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Satbayev University

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ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ
НАУК РЕСПУБЛИКИ
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THE EFFECT OF SYRDARYA RIVER RUNOFF ON THE ECOLOGICAL STATE OF WATERS THE SMALL ARAL SEA

Abstract. This scientific work examines the hydroecological state of the waters of the Syrdarya River and the Small Aral Sea during their ecological degradation. The analysis of the formation of the regime of the aquatic ecosystem under the influence of river water runoff affecting salt exchange and metomorphization of the composition of marine waters under the influence of anthropogenic factors is carried out. Annual flows of p. The Syr Darya in the lower reaches is characterized by instability over a long period of time, which is due to both natural and anthropogenic factors. After the construction of the Kokaral dam, the hydroecological state of the Small Aral Sea underwent some changes in relation to the hydrochemical regime of waters. The waters of the Syrdarya river after the growing season are enriched with chemical compounds from runoff from irrigation fields. The maximum concentrations of such compounds occur in the low runoff of the low-water period of the Syrdarya River, which gives more background pollution with various toxicants in general.

In recent years, 4 years from 2017 to 2021, there has been low water in the Aral-Syrdarya basin. The low flow of the Syrdarya River leads to a decrease in the water level in all reservoirs of the basin, in summer periods acute water shortage negatively affects the existence of hydrobionts. The main negative consequences of this influence are a decrease in the concentration of oxygen in the water, an increase in salinity and toxic compounds. Conducting monitoring work to assess the hydroecological state of the aquatic ecosystem allows timely identification of negative impacts.

Key words: Syrdaria River, Small Aral Sea, runoff, discharge, pesticides, hydrochemical

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КІШІ АРАЛ ТЕҢІЗ СУЛАРЫНЫҢ ЭКОЛОГИЯЛЫҚ ЖАҒДАЙЫНА СЫРДАРЬЯ ӨЗЕН АҒЫСЫНЫҢ ӘСЕРІ

Аннотация. Бұл жұмыста Сырдария өзені мен Кіші Арал теңізі суларының экологиялық дағдарыс кезеңіндегі гидроэкологиялық жағдайы қарастырылады. Антропогендік факторлардың әсер ету жағдайында теңіз суларының құрамына тұз алмасу мен метоморфизацияға ұшырайтын өзеннің су ағысының экожүйелік режимінің қалыптасуына талдау жүргізілді. Сырдария өзенінің жылдық ағыстары төменгі сағасының көпжылдық кезеңде тұрақсыздықпен сипатталады, бұл табиғи және антропогендік факторларға байланысты екенін көрсетті. Көкарал бөгетін салғаннан кейін Кіші Арал теңізінің гидроэкологиялық жағдайы судың гидрохимиялық режиміне қатысты бірқатар өзгерістерге ұшырады. Сырдария өзенінің суы вегетациялық кезеңнен кейін суару алқаптарынан ағатын химиялық қосылыстармен байытылады. Мұндай қосылыстардың ең жоғары концентрациясы Сырдария өзенінің суы аз кезеңіндегі төменгі ағысқа келеді, бұл тұтастай алғанда әртүрлі токсиканттармен фондық ластануды береді.

Соңғы төрт жылда 2017 жылдан 2021 жылға дейін Арал-Сырдария бассейнінде судың аздығы байқалады. Сырдария өзенінің төмен ағысы бассейннің барлық су айдындарында су деңгейінің төмендеуіне алып келеді, жазғы кезеңдерде судың жетіспеушілігі гидробионттардың болуына теріс

әсер етеді. Бұл әсердің негізгі теріс салдары – судағы оттегінің концентрациясының төмендеуі, тұздылық пен улы қосылыстардың жоғарылауы. Су экожүйесінің гидроэкологиялық жағдайын бағалау бойынша мониторингтік жұмыстарды жүргізу жағымсыз әсерлерді уақтылы анықтауға мүмкіндік береді.

Түйін сөздер: Сырдарья өзені, Кіші Арал теңізі, өзен ағысы, шығыс, пестицидтер, гидрохимия.

