

ISSN 2518-170X (Online)

ISSN 2224-5278 (Print)

**NEWS OF THE NATIONAL ACADEMY
OF SCIENCES OF THE REPUBLIC
OF KAZAKHSTAN, SERIES OF
GEOLOGY AND TECHNICAL SCIENCES**

№2

2026

ISSN 2518-170X (Online)

ISSN 2224-5278 (Print)



N E W S
OF THE NATIONAL ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN,
SERIES OF GEOLOGY AND TECHNICAL
SCIENCES

2 (476)
MARCH – APRIL 2026

THE JOURNAL WAS FOUNDED IN 1940

PUBLISHED 6 TIMES A YEAR

ALMATY, 2026



Scopus®



The scientific journal News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences has been indexed in the international abstract and citation database Scopus since 2016 and demonstrates stable bibliometric performance.

The journal is also included in the Emerging Sources Citation Index (ESCI) of the Web of Science platform (Clarivate Analytics, since 2018).

Indexing in ESCI confirms the journal's compliance with international standards of scientific peer review and editorial ethics and is considered by Clarivate Analytics as part of the evaluation process for potential inclusion in the Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI), and Arts & Humanities Citation Index (AHCI).

Indexing in Scopus and Web of Science ensures high international visibility of publications, promotes citation growth, and reflects the editorial board's commitment to publishing relevant, original, and scientifically significant research in the fields of geology and technical sciences.

«Қазақстан Республикасы Ұлттық ғылым академиясының Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналы 2016 жылдан бастап халықаралық реферативтік және ғылымиметриялық Scopus дерекқорында индекстеледі және тұрақты библиометриялық көрсеткіштерді көрсетіп келеді.

Сонымен қатар журнал Web of Science платформасының (Clarivate Analytics, 2018) халықаралық реферативтік және наукометриялық дерекқоры Emerging Sources Citation Index (ESCI) тізіміне енгізілген.

ESCI дерекқорында индекстелуі журналдың халықаралық ғылыми рецензиялау талаптары мен редакциялық этика стандарттарына сәйкестігін растайды, сондай-ақ Clarivate Analytics компаниясы тарапынан басылмды Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI) және Arts & Humanities Citation Index (AHCI) дерекқорларына енгізу қарастырылуда.

Scopus және Web of Science дерекқорларында индекстелуі жарияланымдардың халықаралық деңгейде жоғары сұранысқа ие болуын қамтамасыз етеді, олардың дәйексөз алу көрсеткіштерінің артуына ықпал етеді және редакциялық алқаның геология мен техникалық ғылымдар саласындағы өзекті, бірегей және ғылыми тұрғыдан маңызды зерттеулерді жариялауға ұмтылысын айқындайды.

Научный журнал «News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences» с 2016 года индексируется в международной реферативной и наукометрической базе данных Scopus и демонстрирует стабильные библиометрические показатели.

Журнал также включён в международную реферативную и наукометрическую базу данных Emerging Sources Citation Index (ESCI) платформы Web of Science (Clarivate Analytics, 2018).

Индексирование в ESCI подтверждает соответствие журнала международным стандартам научного рецензирования и редакционной этики, а также рассматривается компанией Clarivate Analytics в рамках дальнейшего включения издания в Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI) и Arts & Humanities Citation Index (AHCI).

Индексирование в Scopus и Web of Science обеспечивает высокую международную востребованность публикаций, способствует росту цитируемости и подтверждает стремление редакционной коллегии публиковать актуальные, оригинальные и научно значимые исследования в области геологии и технических наук.

EDITOR-IN-CHIEF

ZHURINOV Murat Zhurinovich, Doctor of Chemical Sciences, Professor, Academician of IAAS and NAS RK, General Director of the Research Institute of Petroleum Refining and Petrochemicals (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=6602177960>; <https://www.webofscience.com/wos/author/record/2017489>

DEPUTY EDITOR-IN-CHIEF

ABSADYKOV Bakhyt Narikbayevich, Doctor of Technical Sciences, Professor, Academician of NAS RK, Satbayev University (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=6504694468>; <https://www.webofscience.com/wos/author/record/2411827>

EDITORIAL BOARD:

ABSAMETOV Malis Kudysovich, Doctor of Geological and Mineralogical Sciences, Professor, Academician of NAS RK, Director of the U.M. Akhmedsafa Institute of Hydrogeology and Geoecology (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=56955769200>; <https://www.webofscience.com/wos/author/record/1937883>

ZHOLTAEV Geroy Zholtaevich, Doctor of Geological and Mineralogical Sciences, Professor, Honorary Academician of NAS RK (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=57112610200>; <https://www.webofscience.com/wos/author/record/1939201>

SNOW Daniel, PhD, Associate Professor, Director, Aquatic Sciences Laboratory, University of Nebraska (Nebraska, USA), <https://www.scopus.com/authid/detail.uri?authorId=7103259215>; <https://www.webofscience.com/wos/author/record/1429613>

SELTMAN Reimar, PhD, Head of Petrology and Mineral Deposits Research in the Earth Sciences Department, Natural History Museum (London, Great Britain), <https://www.scopus.com/authid/detail.uri?authorId=55883084800>; <https://www.webofscience.com/wos/author/record/1048681>

PANFILOV Mikhail Borisovich, Doctor of Technical Sciences, Professor at the University of Nancy (Nancy, France), <https://www.scopus.com/authid/detail.uri?authorId=7003436752>; <https://www.webofscience.com/wos/author/record/1230499>

SHEN Ping, PhD, Deputy Director of the Mining Geology Committee of the Chinese Geological Society, Member of the American Association of Economic Geologists (Beijing, China), <https://www.scopus.com/authid/detail.uri?authorId=57202873965>; <https://www.webofscience.com/wos/author/record/1753209>

FISCHER Axel, PhD, Associate Professor, Technical University of Dresden (Dresden, Germany), <https://www.scopus.com/authid/detail.uri?authorId=35738572100>; <https://www.webofscience.com/wos/author/record/2085986>

AGABEKOV Vladimir Enokovich, Doctor of Chemical Sciences, Academician of NAS of Belarus, Honorary Director of the Institute of Chemistry of New Materials (Minsk, Belarus), <https://www.scopus.com/authid/detail.uri?authorId=7004624845>

CATALIN Stefan, PhD, Associate Professor, Technical University of Dresden (Dresden, Germany), <https://www.scopus.com/authid/detail.uri?authorId=35203904500>; <https://www.webofscience.com/wos/author/record/1309251>

JAY Sagin, PhD, Associate Professor, Nazarbayev University (Astana, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=57204467637>; <https://www.webofscience.com/wos/author/record/907886>

FRATTINI Paolo, PhD, Associate Professor, University of Milano - Bicocca (Milan, Italy), <https://www.scopus.com/authid/detail.uri?authorId=56538922400>

NURPEISOVA Marzhan Baysanovna, Doctor of Technical Sciences, Professor of Satbayev University (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=57202218883>; <https://www.webofscience.com/wos/author/record/AAD-1173-2019>

RATOV Boranbay Tovbasarovich, Doctor of Technical Sciences, Professor, Head of the Department of Geophysics and Seismology, Satbayev University (Almaty, Kazakhstan), <https://www.scopus.com/authid/detail.uri?authorId=55927684100>; <https://www.webofscience.com/wos/author/record/1993614>

RONNY Berndtsson, Professor, Director of the Centre for Advanced Middle Eastern Studies, Lund University (Lund, Sweden), <https://www.scopus.com/authid/detail.uri?authorId=7005388716>; <https://www.webofscience.com/wos/author/record/1324908>

MIRLAS Vladimir, PhD, Professor, Eastern R&D Center, Ariel University (Ariel, Israel), <https://www.scopus.com/authid/detail.uri?authorId=8610969300>; <https://www.webofscience.com/wos/author/record/53680261>

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: «Central Asian Academic Research Center» LLP (Almaty).

