

ISSN 2518-170X (Online)

ISSN 2224-5278 (Print)



ҚАЙЫРЫМДЫЛЫҚ ҚОРЫ

**HALYK**

CHARITY FOUNDATION

«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ  
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ  
«ХАЛЫҚ» ЖҚ

# Х А Б А Р Л А Р Ы

---

---

## ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ  
АКАДЕМИИ НАУК РЕСПУБЛИКИ  
КАЗАХСТАН»  
ЧФ «Халық»

## N E W S

OF THE ACADEMY OF SCIENCES  
OF THE REPUBLIC OF  
KAZAKHSTAN  
«Halyk» Private Foundation

SERIES

OF GEOLOGY AND TECHNICAL SCIENCES

# 6 (462)

NOVEMBER – DECEMBER 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.*

*НАНПК сообщает, что научный журнал «Известия НАНПК. 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 НАНПК. 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.*



## ЧФ «ХАЛЫҚ»

В 2016 году для развития и улучшения качества жизни казахстанцев был создан частный Благотворительный фонд «Халык». За годы своей деятельности на реализацию благотворительных проектов в областях образования и науки, социальной защиты, культуры, здравоохранения и спорта, Фонд выделил более 45 миллиардов тенге.

Особое внимание Благотворительный фонд «Халык» уделяет образовательным программам, считая это направление одним из ключевых в своей деятельности. Оказывая поддержку отечественному образованию, Фонд вносит свой посильный вклад в развитие качественного образования в Казахстане. Тем самым способствуя росту числа людей, способных менять жизнь в стране к лучшему – профессионалов в различных сферах, потенциальных лидеров и «великих умов». Одной из значимых инициатив фонда «Халык» в образовательной сфере стал проект *Ozgeris powered by Halyk Fund* – первый в стране бизнес-инкубатор для учащихся 9-11 классов, который помогает развивать необходимые в современном мире предпринимательские навыки. Так, на содействие малому бизнесу школьников было выделено более 200 грантов. Для поддержки талантливых и мотивированных детей Фонд неоднократно выделял гранты на обучение в Международной школе «Мирас» и в Astana IT University, а также помог казахстанским школьникам принять участие в престижном конкурсе «USTEM Robotics» в США. Авторские работы в рамках проекта «Тәлімгер», которому Фонд оказал поддержку, легли в основу учебной программы, учебников и учебно-методических книг по предмету «Основы предпринимательства и бизнеса», преподаваемого в 10-11 классах казахстанских школ и колледжей.

Помимо помощи школьникам, учащимся колледжей и студентам Фонд считает важным внести свой вклад в повышение квалификации педагогов, совершенствование их знаний и навыков, поскольку именно они являются проводниками знаний будущих поколений казахстанцев. При поддержке Фонда «Халык» в южной столице был организован ежегодный городской конкурс педагогов «Almaty Digital Ustaz».

Важной инициативой стал реализуемый проект по обучению основам финансовой грамотности преподавателей из восьми областей Казахстана, что должно оказать существенное влияние на воспитание финансовой грамотности и предпринимательского мышления у нового поколения граждан страны.

Необходимую помощь Фонд «Халык» оказывает и тем, кто особенно остро в ней нуждается. В рамках социальной защиты населения активно проводится

работа по поддержке детей, оставшихся без родителей, детей и взрослых из социально уязвимых слоев населения, людей с ограниченными возможностями, а также обеспечению нуждающихся социальным жильем, строительству социально важных объектов, таких как детские сады, детские площадки и физкультурно-оздоровительные комплексы.

В копилку добрых дел Фонда «Халык» можно добавить оказание помощи детскому спорту, куда относится поддержка в развитии детского футбола и карате в нашей стране. Жизненно важную помощь Благотворительный фонд «Халык» оказал нашим соотечественникам во время недавней пандемии COVID-19. Тогда, в разгар тяжелой борьбы с коронавирусной инфекцией Фонд выделил свыше 11 миллиардов тенге на приобретение необходимого медицинского оборудования и дорогостоящих медицинских препаратов, автомобилей скорой медицинской помощи и средств защиты, адресную материальную помощь социально уязвимым слоям населения и денежные выплаты медицинским работникам.

В 2023 году наряду с другими проектами, нацеленными на повышение благосостояния казахстанских граждан Фонд решил уделить особое внимание науке, поскольку она является частью общественной культуры, а уровень ее развития определяет уровень развития государства.

Поддержка Фондом выпуска журналов Национальной Академии наук Республики Казахстан, которые входят в международные фонды Scopus и WoS и в которых публикуются статьи отечественных ученых, докторантов и магистрантов, а также научных сотрудников высших учебных заведений и научно-исследовательских институтов нашей страны является не менее значимым вкладом Фонда в развитие казахстанского общества.

**С уважением,  
Благотворительный Фонд «Халык»!**

### Бас редактор

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

### Ғылыми хатшы

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

### Редакциялық алқа:

**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**

**ЗЕЛЪТМАН 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» РҚБ 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 № **KZ39VPU00025420** 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» РҚБ, 2023

---

### **Главный редактор**

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

### **Ученый секретарь**

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

### **Редакционная коллегия:**

**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 РОО «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/>

© РОО «Национальная академия наук Республики Казахстан», 2023

---

### **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**

### **Scientific secretary**

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

### **Editorial board:**

**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 Zholtaevich**, (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

---

NEWS of the National Academy of Sciences of the Republic of Kazakhstan  
SERIES OF GEOLOGY AND TECHNICAL SCIENCES  
ISSN 2224–5278  
Volume 6. Number 462 (2023), 111–124  
<https://doi.org/10.32014/2023.2518-170X.353>

UDC 556.18

© M. Li<sup>1\*</sup>, T. Ibrayev<sup>1</sup>, N. Balgabayev<sup>1</sup>, T. Imanaliyev<sup>1</sup>, K. Yestaev<sup>2</sup>, 2023

<sup>1</sup>Kazakh Scientific Research Institute of Water Economy, Taraz, Kazakhstan;

<sup>2</sup>Taraz Regional University named after M.Kh. Dulati, Taraz, Kazakhstan.

