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INFLUENCE OF THE HYDROLOGICAL REGIME ON THE STATE OF FLOODPLAIN GEOSYSTEMS OF THE CHARYN RIVER

B.S. Kerimbay, S.R. Sadvakassova, A.N. Dunets

The paper deals with the influence of the hydrological regime of the Charyn River, where the Bestyubinsk reservoir was built in 2012, on the state of floodplain geosystems. The research aims to identify and analyze the impact of regulation of the Charyn River flow reservoir on the state of geosystems. Research tasks include (1) calculating and analyzing the hydrological regime of the Charyn River; (2) identifying the sections of the river floodplain most susceptible to the threat of flooding before and after the construction of the reservoir; (3) compiling comprehensive physical and geographical characteristics of the floodplain geosystems of the Taskarasu Valley subject to frequent flooding. In the analysis of the hydrological regime of the river, we used difference and total integral curves to identify the cycles of fluctuations in the annual runoff. The river runoff was estimated by the change in the parameter of the mean annual runoff for 2004–2018. As a result of the interpretation of satellite images, using the Automated Water Extraction Index integrated with ArcGIS, the most frequently flooded area of the river floodplain for this period was identified. The time and area of flooding were determined. Based on the data obtained, the flooded areas were compared for 2004–2018. The advantages of visual observation using satellite images are the ability to clearly and intelligibly visualize the flooded area and systematically, as quickly as possible, reach the required site coordinates using decoded digital data, which is necessary when studying the functioning of geosystems. To describe the state of the floodplain geosystems most susceptible to flooding, we used the data for many years of field landscape studies. Thus, comprehensive physical and geographical characteristics of the Taskarasu Valley were given.

Keywords: *hydrological regime; long-term river flow; flow regulation; flooding; floodplain geosystems*

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ВЛИЯНИЕ ГИДРОЛОГИЧЕСКОГО РЕЖИМА НА СОСТОЯНИЕ ПОЙМЕННЫХ ГЕОСИСТЕМ РЕКИ ЧАРЫН

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В статье рассматривается влияние гидрологического режима реки Чарын на состояние пойменных геосистем, где в 2012 году было построено Бестюбинское водохранилище. Целью исследования является выявление и анализ влияния регулирования стока реки Чарын на состояние геосистем. Исследовательские задачи включают (1) расчет и анализ гидрологического режима реки Чарын; (2) выявление наиболее подверженных угрозе затопления участков речной поймы до и после строительства водохранилища; (3) комплексная физико-географическая характеристика пойменных геосистем долины Такарасу, подверженных частым затоплениям. При анализе гидрологического режима реки были использованы разностные и суммарные интегральные кривые для выявления циклов колебаний годового стока. Речной сток оценивался по изменению параметра среднегодового стока за 2004–2018 годы. В результате дешифрирования спутниковых снимков с помощью интегрированного с ArcGIS автоматизированного индекса извлечения воды был определен наиболее часто затопляемый участок поймы реки за этот период. Были определены время и площадь затопления. На основе полученных данных было проведено сравнение затопленных территорий за 2004-2018 годы. Преимущества визуального наблюдения с использованием спутниковых снимков заключаются в возможности четко и доходчиво визуализировать зону затопления и систематически, максимально быстро выходить на требуемые координаты участка по декодированным цифровым данным, что необходимо при изучении функционирования геосистем. Для описания состояния пойменных геосистем, наиболее подверженных наводнениям, мы использовали данные многолетних полевых ландшафтных исследований. Таким образом, в статье дана комплексная физико-географическая характеристика долины Таскарасу.

Ключевые слова: *гидрологический режим; многолетний сток рек; зарегулирование стока; затопление; пойменные геосистемы*

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Introduction

At present, special attention is paid to the state of floodplain geosystems in the Charyn River basin. Administratively, the Charyn River basin is part of the Uygur, Kegen, and Raiymbek districts of the Almaty Region of the Republic of Kazakhstan. This river is located in the extreme southeast of the country, in the foothills of the northern Tien Shan. Charyn, a large left tributary of the Ile River, begins on the southern slope of the eastern part of the Ketmen ridge and occupies an area of 12,693 km^2 [13].

