ISSN 2518-170X (Online)
ISSN 2224-5278 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ
Satbayev University

ХАБАРЛАРЫ

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ
НАУК РЕСПУБЛИКИ
КАЗАХСТАН
Satbayev University

N E W S

OF THE ACADEMY OF SCIENCES
OF THE REPUBLIC OF
KAZAKHSTAN
Satbayev University

SERIES

OF GEOLOGY AND TECHNICAL SCIENCES

5 (455)

SEPTEMBER – OCTOBER 2022

THE JOURNAL WAS FOUNDED IN 1940

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

«ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Меншіктеуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.).

Қазақстан Республикасының Ақпарат және қоғамдық даму министрлігінің Ақпарат комитетінде 29.07.2020 ж. берілген **№ KZ39VPY00025420** мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Тақырыптық бағыты: *геология, мұнай және газды өңдеудің химиялық технологиялары, мұнай химиясы, металдарды алу және олардың қосындыларының технологиясы.*

Мерзімділігі: жылына 6 рет.

Тиражы: 300 дана.

Редакцияның мекен-жайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., тел.: 272-13-19
http://www.geolog-technical.kz/index.php/en/

Типографияның мекен-жайы: «Аруна» ЖК, Алматы қ., Мұратбаев көш., 75.

«Известия НАН РК. Серия геологии и технических наук».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан» (г. Алматы).

Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и общественного развития Республики Казахстан **№ KZ39VPY00025420,** выданное 29.07.2020 г.

Тематическая направленность: *геология, химические технологии переработки нефти и газа, нефтехимия, технологии извлечения металлов и их соеденений.*

Периодичность: 6 раз в год.

Тираж: 300 экземпляров.

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, оф. 219, тел.: 272-13-19

http://www.geolog-technical.kz/index.php/en/

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75.

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Owner: RPA «National Academy of Sciences of the Republic of Kazakhstan» (Almaty).

The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Social Development of the Republic of Kazakhstan **No. KZ39VPY00025420,** issued 29.07.2020.

Thematic scope: *geology, chemical technologies for oil and gas processing, petrochemistry, technologies for extracting metals and their connections.*

Periodicity: 6 times a year.

Circulation: 300 copies.

Editorial address: 28, Shevchenko str., of. 219, Almaty, 050010, tel. 272-13-19

http://www.geolog-technical.kz/index.php/en/

Address of printing house: ST «Aruna», 75, Muratbayev str, Almaty.

NEWS *of the National Academy of Sciences of the Republic of Kazakhstan*
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
https://doi.org/10.32014/2518-170X.214

UDC 556.5; 504.45

G.R. Baspakova[1,2*], S.K. Alimkulov[1], E.S. Sarkynov[2], A.A. Tursunova[1], A.R. Zagidullina[1,2], A.A. Saparova[1], K.M. Kulebayev[1]

[1]Institute of Geography and Water Security, Almaty, Kazakhstan;
[2]Kazakh National Agrarian Research University, Almaty, Kazakhstan.
E-mail: *sharafedenova@mail.ru*

IMPACT OF CLIMATE CHANGE AND ANTHROPOGENIC FACTORS ON THE RUNOFF OF THE ERTIS RIVER

Abstract. The article examines the current change in renewable water resources of the Ertis River basin, taking into account regional climatic and anthropogenic impacts. The study of the river flow of the transboundary Ertis River is extremely important for interstate cooperation of 3 neighboring countries regarding the joint use and protection of water resources. The flow of the Ertis River has a huge impact on the socio-economic development of the Republic of Kazakhstan, as it is the main source of water for the northeastern and eastern parts of the country. The main goal of the authors is to study long-term trends in runoff changes, taking into account climatic and anthropogenic loads in order to develop scientifically justified strategies for sustainable management and protection of water resources of the Ertis transboundary river basin.

The results of assessments taking into account climate change show that since 1973 there has been an increase in river flow at gauging stations located in runoff formation zones in mountainous areas, and a decrease in runoff located in the flat part of the basin in the dispersion zone. When assessing anthropogenic factors on river runoff, the method of hydrological analogy, the method of water balance and statistical data on the coefficient of water withdrawal of non-returnable water consumption were used. In general, the assessment of the anthropogenic impact on the basin of the river Ertis shows a decrease in total runoff by 6.08 km3, i.e. by 16.9% of the climatically determined runoff.

Key words: climate change, anthropogenic activity, river runoff, air temperature, precipitation.

Г.Р. Баспакова[1,2*], С.К. Алимкулов[1], Е.С. Саркынов[2], А.А. Турсунова[1], А.Р. Загидуллина[1,2], А.А. Сапарова[1], К.М. Кулебаев[1]

[1]География және су қауіпсіздігі институты, Алматы, Қазақстан;
[2]Қазақ ұлттық аграрлық зерттеу университеті, Алматы, Қазақстан.
E-mail: sharafedenova@mail.ru

ЕРТІС ӨЗЕНІ АҒЫНДЫСЫНА КЛИМАТТЫҢ ӨЗГЕРУІ МЕН АНТРОПОГЕНДІК ФАКТОРЛАРДЫҢ ӘСЕРІН БАҒАЛАУ

Аннотация. Мақалада аймақтық климаттық өзгерістер мен антропогендік әсерлерді ескере отырып, Ертіс өзені алабының жаңғырмалы су ресурстарының қазіргі өзгерістері қарастырылады. Трансшекаралық Ертіс өзенінің өзен ағындысын зерттеу су ресурстарын бірігіп пайдалану және қорғау барысында көршілес жатқан 3 мемлекет арасындағы мемлекетаралық келісім үшін өте маңызды. Ертіс өзенінің ағындысы Қазақстан Республикасының әлеуметтік-экономикалық дамуына үлкен үлес қосады, себебі ол еліміздің солтүстік-шығыс және шығыс бөлігіндегі негізгі су көзі екені белгілі. Авторлардың негізгі мақсаты Ертіс өзенінің трансшекаралық алабының су ресурстарын қорғау және тиімді басқарудың ғылыми негізделген стратегиясын әзірлеу мақсатында антропогендік жүктемелер мен климаттық өзгерістерді ескере отырып, ағынды өзгерісінің ұзақ мерзімді үрдістерін зерттеу.

Аймақтық климаттың өзгерісін ескере отырып, өзен ағындысын бағалау нәтижелері 1973 жылдан бастап ағынды қалыптастыру аймақтарында, таулы аудандарда орналасқан гидробекеттерде өзен ағындысы көлемінің ұлғаюы және алаптың жазық бөлігінде, яғни шашырау аймағында ағынды мөлшерінің азаюы байқалды. Антропогендік факторларды ескере отырып, өзен ағындысын бағалау кезінде гидрологиялық ұқсастық әдісі, су теңгерімдік әдісі және қайтарымсыз су тұтынудың су алу коэффициентінің статистикалық деректері пайдаланылды. Жалпы, Ертіс өзені алабының антропогендік әсерді бағалау жиынтық ағынды көлемінің 6,08 км^3-ке, соның ішінде климаттық ағындыдан 16,9% - ке азайғанын көрсетеді.

Түйін сөздер: климаттың өзгерісі, антропогендік іс-әрекет, өзен ағындысы, ауа температурасы, атмосфералық жауын-шашын.

