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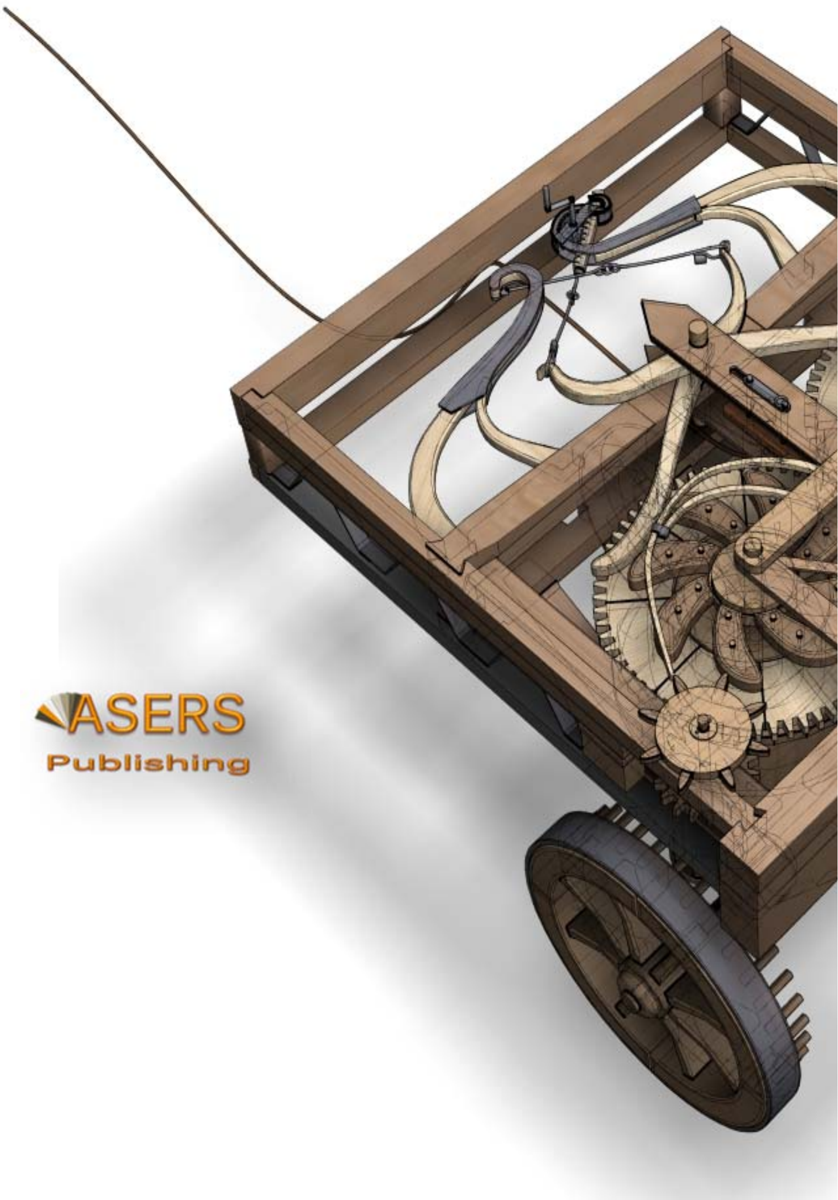

Quarterly
Volume XI
Issue 5(45)
Fall 2020
ISSN 2068 – 7729
Journal DOI
https://doi.org/10.14505/jemt

ASERS Publishing

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Table of Contents:

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DOI : https://doi.org/10.14505/jemt.v11.5(45).07

Studying the Self-Cleaning Ability of Water Bodies and Watercounts of Arshalyn District of Akmola Region

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Suggested Citation:

Akbayeva, L. *et al.* (2020). Studying the Self-Cleaning Ability of Water Bodies and Watercounts of Arshalyn District of Akmola Region. *Journal of Environmental Management and Tourism*, (Volume XI, Fall), 5(45): 1095-1106. DOI:10.14505/jemt.v11.5(45).07

Article's History:

Received 29th of May 2020; Received in revised form 12th of June 2020; Accepted 16th of July 2020; Published 24th of August 2020.

Abstract:

In this paper, the self-purification potential of water bodies and watercourses in the Arshalinsky district was studied in an administrative unit of the Akmola region: Bolshaya Saryoba, Malaya Saryoba, Zhaltyrkol (Arhaniya), Koigeldy, Zhangula, and a section of the Yesil River. The self-cleaning ability of water bodies was assessed by such oxygen indicators as the amount of dissolved oxygen and BOD5. In water samples from water bodies, the dominant phytoplankton and zooplankton species were identified as possible agents or indicators of the self-purification capacity of water bodies. The task of the work was to identify the relationship of self-cleaning ability with inorganic pollution, saprobity.

Keywords: hydrobionts; self-purification; saprobity; biological oxygen demand; oxygen solubility; algae; phyto-zooplankton; water bodies; water courses.

JEL Classification: F64; O13; Q53.