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ВЛИЯНИЕ СТОКА р. СЫРДАРЬЯ НА ЭКОЛОГИЧЕСКОЕ СОСТОЯНИЕ ВОД МАЛОГО АРАЛЬСКОГО МОРЯ

Аннотация. В данной работе рассматривается гидроэкологическое состояние вод р. Сырдарья и Малого Аральского моря в период их экологической деградации. Проводится анализ формирования режима водной экосистемы под воздействием стока речных вод, влияющих на солеобмен и метоморфизацию состава морских вод в условиях влияния антропогенных факторов. Годовые стоки р.Сырдарья в нижнем течении за многолетний период характеризуется нестабильностью, что обусловлено как природными, так и антропогенными факторами. После сооружения Кокаральской плотины гидроэкологическое состояние Малого Аральского моря подверглось некоторым изменениям в отношении гидрохимического режима вод. Воды р. Сырдарья после вегетационного периода обогащаются химическими соединениями из стока с полей орошения. Максимальные концентрации таких соединений приходятся на низкий сток маловодного периода р. Сырдарья, что более выдает фоновое загрязнение с различными токсикантами в целом.

За последние четыре года – с 2017 по 2021 гг. – на Арало-Сырдаринском бассейне наблюдается маловодье. Низкий сток р.Сырдарья приводит к снижению уровня воды во всех водоемах бассейна, в летние периоды острая нехватка воды отрицательно влияет на существование гидробионтов.

Основные негативные последствия этого влияния – снижение концентрации кислорода в воде, рост солености и токсичных соединений. Проведение мониторинговых работ по оценке гидроэкологического состояния водной экосистемы позволяет своевременно выявлять негативные воздействия.

Ключевые слова: река Сырдарья, Малое Аральское море, речной сток, расход, пестициды, гидрохимический.

Introduction. On the scale of global anthropogenic degradation of all components of the natural environment of the Aral Sea region, a separate important problem is the study of deep changes in the aquatic environment of the reservoirs of the Aral Basin.

The main changes that have occurred since the beginning of the drying of the Aral Sea include the following:

- the continuing drop in the surface level of the Great Aral Sea, salinization of its waters to 120-160%, the dismemberment of the sea into separate relatively deep-water areas (Izhitskiy et al., 2016; Izhitskiy et al., 2021);
- significant changes in the aquatic ecosystem of the Small Aral Sea: ongoing processes of water desalination (Andrulionis et al., 2022), formation of specific hydrochemical (Izhitskaya et al., 2019) and toxicological regimes, restoration of native species of hydrofauna.
- transformation of the Syrdarya River in the years of the greatest environmental stress into a natural channel for the discharge of collector and drainage waters saturated with pesticides, fertilizers and salts entering the Small Aral Sea.

After the separation of the Small (Northern) Aral Sea from the southern part of the sea, its level continuously decreased, the process of intensive salinization continued. However, with the commissioning of the Kokaral earthen dam in 1996, as well as with the supply of Syrdarya water to the Small Sea, from 1989 to 1998 in a volume of 3 to 8 km^3, for the first time in the last 30 years, the fall in the level of the Small Sea was stopped.

The salinity value has significantly decreased in comparison with 1992, in absolute terms, the average salinity for the compared period decreased by 6.5%, the maximum – by 11.1%.

Analyzing the data of long-term materials for the period from 1780 to 2019, the change in the state of the Aral Sea can be divided into 3 periods: 1. The Aral Sea during the period of natural formation (1780-1960). 2. The Aral Sea during the period of intensive water level decline (1960 - 1987). 3. The Aral Sea after its division into two parts (the Big and Small Sea 1987 – 2019).

The rise in the level of the Small Sea led to the partial filling of previously dried-up bays, and fourth, the threat of self-deepening and self-extension of the channel from the Small to the Big Sea was eliminated, which could lead to the collapse of a single water area of the Small Aral.