E-mail: [limarina76@mail.ru](mailto:limarina76@mail.ru)

## INFORMATION SUPPORT FOR THE PROCESS OF WATER RESOURCES MANAGEMENT IN IRRIGATION SYSTEMS

**Marina Li** — Candidate of Technical Sciences, Leading Researcher at Department “Water Resources Management” of the Kazakh Scientific Research Institute of Water Economy LLP, Taraz, Kazakhstan  
E-mail: [limarina76@mail.ru](mailto:limarina76@mail.ru); <https://orcid.org/0000-0002-8880-5705>;

**Tursun Ibrayev** — PhD, Deputy Director for Research of The Kazakh Scientific Research Institute of Water Economy LLP, Taraz, Kazakhstan  
E-mail: [kiwr-t@mail.ru](mailto:kiwr-t@mail.ru); <https://orcid.org/0000-0002-1450-5275>;

**Nurlan Balgabayev** — Doctor of Agricultural Sciences, Director of Scientific Research Work of the Kazakh Scientific Research Institute of Water Economy LLP, Taraz, Kazakhstan  
E-mail: [balgabayev@mail.kz](mailto:balgabayev@mail.kz); <https://orcid.org/0000-0001-8127-7981>;

**Talgat Imanaliyev** — Researcher at Department “Water Resources Management», «Kazakh Scientific Research Institute of Water Economy” LLP, Taraz, Kazakhstan  
E-mail: [tonimontana\\_777@mail.ru](mailto:tonimontana_777@mail.ru); <https://orcid.org/0000-0002-9039-2671>;

**Kuat Yestaev** — Head of the Department of “Melioration and Agronomy”, Candidate of Agricultural Sciences, Associate Professor of Taraz Regional University named after M.Kh. Dulati, Taraz, Kazakhstan  
E-mail: [Estaev.06@mail.ru](mailto:Estaev.06@mail.ru); <https://orcid.org/0000-0002-2030-1666>.

**Abstract.** The main functions of an irrigation system include the collection of water from an irrigation source, its transportation, and distribution to consumers by irrigation plans and irrigation standards. The most optimal solution to this problem is to automate the process of managing the irrigation system, which allows for solving the following issues: providing agricultural crops with water in accordance with their needs, which helps to increase productivity, and prevent the rise of groundwater levels, and secondary soil salinization; saving water, and the ability to irrigate additional areas, which is especially important with limited water resources in the dry areas of the River basin Shu; reducing the time required to complete technological operations and increasing the productivity of service personnel. Information technologies greatly facilitate the process of making management decisions by increasing the availability of information and the speed of its analysis. The experimental research object is located in the valley of the River Shu, which represents an intermountain depression limited in the south by



the Kyrgyz ridge, in the east by the tip of the Trans-Ili Ala-Tau ridge, and in the north by the gently sloping Shu-Ili Mountains. The geological structure of the region consists of a complex of igneous, metamorphic, and sedimentary rocks. The following structural and geological parts have been established: mountain frame composed of Precambrian-Paleozoic rocks; valley, consisting of Precambrian-Paleozoic basement and Meso-Cenozoic cover. Information support for the water resources management process is made in the form of an information system consisting of a “cloud” service (website [uvrcloud.kz](http://uvrcloud.kz)), an information collection and transmission device Data collection module (DCM - 1), an electric gate control program, and a mobile application MSD-1 (Scientific Research Report for 2023 “Development of principles and methods for balanced management of water distribution in irrigation systems based on hydrogeological information, taking into account the formation of water resources in river basins”). The developed software for the water resource management process in irrigation systems is an effective solution for automating the water distribution process, allowing for the management and monitoring of elements of water management facilities, which helps reduce response time to possible emergency situations and increase the efficiency of water resource use. An important advantage of the software product is its ease of use and configuration flexibility, which allows it to be adapted to the specific needs and requirements of users. In addition, modern technologies and tools were used in the development process of the software product, which ensures its high reliability, stability, and performance.

**Keywords:** Irrigation system, management, software product, software, testing, debugging, information system, water resources, water distribution

© М. Ли<sup>1\*</sup>, Т. Ибраев<sup>1</sup>, Н. Балғабает<sup>1</sup>, Т. Иманалиев<sup>1</sup>, К. Естаев<sup>2</sup>, 2023

<sup>1</sup>Қазақ су шаруашылығы ғылыми зерттеу институты, Тараз, Қазақстан;

<sup>2</sup>М.Х. Дулати атындағы Тараз өңірлік университеті, Тараз, Қазақстан.

E-mail: [limarina76@mail.ru](mailto:limarina76@mail.ru)

**Марина Ли** — техника ғылымдарының кандидаты, «Қазақ су шаруашылығы ғылыми-зерттеу институты» ЖШС, «Су ресурстарын басқару» бөлімінің жетекші ғылыми қызметкері, Тараз қ., Қазақстан

E-mail: [limarina76@mail.ru](mailto:limarina76@mail.ru); <https://orcid.org/0000-0002-8880-5705>;

**Тұрсын Ибраев** — PhD, «Қазақ су шаруашылығы ғылыми-зерттеу институты» ЖШС директорының ғылыми жұмыстар жөніндегі орынбасары, Тараз қ., Қазақстан

E-mail: [kiwr-t@mail.ru](mailto:kiwr-t@mail.ru); <https://orcid.org/0000-0002-1450-5275>;

**Нұрлан Балғабает** — ауыл шаруашылығы ғылымдарының докторы, «Қазақ су шаруашылығы ғылыми-зерттеу институты» ЖШС ғылыми жұмыстар жөніндегі директоры, Тараз, Қазақстан

E-mail: [balgabaev@mail.kz](mailto:balgabaev@mail.kz); <https://orcid.org/0000-0001-8127-7981>;

**Талғат Иманалиев** — «Қазақ су шаруашылығы ғылыми-зерттеу институты» ЖШС, «Су ресурстарын басқару» бөлімінің ғылыми қызметкері, Тараз қ., Қазақстан

E-mail: [tonimontana\\_777@mail.ru](mailto:tonimontana_777@mail.ru); <https://orcid.org/0000-0002-9039-2671>;

**Қуат Естаев** — «Мелиорация және агрономия» кафедрасының меңгерушісі, ауыл шаруашылығы ғылымдарының кандидаты, доцент. М.Х. Дулати атындағы Тараз өңірлік университеті, Тараз, Қазақстан

E-mail: [Estaev.06@mail.ru](mailto:Estaev.06@mail.ru); <https://orcid.org/0000-0002-2030-1666>.