The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Communications of the Republic of Kazakhstan № KZ50VPY00121155, issued on 05.06.2025
Thematic scope: *geology, hydrogeology, geography, mining and chemical technologies of oil, gas and metals*
Periodicity: 6 times a year.

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

© «Central Asian Academic Research Center» LLP, 2026.

БАС РЕДАКТОР

ЖҰРЫНОВ Мұрат Жұрыңұлы, химия ғылымдарының докторы, профессор, ХҒАҚ және ҚР ҰҒА академигі, Мұнай өңдеу және мұнай-химиясы ғылыми-зерттеу институтының бас директоры (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=6602177960>; <https://www.webofscience.com/wos/author/record/2017489>

БАС РЕДАКТОРДЫҢ ОРЫНБАСАРЫ:

АБСАДЫҚОВ Бақыт Нәрікбайұлы, техника ғылымдарының докторы, профессор, ҚР ҰҒА академигі, Қ.И. Сәтбаев атындағы Қазақ ұлттық техникалық зерттеу университеті (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=6504694468>; <https://www.webofscience.com/wos/author/record/2411827>

РЕДАКЦИЯ АЛҚАСЫ:

ӨБСӘМЕТОВ Мәліс Құдысұлы, геология-минералогия ғылымдарының докторы, профессор, ҚР ҰҒА академигі, У.М. Ахмедсафин атындағы Гидрогеология және геоэкология институтының директоры (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=56955769200>; <https://www.webofscience.com/wos/author/record/1937883>

ЖОЛТАЕВ Герой Жолтайұлы, геология-минералогия ғылымдарының докторы, профессор, ҚР ҰҒА құрметті академигі (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=57112610200>; <https://www.webofscience.com/wos/author/record/1939201>

СНОУ Дэниел, PhD, қауымдастырылған профессор, Небраска университетінің Су ғылымдары зертханасының директоры (Небраска, АҚШ), <https://www.scopus.com/authid/detail.uri?authorId=7103259215>; <https://www.webofscience.com/wos/author/record/1429613>

ЗЕЛБТМАНН Раймар, PhD, Жер туралы ғылымдар бөлімінің петрология және пайдалы қазбалар кен орындары саласындағы зерттеулерінің жетекшісі, Табиғи тарих мұражайы (Лондон, Ұлыбритания), <https://www.scopus.com/authid/detail.uri?authorId=55883084800>; <https://www.webofscience.com/wos/author/record/1048681>

ПАНФИЛОВ Михаил Борисович, техника ғылымдарының докторы, Нанси университетінің профессоры (Нанси, Франция), <https://www.scopus.com/authid/detail.uri?authorId=7003436752>; <https://www.webofscience.com/wos/author/record/1230499>

ШЕН Пин, PhD, Қытай геологиялық қоғамының Тау-кен геологиясы комитеті директорының орынбасары, Американдық экономикалық геологтар қауымдастығының мүшесі (Бейжің, Қытай), <https://www.scopus.com/authid/detail.uri?authorId=57202873965>; <https://www.webofscience.com/wos/author/record/1753209>

ФИШЕР Аксель, PhD, қауымдастырылған профессор, Дрезден техникалық университеті (Дрезден, Германия), <https://www.scopus.com/authid/detail.uri?authorId=35738572100>; <https://www.webofscience.com/wos/author/record/2085986>

АГАБЕКОВ Владимир Енокович, химия ғылымдарының докторы, Беларусь ҰҒА академигі, Жаңа материалдар химиясы институтының құрметті директоры (Минск, Беларусь), <https://www.scopus.com/authid/detail.uri?authorId=7004624845>

КАТАЛИН Стефан, PhD, қауымдастырылған профессор, Дрезден Техникалық университеті (Дрезден, Германия), <https://www.scopus.com/authid/detail.uri?authorId=35203904500>; <https://www.webofscience.com/wos/author/record/1309251>

САҒЫНТАЕВ Жанай, PhD, қауымдастырылған профессор, Назарбаев университеті (Астана, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=57204467637>; <https://www.webofscience.com/wos/author/record/907886>

ФРАТТИНИ Паоло, PhD, қауымдастырылған профессор, Бикокк Милан университеті (Милан, Италия), <https://www.scopus.com/authid/detail.uri?authorId=56538922400>

НҮРПЕЙІСОВА Маржан Байсанқызы, техника ғылымдарының докторы, Қ.И. Сәтбаев атындағы Қазақ ұлттық техникалық зерттеу университетінің профессоры (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=57202218883>; <https://www.webofscience.com/wos/author/record/AAD-1173-2019>

РАТОВ Боранбай Товбасарович, техника ғылымдарының докторы, профессор, «Геофизика және сейсмология» кафедрасының меңгерушісі, Қ.И. Сәтбаев атындағы Қазақ ұлттық техникалық зерттеу университеті (Алматы, Қазақстан), <https://www.scopus.com/authid/detail.uri?authorId=55927684100>; <https://www.webofscience.com/wos/author/record/1993614>

РОННИ Беридтссон, профессор, Таяу Шығысты заманауи зерттеу орталығының директоры, Лунд университеті (Лунд, Швеция), <https://www.scopus.com/authid/detail.uri?authorId=7005388716>; <https://www.webofscience.com/wos/author/record/1324908>

МИРІАС Владимир, PhD, профессор, Ариэль университетінің Шығыс ғылыми-зерттеу орталығы (Ариэль, Израиль), <https://www.scopus.com/authid/detail.uri?authorId=8610969300>; <https://www.webofscience.com/wos/author/record/53680261>

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)

Меншіктеуші: «Орталық Азия академиялық ғылыми орталығы» ЖШС (Алматы қ.).

Қазақстан Республикасының Ақпарат және коммуникациялар министрлігінің Ақпарат комитетінде 05.06.2025 ж. берілген № KZ50VPY00121155 мерзімдік басылым тіркеуіне қойылу туралы куәлік. Тақырыптық бағыты: *геология, гидрогеология, география, тау-кен ісі, мұнай, газ және металдардың химиялық технологиялары*

Мерзімділігі: жылына 6 рет.

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

ГЛАВНЫЙ РЕДАКТОР

ЖУРИНОВ Мурат Журинович, доктор химических наук, профессор, академик МАН и НАН РК, Генеральный директор НИИ нефтепереработки и нефтехимии (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=6602177960>; <https://www.webofscience.com/wos/author/record/2017489>

ЗАМЕСТИТЕЛЬ ГЛАВНОГО РЕДАКТОРА

АБСАДЫКОВ Бахыт Нарикбаевич, доктор технических наук, профессор, академик НАН РК, Казахский национальный исследовательский технический университет им. К.И. Сатпаева (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=6504694468>; <https://www.webofscience.com/wos/author/record/2411827>

РЕДАКЦИОННАЯ КОЛЛЕГИЯ:

АБСАМЕТОВ Малис Кудысович, доктор геолого-минералогических наук, профессор, академик НАН РК, директор Института гидрогеологии и геоэкологии им. У.М. Ахмедсафина (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=56955769200>; <https://www.webofscience.com/wos/author/record/1937883>

ЖОЛТАЕВ Герой Жолтаевич, доктор геолого-минералогических наук, профессор, почетный академик НАН РК (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=57112610200>; <https://www.webofscience.com/wos/author/record/1939201>

СНОУ Дэниел, PhD, ассоциированный профессор, директор Лаборатории водных наук Университета Небраски (Небраска, США), <https://www.scopus.com/authid/detail.uri?authorId=7103259215>; <https://www.webofscience.com/wos/author/record/1429613>

ЗЕЛЬТМАНН Раймар, PhD, руководитель исследований в области петрологии и месторождений полезных ископаемых в Отделе наук о Земле Музея естественной истории (Лондон, Великобритания), <https://www.scopus.com/authid/detail.uri?authorId=55883084800>; <https://www.webofscience.com/wos/author/record/1048681>

ПАНФИЛОВ Михаил Борисович, доктор технических наук, профессор Университета Нанси (Нанси, Франция), <https://www.scopus.com/authid/detail.uri?authorId=7003436752>; <https://www.webofscience.com/wos/author/record/1230499>

