ICOMP

XIV International Conference

ENVIRONMENT AND SUSTAINABLE DEVELOPMENT OF THE MONGOLIAN PLATEAU AND SURROUNDING TERRITORIES

PROCEEDINGS

2026

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ORGANIZER

Mongolian Geographical Society

Institute of Geography and Geoecology, MAS

National University of Mongolia

CO-ORGANIZER

National Science and Technology Fund of Mongolia

Mongolian National University of Education

Baikal Institute of Nature Management, SB RAS (Russia)

Institute of Geographical Sciences and Natural Resources Research (CAS, China)

Inner Mongolia Normal University (China)

Future Earth Mongolian Committee

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2026 ICOMP

ICOMP 2026 goal

The goal of ICOMP 2026 is to provide an international and interdisciplinary platform for researchers, policymakers, and practitioners to exchange knowledge, share recent scientific advancements, and address emerging challenges related to environmental sustainability and regional development of the Mongolian Plateau and surrounding territories which is one of the most unique and scientifically significant regions for global geographical research.

As a vast and dynamic socio-ecological system, the Mongolian Plateau represents a critical natural laboratory for understanding interactions among climate change, land degradation, desertification, nomadic livelihoods, and regional development. The conference aims to highlight the global scientific importance of this region and promote its role as a key research frontier in contemporary geography.

In addition, ICOMP 2026 seeks to contribute to the advancement of geographical sciences by fostering innovative approaches, integrating traditional and modern knowledge systems, and promoting the application of emerging technologies such as Big Data, remote sensing, and artificial intelligence in geographical research and practice.

The conference aims to:

- Facilitate interdisciplinary dialogue across natural and social sciences to address complex environmental and socio-economic challenges;
- Promote the Mongolian Plateau as a globally significant research region and a priority area for integrated geographical studies;
- Advance the development of geographical sciences through methodological innovation, data-driven approaches, and transdisciplinary research;
- Promote the integration of scientific research, technological innovation, and policy development for sustainable land and resource management;
- Identify practical and innovative solutions to climate change, desertification, and regional development challenges;
- Strengthen international collaboration and joint research initiatives among countries of the Mongolian Plateau region;
- Contribute to evidence-based policymaking by providing scientific insights to support sustainable development strategies at national and regional levels;

The XIV International Conference on Environment and Sustainable Development of the Mongolian Plateau and Surrounding Territories
2026 ICOMP

Scientific Committee

- Battogtokh Dorjgotov, PhD – President, Mongolian Geographical Society, Conference Chair of the ICOMP 2026.
- Dashtseren Avirmed, PhD – Director, Institute of Geography and Geoecology, MAS, & Conference Vice Chair of the ICOMP 2026.
- Amarsaikhan Damdinsuren, Academician, Institute of Geography and Geoecology, MAS.
- Dagvadorj Damdin, Academician – President, Academy of the Climate Change and Development, Mongolia.
- Garmaev Endon Zhamyanovich, Academician – Director, BINM SB RAS.
- Battsengel Vandansambuu, PhD – Director, Institute for Urban and Regional Studies, NUM.
- Sonomdagva Chononkhuu, PhD – Director, School of Engineering and Technology, NUM.
- Byambakhuu Gantumur, PhD – Head, Department of Geography, NUM & Conference Vice Chair of the ICOMP 2026.
- Bao Yuhai, PhD – Director, Key Laboratory of Remote Sensing and GIS, IMNU.
- Dong Suocheng, PhD – Leading Professor, IGSNRR CAS.
- Altanbagana Myagmarsuren, PhD – Head, Socio-economic Geography Department, IGG, MAS.
- Batomunkuev Valentin Sergeyevich, PhD – Vice Director, BINM SB RAS.
- Gantulga Gombodorj, PhD, Department of Geography, NUM.
- Tsogbadral Khurelbaatar, PhD – Head, Department of Geography, MNUE.
- Sainbuyan Bayarsaikhan, PhD, Department of Geography, NUM.
- Narangerel Serdyanjiv, PhD – Director, Mongolian Geographical Society, Conference Secretary General of the ICOMP 2026.

WELCOME MESSAGE

Dr. BATTOGTOKH DORJGOTOV

President, Mongolian Geographical Society

Distinguished guests, esteemed Scientists, Researchers, and Delegates,

On behalf of the Organizing Committee, I would like to extend my sincere gratitude to all distinguished participants from universities, research institutions, government agencies, and international organizations who have joined us for the XIV International Conference on Environment and Sustainable Development of the Mongolian Plateau and Surrounding Territories (ICOMP 2026).

Since its establishment in 2005, ICOMP has served as an important platform for scientific exchange and regional cooperation, bringing together researchers from Mongolia, Russia, China, and the broader international scientific community. Over the years, the conference has been successfully organized in Ulaanbaatar, Beijing, Ulaan-Ude, and Hohhot. Today, we are honored to convene the 14th conference here in Ulaanbaatar.

ICOMP 2026 is particularly significant as it is dedicated to the 70th anniversary of the establishment of the Department of Geography at the National University of Mongolia, which laid the foundation for higher education in geography in Mongolia. During the past seven decades, the department has educated thousands of professionals and scholars in geography, geology, environmental sciences, land management, urban planning, remote sensing, and related disciplines, making an invaluable contribution to the development of science and education in Mongolia.

Today, geography is no longer limited to understanding and describing places and landscapes. It plays a critical role in addressing some of the most pressing global challenges of our time, including climate change, desertification, biodiversity loss, water scarcity, regional development, and human well-being.

In this context, geographical societies serve as important bridges connecting science, education, public awareness, and policymaking while fostering interdisciplinary collaboration. Since its establishment, the Mongolian Geographical Society has actively promoted geographical sciences, disseminated geographical knowledge to society, and strengthened national and international cooperation. We remain committed to expanding these activities and enhancing our contribution to both science and society.