Г.Р. Баспакова[1,2*], С.К. Алимкулов[1], Е.С. Саркынов[2], А.А. Турсунова[1], А.Р. Загидуллина[1,2], А.А. Сапарова[1], К.М. Кулебаев[1]

[1]Институт географии и водной безопасности, Алматы, Казахстан;
[2]Казахский национальный аграрный исследовательский университет, Алматы, Казахстан.
E-mail: sharafedenova@mail.ru

ВЛИЯНИЕ ИЗМЕНЕНИЯ КЛИМАТА И АНТРОПОГЕННЫХ ФАКТОРОВ НА СТОК РЕКИ ЕРТИС

Аннотация. В статье рассматриваются современные изменения возобновляемых водных ресурсов бассейна реки Ертис с учетом региональных климатических и антропогенных воздействий. Изучение речного стока трансграничной реки Ертис чрезвычайно важно для межгосударственного сотрудничества 3-х соседних стран в отношении совместного использования и охраны водных ресурсов. Сток реки Ертис оказывает огромное влияние на социально-экономическое развитие Республики Казахстан, так как она является основным источником воды для северо-восточной и восточной частей страны. Основной целью авторов является изучение долгосрочных тенденций изменения стока с учетом климатических изменений и антропогенных нагрузок с целью разработки научно обоснованных стратегий устойчивого управления и охраны водных ресурсов трансграничного бассейна реки Ертис.

Результаты оценки речного стока с учетом изменения регионального климата показывают, что с 1973 г. наблюдается увеличение стока рек на гидропостах, расположенных в зонах формирования стока, в горных районах, и уменьшение стока в равнинной части бассейна, в зоне рассеяния. При оценке речного стока с учетом антропогенных факторов использовались метод гидрологической аналогии, метод водного баланса и статистические данные о коэффициенте водозабора безвозвратного водопотребления. В целом оценка антропогенного влияния по бассейну р. Ертис показывает уменьшение суммарного стока показывает на 6,08 км^3, т.е. на 16,9 % от климатически обусловленного стока.

Ключевые слова: изменение климата, антропогенная деятельность, речной сток, температура воздуха, атмосферные осадки.

Introduction. The problem of assessing water resources is of great importance and relevance not only from a scientific point of view, but also in recent years has acquired an acute socio-economic and political character, which is due, on the one hand, to the increasing role of anthropogenic factors, and on the other, to factors caused by all more noticeable climate changes. The Republic of Kazakhstan is one of the least water-supplied countries in Central Asia. The severity of the water supply problem in Kazakhstan is due to the limited accessibility of water resources, their uneven distribution over the territory, and significant variability over time. The total water resources are estimated at about 100-110 km^3, of which 44.4% come from neighboring countries (China, Russia, Kyrgyzstan, Uzbekistan), the remaining 55.6% are formed within the country (Alimkulov et al., 2019:9; Meyer et al., 2016:10).

The territory of the Republic of Kazakhstan is divided into 8 water economy basins (WEB). 7 of them are transboundary and one - Nura-Sarysu is internal WEB (Absametov et al., 2019:7). The main part of water resources falls on the water resources of Ertis water economy basin (about 45%). According to scientists, Kazakhstan is one of the countries that is experiencing the greatest scarcity of water resources.

In terms of water sufficiency, the republic occupies one of the last places among the CIS countries. That is mainly due to the fact that about half of the surface water resources of our republic come from the territories of neighboring countries (Malkovsky, 2012). The river runoff of the Ertis River basin is of particular importance and relevance due to the fact that Ertis belongs to transboundary rivers and its water resources are intensively used by three neighboring countries: the People's Republic of China, the Republic of Kazakhstan and the Russian Federation (Muratshina, 2012).

Study area. The cross-border Ertis River begins on the slopes of the Altai Mountains on the border of Mongolia and China, then flows into Kazakhstan under the name Kara Ertis and flows into the flowing lake Zhaisan (Zaisan), from where Ertis itself passes through a cascade of hydroelectric power plants. It carries its waters to Russia, where the city flows into the Ob River near Khanty-Mansiysk.

The total distance of the Ertis River is 4248 km (of which 512 km flows on the territory of the People's Republic of China under the name of the Black Irtysh, 1696 km - on the territory of the Republic of Kazakhstan and 2040 km - on the territory of the Russian Federation). The length of the Ertis River exceeds the length of the Ob itself, and together the Ob' and Ertis it is the longest watercourse in Russia, the second longest in Asia and the sixth in the world (5410 km). Fig.1 shows a diagram of the Ertis River basin.

The average long-term volume of surface runoff of the Ertis River (on the territory of the three countries) is approximately 88.3 km^3, which is approximately 27% of the total runoff of the Ob River (Vinokurov et al., 2012).

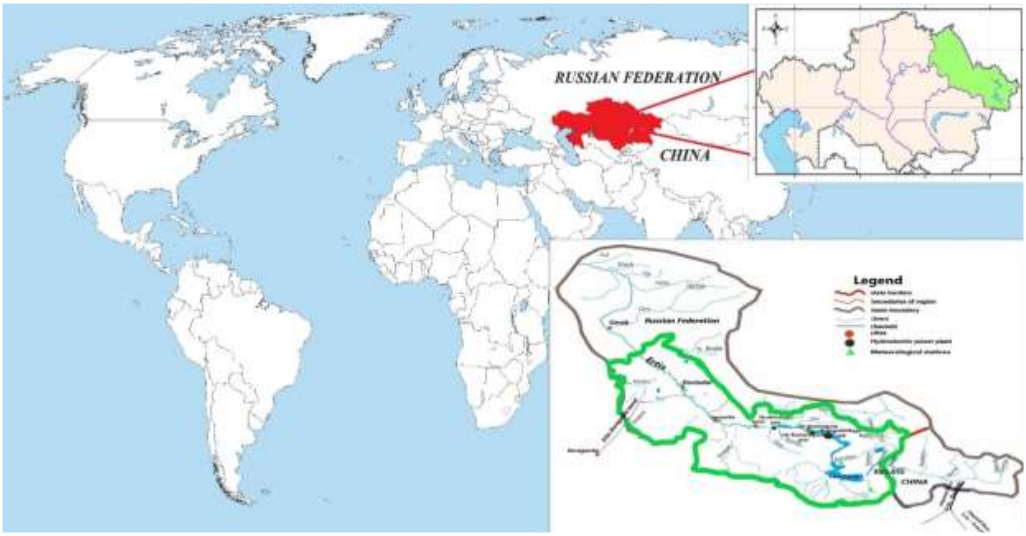

Figure 1. Scheme of the Ertis river basin location

Conditions for the formation of river flow in Ertis river basin are distinguished by the significant variety of climatic and orographic conditions, terrain relief, which is reflected in the uneven distribution of both atmospheric precipitation and air temperature, and, as a result, river runoff.

By the highest value of surface water resources in the considered territory is characterized the right bank of the Upper Ertis of the East Kazakhstan region - the mountainous part of the river runoff formation, and the least value of local resources is characteristic of the left bank part of the East Kazakhstan and especially Pavlodar regions - the flat territory (Fig. 2).