ШЕН Пин, PhD, заместитель директора Комитета по горной геологии Китайского геологического общества, член Американской ассоциации экономических геологов (Пекин, Китай), <https://www.scopus.com/authid/detail.uri?authorId=57202873965>; <https://www.webofscience.com/wos/author/record/1753209>

ФИШЕР Аксель, PhD, ассоциированный профессор, Технический университет Дрезден (Дрезден, Берлин), <https://www.scopus.com/authid/detail.uri?authorId=35738572100>; <https://www.webofscience.com/wos/author/record/2085986>

АГАБЕКОВ Владимир Енокович, доктор химических наук, академик НАН Беларуси, почетный директор Института химии новых материалов (Минск, Беларусь), <https://www.scopus.com/authid/detail.uri?authorId=7004624845>

КАТАЛИН Стефан, PhD, ассоциированный профессор, Технический университет Дрезден (Дрезден, Германия), <https://www.scopus.com/authid/detail.uri?authorId=35203904500>; <https://www.webofscience.com/wos/author/record/1309251>

САГИНТАЕВ Жанай, PhD, ассоциированный профессор, Назарбаев университет (Астана, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=57204467637>; <https://www.webofscience.com/wos/author/record/907886>

ФРАТТИНИ Паоло, PhD, ассоциированный профессор, Миланский университет Бикокк (Милан, Италия), <https://www.scopus.com/authid/detail.uri?authorId=56538922400>

НУРПЕИСОВА Маржан Байсановна, доктор технических наук, профессор Казахского национального исследовательского технического университета им. К.И. Сатпаева (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=57202218883>; <https://www.webofscience.com/wos/author/record/AAD-1173-2019>

РАТОВ Боранбай Товбасарович, доктор технических наук, профессор, заведующий кафедрой «Геофизика и сейсмология», Казахский национальный исследовательский технический университет им. К.И. Сатпаева (Алматы, Казахстан), <https://www.scopus.com/authid/detail.uri?authorId=55927684100>; <https://www.webofscience.com/wos/author/record/1993614>

РОННИ Берндтссон, профессор, Директор Центра современных ближневосточных исследований, Лундский университет (Лунд, Швеция), <https://www.scopus.com/authid/detail.uri?authorId=7005388716>; <https://www.webofscience.com/wos/author/record/1324908>

МИРЛАС Владимир, PhD, профессор, Восточный научно-исследовательский центр, Университет Ариэля (Ариэль, Израиль), <https://www.scopus.com/authid/detail.uri?authorId=8610969300>; <https://www.webofscience.com/wos/author/record/53680261>

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)

Собственник: ТОО «Центрально-Азиатский академический научный центр» (г. Алматы).

Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и коммуникаций и Республики Казахстан № KZ50VPY00121155, выданное 05.06.2025 г.

Тематическая направленность: *геология, гидрогеология, география, горное дело и химические технологии нефти, газа и металлов*

Периодичность: 6 раз в год.

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

© ТОО «Центрально-Азиатский академический научный центр», 2026.

CONTENTS

Abetov A.E., Seitzhanov A.K., Samenov Y.R., Zhassymbek S.A. Machine learning and neural networks for lithofacies mapping and reservoir property evaluation of core samples.....	8
Aitkaliyev A.K., Pak Y.N., Kolmakov Y.V., Pak D.Y., Matishev T.V. Application of the X-Ray radiometric method to improve the operational quality control of copper ores during geological testing.....	26
Altay Y.A., Karymsakova N.T., Fedorov A.V., Absadykov D.B., Ismagul G.K. Predictive control of diagnostically significant parameters of acoustic emission using machine learning: new data.....	41
Astanakulov K.D., Kodirova M.G., Saydumarov B., Nersesyan D.V., Kurashkin S.O. Resource potential of ecological and geological systems of allocated soil masses.....	58
Avazov Sh.B., Yodgorov Sh.I., Mukhammadkulov N.M., Aktamov B.U., Khayriddinov B.B. Instrumental seismometric assessment of the impact of technogenic seismic vibrations on the structural stability of historical objects.....	74
Baskanbayeva D., Kalmaganbetov S., Sabirova L., Zholdybayeva G., Koptleuov K. CFD analysis of screw compressor rotor geometry influence on gas compression efficiency in geology.....	92
Borotov A.N., Karshiev F.U., Igamberdiyev A.A., Grigoryan A.G., Sarigo N.V. Ecological aspects of resource conservation in the development of mineral deposits.....	107
Gerasidi V.V., Lisachenko A.V., Apatenko A.S., Sevryugina N.S., Fomin A.Y. Analysis of the application of non-destructive testing methods for assessing the technical condition of mining equipment motors based on vibration parameters.....	121
Hajiyeva A.Z., Ibrahimova L.P., Humbatova Sh.Y., Jafarova F.M. Ecological processes of vertical landscape transformation and their manifestation in the natural landscapes of Nakhchivan.....	135
Jakiyayev D.K., Nussipali R.K.*, Malibekov A.K., Jakiyayev B.D., Zhashen S.Zh. Statistical model of multi-cycle fatigue of steel structural elements under a complex non-uniform stress state.....	149
Jumatov Y.K., Tashbulatov S.B., Pushanov A.N., Kozenkova G.L., Yarygina I.V. Technological substantiation of sustainable mining reclamation of disturbed lands in open pit operations.....	169
Kainenova T.S., Kosmbaeva G.T., Bissembayeva K.T., Otarbayeva A.T., Orazbek A.A. Effectiveness of measures to regulate the development process at the Alibekmola field.....	185

Koishiyeva G.Zh., Yerimova A.Zh., Kurbaniyazov S.K., Agaidarova K.H., Abdraimova K.T. Radiological properties and stratigraphic significance of glauconite-bearing formations: implications for paleoenvironments and geochemical zonation.....	203
Kondratiev V.V., Bryukhanova N.N., Kononenko R.V., Gladkikh V.A., Matasova I.Y. Environmental and technological assessment of beneficiation tailings reprocessing based on mechanical activation and non-ferrous metals leaching.....	223
Kuldeyev Ye., Negmatov S., Nurpeissova M., Kirgizbaeva D., Donenbayeva N. Geodynamic Polygon of the Zhilandy Ore Field: Results and Prospects.....	237
Madibekov A., Christian Opp., Karimov A., Ismukhanova L., Zhadi A. Regularities of distribution and accumulation factors of heavymetals in soils of the Zhetysu region (Kazakhstan).....	253
Malikov G.I., Musayeva S.A., Mammadov K.S., Jabiyeva U.M., Jafarova K.V. Effects of hydrocarbon fuel quality fluctuations on energy generation efficiency, economic viability, and environmental footprint.....	272
Narbaev M.T., Ismailova G.K., Narbaeva K.T., Burlibayeva D.M., Groll M. Assessment of ecological and water management parameters of the Syrdarya River.....	290
Nurmagambetov A. On seismic hazard of Almaty and tectonic faults in the city.....	309
Permana A.P., Kasim M., Hutagalung R., Uno D.A.N., Sandi I.N. petrographic, provenance, and tectonic setting of Dolokapa formation sandstone, North Gorontalo.....	319
Ratov B.T., Khomenko V.L., Yavorska O.O., Koroviaka Ye.A., Akhmetova N.S. Analytical and structural justification of a wellhead sealing device for large-diameter drilling operations.....	335
Skrobala V.M., Popovych V.V., Kopylov V.P., Popovych N.P. Comprehensive assessment of heavy metal pollution of a river within a large city.....	355
Sunakbaeva D.Kh., Yuldashbek D.Kh., Aitekova K., Seitbayev K.Zh. Monitoring heavy metals in soils and waters of the City of Turkestan: geoeological aspect.....	371
Zakirov M.M., Agzamova I.A., Ochilov G.E., Gulyamov G.D., Xudayberdiyev T.M. Analysis of the results of changes in the gas and isotopic composition of groundwater during the period of earthquake preparation.....	385
Zhanbatyrov A.A., Tukhfatov Zh.K., Bektay E.K., Turisbekova G.S., Zhanbatyrov N.A. Current state of potash ore development in the Caspian lowlands of the Republic of Kazakhstan: problems and solutions.....	309

NEWS OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC
OF KAZAKHSTAN, SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224-5278
Volume 2.
Number 476 (2026), 135–148

<https://doi.org/10.32014/2026.2518-170X.620>

UDC: 528.873

IRSTI: 39.19.31; 87.29.91

**©Hajiyeva A.Z.^{1*}, Ibrahimova L.P.², Humbatova Sh.Y.³,
Jafarova F.M.¹, 2026.**

¹UNEC (Azerbaijan State University of Economics), Baku, Azerbaijan;

²NSU (Nakhchivan State University) Nakhchivan, Azerbaijan;

³BSU (Baku State University), Baku, Azerbaijan.

