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ANTHROPOGENIC IMPACTS INFLUENCE ON THE RIVERS OF THE YESIL BASIN

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ANNOTATION

The article assesses the impact of human activities on the Ishim river basin, taking into account the sources of recent years. The control data necessary for the assessment of human economic activity in the basin were provided by the Kazhydromet RSE in 1933-2019. Analysis of numerous sources - statistical collections, data from the website of the National Bureau of Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, various monographs and scientific articles - made it possible to reliably assess the water consumption of Kazakhstan. Hydrological study of strategically important territories will ensure the sustainable development of Kazakhstan. The Ishim River Basin, which is the object of study, is one of such important areas.

An analysis of the available materials made it possible to identify indicators of irretrievable water consumption in various sectors of the economy, including utilities, industry and irrigation. As a result, irretrievable water consumption in the Ishim basin in terms of water use ranged from 3 % to 29 % of the total irrevocable water consumption, the largest value of irrevocable water consumption was observed in 2007. It has also been established that such large reservoirs as Vyacheslavskoe and Sergeevskoe exerted a regulating influence on the long-term flow of rivers in the basin. Analysis of the obtained data revealed that the decrease in runoff during the disturbed period compared to the natural conditional period is due not only to the influence of reservoirs, but also to agrotechnical measures and climate change.

The results of the study can be used for water management purposes, in the design of hydraulic structures. The conducted studies can expand the theoretical and applied aspects of

regional hydrological studies.

Keywords: Yesil River; Irreversible Water Consumption**;** Anthropogenic Activity; Intra-Annual Flow Distribution.

Introduction

For a reliable comprehensive assessment of water resources and water availability of a basin or region for the current period and for the future, in addition to data on fluctuations in river flow, a quantitative assessment of its changes under the influence of human economic activity is necessary.

For many hundreds of years, the impact of human activity on the flow of rivers was very insignificant and had a local character. The remarkable properties of natural waters - their renewal in the process of circulation and the ability to cleanse – made it possible to maintain the relative purity, quantity and quality of fresh water for a long time. In Kazakhstan, the situation has changed radically in recent decades: in many regions and countries of the world, the fruits of many years of unreasonable activity in the use of water resources and the transformation of the surface of river catchment areas, where they are formed, have begun to be found. First of all, this affected small and medium-sized rivers; in many densely populated regions, their water regime has undergone cardinal changes [1]. From 1950-1960 noticeable anthropogenic changes in the flow of large river systems began, primarily in areas of variable and insufficient moisture. Increasingly, the shortage of water resources began to be felt, especially in dry years, the problem of depletion of water resources in large areas became aggravated.

Within river catchment areas located in the most economically developed regions, river runoff is usually influenced simultaneously by many anthropogenic factors, the main of which, in terms of impact on the quantitative characteristics of river runoff, are: channel regulation; irrigated agriculture; transfer of runoff; industrial and municipal water supply; agricultural water supply; agroforestry measures; urbanization.

Anthropogenic activities inevitably have an impact on water resources. Due to the growth of population and economy, the role of water resources is constantly increasing. Unlike other natural resources, water is renewed in the process of its circulation in nature. But water resources, which are based on river runoff, are distributed extremely unevenly over the territory and in time. In many parts of the world, the available water resources cannot meet the demand for water, especially since it is often polluted by industrial waste. This fully applies to the water management basins of Kazakhstan [1]. Water resources of river runoff in the Republic of

Kazakhstan decreased by 16.0 km ^{3} per year due to anthropogenic activities [2].

Since the 70s. In the twentieth century, the relevance of a reliable assessment of water resources and their predicted changes under the influence of economic activity has increased even more in connection with the real problem of changes in global and regional climatic characteristics. These changes are already taking place in the Yesil Basin and may lead to large-scale transformations of the hydrological cycle, changes in water resources and their use, distribution in time and space, extreme characteristics of river flow and their variability.

The investigated Yesil River flows on the territory of Kazakhstan at the coordinates 50°38′05″ n.l. 73°11′41″ e.l. and 57°41′53″ n.l. 71°11′51″ e.l. left - bank tributary of Ertis, the length of the river is 2450 km, the catchment area is 177000 km^2 , including the active 141000 km^2 [3]. The Yesil River Basin is an important ecosystem of the Republic of Kazakhstan, including the new capital of Nur-Sultan, which is currently receiving a strong impetus for further development. The water resources of the Yesil River are practically the only source of water supply for the population, industry and agriculture of the Akmola and North Kazakhstan regions, as well as the main natural factor of the region under consideration, which contributes to the creation of favorable living conditions for the population. Long-term impact in the Yesil River basin of the totality of sources of anthropogenic and technogenic origin manifested itself in a change in the regime and deterioration in the qualitative composition of surface and groundwater.

Works aimed at identifying the impact of anthropogenic factors on the rivers of the YYesil basin are found in [4, 5, 6] research papers. For the most part, these works dealt with the issues of the impact of anthropogenic activities in the basin of the river. Yesil for the formation of runoff and for intra-annual distribution, taking into account the regulatory capacity of reservoirs and ponds.