Introduction

In the task of preserving water resources, an important role is played by the potential capabilities of natural ecosystems to restore equilibrium and self-purification abilities [Ostroumov 2004; Ostroumov 2008; Alimov and Finogenova 1976). Without maintaining the self-cleaning potential of lakes and rivers, other measures for cleaning and preserving the quality of water bodies can be ineffective. In this regard, it is important to accurately know the mechanisms of interaction of many factors that provide water purification potential, as well as the causes and patterns of violation of this potential. Studies by a number of authors indicate the ambiguous influence of a number of factors on this process (Alimov 2000; Ostroumov 2016; *Proceedings of the Zoological Institute, chapter 272, Reaction of lake ecosystems to changes in biotic and abiotic conditions*. 1997). The lakes and rivers of the Akmola region of the Republic of Kazakhstan are located in arid steppes that undergo aridization due to climate change (Tursunov 1998; Absametov, Adenova and Nusupova 2019). In recent decades, the natural hydrological processes of water bodies in the region also undergo negative changes due to increasing anthropogenic influence: drying and eutrophication of lakes accelerate, hydro ecological parameters worsen (Ostroumov 2004; Razumnaya 2011; Durnikin 2010). At the same time, lakes and streams degrade at different speeds, despite the same climatic and similar hydrographic conditions.

Objective of this work is to study the self-purification potential of water bodies and watercourses in the Arshalinsky district, an administrative unit of the Akmola region.

The working hypothesis is that self-purification of water bodies is a complex multifactorial process, which can be estimated from the value of the ratio of the processes of oxygen formation and its destruction. The self-cleaning ability of water bodies in different conditions may show different dependence on pollution by inorganic pollutants, on the presence of different types of phyto- and zooplankton, which directly affects the saprobity of the reservoir.

Figure 1. Location of water bodies Arshaly district of Akmola region

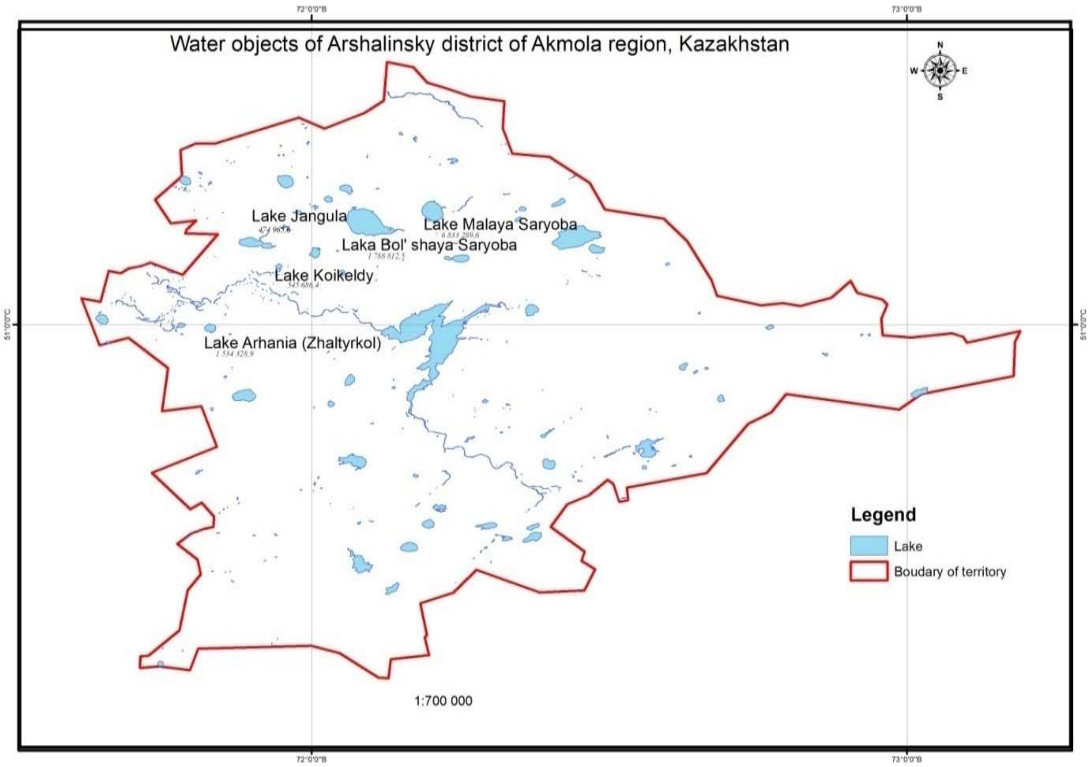

Table 1. Coordinates of the studied water objects of Arshaly district

Lakename	Location relative to populated areas	The area of the reservoir, km2	Samplingpoint
Lake Zaltyrkol (Arhaniya)	rural district Zhibek	1 534 328,9	51°12'22.1" N 72°01'18.0" E
Lake Koilgeldy	rural district Koigeldy	545 682,4	51°05'42.9" N 71°56'38.1" E
Lake Zhangula	near the village of Bereke	474 965,6	51°11'35.0" N 71°59'54.8" E
LakeBigSaryoba	far from inhabited places	1 778 812,5	51°10'09.1" N 72°04'53.0" E
Lake small Saryoba	village Saryoba	6 833 289,6	51°11'05.2" N 72°11'56.8" E
Esil river	far from inhabited places	-	51°03'46.4"N 71°51'52.6"E

Arshalynsky district is located in the south-east of Akmola region of Kazakhstan (see Figure 1). The climate of the region is continental: the average temperature in the winter is –17 ° C; average summer temperature is 20 ° C.

The average annual precipitation is 300–350 mm, in winter, 17.7 mm, in summer, 38.6 mm (https://kazhydromet.kz). The Esil River with small tributaries of the Kyzylmola and Olenta flows through the district. We have studied the previously unexplored lakes Bolshaya Saryoba, Malaya Saryoba, Zhaltyrkol (Arhaniya), Koygeldy, Zhangula, as well as part of the Yesil River (see Table 1).