**Аннотация.** Суару жүйесінің негізгі функцияларына суару көзінен су алу, оны тасымалдау және суару жоспарлары мен суару нормаларына сәйкес тұтынушылар арасында бөлу жатады. Бұл мәселені шешудің ең оңтайлы шешімі суару жүйесін басқару процесін автоматтандыру болып табылады, ол келесі мәселелерді шешуге мүмкіндік береді: ауыл шаруашылығы дақылдарын олардың қажеттіліктеріне сәйкес сумен қамтамасыз ету, бұл өнімділікті арттыруға, жер асты сулары деңгейінің көтерілуіне және екінші реттік топырақтың сортаңдануына жол бермеуге көмектеседі, бұл Шу өзен бассейнінің құрғақ жерлеріндегі су ресурстарының шектеулі болуымен ерекшеленеді, суды үнемдеу және қосымша аумақтарды суаруға; технологиялық операцияларды орындауға кететін уақытты қысқарту және қызмет көрсететін персоналдың өнімділігін арттыруға мүмкіндік береді. Ақпараттық технологиялар ақпараттың қолжетімділігін және оны талдау жылдамдығын арттыру арқылы басқару шешімдерін қабылдау процесін айтарлықтай жеңілдетеді.

**Түйін сөздер:** Суару жүйесі, басқару, бағдарламалық өнім, бағдарламалық қамтамасыз ету, тестілеу, жөндеу, ақпараттық жүйе, су ресурстары, суды бөлу

© М. Ли<sup>1\*</sup>, Т. Ибраев<sup>1</sup>, Н. Балгабаев<sup>1</sup>, Т. Иманалиев<sup>1</sup>, К. Естаев<sup>2</sup>, 2023

<sup>1</sup>Казахский научно-исследовательский институт водного хозяйства,

Тараз, Казахстан;

<sup>2</sup>Таразский региональный университет имени М.Х. Дулати, Тараз, Казахстан.

E-mail: [limarina76@mail.ru](mailto:limarina76@mail.ru)

## ИНФОРМАЦИОННОЕ ОБЕСПЕЧЕНИЕ ПРОЦЕССА УПРАВЛЕНИЯ ВОДНЫМИ РЕСУРСАМИ НА ОРОСИТЕЛЬНЫХ СИСТЕМАХ

**Марина Ли** — кандидат технических наук, ведущий научный сотрудник отдела «Управление водными ресурсами», ТОО «Казахский научно-исследовательский институт водного хозяйства», Тараз, Казахстан

E-mail: [limarina76@mail.ru](mailto:limarina76@mail.ru); <https://orcid.org/0000-0002-8880-5705>;

**Турсун Ибраев** — PhD, заместитель директора по научной работе ТОО «Казахский научно-исследовательский институт водного хозяйства», Тараз, Казахстан

E-mail: [kiwr-t@mail.ru](mailto:kiwr-t@mail.ru); <https://orcid.org/0000-0002-1450-5275>;

**Нурлан Балгабаев** — доктор сельскохозяйственных наук, директор по научно-исследовательской работе, ТОО «Казахский научно-исследовательский институт водного хозяйства», Тараз, Казахстан

E-mail: [balgabaev@mail.kz](mailto:balgabaev@mail.kz); <https://orcid.org/0000-0001-8127-7981>;

**Талгат Иманалиев** — научный сотрудник отдела «Управление водными ресурсами», ТОО «Казахский научно-исследовательский институт водного хозяйства», Тараз, Казахстан

E-mail: [tonimontana\\_777@mail.ru](mailto:tonimontana_777@mail.ru); <https://orcid.org/0000-0002-9039-2671>;

**Қуат Естаев** — заведующий кафедрой «Мелиорация и агрономия», кандидат сельскохозяйственных наук, доцент Таразского регионального университета имени М.Х. Дулати, Тараз, Казахстан

E-mail: [Estaeв.06@mail.ru](mailto:Estaeв.06@mail.ru); <https://orcid.org/0000-0002-2030-1666>.

**Аннотация.** К основным функциям оросительной системы относят забор воды из источника орошения, ее транспортирование и распределение между потребителями в соответствии с планами полива и поливными нормами.

Наиболее оптимальным решением данной задачи является автоматизация процесса управления оросительной системой, позволяющая решить следующие вопросы: обеспечение сельскохозяйственных культур водой в соответствии с их потребностью, что способствует повышению урожайности, предотвращению подъема уровня грунтовых вод и вторичного засоления почв; экономия воды и возможность орошения дополнительных площадей, что особенно актуально при ограниченных водных ресурсах в засушливых районах бассейна р. Шу; сокращение времени на выполнение технологических операций и повышение производительности труда обслуживающего персонала. Информационные технологии значительно облегчают процесс принятия управленческих решений за счет увеличения доступности к информации и скорости ее анализа.

**Ключевые слова:** оросительная система, управление, программный продукт, программное обеспечение, тестирование, отладка, информационная система, водные ресурсы, водораспределение

### **Introduction**

The main functions of the irrigation system include water intake from the irrigation source, its transportation and distribution among consumers in accordance with irrigation plans and irrigation norms. Not only the efficiency of the irrigation system, but also the efficiency of irrigation and irrigated agriculture in general depends on the quality of performance of these functions.

The most optimal solution to this problem is to automate the process of managing the irrigation system, which in turn cannot be imagined without modern instruments, equipment, computer technology and software.

