030	0,0039	0,0789	0,0044	200	7	1,31	1,33	25,5	25,49
Sasykkol	0,0770	0,0055	0,0071	0,0053	200	7	10,85	39,72	72,2	72,21
Karakoz	0,0890	0,0046	0,0091	0,0045	200	7	9,78	18,35	82,7	82,67
Toleuberdy	0,0224	0,0031	0,0180	0,0035	200	7	1,24	1,33	5,0	4,97
Kezental	0,0380	0,0038	0,0364	0,0038	200	7	1,04	1,05	1,7	1,66
STD 200 mg/l (8.07.21) in proportion 1:200. 1050 mg/l of CHLA	0,0841	0,0000	0,0490	0,0000	1	1	1,72	1,72	1039,0	1038,96
STD 200 mg/l (8.07.21) in proportion 1:200. 1050 mg/l CHLA	0,0834	0,0000	0,0478	0,0000	1	1	1,74	1,74	1053,8	1053,76
	500 ml/ 7ml									

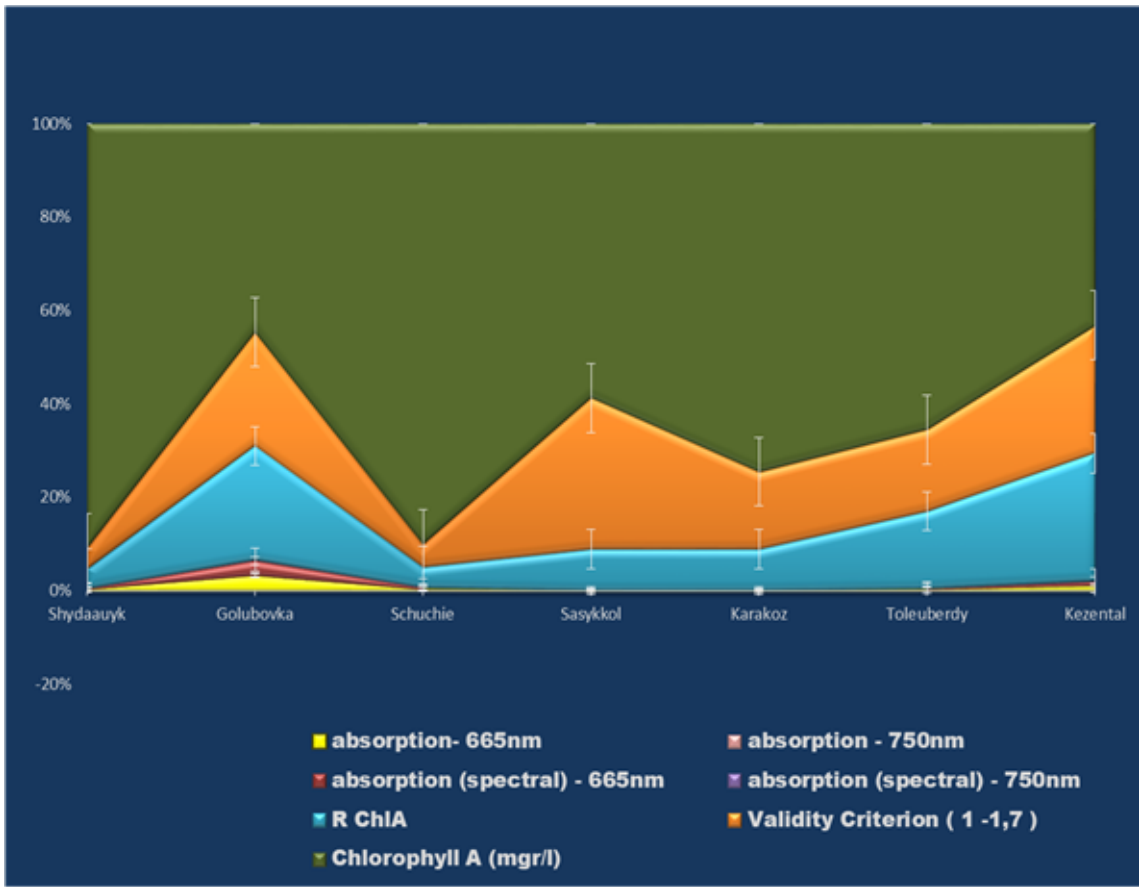


Figure 4. The graph-association of degree chlorophyll-a in lakes

The assessment of trophic status in water bodies of the Pavlodar region was conducted using the method of chlorophyll-a determination. The results are presented in the table, which includes values of absorption for various water bodies, as well as concentrations of chlorophyll-a and its degree of coloring (DIN). The data were obtained from April 15 to April 20, 2022.

