ECOLOGY

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SEASONAL DYNAMICS OF SELF-CLEANING ABILITY OF WATERCOURSES OF THE AKMOLA REGION

L.H. Akbaeva, N.S. Mamytova, E.A. Tulegenov

L.N. Gumiliyev Eurasian national university, Astana, Kazakhstan

Abstract. The seasonal dynamics of the self-cleaning capacity of the rivers of the Akmola region in a highly continental climate was studied. At the same time, such oxygen parameters in water as BOD5 and total oxygen content were taken into account. Rivers of one region differed in the degree of average annual self-cleaning ability. It was found that the processes of self-purification are largely determined by the depth of the rivers, the freezing of water in the rivers in the winter, general chemical pollution.

Key words: self-cleaning, biological oxygen index, oxygen solubility, hydrobionts.

Akmola region is one of the strategic administrative divisions of the territory of the Republic of Kazakhstan. The territory of the region is crossed by a relatively small number of watercourses, which are of important economic and recreational importance. With the growth of the economy, watercourses are experiencing increasing anthropogenic pressure, which affects the natural processes of self-regulation and self-purification [1,2].

A number of authors [Ostraumov S.A., Bulion V.V., Abakumova V.A., Alimov A.F.] attaches particular importance to the self-purification ability of water bodies and watercourses, as an indispensable condition for the preservation of the environmental health of water bodies. This process depends on many conditions: climatic, hydrological and other physical factors, but they pay special attention to the biotic component. Hydrobionts are capable of not only mineralizing organic pollutants, but also accumulate inorganic pollution with subsequent sedimentation. Thus, the quality of the aquatic environment is naturally preserved.

The vital activity of aquatic organisms, the composition of pollutants in a highly continental climate depends on seasonal fluctuations, therefore the self-cleaning ability should change depending on the season [3].

In connection with these studies, the goal was set in the work: to study the dynamics of the self-cleaning capacity of the rivers of the Akmola region by months of the year.

Material and methods

In a comparative aspect, 7 rivers of the Akmola region were studied: Esil, Akbulak, Sarybulak, Bettybulak, Kypshakty, Shagalaly, Nura. Rivers differ in a number of hydrological and hydroecological characteristics [4], which directly or indirectly can affect the self-cleaning potential of water bodies. In the end, certain oxygen conditions are formed, which provide the reservoir with the possibility of mineralization of organic substances by chemical or biological methods.

In the rivers, such oxygen indicators as the amount of dissolved oxygen (R), mg/dm^3 and BOD_5 were studied. The measurements were carried out on a laboratory oxygen-meter Anion 4141 (Russia) under laboratory conditions. Measurements were performed on the day of sampling in triplicate.

Disruption of the balance between the process of photosynthesis and the destruction of organic substances can lead to a deterioration in the self-cleaning ability of watercourses [5,6]. The intensity of photosynthesis can be characterized by the amount of dissolved oxygen in water (R), whereas the activity of mineralization of organic substances by bacteria can be judged by the biological consumption of oxygen, in particular BOD_5. In this case, the ratio R / BOD5 can be used as a rapid

test to assess the self-cleaning potential of the watercourse [4].

We have compiled a number of indicators of the amount of dissolved oxygen (R) and BOD5 in the studied rivers, and also calculated the ratio of these indicators as the characteristics of the photosynthetic activity in the watercourse to its destructive ability: R/BOD_5. The higher this ratio, the higher the self-cleaning capacity of watercourses, and vice versa - the lower the ratio, the lower the self-purification capacity of the watercourse.

Table 1 presents the results of measurements of oxygen content and BOD_5 in rivers from January to December 2018. Also in the table are given the average values of R/BOD_5 per month for all rivers. This indicator was supposed to give information about the seasonal dynamics of self-cleaning ability of all rivers in the region.