Automation of irrigation management helps solve the following issues: providing agricultural crops with water in accordance with their needs (water use plan), which helps increase productivity, prevent rising groundwater levels and secondary soil salinization; saving water and the possibility of irrigating additional areas, which is especially important with limited water resources in the dry areas of the River basin Shu; reducing the time required to perform technological operations and increasing the productivity of service personnel.

It is obvious that management must be based on extensive and reliable information. Information technologies greatly facilitate the process of making management decisions by increasing the availability of information and the speed of its analysis. An information system is a necessary part in water resource management at the basin level, since with its help it is possible to analyze the current and future water balances of any hydrographic unit. Today, a huge amount of data has been accumulated, but, nevertheless, the practice of water resources management experiences a certain information deficit (both in terms of reliability and efficiency in obtaining data). Work on the creation of information systems and databases for river basin management, which has been widely developed in recent years, is aimed at improving methods and means of collecting, storing and processing information.

## **Materials and research methods**

Research methodology and methodological support for research are aimed at expanding the functionality of information support for the water resources management process.

The research methodology consists of theoretical and practical aspects of water management in irrigation systems; information and analytical approaches to the creation of automated control systems; methods and means of computer information processing; experimental and applied techniques for creating and implementing software modeling systems for water use planning.

Analysis of foreign research of water distribution management based on modern computing technology, and computer technologies for managing technological processes is characterized by their active development and intensive research on their further improvement (Zheli et al., 2023; Habib Karimi et al., 2022; Giovanni et al., 2023; Veerachamy et al., 2022; Feliu-Batlle et al., 2009; Mohsen Hosseini et al., 2023; Soroush et al., 2021; Ardalan et al., 2022; Matthew et al., 2023; Peng et al., 2023; Li et al., 2023; Ibrayev et al., 2022; Habib Karimi et al., 2022; Hashemy et al., 2019; Robles et al., 2015; Supriya et al., 2020; Monalisha et al., 2022).

Improving existing and developing new information support of water conservation in irrigation systems is of central importance for the further effective development of water management science and practice. In this problem, at the moment, the development of devices and control systems in the presence of a shortage of water resources is of paramount importance. These are, first of all, devices for regulating water levels and balancing water distribution through the use of automated control systems and computers.

Information and analytical research include a theoretical study of the elements of the system being developed, development of the functional structure of the designed system, clarification of technical requirements for the designed information system (IS), and determination of the structure of intermodular interaction.

Experimental studies include:

- development of the user interface and structure of the IS database, i.e. appearance of the software product, methods of communication between the user and the program;
- development of exchange protocols with level measurement devices and data collection module DCM -1 and similar;
- debugging of IS software for water resources management based on hydrological information;
- testing a software product and using it as a software and technology platform that provides the Internet user with computer resources in an “online service” mode in laboratory and field conditions.

At the demonstration site of the laboratory of hydraulic structures of the Kazakh Scientific Research Institute of Water Economy and the pilot site, comprehensive testing was carried out, based on the results of which the software was debugged. The pilot site is located in the valley of the River Shu, which is an intermountain depression limited in the south by the Kyrgyz ridge, in the east by the tip of the Trans-Ili Ala-Tau

ridge, and in the north by the gently sloping Shu-Ili mountains. The geological structure of the region consists of a complex of igneous, metamorphic, and sedimentary rocks Matthew. The following structural and geological parts have been established: mountain frame composed of Precambrian-Paleozoic rocks; valley, consisting of Precambrian-Paleozoic basement and Meso-Cenozoic cover.

The studies were carried out using standard regulatory documents with the necessary set of measures that provide a scientifically based methodology for setting up, organizing, and conducting experiments (GOST 7.32-2017 7.32-2017 Scientific Research report. Structure and design rules. — Moscow: Standartinform, 2017: 32).

### **Main Results and Analysis**

Information support for the water resources management process is made in the form of an information system consisting of a “cloud” service (website [uvrcloud.kz](http://uvrcloud.kz)), (GOST R IEC 60870-5-101-2006 Telemechanics devices and systems. Part 5 Transmission protocols. Section 101 General standard for the basic functions of telemechanics. — Moscow: Standartinform, 2006: 29) an information collection and transmission device DCM-1, an electric gate control program, and a mobile application MSD-1 ().

*Cloud service development.* Data on water consumption for water management facilities using DCM-1 devices (data acquisition module) are transmitted to the website [uvrcloud.kz](http://uvrcloud.kz) where they are stored and archived. The website [uvrcloud.kz](http://uvrcloud.kz) consists of two parts:

- client part – to display the user interaction interface;
- server part - performing mathematical calculations, recording data in the database, and ensuring the functionality of the entire information system (IS).

Users. Only those users who are added to the list on the page of users registered in the system have access to the IS.

Based on the results of the work of DCM-1, a comparative calculation of the percentage discrepancy was carried out with the data from the operational service of the production site (PS), which showed discrepancies of no more than 5 % (Figure 1).

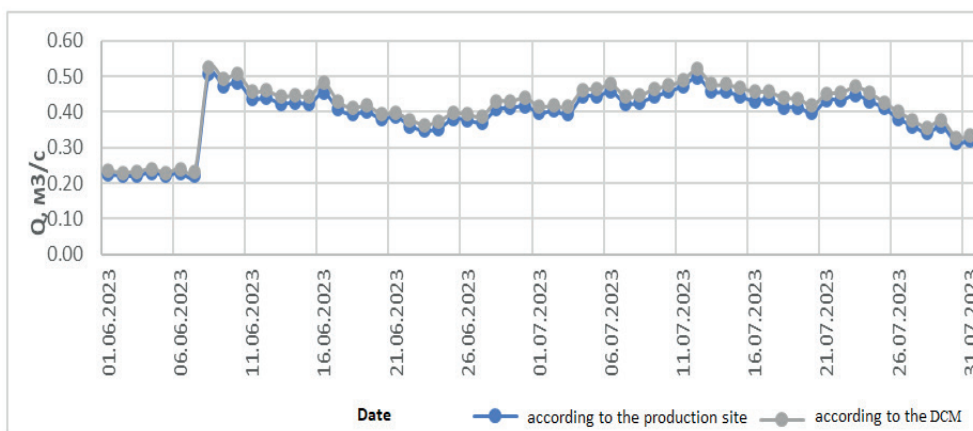


Figure 1 – Graph of comparison of measurement data from the operational service of PS and DCM-1

The developed DCM-1 device shows satisfactory convergence of calculated and actual values of water flow at the pilot site, which gives grounds to assert the possibility of using the DCM-1 device in irrigation systems. Reasons for discrepancies in data may vary, including data errors, calculation errors, insufficient accuracy of measurement methods, and other factors.