1. Methodology

In the summer period of 2018, samples (in three points) from each lake and Esil river were taken from the water bodies of the district to study hydro chemical and hydro biological indicators.

1.1 The Study of Hydrochemical Indicators of Water Bodies

The content of the following components was studied in lakes and rivers: pH, suspended matter, dry residue, electrical conductivity, chlorides, sulfates, phosphates, total hardness, calcium, magnesium, sodium, ammonium salt, nitrites, nitrates, COD, BOD_5, anionic surfactants, iron total, fluorides, manganese, copper, lead, cadmium, chromium, zinc.

Taking into account the concentration of substances in water (Ci) and their maximum permissible content (MAC), the hydro chemical index of water pollution (WPI) was calculated for several components (n) (Sibagatullina and Mazurkin 2009):

$$WPI = \frac{1}{n} * \sum_{i=1}^{n} \frac{Ci}{ПДКi} \quad 1.1$$

We have studied such indicators as the amount of dissolved oxygen (R) and BOD5 in the lakes and the Esil River under study. We also calculated the ratio of these indicators as the ratio of photosynthetic activity in a pond to its destructive ability: R/BOD_5. The higher this ratio, the higher the potential of self-cleaning ability in water bodies, and vice versa - the lower the ratio, the lower the self-cleaning capacity of the water body.

1.2 Hydro-Biological Methods

To collect phytoplankton, the Upstein gas network No. 77 was used (Federov 2006). Samples were taken from the surface of the reservoir with a capacity of 10 liters and passed through the Apstein network — only 10 times. The sample was fixed at the rate of: 20-40 ml of 40% formalin per liter of sample. Preliminarily, the pH of the fixer was adjusted to 7 by adding a small amount of Na_2CO_3 solution. After that, the sample was concentrated by sedimentation to 100 ml for 1 day.

Phytoplankton was identified by microscopy using an 90 (2mm) immersion objective lens on an Olympus CX-31 microscope.

The identification of the species composition of algae was carried out in the evaluation of the frequency of occurrence of S according to the Sladechek technique (Federov 2006; Sadchikov 2003): 1-very rare, 2-rare, 3-often, 5-often, 7-very often, 9-mass development.

Based on the indicator significance of species S and frequency of occurrence, we calculated the indices of saprobity of water bodies.

$$S = \frac{\sum(sh)}{\sum h} \quad 1.2$$

To identify species of zooplankton, water was drawn from a 100-liter boat and gas No. 55 was passed through the Apstein network (Federov 2006). The collected samples were immediately fixed with 4% formalin. To prevent deformation of the shells and the loss of eggs from brood chambers, sucrose (40 g/l) was added to the samples. Sample defended to 200 ml.

Microscopic examination of zooplankton samples and the determination of species affiliation were carried out with an increase of 90 (2 mm) with an Olympus CX-31 microscope.

Methods of statistical processing: for the data obtained, the arithmetic average and its error, the correlation coefficient was calculated.

2. Results and Discussion

According to the results of hydrochemical analyzes (Table 2), the studied lakes mostly belong to the chloride type of lakes, except Lake Malaya Saryoba, where the sulfate ions are almost twice the content of chloride ions. Water in all water bodies is distinguished by increased hardness: the multiplicity of exceeding the maximum permissible concentration is from 1.2 (Zhaltyrkol Lake, Zhangula) to 15.5 (Big Saryoba Lake). In general, hydrochemical parameters are normal, with the exception of a few components, the excess of which may be due to the natural xenobiotic profile of the medium. Water pollution indices, calculated on the basis of key indicators, characterize water bodies as classes 1 and 2 of purity - very clean and clean.