As part of this vision, we are launching new initiatives aimed at promoting the Mongolian Plateau as a globally significant region for scientific research and international cooperation.

The Mongolian Plateau, spanning Mongolia, the Inner Mongolia Autonomous Region of China, and adjacent regions of Russia, covers approximately 3–4 million square kilometers and represents one of the largest dryland ecosystems on Earth. It is a unique region encompassing vast steppe, forest-steppe, desert, mountain, wetland, and permafrost ecosystems, playing a vital role in ecological security, climate regulation, and carbon cycling across Northeast Asia.

However, the region is increasingly facing serious challenges, including climate change, aridification, rangeland degradation, desertification, water scarcity, and biodiversity decline. These challenges pose significant risks to the sustainable development and resilience of the Mongolian Plateau.

To address these challenges, the Mongolian Geographical Society is proud to introduce the Mongolian Plateau Resilience Initiative (MPRI). This initiative aims to establish a long-term collaborative research platform that brings together institutions and researchers from Mongolia, China, Russia, and international partners. By integrating science, technology, innovation, open data, artificial intelligence, remote sensing, and local traditional knowledge, the initiative seeks to strengthen regional sustainability and enhance ecosystem resilience across the Plateau.

We invite scientists, research institutions, and partner organizations to join us in developing this initiative into a major international platform for cooperation and long-term ecological and socio-economic research. Together, we can elevate the Mongolian Plateau as a leading global region for integrated sustainability science.

I am confident that ICOMP 2026 will serve not only as a forum for presenting scientific findings, but also as a catalyst for new ideas, new partnerships, and new opportunities for collaboration. May our collective efforts contribute to the sustainable development of the Mongolian Plateau and further strengthen regional scientific cooperation and friendship.

CONGRATULATORY REMARKS

Dr. DASHTSEREN AVIRMED

Director, Institute of Geography and Geoecology, Mongolian Academy of Sciences
Unesco Chair, on Environmental Sciences in Eastern Central Asia

Distinguished guests, respected scientist, colleagues, ladies and gentlemen,

On behalf of the Institute of Geography and Geoecology of the Mongolian Academy of Sciences, It is my great honor to warmly welcome all participants to the XIV International Conference on Environment and Sustainable Development of the Mongolian Plateau and Surrounding Territories (ICOMP 2026).

This conference has, since its establishment in 2005, served as an important scientific platform bringing together researchers from Mongolia, China, Russia, and many other countries to exchange knowledge and strengthen cooperation in environmental research and sustainable development. Today, ICOMP continues to grow as a unique forum for interdisciplinary dialogue and international collaboration.

This year's conference is especially meaningful as it commemorates two important milestones: the 70th anniversary of the Department of Geography at the National University of Mongolia and the 36th anniversary of the Mongolian Geographical Society. These anniversaries reflect the long-standing contributions of geographical sciences to the advancement of knowledge, education, and sustainable development in Mongolia and beyond.

The Mongolian Plateau is one of the world's most distinctive socio-ecological systems and serves as a natural laboratory for understanding the complex interactions among climate change, desertification, land degradation, nomadic livelihoods, and regional development. The scientific importance of this region extends far beyond national boundaries, making it a critical area for global geographical research.

At a time when humanity faces unprecedented environmental challenges, science must play an increasingly important role in guiding policy and informing sustainable solutions. ICOMP 2026 provides an opportunity to integrate traditional knowledge with emerging technologies such as remote sensing, Big Data, and artificial intelligence to address complex environmental and societal challenges.

I am confident that the discussions, presentations, and collaborations fostered during this conference will generate new ideas, strengthen partnerships, and contribute valuable scientific insights for sustainable land and resource management across the Mongolian Plateau and surrounding regions.

I would like to express my sincere gratitude to all organizers, partner institutions, sponsors, and participants for their invaluable contributions to making ICOMP 2026 possible. Your commitment to scientific excellence and international cooperation is essential for building a sustainable future.

I wish you all a productive conference, inspiring discussions, and an enjoyable stay in Ulaanbaatar.

CONGRATULATORY REMARKS

Dr. BYAMBAKHUU GANTUMUR

Associate Professor, Head of Department of Geography, Division of Natural Science
School of Arts & Sciences, National University of Mongolia

On behalf of the Department of Geography at the National University of Mongolia (NUM), it is a pleasure to welcome you to the XIV International Conference on Environment and Sustainable Development of the Mongolian Plateau and Surrounding Territories (ICOMP 2026) in Ulaanbaatar, Mongolia. ICOMP is a major conference for the Mongolian Plateau, and we are proud to continue to be its largest contributor.

This conference is particularly unique as it is being organized within the framework of the 70th anniversary of the Department of Geography at the National University of Mongolia. This milestone allows us to reflect on the significant achievements and transformations that have occurred throughout the department's 70-year history. The development of Mongolian geography is inextricably linked to our department, a testament to the dedicated efforts of all generations of faculty members, professors, lecturers, graduates, and partner organizations. Therefore, on behalf of the teachers, researchers, and graduates of our department, I extend my warmest greetings on this 70th anniversary.

The purpose of this conference is to convene geographical science experts from academia, universities, and other interested organizations to discuss the latest developments and challenges in the field. Our aim is to foster interaction and networking among universities and academic institutions. This includes vital discussions on advancements in geographical research and pressing regional issues. The organizing committee has diligently planned a memorable event, ensuring that the presentations and content achieve a high scientific impact. Experts will deliver original scientific papers and presentations on cutting-edge topics, covering geographical research trends and emerging challenges, environmental sustainability and natural resource management, climate change and adaptation strategies, socio-economic geography and regional development, and Big Data and Artificial Intelligence in Geography.