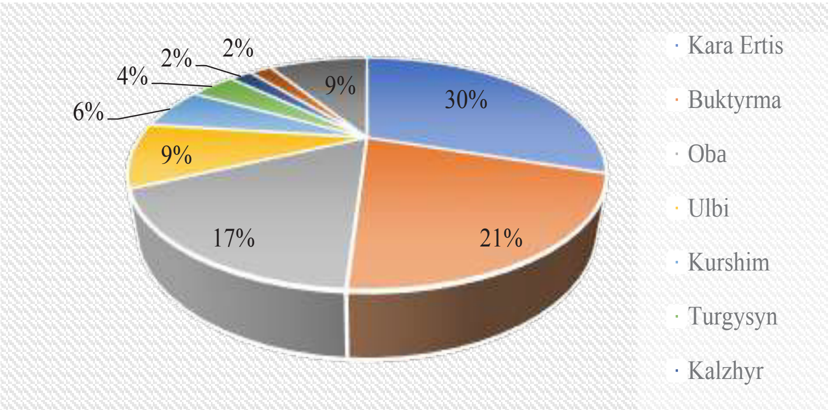

Figure 2. The share of the main rivers flow in the formation of water resources in the Upper Ertis basin (Galperin 2012).

The water resources of Ertis are of exceptional importance, since the Ertis basin is the most water-rich in the republic (Galperin, 2012) and meets the needs of drinking water supply and economic sectors (especially industry) not only in the eastern part of the country, as well as by diverting part of the flow through the I.K. Satpayev canal ("Ertis-Karaganda") with extension of 458 km to industrial objects in the cities of Karaganda, Ekibastuz and Temirtau, as well as the capital Astana The Ertis river basin is a potential donor basin for water-deficient regions of the country, the diversion of the Ertis river flow to cover the expected water shortages in the basins of the Esil, Nura, Tobyl, Syrdaria rivers will contribute to solving critical national problems of the Republic of Kazakhstan (Malkovsky, 2012).

The work of the cascade of Ertis hydroelectric power plants, operating since the second half of the 20th century, provides electricity to numerous industrial facilities, settlements, and also regulates the runoff in the central and low reaches of the river, including environmental releases for watering the largest Pavlodar-Omsk floodplain (Burlibayev et al., 2012). In Russia, the waters of the Ertis satisfy the needs of the population of the Omsk and Tyumen regions, provide shipping, through which transport links are carried out in the swampy conditions of the Siberian territories, which have an extremely rare net of roads and railways, including the most important for this region "northern delivery" (Kozlov and Ratkovich 2010:5; Romanova, 2013). Biodiversity of the fertile floodplain of Ertis river is of unique natural (flora and fauna) and economic value (flood meadows, hayfields, pastures).

Water resources of Ertis river are of particular importance for all three countries, on which territories its basin extends.

In China, the water resources of Kara Ertis are the main source of water supply for the Xinjiang Uygur Autonomous Region (XUAR), which has been intensively developing since 2000 as part of the implementation of the large-scale Chinese roadmap for the business development of the western provinces "Go West" ("Go West"), which includes projects for the development of the oil and gas industry, coal industry in the region, as well as increasing the area of irrigated land. The development of water resources is accompanied by the widespread regulation of river flow, including the transfer of water to neighboring water-deficient areas. Thus, in the middle reaches of the Kara Ertis, there is a large hydroelectric complex with Karasu reservoir, from where begins the largest drainage canal "Kara Ertis - Karamay - Urumqi" (Prokhorova, 2015:10). After passing the common section about 139 km long, the canal is divided into two directions: first to the Karamai city with a length of 335 km, the second to the city of Urumqi with a length of about 470 km (Fig.1). More than 2.5 km^3 of the Kara Ertis runoff is already being transferred through the canal; however, according to various expert assessments of specialists from Kazakhstan, the design capacity of the canal is 5.0-7.0 km^3 by the total runoff of 9.5 km^3 in an average year of the water content.

Water resources of Ertis river are of great importance for the economy and health of the population of a large industrial area of Kazakhstan, which includes three regions: East Kazakhstan, Pavlodar and Karaganda.

Materials and data. To assess the impact of climate change to the river runoff in the basin under consideration, 8 hydrological stations were selected for various hydrologically homogeneous regions, with the longest periods of runoff observations, for which the series of annual (conditionally natural) runoff was reconstructed for the period from the date of the observation start until 2015. The time series of air temperature and atmospheric precipitation served as meteorological data also up to 2015 for 8 representative meteorological stations, covering the entire length of the Ertis river in the Kazakhstan sector.

The data of long-term observations of the hydrological network of RSE "Kazhydromet" are the basis for identifying the trend of changes in river flow on the territory of Kazakhstan.

Methodology. To identify the climatic and anthropogenic impact to the water resources (in our case these are the volumes of river runoff of Ertis river basin in the territory of Kazakhstan) are used the traditional in the CIS methods of their assessment. The change in runoff taking into account climatic factors (atmospheric precipitation, air temperature) was estimated using the linear trend coefficient, which is widely used in hydrology and meteorology (Polyak, 1975:10; Talipova et al., 2021:14).

To identify the anthropogenic component of the river runoff, the method of hydrological analogy was used, which is based on long-term fluctuations in runoff for a conditionally natural and for a conditionally actual period) in the main gauging stations of the river, as well as an integrated approach using the calculation of the water balance of the main river channel, the coefficient of irretrievable water consumption, and also a verification element of calculations, data on water consumption by industry. All the methods that were used to assess the climatic and anthropogenic impact are described in detail and considered in the following studies (Medeu et al.,2020:7; Shiklomanov, 2008).

Impact of climate change to the river runoff. The water resource potential of river waters can be characterized by the following two indicators: natural (climatic) resources, actual (transformed under the influence of anthropogenic load) resources. Natural means the annually renewable potential resources of river runoff of any territory. For sufficiently clear representation of the resources condition, it is necessary to know the anthropogenic changes in the local and total runoff. In this case, the indicator is actual resources - resources transformed under anthropogenic impact, both inflow from outside the country and local, own.

Under the conditions of climate change, the uneven distribution of water resources across the territory is aggravated. The main factors of the runoff formation are most subjected to changes, in contrast to the terrain relief, geological structure, and the nature of nutrition, are such meteorological characteristics as air temperature and precipitation. In addition, the assessment of modern changes in climatic characteristics makes it possible to assess the river runoff in relation to these changes. In the studies dedicated to the research of climate variation, mainly the fluctuations in time of air temperature and precipitation are investigated, since these elements have the longest and most reliable series of observations. To assess the long-term dynamics of the annual river runoff and meteorological parameters there were allocated two periods: until 1973 and 1974-2015 according to the differential integral curves of the runoff, as well as in connection with the intense warming of the climate after the 1970s (Fig. 3) (Alimkulov et al., 2021:15).

According to the analysis of the differential integral curves of the river runoff of Ertis river basin, it can be said that after 1971-1973 almost in all tributaries of the basin and in the channel of the Ertis river the change in runoff is observed.

Long-term changes in air temperature (ºC/10 years) and precipitation (mm/10 years) until 1973 and for the period 1974-2015 at meteorological stations located along the Ile river basin were calculated according to the linear trend for the periods until 1973 and 1974-2015 for the Ertis river basin.