It is evident that most water bodies exhibit diverse levels of chlorophyll-a content, indicating variations in trophic status. For instance, the Shydauyk water body demonstrates a high level of chlorophyll-a (29,8 mg/l), suggesting the presence of eutrophication and biological activity. Meanwhile, Golubovka and Schuchie display more moderate values (1,9 mg/l and 25,5 mg/l, respectively).

Comparing these findings with established standards and norms for chlorophyll-a allows identification of potential exceedances. For instance, values surpassing set norms, such as in Sasykkol (72,2 mg/l) and Karakoz (82,7 mg/l), may indicate high phytoplankton activity and eutrophication.

Thus, the research results provide crucial insights into the trophic status of water bodies and form the basis for further analyses of the impact of various factors on the aquatic ecosystems in this region.

Conclusion

Based on the findings of the conducted study, several pivotal observations can be delineated concerning the trophic status of fishery water bodies within the Pavlodar region:

Variability in Chlorophyll-a Concentrations: The analysis outcomes unveil substantial fluctuations in the levels of chlorophyll-a across diverse water bodies. This signifies distinctions in trophic status and biological activity within the scrutinized aquatic entities.

Potential Indicators of Eutrophication: Specific water bodies, exemplified by Sasykkol and Karakoz, manifest elevated concentrations of chlorophyll-a (72,2 mg/l and 82,7 mg/l, respectively), implying plausible eutrophication and heightened phytoplankton activity.

Divergence in Responses Among Water Bodies: Discrepancies in chlorophyll-a content observed among water bodies like Shydauyk, Golubovka, and Schuchie suggest a spectrum of conditions and influences to which these aquatic systems are subjected.

Imperative for Further Inquiry: The acquired results underscore the imperative of conducting supplementary research to attain a more profound comprehension of the factors impacting the trophic status of fishery water bodies in the region. This is indispensable for formulating targeted measures conducive to the management of aquatic ecosystems.

In summation, the scrutiny of chlorophyll-a content imparts invaluable insights for the assessment of ecological conditions and the efficacious administration of fishery water bodies. The identified trends furnish a basis for the formulation of ecologically sustainable strategies in fisheries.

Author contributions

Zh. Samenova, provided conceptualization, methodology, data collection, wrote the writing - origi-nal draft, made formal analysis, supply investigation, wrote review and editing, contributed in supervising.

N. Yerzhanov oversaw the project administration, contributed in supervising, prepared conceptualization, and methodology.

M. Uruzalinova participated in writing - visualization.

M. Kravka oversaw the project ad-ministration, prepared methodology.

All authors have made substantial contributions to the research, critically reviewed and approved the final version of the manuscript, and agreed to take responsibility for all aspects of the work, ensuring its accuracy and integrity.

References

1. Ванштайн В.О. Наблюдение за экологическим состоянием природных поверхностных вод Южного Урала// Взаимодействие науки и общества: проблемы и перспективы: сборник статей международной научно-практической конференции. – Казань: МТСII Омега Сайнс, 2017. – С. 10-11.

2. Kennish M. Encyclopedia of Estuaries //Anthropogenic impacts. Spring-er Neth. – 2016. – Vol. 1. – P. 29-35.

3. Gleick P. Global Freshwater Resources: Soft-Path Solutions for the 21st Century // Science. – 2003. – Vol. 302. – P. 1524-1528.