In closing, I wish you an enjoyable, memorable, and productive time at this year's ICOMP, and I look forward to the partnerships that will emerge from your networking and discussions.

CONGRATULATORY REMARKS

Mr. BAT-ERDENE BATNASAN

Director,
National Science and Technology Fund of Mongolia

Distinguished guests, delegates, researchers, and professors, It is my great pleasure to extend my warm greetings to all of you.

On behalf of the National Science and Technology Fund of Mongolia, as well as personally, I would like to express my sincere appreciation to all Mongolian and international researchers, scholars, and distinguished guests participating in the International Conference on "Environment and Sustainable Development of the Mongolian Plateau and Surrounding Territories – 2026."

The advancement of science, technology, and innovation has become a fundamental driver of sustainable socio-economic growth, the development of a knowledge-based society, and the generation of effective solutions to the global challenges facing humanity today. In this context, the exchange of knowledge, experience, and research findings among scientists, as well as the expansion of international scientific cooperation, is of particular importance.

I am confident that this conference serves not only as a platform for presenting and discussing scientific research but also as an important venue for generating new ideas, fostering innovative solutions, creating opportunities for collaborative research, supporting young scholars, and enhancing the societal impact of science.

The foundation of Mongolia's development policy relies on science and knowledge-based development. Building a sustainable future requires addressing pressing socio-economic challenges through scientific approaches and evidence-based solutions.

The National Science and Technology Fund of Mongolia is committed to supporting fundamental research in priority areas of science and technology, financing national scientific and technological projects and programs, and promoting the application of research outcomes in industry, services, policy development, and planning processes.

Issues related to environmental change, ecosystem sustainability, and regional development across the Mongolian Plateau have increasingly attracted the attention of international scientific organizations and researchers. Therefore, I believe that this conference will make a significant contribution to advancing scientific knowledge of the Mongolian Plateau, strengthening regional cooperation, and supporting sustainable development policies through scientific evidence and research-based solutions.

I have no doubt that the presentations and discussions delivered by the participating researchers and scholars will contribute greatly to the dissemination of new scientific knowledge, the strengthening of inter and trans-disciplinary collaboration, and the creation of new opportunities for future research.

I wish every success to ICOMP2026 and extend my best wishes for continued achievements, prosperity, and excellence in your scientific endeavors.

Detailed Program

"THE XIV INTERNATIONAL CONFERENCE ON ENVIRONMENT AND SUSTAINABLE DEVELOPMENT OF THE MONGOLIAN PLATEAU AND SURROUNDING TERRITORIES" (ICOMP 2026)

Date: June 26, 2026
Conference venue: Library Building, National University of Mongolia
University Street 1, Baga Toiruu, Sukhbaatar District, Ulaanbaatar 14201, Mongolia

Time	Activities
08:00 - 09:00	Registration
	OPENING CEREMONY (09:00-09:40) 502, 5th floor, Library Building, NUM
09:00 - 09:10	Traditional cultural performance
09:10 - 09:15	**Opening speech:** **Dr. Battogtokh Dorjgotov,** President, Mongolian Geographical Society
09:15 - 09:20	**Congratulatory Remarks:** **Dr. Dashtseren Avirmed,** Director, Institute of Geography and Geoecology, Mongolian Academy of Sciences
09:20 - 09:25	**Mr Bat-Erdene Batnasan,** Director, Mongolian National Foundation for Science and Technology
09:25 - 09:30	**Dr. Byambakhuu Gantumur,** Associate Professor, Head of Department of Geography, Division of Natural Science School of Arts & Sciences, National University of Mongolia
09:30 - 09:40	Group Photo (All participants)
09:40 - 10:00	Coffee Break
	KEYNOTE PRESENTATIONS Chair: Sc.D, Academician Dagvadorj.D (10:00-11:30)
10:00 - 10:15	**"Big Data and Intelligent Computing Enable Ecological Sustainability on the Mongolian Plateau"** Dr, Professor, Juanle Wang, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences
10:15 - 10:30	**"State of Natural Components Under a Changing Climate in Mongolia"** Dr. Dashtseren Avirmed, Director, Institute of Geography and Geoecology, Mongolian Academy of Sciences

10:30 - 10:45	**"The Response of Global Climate Change on the Great Asian Watershed"** Sc.D, Academician, Garmaev Endon Zhamyanovich, Director of the Baikal Institute of Nature Management of the Siberian Branch of the Russian Academy of Sciences, Vice-President of the Russian Geographical Society Dr. Alexander Ayurzhanaev Candidate of Sciences, Head of laboratory of Geoecology, BINM SB RAS
10:45 - 11:00	**"Traversing Spatial Horizons - History, Achievements, and Future of Geography"** Dr. Associate Professor, Byambakhuu Gantumur, Head of Department of Geography, Division of Natural Science School of Arts & Sciences, National University of Mongolia
11:00 - 11:15	**"The Green Governance Model and Sustainable Effects Assessment for Combating Desertification in Northern China"** Dr, Professor, Dong Suocheng, Director, the Northeast Asia Sustainable Development Research Center, Chairman of International Scientists Union for the Belt and Road, China
11:15 - 11:30	**"Why the Mongolian Plateau Matters: Future Directions for Science, Sustainability and Regional Cooperation"** Dr. Battogtokh Dorjgotov, President, Mongolian Geographical Society
11:30 - 12:00	**Poster session**
LUNCH (12:00 - 13:00)	
SESSION 1: Topics: Geographical research trends and emerging challenges; Environmental sustainability and natural resource management; Climate change and adaptation strategies; **502, 5th floor, Library Building, NUM**	
Chairs: Dr. Narangerel.S; Dr. Prof. Juanle Wang; (13:00 - 15:00)	
13:00 – 13:15	**"Satellite-Based Analysis of Spatiotemporal Variations in Atmospheric CO_2 and CH_4 over Mongolia"** Professor, Hasi Bagan, School of Environmental and Geographical Sciences, Shanghai Normal University, China
13:15 – 13:30	**"The Ecological Status of Water Bodies in The Baikal Region: The Current State and Environmental Risk Assessment"** Dr. Pintaeva Evgeniya Tsydenovna Scientific Secretary of the Baikal Institute of Nature Management Siberian Branch of Russian Academy of Sciences
13:30 – 13:45	**"Toward Retrieval of Dead Fuel Moisture in Boreal Forests: Integrating Multisource Microwave Remote Sensing with Physical Constraints"** Associate Professor, Tongxin Hu, Northeast Forestry University, China
13:45 – 14:00	**"Flash Droughts Increasingly Associated with Global Wildfire Activity"** Professor, Keyan Fang, College of Geographical Sciences, Fujian Normal University, China
14:00 – 14:15	**"NoahPy: A Differentiable Noah Land Surface Model for Simulating Permafrost Thermo-hydrology"** Professor, Zhuotong Nan, School of Environmental and Geographical Sciences, Shanghai Normal University, China