According to the international agreements of the Central Asian states, the share of the Aral Sea and the deltas of the Syrdarya and Amudarya rivers was estimated at 4,5 km^3 per year for water supply, of which 3,0 km^3 along the Amudarya River is below the Takhiatash hydroelectric complex (the minimum volume of sanitary releases (Kipshakbaev et al., 2002). It is known that in order to preserve the Aral Sea at the current level (Large and Small Seas), the water supply according to approximate calculations is estimated at 8-10 km^3, while the need of the Syr Darya and Amu Darya deltas is 6,0 km^3. The systematic study of the influence of these and a number of many different factors on the formation of the biological and hydrochemical regime of the reservoirs of the basin, the creation of hydraulic structures is undoubtedly of scientific interest and can outline ways of optimal functioning of aquatic ecosystems in conditions of a variety of anthropogenic influences. The purpose of our research is to assess the state of the hydroecological state of the Small Aral Sea.

Materials. The necessity and significance of the study are related to the fact that the physical, chemical and biological regimes of the Small Aral Sea, which has lost about 90% of its volume over the past half century as a result of the combined effect of anthropogenic load and global climate change, are in the process of radical restructuring taking place before our eyes. These processes are studied relatively poorly. As you know, in the lower reaches of the Syrdarya River, already in the second half of the last century, there was an acute shortage of water, and about 30 years ago, the flow was reduced to almost zero at its mouth. But at the end of the 80 years on the territory of the former USSR, people's views on the state of the environment changed a lot, and the dekhans of the Syr Darya began to take more care of water resources. As a result, already in the early 90s, water along the Syrdarya River began to flow regularly into the northern part of the Aral Sea (Amirgaliev, 2007). Although the volume of this water was about 2-4 times less than the amount of natural runoff (14,9 km^3), it was enough to water a significant part of the modern Small Aral Sea, thereby starting the desalination process itself. If in 2010, the value of the annual runoff at the mouth of the Syrdarya River reached 10 km^3, at present the value does not exceed the limits of 4,4 km^3.

Analyzing the values of annual water runoff according to the Kyzylorda Center "Kazhydromet", the maximum flow of the Syrdarya River into the Small Aral Sea over the past ten years was noted in 2010 – 9198 million m^3. In 2011, the annual flow was 4636 (million m^3), such a decrease in runoff, apparently, is associated with the intake of water to irrigated there is a significant amount of land in summer and autumn. Analyzing the data for 2012-2014, the values amounted to 4,106-5,134 million m^3.

The value for 7 months of 2015 amounted to 3.473 million m^3, for the 8th month of 2016 amounted to 2600 million m^3 as can be seen, the trend decreased every year, in 2018 and 2019 there is a decrease in runoff to a minimum value. The entire summer period of 2019, the river almost became shallow, and only by the beginning of September there was a release of water from the upper reaches.

On the territory of the Kyzylorda region, there are about 170 collector-drainage water discharges, which significantly affects the formation and accumulation of polluting properties on the river and sea. The main polluting subjects are water discharges from farmland – rice fields, melon cultivation and td, saturated with nitrogenous and nitrate compounds. In the toxicological regime, the concentration of heavy metals at times slightly exceeds the regulatory values of the maximum permissible concentrations (MPC), since there are no particularly polluting facilities of factories and factories within the Kyzylorda region.

The degree of content of biogenic elements in the waters of the Syrdarya River and the Small Sea remains significant today. The concentration of nitrogenous and nitrate groups is always higher than the MPC values. The ongoing anthropogenic pollution of the aquatic ecosystem of the Aral Small Sea and the Syrdarya River by transboundary runoff and discharge of industrial, agricultural and household wastewater into them is currently an important problem. According to the Environmental Information Bulletins, back in 1998-2000, the water of the Syrdarya river was characterized by the degree of contamination in the vast majority of cases as polluted with values higher than 2.5. Priority polluting indicators are petroleum products, pesticides, phenols – up to 3.0-4.2 MPC, nitrogen compounds up to 3.0 MPC, copper 2-4 MPC. Thus, the study of the hydroecological state of the waters of the Syrdarya River and its impact on the ecosystem of the Small Aral Sea is the most important scientific task.