4. Noorzi H. Fresh Water's Vulnerability from Population Growth, Con-ference Paper, 1-4 (2011).

5. Чибилёв А., Левикин С. Ландшафтно-экологические последствия освоения целины в Заволжье и Казахстане: тезисы докладов научно-практической конференции, посвященной 40-летию освоения целины. – Оренбург: Издание ВНИИМС, 1994. – С. 52-54.

6. Dornhofer K., Oppelt N. Remote sensing for lake research and monitor-ing – Recent advances // Ecological Indicators. – 2016. – Vol. 64. – P. 105-122.

7. Zheng Chong, Yang Wei, Yang Zhifeng. Environmental flows manage-ment strategies based on the spatial distribution of water quality, a case study of Baiyangdian Lake, a shallow freshwater lake in China // Procedia Environmental Science. – 2010. – Vol. 2. – P. 896-905.

8. Koski V., Kotamäki N., Hämäläinen H., Meissner K., Karvanen J., Kärkäinen S. The value of perfect and imperfect information in lake monitoring and management // Science of the total environment. – 2020. – Vol. 726. – P. 1-10.

9. Palmer M., Wintera J., Young J., Dillon P., Guildford S. Introduction and summary of research on Lake Simcoe: Research, monitoring, and restoration of a large lake and its watershed // Journal of Great Lake Research. – 2011. – Vol. 37, Supplement 3. – P. 1-6.

10. Johnson T. Sedimentation in Large Lakes // Annual Review of Earth and Planetary Sciences. – 2003. – Vol. 12. – P. 179-204.

11. Ding X., Li X. Monitoring of the water-area variations of Lake Dong-ting in China with ENVISAT ASAR images // International Journal of Applied Earth Observation and Geoinformation. – 2011. – Vol. 13, issue 6. – P. 894-901.

12. Mineeva N. Chlorophyll and Its Role in Freshwater Ecosystem on the Example of the Volga River Reservoirs //Chlorophylls. – 2022. – Chapter 4. – P. 1-21.

13. Расулова М.М., Гаджиев А.А., Рабаданова А.А. Содержание хло-рофилла-а в озерах приморской низменности Дагестана и их трофический статус // География и геоэкология. Юг России: экология, развитие. – 2012. – № 2. – С. 100-102 (2012).

14. Zhao L., Zhu R., Zhou Q., Jeppesen E., Yang K. Trophic status and lake depth play important roles in determining the nutrient-chlorophyll a rela-tionship: Evidence from thousands of lakes globally // Water Research. – 2023. – Vol. 242. – P. 120-182.

15. Науменко М.А. Эвтрофирование озер и водохранилищ. – Санкт-Петербург: изд. РГГМУ, 2007. – 100 с.

16. Karatayev M., Kapsalyamova Z., Spankulova L., Skakova A., Movke-bayeva G., Kongyrbay A. Priorities and challenges for a sustainable management of water resources in Kazakhstan // Sustainability of water quality and ecology. – 2017. – Vol. 9-10. – P. 115-135.

17. Жумагулов Т. Проблемы дальнейшего развития законодательства Республики Казахстан в области обеспечения водной безопасности // Вестник КазНУ, Серия юридическая. – 2015. – № 4(76). – С. 226-230.

18. Шаймерденов Н. Водные ресурсы Павлодарской области. – Павло-дар: Эко, 2002. – 131 с.

19. Азат С., Кабрахманова С., Кабрахманова А., Абдиев К., Арып К., Кульдеев Е., Халхабай Б., Султанхан Ш., Раш А. Качественные показатели питьевой воды Майского района Павлодарской области Республики Казах-стан // Вестник НЯЦ РК. – 2023. – № 2. – С. 25-32.

20. Mahmood M., Orazalin N. Green governance and sustainability report-ing in Kazakhstan's oil, gas, and mining sector: Evidence from a former USSR emerging economy // Journal of Cleaner Production. – 2017. – Vol. 164. – P. 389-397.

21. Baubekova A., Akindykova A., Mamirova A., Dumat C., Jurjanz S. Evaluation of environmental contamination by toxic trace elements in Kazakh-stan based on reviews of available scientific data // Environmental Science and Pollution Research. – 2021. – Vol. 28. – P. 43315-43328.