Table 2. Hydrochemical components in the surface waters of the Akmola region

Name of the defined indicator	Unit of measure ment	MPC	Actual value / multiplicity of exceeding MPC					
			The name of the selection point					
			Lake Zhaltyrgol (Arhaniya)	Lake Koikeldy	Lake Zhangula	Lake Big Saryoba	Lake Small Saryoba	Esil river
1	2	3	4	5	6	7	8	9
pH	-	6-9	7.44	7.40	7.50	7.96	7.99	7.50
Suspended substances	mg / dm^3	-	5.0±1.25	5.0±0.25	< 5.0	7.0±1.4	7.99±0.99	< 5.0
Dry residue	mg /dm^3	1000	220±55	1400±180/1.4 MPC	240±28.4	13400±638/13.4 MPC	2600±150.5 /2.6 MPC	320±64.4
Electrical conductivity	mg /dm^3	-	0.391±0.097	0.0022±0.0002	0.391±0.07	18.29±1.6	3.05±0.08	0.551±0.071
Chlorides	mg /dm^3	350	48.96±8.24	89.34±7.8	8.51±0.7	1425.2±185.2 /4.072 MPC	141.10±15.2	82.96±11.5
Sulfates	mg /dm^3	500	< 20	51.04±10.2	< 20	562.25±82.7 /1.124 MPC	224.32±26.1	49.39±4.8
Phosphates	mg /dm^3	3.5	0.862±0.11	1.048±0.2	1.131±0.14	0.077±0.01	1.185±0.09	0.646±0.09
Total hardness	mg /dm^3	7.0	8.5±1,07/1.2 MPC	18.75±1.75/2.6 MPC	8.8±1.06 /1.2 MPC	109±17.2/15.5 MPC	28.1±2.0/4 MPC	9.3±1.86 /1.3 MPC
Calcium	mg /dm^3	-	77.5±9.3	162±3.24	70.5±11.3	65±13.25	116±19.1	82±13.4
Magnesium	mg /dm^3	-	4.5±0.12	15±3.1	10.5±1.1	615±74.3	99±2.4	6.6±1.02
Sodium	mg /dm^3	200	36.19±4.0	232.4±26.4 /1,17 MPC	36.66±2.3	1567±213/7.9 MPC	294.9±53.7/1.5 MPC	52.74±8.5
Ammonium saline	mg /dm^3	2.0	0.337±0.08	0.116±0.02	0.127±0.02	< 0.064	0.139±0.034	< 0.064
Nitrites	mg /dm^3	3.0	0.033±0.006	< 0.006	< 0.006	< 0.006	0.043±0.0032	< 0.006
Nitrates	mg /dm^3	45	<0,013	< 0.013	< 0.013	0.323±0.06	< 0.013	0.306±0.051
COD	mgO/dm^3	30	19.45±3.8	82.45±6.49 /2,8 MPC	11.95±1.39	46.95±0.39 /1.6 MPC	82.85±20.7 /2.8 MPC	< 5
BOD_5	mg /dm^3	6.0	< 0.5	< 0.5	1.49±0.21	0.96±0.15	2.15±0.053	< 0.5
APAV	mg /dm^3	0.5	0.073±0.01	0.099±0.019	0.195±0,001	0.220±0.05	0.0885±0.017	< 0.025
Common iron	mg /dm^3	0.3	0.080±0.02	0.063±0.012	0.312±0.04/1.04 MPC	0.321±0.08/1,07 MPC	0.531±0.10/1.77 MPC	< 0.01
Fluorides	mg /dm^3	1.5	0.376±0.04	0.825±0.16	0.741±0.14	0.547±0.11	0.773±0.071	0.290±0.038
Manganese	mg /dm^3	0.1	0.0067±0.001	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Copper	mg /dm^3	1.0	0.5181±0.12	0.3183±0.06	0.3460±0.08	0.2298±0.004	0.1386±0.027	0.6949±0.08
Lead	mg /dm^3	0.03	0.0058±0.001	0.0020±0.0004	< 0.002	< 0.002	< 0.002	0.0072±0.0007
Cadmium	mg /dm^3	0.001	< 0.0001	<0.0001	< 0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg /dm^3	0.05	< 0.005	0.0098±0.0009	< 0.005	< 0.005	< 0.005	< 0.005
Zinc	mg /dm^3	5.0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
WPI			0.489	1.07	0.705	2.75	1.45	0.56
Water quality classes			I very clean	I very clean	I very clean	II clean	I very clean	I very clean

Features of hydrochemical indicators of the studied water bodies are as follows:

1) In the Zhaltyrkol lake, the total water hardness was increased - 8.5±1.07 mg-eq/dm^3 (1.2 MPC), WPT -0.030.

2) In Koykeldy Lake, the dry residue of the hydrochemical sample was 1400±180 mg/dm^3 (1.4 MPC), the total water hardness was increased - 18.75±1.75 mg-eq/dm^3 (2.6 MAC), the sodium content was 232.4±26.4 mg/dm^3 (1.17 MAC), COD - 82.45±6.49 mgO/dm^3 (2.8 MPC), WPI - 0.07.

3) In Zhangula lake, the total water hardness is 8.8±1.06 mg-eq/dm^3 (1.2 MPC), the total iron content is 0.312±0.04 mg/dm^3 (1.04 MPC), and WPI is 0.04.

4) In Bolshaya Saryoba Lake, the dry residue of the sample is 13400±638 mg/dm^3 /(13.4 MPC), the chloride content is 1425.2±185.2 mg/dm^3 (4.072 MPC), sulfates - 562.25±82.7 mg/dm^3 (1.124 MAC), the total water hardness - 109±17.2 mEq/dm^3 (15.5 MPC), sodium content - 1567±213 mg/dm^3 (7.9 MAC), COD - 46.95±0.39 mgO/dm^3 (1.6 MAC), total iron - 0.321±0.08 mg/dm^3 (1.07 MPC), WPI - 0.55.

5) In Small Saryoba Lake, the dry residue of the sample was - 2600±150.5 mg/dm^3 (2.6 MAC), the total water hardness was 28.1±2.0 mEq/dm^3 (4 MAC), the sodium content was 294.9±53.7 mg/dm^3 (1.5 MAC), COD - 82.85±20.7 mgO/dm^3 (2.8 MPC), total iron - 0.531±0.10 mg/dm^3 (1.77 MPC), WPI - 0.137.

6) In the Esil River, the total water hardness is increased - 9.3±1.86 mg-eq/dm^3 (1.3 MPC), WPI -0.03.

The self-cleaning ability of water is largely associated with the photosynthetic activity of aquatic plants and the destructive ability of heterotrophs, which are used for this oxygen (Akbayeva et al. 2014, Bulion and Nikulina 1976). In this regard, to assess the self-cleaning ability of water bodies, an assumption can be made: the more water is saturated with oxygen (R), and the less oxygen is required for destruction of organic substances (BOD_1 or BOD_5), the higher the potential of self-purification in water bodies.

In this case, the ratio of dissolved oxygen R and BOD_5 can be used as an indicator of self-cleaning potential: the higher the ratio R / BOD_5, the higher the reservoir's ability to self-purify, and vice versa - the lower the ratio, the worse the self-purification capacity of the reservoir.

We have compiled a series of average annual indicators of oxygen dissolved in water, BOD_5 and the ratio of these indicators R/BOD_5 for selected lakes and rivers of the Akmola region (see Table 3).