14:15 – 14:30	**"Identifying and Analyzing the Key Drivers of Drought Propagation under Climate Change"** Dr. Sachula, Vice Dean, College of Geographical Science, Inner Mongolia Normal University
14:30 – 14:45	**"Application of Remote Sensing Monitoring and Rehabilitation Technology Demonstration of Degraded Grassland in Mongolia"** Dr. Urtnasan Mandakh, Senior researcher, Division of GIS and Cartography, Institute of Geography and Geoecology, Mongolian Academy of Sciences
14:45 – 15:00	**"Modern development of the coal industry in southern Mongolia"** Dr. Egor A. Sherin, Researcher, V. B. Sochava Institute of Geography, Siberian Branch of the Russian Academy of Sciences
15:00 – 15:20	Coffee Break – 502, 5th floor, Library of the NUM
Chairs: Dr. Sainbuyan.B, Dr. Pintaeva E.Ts (15:20 - 17:50)	
15:20 – 15:35	**"Grassland Changes Across the China-Mongolia Border over the Past 40 Years and the Spatial Scale Effects of Fenced Grazing"** Associate Professor, Bao Yulong, The College of Geographical Sciences, Inner Mongolia Normal University (IMNU)
15:35 – 15:50	**"Preliminary Results of the Research on Waterfalls in Mongolia"** Associate Professor, Soyoljin Sukhbaatar, National University of Mongolia
15:50 – 16:05	**"Long-term Dynamics of Icings and its Impact on Vegetation Cover: A Case Study"** Dr. Alexander Ayurzhanaev, Head of laboratory of Geoecology, Candidate of Sciences, Baikal Institute of Nature Management, Siberian Branch of the Russian Academy of Sciences
16:05 – 16:20	**"Spatiotemporal Analysis of Drought Conditions and Trends in Mongolia Using MODIS Vegetation Indices for the period 2001-2025"** Dr. Munkhdulam Otgonbayar, Head of Division of Physical Geography, Institute of Geography and Geoecology, Mongolian Academy of Sciences
16:20 – 16:35	**"Compound drought-dust storm events on the Mongolian Plateau"** Dr. Lan Wang, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences
16:35 – 16:50	**"Soil Bacterial EPS across a Precipitation Gradient in Mongolian Grasslands: Environmental Drivers and Practical Applications"** Dr. Punsaldulam Dashnyam, Researcher, Institute of Biology, Mongolian Academy of Sciences
16:50 – 17:05	**"The Green Development Pattern of the Eurasian Continent and its Driving Mechanism"** Dr. Difei Zhang, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences
17:05 – 17:20	**"Climate Change Effects on High Mountain Land Cover: A Case Study of Ikh Bogd National Park, Mongolia"** Dr. Uuganbat Ganbold, Department of Geography, School of Mathematics and Natural Sciences, Mongolian National University of Education

17:20 – 17:35	**"Research on Observation Characteristics and Forest Combustible Parameter Inversion Technology of Multi-source Microwave Remote Sensing in Forest Areas along the China-Mongolia Border"** Yanan Qu, Northeast Forestry University, China
17:35 – 17:50	**"Research on Fire Risk Early Warning Technology in Forest Areas along the China-Mongolia Border Based on Multi-Source Microwave Remote Sensing"** Yuanting Gao, Northeast Forestry University, China
17:50 – 18:05	**"Spatial Assessment of Wind Energy Potential in Kosovo Using GIS"** Associate Professor, Ferim Gashi, Department of Geography, Faculty of Mathematical and Natural Sciences, University of Prishtina, Kosovo
18:05 – 18:25	**CLOSING SESSION** – 502, 5th floor, Library of the NUM
SESSION 2: Topics: Socio-economic geography and regional development; Big Data and Artificial Intelligence in Geography **302, 3rd floor, Library of the National University of Mongolia**	
Chairs: Dr. Battsengel.V; Dr. Tseyenkhand.B; (13:00 - 15:00)	
13:00 – 13:15	**"The Role of Border Port Economic Diversification and regional and local development"** Dr. Altanbagana Mygmarsuren, Head of Division of Social and Economic Geography, Institute of Geography and Geoecology, Mongolian Academy of Sciences
13:15 – 13:30	**"An Empirical Study on Service Quality and Tourist Satisfaction in Mongolia"** Associate Professor, Amartuvshin Dorjsuren, Department of Geography, School of Arts and Sciences, National University of Mongolia
13:30 – 13:45	**"RTSEvo v1.0: A Retrogressive Thaw Slump Evolution Model"** Professor, Shuping Zhao, School of Environmental and Geographical Sciences, Shanghai Normal University, China
13:45 – 14:00	**"A Spatio-Semantic Framework for Eco-National Parks: Integrating Flickr Spatio-Temporal Data with NLP-Based Analysis of YouTube Perceptions"** Professor, Asamaporn Sitthi, Lecturer, Department of Geography, Social Sciences Faculty, Srinakharinwirot University, Bangkok, Thailand
14:00 – 14:15	**"Economic and Geographical Factors of Migration Activity of the Population of the Northern Mongolian Plateau"** Dr. Batomunkuev Valentin Sergeevich, Head of laboratory in Geography Sciences Baikal Institute of Nature Management Siberian Branch of Russian Academy of Sciences
14:15 – 14:30	**"Spatial Comparative Analysis of Planned Railways in Mongolia"** Dr. Urantamir Gankhuyag, Senior researcher, Division of Social and Economic Geography, Institute of Geography and Geoecology, Mongolian Academy of Sciences