*Email: Afag_Hajiyeva@unec.edu.az

ECOLOGICAL PROCESSES OF VERTICAL LANDSCAPE TRANSFORMATION AND MANIFESTATION IN NATURAL LANDSCAPES OF NAKHCHIVAN

Hajiyeva Afag — PhD, Associate Professor, Azerbaijan State University of Economics (UNEC), Baku, Azerbaijan,

E-mail: Afag_Hajiyeva@unec.edu.az, <https://orcid.org/0000-0002-9813-7835>;

Ibrahimova Leyla — PhD, Nakhchivan State University (NSU), Nakhchivan, Azerbaijan,

E-mail: leylaibrahimova@ndu.edu.az, <https://orcid.org/0009-0005-3955-1074>;

Humbatova Shafiga — PhD, Baku State University (BSU), Baku, Azerbaijan,

E-mail: shafiga.humbatova@mail.ru, <https://orcid.org/0000-0002-6724-2106>;

Jafarova Firuza — PhD, Associate Professor, Azerbaijan State University of Economics (UNEC), Baku, Azerbaijan,

E-mail: Firuza_Jafarova@unec.edu.az, <https://orcid.org/0000-0003-1342-1843>.

Abstract. The main subject of the research is the agrocenoses present in the Nakhchivan Autonomous Republic and the factors affecting their sustainable development. The study addresses the problem of spatial differentiation of natural landscapes and their role in shaping the productivity and stability of agrocenoses under increasing anthropogenic pressure. The primary goal is to determine the impact of the natural landscapes of the research area on the development of agrocenoses and to identify ecologically optimal zones for sustainable management. In this article, the natural landscapes are analyzed in a GIS environment, and their impact on agrocenoses is determined. The study employed GIS technologies and remote sensing indices (NDVI, NDWI, NDMI, SAVI) to assess vegetation and soil cover. These approaches were complemented by historical-geographical, mathematical-statistical, cartographic, field-based, comparative, observational, and systematic methods to ensure reliability and spatial accuracy. A landscape-fragmentation

coefficient was calculated to evaluate the influence of tectonic and morphostructural features on agricultural land productivity. In areas where tectonically active and mobile morphostructures of river valleys intersect the land, fragmentation increases, reducing the productivity of agriculturally significant lands. High vertical fragmentation in mountainous areas makes them unfavorable for agrocenoses. Examining the morphogenetic types of elevation landscapes, steppe-meadow and meadow-steppe types on intrusive outcrops are more widespread. A comparative analysis of previous years' data was conducted to study agrocenoses dynamics. The results reveal that landscape structure, vertical differentiation, and soil composition directly influence productivity and ecological stability. Optimal areas for agrocenoses in the Nakhchivan Autonomous Republic are low mountainous and Araz River plain regions. Soil samples determined mineral composition, humus content, and acidity, and studied changes from intensive anthropogenic impacts. The findings provide a scientific basis for landscape-based agricultural planning and sustainable land-use strategies in arid mountainous regions.

Keywords: Natural landscapes, agrocenoses, transformation, usage of lands, transformation

For citations: *Hajiyeva A.Z., Ibrahimova L.P., Humbatova Sh.Y., Jafarova F.M. Ecological Processes of Vertical Landscape Transformation and Their Manifestation in the Natural Landscapes of Nakhchivan. News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences. 2026. No.2. Pp. 135–148. DOI: <https://doi.org/10.32014/2026.2518-170X.620>*

©Гаджиева А.З.^{*1}, Ибрагимова Л.П.², Гумбатова Ш.Ю.³,
Джафарова Ф.М.¹, 2026.

¹Әзірбайжан Мемлекеттік экономика университеті (UNEC),
Баку, Әзірбайжан;

²Нахчыван мемлекеттік университеті, Нахчыван, Әзірбайжан;

³Баку Мемлекеттік университеті (BSU), Баку, Әзірбайжан.

*Email: Afag_Hajiyeva@unec.edu.az

НАХЧЫВАННЫҢ ТАБИҒИ ЛАНДШАФТТАРЫНДАҒЫ ТІК ЛАНДШАФТТЫҚ ТРАНСФОРМАЦИЯНЫҢ ЭКОЛОГИЯЛЫҚ ҮДЕРІСТЕРІ ЖӘНЕ КӨРІНІСІ

Гаджиева Афаг — PhD, доцент, Әзірбайжан Мемлекеттік экономика университеті (UNEC), Баку, Әзірбайжан,

E-mail: Afag_Hajiyeva@unec.edu.az, <https://orcid.org/0000-0002-9813-7835>;

Ибрагимова Лейла — PhD, Нахчыван мемлекеттік университеті (NSU), Нахчыван, Әзірбайжан,
E-mail: leylaibrahimova@ndu.edu.az, <https://orcid.org/0009-0005-3955-1074>;

Гумбатова Шафига — география ғылымдарының кандидаты, Баку Мемлекеттік университеті (BSU), Баку, Әзірбайжан,

E-mail: shafiga.humbatova@mail.ru, <https://orcid.org/0000-0002-6724-2106>;

Джафарова Фируза — PhD, доцент, Әзірбайжан Мемлекеттік экономика университеті (UNEC), Баку, Әзірбайжан,
E-mail: Firuza_Jafarova@unec.edu.az, <https://orcid.org/0000-0003-1342-1843>.

Аннотация. Зерттеудің негізгі тақырыбы. Нахчыван Автономиялық Республикасында кездесетін агроценоздар және олардың тұрақты дамуына әсер ететін факторлар. Зерттеу табиғи ландшафттардың кеңістіктік дифференциациясы мәселесін және олардың антропогендік қысымның артуымен агроценоздардың өнімділігі мен тұрақтылығын қалыптастырудағы рөлін қарастырады. Негізгі мақсат - зерттеу аймағының табиғи ландшафттарының агроценоздардың дамуына әсерін анықтау және тұрақты басқару үшін экологиялық тұрғыдан оңтайлы аймақтарды анықтау. Бұл мақалада табиғи ландшафттар ГАЖ ортасында талданады және олардың агроценоздарға әсері анықталады. Зерттеуде өсімдіктер мен топырақ жамылғысын бағалау үшін ГАЖ технологиялары мен қашықтықтан зондтау индекстері (NDVI, NDWI, NDMI, SAVI) қолданылды. Бұл тәсілдер сенімділік пен кеңістіктік дәлдікті қамтамасыз ету үшін тарихи-географиялық, математикалық-статистикалық, картографиялық, далалық, салыстырмалы, бақылау және жүйелік әдістермен толықтырылды. Тектоникалық және морфоқұрылымдық ерекшеліктердің ауылшаруашылық жерлерінің өнімділігіне әсерін бағалау үшін ландшафттық фрагментация коэффициенті есептелді. Өзен аңғарларының тектоникалық белсенді және жылжымалы морфоқұрылымдары жермен қиылысатын жерлерде фрагментация артып, ауыл шаруашылығы үшін маңызды жерлердің өнімділігін төмендетеді. Таулы аймақтардағы жоғары тік фрагментация оларды агроценоздар үшін қолайсыз етеді. Биіктік ландшафттарының морфогенетикалық түрлерін зерттеу кезінде интрузивті шығыңқы жерлердегі дала-шалғынды және шалғынды-дала түрлері кең таралған. Агроценоздардың динамикасын зерттеу үшін алдыңғы жылдардағы деректерді салыстырмалы талдау жүргізілді. Нәтижелер ландшафт құрылымы, тік дифференциация және топырақ құрамы өнімділік пен экологиялық тұрақтылыққа тікелей әсер ететінін көрсетеді. Нахчыван автономиялық Республикасында агроценоздар үшін оңтайлы аймақтар - аласа таулы және Араз өзенінің жазық аймақтары. Топырақ үлгілері минералды құрамды, гумустың мөлшерін және қышқылдықты анықтап, қарқынды антропогендік әсерлерден болатын өзгерістерді зерттеді. Зерттеу нәтижелері құрғақ таулы аймақтарда ландшафтқа негізделген ауыл шаруашылығын жоспарлау және тұрақты жерді пайдалану стратегиялары үшін ғылыми негіз береді.