According to K. Tockner and J. Stanford [21], natural river floodplains are among the most biologically productive and diverse ecosystems on Earth. Globally, river floodplains cover 2×10 6 km^2, but they are among the most threatened ecosystems. In the developing world, remaining natural floodplains are disappearing at an accelerated rate, primarily due to changes in hydrology. Demmissie et al. [7] argued that the hydrological cycle plays a key role in regulating the dynamics of natural systems.

Dam construction has a great impact on hydrology; therefore, it is of scientific importance to evaluate the hydrologic alteration induced by dam construction [22]. The harmful impact of floods results from an interaction between extreme hydrological events and environmental, social, and economic processes. Flood management should consider diverse aspects and influences. In this regard, an integrated approach to flood management plays an important role [14]. The growing importance of the landscape approach in the sustainable development agenda is due to its potential to overcome the problems of sectoral approaches and address trade-offs within larger spatial entities, enabling a better understanding of the processes of change and the resilience of local communities and their environment [6]. There are many indicators and indices for calculating the nature of water flow patterns. The use of the indices should be chosen according to the purpose of the processing [18].

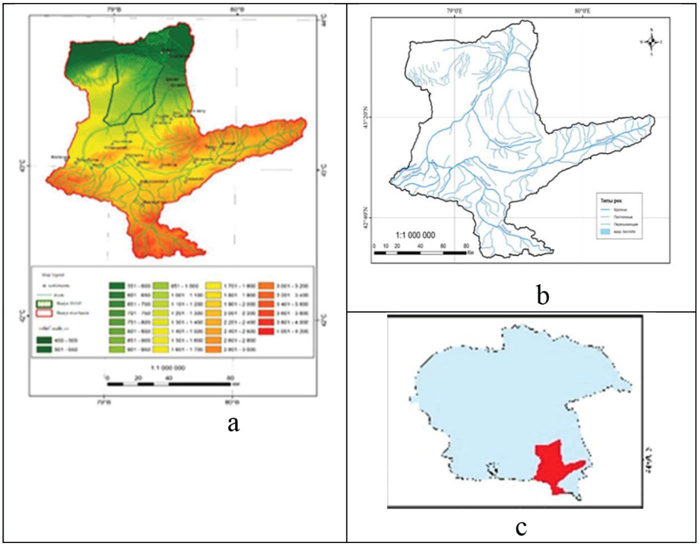
Materials and Methods

The paper aims to identify and analyze the impact of regulation of the Charyn River flow by the Bestyubinsk reservoir on the state of geosystems associated with the river floodplain. The research objectives include (1) calculating and analyzing the hydrological regime of the Charyn River; (2) identifying the sections of the river floodplain most susceptible to the threat of flooding before and after the construction of the Bestyubinsk reservoir for 2004–2018; (3) compiling comprehensive physical and geographical characteristics of the floodplain geosystems of the Taskarasu Valley subject to frequent flooding.

To solve the set tasks, we conducted photogrammetric processing of the Charyn River basin to determine its shape, size, spatial position in a given coordinate system, area, volume, various sections at the time of the shooting, and other factors from the images of the object under study [4]. Using the application programs for processing remote sensing data, we created a digital elevation model [DEM] and a map of the hydrographic network of the Charyn River basin (Fig. 1).

S. S. Nekhin [4] noted that the DEM is the basis for the study and analysis of images, a key aspect on which all image accuracy within the local coordinates depends. The auxiliary data for creating a DEM of the Charyn River basin served as the main observation point in studying the summer field landscape along the routes and key sites measured using a portable Garmin GPS Map-62 navigator.

Various hydrologic metrics have been used to measure flow regime changes. These metrics can be summarized into two different types: static hydrologic metrics, which are broadly used, and metrics that include dynamics or temporal sequencing, which have received increasing attention in recent years [10]. Recognizing the significance of hydrologic alterations in structuring biotic diversity within river geosystems, recent studies have adopted multivariable approaches to quantify these alterations [11].



a

b

c

Fig. 1. a) DEM of the Charyn River Basin; b) Map of the hydrographic network of the Charyn River basin; c) Location of the Charyn River basin in Almaty region (map source: ArcGIS 10.1)

The basis of modern hydrology is that the water content or annual flow of rivers for several decades fluctuates around a certain average value, which is a special hydrological and climatic characteristic formed by the ratio of heat and moisture for each river catchment. According to V. M. Boldyrev [5, 8–20], this characteristic has a name, average long-term runoff, which fully corresponds to that principle in hydrological calculations, defined as the principle of invariability in the course of hydrological processes and the formation of their main parameters.

