

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

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ

Satbayev University

Х А Б А Р Л А Р Ы

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

2 (458)

MARCH – APRIL 2023

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. Web of 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.

Бас редактор

ЖҰРЫНОВ Мұрат Жұрынұлы, химия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, Қазақстан Республикасы Ұлттық Ғылым академиясының президенті, АҚ «Д.В. Сокольский атындағы отын, катализ және электрохимия институтының» бас директоры (Алматы, Қазақстан) **Н = 4**

Редакциялық алқа:

АБСАДЫКОВ Бахыт Нарикбайұлы, техника ғылымдарының докторы, профессор, ҚР ҰҒА жауапты хатшысы, А.Б. Бектұров атындағы химия ғылымдары институты (Алматы, Қазақстан) **Н = 5**

ӘБСАМЕТОВ Мәліс Құдысұлы (бас редактордың орынбасары), геология-минералогия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, «У.М. Ахмедсафина атындағы гидрогеология және геоэкология институтының» директоры (Алматы, Қазақстан) **Н = 2**

ЖОЛТАЕВ Герой Жолтайұлы (бас редактордың орынбасары), геология-минералогия ғылымдарының докторы, профессор, Қ.И. Сатпаев атындағы геология ғылымдары институтының директоры (Алматы, Қазақстан) **Н = 2**

СНОУ Дэниел, Ph.D, қауымдастырылған профессор, Небраска университетінің Су ғылымдары зертханасының директоры (Небраска штаты, АҚШ) **Н = 32**

ЗЕЛЬТМАН Реймар, Ph.D, табиғи тарих мұражайының Жер туралы ғылымдар бөлімінде петрология және пайдалы қазбалар кен орындары саласындағы зерттеулердің жетекшісі (Лондон, Англия) **Н = 37**

ПАНФИЛОВ Михаил Борисович, техника ғылымдарының докторы, Нанси университетінің профессоры (Нанси, Франция) **Н = 15**

ШЕН Пин, Ph.D, Қытай геологиялық қоғамының тау геологиясы комитеті директорының орынбасары, Американдық экономикалық геологтар қауымдастығының мүшесі (Пекин, Қытай) **Н = 25**

ФИШЕР Аксель, Ph.D, Дрезден техникалық университетінің қауымдастырылған профессоры (Дрезден, Берлин) **Н = 6**

КОНТОРОВИЧ Алексей Эмильевич, геология-минералогия ғылымдарының докторы, профессор, РҒА академигі, А.А. Трофимука атындағы мұнай-газ геологиясы және геофизика институты (Новосибирск, Ресей) **Н = 19**

АГАБЕКОВ Владимир Енокович, химия ғылымдарының докторы, Беларусь ҰҒА академигі, Жаңа материалдар химиясы институтының құрметті директоры (Минск, Беларусь) **Н = 13**

КАТАЛИН Стефан, Ph.D, Дрезден техникалық университетінің қауымдастырылған профессоры (Дрезден, Берлин) **Н = 20**

СЕЙТМҰРАТОВА Элеонора Юсуповна, геология-минералогия ғылымдарының докторы, профессор, ҚР ҰҒА корреспондент-мүшесі, Қ.И. Сатпаев атындағы Геология ғылымдары институты зертханасының меңгерушісі (Алматы, Қазақстан) **Н = 11**

САҒЫНТАЕВ Жанай, Ph.D, қауымдастырылған профессор, Назарбаев университеті (Нұр-Сұлтан, Қазақстан) **Н = 11**

ФРАТТИНИ Паоло, Ph.D, Бикокк Милан университеті қауымдастырылған профессоры (Милан, Италия) **Н = 28**

«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/>

© Қазақстан Республикасының Ұлттық ғылым академиясы, 2023

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

Главный редактор

ЖУРИНОВ Мурат Журинович, доктор химических наук, профессор, академик НАН РК, президент Национальной академии наук Республики Казахстан, генеральный директор АО «Институт топлива, катализа и электрохимии им. Д.В. Сокольского» (Алматы, Казахстан) **Н = 4**

Редакционная коллегия:

АБСАДЫКОВ Бахыт Нарикбаевич, доктор технических наук, профессор, ответственный секретарь НАН РК, Институт химических наук им. А.Б. Бектурова (Алматы, Казахстан) **Н = 5**

АБСАМЕТОВ Малис Кудысович, (заместитель главного редактора), доктор геологоминералогических наук, профессор, академик НАН РК, директор Института гидрогеологии и геоэкологии им. У.М. Ахмедсафина (Алматы, Казахстан) **Н = 2**

ЖОЛТАЕВ Герой Жолтаевич, (заместитель главного редактора), доктор геологоминералогических наук, профессор, директор Института геологических наук им. К.И. Сатпаева (Алматы, Казахстан) **Н=2**

СНОУ Дэниел, Ph.D, ассоциированный профессор, директор Лаборатории водных наук университета Небраски (штат Небраска, США) **Н = 32**

ЗЕЛЬТМАН Реймар, Ph.D, руководитель исследований в области петрологии и месторождений полезных ископаемых в Отделе наук о Земле Музея естественной истории (Лондон, Англия) **Н = 37**

ПАНФИЛОВ Михаил Борисович, доктор технических наук, профессор Университета Нанси (Нанси, Франция) **Н=15**

ШЕН Пин, Ph.D, заместитель директора Комитета по горной геологии Китайского геологического общества, член Американской ассоциации экономических геологов (Пекин, Китай) **Н = 25**

ФИШЕР Аксель, ассоциированный профессор, Ph.D, технический университет Дрезден (Дрезден, Берлин) **Н = 6**

КОНТОРОВИЧ Алексей Эмильевич, доктор геолого-минералогических наук, профессор, академик РАН, Институт нефтегазовой геологии и геофизики им. А.А. Трофимука СО РАН (Новосибирск, Россия) **Н = 19**

АГАБЕКОВ Владимир Енокович, доктор химических наук, академик НАН Беларуси, почетный директор Института химии новых материалов (Минск, Беларусь) **Н = 13**

КАТАЛИН Стефан, Ph.D, ассоциированный профессор, Технический университет (Дрезден, Берлин) **Н = 20**

СЕЙТМУРАТОВА Элеонора Юсуповна, доктор геолого-минералогических наук, профессор, член-корреспондент НАН РК, заведующая лабораторией Института геологических наук им. К.И. Сатпаева (Алматы, Казахстан) **Н=11**

САГИНТАЕВ Жанай, Ph.D, ассоциированный профессор, Назарбаев университет (Нурсултан, Казахстан) **Н = 11**

ФРАТТИНИ Паоло, Ph.D, ассоциированный профессор, Миланский университет Бикокк (Милан, Италия) **Н = 28**