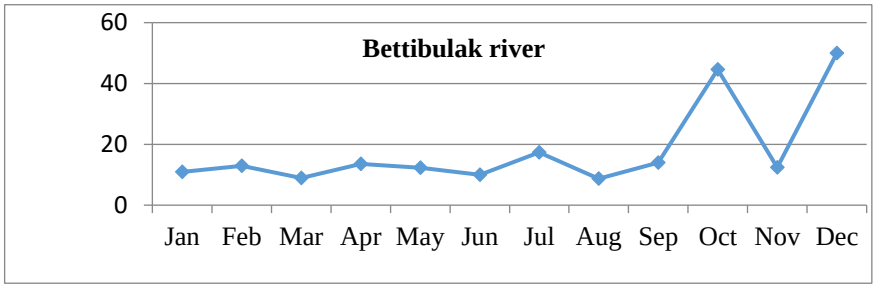
Table 1 - Seasonal indicators of oxygen and BOD5 in the rivers of the Akmola region

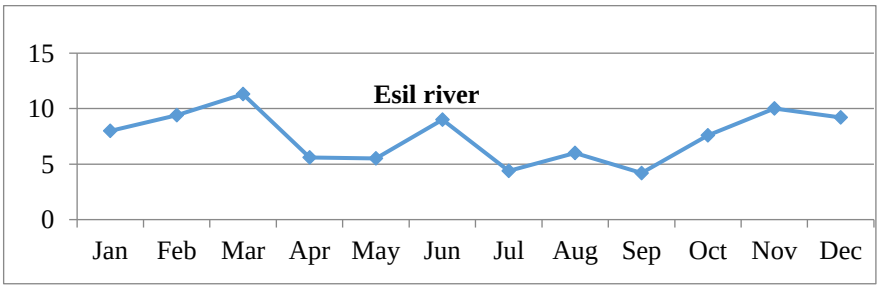
Month	Oxygenindicator	Esil river	Akbulak river	Sarybulak river	Bettibulak river	Kypshakty river	Shagalaly river	Nura river	Average value R / BOD5 month for all rivers
January	R, mg / l	10.6	9.98	10.26	10.72	5.14	9.33	8.61	5.8±1.2
	BOD_5mg / l	1.32	1.58	3.20	0.99	2.62	1.97	1.64	
	R / BOD_5	8	6.4	3.2	10.9	2	4.8	5.25	
February	R, mg / l	10.91	10.35	10.36	10.39	4.48	8.88	9.02	6.7±1.6
	BOD_5mg / l	1.17	0.97	3.13	0.81	2.45	1.13	1.09	
	R / BOD_5	9.4	10.7	3.4	12.9	1.8	7.9	1	
March	R, mg / l	11.00	10.29	9.84	10.25	4.26	10.66	8.23	6.4±1.3
	BOD_5mg / l	0.98	1.32	1.51	1.15	3.10	2.61	1.53	
	R / BOD_5	11.3	7.8	6.5	8.9	1.4	4	5.4	
April	R, mg / l	11.90	9.93	7.6	11.07	8.76	10.97	10.75	5.2±1.6
	BOD_5mg / l	2.14	1.44	4.12	0.81	4.76	5.9	2.21	
	R / BOD_5	5.6	6.9	1.9	13.6	1.8	1.8	4.8	
May	R, mg / l	10.26	11.23	9.38	9.92	7.23	8.77	9.62	6.2±1.4
	BOD_5mg / l	1.85	1.16	5.37	0.81	1.72	1.72	1.80	
	R / BOD_5	5.5	9.6	1.7	12.3	4.2	5	5.3	
June	R, mg / l	9.27	10.93	7.90	8.44	8.18	8.28	9.39	6.1±1.2
	BOD_5mg / l	1.03	1.31	3.64	0.83	6.89	1.39	1.47	
	R / BOD_5	9	8.3	2.1	10	1.1	6	6.4	
July	R, mg / l	8.12	6.91	4.27	8.45	6.72	7.79	8.18	5.5±2.2
	BOD_5mg / l	1.86	1.52	3.68	0.49	1.47	1.81	3.51	
	R / BOD_5	4.4	4.5	1.2	17.3	4.6	4.4	2.4	
August	R, mg / l	10.71	10.83	6.66	8.57	7.18	10.04	12.40	4.2±0.9
	BOD_5mg / l	1.81	2.01	3.61	0.99	3.67	4.25	4.26	
	R / BOD_5	6	5.4	1.9	8.7	2	2.4	3	
September	R, mg / l	10.30	9.68	8.28	9.06	7.66	9.132	11.60	5.6±1.5
	BOD_5mg / l	2.48	2.19	2.85	0.65	2.12	1.30	4.08	
	R / BOD_5	4.2	4.5	3	14	3.7	7	2.8	
October	R, mg / l	13.94	10.87	8.74	13.36	7.26	8.88	14.87	11.3±5.8
	BOD_5mg / l	1.82	2.16	3.43	0.30	1.06	1.17	2.72	
	R / BOD_5	7.6	5	2.5	44.6	6.8	7.5	5.5	