Research methodology. Hydrological studies on the calculation of the water level and volume were carried out quarterly, and these data were compared with the indicators of Kazhydromet. Hydrochemical observations were carried out throughout the water area of the Small Aral Sea at 16 observation points. Sampling was carried out from the surface and bottom layers of water according to generally accepted methods (Abdimutalip et.al., 2017). The content of oxygen dissolved in water was determined by the Samara-2B analyzer, the hydrogen index – CONSORT–C932. Instrumental determination was duplicated by laboratory methods. Determination of the ionic composition and properties of water was carried out in the laboratory by titrimetric and colorimetric methods according to existing methods. The determination of the water class by mineralization and the content of basic ions was carried out according to the methodology of O.A. Alekin (Alekin, 1959). The data on the toxicological state of the water of the Small Aral Sea were presented by the certified laboratory "Kazecoanalysis" (Kazecoanalysis, No. 1-15 2015).

Research results. The Syr Darya River was significantly regulated in the first half of the last century. Since then, the highest monthly water consumption is typical for the beginning of spring, the minimum – for the entire summer period. This distribution of river flow is due to large volumes of water for irrigation of agricultural fields in the upper and middle reaches. The spring flood in the lower reaches of the Syrdarya River usually begins in late March and early April. Then, due to the filling of the overlying reservoirs and water intakes, along with the level rise, a decline begins in April (Figure 1).

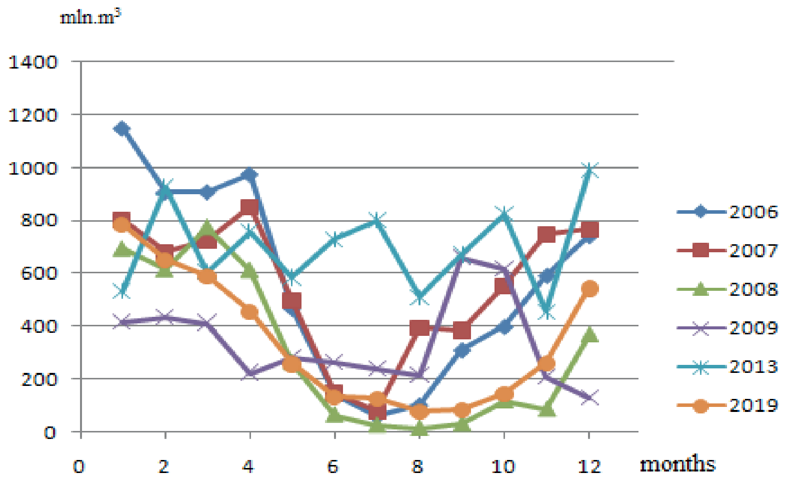

Figure 1 – Graphs of intra-annual distribution of the Syrdarya river run off for individual years

Analysis of water consumption for the period from May 20 to June 20 during the study period shows a sharp drop during this period from 97.5 m^3/s from May 26 to 53.7 m^3/s - until June 20. This in turn causes a decrease in the water level, which creates unfavorable conditions for the natural reproduction of fish. Downstream of the Syr Darya River in the Kokbulak and Tomenaryk channels, there is a decrease in runoff. The decrease is severe in the lower, closing basin of the Syrdarya River, the alignment is significantly lower than in the Tomenaryk. It is likely that the increase in water intakes in the upper reaches of the river caused a decrease in flooding in the Tomenaryk –Kazalinsk section. As a result, the flow costs for irrigation in the upper and lower reaches of the river were partially offset by a reduction in river water losses due to spills in the floodplain of the lower reaches (Bostanova et.al., 2016).

Analyzing the loss of river flow for one month (June), in comparison with the hydraulic posts, you can see a reduction in flow by 1-g/post -703 million m^3, by 2- g/post -56 million m^3, by 3- g/post -15 million m^3, by 4- g/post -88.5 million m^3, by 5- g /post -30 million m^3. Such a significant difference in the loss of river flow is associated with a large fence for irrigation of melon crops and irrigated pastures, starting from g /post Tasboget to g/post Kazaly. The loss of runoff at each g/post averages 60 million m^3 of water (Table 1).