«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 соединений.*

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/>

© Национальная академия наук Республики Казахстан, 2023

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

Editorial chief

ZHURINOV Murat Zhurinovich, doctor of chemistry, professor, academician of NAS RK, president of the National Academy of Sciences of the Republic of Kazakhstan, general director of JSC "Institute of fuel, catalysis and electrochemistry named after D.V. Sokolsky» (Almaty, Kazakhstan) **H = 4**

Editorial board:

ABSADYKOV Bakhyt Narikbaevich, doctor of technical sciences, professor, executive secretary of NAS RK, Bekturov Institute of chemical sciences (Almaty, Kazakhstan) **H = 5**

ABSAMETOV Malis Kudysovich, (deputy editor-in-chief), doctor of geological and mineralogical sciences, professor, academician of NAS RK, director of the Akhmedsafin Institute of hydrogeology and hydrophysics (Almaty, Kazakhstan) **H=2**

ZHOLTAEV Geroy Zholtayevich, (deputy editor-in-chief), doctor of geological and mineralogical sciences, professor, director of the institute of geological sciences named after K.I. Satpayev (Almaty, Kazakhstan) **H=2**

SNOW Daniel, Ph.D, associate professor, director of the laboratory of water sciences, Nebraska University (Nebraska, USA) **H = 32**

ZELTMAN Reyman, Ph.D, head of research department in petrology and mineral deposits in the Earth sciences section of the museum of natural history (London, England) **H = 37**

PANFILOV Mikhail Borisovich, doctor of technical sciences, professor at the Nancy University (Nancy, France) **H=15**

SHEN Ping, Ph.D, deputy director of the Committee for Mining geology of the China geological Society, Fellow of the American association of economic geologists (Beijing, China) **H = 25**

FISCHER Axel, Ph.D, associate professor, Dresden University of technology (Dresden, Germany) **H = 6**

KONTOROVICH Aleksey Emilievich, doctor of geological and mineralogical sciences, professor, academician of RAS, Trofimuk Institute of petroleum geology and geophysics SB RAS (Novosibirsk, Russia) **H = 19**

AGABEKOV Vladimir Enokovich, doctor of chemistry, academician of NAS of Belarus, honorary director of the Institute of chemistry of new materials (Minsk, Belarus) **H = 13**

KATALIN Stephan, Ph.D, associate professor, Technical university (Dresden, Berlin) **H = 20**

SEITMURATOVA Eleonora Yusupovna, doctor of geological and mineralogical sciences, professor, corresponding member of NAS RK, head of the laboratory of the Institute of geological sciences named after K.I. Satpayev (Almaty, Kazakhstan) **H=11**

SAGINTAYEV Zhanay, Ph.D, associate professor, Nazarbayev University (Nursultan, Kazakhstan) **H = 11**

FRATTINI Paolo, Ph.D, associate professor, university of Milano-Bicocca (Milan, Italy) **H = 28**

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/>

© National Academy of Sciences of the Republic of Kazakhstan, 2023

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
ISSN 2224-5278
Volume 2, Number 458 (2023), 118–125
<https://doi.org/10.32014/2023.2518-170X.286>
ISSN 2224–5278
UDC 631.67

© Y.M. Kalybekova^{1*}, A.K. Zauirbek¹, N.N. Balgabayev², T.S. Ishangalyev¹, Y.K. Auelbek¹,
A.V. Cravchuk³, 2023

¹Kazakh National Agrarian Research University, Almaty, Kazakhstan;

²Kazakh Scientific Research Institute of Water Economy, Taraz, Kazakhstan;

³Saratov State Agricultural University, Saratov, Russian Federation.

E-mail: yessenkul.kalybekova@kaznaru.edu.kz

IMPROVEMENT OF THE WATER DISTRIBUTION MANAGEMENT SCHEME ON IRRIGATION SYSTEMS USING HYDROLOGICAL INFORMATION

Yessenkul Kalybekova — Doctor of Technical Sciences, Professor of "Water Resources and Land Reclamation" department, Kazakh National Agrarian Research University, Almaty, Kazakhstan

E-mail: yessenkul.kalybekova@kaznaru.edu.kz, <https://orcid.org/0000-0001-6224-8288>;

Auelbek Zauirbek — Doctor of Technical Sciences, Professor of "Water Resources and Land Reclamation" department, Kazakh National Agrarian Research University, Almaty, Kazakhstan

E-mail: jakajak9@mail.ru, <https://orcid.org/0000-0002-4438-0178>;

Nurlan Balgabayev — Doctor of agricultural sciences. Academician of the Academy of Agricultural Sciences of the Republic of Kazakhstan and the International Academy of Agricultural Education. Director of the Kazakh Scientific Research Institute of Water Economy, Taraz, Kazakhstan

E-mail: iwre@bk.ru, <https://orcid.org/0000-0003-1645-6283>;

Timurlan Ishangaliyev — Candidate of Technical Sciences. Associated Professor of "Water Resources and Land Reclamation" department, Kazakh National Agrarian Research University, Almaty, Kazakhstan

E-mail: takazgidro@mail.ru, <https://orcid.org/0000-0003-4349-2685>;

Yermek Auelbek — Master of Agricultural Sciences of "Water Resources and Land Reclamation" department, Kazakh National Agrarian Research University, Almaty, Kazakhstan

E-mail: ermek.a.k@mail.ru, <https://orcid.org/0000-0001-5651-421X>;

Aleksey Cravchuk — Doctor of Technical Sciences. Professor of "Hydro-reclamation, environmental management and construction in the agro-industrial complex" department, Saratov State Agrarian University, Saratov, Russian Federation; E-mail: aleks100sgau@yandex.ru, <https://orcid.org/0000-0002-6797-3275>.

Abstract. Hydraulic reclamation and water management facilities for regulating or redistributing river flow have a significant impact on the geological environment. To take into account these natural and anthropogenic factors, a detailed study of existing conditions in order to predict their changes due to land reclamation, an important part is engineering-geological, hydrological studies, as well as the regime and operational reserves of groundwater. At the same time, the problem of effective water resources management and water allocation on irrigated lands is one of the most important for human society, since decisions on water resources management occur due to a variety of natural (geological, hydrological) and anthropogenic factors. Considering such issues, the need for which requires the development of a clear concept of water resources management and is determined by the complex role of water, its numerous interrelations and impact on ecosystems, as well as the vital need of the population for water, we come to the conclusion that the creation of a comprehensive structure for the use of water resources in economic sectors is relevant. The improved scheme of water distribution management in irrigation systems, developed by the authors, using hydrological information will solve the problem of improving the principles and methods of balanced water supply management in irrigation systems, taking into account the operating modes of water bodies and possible options for the development of economic sectors both in the Republic of Kazakhstan and in neighboring territories, provided that ecological balance in the environment is preserved.