Түйін сөздер: табиғи ландшафттар, агроценоздар, трансформация, жерді пайдалану, трансформация

©Гаджиева А.З.¹, Ибрагимова Л.П.², Гумбатова Ш.Ю.³,
Джафарова Ф.М.¹, 2026.

¹Азербайджанский Государственный экономический университет (UNEC),
Баку, Азербайджан;

²Нахчыванский государственный университет, Нахчыван, Азербайджан;

³Бакинский Государственный университет, Баку, Азербайджан.

*E-mail: Afag_Hajiyeva@unec.edu.az

ЭКОЛОГИЧЕСКИЕ ПРОЦЕССЫ ВЕРТИКАЛЬНОЙ ТРАНСФОРМАЦИИ ЛАНДШАФТОВ И ПРОЯВЛЕНИЕ В ПРИРОДНЫХ ЛАНДШАФТАХ НАХЧЫВАНА

Гаджиева Афэг — PhD, доцент, Азербайджанский Государственный экономический университет (UNEC), Баку, Азербайджан,

E-mail: Afag_Hajiyeva@unec.edu.az, <https://orcid.org/0000-0002-9813-7835>;

Ибрагимова Лейла — PhD, Нахчыванский государственный университет (NSU), Нахчыван, Азербайджан,

E-mail: leyilaibrahimova@ndu.edu.az, <https://orcid.org/0009-0005-3955-1074>;

Гумбатова Шафига — кандидат географических наук, Бакинский Государственный университет (BSU), Баку, Азербайджан,

E-mail: shafiqahumbatova@mail.ru, <https://orcid.org/0000-0002-6724-2106>;

Джафарова Фируза — PhD, доцент, Азербайджанский Государственный экономический университет (UNEC), Баку, Азербайджан,

E-mail: Firuza_Jafarova@unec.edu.az, <https://orcid.org/0000-0003-1342-1843>.

Аннотация. Основным предметом исследования являются агроценозы, функционирующие на территории Нахчыванская Автономная Республика, а также факторы, влияющие на их устойчивое развитие. В работе рассматривается проблема пространственной дифференциации природных ландшафтов и их роли в формировании продуктивности и устойчивости агроценозов в условиях усиливающегося антропогенного воздействия. Целью исследования является определение влияния природных ландшафтов исследуемой территории на развитие агроценозов и выявление экологически оптимальных зон для устойчивого управления. Методологическая основа исследования включает использование геоинформационных систем (ГИС) для анализа природных ландшафтов и оценки их влияния на агроценозы. Для анализа растительного и почвенного покрова применялись индексы дистанционного зондирования, включая NDVI, NDWI, NDMI и SAVI. Для повышения достоверности и пространственной точности результатов использовался комплекс методов: историко-географический, математико-статистический, картографический, полевой, сравнительный, наблюдательный и системный подходы. Для оценки влияния тектонических и морфоструктурных особенностей на продуктивность сельскохозяйственных земель был рассчитан коэффициент фрагментации ландшафта. Установлено, что в районах пересечения тектонически активных морфоструктур речных долин происходит усиление фрагментации, что

приводит к снижению продуктивности сельскохозяйственных угодий. Высокая вертикальная фрагментация в горных районах также ограничивает развитие устойчивых агроценозов. Анализ морфогенетических типов высотных ландшафтов показал преобладание степно-луговых и лугово-степных комплексов, формирующихся на интрузивных породах. Для изучения динамики агроценозов проведён сравнительный анализ многолетних данных. Результаты исследования свидетельствуют о том, что структура ландшафта, вертикальная дифференциация и почвенный состав оказывают прямое влияние на продуктивность и экологическую устойчивость агроценозов. Оптимальными зонами для их развития в пределах Нахчыванской Автономной Республики являются предгорные территории и равнинные участки долины реки Араз. В почвенных образцах определялись минеральный состав, содержание гумуса и уровень кислотности, а также анализировались изменения, вызванные интенсивным антропогенным воздействием. Полученные результаты формируют научную основу для разработки ландшафтно-ориентированных подходов к сельскохозяйственному планированию и стратегий устойчивого землепользования в засушливых горных регионах.

Ключевые слова: природные ландшафты, агроценозы, трансформация, землепользование, трансформация

Introduction. The total land fund of the Autonomous Republic amounts to 550.2 thousand hectares, of which 29% is suitable for agricultural use. The main reason why this figure is significantly lower compared to other regions of our republic is due to the unfavorable physical-geographical conditions of the area under study. Thus, 36% of the arable land is used for crop cultivation, while a portion is utilized as hayfields and pastures. Perennial and annual agrocnoses dominate across 60,000 hectares of land used for agriculture. However, 70,000 hectares of soil in the study area are not suitable for the development of agrocnoses. These lands include badlands, bare rocky areas, watersheds, regions affected by severe salinization, and areas covered with stony-gravelly ridges (Mammadov and Khalilov, 2004).

Our research and statistical data once again confirm that the arable lands of the Autonomous Republic must be used efficiently, while minimizing the negative processes that may arise—such as salinization, erosion, and degradation. To achieve this, particular attention should be paid to the recommendations outlined in the report on the “Ecological Assessment of the Araz River Basin Areas,” which was initiated by Decision No. 80 of the Cabinet of Ministers of the Nakhchivan Autonomous Republic, dated August 29, 2017. This report emphasizes the need to restore and enhance the fertility of arable lands, establish agricultural sectors adapted to arid conditions, and expand cultivation areas for agrocnoses such as forage crops and legumes.

This program represents a significant step toward fundamentally transforming, restoring, and preserving the economic structure of the Araz River region. In the

specified area, agrocenoses such as barley, sesame, soybean, alfalfa, and others—which are highly productive, adapted to local conditions, and cultivated through irrigation—are among the key factors contributing to the enhancement of the plains' natural potential, the preservation of ecological balance, and the sustainable, long-term development of the region.

Additionally, the program also places strong emphasis on improving various categories of land that are currently underutilized in agriculture—such as saline, eroded, slightly swampy, stony, bush-covered lands—through the application of reclamation, corrective-drainage, and other methods (Hajiyeva and Jafarova, 2024). The implementation of these methods will enable the integration of these lands into production, which in turn will support the sustainable development of agrocenoses and ultimately lead to the expansion of arable land area.

Materials and methods. For researching landscape desertification it is necessary to use modern technologies and methods (Imbrenda et al., 2018). We have also used field methods. To determine desertification it is useful to use Landsat images (Lavado et al., 2009). For investigation of vegetation cover of the area we calculated NDV index. For NDV index following formula is used (Cowie et al., 2018).

$$NDVI = (NIR - RED) / (NIR + RED)$$

At the result of comparison o many years we determined desertification in plain. For comparison of NDVI we processed many images from different years.