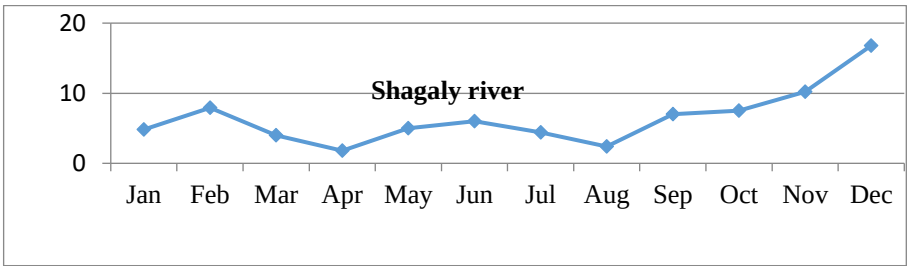
November	R, mg / l	14.15	10.38	10.24	10.01	11.18	10.69	15.10	6.9±1.3
	BOD_5mg / l	1.40	4.33	3.98	0.81	4.16	1.05	1.85	
	R / BOD_5	10	2.4	2.6	12.4	2.8	10.2	8.2	
December	R, mg / l	12.49	9.11	8.75	8.62	4.26	8.20	8.44	12.5±6.6
	BOD_5mg / l	1.37	3.13	3.81	0.17	2.21	0.49	1.97	
	R / BOD_5	9.2	3	2.3	50	2	16.8	4.2	

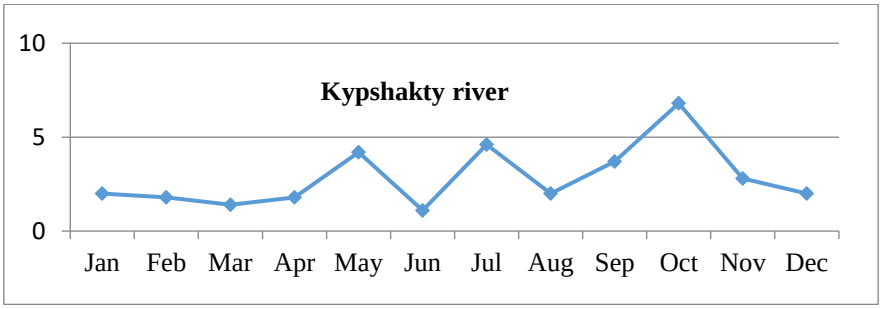
Self-cleaning capacity in the rivers of the Akmola region from January to December 2018 is presented in Figure 1. On average, from January and the warm season to October, the R BOD_5 ratio of rivers decreases and ranges from 4.2±0.9 to 6.2±1.4. In the cold season, the values of the R/BOD5 ratio increase and reach up to 11.3±5.8 in October and 12.5±6.6 months. The explanation of this phenomenon can be given based on the fact that in the cold season, on the one hand, the bioproductivity decreases, and hence the flow of autochontal dead organic matter into rivers.Consequently, in the cold season, the processes of self-purification in water bodies are quite intensive. However, since the second half of the winter in January, the R / BOD5 ratio drops sharply in all rivers. This phenomenon can be explained by the fact that rivers are covered with ice, and the consumption of oxygen is not replenished both by atmospheric oxygen and photosynthesis. Therefore, in the smallest rivers, such as Akbulak and Sarybulak, with a decrease in temperature, self-purification of water courses falls.

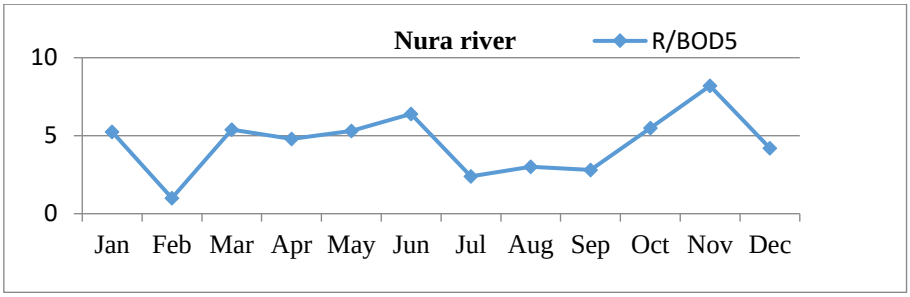
In general, in rivers there is no significant difference in the dynamics of self-cleaning in the warm season, which is a consequence of the constant movement of water. Thus, in the Esil River one can observe peaks of increased self-purification in March (R/BOD_5–11.3), June (R/BOD_5–9), November (R/BOD_5–10). In the Akbulak River in February (R/BOD_5–10.7), May (R/BOD_5–9.6). In the Sarybulak River - in March (R/BOD_5-6.5). In the Kypshakty River - in May (R/BOD_5-4.2), July (R/BOD_5-4.6), October (R/BOD_5-6.8). In the Nura River - in March (R/BOD_5–10.75), June (R/BOD_5–6.4).