In reality, hydrological processes, like many other natural processes, are nonstationary in time and space. However, suppose one takes into account the relative short-term operation of various hydraulic structures, usually measured in tens or the first hundreds of years, as well as the smoothness and insignificance of non-stationarity against the background of noticeably high theoretical errors in calculating the main flow parameters, such as rate, variability, and asymmetry, according to the available actual observation series. In that case, the stationarity proposal is quite acceptable [5].

The calculation and analysis of the hydrological regime of the Charyn River were performed according to the data of the Republican State Enterprise Kazhydromet from the gauging station of the Sarytugay tract [15]. The gidropost is located 3.0 km above the road bridge, in the Uygur region, Almaty region. Together with the data from the gauging station, ERS data were used, which became one of the most efficient, reliable sources of monitoring and information of hydrodynamic processes. Remote sensing data makes it possible to observe the dynamics of surface waters, receive information on the development of floods, flooded areas, and identify areas that are threatened by flooding.

When solving monitoring problems at the local level, it is necessary to regularly obtain high and ultra-high resolution images, which is not always possible technically. During the flood period, the percentage of cloudy days is usually high in spring and summer, which significantly complicates monitoring. The new Automated Water Extraction Index [AWEI] improves classification accuracy; it is used to extract water with high accuracy, especially in mountainous areas where deep shadow caused by terrain is an important source of classification error [8]. Thus, AWEI eliminates various types of environmental noise and accurately extracts water to obtain a stable threshold. When monitoring surface waters of the Charyn River, fragments of Landsat-7,8 and Sentinel-2 images were taken as test data to determine the dynamics of the water surface area of floodplain geosystems most susceptible to frequent flooding for 2004–2018, from early April to late June.

In the process of geographic research, several methods and approaches were applied. First, we used the geosystem approach, rooted in integrative landscape studies with long-standing geographical traditions, which was considered in the works of V.A. Snytko and Yu. M. Semenov [19], N. Tandaric [20], and many other scientists. The study of geosystems places the analysis of the structure and processes in the landscape at the center of attention and, at the same time, focuses on holistic approaches, according to which landscape is understood as “the territory perceived by people, whose character is the result of the action and interaction of natural or human factors.” According to methodological approaches to physical-geographical research on the geosystem-basin approach, geosystems are identified under geomorphological criteria, based on the structure of the natural hydrological network, presented in the works of N.N. Kerimbay [12].

As field landscape research, the standard, classical landscape method of “key” areas was applied. This method is used to study the most typical and important geosystems, the study of which will solve the main problems necessary for landscape monitoring. At the key site, a detailed description of landforms, vegetation, and soils was made. For the environs of the key site, the type of relief and the nature of the morphological structure of the landscape were noted [1, 16–33].

The floodplain geosystem of the Taskarasu Valley, which is most at risk of flooding, was chosen as the key site. The work began with navigation: receiving satellite signals, determining coordinates, establishing absolute altitude using a combined map image and an image on the Garmin GPS Map-62.

The relief description was examined and performed according to external morphological data. The meteorological data were also determined. To describe the morphological structure of the soil profile and take soil samples, soil pits were laid. To study the vegetation in all key areas, geobotanical sites were established, and vegetation descriptions were carried out. Geobotanical descriptions of plant communities at the observation points were carried out on test plots 10m^2 in size. When describing communities, the composition, abundance (according to the Drude scale), plant height, layering, vital state of species, phenophase, general projective cover, and nature of species distribution were taken into account.

The river runoff of the Charyn River was estimated from the change in the parameter of the mean annual runoff. When choosing the calculation period to determine the runoff rate, the coefficient of variability (variation) and asymmetry, the integral difference curves were used at the point of the

Charyn River, the Sarytugay tract. The cumulative integral curve (Fig. 2) and the integral differential curve (Fig. 3) were necessary to identify the cycles of fluctuations in the annual runoff. These curves are convenient for choosing a representative calculation period from a long series of observations if they are available and necessary. We used observation data on the average annual water discharge along the Charyn River when constructing the difference and integral curves at the gauging station of the Sarytugay tract for 2004–2018.