Key words: hydrological information, improvement, water resources management, irrigation systems, water distribution

Funding: This research has been funded by the Ministry of Agriculture of the Republic of Kazakhstan (BR10764920) within the framework of the Scientific and Technical Program (STP) "Technologies and technical means of irrigation when introducing new irrigated lands, reconstructing and modernizing existing irrigation systems" for 2021–2023.

© Е.М. Калыбекова^{1*}, Ә.К. Зәуірбек¹, Н.Н. Балгабаев², Т.С. Ишанғалиев¹, Е.К. Ауелбек¹,

А.В. Кравчук³, 2023

¹Қазақ ұлттық аграрлық зерттеу университеті, Алматы, Қазақстан;

²Қазақ сушаруашылығы ғылыми-зерттеу институты, Тараз, Қазақстан;

³Саратов Мемлекеттік аграрлық университеті, Саратов, Ресей Федерациясы.

ГИДРОЛОГИЯЛЫҚ АҚПАРАТТЫ ПАЙДАЛАНА ОТЫРЫП, СУАРУ ЖҮЙЕЛЕРІНДЕГІ СУ БӨЛҮДІ БАСҚАРУ СХЕМАСЫН ЖЕТІЛДІРУ

Есенкүл Калыбекова — техника ғылымдарының докторы. "Су ресурстары және мелиорация" кафедрасының профессоры. Қазақ ұлттық аграрлық зерттеу университеті, Алматы, Қазақстан

E-mail: yessenkul.kalybekova@kaznaru.edu.kz, <https://orcid.org/0000-0001-6224-8288>;

Әуелбек Зәуірбек — техника ғылымдарының докторы. "Су ресурстары және мелиорация" кафедрасының профессоры. Қазақ ұлттық аграрлық зерттеу университеті, Алматы, Қазақстан

E-mail: jakajak9@mail.ru, <https://orcid.org/0000-0002-4438-0178>;

Нұрлан Балгабаев — ауыл шаруашылығы ғылымдарының докторы. Қазақстан Республикасының Ауыл шаруашылығы Академиясының және ауыл шаруашылық білім беру Халықаралық Академиясының академигі. Қазақ су шаруашылығының ғылыми – зерттеу институтының директоры, Тараз, Қазақстан

E-mail: iwre@bk.ru, <https://orcid.org/0000-0003-1645-6283>;

Тимурлан Ишанғалиев — техника ғылымдарының кандидаты. "Су ресурстары және мелиорация" кафедрасының қауымдастырылған профессоры. Қазақ ұлттық аграрлық зерттеу университеті, Алматы, Қазақстан

E-mail: tarazgidro@mail.ru, <https://orcid.org/0000-0003-4349-2685>;

Ермек Әуелбек — "Су ресурстары және мелиорация" кафедрасының ауыл шаруашылық магистры. Қазақ ұлттық аграрлық зерттеу университеті, Алматы, Қазақстан

E-mail: ermek.a.k@mail.ru, <https://orcid.org/0000-0001-5651-421X>

Алексей Кравчук — техника ғылымдарының докторы. "Гидромелиорация, табиғатты үйлестіру және АӨК-дегі құрылыс" кафедрасы. Саратов мемлекеттік аграрлық университеті, Саратов, Ресей Федерациясы

E-mail: aleks100sgau@yandex.ru, <https://orcid.org/0000-0002-6797-3275>.

Аннотация. Өзен ағынын реттеуге немесе қайта бөлуге арналған гидротехникалық мелиорациялар мен су шаруашылығы құрылыстары геологиялық ортаға айтарлықтай әсер етеді. Осы табиғи және антропогендік факторларды ескеру мақсатында, мелиорация нәтижесінде олардың өзгеруін болжау үшін қолданыстағы жағдайларды егжей-тегжейлі зерттеу үшін инженерлік-геологиялық, гидрологиялық зерттеулер, сондай-ақ жер асты суларының режимі мен пайдалану қорлары маңызды бөлік болып табылады. Сонымен бірге, су ресурстарын тиімді басқару және суармалы жерлерде су бөлу проблемасы адамзат қоғамы үшін ең маңызды мәселелердің бірі болып табылады, өйткені су ресурстарын басқару жөніндегі шешімдер көптеген табиғи (геологиялық, гидрологиялық) және антропогендік факторларға байланысты туындайды. Қажеттілігі су ресурстарын басқарудың нақты тұжырымдамасын әзірлеуді талап ететін және судың күрделі рөлімен, оның көптеген өзара байланыстарымен және экожүйеге әсерімен, сондай-ақ халықтың суға деген өмірлік қажеттілігімен айқындалатын мәселелерді қарай отырып, экономика салаларында су ресурстарын пайдаланудың кешенді құрылымын құру өзекті болып табылады деген пікірге келеміз. Авторлар әзірлеген гидрологиялық ақпаратты пайдалана отырып, суландыру жүйелерінде су бөлуді басқарудың жақсартылған схемасы қоршаған ортада экологиялық тепе-теңдік сақталған жағдайда, Қазақстан Республикасында да, көршілес аумақтарда да су объектілерінің жұмыс режимдерін және экономика салаларын дамытудың ықтимал нұсқаларын ескере отырып, ирригациялық жүйелерде су құбырын теңгерімді басқарудың қағидаттары мен әдістерін жетілдіру жөніндегі міндетті шешуге мүмкіндік береді.

Түйін сөздер: гидрологиялық ақпарат, жетілдіру, су ресурстарын басқару, суару жүйелері, суды бөлу

Қаржыландыру: Бұл зерттеулер 2021–2023 жылдарға арналған "Жаңа суармалы жерлерді енгізу, қолданыстағы ирригациялық жүйелерді реконструкциялау және жаңғырту кезіндегі суару технологиялары мен техникалық құралдары" ғылыми-техникалық бағдарламасы (ҒТБ) шеңберінде Қазақстан Республикасының ауыл шаруашылығы министрлігімен қаржыландырылды (BR10764920).

© Е.М. Калыбекова^{1*}, Ә.К. Зәуірбек¹, Н.Н. Балгабаев², Т.С. Ишанғалиев¹, Е.К. Ауелбек¹,
А.В. Кравчук³, 2023

¹Казахский национальный аграрный исследовательский университет, Алматы, Казахстан;

²Казахский научно-исследовательский институт водного хозяйства, Тараз, Казахстан;

³Саратовский государственный аграрный университет, Саратов, Россия.