14:30 – 14:45	**"Analysis of the Ecological and Economic Condition of the Asian Russia Regions (Using the Regions of Siberia and the Far East as an Example) Based on Integrated Indicators"** Dr. Zhamyanov Daba Tsyban-Dorzhievich, Senior Research Fellow, Baikal Institute of Nature Management of Siberian Branch of the Russian Academy of Sciences
14:45 – 15:00	**"Tourism Development and Land Use/Land Cover Changes in Khatgal, Khuvsgul Aimag, Mongolia"** Dr. Natalia Krasnoshtanova, Senior Researcher, V. B. Sochava Institute of Geography Siberian Branch of the Russian Academy of Sciences
15:00 - 15:20	Coffee Break – 302, 3rd floor, Library of the National University of Mongolia
Chairs: Dr. Altanbagana.M, Dr. Batomunkuev V.S (15:20 -1 7:45)	
15:20 – 15:35	**"Implementation Assessment of the New Urban Agenda (2020-2024): Experiences, Challenges and Future Directions in Mongolia"** Dr. Tseyenkhand Punsantsogvoo, Senior researcher, Division of Social and Economic Geography, Institute of Geography and Geoecology, Mongolian Academy of Sciences
15:35 – 15:50	**"Spatiotemporal Drought Dynamics and Future Trends on the Mongolian Plateau"** Dr. Lizhi Pan Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences
15:50 – 16:05	**"Strengthening Local Adaptation Resilience to Climate Change Through Identifying the Gap Between National and Local Policy Documents in Mongolia"** Dr. Lavdmaa Dagvadorj, Researcher, Division of Social and Economic Geography, Institute of Geography and Geoecology, Mongolian Academy of Sciences
16:05 – 16:20	**"Water Use and the Lake Baikal Level: Assessment of Drinking Water Quality and Public Health Risks"** Ulzetueva Irina Dabaevna, Research Fellow, Baikal Institute of Nature Management of Siberian Branch of the Russian Academy of Sciences
16:20 – 16:45	**"Determinants of Herder Household Migration Decisions and Policy Coherence: A Case Study of Khovd aimag"** MSc. Otgonkhuu Tsedev-Ish, Researcher, Division of Social and Economic Geography, Institute of Geography and Geoecology, Mongolian Academy of Sciences
16:45 – 17:00	**"Integrating InVEST Habitat Quality and GLUE Uncertainty Analysis for Conservation Target-Based Habitat Assessment in Ikh Gazriin Chuluu National Park, Mongolia"** MSc. Batnyam Tseveengerel, Researcher, Division of Physical Geography, Institute of Geography and Geoecology, Mongolian Academy of Sciences
17:00 – 17:15	**"Implementation of the "Power of Siberia" Main Gas Pipeline Projects in the Context of the International Transport Corridors Creation: The Experiences of Russia and Mongolia"** Researcher, Konstantin Tszian, V.B. Sochava Institute of Geography, Siberian Branch of the Russian Academy of Sciences, Russia

17:15 – 17:30	**"Climatic and Socioeconomic Risk Factors for Livestock Mortality During Winter Disasters in Western Mongolia"** MSc, Saruul Galtbayar, Researcher, Division of Social and Economic Geography, Institute of Geography and Geoecology, Mongolian Academy of Sciences
17:30 – 17:45	**"Urban Development Perception along the Transportation Corridors of the Mongolian Plateau Supported by SDGSAT-1 & VIIRS NTL Data"** Zhichen SUN, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences
CLOSING SESSION (18:05 – 18:25) 502, 5th floor, Library of the NUM	
18:05 – 18:10	**ICOMP 2026 Conference Recommendations and Future Directions** Scientific Committee
18:10 – 18:20	**Awards Ceremony** • Certificate of Recognition for Distinguished Keynote Speaker • Best Oral Presentation awards • Best Poster Presentation Award • Early Career Researcher Award
18:20 – 18:25	**Closing Remarks** • Organizing Committee Chair • Announcement of ICOMP 2028
CONFERENCE RECEPTION (18:30 – 22:00) **(MG Steak restaurant on the 3rd floor of Galleria Ulaanbaatar)**	

ICOMP 2026 – POSTER SESSION

Poster	Title
1	**"Informal Social Networks in Tourism in Khuvsgul Aimag of Mongolia"** Dr. Mariia Kuklina, ARCTICenter of University of Northern Iowa, US
2	**"Machine Learning Classification of PRISMA hyperspectral data for land cover mapping"** Academician, Amarsaikhan Damdinsuren, Head of Division of Aerospace Remote Sensing, Institute of Geography and Geoecology, Mongolian Academy of Sciences
3	**"Spatial Assessment and Mapping of Human Pressure on Dry Steppe Pasture"** MSc. Narantsatsral Tseren, Head of the Division of GIS and Cartography, Institute of Geography and Geoecology, Mongolian Academy of Sciences
4	**"Assessing Geo-ecological Conditions: (A Case Study in Erdenet Area)"** Dr. Sainbayar Dalantai, Researcher, Division of Aerospace Remote Sensing, Institute of Geography and Geoecology, Mongolian Academy of Sciences
5	**"Assessment of Sustainable Tourism Carrying Capacity in Khyargas Lake National Park, Mongolia"** Dr. Renchinmyadag Tovuudorj, Researcher, Division of Physical Geography, Institute of Geography and Geoecology, Mongolian Academy of Sciences