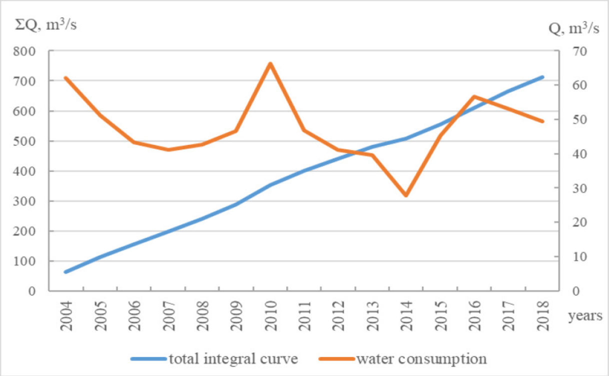


Fig. 2. The total integral curve and long-term variation of the water consumption of the Charyn River, Sarytugay tract, g/s, for 2004–2018 years

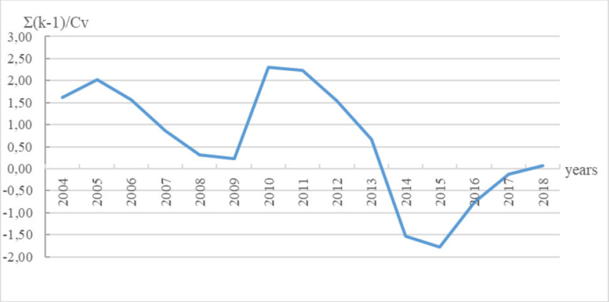


Fig. 3. Difference integral curve of average annual water consumption of the Charyn River, Sarytugay tract, for 2004–2018

On this curve, sharp drops and rises of water discharge are clearly distinguished. First decline from 2005 to 2009 reflects the conditions for the formation of the flow of the Charyn River in a conditionally natural period and reflects climatic conditions for 5 years, comparisons of which will be given below. The next move was an increase in water discharge, rather associated with increased precipitation and relatively warm air temperatures. Also, a sharp decrease in water consumption. First, one can see anthropogenic activity due to the regulation of the river by building and putting into operation the Bestyubinsk reservoir in the bed of the Charyn River. Second, as already mentioned in the paper by N. I. Ivkina, I. V. Shenberger, and A. G. Terekhov [2], as a result of climate change during this period in the Ile River basin, one can observe a significant increase in air temperature and degradation of mountain glaciers. The river runoff in 2015–2018 began to increase gradually and amounted to about 20%.

The parameters of the analytical distribution curves (Qav, Cv, Cs) were determined from the hydrometric series of observations of the hydrological characteristic by one of three methods: the method of moments, the method of maximum likelihood, or the graphical analytical method [5]. In our work, the estimation of the parameters of the analytical curve was determined by the method of moments; the calculation procedure and formulas were given in the work of V. M. Boldyrev [5].

Results

According to the calculations, several results were obtained. Along the Charyn River at the gauging station in the Sarytugay tract, for 2004–2018, the flow rate was Q = 47.5 m^3/s, the coefficient of variability was Cv = 0.19, the asymmetry coefficient was Cs = 0.14, and the calculation error was 4.9% (which is included in the confidence interval of the permissible error, up to 5%).

Additionally, the curve of the provision of average annual water discharge along the investigated river was calculated, built, and analyzed (Fig. 4).