УСОВЕРШЕНСТВОВАНИЕ СХЕМЫ УПРАВЛЕНИЯ ВОДОРАСПРЕДЕЛЕНИЕМ НА ОРОСИТЕЛЬНЫХ СИСТЕМАХ С ИСПОЛЬЗОВАНИЕМ ГИДРОЛОГИЧЕСКОЙ ИНФОРМАЦИИ

Есенкул Калыбекова — доктор технических наук, профессор кафедры «Водные ресурсы и мелиорация». Казахский национальный аграрный исследовательский университет, Алматы, Казахстан

E-mail: yessenkul.kalybekova@kaznaru.edu.kz, <https://orcid.org/0000-0001-6224-8288>;

Ауелбек Зәуірбек — доктор технических наук, профессор кафедры «Водные ресурсы и мелиорация». Казахский национальный аграрный исследовательский университет, Алматы, Казахстан

E-mail: jakajak9@mail.ru, <https://orcid.org/0000-0002-4438-0178>;

Нурлан Балгабаев — доктор сельскохозяйственных наук, академик Академии сельскохозяйственных наук Республики Казахстан и Международной академии сельскохозяйственного образования, директор научно – исследовательского института водного хозяйства, Тараз, Казахстан

E-mail: iwre@bk.ru, <https://orcid.org/0000-0003-1645-6283>;

Тимурлан Ишангалиев — кандидат технических наук, ассоциированный профессор кафедры «Водные ресурсы и мелиорация». Казахский национальный аграрный исследовательский университет, Алматы, Казахстан

E-mail: tarazgidro@mail.ru, <https://orcid.org/0000-0003-4349-2685>;

Yermek Auelbek — магистр сельского хозяйства кафедры «Водные ресурсы и мелиорация». Казахский национальный аграрный исследовательский университет, Алматы, Казахстан

E-mail: ermek.a.k@mail.ru, <https://orcid.org/0000-0001-5651-421X>;

Алексей Кравчук — доктор технических наук, профессор кафедры «Гидромелиорация, природообустройство и строительство в АПК» department. Саратовский государственный университет. Саратов, Российская Федерация

E-mail: aleks100sgau@yandex.ru, <https://orcid.org/0000-0002-6797-3275>

Аннотация. Гидротехнические мелиорации и водохозяйственные сооружения для регулирования или перераспределения речного стока оказывают значительное воздействие на геологическую, гидрогеологическую и гидрологическую среду. Для учета этих природных и антропогенных факторов, детального изучения существующих условий с целью прогнозирования их изменений вследствие мелиорации, важной частью являются инженерно-геологические, гидрологические исследования, а также режим и эксплуатационные запасы подземных вод. Вместе с тем, проблема эффективного управления водными ресурсами и вододелинии на орошаемых землях является одной из самых важных для человеческого общества, поскольку решения по управлению водными ресурсами происходят из-за множества природных (геологических, гидрологических) и антропогенных факторов. Рассматривая такие вопросы, необходимость которых требует разработки четкой концепции управления водными ресурсами и определяется сложной ролью воды, ее многочисленными взаимосвязями и влиянием на экосистемы, а также жизненной потребностью населения в воде, приходим к мнению, что создание комплексной структуры использования водных ресурсов в отраслях экономики, является актуальной. Разработанная авторами улучшенная схема управления водораспределением на оросительных системах с использованием гидрологической информации позволит решить задачу по совершенствованию принципов и методов сбалансированного управления водоподачей на ирригационных системах с учетом режимов работы водных объектов и возможных вариантов развития отраслей экономики как в Республике Казахстан, так и на соседних территориях, при условии сохранения экологического равновесия в окружающей среде.

Ключевые слова: гидрологическая информация, усовершенствование, управление водными ресурсами, оросительные системы, водораспределение

Финансирование: Данные исследования были профинансированы Министерством сельского хозяйства Республики Казахстан (BR10764920) в рамках научно-технической программы (НТП) “Технологии и технические средства орошения при внедрении новых орошаемых земель, реконструкции и модернизации существующих ирригационных систем” на 2021–2023 годы.

Introduction

Water reclamation and hydraulic structures for regulating or redistributing river flow have a significant impact on the geological environment. To account for these impacts, a detailed study of existing natural conditions in order to predict their changes due to land reclamation, engineering-geological and hydrological studies are an important part. The main directions of engineering-geological and hydrological research for reclamation construction differ significantly from those for other types of construction. This is due to the special specifics of the construction of hydro-reclamation and water management systems, their special purpose. The intensity of the impact of hydro-reclamation systems on the natural environment is higher than the effects that many other types of construction have. For example, irrigation of vast territories in the arid zone can change natural landscapes, entail noticeable hydrological studies.

Under modern conditions, the remarkable ability of nature to regulate itself, acquired in the process of evolution, has become disrupted. Now, with the modern development of society, natural processes also occur under the influence of anthropogenic activities. People, introducing artificial changes into the natural environment and biogeocenoses, deprives them of stability, which often leads to radical changes in ecosystems, the progressive destruction of the biosphere (Shiklomanov, 2008; Zauirbek, 2019; Urkumbaev, 2003).

Water is the most important resource of the environment and one of the determinants of the development and distribution of productive forces of the country. The deficit of water resources in the Republic of Kazakhstan will increase more and more as economic sectors develop. This problem arises primarily because of the irrational use of water resources, especially in the irrigation sector and, the gradual reduction of water flow in the basins of trans boundary rivers is another reason.

In the long term, the size of the formed flow will also be affected by global climatic changes. Much attention has been paid to changes in temperature regime and sea level rise of the oceans. However, there has been little research into the magnitude of the potential impacts of impending climate change on water resources at the regional, national or local level.

According to calculations in the next 30 years in the basins of mountain rivers in Kazakhstan, the annual flow may increase to 22.5 % (due to melting glaciers), and in plain rivers — to decrease to 10.3 % (Annual bulletin, 2016). The unevenness of flow distribution during the year is increasing.

At the same time, the water sector in Kazakhstan is characterized by a weak material and technical base and low capital equipment, especially in irrigated agriculture. Traditional provisions of market economy and methodology for assessment of economic efficiency of water sector performance and solving water problems have not been fully formed in the sector, as well as water use strategy linked to available water resources and taking into account requirements of natural complexes has not been developed yet. For the basins of transboundary rivers is not appreciated the growth of water withdrawal for the future in the territories of neighboring states.

Materials and methods

Problems of planning of use and protection of water resources, and also struggle against harmful influences of water, first of all, depend on strategy of development of branches of economy.

Analysis and assessment of water resources use efficiency on the basis of hydrological information in the river basin in question cannot do without clarification of some generally applicable and frequently operated concepts when developing recommendations on rational water resources use for economic sectors and, in particular, for irrigated agriculture as the largest water consumer of the country.

Effective management of water distribution and water supply processes in irrigation systems directly affect the quality of functioning of the agro-industrial complex of Kazakhstan. To solve this problem, it is necessary to ensure the coordinated work of all parts of the irrigation system in the presence of a large number of technological resources and other constraints.