The minimum value of the R/BOD_5 ratio was in three lakes: Zhangula, Bolshaya Saryoba, Malaya Saryoba and the maximum value in Zhaltyrkol Lake, Koikkeldy Lake, and Yesil River.

Table 3. Average annual oxygen indicators of surface water Akmola region

№	**Surfacewater Akmolaregion**	**The amount of dissolved oxygen (R), mg/l**	**BOD_5, mg/dm^3**	**R / BOD_5**
1	Lake Zhaltyrgol(Arhaniya)	7.56	0.5	15.12
2	Esil river	8.24	0.5	16.48
3	Lake Koikeldy	8.51	0.5	17.02
4	Lake Small Saryoba	7.27	2.15	3.3
5	Lake Zhangula	8.27	1.49	5.5
6	Lake Big Saryoba	7.06	0.96	7.3

Comparing the self-cleaning capacity of the lakes with each other, one can see that they are divided into 2 groups: water bodies with a high R/BOD_5 ratio: Zhaltyrkol lake (15.12), Yesil river (16.48), Koikeldy lake (17.02). As well as lakes with low R/BOD_5: Zhangula lake (5.5), Lake Big Saryoba (7.3), Lake SmallSaryoba (3.3). Between these two groups of intermediate values of R/BOD_5 in the territory of Arshalyn districts were not identified.

The hydrobiological characteristics of lakes are an identification of the dominant indicator species of hydrobionts (see Table 4).

In total, in the studied water bodies, we identified 39 species of phytoplankton and 21 species of zooplankton (see Table 4).

Of diatoms identified – *Melosira varians* Ag., *Melosiraarenaria* Moore., *Diatoma vulgare* Bory., *Synedra ulna* (Nitzsch.) Ehr., *Synedra tabulata* (Ag.) Kütz., *Cocconeis pediculus* Ehr., *Cocconeis placentula* Ehr., *Rhoicosphenia curvata* (Kütz.) Grun., *Navicula cuspidate* Kütz, *Navicula radiosa* Kütz, *Navicula exigua* (Greg.) J.Müll., *Navicula humerosa* Breb., *Caloneis amphisbaena* (Bory) Cl., *Girosigma strigile* (W.Sm.) Cl., *Girosigma Spenseri* (W.Sm.) Cl., *Girosigmabalticum* (Ehr.) Rabenh., *Amphora ovalis* Kütz, *Cymbe llaaffinis* Kütz., *Cymbella* *cistula* (Hemp.) Grun., *Cymbella lanceolata* (Ehr.) V.H., *Gomphonema constrictum* Ehr., *Bacillaria paradoxa* Gmelin, *Nitzschia sigma* (Kütz.) W.Sm., *Symatopleura solea* (Breb.) W.Sm., *Surirella capronii* Breb.

Algae group of Chlorophytasubmitted species – *Cladophora glomerata* (L.) Kütz., *Spirogira crassa* Kütz., *Pediastrum duplex* Meyen., *Scenedesmus acuminatus* (Lag.) Chodat., *Scenedesmus falcatus* Chodat., *Closterium moniliferum* (Bory.) Ehr., *Cosmarium impressulum* Elfv., *Cosmarium punctulatum* Breb.

Blue-green algae mainly include species – *Merismopedia tenuissima* Lemm., *Oscillatoria princeps* Vauch., *Holepedia geminate* Lagerh, *Microcystis aeruginosa* Kutz., *Oscillatoria chalybea* Mertens ex Gomont, *Synechocystis minuscule* Woronich.

Considering the well-known indicator significance of phytoplankton species (Federov 2006), the saprobity of water bodies was calculated according to the PantleBukk method in the Sladechek modification. For the Zhaltyrkol lake S=1.92, for the Koikeldy lake S=1.97, Zhangula lake S=1.88, Big Saryoba lake S=2.07, Small Saryoba lake S=2.0 and Esil river S=1.97.

The dominant species of aquatic organisms in the studied water bodies, besides the fact that they are indicators of saprobity, can also become indicators of self-purification of a water body. In the Phytoplankton Lake Koykeldy dominate: diatoms-*Melosira arenaria* Moore, *Gomphonema constrictum* Ehr., *Bacillaria paradoxa* Gmelin, *Surirella capronii* Breb., from green algae - *Closterium moniliferum* (Bory.) Ehr.

In the lake Zhaltyrkol diatoms dominate - *Synedra ulna* (Nitzsch.) Ehr., *Rhoicosphenia curvata* (Kütz.) Grun., *Navicula exigua* (Greg.) J.Müll., *Girosigma balticum* (Ehr.)Rabenh., *Cymbella cistula* (Hemp.) Grun., *Gomphonema constrictum* Ehr., *Bacillaria paradoxa* Gmelin, and green algae *Cladophora glomerata* (L.) Kütz., from blue-green – *Merismopedia tenuissima* Lemm.

In the Esil River diatoms *Synedra ulna* (Nitzsch.) Ehr., *Navicula exigua* (Greg.) J.Müll., *Girosigma balticum* (Ehr.)Rabenh., *Gomphonema constrictum* Ehr., and green algae *Cladophora glomerata* (L.) Kütz., *Closterium moniliferum* (Bory.) Ehr. from blue-green algae *Merismopedia tenuissima* Lemm.