Table 1 – Monthly distribution of the flow of the lower reaches of the Syrdarya river by hydraulic posts (million m^3)

Hydro posts	Months											
	January	February	March	April	May	June	July	August	september	October	November	December
Syrdaria -Koktobe	693	337	107	428	659	918	89	615	309	202	602	650
Syrdaria -Tasboget	459	359	145	149	111	215	191	292	286	113	348	-
Syrdaria-Karaozek	389	277	57,9	34,1	72,8	159	171	312	177	47,7	263	373
Syrdaria -Zhosaly	217	190	118	105	97,3	144	138	166	156	102	207	245
Syrdaria -Kazaly	443	405	72,2	83,4	26,6	55,5	107	216	207	54,6	189	333
Syrdaria- Karateren	334	274	139	33	26,8	25,5	88,1	70,3	289	102	180	199

The lowest monthly expenses (in some years - 6-10 m^3/s or 16-50 million m^3) at the mouth of the river are observed in the summer months, when irrigation of agricultural land is in full swing. With such a flow rate, the movement of water in the main riverbed is practically not detected by a conventional hydrometric turntable.

At the end of the irrigation season, the water flow in the river increases again and reaches up to 150-200 m^3/s. Currently, the new mouth of the Syrdarya River is branched into dozens of branches having very different sizes. Most of the arms are shallow, overgrown with reeds and are not of interest as a fish walker. During the summer autumn, most of them dry up, and the main channels greatly slow down the currents, the estuary bar is exposed.

The extensive networks of irrigation and collector channels located lead to a strong change in the flow regime along the river not only during the irrigation season, but also throughout the autumn-winter period. The latter is due to the fact that each regulator (dam with sluices) accumulates a certain amount of water even during the absence of irrigation, and this often happens purposefully in order to save settlements from flooding (Kipshakbaev et.al., 2010). However, the above-mentioned irrigation channels located in the middle and lower reaches of the Syrdarya River, built mainly during the Soviet period, are not “sheathed” with anti-filtration materials. As a result, a significant part of the water supplied through the channel penetrates through their walls, forming huge swamps stretched along the shores. Their areas reach hundreds and thousands of hectares. A very large amount of water evaporates from their surface every year, and is also filtered into the soil, that is, a huge amount of the runoff of the Syrdarya River is wasted.

The sources of anthropogenic pollution of the Small Aral Sea in the Kazakh part of the basin are mainly the transboundary influx of toxicants (pesticides, metals, etc.) along the Syrdarya River, as well as agricultural and industrial facilities located in the republic.

Intensive intake of collector –drainage waters from irrigated massifs into the river network in the summer and autumn periods and the flushing of pesticides from the surface of the catchment area and irrigated lands during winter thaws and spring snowmelt are the main factors of pollution and changes in the composition and properties of water, also affecting salinity in general. Interannual and seasonal fluctuations in water runoff over many years, due to the influence of various natural and anthropogenic factors, as well as violation of the natural water-salt regime of soils of vast territories of the river basin and unreasonable irrigation, can significantly change the nature of the denudation process of the basin and the chemical composition of the river runoff carried into the Small Aral Sea (Amirgaliev et.al., 2003).

The change in salt runoff is mainly due to the continuous salinization of river waters under the influence of collector-drainage runoff formed in various river flows and conditions of general violation of the natural salt regime of soils and groundwater in the catchment area. During periods of reduced water runoff and increased anthropogenic impacts, the river is characterized by a decrease in the relative index of calcium and bicarbonates, the comparative constancy of magnesium ions, which is associated with an increase in the removal of the proportion of sulfate compounds from their basins. The process of diffusion mixing of salts, directed towards equalizing the concentrations of solutions, is accelerated under the influence of wind mixing of water masses, the difference in their density, temperatures. The diffusion rate is proportional to the gradient of salt concentrations in solutions. This explains the observed increase in the intensity of desalination of the sea in years of higher salinity.

The main ionic effluents are characteristic of sulfates, and among the cations, the effluents of alkali metals and calcium by seasons mainly correspond to the distribution of water runoff during the year. The runoff of mineral salts (45-59%) occurs in the spring and summer months. The volume of salt runoff of rivers primarily depends on water runoff, there can be no direct proportionality between these indicators due to differences in water mineralization. In the conditions of the natural regime and in the initial stages of anthropogenic load (1937-1970), the relationship between these indicators changed from 0,44 to 0,94. In subsequent periods of increased anthropogenic impact, it increased to 1,55 – 1,87. This period is naturally characterized by a decrease in salt runoff and its indicator.