6	**"Spatial Optimization and Economic Integration of Tourism Development in Mongolia"** Dr. Amgalan Ulziikhutag, Academic Secretary, Urban and Regional Development Research Institute of the National University of Mongolia
7	**"Earthquake-Induced Rockslides and Lake Depression Geomorphology in the Gobi-Altay Range, Mongolia"** Dr. Altanbold Enkhbold, Department of Geography, School of Art and Sciences, National University of Mongolia
8	**"Ecological Risk Assessment and Spatial Distribution of Toxic Heavy Metals in the Pasture Soils of Tsenkher Soum, Arkhangai Province, Mongolia"** Dr. Bilguun Ulziibat, Researcher, Division of Environmental and Natural Resource Management, Institute of Geography and Geoecology, Mongolian Academy of Sciences
9	**"Comparative Evaluation of Spectral Indices for Surface Water Mapping: A Case Study of Uvs Lake Region, Western Mongolia"** MSc. Unurnyam Jugnee, Researcher, Division of Water Resources and Water Utilization, Institute of Geography and Geoecology, Mongolian Academy of Sciences
10	**"The Factors Contributing to the Wildfire Occurrence in the Border Area of Mongolia and China"** MSc. Amarjargal Sanjjav, Researcher, Division of GIS and Cartography, Institute of Geography and Geoecology, Mongolian Academy of Sciences
11	**"Spatiotemporal Patterns and Driving Forces of Land Degradation in Mongolia from 1985 to 2022: Insights from Long-Term NDVI Time Series and Geospatial Analysis"** MSc. Danzanchadav Ganbat, College of Geographical Science, Inner Mongolia Normal University, China; Researcher, Institute of Geography and Geoecology, Mongolian Academy of Sciences
12	**"Watershed-Based Morphometric Analysis of the Selenge River Basin"** MSc. Bayanjargal Bumtsend, Researcher, Division of Physical Geography, Institute of Geography and Geoecology, Mongolian Academy of Sciences
13	**"Spatial Distribution of Heatwaves in Arkhangai Province Assessed Using Machine Learning Methods"** MSc. Byambadolgor Batdorj, Researcher, Division of Aerospace Remote Sensing, Institute of Geography and Geoecology, Mongolian Academy of Sciences
14	**"Methodological Issues in Delineating Tourism Regions Using Cluster Analysis"** MSc. Natsagsuren Bayasgalan, Researcher, Division of Social and Economic Geography, Institute of Geography and Geoecology Mongolian Academy of Sciences
15	**"Remote Sensing-Based Estimation of Soil Organic Carbon Stock (SOC) in Croplands"** MSc. Delgertsetseg Renchinmyadag, Researcher, Division of Land Resource and Land Use, Institute of Geography and Geoecology Mongolian Academy of Sciences
16	**"Evaluating the Spectral Reflectance Characteristics of Arid Steppe Vegetation in Relation to Long-Term Trends in Vegetation Cover Changes"** MSc. Nyamkhuu Myanganbuu, Researcher, Division of GIS and Cartography, Institute of Geography and Geoecology, Mongolian Academy of Sciences
17	**"Estimating Soil Total Nitrogen and Total Phosphorus Using Machine Learning Methods"** MSc. Jargaldalai Enkhtuya, Researcher, Division of Aerospace Remote Sensing, Institute of Geography and Geoecology, Mongolian Academy of Sciences

18	**"Assessment of Corrosion Potential in Drinking Water Distribution Networks Using Water Stability Indices: A case Study of Khan-Uul District, Ulaanbaatar, Mongolia"** MSc. Enkhjargal Togtokh, Researcher, Division of Water Resources and Water Utilization, Institute of Geography and Geoecology, Mongolian Academy of Sciences
19	**"Assessment of the Current Condition of Mongolian Border Ports"** MSc. Nandin-Erdene Amartuvshin, Researcher, Division of Social and Economic Geography, Institute of Geography and Geoecology, Mongolian Academy of Sciences
20	**"Results of Integrating Field Vegetation Survey and Remote Sensing Analysis of Pasturelands in the Kherlen River Basin"** MSc. Uuriintsolmon Enkhtaivan, Researcher, Division of Land Resource and Land Use, Institute of Geography and Geoecology, Mongolian Academy of Sciences
21	**"Hydroclimatic Drivers of Lake Area Dynamics in the Khar-Us Lake Basin, Western Mongolia"** MSc. Tsolmonbayar Galbadrakh, Researcher, Division of GIS and Cartography, Institute of Geography and Geoecology, Mongolian Academy of Sciences
22	**"Evaluation of the Ecological Vulnerability in the Eastern Region of Mongolia"** Munkhtur Batkhuu, Researcher, Division of GIS and Cartography, Institute of Geography and Geoecology, Mongolian Academy of Sciences
23	**"Assessment of Hydrogeochemical Processes in Lake Khuvsgul Using Saturation Indices"** Erdenechimeg Surenjav, Researcher, Division of Water Resources and Water Utilization, Institute of Geography and Geoecology, Mongolian Academy of Sciences
24	**"Sustainable Green Space Development in Kharkhorum City: Soil Characteristics and Irrigation Requirements"** Zoljargal Tuvshin, Researcher, Division of Environmental and Natural Resource Management, Institute of Geography and Geoecology, Mongolian Academy of Sciences
25	**"Pollution and Degradation of Ugii Lake"** Tsend-Ayush Tserentogtokh, Researcher, Division of Environmental and Natural Resource Management, Institute of Geography and Geoecology, Mongolian Academy of Sciences
26	**"A Study on Environmental Degradation Caused by Solid Waste in Ulaanbaatar City"** Gansaikhan Munkhjargal, Researcher, Division of Environmental and Natural Resource Management, Institute of Geography and Geoecology, Mongolian Academy of Sciences
27	**"Assessing Habitat Quality and Degradation Using the InVEST Habitat Quality Model: A Case Study of the Zed-Khantai-Buteel Mountain Range Strictly Protected Area, Mongolia"** Arvinzaya Amarsaikhan, Researcher, Division of Physical Geography, Institute of Geography and Geoecology, Mongolian Academy of Sciences
28	**"The issues of the sustainable development achievement in the mining areas of the Umnugovi Aimag, Mongolia"** Dr. Nataliia Emelianova, Senior Researcher, V.B. Sochava Institute of Geography, Siberian Branch of the RAS and A.E. Favorsky Institute of Siberian Branch of the Russian Academy of Sciences
29	**"Russian and Mongolian cases in the development of the territory"** Dr. Gerelma Dugarova, Senior Researcher, V.B. Sochava Institute of Geography, Siberian Branch of the Russian Acadmy of Sciences