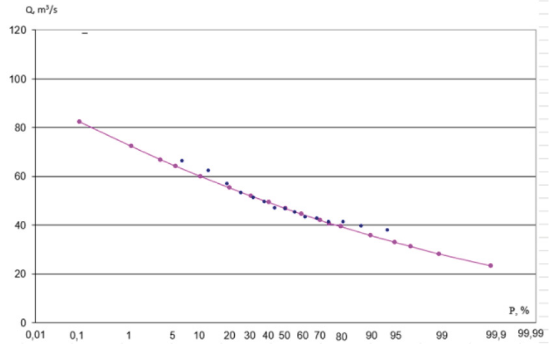


Fig. 4. The curve of the average annual water discharge along the Charyn River, Sarytugay tract, for 2004–2018, with the following parameters: Q = 47.5 m^3/s, Cv = 0.19, Cs = 2Cv

Suppose the fluctuations in the runoff have a certain periodicity and the law of fluctuations are known, then according to the available observational data. In that case, it will be possible to establish the chronological course of the runoff for a given future period and determine when a certain runoff value will be observed or how many times the annual runoff will exceed a certain value during this period. However, this task is still insoluble. Therefore, the calculations of the annual runoff and its other characteristics were presented in the form of a quantitative assessment of the corresponding specified supply or recurrence (on average, once every *N* years without specifying the date of occurrence of the calculated value).

The provision of a hydrological quantity is the probability that its considered value may be exceeded; they are distinguished as follows:

- Probability of exceeding for events observed once a year;
- Probability of exceeding among the totality of all possible values for the phenomena that can be observed several times a year;
- Probability of exceeding at the point under consideration or in the area under consideration at any point.

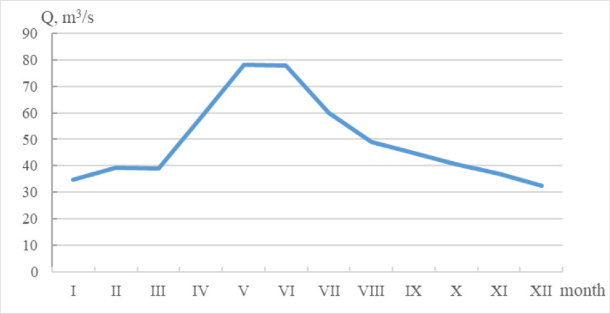


Fig. 5. Intra-annual distribution of long-term runoff along the Charyn River, Sarytugay tract, for 2004–2018

Probability serves as a measure for assessing the reliability of the appearance of a particular value of the considered characteristic or phenomenon [9].

The coefficient of variation for the period under study increased slightly due to the increase in the humidification of the mountain slopes and the flow of water into the rivers due to the degradation of mountain glaciers. This situation led to an increase in the values of river runoff of varying availability. The analysis of the chronological course of the maximum water flow rates shows a trend towards a decrease in the maximum water flow rate and a decrease in their variability. The single-peak hydrograph transforms into a more flattened intra-annual flow hydrograph (Fig. 5), which is determined by the influence of anthropogenic load on the river flow by building a reservoir.

A large anthropogenic structure in the Charyn River basin, which may have an impact on the functioning of floodplain geosystems, is currently the Bestyubinsk reservoir (Fig. 6) built in 2012 on the site where the river flows through the Lower Kegen intramontane slightly hilly plain. The hydraulic structure was built according to the project "Creation of the Bestyubinsk reservoir on the Charyn River" [12].

Fig. 6. Satellite images of Bestobinsky reservoir. in the Charyn River basin

Fig. 7. A snapshot of a section of the frequently flooded floodplain of the Charyn River in the Taskarasu Valley selected for analysis

The flow regulation significantly affects the hydrological regime and the onset of the danger of floods in the study area. The period of flooding of the Charyn River lasts from April to June. Therefore, the study was carried out using satellite images taken during these months. According to remote sensing data, it was found that the threat of flooding was posed to the floodplain Taskarasus Valley (near the settlements of Taskarasu and Charyn) (Fig. 7).

For comparison and analysis, the selected most flooded part in the river floodplain was visualized. As a result of decoding the remote sensing data, a dynamic model of the flooded area in 2004–2018 was obtained in the floodplain of the Charyn River in the Taskarasu Valley (Fig. 8).