Materials and methods

In the work under consideration, observational data for the period from 1933 to 2019 were used. networks of the RSE "Kazhydromet", published in the Hydrological yearbooks, the State Water Cadastre (annual data on the regime and resources of surface waters on land) [7, 8, 9, 10]. Analysis of numerous sources - statistical collections, data from the website of the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, various monographs and scientific articles allows us to fairly reliably assess the dynamics of water consumption in Kazakhstan [11-14].

The choice of the boundaries of the calculation periods is based on the results of the earlier analysis of long-term fluctuations in the runoff of rivers in the Yesil water management basin

[3]. To assess the impact of economic activities on river flow, data on the characteristics of total water consumption were used, including the main water users: utilities, industry, irrigation and agricultural water supply. Various methods were used in data processing, including multivariate statistical analysis; correlation dependencies; methods of geographical analogy.

In our work, an assessment of the total and irretrievable water consumption was made, the results of the assessments were differentiated by sectors of the economy, which would make it possible to obtain relatively reliable forecasts of the future impact of anthropogenic impact on water resources in the future.

The main characteristics of any water use accounting system are: the volume of water withdrawal from a water body (separately from surface water bodies, and from groundwater), often the volume of water withdrawal is called total water consumption; the volume of discharge of used water or the volume of water disposal with mandatory indicators of water quality is a fundamental characteristic of the impact of water consumption on the quality of natural waters; the volume of irretrievable water consumption, which is the difference between the water intake and the volume of water that came back to the water bodies after use - usually this volume is identified with the volume of water discharged or discharged.

The volume of non-returnable water consumption, which is given as a percentage of the volume of total water consumption, is the most important characteristic of a quantitative assessment of the impact of water consumption on water resources. The volume of irretrievable water consumption not only in irrigation, but also in industry and public utilities is more significant for regions with a dry and hot climate, which is the study area.

To assess the impact of municipal water consumption on the annual runoff, the SGI materials mainly provide data on total water consumption, moving from them to irretrievable losses by introducing coefficients that depend on various types of water consumption characteristics and climatic conditions.

Thus, the decrease in the average annual river flow due to municipal water consumption ΔY will be equal to:

$$\Delta Y = K \times Q \quad (1)$$

where Q - the volume of water intake for utility needs; K is a coefficient, the values of which depend on climatic conditions and water intake values.

Based on the experience of the SHI studies [15] at the level of 1985, the value of the coefficient was taken equal for large river basins in the northern regions from 0.10 to 0.15, in the

southern regions from 0.20 to 0.30. Considering that for the period from 1985 to 2005. The amount of water withdrawal for communal needs has changed insignificantly, the indicated values of the coefficients, apparently, can be accepted for modern assessments.

In the SHI, for an approximate assessment of the impact of industrial (as well as municipal) water consumption on river flow, more or less reliable data on water withdrawal volumes are used; at the same time, irretrievable water consumption is determined approximately by maintaining coefficients that depend on industries, the adopted water supply system and climatic conditions.

With regard to large regions and river basins, where a wide variety of industries take place, the change in the annual runoff of rivers (water resources) ΔY due to industrial water consumption can be approximately estimated by the following relationships:

$$\Delta Y = K \times Q \tag{2}$$

where Q - total water withdrawals for the needs of industry; K - coefficient, the values of which are at the level of 1980-1990. (when the volume of industrial water consumption was practically stable) can be accepted K=0.08-0.10 in the northern regions and K=0.15-0.20 in the southern regions.

From a practical point of view, the most important aspects of the impact of irrigation on the hydrological regime and water balance are the issues of changes in the total flow of rivers, the intensity of which depends on a large number of natural and anthropogenic factors and, above all, on the scale of irrigation, types of irrigation systems, volumes of full and irretrievable water consumption, local physical and geographical conditions.

In the zone of traditional irrigation, where irrigation is the main type of economic activity that has a prevailing impact on water resources, the assessment and forecast of the impact of irrigation on river runoff can be quite reliably performed on the basis of a statistical analysis of long-term observational data on runoff in the outlet sections of rivers together with the main runoff-forming factors, meteorological conditions and dynamics of irrigated areas in the basin [16].

The problem of changes in the annual runoff of rivers under the influence of reservoirs has been studied quite well [16, 17, 18]. However, the decisive influence in the regulation of river runoff by reservoirs is manifested, first of all, in the intra-annual distribution of runoff in the outlet section. Here, the role of reservoirs is to eliminate the natural unevenness of the runoff: an increase in the volume of runoff during low periods due to a decrease in flood runoff [18, 19,

20].

The construction of large reservoirs in the region under consideration has led to a gradual change (leveling) of the intra-annual flow distribution. In order to study these changes, an analysis of long-term series of monthly runoff for the river was carried out. Yesil along the length of the river in various hydrological posts.

Analysis of the intra-annual distribution of annual runoff in a long-term context can be carried out using the method of moving averages, integral curves of monthly runoff, as well as by comparing the distribution of monthly runoff in different years with different levels of runoff regulation in the catchment area, but with approximately the same meteorological conditions. Calculation methods are also used [21], when the regulated observed runoff is compared with the reconstructed values. However, the retransformation of the monthly and ten-day runoff by existing methods of calculation [22], as rightly noted in [23, 24], is difficult due to the fact that errors in the restoration of runoff are often commensurate with the monthly runoff.