Analysis of the data obtained shows that for the periods until 1973 and 1974-2015, statistically significant increase in air temperature is observed in Ertis river basin. Moreover, the highest rate of increase in air temperature falls on the period 1974-2015 and a statistically significant increase in air temperature is observed at all considered meteorological stations. Intense warming occurs unevenly and warmed most of all at the Shemonaikha and Ust-Kamenogorsk meteorological stations (for more than 0.35 ºC/10 years) (1974-2015).

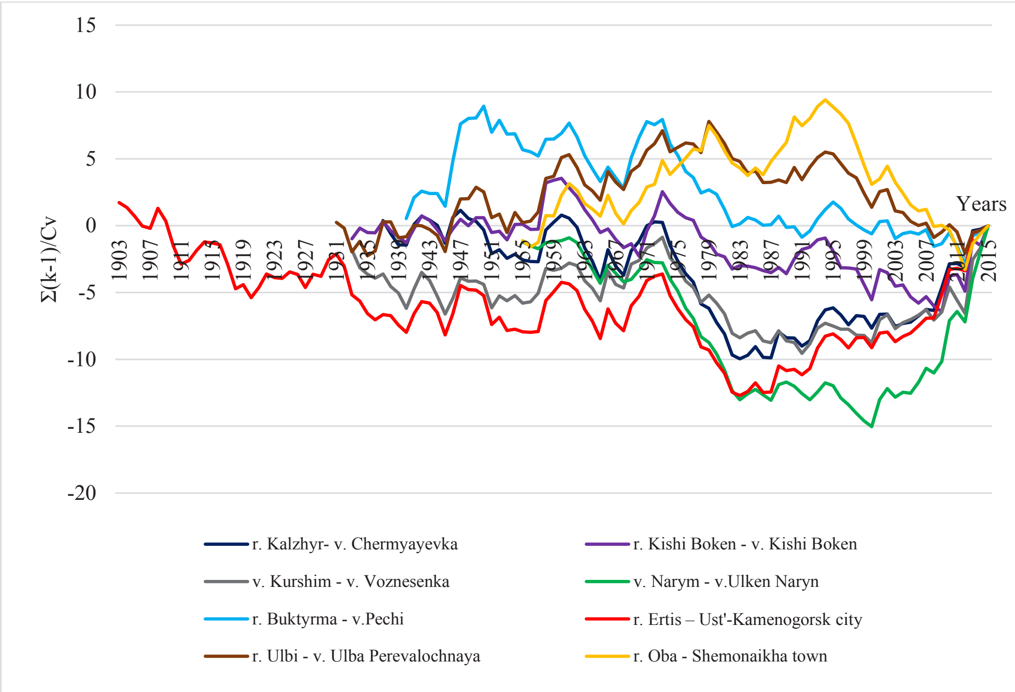

Figure 3. Difference integral curve of the river runoff of Ertis river basin

In most meteorological stations during the periods under consideration, there is a statistically insignificant, multidirectional trend in the change in annual precipitation amounts. The greatest increase in the annual precipitation after 1973 falls on the Semipalatinsk and Zaysan MSs. Decrease in annual precipitation for the period 1974-2015 is observed at MS Shemonaikha (9.55 mm/10 years) and until 1973 the maximum decrease was observed in MS Katon-Karagai (26.7 mm/10 years). Common features of climate change for the study area are increase in air temperature throughout the entire river basin and statistically insignificant multidirectional trend in annual precipitation.

Long-term dynamics of the total annual runoff values of the rivers of Ertis river basin for the two periods - until 1973 and 1974-2015 shows that since the beginning of the 1970s, there has been increase in river runoff at gauging stations located in the zones of runoff formation, and decrease in runoff in the flat part of the basin. It should be noted that all river basins, where the annual runoff increased, have different degrees of glacial recharge. To assess the impact of climate change to the river runoff, the example shows the long-term course of the river flow at the main hydrological stations (Fig. 4,5) and the long-term course of climatic factors (precipitation and air temperature) at the nearby located meteorological stations.

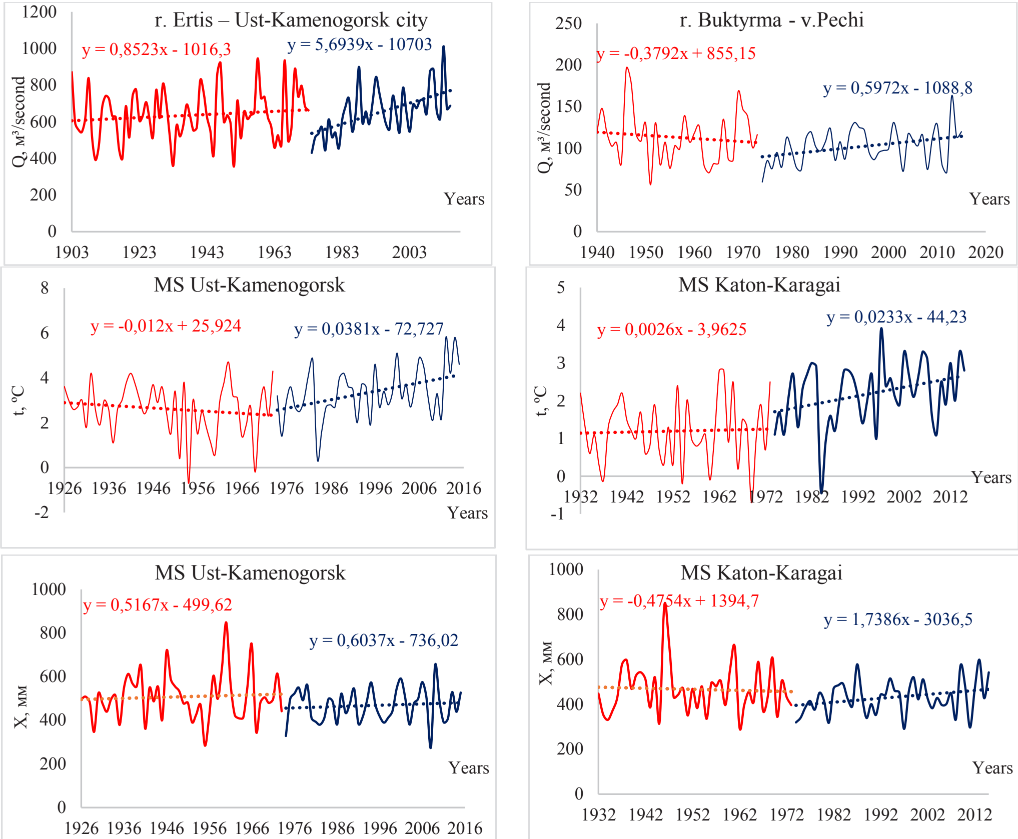

Figure 4. Long-term dynamics of the river runoff and dynamics of atmospheric precipitation and air temperature at nearby located meteorological stations (MS) of Ertis river basin

At the stream flow measuring stations located in the lowland part of the basin a decrease in runoff is observed after the year 1973, this is possibly connected with intense increase in air temperature. It is possible that increase in air temperature led to increase in evaporation, which led to decrease in water runoff.