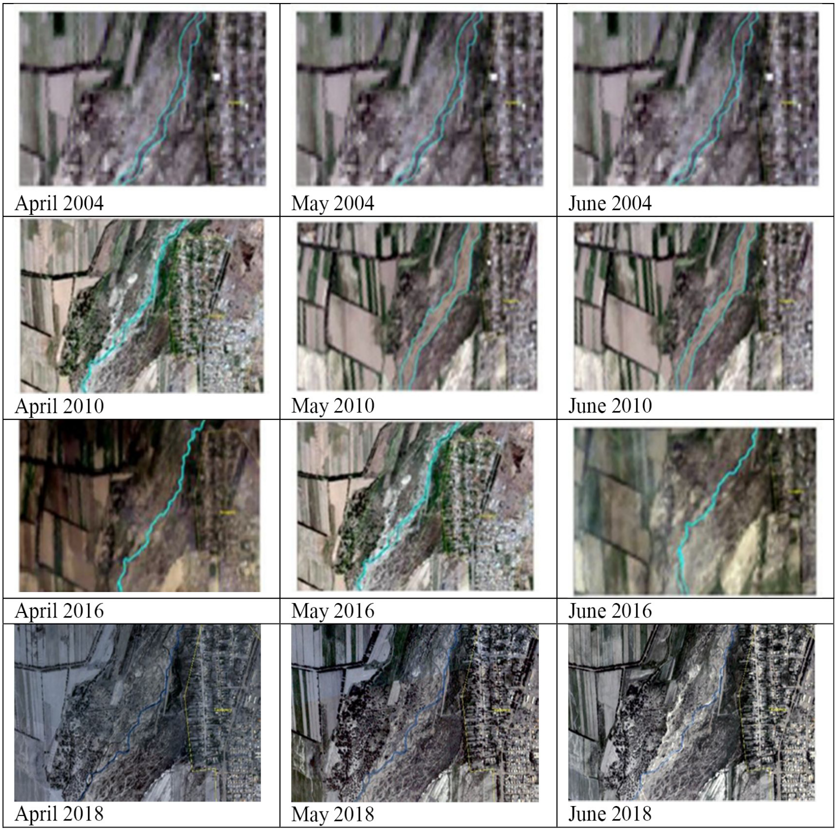

April 2004
May 2004
June 2004
April 2010
May 2010
June 2010
April 2016
May 2016
June 2016
April 2018
May 2018
June 2018

Fig. 8. The dynamic model of the Charyn River section in the Taskarasu Valley, during the flooding period; April, May, June 2004–2018

Table 1 shows the data on the dynamics of the flooding area as a result of remote sensing monitoring.

Table 1.

The flooding area of the Charyn River floodplain in the Taskarasu Valley, 2004–2018

Year	Month	Flooded area, km^2
2004	April	2.77
	May	2.85
	June	2.83
2010	April	1.67
	May	3.81
	June	3.37
2016	April	0.56
	May	2.38
	June	0.87
2018	April	1.43
	May	1.11
	June	1.56

A static model of the area at risk of flooding, the floodplain geosystem in the Taskarasu Valley, and the settlement along the Charyn River during the flooding period (Fig. 9).

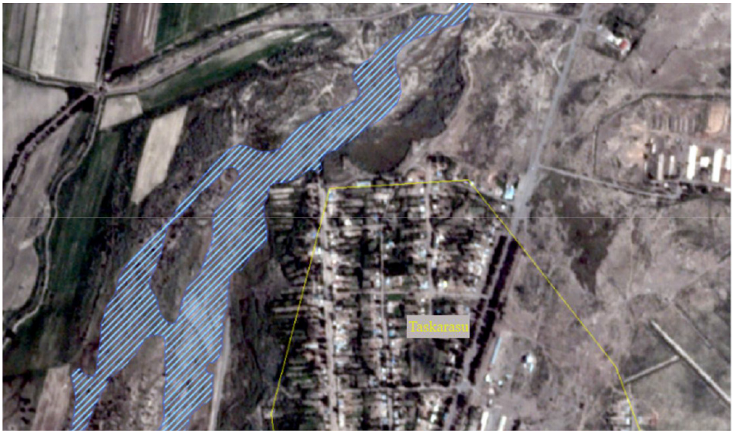


Fig. 9. A static model of floodplain geosystems at risk of flooding; yellow color indicates the border of the Taskarasu settlement, Uygur district of Almaty region

During field landscape research, we studied a key area in the geosystem of the Charyn River floodplain: a floodplain section in the Taskarasu Valley. As a result, a comprehensive physical and geographical description of the current state of the floodplain geosystems of the Taskarasu Valley was compiled.