Characterizing the composition of the water of the Syrdarya river according to Alekin's classification, the water is sulfate-chloride type II (Alekin, 1953; Yu, 1973). The subsequent chain of mineralization can be formulated by the following scheme:

$$Ca_{II} \xrightarrow{Ca} \quad S_{II} \xrightarrow{Ca} \quad S_{II} \xrightarrow{Mg\ Ca} \quad S_{II} \xrightarrow{NaMg}$$

The content of ammonium and nitrate nitrogen in water is subject to seasonal fluctuations. The concentration of ammonium nitrogen in river water is contained in the range of 0,15-0,32 mg /dm^3, nitrates – 2,06-6,25 mg /dm^3, mineral phosphorus 0,020-0,098 mg /dm^3. Fluctuations in the content of biogens in the long-term aspect is uneven, as it is caused by water runoff and the intra-annual cycle, many biological processes are associated with abiotic factors. In recent years, there has been an increase in ammonium and nitrate nitrogen, as well as mineral phosphorus, the concentration of which reaches the values of the MPC of the regulatory level for fisheries significance. Seasonal fluctuations of biogenic elements are distributed unevenly, excess is observed in spring periods.

An increase in the concentration of phosphorous compounds according to research data is recorded above the sections of the Syrdarya River in the South Kazakhstan region. One of the reasons is obviously related to an anthropogenic factor, such as an increase in the amount of phosphorus fertilizers used in the basin in recent years, during the period of increasing water runoff, which amplify erosion processes in the basin.

The main sources of pollution areSyrdarya rivers are the discharge of collector-drainage waters from rice and cotton fields. As is known, pesticides such as dichlorodiphenyltrichloromethylmethane (DDT), aldrin, heptachlor, etc., as well as industrial chemicals, polychlorobiphinyls (PCBs) and hexachlorobenzene are among the 12 persistent organic pollutants (POPs) defined by the Stockholm Convention in 2000. Taking into account the dangerous impact on the natural environment and the possibility of leading to irreversible processes at the genetic level in the "Concept of Environmental Safety" of the Republic of Kazakhstan for 2004-2015yy, a program for control, monitoring and management of persistent organic pollutants has been developed (Decree, No. 1241-2003-03.12).

This document also states that, despite the huge variety of new plant protection products, various pesticides are still found in the analyzed samples on the territory of Kazakhstan. The basin of the Syrdarya River is not in this relationship either. According to available data, only from 1975y to 1990y, more than 1015 thousand tons of pesticides were used in the Aral Sea region, on average 20-25 kg per 1 ha per year. During this period, more than 55 million tons of mineral fertilizers were used in the Aral Sea region, an average of 400 kg and 1 ha per year. According to Kazhydromet data, in 1986-1990yy, the total concentration of hexachlorocyclohexane γ isomer (HCG) and DDT metabolites in the water of the Syrdarya River at the Kokbulak transboundary alignment reached 0,376 and 0,397 micrograms/dm^3, respectively. The maximum concentrations of DDT metabolites up to 1,939-4,906 mcg/dm^3 were observed in the Kyzylorda region in the summer, while the HCG content increased to 0,824 mcg/dm^3. Downstream in Kazalinsk, near the Aral Sea, HCG and DDT were detected in the spring in amounts up to 1,022 and 0,892 micrograms/dm^3, respectively. Despite the agreements adopted over the past 15 years on water problems in Central Asia and the requirements of international documents on regulating the issue of sharing water resources of transboundary watercourses along the Syrdarya River, the influx of pollutants into Kazakhstan from the territory of neighboring states continues (Toleubaeva, 2006).

The entry of pesticides into the river network and their transformation within the water basin obviously depends not only on the water content of the year in the river basin. The dynamics of the removal of toxicants from irrigated massifs is due to a number of factors, including the amount of pesticides used in the basin, drainage conditions of irrigated mapsives and river valleys, temperature conditions, precipitation in certain seasons.