Influence of anthropogenic activities to the river runoff. Intensive growth of anthropogenic influence in Ertis river basin begins in the mid-1950s (the upper part of the Kara Ertis basin in the PRC), but until the 1990s, anthropogenic activity did not significantly affect the river regime. Serious measures for the development of water resources originate from the second half of the 1990s, to provide water to the region of the oil field near the Chinese city of Karamai. In the territory of the Republic of Kazakhstan, in connection with the commissioning of the Ust-Kamenogorsk hydroelectric power station in 1953, as well as after the construction of the Bukhtyrma reservoir in 1960, we can observe disturbance in the flow regime of Ertis river (Zhurinov et al., 2019:6).

The water resources of the Ertis River and its tributaries in the territory of the Republic of Kazakhstan are used for the needs of industry, housing and communal services, fisheries, agriculture (regular irrigation, flooding of estuaries and hayfields, agricultural water supply, irrigation of pastures). In the Ertis basin, from the surface waters the total water intake for 2000-2015 is 3.12 km^3, from underground sources - 0.2 km^3, of which for the needs of industry is 1.93 km^3 (62%), for housing and communal services 0.11 km^3 (3.67%), flooding of estuaries (13, 4%) and hayfields (19.6%), for regular irrigation 3.69%, agricultural water supply 1.12%.

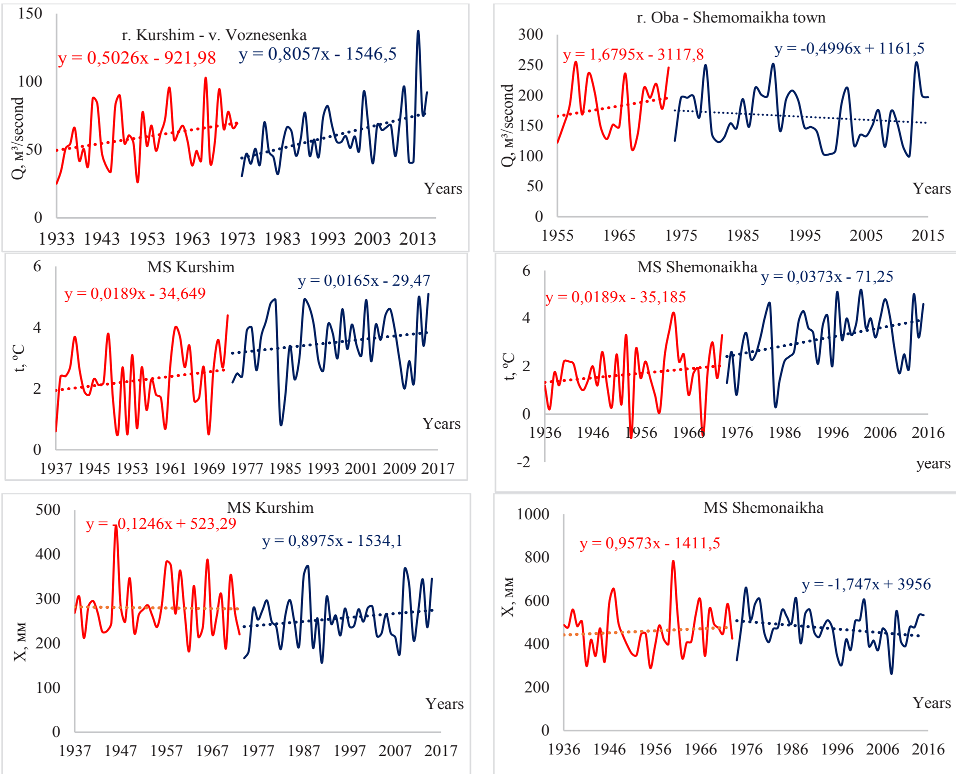

Figure 5. Long-term dynamics of river runoff and dynamics of atmospheric precipitation and air temperature of nearby located meteorological stations (MS) in Ertis river basin

In addition, the water resources of the river are used for the generation of hydroelectric power, the needs of navigation. Every year, from the Shulba reservoir, in order to maintain conditions close to natural floods in the middle reaches of the Ertis River, to preserve biological productivity, ecological habitat of flora and fauna of the floodplain, environmental releases are carried out.

The Ertis river runoff is regulated by a cascade of reservoirs with a design capacity of: 49.8 km^3 - Bukhtyrminskoye, which is one of the largest reservoirs in the CIS; 0.65 km^3 - Ust-Kamenogorsk reservoir; 2.39 km^3 - Shulbinsk reservoir (Huang et al., 2014:10; Yang et al., 2004:16). The runoff distribution of the Ertis river basin over the territory of Kazakhstan is complex, with great contrasts. Ertis river and Zaisan lake are water bodies of special state significance in Kazakhstan.

Results and discussion. At the first stage, assessment of anthropogenic changes in river runoff was carried out at the main observation points based on the method of hydrological analogy (Table 1, Fig. 6). The method gives quite reliable results, although they represent integral values of changes and are limited for assessing the role of certain industries or types of economic activity. These results, as the most reliable, will be used as control materials for further detailing of anthropogenic changes. According to the results of Table 1, the greatest changes along the main channel of Ertis river occurred at the Priirtyshskoye border gauging station, which shows an approximate general picture of anthropogenic changes in the channel of Ertis river in the territory of the Republic of Kazakhstan and PRC due to irretrievable water consumption and due to reservoirs and preservation of the river floodplain.

At the second stage, the assessment of economic activity based on the channel water balance was carried out for four main sections along the main river of Ertis river basin:

1 section – from the state border between the Republic of Kazakhstan and PRC to the tail-water of the Buktyrma Reservoir;

2 section – from the tail-water of the Buktyrma Reservoir to the tail-water of the Shulba Reservoir;

3 section – from the tail-water of the Shulba Reservoir to the border between East Kazakhstan and Pavlodar regions;

4 section – from the border of the East Kazakhstan and Pavlodar regions to the state border between the Republic of Kazakhstan and Russian Federation.

1 section – More than 60% of the surface runoff of Ertis river basin is formed in this area. The decrease in river runoff in the PRC during the considered period is 2.28 km^3 which is caused by water intakes in the territory of PRC due to increase of irrigated area and construction of hydrotechnical structures on the river Kara Ertis, as well as the transfer of the flow through the Ertis-Karamai canal to provide water to the region of the oil field near the Chinese city of Karamai. Anthropogenic change in the channel on the territory of the Republic of Kazakhstan along the river Ertis is due to additional losses after the construction of the Buktyrma reservoir on Lake Zhaisan. The change in the local runoff here makes 272 million m^3.