22. Valeeva D., Kunilova I., Alpatov A., Mikhailova A., Goldberg M., Kondratiev A. Complex utilisation of Ekibastuz brown coal fly ash: Iron and carbon separation and aluminum extraction // Journal of Cleaner Production. – 2019. – Vol. 218. – P.192-201.

23. Nosenko Y.G., Safarov R. Z., Mukanova R. Zh, Zhunusova K.Z., Bai-murat M., Zhanibekova A.T., Ecological problems of Pavlodar region, Materials of the International Scientific Conference "Global Science and Innovations 2018". – Eger: Eurasian Center of Innovative Development «DARA», 2018. – P. 217-223.

24. Сидорова А., Баимбетов А., Махмутова Р. Рыбохозяйственная оценка водоемов Павлодарской области: материалы научной конференции по проблеме: «Биологические основы освоения, рационального использова-ния и воспроизводства рыбных запасов в водоемах Средней Азии и Казах-стана». – Алма-Ата: Наука, 1966. – С. 154-168.

25. Царегородцева А. Лимнологические особенности озерных геоси-стем Северо–Восточного Казахстана в рассмотрении вопросов устойчивости природно-аквальных комплексов// Успехи современного естествознания, Географические науки. – Москва: Академия естествознания, 2014, 51-55 с.

26. Romanova S., Kazangapova N. Quality of waters lakes Kazakhstan in contemporaneous period (for example of lake Kopa) // International Journal of Biology and Chemistry. – 2013. – № 6, 2. – P. 65-70.

27. O'Sullivan P.E., Reynolds C.S. The lakes handbook: limnology and limnetic ecology, 1. – Blackwell publishing, 2008, 700 p.

28. Ходоровская Н.И., Кандерова О.Н. Физико-химические и гидро-биологические методы исследования экологического состояния водоемов. – Челябинск: Издательство ЮУрГУ, 2002, 70 с.

Ж.Қ. Саменова[1], Н.Т. Ержанов[1], М.Б. Урузалинова[1], М. Кравка[2]

[1]Торайғыр университеті, Павлодар, Қазақстан

[2]Чех техникалық ғылымдар университеті, Прага, Чехия

Павлодар облысының тұщы су көлдеріндегі хлорофилл-а деңгейін зерттеу

Аңдатпа. Тұщы судың экожүйелері экологиялық тепе-теңдік пен адамның әл-ауқатын сақтауда шешуші рөл атқарады. Дегенмен, бұл экожүйелерге әртүрлі антропогендік әрекеттердің қаупі артып келеді. Қазақстанның Павлодар облысы қарқынды индустрияландыру мен урбанизацияны бастан өткерді, бұл оның таза көлдеріне тікелей әсер етті.

Бұл мақала Павлодар облысындағы бір-бірінен бірдей қашықтықта орналасқан кейбір көлдердегі хлорофилл-а деңгейін анықтау мақсатында докторлық зерттеу аясында жазылған.

Әртүрлі антропогендік әсерлерді ескере отырып, Павлодар облысындағы көптеген көлдердің ішінен зерттеу үшін мақсатты түрде жеті көл таңдалды. Су үлгілері 2022 жылдың көктемінде алынды.

Салыстырмалы бағалау бірнеше көлдерде байқалған хлорофилл деңгейінде айтарлықтай айырмашылықтарды анықтады. Зерттеу нәтижелері аймақтағы ластанған су бассейндерін анықтап, қоршаған ортаны сақтау үшін шұғыл назар аударуды қажет ететін маңызды аймақтарды атап өтті.

Жүргізілген талдаулар еріген оттегінің төмендеуіне және экологиялық зардаптарға әкелетін ықтимал өсімдіктердің деградациясын және су басу процестерін көрсетті. Алынған нәтижелер зерттелетін су объектілерінің экологиялық тұтастығын сақтау үшін тұрақты мониторинг пен тиімді басқару стратегияларының маңыздылығын көрсетеді.