As a result, the three dominant phytoplankton species can be distinguished in the three lakes with a high self-cleaning ability:

Synedra ulna (Nitzsch.) Ehr., *Navicula exigua* (Greg.) J.Müll., *Girosigma balticum* (Ehr.)Rabenh., *Cladophora glomerata* (L.) Kütz, *Merismopedia tenuissima* Lemm. in the Zhaltyrkol lake and in the Yesil river.

Gomphonema constrictum Ehr., *Bacillaria paradoxa* Gmelin in the lake Zhaltyrkol and Koikeldy.

Gomphonema constrictum Ehr., *Closterium moniliferum* (Bory.) Ehr. in the river Esil and in the lake Koikeldy.

A qualitative study of zooplankton revealed the presence of the following dominant species (see Table 5):

In reservoirs with a high self-cleaning ability (Zhaltyrkol, Esil River, Koygeldy) in two out of three cases, they are found from the section of the *Cladosera - Acroperusharpae* (Baird 1834), *Daphnia galeata*, *Pleuroxus striatus*; from the *Soreroda* department - *Cyclop strenuous*; from *Roster - Euchlanis triquetra*.

In lakes with a low self-cleaning ability, in 2 out of 3 cases it is found from the section of the *Cladosera — Rhynchotalona falcata*; from the *Soreroda* department - *Cyclops strenuus*, *Eurytemora velox*.

The presence of these dominant species in reservoirs with a high self-cleaning ability may indicate both their environmental requirements for environmental factors and that they may participate in the processes of water self-purification.

The influence of various processes and indicators on the self-purification of water, depending on the specific water body and its characteristics, may be equally important. Each of these factors at a certain quantitative value can be decisive for a sharp deterioration in the cleaning capacity of a reservoir.

The obtained overall estimated indicators (WPI, self-cleaning ability, saprobity) were compared for comparison (see Table 6).

The correlation dependencies between self-cleaning ability and saprobity ($R/BOD_5/S$), self-cleaning ability and water pollution index ($R/BOD_5/WPI$), water pollution index and saprobity (WPI/S) were calculated (see Table 7).

A close negative relationship was obtained between the self-cleaning ability of water in water bodies and the saprobity of $r_{R/BOD5/S}$=0.68. This confirms that the R / BOD5 ratio chosen by us can be used as the simplest and informative self-cleaning indicator. So, as it is well known that the deterioration of self-cleaning ability directly affects the increase in saprobity (Bulion and Nikulina 1976).

According to the water bodies studied by us, the self-cleaning ability of water bodies according to oxygen indicators has a negative correlation dependence on the water pollution index with inorganic components $r_{R/BOD5/WPI}$=-0.47. With an increase in the pollution index of inorganic components, the potential ability of water to self-purification decreases.

Table 4. Phytoplankton species in lakes of Arshalinsky district

Kinds of phytoplankton	The relative occurrence of species in points (according to V. Sladechek 1965, 1967M						
	Indicator significance	Lake Zhaltyrkol (Arhaniya)	Esil river	Lake Koikeldy	Lake Small Saryoba	Lake Zhangula	Lake Big Saryoba
Bacillariophyta							
Amphora ovalis Kütz.	2	-	-	2	-	3	2
Bacillaria paradoxa Gmelin	1	4	-	4	-	-	3
Cocconeis pediculus Ehr.	2	-	3	3	-	-	2
Cocconeis placentula Ehr.	2	2	2	-	2	-	2
Caloneis amphisbaena (Bory) Cl.	2	-	-	-	2	2	-
Cymbella affinis Kütz.	2	3	3	2	-	3	-
Cymbella cistula (Hemp.) Grun.	1.8	5	-	-	5	-	-
Cymbella lanceolata (Ehr.) V.H.	2	-	-	-	3	-	-
Diatoma vulgare Bory.	2	-	3	2	-	-	-
Girosigma strigile (W.Sm.)Cl.	1	-	-	3	-	-	-
Girosigma Spenseri (W.Sm.)Cl.	2	2	-	-	2	-	3
Girosigma balticum (Ehr.)Rabenh.	2	5	5	-	-	4	3
Gomphonema constrictum Ehr.	2	5	4	5	-	-	-
Melosira arenaria Moore.	1	3	1	4	2	-	3
Melosira varians Ag.	2	-	3	-	-	3	2
Navicula cuspidate Kütz.	3	-	-	-	3	-	5
Navicula radiosa Kütz	3	3	-	-	3	-	3
Navicula exigua (Greg.) J.Müll.	2	5	5	-	-	3	-
Navicula humerosa Breb.	1	-	3	3	-	-	-
Nitzschia sigma (Kütz.) W.Sm.	3	-	1	-	2	3	-
Rhoicosphenia curvata (Kütz.) Grun.	2	5	-	2	-	2	-
Synedra ulna (Nitzsch.) Ehr.	2	5	5	-	3	-	3
Synedra tabulata (Ag.) Kütz.	2	3	3	2	-	2	-
Symatopleura solea(Breb.) W.Sm.	3	3	3	-	2	-	2
Surirella capronii Breb.	1	-	-	4	-	2	2
Chlorophyta							
Closterium moniliferum (Bory.) Ehr.	2	-	5	4	-	-	4
Cosmarium impressulum Elfv.	2	2	2	-	2	-	-
Cosmarium punctulatum Breb.	1.2	-	3	3	2	-	2
Cladophora glomerata (L.) Kütz.	2.7	5	5	-	-	-	5
Pediastrum duplex Meyen.	2	-	3	2	-	2	2
Spirogira crassa Kütz.	1	3	2	-	3	-	-
Scenedesmus acuminatus (Lag.) Chodat.	2	-	-	2	-	-	-
Scenedesmus falcatus Chodat.	1	-	2	3	-	-	-
Cyanophyta							
Merismopedia tenuissima Lemm.	2	4	4	-	4	-	3
Microcystis aeruginosa Kutz.	2	-	-	3	-	-	-
Holepedia geminate Lagerh	1	-	-	3	-	-	-
Oscillatoria princeps Vauch.	3	-	-	-	-	-	2
Oscillatoria chalybea Mertens ex Gomont	3	-	-	-	-	3	-
Synechocystis minuscule Woronich	1	2	-	-	2	-	2