Table 1. Anthropogenic changes in the flow of the main rivers of the Republic of Kazakhstan (Medeu et al., 2020:7)

№	River-gauging station	W, km^3		Changes, km^3	In % from naturally-restored flow
		Naturally-restored	Actual		
1	r.Kara Ertis - v. Boran	10,6	8,32	-2,28	-21,5
2	r. Ertis - Hydropower plant Buktyrminskaya	20,7	16,6	-4,16	-20,1
3	r. Ertis - Ust-Kamenogorsk city	21,4	17,0	-4,44	-20,7
4	r. Ertis - v. Shulbi	30,6	27,6	-3,00	-9,8
5	r. Ertis – Semiyarka town	30,6	26,5	-4,13	-13,5
6	r. Ertis – Pavlodar city, zaton	30,6	27,2	-3,32	-10,9
7	r. Ertis -v. Priirtyshskoye	30,5	24,4	-6,08	-19,9

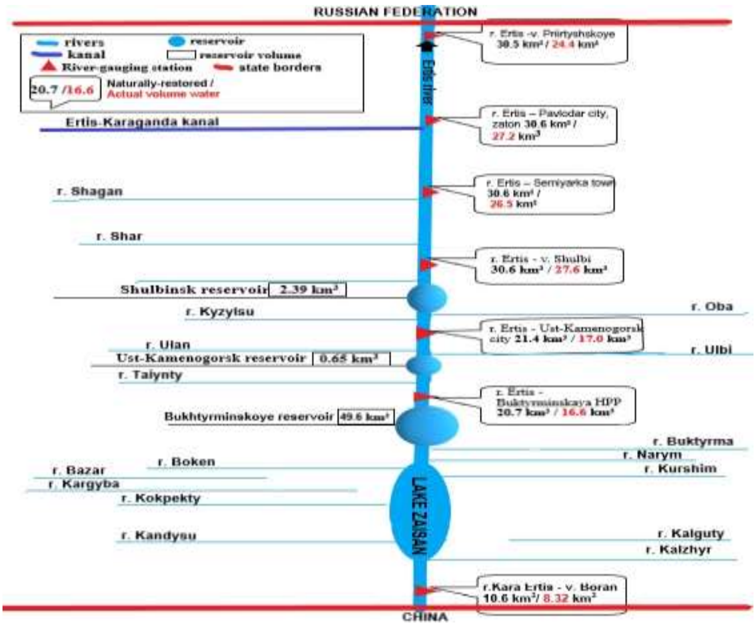

Figure 6. Scheme of the Ertis river basin on the territory of the Republic of Kazakhstan

2 section – 33% of the water resources of the basin are formed in the territory of this sector. There is a slight decrease in local resources (1.3%), which is caused by irrevocable water consumption by industry and municipal water supply in the big cities of Ust-Kamenogorsk and Ridder. The impact to the bed of the Ertis river was influenced by the construction of the Ust-Kamenogorsk hydroelectric power station in 1953 and Shulbinskoye water reservoir.

3 section – This sector is almost without inflow and for the needs of economic activities the water resources of river Shar and from the main channel of river Ertis are used; in this sector occur mainly small changes in the channel due to the changes in the regime and area of flooding of the floodplain.

4 section – In the territory of Kazakhstan, the greatest change in river flow occurs in this section of the basin, since water intakes are mainly made from the bed of the Ertis river to meet the needs of the region's industry and transfer the flow of the river Ertis by K. Satpayev Canal for water supply of the population, industry and agriculture of Central Kazakhstan. Here, irrecoverable water consumption throughout the basin in the territory of the Republic of Kazakhstan makes 76%.

Comparative analysis of natural runoff in Ertis river basin in the territory of Kazakhstan for the period 1932-1966 and the modern period shows an increase in renewable water resources, both local flow and inflow from neighboring country, this can be explained by the fact that in the region there is a gradual increase in the rate of runoff-forming factors, namely increase in air temperature and atmospheric precipitation (Fig. 7).

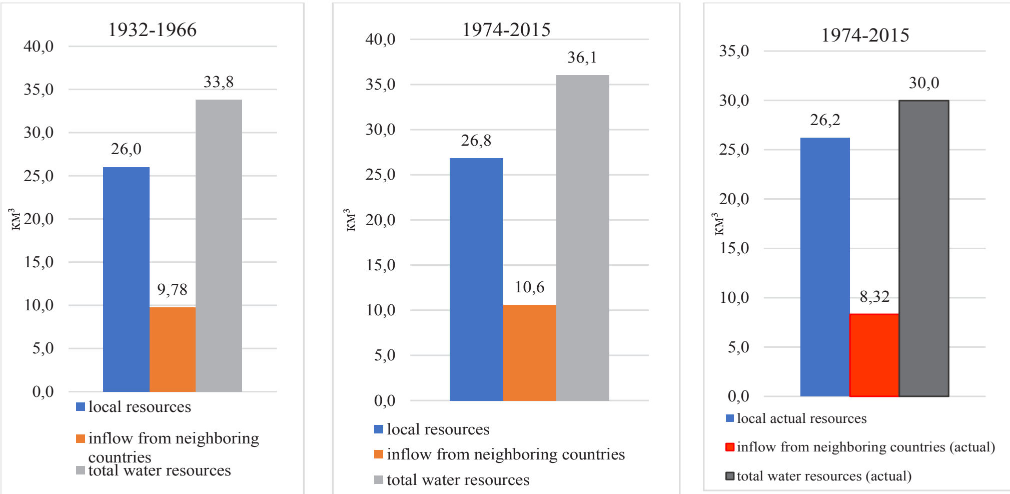

Figure 7. Changes in the natural (climatic) and actual runoff of Ertis river basin (Kazakhstan part)

The total natural (climatic) resources of river runoff in Ertis river basin over the modern period are 36.1 km^3, of which local resources are 26.8 km^3, inflow from China - 10.6 km^3, outflow to China (Kaba, Belozek) - 1.36 km^3. In addition, the lower reaches of Ertis rive are located in the territory of the Russian Federation, and the outflow from the Republic of Kazakhstan to the Russian Federation in natural conditions makes 30.0 km^3.

In the period from 1932 to 1966 in the considered territory the water resources were used for the needs of the local population and some works were also carried out to develop natural resources, but there was no particular impact to the natural regime of the river, in this regard the assessment was carried out for the period from1974 to 2015. In general, the assessment of anthropogenic impact in Ertis river basin shows decrease in runoff by 6.08 km^3, i.e. by 16.9% of the climatic natural runoff. Of which 6.31% is the influence of economic activity in the territory of PRC, or about 38% of the total anthropogenic change; the remaining 62% in the territory of the Republic of Kazakhstan is due to anthropogenic changes in Ertis river bed, in connection with the construction of cascades of hydroelectric power plants and irretrievable water consumption in the basin.

Conclusion. This study was aimed at assessing the current condition of water resources in Ertis river basin in the territory of Kazakhstan under conditions of climate change and increase of anthropogenic load.

The current change in river flow resources, taking into account economic activities is mainly associated with the functioning of the Bukhtyrma reservoir, with increase in water consumption by sectors of the economy in the territory of the Republic of Kazakhstan, as well as in the territory of the PRC. In general, for the period under consideration (1974-2015), the actual runoff in Ertis river basin is 30.0 km^3, i.e. runoff decreased by 16.9% compared to climatic runoff due to anthropogenic influence. In conclusion, the resources of river runoff due to the climate change tend to increase slightly, but unfortunately due to the modern needs of people and construction of hydrotechnical structures, the anthropogenic impact to renewable resources occurs both in quantitative and qualitative volumes.