Results. One of the significant steps taken in the Nakhchivan Autonomous Republic through land reforms is the restoration of degraded soils and the prevention of further degradation processes. To achieve this, special attention must be paid to reducing the negative impacts that trigger soil degradation processes—such as surface runoff, wind and water erosion, intensified slope processes, salinization, deforestation, destruction of shrublands, and the irregular and unregulated use of summer and winter pastures (Ismayilov and Amanova, 2015). Naturally, a thorough study of the problems listed above will create conditions for the restoration of the physical and chemical composition of soils in the research area, ensuring the supply of essential nutrients. This, in turn, will contribute to the expansion of arable lands and help prevent both direct and indirect food shortages.

These degradation processes are primarily observed in gray, gray-brown, and meadow-gray soils of gently sloped plains with weak and moderate fragmentation, as well as in primitive gray, light kastanozem, and gray-brown soils found in moderately and heavily fragmented terrains.

To mitigate soil degradation, the first step is to accurately study the type of soil in question (Arestova, 2009). This process involves considering the components of physical-geographical factors—such as relief, climate, vegetation cover, and surface and groundwater. Therefore, the morphometric indicators of the relief

(slope, aspect, vertical and horizontal dissection) in the areas where the soil types are distributed must be studied, along with the geological base of the soil.

Climatic indicators such as temperature, precipitation, and evaporation also play a crucial role in the vertical and horizontal zonal distribution and development of soils, making the analysis of these factors essential.

One of the main parameters of degradation is the variation in the mineral composition of horizons within the vertical structure of the soil. The presence of different characteristics in soil layers—such as clay, loamy clay, heavy and light loam, sandy, and sandy-loam textures—leads to differences in soil compaction and water permeability. This, in turn, results in processes such as salinization, alkalization, and waterlogging in low-lying areas.

In the low-lying parts of the Araz River plains, which exhibit these characteristics, it is necessary to implement deep plowing, apply fertilizers using modern technologies, and cultivate agrocenoses with branched root systems. In particular, the cultivation of legumes and perennial forage crops in this zone is considered highly appropriate. These agrocenoses have the ability to absorb atmospheric nitrogen and enhance soil productivity.

One of the negative factors contributing to the intensification of degradation processes in the Araz River plains of the Nakhchivan Autonomous Republic is the secondary salinization and alkalization of soils. This process increases ecological risks and hinders the development of agrocenoses. The results of conducted studies indicate that soil salinization in the region occurs in two genetic types: automorphic and hydromorphic (Sadigov and Mustafayev, 2024).

Automorphic salinization is primarily observed in the Araz River basin areas of Nakhchivan, including Julfa, Boyukduz, Yaycı-Diza plains, and around alluvial fans. This type of salinization itself is divided into two subtypes: typical saline soils and takir-like saline soils. The typical subtype appears in microdepressions in patch form, while the takir subtype forms a clayey crust and salt crusts, and is mainly observed in the eastern and southern parts of the Boyukduz area within the research zone. The second genetic type, hydromorphic salinization, is found along the banks of the Araz River, particularly in areas where agrocenoses are intensively developed. These saline soils form under the influence of groundwater. They are widespread in gray, primitive, and saline soils of gently sloped plains with low dissection, as well as in primitive gray soils of more intensively dissected sloped plains.

The majority of saline and alkaline soils are found in the Araz River plains, as well as in the foothill and intermountain depressions, occurring within soil types such as gray-brown, gray, light gray-brown, gray meadow, light gray-brown, and others. These soil types are particularly prone to salinization. Analysis of statistical data shows that the highest concentrations of saline soils are located in Boyukduz, the Sharur plain, Culfa, and the Yaycı plains. An analysis of materials reflecting salinization levels across individual administrative districts indicates that in

Babek District, 5.9% of cultivated lands and 23.4% of pasturelands are affected by salinization to varying degrees. The situation is even more alarming in the Sharur District, where 32.9% of cultivated lands and 35.2% of pasture and grazing lands are affected by varying degrees of salinization (Mammadov and Khalilov, 2004).

Overall, 5,694 hectares of land in the Babek District and 13,272 hectares in the Sharur District are affected by varying degrees of salinization (Bababeyli and Imat, 2010). This salinization is also characteristic of the Sadarak, Kangarli, Julfa, and Ordubad districts of the Autonomous Republic. The primary factor driving this process is the high mineralization level of groundwater. In areas such as between the villages of Ibadulla and Didadin in the Sharur plain, as well as in the Yayı and Julfa plains, the shallow depth of groundwater has led to a wider spread of salinization.

In these regions, where the population is densely and compactly settled and where intensive irrigation is practiced, the salinization of soil increases over time, leading to a reduction in the productivity of agrocenoses. If this process continues, it results in secondary salinization and the expansion of degraded land areas (Shukurov et al., 2025). From this perspective, a systematic and regular monitoring of salinized soils must be carried out. Through the interpretation of aerial and satellite imagery, these soils should be mapped, and their general physical and chemical properties, humus content, and granulometric composition should be analyzed under laboratory conditions. Furthermore, incorporating the scientific findings from advanced research conducted in leading countries in this field would be highly commendable. Taking all this into account, our research has paid particular attention to identifying the factors contributing to the risk of salinization. Salinization primarily manifests in the landscapes of plains, depressions, and low mountainous areas. In these regions, alkalization processes become more active in areas where groundwater lies close to the surface. In such landscapes, irrigation is crucial for the development of agrocenoses, as their cultivation is only feasible through irrigation.

Another factor contributing to soil degradation in the territory of the Nakhchivan Autonomous Republic is the process of waterlogging. Waterlogging occurs in relatively limited areas, particularly in carbonate-rich marsh-meadow soils, and is found in small patches. Due to prolonged irrigation, groundwater levels have risen in the Ordubad, Sharur, and Boyukduz plains, leading to the activation of this process. In the Nakhchivan plain, marsh and marsh-meadow soils with varying degrees of carbonatization and humification are distributed. These soils are found in small areas on leveled river terraces, in low-lying depressions where rivers can directly infiltrate, and in lower relief zones. They form as a result of both seepage from rivers and rising groundwater levels. For instance, 15 km from Nakhchivan city, water seepage from Lake Sirab has led to the emergence of waterlogging in the surrounding area (Bababayli et al., 2026). It should also be noted that the mineralization of groundwater causes the progressive alkalization of meadow-

marsh soils. This phenomenon mainly occurs in the alluvial stony-meadow parts of riverbeds and floodplains.

In addition to natural factors, anthropogenic influences play an undeniable role in the activation of soil degradation (Abramova, 2012). The impact of anthropogenic factors on degradation occurs in two ways. The first way is through direct human intervention in natural landscapes, which leads to an imbalance in natural components and accelerates the already existing natural degradation. This process results in the formation of new complications in the soil. The second way is through unsuccessful projects carried out due to improper agricultural practices. These projects are planned and executed without considering any natural factors or their potential. In such cases, the irregular appropriation of natural ecosystems, such as the establishment of new agricultural lands and vineyard plantations, leads to landscape degradation, intensified erosion, hillside washing, increased salinization of plains and depressions, and a decrease in vegetation cover in pastures and meadows, among other negative phenomena (Amanova and Hajiyeva, 2023). The result of the processes mentioned above is the emergence of alien synoses in the area, which further exacerbate the ecological situation. The increase in these anthropogenic influences leads to the expansion of degraded land areas. To prevent this, it is crucial to adhere to proper agro-technical practices, plant agrocenoses that are suited to the natural conditions of the area, and regulate the irrigation system.

The haphazard and irregular anthropogenic impacts resulting from projects carried out without adhering to agro-technical practices accelerate degradation. This, in turn, leads to the development of erosion and negatively affects the productivity of agrocenoses (Zvereva, 2006). Additionally, in the low and mid-mountainous regions of the Autonomous Republic, which have weak forest and plant cover, the destruction of forests, burning and devastation of shrubs, and the expansion of erosion are common consequences. In the studied area, which differs due to its arid ecological environment, anthropogenic processes contribute to the expansion of desertification (Guliyeva, 2011).