Results and discussion

The primary task of improving the technical level of irrigation systems is to develop a set of measures to minimize or completely eliminate technological losses, as well as the scientific rationale and development of new methodologies for planning and implementing water use processes in irrigation systems, taking into account the current level of digitization, methods of mathematical and physical modeling, computer technology. Modern irrigation strategy should be based on the improvement of both existing and development of new methodologies for planning and implementation of water use processes, providing optimal management decisions in a single technological process, taking into account natural factors and man-made technical means.

Taking I.V. Olgarenko's scheme of irrigation water distribution technological process management in irrigation systems as a basis, a complex structure of water distribution management in the irrigation system, based on hydrological information, taking into account flow formation in river basins presented in Figure 1, (Olgarenko, 2013: 218; Tkachev et al., 2021: 69).

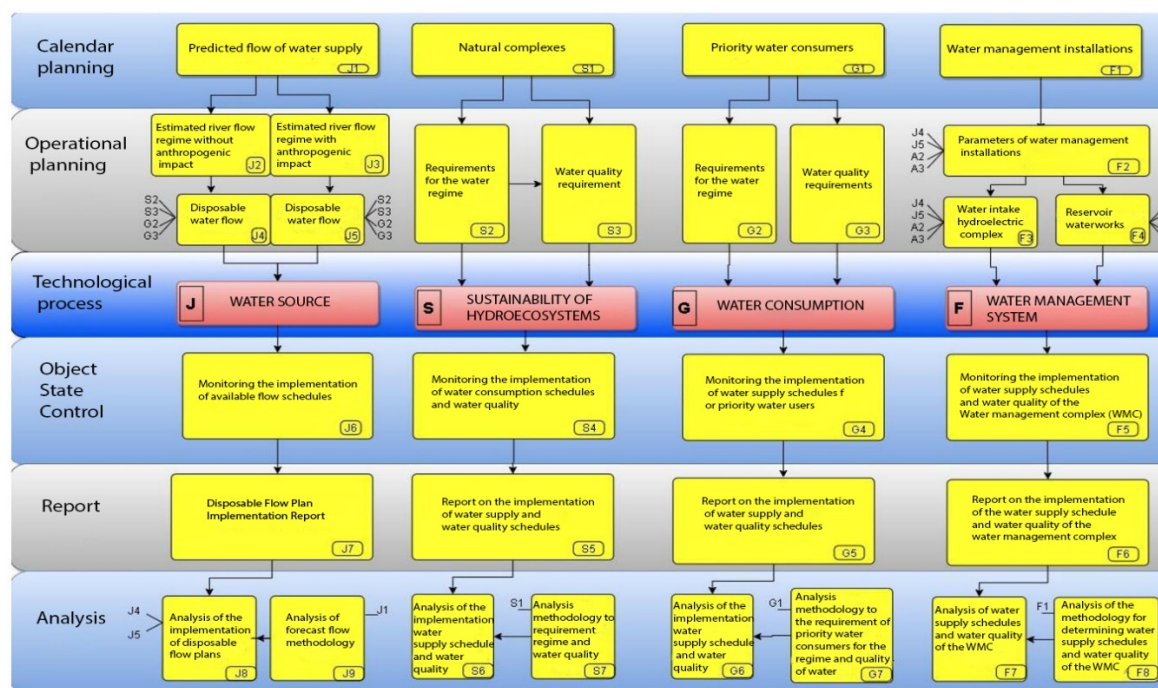


Figure 1. Blocks included in the water management structure

The proposed structure for effective management of irrigation water distribution in irrigation systems took into account and included the following features and factors:

- global climatic changes;
- hydrological information of water source (water source regime, water quality)
- extent to which the irrigation system's water requirements are met;
- combination of river flow regimes and crop water requirements;
- parameters of water management facilities and their operation regimes;
- water requirements of priority water users and natural complexes.

Justification of included blocks in the structure of balanced irrigation water distribution management in irrigation systems is given below.

Water resources (water source). In order to make water management calculations it is necessary to have hydrographic network parameters. Principles of determining the calculated regime of river flow in a certain site depend on the scheme of water and land resources use in the river basin: simple and complex.

They collect materials: hydrographic characteristics of the water source under consideration, possibility of use of the reservoir for the purposes of hydropower, navigation, recreation, fishery value of the river, etc. The study of the river, the annual flow and its intra-annual distribution are established. These materials are given for the multiyear period. Identify the time of freeze-up, opening of the river, duration of freeze-up, ice thickness and ice strength and determine: the water flow rate — Q , m^3/s ; the flow volume — W , m^3 ; flow module — M , $\text{l}/(\text{s} \cdot \text{km}^2)$; a flow layer — h , mm.

Also their calculated values are determined — Q_p , W_p , h_p , M_p , with the use of the coefficient of variation; the asymmetry coefficient and the correlation coefficient. In the future, the size of the formed runoff will also be influenced by the onset of the expected global climatic changes. In this regard, development of special measures for adaptation to climate change will be required.

Air temperature in Kazakhstan has started to rise since the early 1960s. Temperature growth rate is 0.028 degrees a year, or 0.28 degrees every 10 years (Kromer, 2002). According to calculations, the annual runoff in mountain river basins in Kazakhstan may increase by up to 22.5 % in the next 30 years (due to melting glaciers). The annual flow of basins of plain rivers may decrease to 10.3 % (Framework Convention, 2015; Rio Declaration, 1992).

The decrease is expected and the more uneven distribution of runoff during the year increases.

With the expected increase in air temperature and unchanged atmospheric precipitation, the specific values of crop irrigation rates will increase by 4–5 % every 10–20 years. Hence, it follows that the rate of implementation of water-saving and innovative technologies in irrigated agriculture should be almost twice as high as they were adopted in the Scenario of Sustainable Development of the State Hydrological Institute (SSD SHI) (Afzal et al., 2016: 40; Zauribek, 2018: 240; Gleick et al., 2016: 784).

Development of other branches of economy will take place only at the expense of specific water consumption norms reduction.

Provision of irrigation systems with necessary regime and water quality is impossible without water management facilities, which carry out necessary level of river basin water resources use, which use is possible by flow regulation. Therefore, it is necessary to have a special block: "Water management system".

Water management system. Dispatch schedules, which are a set of lines, connecting water and power output of hydro schemes with level or volume of water in the reservoir, are used for reservoirs operation control and allow to manage completely water resources use of isolated hydroschemes reservoirs. For cascades and their associations, the dispatch schedules are supplemented by the system of dispatch rules, which regulate the order of water resources use of reservoirs of different stages.

Operation regime and water release from reservoirs in turn depends on the level of water resources use and water consumption regimes of natural complexes and economic sectors. The task is to meet the water requirements of natural complexes with reliability of $p=95\%$ and priority water consumers $p=95$ or 97% —for municipal and agricultural water supply; $p=95\%$ —for industrial water supply of special state significance.