*Database structure.* The uvrcloud.kz IS database consists of the following tables:

- Sensors – the table contains all the sensors available in the system with names and descriptions;
- Records – this table stores all data received from sensors;
- Users – user table;
- User\_levels – User types (administrator, manager, etc.);
- Functions – a table describing the various functions of the IS, to differentiate user access to different parts of the IS;
- Access\_users – a table describing which section of the IS which user type has access to.

The developed user interface of the uvrcloud.kz IS and the database structure allows the user to intuitively navigate through the pages of the site and find the necessary information. The IS also provides the ability to work with the system using a mobile application or an application for a personal computer (PC) through requests.

Program for controlling electrically driven gates of a water distribution facility. The main objective of the developed program is to provide the irrigation system operator with the ability to monitor and manage the operation of each gate of the water distribution unit in the system, as well as receive up-to-date information from sensors. For this purpose, the program provides a graphical interface and a status and shutter control block. The graphical interface contains a channel layout that displays the location of all gates and sensors in the pilot site. The gate status and control unit provides the system operator with the ability to select the gate to be controlled and set its operating parameters.

The program is implemented in the Pascal programming language, which is an object-oriented programming language and allows you to create high-quality and efficient programs. To create a graphical interface, various components are used, such as TButton, TLabel, TEdit, TListBox, and others.

The interface provides the user with the opportunity to select the shutter to be controlled and set its operating parameters, as well as detailed information about the data received from the sensors (Figure 2).



Figure 2 – The main window of the system

The program interface itself can be divided into three main blocks: a channel layout block, a status and gate control block, and a block for receiving various data.

This software can be installed at any control center. Simplicity in management, efficiency, and reliability in operation will allow it to be relatively quickly implemented at water economy facilities, and it will be easy for employees of operational services to master the use of a computer software complex.

*Interaction of the program for controlling the gates of a water distribution structure with an electric drive with a database.* All data on system statuses, valves, water consumption, and sensor readings are located in the MySQL database.

Storing data in a MySQL database provides convenient access to data, as well as the ability to quickly search and process data. A MySQL database can be used to store large amounts of data and support multiple users and applications (GOST R MEK 62421–2016 Electronic installation technology. Electronic modules. — Moscow: Standardinform, 2016: 15). Integration with the MySQL database management system provides the program with the ability to efficiently store and manage data on water seals, humidity tasks, and other information necessary for automatic control of the irrigation system.

Humidity sensor calibration. To obtain accurate readings from the humidity sensor, the sensor readings were linked to the water-physical properties of the soil of the site (Figure 3).

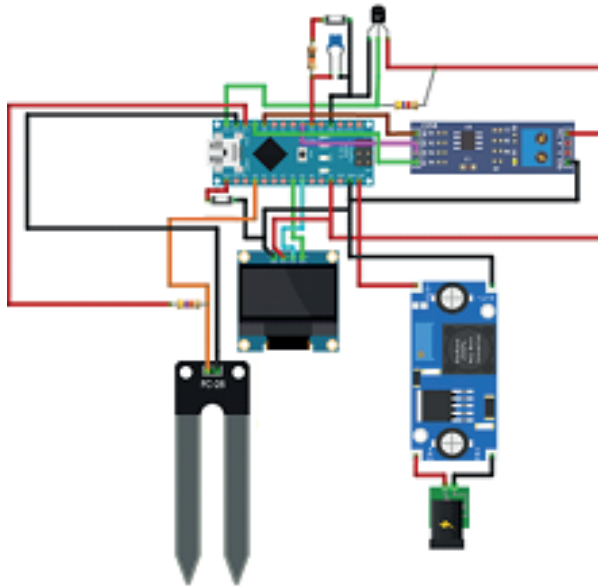


Figure 3 – Diagram for connecting the soil moisture sensor to Arduino

*Automatic operating mode of the program.* In automatic mode, the program offers a convenient schedule for controlling water valves, allowing you to set precise intervals for opening and closing the valves of a water distribution structure, as well as control using external sensors of humidity sensors. This mode allows you to automatically adapt to changing field conditions, optimizing the use of water resources and ensuring maximum irrigation efficiency.

*Automatic control of water distribution facility gates.* To create a task for scheduling automatic control of hydraulic valves over time, an interface has been developed for the operator that allows you to set the necessary parameters. It is also possible to automatically control water seals based on the readings of humidity sensors, which allows you to optimize the process of irrigating fields, maintaining optimal humidity levels for crops.

*Determining errors when receiving data packets.* The program also contains algorithms for monitoring and handling errors, as well as exception situations such as loss of communication with the shutter controller or incorrect parameter entry. In general, the program for controlling hydraulic valves at the pilot site is a reliable and convenient solution for automating the process of controlling valves.

*Debugging and fixing problems with the program.* When developing software, it is impossible to avoid errors and malfunctions. These situations are most likely to arise during the testing process of the program when it comes into contact with real data and use cases. However, it is important to understand that debugging and eliminating errors is an integral part of the development process, which contributes to the creation of a reliable, stable, and high-quality software product. For this purpose, a guide has been developed for detecting, analyzing, and correcting errors in the program. This guide



covers a wide range of program problems, from errors connecting to the database to problems with control algorithms, and also offers a solution for each possible problem.

*Mobile application development.* The MSD-1 mobile application, which displays data from the server site, is designed for convenient operation and monitoring of DCM-1 devices (Figure 4).