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KEYNOTE

PRESENTATIONS

BIG DATA AND INTELLIGENT COMPUTING ENABLE ECOLOGICAL SUSTAINABILITY ON THE MONGOLIAN PLATEAU

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Abstract: The Mongolian Plateau (MP) plays an important role in maintaining the ecological security and sustainable development of Eurasian nomadic societies. However, the MP is poor for available scientific data resources and related cyber platforms because of its vast area and sparse population. Under the context of the data-intensive science paradigm shifting during the era of Artificial Intelligence (AI), we propose a big data and intelligent computing framework to support ecological sustainability on the MP.

This involves four implementation pathways: algorithm design for land surface parameter datasets; citizen science data fusion coupled with physical transect surveys; intelligent computing platform for ecological shelters, scenario demonstrations, and knowledge discovery applications. This framework will facilitate computational collaboration among data, models, platforms, and scenarios on the MP using big data and AI, thereby providing a reference for the development of ecological sustainability in vulnerable regions worldwide.

STATE OF NATURAL COMPONENTS UNDER A CHANGING CLIMATE IN MONGOLIA

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Abstract: Mongolia is characterized by diverse ecosystems spanning forest, steppe, desert, mountain, and permafrost regions, making it highly vulnerable to climate change. Natural components, including land, water resources, glaciers, permafrost, vegetation, and biodiversity, play a critical role in sustaining the country's economy, livelihoods, and ecosystem services. However, rapid climatic changes are altering these natural systems at an unprecedented rate.

Meteorological observations indicate that Mongolia's mean annual air temperature has increased by 2.4°C during 1960–2020, exceeding the global average warming rate. Warming has occurred across all seasons, with stronger increases in northern mountainous areas during winter and in steppe and desert regions during summer. Precipitation trends exhibit considerable spatial variability, ranging from decreases of approximately 100 mm to increases of 50 mm, while evaporation has changed between −230 mm and +50 mm, contributing to intensified aridity, desertification, and land degradation.

Permafrost, a key component of Mongolia's cryosphere and hydrological systems, currently occupies approximately 29.3% of the country's territory, primarily in the Altai, Khangai, Khentii, and Khuvsgul mountain regions. Long-term monitoring reveals that permafrost temperatures have increased by 0.002–0.08°C yr^{-1}, with widespread thawing and degradation occurring across mountain regions. Historical comparisons show that permafrost extent declined from approximately 63% in 1971 to 29.3% in 2016, accompanied by a northward retreat of the southern permafrost boundary. Climate projections under the CMIP6 SSP2-4.5 scenario suggest continued degradation, with permafrost coverage potentially decreasing to 10.6% by 2050 and 1.9% by 2100.

Permafrost and glaciers constitute important water sources in Mongolia's headwater regions. Glaciers cover approximately 304 km^2, representing around 10% of national freshwater reserves, while permafrost regulates groundwater storage and river discharge. Their degradation threatens water availability, ecosystem stability, and the resilience of pastoral livelihoods.

These findings demonstrate that climate change is profoundly transforming Mongolia's natural components and increasing environmental vulnerability. Strengthening monitoring networks, improving climate adaptation strategies, and promoting sustainable management of land and water resources are essential for enhancing ecosystem resilience and supporting sustainable development under a changing climate.

THE RESPONSE OF GLOBAL CLIMATE CHANGE ON THE GREAT ASIAN WATERSHED

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Abstract: The Great Asian Watershed is a highly sensitive natural boundary where the effects of global climate change are manifested through the transformation of temperature, precipitation, permafrost, vegetation, hydrological regimes, and hydroecological risks. The report presents the results of an integrated analysis of climatic and environmental changes across this vast transboundary region, with particular attention to the Baikal region and the Selenga River basin.

The research is based on long-term meteorological observations, CRU climatic data, high-resolution climate datasets, remote sensing products, NDVI trends, dendroclimatic reconstructions, and field expedition materials. The obtained results show a statistically significant increase in near-surface air temperature over most of the Great Asian Watershed and adjacent territories. The most intensive warming is recorded in Arctic and subarctic areas, where it is associated with permafrost degradation and an increase in active-layer depth. At the same time, a decrease in precipitation is observed along the watershed, especially in the territories located to the south of it, including parts of Russia, Mongolia, and China.