Therefore, there is a need to include special blocks: "Stability of hydroecosystems" and "Priority water consumers".

Water management problems are most rationally solved under integrated water resources use, when it is necessary to meet water requirements of all economic sectors in given region. At the same time, protection of water resources from depletion and pollution is inseparable from their rational use.

Nature protection. Water management problems are solved most rationally under integrated water resources use, when it is necessary to meet water demands of all sectors of economy in given region. Protection of water resources from depletion and pollution is inseparable from their rational use. Another important direction of water management is the control of harmful water impact, which includes development of engineering measures against floods, mudflows, flooding, water erosion, erosion of river banks, channels, reservoirs and seas, formation of ravines, landslides, snow avalanches, engineering protection of territories, etc.

In existing schemes of water resources use, demands of objects of nature to water are taken into account according to the "residual principle". For them, the so-called "environmental flow" is not allocated, their requirements are satisfied as a residual term of the water balance equation.

In addition, a unified methodological approach to establishing the permissible load on the natural environment, including permissible limits of withdrawal of water resources from water bodies that meet social, environmental and economic aspects of environmental protection, i.e. the conditions of environmentally sustainable development, which is the main objective of the Water Code of the Republic of Kazakhstan, is not developed. Thus, sustainable functioning of water sector and preservation of natural complexes in river basins is not achieved.

Dynamics of water and land resources use in river basins of Kazakhstan shows that water needs of water management sectors are increasing from year to year. Until recently these needs are met at the expense of extensive use of surface water volume, which disturbs ecological equilibrium (ecological stability) in lower reaches of rivers. As a result, sectors of the economy as a whole suffer significant damage (Kalybekova et al., 2022: 104).

In order to give special status to natural complexes, to take into account their requirements to water quantity and quality, it is necessary to introduce a special indicator—the level of satisfaction of natural complexes' requirements to water regime and water quality—into statistical reporting. For this purpose it is necessary to establish the state of environment and possibility of coordination of level of technogenic load on ecosystem with "possible endurance of natural environment" already at new level (Litrico et al., 2021: 317; Hashemy et al., 2021; García Villanueva, 2021).

Thus, management of water resources of the river basin with long-term planning of spatial distribution, will allow using resources of the state, business and the population rationally. For this purpose, at the first stage the modern condition of use of water resources and an ecological condition in the river basin at its various water availability is analyzed, level of use of water resources and level of satisfaction of need for water of natural complexes is estimated. At the second stage possibility of economic branches development for perspective taking into account predicted changes of water resources which, in turn, depend on accepted scenarios of global climatic changes in biosphere.

In order to substantiate economic efficiency of water management measures and achieve optimal parameters of water management installations, an improved criterion is proposed (Zaurbek, 2018: 234).

$$SEER_i = I_i - D_i - E_i + EEA \rightarrow \max \quad (1)$$

where $SEER_i$, I_i , D_i , E_i , EEA_i — respectively, socio-ecological and economic result, income of industries, damage from depletion and pollution of water sources, costs of construction of water management and water protection facilities, additional economic effect arising from the increase in value of natural resources at the i – th option of integrated use of water resources of the river basin.

Based on the difference between income and environmental damage, the criterion makes it possible to determine the environmental and economic result for various degrees water resource use (on the example of the Ile river basin) in Figure 2.

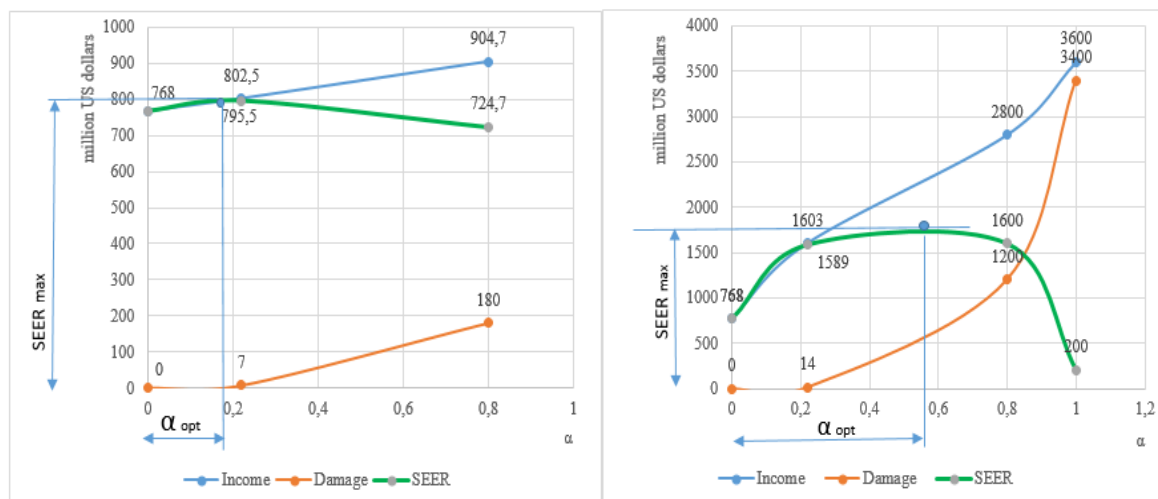


Figure 2. Dynamics of income changes, environmental damage, and criteria of ecological-economic results with varying degrees water resources use (on the example of the Ile River).

As can be seen from the graphs, at the current level of water use technology, the optimal level of water use of a water source is $\alpha = 0.18$. With an increase in water intake from a water source, the income of economic sectors increases. We see that the negative consequences of depletion and pollution of the water source for the environment also increase, and the first indicator doubles as the second. At the same time, we can see that the socio-environmental and economic indicator, on the contrary, has gradually decreases.

In the case of the use by water consumers of advanced technologies for the use of water resources at $\alpha = (0.2-0.4)$, the incomes of economic sectors and additional economic effects increase, and at the same time the damage to the environment in the river basin increases. However, reaching the level $\alpha = (0.55)$ of water resources use, the socio-ecological and economic indicator begins to decline and tend to zero in the case of full use of the river flow, that is at $\alpha = 1.0$.

Priority water consumers. When drawing up a water balance, different ratios between its discharge and inflow parts are possible, namely: water resources are sufficient and their distribution in time in all points of the territory provides coverage of water consumption schedules taking into account necessary transit water releases, i.e. the balance is positive. In this case there is no water deficit in this region. In order to increase economic efficiency of water resources use it is possible to develop and expand branches of economy.

Thus developed structure will allow to solve a problem on perfection of principles and methods of balanced management of water distribution on irrigation systems taking into account hydrological information, operating regimes of water facilities and possible variants of economic branches development both on neighboring territories and in the Republic of Kazakhstan under condition of ecological equilibrium preservation in environment.