Бұл зерттеу Қазақстандағы Павлодар облысы көлдерінің экологиялық жағдайы туралы құнды мәліметтер береді және су сапасына табиғи және антропогендік факторлардың әсерін көрсетеді. Зерттеу қорытындылары мақсатты экологиялық әрекеттердің қажеттілігін көрсетеді.

Түйін сөздер: тұщы, шығу тегі, көл, судың ластануы, хлорофилл-а.

Ж.Қ. Саменова[1], Н.Т. Ержанов[1], М.Б. Урузалинова[1], М. Кравка[2]
[1]Торайгыров университет, Павлодар, Казахстан
[2]Чешский университет технических наук, Прага, Чехия

Исследование уровня хлорофилла-а в пресноводных озерах на территории Павлодарской области

Аннотация. Пресноводные экосистемы играют ключевую роль в поддержании экологического баланса и обеспечении благополучия человека. Однако экосистемы все более подвергаются угрозам антропогенной деятельности. Павлодарская область пережила быструю индустриализацию и урбанизацию, что повлияло на его первозданные озера.

Данная статья была написана в рамках докторского исследования озер, расположенных на одинаковом расстоянии друг от друга, с целью определения уровня хлорофилла А в озерах региона Павлодар.

Для исследования было целенаправленно выбрано семь озер из большого числа озер региона с учетом различных антропогенных воздействий. Образцы воды были собраны весной 2022 года.

Сравнительная оценка выявила значительные различия в уровнях хлорофилла, наблюдаемых в нескольких водоемах. Исследование выявило загрязненные водные бассейны в регионе, что подчеркивает критические зоны, требующие срочного внимания для сохранения окружающей среды.

Проведенные анализы указывают на возможные процессы деградации растительности и затопления, приводящие к уменьшению растворенного кислорода и потенциальным последствиям для окружающей среды. Полученные результаты подчеркивают важность непрерывного мониторинга и эффективных стратегий управления для сохранения экологической целостности изученных водоемов.

Данное исследование предоставляет ценную информацию о экологическом состоянии озер в регионе Павлодарской области и выделяет влияние как естественных, так и антропогенных факторов на качество воды. Полученные результаты подчеркивают необходимость целевых экологических усилий.

Ключевые слова: пресный, происхождение, озеро, загрязнение воды, хлорофилл-а.

References

1. Venshtein V.O. Nablyudeniye za ekologicheskim sostoyaniyem prirodnykh poverkhnostnykh vod Yuzhnogo Urala, Vzaimodeistviye nauki i obshchestva: problemy i perspektivy, Sbornik statey Mezhdunarodnoy nauchno-prakticheskoy konferentsii, Kazan': MTSII Omega Scince. [Observation of the ecological state of natural surface waters of the Southern Urals, Ineraction sciences and societies: problems and prospects, Collection of the International Scientific and Practical Conference: in 4 parts, Kazan': Omega Science], 10-11 (2017). [in Russian]

2. Kennish M. Encyclopedia of Estuaries, Anthropogenic impacts. Springer Neth., 1, 29-35 (2016).

3. Gleick P. Global Freshwater Resources: Soft-Path Solutions for the 21st Century, Science, 302, 1524-1528 (2003).

4. Noorzi H. Fresh Water's Vulnerability from Population Growth, Conference Paper, 1-4 (2011).

5. Chibilyov A., Levikin S. Landshaftno-ekologicheskiye posledstviya osvoyeniya tseliny v Zavolzh'ye i Kazakhstane, Tezis dokladov nauchno-prakticheskoy konferentsii, posvyashchennoy soroka letiyu osvoyeniya tseliny, Orenburg: Izdaniye VNIIMS. [Landscape and ecological consequences of Tselina development in the Volga region and Kazakhstan, Thesis report of the scientific and practical conference dedicated to the 40-th anniversary of the development of Tselina, Orenburg: All-Russian Scientific Research Institute of Beef Cattle Breeding], 52-54 (1994). [in Russian]

6. Dornhofer K., Oppelt N. Remote sensing for lake research and monitoring – Recent advances, Ecological Indicators, 64, 105-122 (2016).