Results

Irreversible water consumption (by types of use) according to the characteristics of total water consumption in the Yesil basin has been estimated over the past 15 years. The results show that irretrievable water consumption by household and drinking type of use in the Yesil basin ranges from 33 to 54% of the total irrevocable water consumption, the maximum value for irrevocable domestic and drinking water consumption was in 2016. Irreversible water consumption by industrial type of use ranges from 24 to 64 % of the total non-returnable water consumption, the maximum value was in 2019. The irrevocable water consumption of agriculture from the total non-returnable water consumption is up to 30 %, the maximum value was observed in 2005.

Using the SHI methodology according to formula (1) to assess the impact of municipal water consumption on the annual runoff, in this work, the value of ΔY for the period from 2005 to 2019 was calculated. In the Yesil basin, the decrease in the average annual river flow due to municipal water consumption averaged from 10 to 16 %, the maximum decrease in the average annual river flow due to municipal water consumption was observed in 2006, 2008-2009, 2011-2016.

In the Yesil Basin, against the background of a sharp increase in the volume of total water consumption over the period from 2017-2019, the volume of communal water consumption increased, the dynamics of communal water consumption in the Yesil Basin for the period from 2005 to 2019. shown in Figure 1.

Calculated by the SHI method using formula (2), the magnitude of the decrease in the annual runoff of the river Yesil due to industrial water consumption are shown in Table 3 for the period from 2005 to 2019.

Figure 1- Dynamics of municipal water consumption in the Yesil basin (water withdrawal, non-returnable water consumption, municipal water consumption)

In the Yesil basin, the decrease in the average annual river flow due to industrial water consumption averaged from 5 to 10 %, the maximum decrease in the average annual river flow due to industrial water consumption was observed in 2017, 2018, 2019.

The calculated values of the decrease in the annual runoff of the river. Yesil due to industrial water consumption amounted to 40988 thousand m ^{3} (2019), or approximately 10 % of the water intake in the basin.

In this basin, since 2017, there has been an increase in industrial production and new enterprises began to be built with modern water-saving technologies for using water, therefore, when calculating for the future until 2030, it is necessary to take into account the trend of a possible increase in this coefficient.

Figure 2 shows data on the dynamics of non-returnable water consumption for irrigation and agricultural water supply in the basin of the river Yesil for the period from 2005 to 2019.

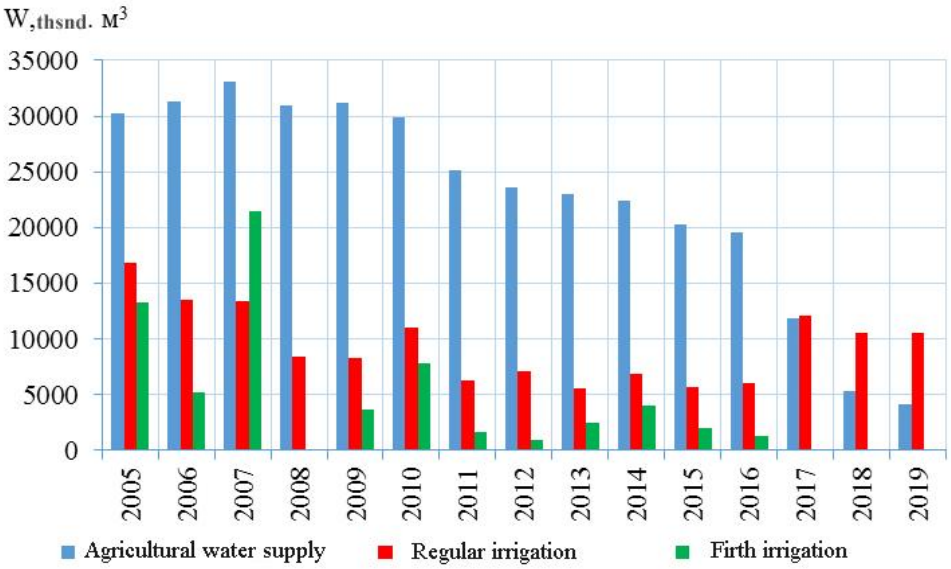


Figure 2 - Dynamics of non-returnable water consumption for irrigation (regular and estuary) and agricultural water supply in the basin of the river Yesil, thousand m^3

The data shown in Figure 2 show that the maximum values of non-returnable water consumption for irrigation and agricultural water supply in the basin under consideration refer to the following years: 2007, 2009 (agricultural water supply), 2005, 2010, 2017 (regular irrigation), 2005, 2007 - firth irrigation.

Attention is drawn to a very sharp decrease in irreversible water consumption over the past ten years in the region under consideration, irrigated areas in the basin of the river. Yesil decreased by 1.2 times compared to 1990 (Table 1). This is due to the intensive reduction of actually irrigated lands in the basin, which is accompanied by a decrease in irrigation rates.