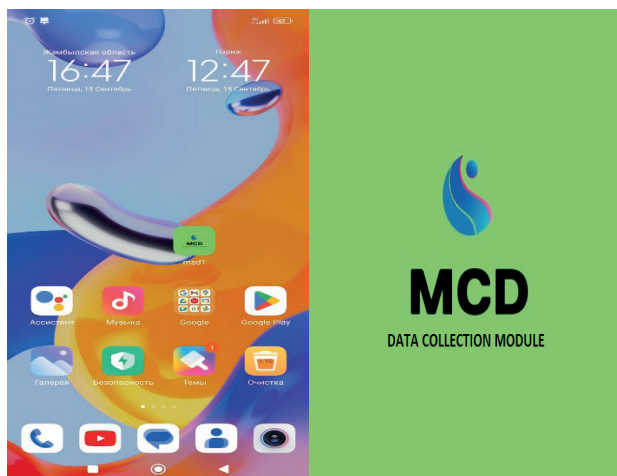


Figure 4 – Mobile application MMSD-1

The application is implemented in Russian, Kazakh, and English, developed on the Android operating system, in the Flutter platform, and in the Dart programming language. Queries to the database are written in PHP, and hosted on Google Play.

After analyzing the operation of the software product for water resource management in irrigation systems, we can highlight the following advantages and disadvantages (Table 3).

Table 3 - Comparative analysis of the advantages and disadvantages of MSD-1

Advantages	Disadvantages
<ul style="list-style-type: none"> <li>- Extensibility. You can add new sensors and input/output modules to the system.</li> <li>- Decentralization. You can control the system and view the status from different places: PC, website, mobile application.</li> <li>- Mobility. You can install the program on another PC.</li> <li>- Flexibility. The software allows you to switch between automatic and manual shutter control modes, giving the operator more control.</li> <li>- Service. Setup and warranty service.</li> </ul>	<ul style="list-style-type: none"> <li>- Internet addiction. Without the Internet, there is no way to remotely control or view status.</li> <li>- Restriction. The limit on the number of Modbus devices in one network is no more than 127 pcs.</li> <li>- Security and access. Due to the possibility of remote control of hydraulic gates, there is a definite need to protect autorotation data in the database.</li> </ul>

In general, a custom software solution for water management based on hydrological information, created from scratch, is always original and specialized.

*Debugging and testing of a software product.* Debugging and testing of cloud service

software (website [uvrcloud.kz](http://uvrcloud.kz)) include the following types: static, dynamic, integration, and memory debugging.

Integration debugging is applied to software packages or systems. After the individual parts of the software package have been debugged, they begin to debug the interaction of the various parts with each other. Let's consider the network structure of a DCM complex, where a USB/rs485 interface converter is connected to a computer in the laboratory. A Modbus RTU line is connected to the converter. Various devices, modules, and sensors are connected to this line (Figure 5).

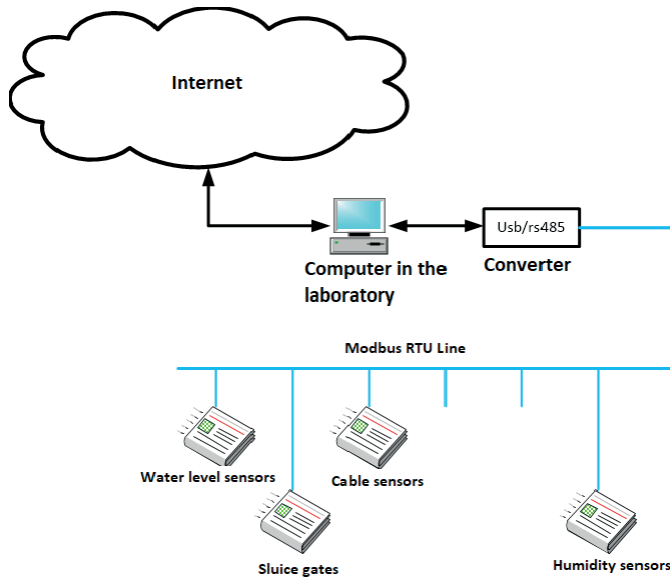


Figure 5 - DCM complex network topology

Several programs are installed on the complex computer, which also interact with each other, creating a system. Let's take a closer look at the interaction of these programs (Figure 6).

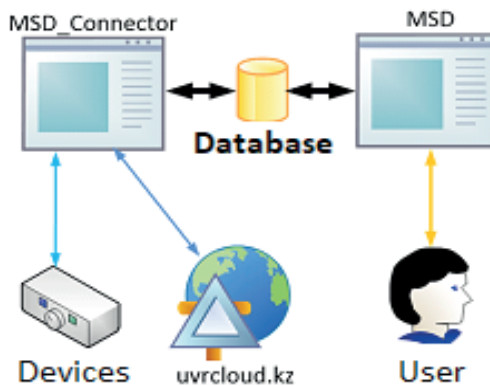


Figure 6 - Interaction of the software product

Programs included in the DCM complex:

- DCM\_Connector – a program that acts as an intermediary between devices on the Modbus RTU network and the database;
- DCM – a user interface program that acts as an intermediary between the user and the database;
- A database is also a program that stores and processes data.

This software package demonstrates integration debugging because the operation of the entire system as a whole depends on the operation of each component separately.

In the modern world, writing software is not complete without debugging and testing. Any software manufacturer strives to make its products high quality and reliable. Therefore, debugging and testing must be included in the stages of software development.

As a result of testing the software product for controlling water seals and monitoring humidity sensors, it was found that the product functions correctly and performs its tasks. The debugging and testing process allowed us to identify and eliminate potential problems, ensuring the reliable and stable operation of the system.

### **Conclusions**

The developed software for the water management process in irrigation systems is an effective solution for automating the water distribution process. It allows you to manage and monitor elements of water management facilities, which helps reduce response time to possible emergencies and increase the efficiency of water resource use.

As a result of comparing data from two systems: measurements at the production site, and readings from the DCM-1 device, discrepancies are noted in the range of no more than 5%. Which is a satisfactory convergence of calculated and actual values of water flow at the pilot site. Based on this, it can be stated that the DCM-1 device can be used in irrigation systems.