Table 5. Dominant species of zooplankton in the lakes of Arshalinsky district

Kinds of zooplankton	Lake Zhaltyrkol (Arhaniya)	Esil river	Lake Koigrldy	Lake small Saryoba	Lake Zhangula	Lake big Saryoba
Cladocera						
Acroperus harpae (Baird,1834)		+	+			
Bosmina obtusirostris (Sars, 1861)	+					
Bosmina longispina (Leydig, 1860)			+		+	
Daphnia Longispina (Muller, 1785)					+	
Daphnia galeata (Sars, 1863)	+	+				
*Leptodora kindtii (Focke,*1844)			+	+		
Pleuroxus striatus (Schoedler,1863)	+	+				
Rhynchotalona falcata(G.O. Sars,1861)				+		+
Copepoda						
Acanthocyclops vernalis(Fischer,1853)			+			
Cyclop strenuous(Fischer,1851)	+	+				+
Cyclops strenuus Fischer, 1851				+	+	
Eurytemora velox (Lilljeborg,1853)			+		+	+
Macrocyclops albidus (Jurine, 1820	+					
Rotifera						
Brachionus diversicornic (Daday,1883)		+			+	
Euchlanis triquetra (Ehrenberg,1838)	+		+			
Filina longiseta (Ehrenberg,1834)			+			
Keratella cochlearis (Gosse,1851)	+				+	
Keratella quadrata (Muller, 1786)						
Lepadella patella (Muller,1773)						+
Mesocyclops leucarti (Claus,1857)		+		+		
Testudinella trilobata (Hermann, 1783)	+					

Table 6. Self-cleaning ability, WPI, saprobity indices in water bodies of Arshaly district of Akmola region

Indicators	Lake Koigeldy	Lake Zhaltyrgol (Arhaniya)	Esil river	Lake big Saryoba	Lake Zhangula	Lake small Saryoba
R/BOD_5	17.02	15.12	16.48	7.3	5.5	3.3
WPI	1.07	0.489	0.56	2.75	0.705	1.45
V. Sladechek (1965, 1967[M)])	1.5	1.92	1.97	2.07	2.2	2.0

Table 7. Dependence between the indicators of self-cleaning ability of reservoirs, WPI, saprobity in water bodies of Arshaly district of Akmola region

Correlation dependencies	Correlation coefficient
$r_{R/BOD5/S}$	- 0.68
$r_{R/BOD5/WPI}$	- 0.47
$r_{WPI/S}$	0.14

It is considered that the main role in heterotrophic destruction of organic matter up to 70% belongs to heterotrophic bacterioplankton. Inorganic pollutants are able to inhibit the function of these bacteria. In our work, the dependence of self-cleaning ability on a WPI exists, but is not high. That is, the deterioration of self-purification of the studied water bodies depends not only on the excess of the content of inorganic components (Afanas'ev and Shash 2020; Afanasyev and Shash 2019).

In this work, the dependence of the increase in saprobity on WPI is practically not established: $r_{WPI/S}$=0.14, but the value is nonetheless positive. This may indicate that self-cleaning in our waters may deteriorate with increasing inorganic pollution, but in this case, it is not the main cause of deterioration of saprobity.

Conclusions

1) Water bodies of the Arshaly district of the chloride type, of increased hardness, are generally assessed as clean and very clean by hydrochemical parameters (WPI from 0.489 to 2.75).

2) Despite the fact that the lakes and the Esil river are located on the same territory with the same morphometric and hydrological conditions, they differ in the ratio of oxygen indicators R/BOD_5, which indicates a different self-cleaning ability of water bodies: high self-purification capacity in the Zhaltyrkol lakes (Arhaniya), Koikeldy and in the Esil River; low self-cleaning ability in Zhangula, Bolshaya Saryoba, Malaya Saryoba lakes.

3) In water bodies with high self-cleaning ability, the common dominant species of phytoplankton are diatoms – *Bacillaria paradoxa* Gmelin, *Cocconeis pediculus* Ehr., *Cocconeis placentula* Ehr., *Cymbella affinis* Kütz., *Diatoma vulgare* Bory., *Girosigma balticum* (Ehr.) Rabenh., *Gomphonema constrictum* Ehr., *Melosira arenaria* Moore., *Navicula exigua* (Greg.) J.Müll., *Navicula humerosa* Breb., *Rhoicosphenia curvata* (Kütz.) Grun., *Synedra ulna* (Nitzsch.) Ehr., *Synedra tabulata* (Ag.) Kütz., *Symatopleura solea* (Breb.) W.Sm. green algae – *Closterium moniliferum* (Bory.) Ehr., *Cosmariumim pressulum* Elfv., *Cosmarium punctulatum* Breb., *Cladophora glomerata* (L.) Kütz., *Pediastrum duplex* Meyen., *Spirogira crassa* Kütz., *Scenedesmus falcatus* Chodat., blue-green algae – *Merismopedia tenuissima* Lemm.