Table 1- Dynamics of the area of irrigated lands in the Yesil water management basin, thousand ha

Region	1991	2000	2018	2019
Akmola	45.2	44.5	31.6	31.6
Karaganda	96.6	89.6	93.0	93.1
Kostanay	39.8	41.6	32.3	32.3
North Kazakhstan	35.4	22.8	17.0	17.0
Total	217.0	198.5	173.9	174.0

In the river basin Yesil, there is a reduction in irretrievable water consumption for

agricultural water supply, a significant reduction is due to a sharp decrease in the number of livestock, a decrease in the rural population and the transfer of a significant part of agricultural water pipelines to the housing and communal services system. Irreversible losses, defined as a percentage of water withdrawal, as well as in municipal water consumption, depend primarily on the volume of water withdrawal and climatic conditions. With water consumption of 100–200 l/day per person, irretrievable water losses usually do not exceed 15–30 % of the water intake (20–50 l/day), while with small water intakes of 20–50 l/day, they can be up to 70–100 %. Irrevocable water consumption by sectors of use in the Yesil basin ranges from 3 to 29 % of the total irrevocable water consumption, the maximum value for irrevocable water consumption was in 2007 (Table 2).

Table 2 - Dynamics of irretrievable water consumption by sectors in the basin of the river Yesil, %

Year	Water intake, thousand m^3	Municipal non-returnable water consumption, %	Industrial non-returnable water consumption, %	Agricultural non-returnable water consumption, %
2005	222825	10	4	29
2006	218466	15	4	23
2007	232283	12	4	29
2008	214466	15	4	18
2009	213072	15	4	10
2010	217782	14	4	22
2011	213314	15	5	15
2012	212889	15	5	15
2013	210625	15	5	15
2014	212630	16	5	16
2015	198994	16	5	14
2016	196883	16	5	14
2017	361610	10	9	7
2018	338846	11	9	5
2019	425756	10	10	3

In all studies assessing the dynamics of non-returnable water consumption in river basins, the values of agricultural water supply are not singled out separately, but are taken into account

together with water consumption for irrigated agriculture.

The regime and water resources of the rivers under consideration are also significantly affected by water consumption in watersheds and the operation of reservoirs. Water consumption in river basins leads to a decrease in the annual flow of river water. The decrease in the annual water flow of regulated rivers is associated with the initial filling of reservoirs, evaporation from its surface and water saturation of the soils of its bed.

At present, there are 45 reservoirs in the Yesil River basin: 3 complex-purpose reservoirs with a volume of more than 100 million m^3 ; 6 - with a volume of more than 10 million m^3 ; 36 special-purpose reservoirs with a capacity of 1 to 10 million m^3 .

For the period from 1946 to 1993 in the basin of the river Yesil were put into operation 45 reservoirs - the maximum number of reservoirs put into operation in the Yesil water management basin is three reservoirs per year (1978, 1988) (Figure 3).

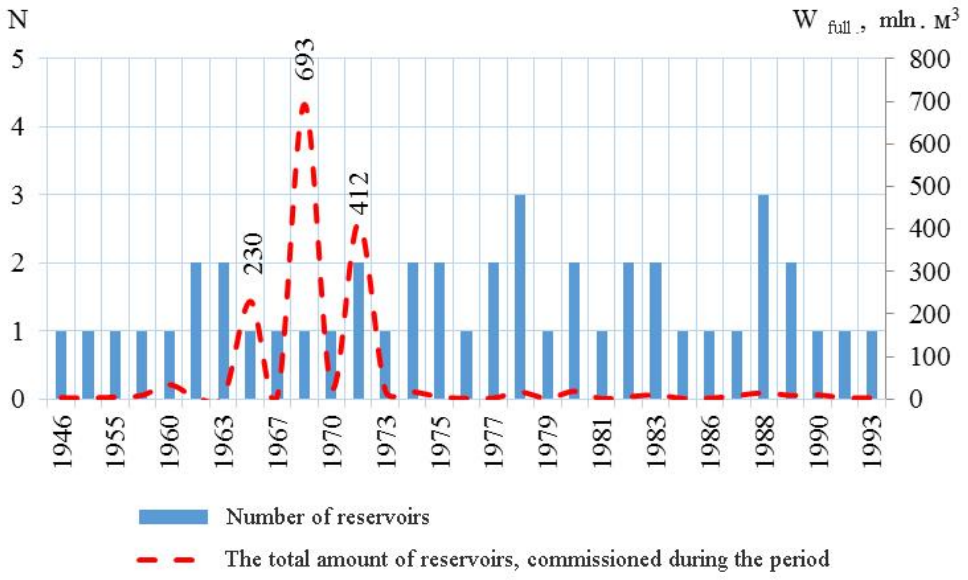


Figure 3. Dynamics of the commissioning of reservoirs in the basin of the river Yesil

To quantify the change in the intra-annual distribution of runoff in the Yesil River basin, calculations were made for two characteristic periods:

- before the creation of the main reservoirs (1933-1973), characterized by a slight influence of economic activity - a conditionally natural period;

- the second period (1974-2018), which differs from the first one by a significant violation of the hydrological regime as a result of deep long-term flow regulation by the Vyacheslav and Sergeev reservoirs (Table 3).

Flow regulation in the Yesil River basin is carried out in the interests of industrial,

domestic and agricultural water supply, estuary and regular irrigation and fisheries.

The results of the calculation for two periods showed that in the upper reaches of the river Yesil runoff regulation did not have a significant impact on the hydrological regime.

In high-water years in the spring period from April to May in the alignment of the river Yesil - Udarnoe for a conditionally natural period passes 94.6% of the annual runoff, and the summer-autumn period 5.64%. During the disturbed period, 89.8% of the annual flow passes in the spring, 6.15% in the summer-autumn period, and 4.06% in the winter period.