An important advantage of the software product is its ease of use and configuration flexibility, which allows it to be adapted to the specific needs and requirements of users. In addition, modern technologies and tools were used in the development process of the software product, which ensures its high reliability, stability, and performance (Scientific Research Report for 2023 “Development of principles and methods for balanced management of water distribution in irrigation systems based on hydrogeological information, taking into account the formation of water resources in river basins” for 2021–2023).

Overall, the development of this software is a successful step in automating the process of water resource management and data processing in the irrigation system. It provides users with a convenient and efficient tool for controlling valves and collecting data, thereby improving system efficiency and optimizing the use of water resources.

### **REFERENCES**

- Ardalan Askari Fard S. Mehdy Hashemy Shahdany, Saman Javadi J.M. (2022). Maestre Developing an automatic conjunctive surface-groundwater operating system for sustainable agricultural water distribution / Computers and Electronics in Agriculture. — Volume 194. — March 2022. — 106774. — <https://doi.org/10.1016/j.compag.2022.106774>

Feliu-Batlle V., Rivas-Perez R., Castillo-Garcia F.J. (2009). Fractional order controller robust to time delay variations for water distribution in an irrigation main canal pool / *Computers and Electronics in Agriculture*. — Volume 69. — Issue 2. — December 2009. — Pp. 185–197. — <https://doi.org/10.1016/j.compag.2009.08.005>

GOST 7.32-2017 7.32-2017 Scientific Research report. Structure and design rules. — Moscow: Standartinform, — 2017. — 32 p.

GOST R IEC 60870-5-101-2006 Telemechanics devices and systems. Part 5 Transmission protocols. Section 101 General standard for the basic functions of telemechanics. - Moscow: Standartinform, — 2006. — 291 p.

GOST R MEK 62421-2016 Electronic installation technology. Electronic modules. — Moscow: Standartinform, — 2016. — 15 p.

Habib Karimi Avargani S. Mehdy Hashemy Shahdany, Kazem Kamrani, Jose M. Maestre S. (2022). Ebrahim Hashemi Garmdareh, Abdolmajid Liaghat Prioritization of surface water distribution in irrigation districts to mitigate crop yield reduction during water scarcity/*Agricultural Water Management*. — Volume 269. — 1 July. — 2022. — <https://doi.org/10.1016/j.agwat.2022.107653/>.

Hashemy Shahdany S.M., Taghvaeian S., Maestre J.M., Firoozfar A.R. (2019). Developing a centralized automatic control system to increase flexibility of water delivery within predictable and unpredictable irrigation water demands / *Computers and Electronics in Agriculture*. — Volume 163. — August 2019. — <https://doi.org/10.1016/j.compag.2019.104862>.

Ibrayev T., Li M., Bakbergenov N., Panenka P., Batyrbayeva A. (2022). PROBLEMS OF THE USE OF WATER RESOURCES AND THE WAYS OF THEIR SOLUTION IN KAZAKHSTAN / *News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences* 2022, — 2022(4), — 69–80

Li M.A., Ibrayev T.T., Balgabayev N.N., Kali B.S., Toleubek D.A. (2023). Simulation and optimization modeling of water use management in irrigation systems / *NEWS of the National Academy of Sciences of the Republic of Kazakhstan SERIES OF GEOLOGY AND TECHNICAL SCIENCES*. — ISSN 2224–5278. — Volume 3. — Number 459 (2023). — 119–129. — <https://doi.org/10.32014/2023.2518-170X.304>

Matthew McPhersona, Andrew Ropickib (2023). Network analysis of collaboration and information sharing in the management of the Lower Mekong River Basin - <https://www.sciencedirect.com/science/article/abs/pii/S0964569120302660> <https://doi.org/10.1016/j.ocecoaman.2020.105356> (date of reference 23.10.2023)

Mohsen Hosseini Jolfan, S. Mehdy Hashemy Shahdany, Saman Javadi, Sami Ghordoyee Milan, Aminreza Neshat, Ronny Berndtsson, Hamed Tork Modernization in agricultural water distribution system for aquifer storage and recovery – A case study / *Agricultural Water Management*. — Volume 282. — 31 May 2023. — 108270 — <https://doi.org/10.1016/j.agwat.2023.108270>

Monalisha Pramanik, Manoj Khanna, Man Singh, D.K. Singh, Susama Sudhishri, Arti Bhatia, Rajeev Ranjan Automation of soil moisture sensor-based basin irrigation system / *Smart Agricultural Technology*. — Volume 2. — December 2022. — <https://doi.org/10.1016/j.atech.2021.100032>

Peng Yanga, Yanchao Zhua, Xiaoyan Zhaib, Jun Xiac, Yaning Chend, Heqing Huang a, Zhi Li d, Xiaorui Shi a, Libo Zhou E, Cai Fu E/ Adaptive management of water resources system in the arid Aksu river basin, northwest China <https://www.sciencedirect.com/science/article/abs/pii/S0959652623023430>, — <https://doi.org/10.1016/j.jclepro.2023.138185>

Ramachandran Veerachamy, Ramalakshmi Ramar, S. Balaji, L. Sharmila Autonomous Application Controls on Smart Irrigation / *Computers and Electrical Engineering*. — Volume 100. — May 2022. — 107855 — <https://doi.org/10.1016/j.compeleceng.2022.107855>

Robles T., Alcarria R., Martín D., Navarro M., Calero R., Iglesias S., López M. (2015). An iot based reference architecture for smart water management processes/*J. Wireless Mobile Networks Ubiquitous Comput. — Dependable Appl.* 6, — 2015. — Pp. 4–23.

Scientific Research Report for (2023). “Development of principles and methods for balanced management of water distribution in irrigation systems based on hydrogeological information, taking into account the formation of water resources in river basins” according to the STP (IRN BR10764920) “Technologies and technical means of irrigation when introducing new irrigation lands, reconstruction and modernization existing irrigation systems” for 2021–2023. — Inv. № 0223RK00290. — P. 157.