The investigated key area is located in the floodplain of the Charyn River, in the runoff dispersion zone, 2.5 km from 8A highway, near the village of Taskarasu. The site is represented by the Taskarasu gently sloping plain with fragments of small outliers and numerous swampy depressions, composed of gravel-sandy-loamy deposits with forb-grass-tugay vegetation on alluvial-meadow and meadow-tugay soils.

Such soils are usually formed under conditions of periodic flooding by floodwaters. The soil profile includes the upper humus horizon of 25–40 cm, brownish-dark gray color. In the upper part, a soddy horizon is isolated, intertwined with plant roots, of a layered-lumpy structure, 5–10 cm thick.

A number of communities was found, such as herb-grass vegetation *(Phragmites australis, Calamagrostis epigeios, Glycyrrhiza uralensis, Trachomitum lanacifolium)* ***on alluvial-loot soils → cereal-forb meadows*** **(***Vexibia alopecuroides, Leymus multicaulis***)** with groups of trees *(Salix songarica, Elaeagnus oxycarpa)* on meadow-tugai soils of a low floodplain [17].

Project coverage was 85% with full viability (plants have normal growth), full bloom, grow in common clusters.

The identified quantitative indicators characterizing the geosystem of the Taskarasu gently sloping plain are shown in Table 2.

Table 2.

Quantitative indicators characterizing the geosystem of the Taskarasu gently sloping plain

1	Coordinates	N.L. 43^{o} 47.97$^{/}$ E.L. 79^{o}25.04$^{/}$
2	Height above sea level, m	571
3	Valley slope height, m	501–550
4	Slopes	0-3^{o}
5	Exposition	not defined
6	Average monthly air temperature, t^{0}C	+22
7	Air humidity, %	57.17
8	Average monthly precipitation, mm	44
9	Direction and mean wind speed, m/s	North East. 3.05
10	Average annual water level, cm	133
11	Average annual water consumption, m^{3}/s	47.5
12	Water flow speed, m/s	1.5
13	Flood duration, day	114–121
14	Flood mineralization, g/L In low water, g/L	0.2–0.3 0.4–0.5

Discussion

The influence of hydrodynamic processes of the mountain river Charyn (Kazakhstan) on floodplain geosystems today (during global climate change) is poorly studied.

The novelty of our scientific research is as follows:

- We obtained a dynamic model of the flooding zone for 2004–2018 in the Charyn River floodplain (Taskarasu Valley);
- We compiled a contemporary and comprehensive physical and geographical description of the Taskarasu Valley (using the data obtained from long-term field landscape studies);
- We compiled a digital relief model and a map of the hydrographic network of the entire Charyn River basin.

The river belongs to the type of rivers with spring-summer floods and floods in the warm season. High water and floods in the river continue from April to July. The main phase of the water regime is the flood, during which most of the annual runoff, maximum flow rates, and highest water levels occur. According to our data, high water starts in late March–early April and ends in July–August. The average date of the beginning of the flood is March 24, and the end is August 17. The dates of the passage of the highest expenditures are noted in May–June.

Water levels and discharges are uneven across the seasons: in May and June, water discharges are four to five times higher than in autumn and winter. The flow hydrograph has a multi-vertex shape. The number of peaks can reach 20–25, which is explained by the non-simultaneous melting of snow in different altitudinal zones, the superposition of rain floods on the flood runoff. Fig. 3 shows runoff hydrographs for low-water 2014 and high-water 2009 and average water regimes in 2015. Thus, the water regime of the river is characterized by a constant flow.

In 2004, the flooded area was 2.77 km^2 in April, 2.85 km^2 in May, and 2.83 km^2 in June. This trend was due to the sharp warming of the weather in February and March, when the water level in the riverbed increased as a result of melting snow and heavy rainfall in April. In 2010, the flooding area was 1.67 km^2 in April, 3.81 km^2 in May, and 3.37 km^2 in June.

In 2010, a flood on the Charyn River created emergencies in the Uygur region. Then 9 streets out of 26 and the villages of Charyn and Taskarasu and 250 out of 1070 houses were flooded, more than 400 residents were evacuated. In the same year, May and June had the highest water level and flooding areas (3.81 km^2 in May and 3.37 km^2 in June). This situation is due to the sharp warming of the weather in late April - early May this year. In May and June 2010, the flooding was caused by increased water inflow, associated with the spring melting of snow in the plains and the summer melting of snow and glaciers in the mountains (Fig. 7).