In the section of Nur-Sultan, natural water discharges for the spring months decrease under the influence of the Ishim and Vyacheslav reservoirs for a high-water year by 18.6%, an average water content - 30.1%, a low-water year - 43.0%. In the summer-autumn and winter periods, when the reservoirs are depleted, the regulated water discharges in high-water and average years are significantly higher than the natural water discharges.

Table 3. Distribution of runoff by seasons (as a percentage of annual runoff) at observation points in the basin of the river Yesil

Post Code	River-post	F, km^2	Billing period	Water content of the year	seasonal runoff		
					Spring (IV-V)	Summer-autumn (VI-X)	Winter (XI-III)
11395	Yesil - Udarnoe	202	1949-1973	high-water	94.6	4.20	1.20
				Medium	91.2	6.32	2.55
				Shallow	92.4	7.44	0.21
			1974-1991	high-water	89.8	6.15	4.06
				Medium	91.2	6.32	2.55
				Shallow	92.4	7.44	0.21
11397	Yesil - Turgen	3240	1974-2018 _	high-water	86.5	5.01	8.52
				Medium	93.2	5.64	1.16
				Shallow	93.1	6.36	0.51
11398	Yesil - Nur-Sultan	7400	1933-1973	high-water	91.0	6.36	2.61
				Medium	93.8	4.96	1.29
				Shallow	95.5	4.14	0.41
			1974-2005	high-water	72.4	16.0	11.6
				Medium	63.7	22.7	13.6

				Shallow	52.5	31.3	16.2
11410	Yesil - Petropavlovsk	106000 118000	1932-1973	high-water	76.9	19.9	3.20
				Medium	68.5	26.1	5.34
				Shallow	54.1	36.3	9.57
			1974-2018	high-water	69.7	22.4	7.83
				Medium	64.4	24.7	11.0
				Shallow	55.3	28.9	15.8
11433	Zhabay - Atbasar	8530	1936-1973	high-water	68.5	30.1	1.36
				Medium	67.6	31.6	0.77
				Shallow	66.3	33.3	0.36
			1974-2018	high-water	88.2	8.44	3.36
				Medium	87.3	8.68	4.04
				Shallow	87.3	8.49	4.18
11461	Imanburluk - Sokolovka	3870 4070	1950-1973	high-water	93.7	4.46	1.81
				Medium	92.0	6.77	1.23
				Shallow	86.8	12.3	0.86
			1974-2018	high-water	89.2	8.59	2.24
				Medium	88.2	9.05	2.75
				Shallow	85.1	9.86	5.05

In June-October, the amount of regulated average monthly water discharges exceeds the amount of natural water discharges by 2.5 times in wet years and up to 7.5 times in dry years. In winter, the regulated runoff exceeds the natural runoff in wet years by 4.5 times, and in dry years by 39.5 times.

In the section of the city of Petropavlovsk, the natural water discharges for the month of April decrease under the influence of the Sergeevskoye Reservoir in high-water years by 10%, and in medium and low-water years, the water content practically does not change. In the summer-autumn and winter periods, the amounts of regulated water flow exceed the natural water flow significantly, 7.5% and 6.5%, respectively.

The assessment of changes in the intra-annual distribution of runoff in the section of the city of Petropavlovsk reflects the impact of four large reservoirs of long-term and seasonal regulation (Figure 4, 5).

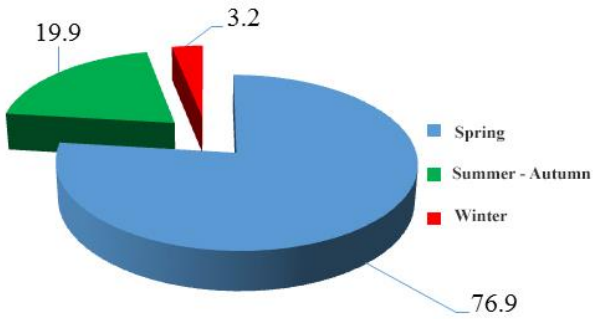
From the analysis of the change in runoff and its intra-annual distribution of runoff, it can be noted that the hydrological regime of the river. Yesil has undergone major changes in most of

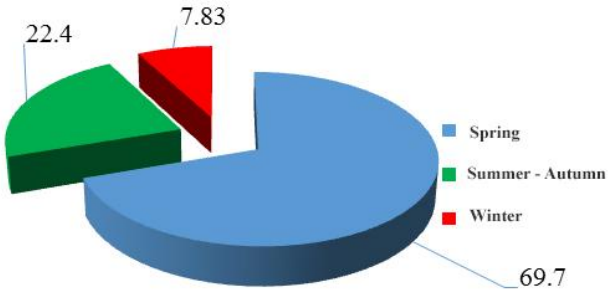
its part. At the same time, in the upper reaches to Nur-Sultan, the flow regime is leveled and transformed, and in the lower reaches, the influence of reservoirs is weak, and the hydrograph does not differ much in shape from the hydrograph observed under natural conditions. In the upper reaches of the river Yesil most noticeably decrease in spring runoff. In the lower reaches of the river at the site of the city of Petropavlovsk, the spring runoff for the period with a disturbed regime is much higher than the spring runoff for the natural period and an increase in seasonal runoff, especially winter runoff, is observed in dry years of 95% security.