Information about the authors:

Baspakova Gaukhar – Master, research scientist, Department of Water resources, Institute of Geography and Water Security, Ph.D. student, Kazakh National Agrarian Research University, Republic of Kazakhstan, 050010, Almaty, Pushkin st. 99, tel.: 87770141545, e-mail: sharafedenova@mail.ru, https://orcid.org/0000-0002-3795-0259;

Alimkulov Sayat – Candidate of geographical sciences, Deputy Chairman of the Board, Institute of Geography and Water Security, Republic of Kazakhstan, 050010, Almaty, Pushkin st. 99, tel.: 87016224327, e-mail: sayat.alimkulov@mail.ru, https://orcid.org/0000-0003-3236-2084;

Sarkynov Erbol – Professor, Candidate of technical sciences, Dean, Faculty of Water, Land and Forest resources, Kazakh National Agrarian Research University, Republic of Kazakhstan, 050010, Almaty, Abai avenue, 8, tel.: 87012274604, e-mail: sarkynov_e@mail.ru, https://orcid.org/0000-0002-6412-715;

Tursunova Aisulu – Candidate of geographical sciences, Head of the Department, Department of Water resources, Republic of Kazakhstan, 050010, Almaty, Pushkin st. 99, tel.: 87714738245, e-mail: ais.tursun@bk.ru, https://orcid.org/0000-0002-7814-0228;

Zagidullina Alfiya – Master, research scientist, Department of Water resources, Institute of Geography and Water Security, Ph.D. student, Kazakh National Agrarian Research University, Republic of Kazakhstan, 050010, Almaty, Pushkin st. 99, tel.: 87474828755, e-mail: zagidullina_a_88@mail.ru, https://orcid.org/0000-0002-8649-1757;

Saparova Assel – Master, research scientist, Department of Water resources, Institute of Geography and Water Security, Republic of Kazakhstan, 050010, Almaty, Pushkin st. 99, tel.: 87059634060, e-mail: aselek.a.s@mail.ru, https://orcid.org/0000-0003-0996-3594;

Kulebayev Kairat – Master, research scientist, Department of Water resources, Institute of Geography and Water Security, Republic of Kazakhstan, 050010, Almaty, Pushkin st. 99, tel.: 87073211351, e-mail: kairat.kulebayev@mail.ru, https://orcid.org/0000-0003-3421-3103.

REFERENCES

Absametov M.K., Adenova D.K., Nusupova A.B. (2019) Assessment of the impact of anthropogenic factors water resources of Kazakhstan. News of the national academy of sciences of the Republic of Kazakhstan. Series of geology and technical sciences, 1 (433): 248-254, *https://doi.org/10.32014/2019.2518-170X.30* (in Eng.).

Alimkulov S.K., Saparova A.A., Tursunova A.A., Baspakova G.R. (2021) Measuring spatial-temporal regularities of river flow based on IoT technology. International Journal of Agricultural Resources, Governance and Ecology this link is disabled, 17(2-4): 247–261, *https://doi:10.1504/IJARGE.2021.121673* (in Eng.).

Alimkulov S., Tursunova A., Saparova A., Kulebayev K., Zagidullina A., Myrzahmetov A. (2019) Resources of River Runoff of Kazakhstan. International Journal of Engineering and Advanced Technology, 8(6): 2242 – 2250 (in Eng.).

Burlibayev M.Zh., Kuts S.I., Fashevsky B.V., Opp K., Tsaregorodtseva A.G., Schenberger I.V., Burlibayeva D.M., Aitureyev A.M. (2012) Flooding of the Ertis floodplain is the main factor of sustainable development of the river ecosystem; Almaty, p. 396 (In Russ).

Galperin I.R. (2012) Water resources of Kazakhstan: assessment, forecast, management. Resources of river flow of Kazakhstan. Renewable surface water resources of Western, Northern, Central and Eastern Kazakhstan; Almaty, Vol. II, Book 2, p. 684 (In Russ).

Huang Feng, Xia Zi-qiang, Guo Li-dan, Yang Fu-cheng. (2014) Effects of reservoirs on seasonal discharge of Irtysh River measured by Lepage test; Water Science and Engineering, 7 (4): 363-372, *https://doi:10.3882/j.issn.1674-2370.2014.04.002 (in Eng.).*

Kozlov D.V., Ratkovich L.D. (2010) Water management aspects of transboundary water allocation and joint water resources management: Transboundary water resources management. Proceedings of the Second International Conference. M.: FGOU VPO MGUP, pp. 165–169 (In Russ).

Malkovsky I.M. (2012) Territorial redistribution of water resources in Kazakhstan: possibility and feasibility; Almaty, p. 414 (In Russ).

Medeu A.R., Alimkulov S.K., Tursunova A.A., Myrzakhmetov A.B., Saparova A.A., Baspakova G.R., Kulebayev K.M. (2020) Anthropogenic load on water resources of Kazakhstan. Eurasian J Biosci, 14: 301-307 (in Eng.).

Medeu A.R., Malkovsky I.M., Toleubayeva L.S. (2012) Water resources of Kazakhstan: assessment, forecast, management (concept). Water resources of Kazakhstan: assessment, forecast, management. Almaty, Vol. 1, p. 94 (in Russ).

Meyer B., Lundy L., Watt J., Abdullaev I., Jose E., Capilla R. (2016). Risk management as a basis for integrated water cycle management in Kazakhstan. Journal of Environmental Geography, 9 (3–4): 33–42, *http://dx.doi.org/10.1515/jengeo-2016-0010* (in Eng.).

Muratshina K. (2012) The Irtysh River in the hydro policy of Russia, Kazakhstan and China. Russian International Affairs Council; 29 May 2012. *https://russiancouncil.ru/en/analytics-and-comments/analytics/the-irtysh-river-in-the-hydro-policy-of-russia-kazakhstan-an/ (In Russ).*

Polyak I.I. (1975) Numerical methods of analysis of observations; L.: Gidrometeoizdat, p. 211 (In Russ).

Prokhorova N. (2015) China's policy on changing the structure of natural distribution of internal water resources. Problems of the Far East., 5: 96-107 (In Russ).

Romanova Yu.A. (2013) Water management complex of the Irtysh river basin in the context of redistribution of river flow upstream of transboundary sections: author. dis. cand. tech. sciences; Moscow, p. 21 (In Russ).

Shiklomanov I.A. (2008) Water resources of Russia and their use; GGI, St. Petersburg, p. 600. (In Russ).

Talipova E.K., Shrestha S., Alimkulov S., Nyssanbayeva A., Tursunova A., Isakan G. (2021) Influence of climate change and anthropogenic factors on the Ile River basin streamflow, Kazakhstan. Arabian Journal of Geosciences, 14: 1756, *https://doi.org/10.1007/s12517-021-08152-6* (in Eng.).

Vinokurov Yu.I., Puzanov A.V., Bezmaternykh D.M. (2012) The current condition of water resources and the functioning of the water economic complex of the Ob and Irtysh basins; Rus. Academy of Sciences, Siberian Branch, Institute of Water and Environmental Problems SB RAS, Novosibirsk: Publishing house of the SB RAS, p. 236. ISBN 978-5-7692-1293-2 (In Russ).

Yang D., Ye B., Shiklomanov A. (2004) Discharge Characteristics and Changes over the Ob River Watershed in Siberia; Journal of hydrometeorology, 5: 595-610, *https://doi:10.1175/1525-7541(2004)005<0595:DCACOT>2.0.CO;2* (in Eng.).