According to the results of studies in the intra-annual regime of pesticide concentrations in river water, two peaks were established. The first peak falls on the period from September to November and is due to the intensive flow of collector-drainage waters from irrigated massifs into the river network. The second peak is observed in early spring and occurs as a result of the flushing of pesticides from the surface of the catchment area and irrigated lands during winter thaws and spring snowmelt. In June and July, the concentration of pesticides in the water of the Syrdarya river is minimal or absent. The autumn rises in the concentration of pesticides in the waters of the estuary of the river occur 1 and 2 months later than in the upstream areas, which depends on the time of arrival of more polluted waters, filling of the Shardarinsky reservoir and on the observed values of water flow in the river (Ermakhanov et.al., 2012; Aladin et.al., 2018).

According to studies conducted in the spring and autumn periods of 2010-2013-2019yy, only organochlorine forms were found. Of these, DTT metabolites were not established, but HCG isomers were constantly present, especially elevated concentrations were recorded in the spring. Within the Kyzylorda region, the waters of the Syr Darya were studied at three sites: Amanotkel, Aklak and Estuary. Maximum concentrations of 0,035 micrograms/dm^3 were observed at the Amanotkel station. The minimum values were typical for the estuary part at the mouth of the estuary – 0,023 mcg/dm^3. The average content of pesticides in the waters of the river and sea are shown in table 2.

Table 2 - Average concentration of pesticides in the water of the Aral Small Sea and the Syrdarya River within the Kyzylorda region in 2015y

Year, month	Number of detected types of pesticides	Hexachlorocyclohexane γ isomer	Dichlorodiphenyltrichloromethylmethane	The sum of organochlorine and organophosphate pesticides
		mcg/dm³		
Syrdarya River Amanotkel	2	0,035	absent	0,035
station Aklak	1	0,025	0,0	0,025
station Ustye station	1	0,023	0,0	0,023
Small Sea				
Eastern part	1	0,015	0,0	0,015
The central part	1	0,013	0,0	0,013
The western part	1	0,010	0,0	0,010

Discussion. In the Aral Small Sea, the concentration of HCG isomers was generally stable, varying from 0,010-0,015 mcg/dm^3 by average values. The eastern part of the sea, where the pre-estuarine zone is located, is the most polluted both in terms of heavy metals and the content of pesticides. The results of gas chromatographic analysis of water samples taken on the Syrdarya River and at sea over the past 4 years have shown that both the quantitative and species composition of pesticides used has decreased. The presence of only organochlorine pesticides – HCG isomers and rarely DDT metabolites - is recorded in river water. In 2015y, during the spring observation period, a single case of the presence of HCG isomers in the amount of 0,030 mcg/dm^3 was recorded, while DDT metabolites were absent in the fall of 2014y. Only HCG isomers in the amount of 0,035 mcg/dm^3 were registered in river water in the absence of other types of pesticides.

According to the Ministry of Agriculture of the Republic of Kazakhstan, 123 registered names of pesticides are currently used in Kazakhstan, of which 23 are dangerous and have been discontinued. The presence of HCG isomers, in the absence of other classes of pesticides, has been recorded in the waters of a number of fishing reservoirs of the republic in recent years. The reason for this is either the use of this drug in agriculture at the present time, or the gradual flushing of toxicants accumulated in the soil layers of irrigated massifs, where they were previously used in large quantities.

In the Kazakh part of the river. Syrdarya has 6 irrigation arrays with a total area of 772,246 ha. The total volume of collector and drainage waters (CDW) and household industrial effluents formed in this territory amounted to 3215,0 million m^3, while the share of CDW was 2354,0 million m^3, it is 90%. About 1600 million m^3 of CDW is formed in the South Kazakhstan region, the rest falls in the Kyzylorda region. Of the total amount of CDW, about 950 million m^3 is discharged into the Syrdarya River basin, and the rest is diverted to natural depressions or partially used for re-irrigation. Figure 2 shows the distribution zones of pollution and concentration on the Aral Small Sea and the Syrdarya River.