Calculations of the intra-annual distribution of runoff for specific years of different water content (25, 50, 75 and 95%) under conditions of a conditionally natural and regulated regime (according to the Chagodaev formula) made it possible to assess changes in the intra-annual distribution of runoff by graphical comparison of natural and disturbed hydrographs of the river runoff Yesil on separate alignments (Figure 6).

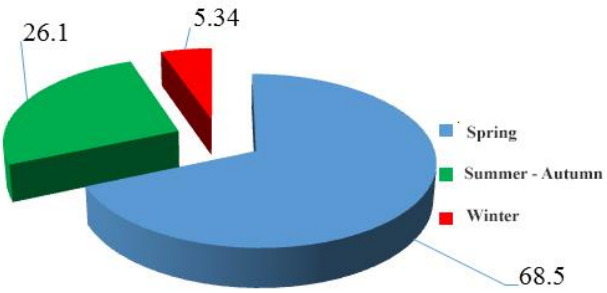
Conditionally natural period | Disturbed period

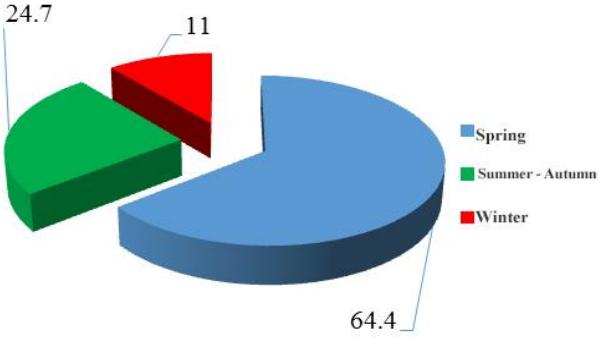
high-water





Medium





Shallow

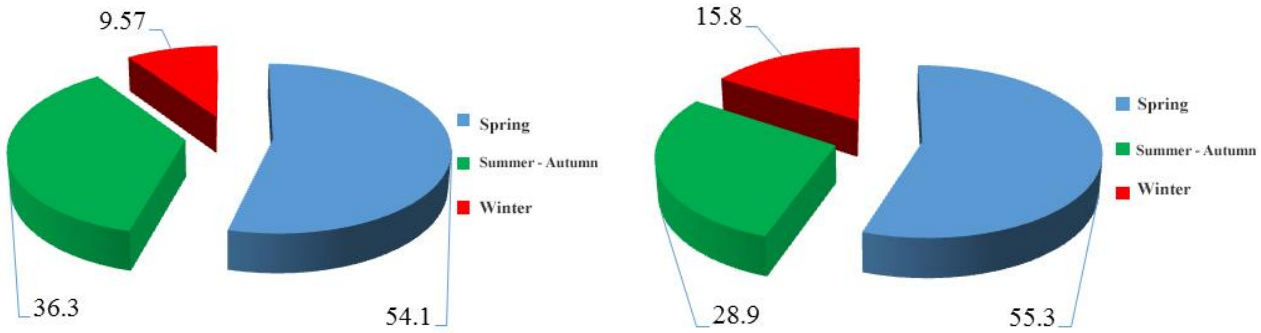


Figure 4 - Distribution of runoff by season (as a percentage of annual runoff) Yesil - Nur-Sultan