7. Zheng Chong, Yang Wei, Yang Zhifeng. Environmental flows management strategies based on the spatial distribution of water quality, a case study of Baiyangdian Lake, a shallow freshwater lake in China, Procedia Environmental Science, 2, 896-905 (2010).

8. Koski V., Kotamäki N., Hämäläinen H., Meissner K., Karvanen J., Kärkäinen S. The value of perfect and imperfect information in lake monitoring and management, Science of the total environment, 726, 1-10 (2020).

9. Palmer M., Wintera J., Young J., Dillon P., Guildford S. Introduction and summary of research on Lake Simcoe: Research, monitoring, and restoration of a large lake and its watershed, Journal of Great Lake Research, 37(3), 1-6 (2011).

10. Johnson T. Sedimentation in Large Lakes, Annual Review of Earth and Planetary Sciences, 12, 179-204 (2003).

11. Ding X., Li X. Monitoring of the water-area variations of Lake Dongting in China with ENVISAT ASAR images, International Journal of Applied Earth Observation and Geoinformation, 13(6), 894-901 (2011).

12. Mineeva N. Chlorophyll and Its Role in Freshwater Ecosystem on the Example of the Volga River Reservoirs, Chlorophylls, 4, 1-21 (2022).

13. Rasulova M.M., Gadzhiyev A.A., Rabadanova A.A. Soderzhaniye khlorofilla-a v ozerakh primorskoy nizmennosti dagestana i ikh troficheskiy status, Geografiya i geoekologiya. Yug Rossii: ekologiya, razvitiye. [The content of chlorophyll-A in coastal lakes lowlands of Dagestan and their trophic status, Geography and geoecology. The South of Russia: ecology, development], 2, 100-102 (2012). [in Russian]

14. Zhao L., Zhu R., Zhou Q., Jeppesen E., Yang K. Trophic status and lake depth play important roles in determining the nutrient-chlorophyll a relationship: Evidence from thousands of lakes globally, Water Research, 242, 120-182 (2023).

15. Naumenko M.A. Evtrofirovaniye ozor i vodokhranilishch [The eutrophication of lakes and reservoirs] (SPb: RSHMU publ., 2007, 100 p.). [in Russian]

16. Karatayev M., Kapsalyamova Z., Spankulova L., Skakova A., Movkebayeva G., Kongyrbay A. Priorities and challenges for a sustainable management of water resources in Kazakhstan // Sustainability of water quality and ecology. – 2017. – Vol. 9-10. – P.115-135.

17. Zhumagulov T. Problemy dal'neyshego razvitiya zakonodatel'stva Respubliki Kazakhstan v oblasti obespecheniya vodnoy bezopasnosti, Vestnik KazNU, Seriya yuridicheskaya. [Issues of further development of the Republic of Kazakhstan legislation in the sphere of ensuring water security, KazNU Bulletin, Law series], 4(76), 226-230 (2015). [in Russian]

18. Shaimerdenov N. Vodnyye resursy Pavlodarskoy oblasti [Water resourses of Pavlodar area] (Pavlodar: Eco, 2002, 131 p.). [in Russian]

19. Azat S., Kabdrakhmanova S., Kabdrakhmanova A., Abdiyev K., Aryp K., Kuldeyev E., Khalkhabay B., Sultakhan Sh., Rash A. Kachestvennyye pokazateli pit'yevoy vody Mayskogo rayona Pavlodarskoy oblasti Respubliki Kazakhstan, Vestnik NYATS RK [Qualitative indicators of drinking water of the Maysky district Pavlodar region of the Republic Kazakhstan, NNC RK Bull.], 2, 25-32, (2023). [in Russian]

20. Mahmood M., Orazalin N. Green governance and sustainability reporting in Kazakhstan's oil, gas, and mining sector: Evidence from a former USSR emerging economy, Journal of Cleaner Production, 164, 389-397 (2017).

21. Baubekova A., Akindykova A., Mamirova A., Dumat C., Jurjanz S. Evaluation of environmental contamination by toxic trace elements in Kazakhstan based on reviews of available scientific data, Environmental Science and Pollution Research, 28, 43315-43328 (2021).