Zhurinov M.Zh., Kassymbekov Zh.K., Kassymbekov G.Zh. (2019) Mastering and development hydropower in Kazakhstan. News of the national academy of sciences of the Republic of Kazakhstan. Series of geology and technical sciences, 3 (435): 219 – 224, *https://doi.org/10.32014/2019.2518-170X.88 (in Eng.).*

CONTENTS

G.R. Baspakova, S.K.Alimkulov, E.S. Sarkynov, A.A. Tursunova, A.R. Zagidullina, A.A. Saparova, K.M. Kulebayev
IMPACT OF CLIMATE CHANGE AND ANTHROPOGENIC FACTORS ON THE RUNOFF OF THE ERTIS RIVER......6

K.A. Battakova, A.A. Saipov
THE INFLUENCE OF ATMOSPHERIC AIR POLLUTION ON THE GEOGRAPHY OF PROFESSIONAL HEALTH......23

Zh.G. Berdenov, R.Z. Safarov, E.Kh. Mendybaev, Zh.K. Shomanova, D.C. Ilies
IMPACT OF TECHNOGENIC FACTORS ON SURFACE WATER OF THE ILEK RIVER BASIN......37

M.T. Biletsky, B.T. Ratov, V.L. Khomenko, B.R. Borash, A.R. Borash
INCREASING THE MANGYSTAU PENINSULA UNDERGROUND WATER RESERVES UTILIZATION COEFFICIENT BY ESTABLISHING THE MOST EFFECTIVE METHOD OF DRILLING WATER SUPPLY WELLS......51

I.M. Dyussebayev, Zh. Issabekov, A.D. Tulegulov, D.S. Yergaliyev, N.A. Bazhaev, A.A.Kaipova
METHODOLOGICAL BASIS FOR THE APPLICATION OF WIND GENERATORS IN GEOLOGY......63

T. Ibrayev, M. Li, N. Bakbergenov, M. Narbayev, A. Batyrbayeva
CURRENT ISSUES OF WATER MANAGEMENT IN KAZAKHSTAN......79

I. Isa, L.T. Kurmangaziyeva, M.K. Urazgaliyeva, A.A. Kubasheva, A.G. Kassanova
DEVELOPMENT OF A MATHEMATICAL MODEL OF THE OIL RESERVOIR KENKIYAK FIELD ON THE BASIS OF ITS GEOLOGICAL MODELS......93

G.Zh. Kokymbaeva, R.N. Uteev, A.S. Mardanov, Zh.S. Murzagalieva, E.V. Yermekov
MODELING PVT PROPERTIES OF RESERVOIR FLUIDS WITHIN THE KARATON-SARKAMYS BLOCK BY THE EXAMPLE OF THE PRORVA GROUP OF FIELDS..........109

M. Mirdadayev, A. Basmanov, N. Balgabayev, B. Amanbayeva, A. Duisenkhan
RESEARCH OF HYDROGEOLOGICAL CONDITIONS AND ENERGY PARAMETERS OF ZONAL IRRIGATED SOILS WHEN OPTIMIZING ENERGY-EFFICIENT RECLAMATION TECHNOLOGIES IN THE REPUBLIC OF KAZAKHSTAN..........128

Ye.Zh. Murtazin, D.K. Adenova, S.R. Tazhiyev
ASSESSMENT OF THE POTENTIAL OF SELF-DISCHARGING HYDROGEOLOGICAL WELLS FOR SUSTAINABLE DEVELOPMENT OF RURAL AREAS OF ZHAMBYL REGION..........143

K.N. Orazbayeva, Zh.Zh. Moldasheva, B.B. Orazbayev, Y.A. Ospanov, S.Sh. Iskakova
MODELING AND OPTIMIZATION OF OPERATING MODES OF OIL HEATING TUBE FURNACES..........156

V. Padar, S. Kuzembayev, V. Berezyuk, M. Sikhimbayev, B. Absadykov
RECOVERY AND HARDENING OF WORN PARTS FROM STEEL 25L FOR GRINDING EQUIPMENT..........176

B.R. Rakishev, M.M. Mataev, Z.S. Kenzhetaev, A.Kh. Shampikova
INNOVATIVE METHODS OF INTENSIFICATION IN SITU LEACHING OF URANIUM IN DEPOSITS WITH LOW FILTRATION CHARACTERISTICS OF ORES..........188

A.K. Sambetbaeva, E.B. Kurmanbekova, S.T. Shaltabaeva, S.A. Ugryumov
EVALUATION OF PROTECTIVE PROPERTIES OF COATINGS OF FILLED COMPOSITIONS BY ELECTROCHEMICAL METHODS..........207

V.G. Stepanets, V.L. Levin, K.S. Togizov, I.Yu. Silachyov, D.A. Zheltov
NEW DATA ON THE MINERALOGY OF SUPRA-SUBDUCTION OPHIOLITES OF THE TEKTURMAS MOUNTAINS (CENTRAL KAZAKHSTAN)..219

V. Solonenko, N. Makhmetova, M. Kvashnin, N. Ivanovtseva, V. Nikolaev
VIBRODIAGNOSTICS OF METAL RAIL STRANDS FOR DIFFERENT TYPES OF FASTENINGS..238

N. Tauova, M.S. Yessenamanova, K. Kozhakhmet, A.R. Kushakov, A. Kaliyeva
GEOLOGICAL STATE OF THE STRATIGRAPHIC COMPLEX OF THE TENGIZ DEPOSIT..249

D. Urmanova, B. Durmagambetov, John D. Humphrey, S. Zagranichniy
GEOLOGICAL AND HYDRODINAMIC MODELING OF AN OIL FIELD OF THE PRICASPIAN REGION OF THE REPUBLIC OF KAZAKHSTAN..266

A.S. Zhumagulov, M.T. Manzari, G.B. Kezembayeva, S.M. Nurmakova, D.B. Mukanov
TECTONIC EVOLUTION AND HYDROCARBON ACCUMULATION CONTROLLING CHARACTERISTICS OF THE SHU-SARYSU BASIN..289

K.T. Sherov, A.K. Rakishev, B.N. Absadykov, M.R. Sikhimbayev, A. Esirkepov
EXPERIMENTAL STUDY OF CHIP FORMATION DURING ROTARY-FRICTION TURNING OF PARTS TYPE OF ROTATION BODIES FROM VARIOUS MATERIALS..306

Publication Ethics and Publication Malpractice in the journals of the National Academy of Sciences of the Republic of Kazakhstan

For information on Ethics in publishing and Ethical guidelines for journal publication see http://www.elsevier.com/publishingethics and http://www.elsevier.com/journal-authors/ethics.

Submission of an article to the National Academy of Sciences of the Republic of Kazakhstan implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see http://www.elsevier.com/postingpolicy), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The National Academy of Sciences of the Republic of Kazakhstan follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics.org/files/u2/New_Code.pdf). To verify originality, your article may be checked by the Cross Check originality detection service http://www.elsevier.com/editors/plagdetect.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the National Academy of Sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of Sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации в журнале смотреть на сайтах:
www:nauka-nanrk.kz
http://www.geolog-technical.kz/index.php/en/
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

Директор отдела издания научных журналов НАН РК *А. Ботанқызы*
Заместитель директор отдела издания научных журналов НАН РК *Р. Жәлиқызы*
Редакторы: *М.С. Ахметова, Д.С. Аленов*
Верстка на компьютере *Г.Д.Жадыранова*

Подписано в печать 14.10.2022.
Формат $70х90^{1}/_{16}$. Бумага офсетная. Печать – ризограф.
20,0 п.л. Тираж 300. Заказ 5.

Национальная академия наук РК
050010, Алматы, ул. Шевченко, 28, т. 272-13-19