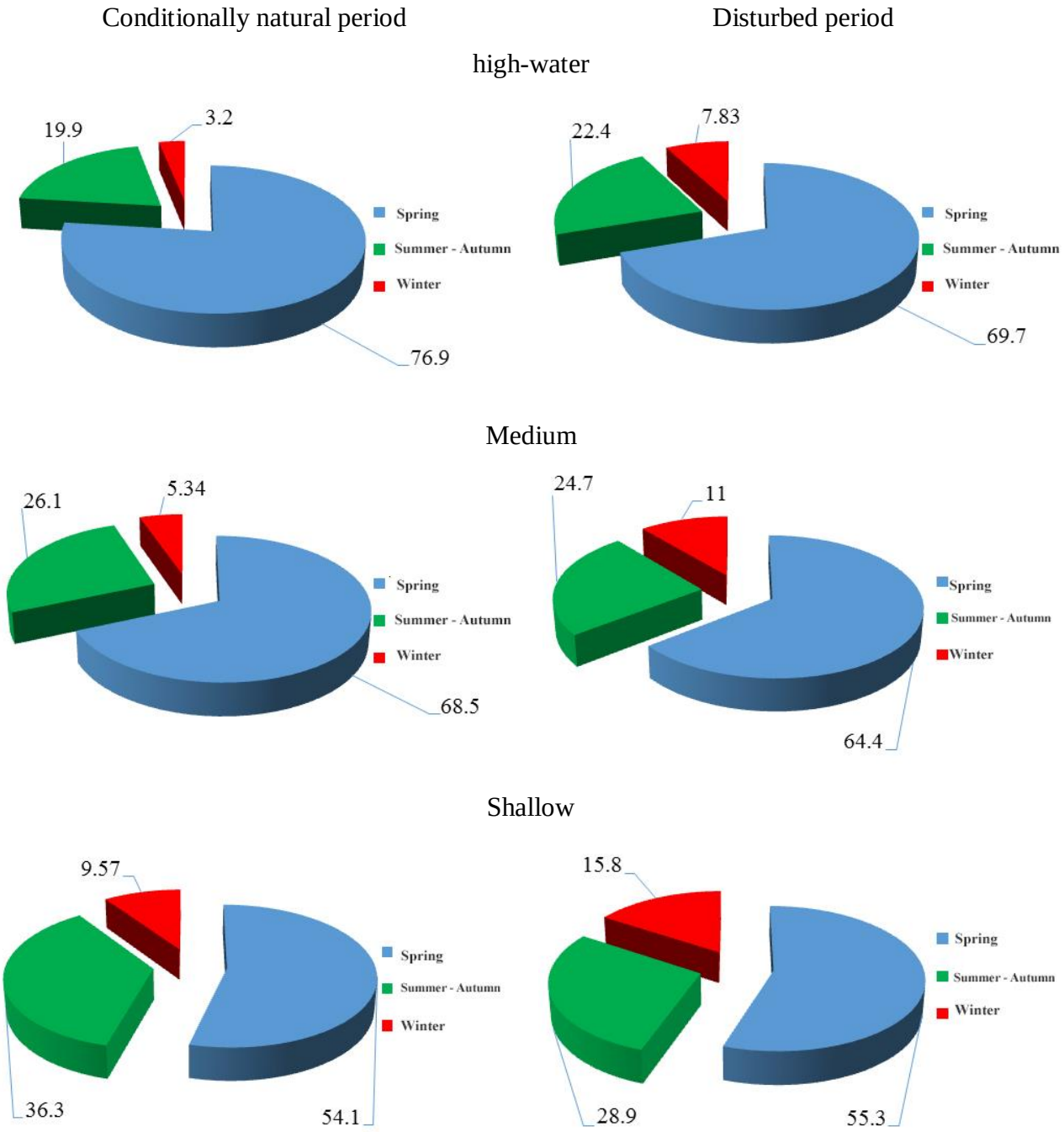


Figure 5 - Distribution of runoff by season (as a percentage of annual runoff) Yesil – Petropavlovsk

Figure 6 - Hydrographs of the runoff of the Yesil in conditionally natural and regulated by reservoir conditions for years of different water content

Thus, under conditions of regulated flow, the moment of violation of the natural

hydrological regime begins from the moment the reservoir is filled. The results of a quantitative assessment showed that, due to a decrease in spring runoff in the second period (1974-2019), which differs from the first in a significant violation of the hydrological regime, as a result of deep long-term regulation of the runoff, the summer-autumn and winter low-water runoff significantly increased.

Conclusions and discussions

At the end of the 20th century, the accomplished fact of global warming began to be recognized as proven [25, 26, 27], but discussions about the causes of modern climate change remain unfinished. Many scientists recognize the fact of anthropogenic climate change as a result of the accumulation of carbon dioxide in the atmosphere, others are firmly convinced that the energy power of the processes occurring in the natural cycle is several orders of magnitude higher than man-made energy capabilities. Natural rhythm and its phases have a significant impact on many processes occurring on Earth, including long-term fluctuations in river flow, which are an integral indicator of climate change. As for the anthropogenic changes in the runoff of the last modern period, they are quite justifiably disturbing for humanity. They really exist, but their values are not comparable with natural cyclic climate changes of different nature. The danger of anthropogenic changes lies in their irreversibility.

In addition, the totality of accumulating anthropogenic and cyclic natural climate changes is dangerous because there are periods of years when anthropogenic and natural changes are directed in the same direction and can manifest themselves with alarming speed, so minimizing the anthropogenic component is a safety option for mankind.

Irreversible water consumption by sectors of use in the Yesil basin ranges from 3 to 29% of the total irrevocable water consumption, the maximum value for irrevocable water consumption was in 2007.

Large reservoirs, such as Vyacheslavskoe and Sergeevskoe, had a regulating effect on the long-term runoff of the rivers in the basin, which led to a division into two periods: before the creation of the main reservoirs, the period characterizing the current phase of the climate and the current level of anthropogenic influences on the runoff. In high-water years, the values of spring and summer-autumn runoff shifted, spring runoff decreased by 5% compared to the catch - natural period, and summer-autumn runoff increased by almost 2% due to the regulating capacity of reservoirs.

In average water content and dry years, no change in intra-annual runoff is observed. The small useful capacity of the Ishim reservoir very slightly transforms the runoff in the lower

reaches of the river.

To track the change in runoff under the influence of economic activity in years of different water content, a decrease in natural runoff was calculated. An analysis of the calculations shows that in high-water years (10 and 25% supply), the runoff decreases due to additional evaporation from the water surface of artificial reservoirs to 5%. In average water content years (50% supply), the annual runoff decreases to 18%.

In dry years (80% availability), the decrease in annual runoff ranges from 25 to 80%.

In exceptionally dry years (95% availability), the entire annual runoff is retained in reservoirs and is irretrievably lost due to evaporation and use for economic needs.

An analysis of the obtained data shows that the decrease in runoff from the conditionally natural period to the disturbed period cannot be entirely attributed to the influence due to the influence of reservoirs. Apparently, the anthropogenic impact is due to agrotechnical measures and climate change.