Conclusions

Currently, as a result of the development of natural resources (including water resources), the gross product of economic sectors is increasing, environmental pollution is increasing at the same time, changes are taking place in the ecological state of the bio- and hydrosphere due to man-made impacts on them. Global climatic changes also affect the size of the formed river flow. Therefore, it is necessary to develop scientific and methodological principles for the rational use and protection of water resources of the river basin, taking into account anthropogenic and climatic impacts.

The proposed scientific and methodological basis for the rational use and protection of water resources of the river basin consists of two stages. At the first stage, the optimal level of use of water resources of the river basin is determined based on hydrological information, taking into account the formation of its resources.

At the second stage, a comprehensive functional structure for the management of technological processes of water use in irrigation systems is being developed, which is the basis for the development of principles and methods of balanced water distribution management in irrigation systems based on hydrological information, taking into account the formation of water resources in river basins.

The existing structure of water resources solves the problems of providing irrigation water to reclamation systems. Yet, it does not take into account the complexity of tasks for the formation of the water regime of the irrigation source at the present level and possible schemes for the use of water resources in the future. Also, it does not solve the issues of providing priority water consumers with water both above and below the intake of the irrigated massif and ensuring environmental safety in the river basin.

The proposed integrated functional structure of water resources management is the basis for the development of principles and methods of balanced water distribution management in irrigation systems based on hydrological information, taking into account the formation of water resources in river basins. It will make it possible to use the resources of a water source, both at the current and prospective level of development of economic sectors, meeting the water needs of all water consumers, including natural complexes, and ensuring the environmental safety of regions.

REFERENCES

- M. Afzal, A. Battilani, D. Solimando, R. Ragab, 2016 — *M. Afzal, A. Battilani, D. Solimando, R. Ragab* Improving water resources management using different irrigation strategies and water qualities: field and modelling study // *Agricultural Water Management*. Vol. 1. Pp. 40–54. <https://doi.org/10.1016/j.agwat.2016.05.005>. <https://centaur.reading.ac.uk/66293/> (in Eng.).
- (2016). Annual bulletin of monitoring of climate change and the state of Kazakhstan, Research Center RSE "Kazhydromet", Astana, 55. <https://www.kazhydromet.kz/en/klimat/ezhegodnyy-byulleten-monitoringa-sostoyaniya-i-izmeneniya-klimata-kazahstana> (in Russ.).
- (2015). Framework Convention on Climate Change, The Conference of the Parties, Twenty-first session. Paris, November 30 - December 11, 21—42. <https://enb.iisd.org/negotiations/un-framework-convention-climate-change-unfccc> (in Eng.).
- García Villanueva N. H., 2021 — *García Villanueva N. H.*, Operación de canales: conceptos generales [Electronic resource] / Instituto Mexicano de Tecnología del Agua. México, 2015. 313 p. URL: https://www.imta.gob.mx/biblioteca/libros_html/riego-drenaje/operacion-canales.pdf (date of access: 07.02.2021). (in Eng.).
- P.H. Gleick, L. Allen, J. Christian-Smith, M.J. Cohen, H. Cooley, M. Heberger, J. Morrison, M. Palaniappan, P. Schulte, 2011 — *P.H. Gleick, L. Allen, J. Christian-Smith, M.J. Cohen, H. Cooley, M. Heberger, J. Morrison, M. Palaniappan, P. Schulte*, The World's Water. Vol. 7. The Biennial Report on Freshwater Resources Washington DC: Island Press. 422 p. <https://pacinst.org/publication/the-worlds-water-vol-7/> (in Eng.).
- S.M. Hashemy Shahdany, S. Taghvaeian, J.M. Maestre, A.R. Firoozfar, 2021 — *M. Hashemy Shahdany, S. Taghvaeian, J.M. Maestre, A.R. Firoozfar*, Developing a centralized automatic control system to increase flexibility of water delivery within predictable and unpredictable irrigation water demands Computers and Electronics in Agriculture. Vol. 163. 104862. <https://doi.org/10.1016/j.compag.2019.104862>. (in Eng.).
- Y.M. Kalybekova, A.K. Zaurbek, I.S. Seitasanov, U.Q. Onglassyn, 2022 — *Y.M. Kalybekova, A.K. Zaurbek, I.S. Seitasanov, U.Q. Onglassyn*, Increasing Water Productivity in Irrigation with Regard to Geology and Hydrogeological Conditions NEWS of the National Academy of Sciences of the Republic of Kazakhstan Series of Geology and Technical Sciences. ISSN 2224–5278. Volume 3. Number 453. (2022). 101–114. <https://doi.org/10.32014/2022.2518-170X.183> (in Eng.).
- Kromer R., 2002 — *Kromer R.*, European Directive on water management, Hydrotechnical construction, № 12. Pp. 44–46. (in Eng.).
- Litrico X., Fromion V., 2021 — *Litrico X., Fromion V.*, Modeling and control of hydrosystems [Electronic resource]. London: Springer-Verlag, 2009. 336 p. URL: <https://link.springer.com/book/10.1007/978-1-84882-624-3> (date of access: 07.02.2021). (in Eng.).
- Olgarenko I.V., 2013 — *Olgarenko I.V.*, Information technologies of water use planning and operational management of water distribution on irrigation systems, Abstract of the Doctor of Technical Sciences, Saratov, 44. (in Russ.).
- (1992). Rio Declaration on Environment and Development, United Nations Conference on Environment and Development, Rio de Janeiro 3–14 June 9. (in Eng.).
- Shiklomanov I.A., 2008 — *Shiklomanov I.A.*, Water resources of Russia and their using, St. Petersburg, GGI, 600. (in Russ.).
- Tkachev A.A., Olgarenko I.V., 2021 — *Tkachev A.A., Olgarenko I.V.*, Modern problems in water distribution management in the main channels of irrigation systems // *Scientific Journal of the Russian Research Institute of Problems of Land Reclamation* [Electronic resource]. T. 11. № 2. Pp. 1–23. URL: <http://www.rosniipm-sm.ru/article?n=1192>. DOI: 10.31774/2222-1816-2021-11-2-1-23. (in Russ.).
- Urkumbaev M.F., 2012 — *Urkumbaev M.F.*, Integral equilibrium of the market and society, Taraz, Senim, 540. (in Russ.).
- (2003). World water resources at the turn of the XXI century, St. Petersburg, GGI, 436. (in Russ.).
- Zaurbek A.K., 2019 — *Zaurbek A.K.*, Problems in the field of water management in the modern and prospective periods and justification of the direction of training highly qualified personnel to solve them Bulletin of TarSU named after M.H. Dulati. № 4. Pp. 234–242. (in Russ.).
- Zaurbek A.K., 2018 — *Zaurbek A.K.*, Problems of water resources management in low-water and high-water years (on the example of individual rivers of the Republic of Kazakhstan). Textbook. Almaty, TechnoErudit, 240. (in Russ.).