In 2016, the flooded area was low at the beginning of April (0.56 km^2). We noticed a significant sharp rise in water in May (2.38 km^2). In June 2016, the flooded area dropped sharply again to 0.87 km^2. This situation is due to a flooded, sharp, and short-term rise in the water level in the river, maybe as a result of an intensive melting of snow and volley discharges of water from the reservoir. Flooded can last from a few fractions of an hour to several days.

The water level in the riverbed in 2018 was as follows. In the first week of April, the water level was stable, but from the second week of the month, the water level rose. The water level remained low during the same period until the second half of June with minor changes. This situation was due to warmer weather in March and April, when, as a result of snow melting, the water level in the riverbed increased, but after a while, it became stable. Thus, the intensity of floods in April was 1.43 km^2, in May, it was 1.11 km^2, and in June, it was 1.56 km^2.

The river is mainly fed by snow and glaciers. According to N.N. Kerimbay [3], there are 20 glaciers in the river basin on the northeastern slopes of Terskey and Kungey Alatau. The area of glaciation is 2.4 km^2, which is 0.032% of the total area of the river basin. The ice volume is 0.05 km^3. Since the Charyn is a mountain river, it is obvious that the processes of formation of runoff in the mountains are associated with intensive melting of glaciers with an increase in air temperature. According to the RSE “Kazhydromet,” in Kazakhstan in 1976-2019, the air temperature rises by an average of 0.31°C every 10 years. Annual precipitation increases by 4.3 mm every 10 years. For the Charyn River basin, according to the Kyrgyz meteorological stations, the following periods reflecting long-term trends in temperature and precipitation changes are characteristic. Thus, according to Kazhydromet data, the average annual air temperature in the 1970s was 7.7 ° C, and now it is 8.1°C. At the same time, the average amount of precipitation for this period was within 344 mm, and since 2000, about 398 mm per year, which is reflected in the characteristics of the river flow Charyn [16].

N. I. Ivkina, I. Schoenberger, A. G. Terekhov [2] analyzed the average annual water discharge of the Charyn River (in the Sarytogay tract) for 1929–1986. This period reflects the conditions for the formation of the flow of the Charyn River in a conditionally natural period and reflects the climatic conditions of the 20th century.

According to our studies, the next period, from the beginning of the 21st century, is characterized by significant climate changes, and compared to the first period, it is characterized by an increased runoff due to an increase in the humidification of mountain slopes, an increase in air temperature, and an increase in water flow into rivers due to the degradation of mountain glaciation. The period since 2012 is characterized by a change in the flow hydrograph as a result of climate change and anthropogenic activities due to the regulation of the river.

Conclusion

This study presents the impact of changes in the Charyn River flow for 2004–2018 on floodplain geosystems. The runoff of the Charyn River was estimated from the change in the parameter of the mean annual runoff. The cycle of fluctuations in the annual runoff was revealed using the difference and total integral curves. The Charyn River has a natural flow regime and therefore is sensitive to climate change.

Calculation and analysis show that the water content of the Charyn River increased by about 20%. The increase in water content is associated with the flow of water into the rivers due to the degradation of mountain glaciers as a result of climate warming, which led to an increase in the values of the average annual runoff of different availability.

The redistribution of seasonal runoff in the spring is observed, a single-peak hydrograph turns into a more spread out intra-annual runoff hydrograph, which is determined by the influence of anthropogenic load on the river runoff by building a reservoir, which led to a redistribution of water runoff within the year by seasons. The observed transformation of seasonal and long-term runoff indicates the need to correct water use structure and regulate runoff.

Systematization of the research materials revealed that every year, floodwaters are flooded with a section of the Taskarasu Valley floodplain, located below the Bestyubinsk reservoir. The territory of the river basin differs in height above sea level and relief slopes. Among the floodplain geosystems below the Bestyubinsk reservoir, the Taskarasu has the lowest slopes of 0–3° valley. Thus, we uncovered the current state and functioning of these areas and compiled their physical and geographical characteristics.

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