The anthropogenic and climatic components of the runoff decrease are determined by correcting the river runoff (multiplication of the runoff of the conditionally natural period by the runoff reduction coefficients). In the case when there is no climatic trend, an approximate coincidence of the runoff of different probability and the "corrected" runoff is expected. In high-water years, there is a difference in these values, apparently, when the runoff is not significantly distorted by economic activity, the main role is played by the climatic trend.

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Түйіндеме

ЕСІЛ АЛАБЫ ӨЗЕНДЕРІНЕ АНТРОПОГЕНДІК ЫҚПАЛДЫҢ ӘСЕРІ

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Мақалада Есіл өзені алабы үшін адамның шаруашылық іс-әрекетінің әсері соңғы жылдардағы мәлімет көздерін ескере отырып бағаланған. Алаптағы адамның шаруашылық іс-әрекетін бағалауға қажетті бақылау мәліметтері РММ «Казгидромет» мекемесіне қарасты 1933 - 2019 жж. гидрометеорологиялық мерзімді басылымдардан алынды және көптеген дереккөздерді – статистикалық жинақтарды, ҚР Стратегиялық жоспарлау және реформалар жөніндегі агенттігі Ұлттық статистика бюросы сайтының деректерін, әртүрлі монографиялар мен ғылыми мақалаларды талдау Қазақстанның су тұтыну көрсеткішін сенімді бағалауға мүмкіндік берді. Стратегиялық маңызы үлкен аймақтарды гидрологиялық тұрғыдан зерттеу Қазақстанның тұрақты дамуын қамтамасыз етеді. Зерттеу нысаны ретінде алынған Есіл өзені алабы осындай маңызы үлкен өлкелеріміздің бірі.

Қолда бар материалдарды талдау барысында шаруашылықтың әр саласы бойынша, соның ішінде коммуналдық-тұрмыстық, өнеркәсіптік және суармалау бойынша қайтарымсыз сұ тұтыну көрсеткіштері анықталды. Нәтижесінде Есіл алабында су пайдалану салалары бойынша қайтарымсыз су тұтыну жиынтық қайтарымсыз су тұтынудың 3%-дан 29% - на дейін құрады, қайтарымсыз су тұтынудың ең жоғары мәні 2007 жылы байқалған. Сондай–ақ, Вячеслав және Сергеев сияқты ірі су қоймалары алап өзендерінің көпжылдық ағындысына реттеуші әсер еткендігі анықталып, ағынды қатары екі кезеңге бөліп қарастырылды: су қойма салынғанға дейінгі кезең және климаттың қазіргі кезеңін, ағындыға антропогендік әсердің қазіргі деңгейін сипаттайтын кезең. Алынған деректерді талдау кезінде табиғи-шартты кезеңге қарағанда бұзылған кезеңде ағындының азаюы тек су қоймалардың әсері ғана емес, агротехникалық шаралар мен климаттық өзгерістерге байланысты екендігі анықталды.

Зерттеу нәтижелері су шаруашылығы мақсаттарында, гидротехникалық құрылыстарды жобалауда пайдаланылуы мүмкін. Жүргізілген зерттеулер аймақтық гидрологиялық зерттеулердің теориялық және қолданбалы аспектілерін кеңейте алады.

Түйін сөздер: Есіл өзені, қайтарымсыз су тұтыну, антропогендік іс-әрекет, ағындының жыл ішілік үлестірімі.

Резюме

ВЛИЯНИЕ ТЕХНОГЕННЫХ ВОЗДЕЙСТВИЙ НА РЕКИ БАССЕЙНА РЕКИ ЕСИЛЬ

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С учетом источников последних лет в статье оценивается влияние деятельности человека на бассейн реки Ишим. Контрольные данные, необходимые для оценки хозяйственной

деятельности человека в бассейне этих рек были предоставлены РГП «Казгидромет» в 1933-2019 гг. Анализ многочисленных источников - статистических сборников, данных с сайта Национального бюро статистики Агентства стратегического планирования и реформ Республики Казахстан, различных монографий и научных статей - позволил достоверно оценить водопотребление Казахстана. Гидрологическое изучение стратегически важных территорий обеспечит устойчивое развитие Казахстана. Бассейн реки Ишим, являющийся объектом изучения, является одним из таких важных районов. Анализ имеющихся материалов позволил выявить показатели безвозвратного водопотребления в различных отраслях народного хозяйства, в том числе в коммунальном хозяйстве, промышленности и ирригации. В результате безвозвратное водопотребление в Ишимском бассейне в пересчете на водопользование составило от 3 % до 29 % от общего безвозвратного водопотребления, наибольшее значение безвозвратного водопотребления наблюдалось в 2007 г. Также установлено, что крупные водохранилища – Вячеславское и Сергеевское – оказывали регулирующее влияние на многолетний сток рек бассейна. Анализ полученных данных выявил, что уменьшение стока в нарушенный период по сравнению с естественно-условным периодом обусловлено не только влиянием водохранилищ, но и агротехническими мероприятиями и изменением климата. Результаты исследования могут быть использованы в водохозяйственных целях, при проектировании гидротехнических сооружений. Проведенные исследования могут расширить теоретические и прикладные аспекты региональных гидрологических исследований.

Ключевые слова: река Есиль, необратимое водопотребление, антропогенная деятельность, внутригодовое распределение стока.

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