Soroush Barkhordaria, Seied Mehdy Hashemy Shahdany Developing a smart operating system for fairly distribution of irrigation water, based on social, economic, and environmental considerations / *Agricultural Water Management*. — Volume 250. — 1 May 2021. — 106833. — <https://doi.org/10.1016/j.agwat.2021.106833>

Supriya K.E., Rao K.R. IoT based real time water level monitoring using Texas instruments' CC3200 / *Indian Journal of Science and Technology* 13(17), — 2020. — Pp. 1720–1729.

Zheli Zhu, Guanghua Guan a, Xin Tian, S.M. Hashemy Shahdany, Kang Wang The Integrator Dual-Delay model for advanced controller design of the open canal irrigation systems with multiple offtakes / *Computers and Electronics in Agriculture*. — Volume 205. — February 2023. — <https://doi.org/10.1016/j.compag.2023.107616>

Zoffoli Giovanni, Gangi Fabiola, Ferretti Gianni, Masseroni Daniele The potential of a coordinated system of gates for flood irrigation management in paddy rice farm/ *Agricultural Water Management*. — Volume 289. — 1 November 2023. — 108536 — <https://doi.org/10.1016/j.agwat.2023.108536>

## CONTENTS

<b>K.T. Abdraimova, E.K. Ibragimova, G.I. Issayev, N.A. Akhmetov</b> USE OF FABACEAE PLANTS AS A PHYTOMELIORANT IN SALINATED LANDS AND STUDY OF THE TRANSLOCATION COEFFICIENT.....	8
<b>D.K. Azhgaliev, S.N. Nursultanova</b> PRE-JURASSIC STAGE OF DEVELOPMENT AND PROSPECTS OF OIL AND GAS POTENTIAL NORTHERN USTYURT.....	20
<b>A.I. Azimbay, T.M. Karimzhan</b> DETERMINATION OF THE DEGREE OF PURIFICATION OF WATER CONTAMINATED WITH HEAVY METAL IONS BY DAPHNIA.....	37
<b>S.Zh. Galiyev, F.Ya. Umarov, U.F. Nasirov, Sh.Sh. Zairov, A.U. Fathiddinov</b> SAFETY SYSTEM AT FACTORIES PRODUCING EMULSION EXPLOSIVE COMPOSITIONS IN THE REPUBLIC OF UZBEKISTAN AND RECOMMENDATIONS FOR ENSURING SAFE CONDITIONS FOR BLASTING WORK.....	50
<b>S.K. Davletgaliev, S.K. Alimkulov, A.A. Tursunova, E.K. Talipova</b> LONG TERM FORECAST OF THE MONTHLY FLOW HYDROGRAPH OF YERTIS RIVER (VILLAGE BORAN) BASED ON COMBINED STATISTICAL MODELING OF THE RIVER FLOW AND PRECIPITATION.....	70
<b>N. Zhalgasuly, A.A. Asanov, S.V. Efremova, U.A. Bektibayev, A.A. Ismailova</b> THE SIGNIFICANCE OF MODERN BROWN COAL PROCESSING TECHNOLOGIES FOR THE DEVELOPMENT OF AGRICULTURAL PRODUCTION AND PUBLIC HEAT POWER.....	85
<b>G.I. Issayev, I.G. Ikramov</b> ENVIRONMENTAL IMPACT OF LEAD TOXICITY.....	100
<b>M. Li, T. Ibrayev, N. Balgabayev, T. Imanaliyev, K. Yestaev</b> INFORMATION SUPPORT FOR THE PROCESS OF WATER RESOURCES MANAGEMENT IN IRRIGATION SYSTEMS.....	111
<b>A.S. Madibekov, A.M. Karimov, L.T. Ismukhanova, A.O. Zhadi</b> HEAVY METALS IN THE SNOW COVER AND SOIL OF THE ILE RIVER DELTA.....	125

<b>A.T. Niyaz, K.S. Togizov, S.A. Istekova</b> SEISMIC DATA DYNAMIC INTERPRETATION IN THE STUDY OF THE LATERAL VARIABILITY OF PETROLEUM BEARING TERRIGENOUS RESERVOIRS.....	145
<b>D. Rakhimbayeva, G. Kyrgyzbayeva, D. Shoganbekova, T. Nurpeissova, Kh. Yusupov</b> STUDY OF THE METHOD FOR MONITORING THE CASPIAN SEA COASTLINE BASED ON THE DATA OF REMOTE SENSING OF THE EARTH.....	157
<b>T.K. Salikhov, A.A. Murasheva, G.O. Abisheva, B.O.Kazybayev, S.R. Abildakhanova, A.A. Brataeva</b> THE STUDY OF THE FEATURES OF THE RELIEF AND GEOLOGY OF THE ECOSYSTEM OF THE CHINGIRLAU DISTRICT OF THE WEST KAZAKHSTAN REGION.....	174
<b>G. Seitova, M. Turlybekova, S. Kaldybayeva, A.U. Izdibayev</b> RESEARCH AND ASSESSMENT OF THE STATE OF OCCUPATIONAL INJURIES AT THE DON MINING AND PROCESSING PLANT.....	185
<b>N.Tauova, Zh. Yessenamanova, M. Yessenamanova, A. Tlepbergenova, A. Abilgazyeva, A. Sakparova</b> TECHNOLOGY FOR THE PRODUCTION OF GROUTING CHLORIDE OF ARESIANT DRILLING MUD BASED ON A SULFUR COMPOSITE MATERIAL.....	196
<b>M. Turlybekova, G. Seitova, E. Bilisbekkyzy, A. Tokanbayev, S. Kaldybayeva</b> EVALUATION OF THE EFFICIENCY AND USE OF A COMPLEX FROM NATURAL MINERAL SORBENTS.....	208

## **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](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.nauka-nanrk.kz)**

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

**ISSN 2518-170X (Online),**

**ISSN 2224-5278 (Print)**

Подписано в печать 15.12.2023.

Формат 70x90<sup>1/16</sup>. Бумага офсетная. Печать – ризограф.  
19,0 п.л. Тираж 300. Заказ 6.