22. Valeeva D., Kunilova I., Alpatov A., Mikhailova A., Goldberg M., Kondratiev A. Complex utilisation of Ekibastuz brown coal fly ash: Iron and carbon separation and aluminum extraction, Journal of Cleaner Production, 218, 192-201 (2019).

23. Nosenko Y.G., Safarov R. Z., Mukanova R. Zh, Zhunusova K.Z., Baimurat M., Zhanibekova A.T., Ecological problems of Pavlodar region, Materials of the International Scientific Conference "Global Science and Innovations 2018", Eger: Eurasian Center of Innovative Development «DARA», 217-223 (2018).

24. Sidorova A., Baimbetov A., Mahmutova R., Rybokhozyaystvennaya otsenka vodoyemov Pavlodarskoy oblasti, Materialy nauchnoy konferentsii po probleme: «Biologicheskiye osnovy osvoyeniya, ratsional'nogo ispol'zovaniya i vosproizvodstva rybnykh zapasov v vodoyemakh Sredney Azii i Kazakhstana», Alma-Ata: Nauka. [Fisheries assessment of water bodies in Pavlodar region, Materials of the scientific conference on the problem: "Biological foundations of the development, rational use and reproduction of fish stocks in the reservoirs of Central Asia and Kazakhstan", Almaty: Science], 154-168 (1966). [in Russian]

25. Tsaregorodtseva A. Limnologicheskiye osobennosti ozernykh geosistem severo–vostochnogo Kazakhstana v rassmotrenii voprosov ustoychivosti prirodno-akval'nykh kompleksov, Uspekhi sovremennogo yestestvoznaniya, Geograficheskiye nauki, Moskva: Akademiya yestestvoznaniya [Limnological features of lake geosystems north-west Kazakhstan in addressing sustainable nature-aquatic complexes, Advanced in current natural sciences, Geography sciences, Moscow: Academy of natural science], 51-55 (2014). [in Russian]

26. Romanova S., Kazangapova N. Quality of waters lakes Kazakhstan in contemporaneous period (for example of lake Kopa), International Journal of Biology and Chemistry, 6(2), 65-70 (2013).

27. O'Sullivan P. E., Reynolds C.S. The lakes handbook: limnology and limnetic ecology, 1 (Blackwell publishing, 2008, 700 p.).

28. Hodorovskaiya N.I., Kanderova O.N. Fiziko-khimicheskiye i gidrobiologicheskiye metody issledovaniya ekologicheskogo sostoyaniya vodoyemov [Physicochemical and hydrobiological methods for studying the ecological state of water bodies] (Chelyabinsk: SUSU publ., 2002, 70 p.).

Information about authors:

Samenova Zh.K. **–** PhD student of Biological Sciences, senior lecturer, Department of biology and ecology, Toraighyrov University, Lomov str., 64, Pavlodar, Kazakhstan.

Yerzhanov N.T. **–** Doctor of Biological Sciences, Professor, Department of biology and ecology, Toraighyrov University, Lomov str., 64, Pavlodar, Kazakhstan.

Uruzalinova M.B. **–** master, senior lecturer, Department of biology and ecology, Toraighyrov University, Lomov str., 64, Pavlodar, Kazakhstan.

Kravka M. **–** PhD in environmental science, Czech University of Life Sciences, Prague, Czech Republic.

Саменова Ж.Қ. **–** биология ғылымдарының PhD докторанты, биология және экология кафедрасының аға оқытушысы, Торайғыров университеті, Ломов көш., 64, Павлодар, Қазақстан.

Ержанов Н.Т. **–** биология ғылымдарының докторы, биология және экология кафедрасының профессоры, Торайғыров университеті, Ломов көш., 64, Павлодар, Қазақстан.

Урузалинова М.Б. **–** магистр, биология және экология кафедрасының аға оқытушысы, Торайғыров университеті, Ломов көш., 64, Павлодар, Қазақстан.

Кравка М. **–** экология ғылымдарының кандидаты, Чехия жаратылыстану ғылымдарының университеті, Прага, Чехия.