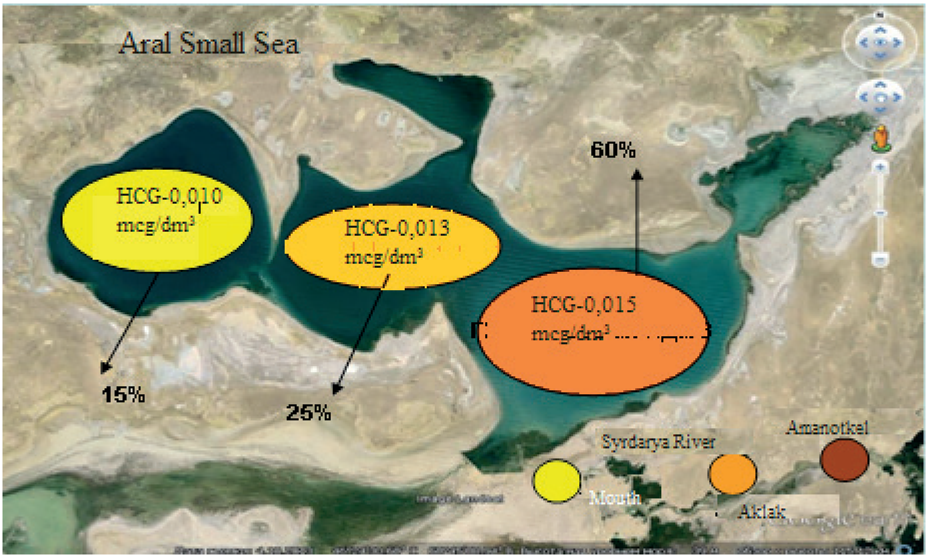

Figure 2 - Schematic map of the Aral Small Sea and the Syrdarya River within the Kyzylorda region with identification of pesticide contamination zones over the past 4 years

These circumstances that have arisen in the last decade have significantly changed the toxicological situation. There have been positive developments associated with a certain decrease in the level of pesticide pollution of the aquatic environment and ecosystems of the region as a whole. Comparing the level of pesticide contamination of river water in the period from 1975y to 1992y and in 2015-2019yy, the following features can be noted: firstly, there was a reduction in the types of pesticides used, and secondly, there was a reduction in their concentrations. Nevertheless, the registration of acute toxic forms of pesticides continues in the aquatic ecosystem of reservoirs on the territory of Kazakhstan, the level of their concentration is subject to significant spatial and temporal changes.

Conclusion. The anthropogenic factor is dominant in influencing the hydrochemical regime of the Syrdarya River. The integrated use of the river's water resources violates the ecological balance of the aquatic environment, affects the quality of water, increasing their toxicity. Priority polluting chemicals are petroleum products, pesticides, phenols, nitrogen and copper compounds. According to the results obtained, HCG isomers are detected after the confluence of the Arys River tributary, as well as the intake of collector-drainage waters into the river. The highest concentrations of these compounds are recorded in the autumn period in the range from 0,026 mcg/dm^3 to 0,065 mcg/dm^3.

The results of the analyses show that the content of heavy metals in the water of the Syrdarya river is uneven and varies in the interannual aspect. Most of the detectable components are contained in concentrations exceeding the MPC: copper by an average of 40 times, zinc 6 times, chromium, lead concentrations within or below the permissible level.

The reduction of runoff associated with water loss leads to the drying up of many lakes in the off-season periods thereby hindering the development of economic efforts (nature resources). Huge water losses up to one third of the water is wasted every year, getting enough sleep and coming out to the daytime surface of the earth together with salts, often which this soil becomes unsuitable for anything.

Interannual and seasonal fluctuations of water runoff over long-term periods are caused by the influence of various natural and anthropogenic factors. Violation of the natural water-salt regime of the soils of vast territories of the river basin and unreasonable irrigation can significantly change the nature of the denudation process of the basin and the chemical flow of the river carried into the Small Aral Sea (Miklin, 2016).

Rational use of water resources of the lower reaches of the Syrdarya River is a necessary step towards the development of the entire economic structure of fish farming and irrigation. For this, the required reclamation works and regulation of water flows should be carried out soon in order to avoid losses in the valley and swampy plains of the Aral-Syrdarya basin, this aspect is especially important in light of the predicted fluctuations in the Syrdarya runoff on a long-term scale (Ayzel and Izhitsky, 2019).

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