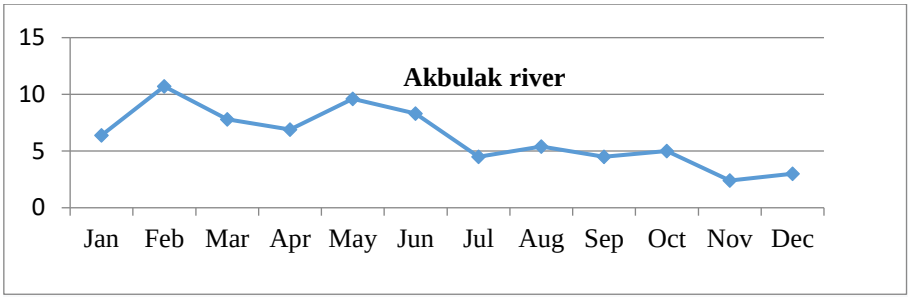












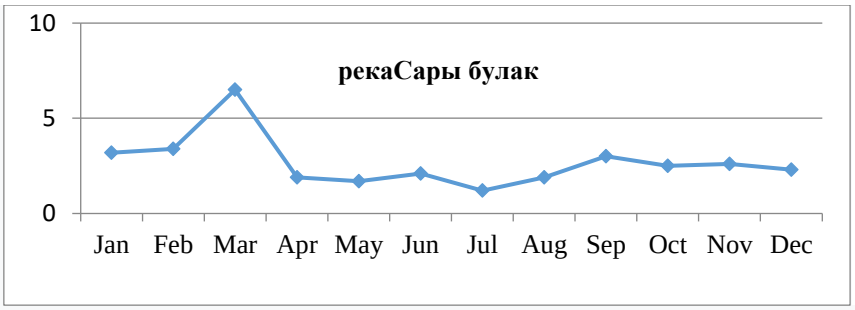


Figure 1. Self-cleaning ability in the rivers of the Akmola region from January to December 2018 in terms of R / BOD5

The average annual R/BOD_5 values for each watercourse made it possible to compare the rivers to each other (Table 2).

The Bettybulak River has a relatively high average annual cleansing capacity (R/BOD_5 17.9) (Table 2).

In this series of rivers, the average self-cleaning capacity is in Esil (R/BOD_5 7.5), in the Chagala River (R/BOD_5 6.4), in the Akbulak River (R/BOD_5 .6.2) and Nura (R/BOD_5 4.5).

The lowest cleaning capacity among the studied watercourses according to oxygen indicators was shown by the Kypshakty River (R/BOD_5 2.85) and Sarybulak (R/BOD_5 2.6). It is known that this is one of the most polluted rivers, especially the Sarybulak River, in whose water the content exceeds the MPC [7].

Thus, self-cleaning in rivers is greatly influenced by general pollutant pollution.

Table 2 - The average annual ratio of R/BOD_5 in water tanks Akmola region

Rivers	Average annual R/BOD_5	The relative degree of self-cleaning ability of watercourses
Bettibulak	17.9	high
Esil	7.5	middle
Shagalaly	6.4	
Akbulak	6.2	
Nura	4.5	
Kypshakty	2.85	low
Sarybulak	2.6	

Conclusion

1. In watercourses, there is no single pattern for all rivers in the dynamics of water self-purification.

2. In the relatively deep rivers Bettybulak, Esil, Shagaly, Nura, there is an increase in self-cleaning processes from October until the end of December, and in the second half of winter the processes of self-purification drop sharply.

3. In the small rivers Akbulak and Sarybulak, the processes of self-purification deteriorate with decreasing temperature.

4. Rivers can be divided by average annual indicators Akbulak and Sarybulak into waterways with high (Bettybulak), medium (Esil, Shagaly, Akbulak, Nura) and low (Kypshakty, Sarybulak) ability to self-purification.

5. The self-purification processes are influenced by the pollution of river water with chemical pollutants - the Sarybulak River.

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