CONTENTS

| | |
|---|-----|
| A.E. Abetov, Sh.B. Yessirkepova, J. Curto Ma REMOTE SENSING AT THE STUDY OF THE THERMAL FIELD OF THE SOUTH USTYURT REGION TO FIND HYDROCARBON DEPOSITS..... | 6 |
| K.I. Akhmetov, G.M. Yessilkanov, A.Zh. Kassanova, A.V. Ubaskin, T.Zh. Abylkhassanov HYDROGEOCHEMICAL FEATURES OF THE WATER OF SALINE LAKES IN PAVLODAR REGION..... | 17 |
| S.V. Gladyshev, K.Sh. Akhmetova, L.M. Imangalieva, A.K. Kasymzhanova, N.K. Akhmadieva STUDY OF PURIFICATION OF COPPER ELECTROREFINING SOLUTION BY FLOW CENTRIFUGATION..... | 26 |
| D.A. Davronbekov, X.F. Alimdjanov, K.S. Chezhibayeva METHODS FOR REMOTE MONITORING OF BRIDGES UNDER THE INFLUENCE OF GROUNDWATER ON THEM..... | 37 |
| ZH.E. Daribayev, A.N. Kutzhanova, G.I. Issayev, I.G. Ikramov, D.U. Seksenova ASSESSMENT OF ENVIRONMENTAL DAMAGE OF NON-FERROUS METALLURGY WASTE TO THE ENVIRONMENT..... | 48 |
| K.R. Dzhabagieva, G.V. Degtyarev, A.M. Baytelieva, S.M. Laiyk, R.A. Pernebayeva FINITE ELEMENT STUDIES OF FLOW PROCESSES IN HYDROCYCLONES AND LOSS OF HEAD-ON FLOW MIXING..... | 57 |
| R.I. Yegemberdiev, I.N. Stolpovskikh, A.D. Kolga IMPROVEMENT OF THE SYSTEM OF EXPLOSIONS OF RING HOLES DURING THE DEVELOPMENT OF LOW-POWER ORE DEPOSITS..... | 68 |
| A.A. Yerzhan, P.V. Boikachev, S. Virko, Z.D. Manbetova, P.A. Dunayev A NEW METHOD OF MATCHING THE SYNTHESIS OF MATCHING DEVICES BASED ON MODIFIED APPROXIMATION IN TELECOMMUNICATION DEVICES..... | 77 |
| N.Zh. Zholamanov, S.M. Koibakov, S.T. Abildayev, G.A. Sarbassova, M.T. Omarbekova RECOMMENDATIONS FOR THE USE AND DESIGN OF FISH PROTECTION AND FISH PASSING STRUCTURES UNDER GEOLOGICAL CONDITIONS..... | 85 |
| L.Z. Issayeva, E. Slaby, S.K. Assubayeva, M.K. Kembayev, K.S. Togizov THE THREE-DIMENSIONAL MODEL OF THE AKBULAK RARE EARTH DEPOSIT (NORTHERN KAZAKHSTAN)..... | 96 |
| A.A. Kabdushev, F.A. Agzamov, B.Zh. Manapbaev, D.N. Delikesheva, D.R. Korgasbekov STUDYING THE EFFECT OF REINFORCEMENT ON THE PROPERTIES OF PLUGGING MATERIALS WITH EXPANDING ADDITIVES..... | 108 |
| Y.M. Kalybekova, A.K. Zauirbek, N.N. Balgabayev, T.S. Ishangalyev, Y.K. Auelbek, A.V. Cravchuk IMPROVEMENT OF THE WATER DISTRIBUTION MANAGEMENT SCHEME ON IRRIGATION SYSTEMS USING HYDROLOGICAL INFORMATION..... | 118 |
| N.Zh. Karsakova, K.T. Sherov, B.N. Absadykov, M.R. Sikhimbayev, G.M. Tussupbekova THE ISSUES OF IMPROVING THE TECHNOLOGY FOR MACHINING THE LARGE DIAMETER HOLES OF THE LARGE-SCALE PARTS OF THE TECHNOLOGICAL EQUIPMENT..... | 126 |
| R.A. Kozbagarov, M.S. Zhiyenkozhaev, N.S. Kamzanov³, S.G. Tsygankov, A.S. Baikenzhayeva DESIGN OF HYDRAULIC EXCAVATOR WORKING MEMBERS FOR DEVELOPMENT OF MUDSLIDES.. | 134 |
| E.I. Kuldeyev, M.B. Nurpeissova, Z.A. Yestemesov, A.A. Ashimova, A.V. Barvinov OBTAINING AGLOPORITE FROM ASH OF EKIBASTUZ COAL SELECTED FROM ASH DUMP OF CRPP-3 OF ALMATY CITY..... | 142 |

| | |
|--|-----|
| A.S. Madibekov, L.T. Ismukhanova, A.O. Zhadi, B.M. Sultanbekova, E.D. Zhaparkulova MICROPLASTICS IN THE AQUATIC ENVIRONMENT: OVERVIEW OF THE PROBLEM AND CURRENT RESEARCH AREAS..... | 149 |
| Y.G. Neshina, A.D. Mekhtiyev, V.V. Yugay, A.D. Alkina, P.Sh. Madi DEVELOPING A SENSOR FOR CONTROLLING THE PIT WALL DISPLACEMENT..... | 160 |
| M.B. Nurpeissova, Z.A. Yestemesov, A.A. Bek, V.S. Kim, G.K. Syndyrbekova MAIN CHARACTERISTICS OF FLY ASH FROM EKIBASTUZ SRPP-2..... | 168 |
| N.D. Spatayev, G.S. Sattarova, A.D. Nurgaliyeva, L. Kh. Balabas, F.K. Batessova ENSURING HEALTHY AND SAFE WORKING CONDITIONS IN BREAKAGE FACE WITH DIRECT-FLOW VENTILATION SCHEME..... | 177 |
| V.M. Shevko, A.M. Nurpeissova, D.K. Aitkylov, A.A. Joldassov THERMODYNAMIC PREDICTION AND EXPERIMENTAL PRODUCTION OF SILICON ALLOYS FROM TAILINGS LEACHING OF OXIDIZED COPPER ORE ALMALY..... | 188 |

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)**

Заместитель директор отдела издания научных журналов НАН РК *Р. Жәліқызы*

Редакторы: *М.С. Ахметова, Д.С. Аленов*

Верстка на компьютере *Г.Д. Жадыранова*

Подписано в печать 14.04.2023.

Формат 70x90^{1/16}. Бумага офсетная. Печать – ризограф.

20,0 п.л. Тираж 300. Заказ 1.