To study how the development of agrocenoses in the Nakhchivan Autonomous Republic contributes to the degradation of the soil cover in the region, we focused on analyzing the ancient irrigated kastanozem soils and alluvial meadow soils that have been most affected by human intervention. We collected samples from these soils and performed the corresponding analyses. Kastanozem soils are found in the foothill areas and in the lower parts of the relief. These soils become narrower as they approach the plain. The favorable relief in this area has created favorable conditions for the development of irrigated agriculture, while the natural conditions have led to the formation of dry-steppe biosenoses.

In the flat areas, there is a favorable environment for the thickening of the humus layer of the soils. However, compared to other regions of our republic, this indicator is low. Over a long period, the dominance of irrigated agriculture and the cultivation of corresponding agrocenoses has led to a complete change in the natural structure

of the mentioned soils. In the upper layers of kastanozem soils, brown spots can be found, which have been formed as a result of long-term irrigation.

Historically, open kastanozem soils have played a significant role in the development of agroecosystems due to irrigation. H.A. Aliyev and E. Zeynalov (1988) noted that the upper horizon of these soils is characterized by high carbon content and heavy clay composition. They also determined that the soil contains 7.1% nitrogen, 1.28% humus, 21.37% CaCO₃, 4.61% hydrophilic moisture, and a pH of 7.4 (Table 1).

Table 1. Main Composition (%) of Historically Irrigated Kastanozem Soils.

	Nitrogen	pH	Humus	CaCO ₃	Hygroscopic moisture
0-15	7,1	7,4	1,28	21,37	4,61
15-35	10,7	7,6	1,96	22,01	4,57
35-50	7,2	7,7	1,06	19,03	4,58

Source: Based on the calculations of H.A. Aliyev and E. Zeynalov.

On the same soil, at an altitude of 1187 m above sea level on the Tivi road, we took a soil sample and conducted our research (Table 2). Compared to 1988, the amount of humus has increased, and the soil has become weakly alkaline. In contrast, calcium carbonate and nitrogen have decreased. Of course, the main reason for these changes is anthropogenic influences and the rapid development of agroecosystems.

Table 2. Main Composition (%) of Historically Irrigated Kastanozem Soils.

Depth in cm	Nitrogen		pH		Humus		CaCO ₃		Phosphorus		Potassium	
	%	Gr- oup	%	Group	%	Gr- oup	%	Group	%	Group	%	Group
Tivi road at an altitude of 1187 m												
0-10	0,30	High	7,4	Neutral	4,8	High	15,4	Highly calcareous	11,1	Low	347	Me- dium
10-25	0,26	High	7,6	Weakly alkaline	2,7	Me- dium	15,7	Highly calcareous	15,3	Me- dium	435	High
Tivi road at an altitude of 1187 m on the right bank of the bridge												
0-15	0,36	Very high	7,5	Weakly alkaline	2,2	Me- dium	15,5	Highly calcareous	15,6	Me- dium	427	High
15-20	0,27	High	7,4	Neutral	1,9	Low	16,4	Highly calcareous	12,8	Low	365	Me- dium
20-40	0,22	Me- dium	7,6	Weakly alkaline	3,4	Me- dium	17,2	Highly calcareous	11,9	Low	356	Me- dium

Note: Based on the soil samples taken during field research.

Other soil samples were taken from the left bank of the river to the north of Bash Diza, at an elevation of 900 m above sea level. We compared the samples of alluvial-meadow soils with those from 1988 (Tables 3, 4).

Table 3. General Composition of Alluvial-Meadow Soils.

Depth in cm	Nitrogen		pH		Humus		CaCO ₃		Phosphorus		Potassium	
	%	Group	%	Group	%	Group	%	Group	%	Group	%	Group
0-15	0,26	High	6,9	Neutral	5,1	High	13,6	Highly calcareous	16,3	Medium	428	High
15-22	0,29	High	7,1	Neutral	2,6	Medium	12,8	Highly calcareous	15,8	Orta	446	Medium

Source: Based on the calculations of H.Aliyev and A.Zeynalov.

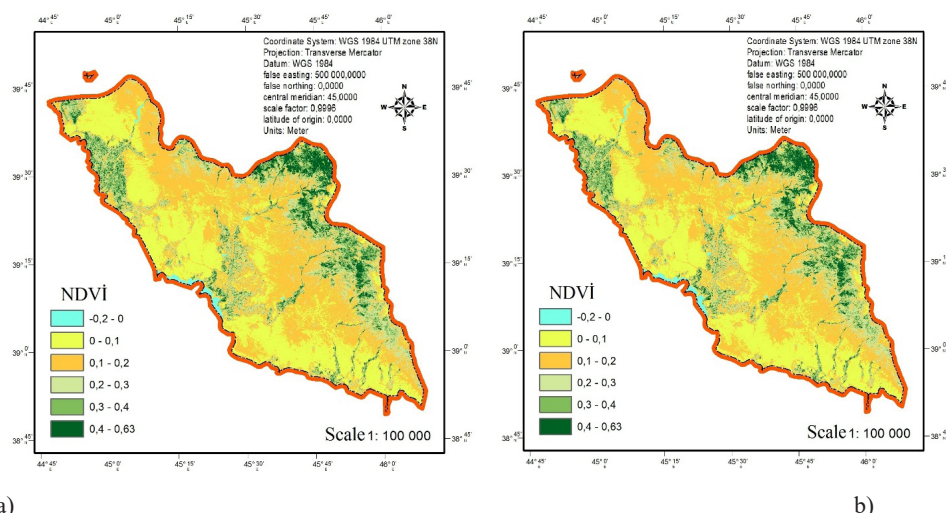
Table 4. Alluvial-meadow soils spread on the left bank of the river north of Bash Diza.

Depth in cm	Nitrogen		pH		Humus		CaCO ₃		Phosphorus		Potassium	
	%	Group	%	Group	%	Group	%	Group	%	Group	%	Group
From Bash Dize to the north, the left bank of the river.												
0-15	0,26	High	7,1	Neutral	4,8	High	12,8	Highly calcareous	15,8	Medium	446	High
15-22	0,29	High	6,9	Neutral	2,7	Medium	13,6	Highly calcareous	16,3	Medium	428	High

Note: Based on the soil samples taken during field research.

Compared to the year 1988, an increase has been observed in all indicators within the overall composition of the land. As mentioned above, the reason for all these changes is the development of agrocenoses without adhering to agrotechnical regulations. If this continues, problems will arise in the sustainable development of agrocenoses.

The intensive anthropogenic transformation of our research area has negatively affected not only the soil cover but also the vegetation, leading to the emergence of ecological problems in biotopes (Allbed et al., 2013; Bellard et al., 2012; Deng et al., 2018). To analyze this factor, the dynamics of vegetation in the research area were observed, and satellite images from Landsat 5 (June 1987) and Landsat 8 (June 2022) were processed (Figure 1). During image processing, Bands 3 and 4 of the Landsat 5 satellite and Bands 4 and 5 of the Landsat 8 satellites were used. The processing results of the satellite images from the two periods were compared (Berra et al., 2019). It was determined that, compared to 1987, the minimum value of the index has increased, while the maximum value has decreased. Specifically, the minimum value, which was -0.5 in 1987, increased to -0.2 in 2022, while the maximum value decreased from 0.75 to 0.63. This dynamic indicates that the water level in water bodies, as well as the density of forests and shrubs in the area, has decreased".



a) b)
Figure 1. NDVI (Normalized Difference Vegetation Index) map based on satellite images from the month of June: (a) 1987, (b) 2022.

Note: Prepared based on Landsat 5, 8, and 9 satellite data.

If we compare consecutively according to the classification, the area with an index of less than 0 has decreased by 73% compared to 1987, now covering 266 km², while areas with an index of 0-0.1 have decreased by 25%, covering 1562.7 km². As a result, we determine that areas which were previously not utilized and were somewhat unsuitable for utilization have also been utilized to some extent over the past 35 years (Table 5).

Table 5. Dynamics of the NDV index in the years 1987-2022.