Common dominant species of zooplankton: from *Cladocera - Acroperus harpae*, *Daphnia galeata*, *Pleuroxus striatus*, *Copepoda - Cyclop* strenuous, *Rotifera - Euchlanis* triquetra.

4) In lakes with a low potential for self-purification, the common dominant phytoplankton species are: diatoms – *Amphora ovalis* Kütz., *Cocconeis placentula* Ehr. *Caloneis amphisbaena* (Bory) Cl. *Girosigma Spenseri (*W.Sm.)Cl. *Girosigma balticum* (Ehr.) Rabenh., *Melosira varians* Ag., *Navicula cuspidate* Kütz, *Navicula radiosa* Kütz., *Nitzschia sigma (*Kütz.) W.Sm., *Synedra ulna* (Nitzsch.) Ehr., *Symatopleura solea* (Breb.) W.Sm., *Surirella capronii* Breb.; fromgreenalgae – *Cosmarium punctulatum* Breb., *Pediastrum duplex* Meyen., синезеленые водоросли – *Merismopedia tenuissima* Lemm., *Synechocystis minuscula* Woronich.

Common dominant species of zooplankton are: from *Cladocera- Rhynchotalona falcata*; *Copepoda-Cyclops strenuus* Fischer, 1851, *Eurytemora velox*.

5) A close negative relationship was obtained between the self-cleaning ability of water in water bodies and the saprobity of $r_{R/BOD5/S}$=0.68, as well as the self-cleaning ability and water pollution by inorganic components $r_{R/BOD5/WPI}$=-0.47

6) At low levels of WPI (pure and very clean water), a correlation relationship with saprobity was not observed in these studies.

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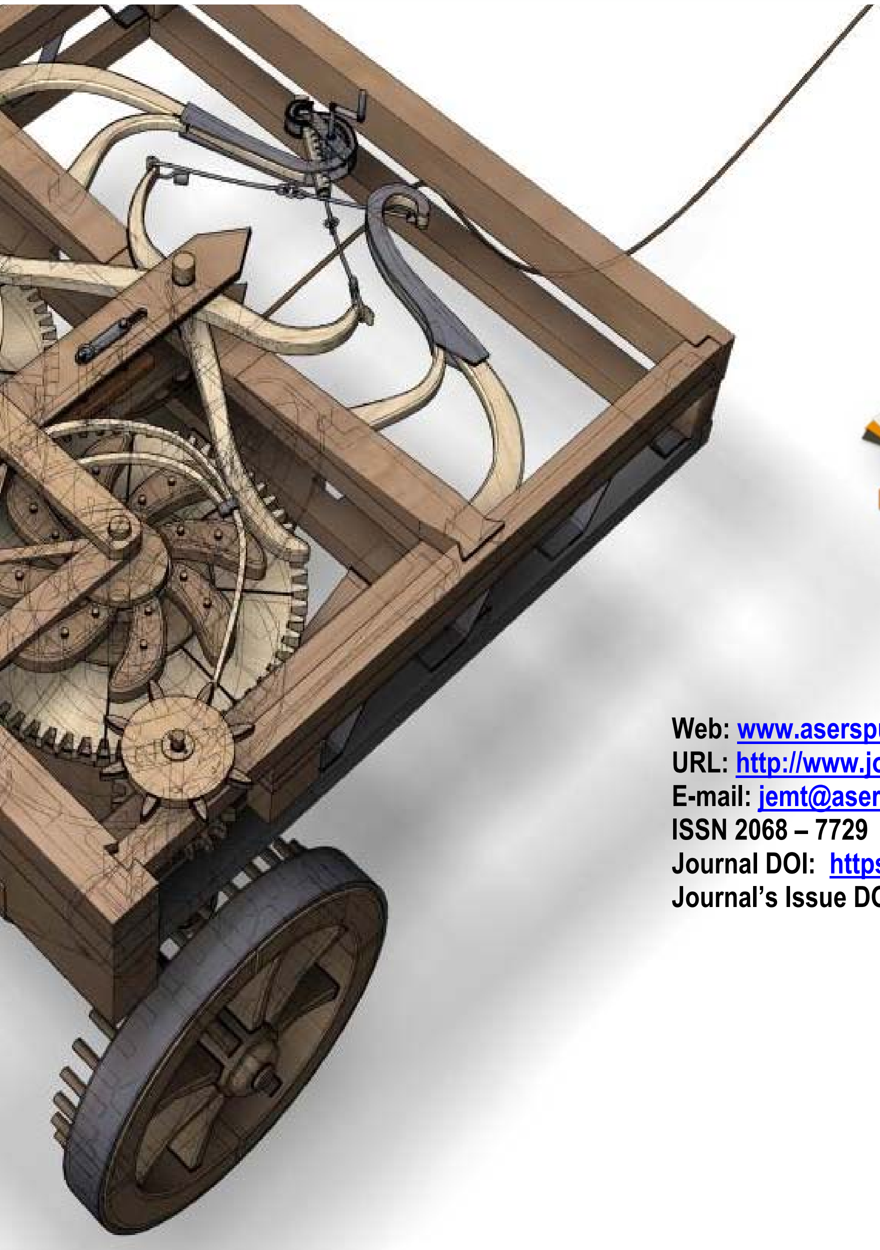

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Journal DOI: https://doi.org/10.14505/jemt
Journal's Issue DOI: https://doi.org/10.14505/jemt.v11.5(45).00