№	NDV index	Area (km ²)	
		Year 1987	Year 2022
1	0 or lower	989,4	266
2	0-0,1	2086,5	1562,7
3	0,1-0,2	910,3	2088,3
4	0,2-0,3	669,6	772,3
5	0,3-0,4	382,6	503,7
6	0,4-0,7	464,4	309,8
Total		5502,8	5502,8

Note: It has been compiled based on Landsat 5, 8, and 9 satellite data.

Conclusion. As a result of the research, it should be noted that in the Araz Plains, areas with a negative index covered a large area in 1987, but the results of processing satellite images from 2022 show that these areas have now become permanently utilized lands. Areas where the index is between 0.1 and 0.2 generally correspond to the land areas of settlements, roads, and other construction and catering facilities, and the area of these lands has increased by 129.5%. These changes in

vegetation cover indicate that great attention needs to be paid to environmental protection in the Autonomous Republic, and special attention must be given. If such utilization continues, it will negatively affect the quality parameters of the soil and the development of agrocenoses, which may lead to future food shortages.

The natural geosystems of the Nakhchivan Autonomous Republic have undergone complete changes in the structure of all geocomplexes due to the development of agrocenoses. The area of agro-irrigation geosystems has significantly increased, and accordingly, the area of irregularly used agrocomplexes has significantly decreased. In 1981, the area of agro-irrigation complexes was recorded as 23.28 thousand ha, and dry farming complexes were 4.92 thousand ha, while today the areas of these complexes are 31.97 thousand ha and 5.56 thousand ha, respectively. For the first time in the Nakhchivan AR, the zoning of agrocenoses was carried out, and it was found that 33% of the areas had more stable landscapes, 20% had moderately stable landscapes, 26% had weakly stable landscapes, 13% had unstable landscapes, and 8% were areas where the natural conditions were unfavorable.

References

- Abramova L.A. (2012) Antropogennaya transformatsiya neorganizovannykh mezhdurechiy Tambovskoy oblasti [Anthropogenic transformation of untrained interfluvies of the Tambov region]. Vestnik TSU. Section Geography, 1(7). – P. 402-404 (in Russ.).
- Aliyev G.A., Zeynalov A.K. (1988) Nakhchivan MR-in torpaglari [Soils of the Nakhichevan ASSR]. Baku: Azerneshr. – 238 p. (in Azerbaijani).
- Allbed A., Kumar L. (2013) Soil Salinity Mapping and Monitoring in Arid and Semi-Arid Regions Using Remote Sensing Technology: A Review. Advances in Remote Sensing, (2). – P. 373-385. (in Eng.).
- Amanova S., Hajiyeva G. (2023) Investigation of Natural Condition in Urban Landscapes of Plain Areas Based on GIS. C. R. Acad. Bulg. Sci., 76(11). – P. 1679-1986. (in Eng.).
- Arestova N.V. (2009) Geocological assessment of anthropogenic impact on the territory of the North-West Caspian region. Bulletin of Volgograd State University. Series: Ecology, Biology, (3). – P. 220-224. (in Eng.).
- Bababayli N., Zeynalov H., Maharramova K., Isgenderova U. (2026) Assessment of the geographic and tourism potential of the mountainous areas of Nakhchivan in the context of landscape ecology. Journal of Geology, Geography and Geocology, 34(4). – P. 721-732. DOI:10.15421/112560. (in Eng.).
- Bababeyli N.S., Imat F. (2010) Recreational potential of desert, semi-desert and dry steppe landscape complexes in the Middle Araz basin. Nakhchivan: News of the Nakhchivan Branch of ANAS, Natural and Technical Sciences Series, (2). – P. 277-281. (in Eng.).
- Bellard C., Bertelsmeier C., Leadley P. (2012) Impacts of climate change on the future of biodiversity. New York: Ecology Letters., 15(4). – P. 365-377. (in Eng.).
- Berra E.A. (2019) Assessing spring phenology of a temperate woodland: A multiscale comparison of ground, unmanned aerial vehicle and Landsat satellite observations. Remote Sensing Environment, (223). – P. 229-242. (in Eng.).
- Cowie A.L., Orr B.J., Sanchez V.M., Chasek P., Crossman N.D., Erlewein A., Welton S. (2018) Land in balance: The scientific conceptual framework for Land Degradation Neutrality. Environ. Sci. Policy., 79. – P. 25–35. (in Eng.).
- Deng L. (2018) UAV-based multispectral remote sensing for precision agriculture: A comparison between different cameras. ISPRS Journal Photogrammetry and Remote Sensing, (146). – P. 124-136. (in Eng.).
- Guliyeva S.Y. (2011) Schralashma xususiyetleri ve Nakhchivan Muxtar Respublikasinin arid

geokomplekslerinde onlara qarshi mubarize tedbirleri: cogrefiya uzre felsefe doktoru dissertasiyasinin avtoreferati [Desertification characteristics of arid geocomplexes of the Nakhchivan Autonomous Republic and measures to combat them: abstract of the dissertation of the doctor of philosophy in geography], Baku. – P. 20. (in Azerbaijani).

Hajiyeva A.Z., Jafarova F.M. (2024) Analysis of the regularity of distribution of natural landscapes in the Greater Caucasus depending on physical-geographical characteristics using GIS technology. *Comptes rendus de l'Académie Bulgare des Sciences*. 77(2). – P. 221-229. DOI:10.7546/CRABS.2024.02.07. (in Eng.).

Imbrenda V., Coluzzi R., Lanfredi M., Loperte A., Satriani A., Simoniello T. (2018) Analysis of landscape evolution in a vulnerable coastal area under natural and human pressure. *Geomat. Nat. Haz. Risk*, 9(1). – P. 1249-1279. (in Eng.).

Ismayilov M.J., Amanova Sh.S. (2015) The impact of land use on anthropogenic transformation of landscapes in the Ajinohur foothills and adjacent areas. Baku: Baku University News, Natural Sciences Series, (4). – P. 158-165. (in Eng.).

Lavado C.J., Schnabel S., Gomez Gutierrez A., Pulido Fernandez M. (2009) Mapping sensitivity to land degradation in Extremadura. SW Spain. *Land Degrad. Dev.*, 20(2). – P. 129-144. (in Eng.).

Mammadov G.Sh., Khalilov M.Y. (2004) *Ecologiya ve atraf muhit* [Ecology and environment], Baku: Science. – 608 p. (in Azerbaijani).

Sadigov R.A., Mustafayev M.G. (2024) Analysis of mountain-forest cinnamon soil types in the basin of the New Shamkirchay Reservoir. *SABRAO J. Breed. Genet.* 56(1). – P. 266-279. DOI:10.54910/sabrao2024.56.1.24. (in Eng.).

Shukurov S.K., Ismayilova A.A., Sadigov R.A., Karimova M.K., Hasanova T.A., Asgarova G.F. (2025) Determination of soil salinization by hyperspectral remote sensing in the Shirvan plain. *Int. J. of Advances in Appl. Sci.*, 14(3). – P. 662-670. DOI:10.11591/ijaas.v14.i3.pp662-670. (in Eng.).

Zvereva G.K. (2006) *Agrotsenozy (ponyatiya, struktura, osobennosti funktsionirovaniya): uchebnoe posobie* [Agrocenoses (concepts, structure, features of functioning): a textbook], Novosibirsk: Publ. NSPU. – 118 p. (in Russ.).

Publication Ethics and Publication Malpractice in the journals of the Central Asian Academic Research Center LLP

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 journals of the Central Asian Academic Research Center LLP 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 Central Asian Academic Research Center LLP 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 Central Asian Academic Research Center LLP.

The Editorial Board of the Central Asian Academic Research Center LLP will monitor and safeguard publishing ethics.

Requirements for articles design for publication in the journal are available on the websites:

**[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)**

Managing Editor: *T. Apendiev*
Editors: *D.S. Alenov, A.Shormakova*
Computer layout: *G.D. Zhadyranova*

Signed for print: April 10, 2026
Format: 70×90 1/16. 26.5 printed sheets. Order No. 2.

*«Central Asian Academic Research Center» LLP
Almaty, Shevchenko Street, 28*