The Baikal region occupies a particularly important position because it combines boreal, steppe, mountain, and permafrost landscapes. In recent decades, this region has experienced an increase in mean annual air temperature, a reduction in moisture availability, a longer growing season, fewer cold nights, more hot days, and an increase in consecutive dry days. The low-water period of 2000-2017 was characterized by a sharp decrease in precipitation, spring droughts lasting up to four months, and the appearance of autumn droughts.

Vegetation response is spatially heterogeneous. In steppe intermontane basins, NDVI dynamics are controlled mainly by precipitation, whereas in forest landscapes they are more strongly related to temperature. Climate-driven changes also affect river runoff, the water level of Lake Baikal, the frequency of droughts, fire risks, and the formation of icings. Thus, the Great Asian Watershed can be considered an important indicator area for assessing the regional consequences of global climate change in Inner and Northern Asia.

The study was carried out in frame of Baikal Institute of Nature Management SB RAS state task (FWSU-2026-0009)

TRAVERSING SPATIAL HORIZONS – HISTORY, ACHIEVEMENTS, AND FUTURE OF GEOGRAPHY

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Abstract: Established in 1956, the Department of Geography at NUM has been a leader in spatial science, education, and regional development for 70 years. This keynote address will trace the department's evolution, from its foundations in classical physical and human geography to its current position as a center for cutting-edge geospatial technologies, remote sensing, and environmental analytics.

Over the past seven decades, the department has continuously updated its curriculum and research to address evolving global and regional challenges. Key milestones include the creation and development of new independent professional programs within the core geography curriculum, established in response to societal needs.

Additionally, the department has founded numerous professional training and research laboratories, institutes, and centers, contributing significantly to solving spatial problems at global, regional, and local levels. Through rigorous academic training and impactful research, the department has cultivated generations of scientific and industry leaders and significantly influenced public policy in areas such as physical and human geography, tourism, land management, urban and regional planning, geographical education, soil sciences, remote sensing, and geographic information science.

Finally, this presentation will look to the future, exploring how the department is leveraging emerging tools like artificial intelligence and Earth observation to address 21st-century crises. By integrating geographical principles with modern innovation throughout its history, the department remains dedicated to educating and developing the next generation of geographers to navigate an increasingly complex and sustainable world.

THE GREEN GOVERNANCE MODEL AND SUSTAINABLE EFFECTS ASSESSMENT FOR COMBATING DESERTIFICATION IN NORTHERN CHINA

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Abstract: This report summarizes representative practices and practical models of desertification control and green development in northern China, with a focus on integrated governance pathways, technology-supported restoration, industry–ecology synergy, and ecological, economic, and social benefit assessment. It highlights the systematic management of mountains, rivers, forests, farmlands, lakes, grasslands, and deserts as an integrated restoration approach rather than a policy-led narrative.

In Maqu County of Gannan, restoration practices center on the coordinated treatment of sandy land, degraded grasslands, wetlands, and shelterbelts, demonstrating a plateau ecological conservation model that combines sand control, grassland rehabilitation, wetland recovery, and water-source protection.

In Ningxia and Inner Mongolia, the "straw checkerboard–desert photovoltaic–vegetation restoration–solar grazing" model presents an integrated pathway linking sand stabilization, renewable energy development, water conservation, vegetation recovery, and pastoral livelihood improvement. In the Horqin Sandy Land and Tongliao, practices such as enclosure-based restoration, aerial seeding, mixed tree–shrub–grass systems, sand-based industries, and ecotourism show how ecological restoration can be combined with industrial upgrading and local economic transformation.

The report places particular emphasis on evaluating the multiple benefits of these models. Ecologically, the practices have increased vegetation cover, reduced desertified land, improved soil and water retention, enhanced ecosystem stability, and mitigated dust storm impacts. Economically, they have supported green agriculture and animal husbandry, photovoltaic development, sand-based industries, and ecotourism.

Socially, they have improved pastoral livelihoods, diversified income sources, strengthened community participation, and provided replicable experience for dryland regions facing similar ecological pressures.

On this basis, the report proposes deepening China–Mongolia–Russia cooperation on transboundary desertification control and green shelterbelt development through joint monitoring, 3S-based evaluation, AI-enabled early warning systems, shared technical standards, and cross-border demonstration projects.

WHY THE MONGOLIAN PLATEAU MATTERS: FUTURE DIRECTIONS FOR SCIENCE, SUSTAINABILITY AND REGIONAL COOPERATION

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Abstract: Humanity faces a growing number of interconnected global challenges, including climate change, desertification, biodiversity loss, water scarcity, energy insecurity, natural disasters, and emerging public health risks. These transboundary challenges extend beyond national borders and cannot be effectively addressed by any single country acting alone. Science, technology and innovation (STI), supported by open science, science diplomacy, and international cooperation, are increasingly recognized as essential mechanisms for driving solutions and supporting evidence-based decision-making.

Within this context, the Mongolian Plateau represents one of the most important yet under-studied socio-ecological regions on Earth. Covering approximately 3–4 million km^2 across Mongolia, the Inner Mongolia Autonomous Region of China, and adjacent regions of Russia, it forms one of the world's largest contiguous temperate grassland and dryland ecosystems.

The Mongolian Plateau encompasses vast steppe, desert, forest-steppe, mountain, wetland, and permafrost systems that support globally significant biodiversity, traditional pastoral livelihoods, and critical ecosystem services. The region also contains major freshwater resources, including the Selenga River Basin, Lake Khuvsgul, and Lake Hulun, and plays a crucial role in regional carbon cycling, ecological security, and climate regulation across Northeast Asia.

The Mongolian Plateau is particularly vulnerable to climate change. Rising temperatures, increasing aridity, grassland degradation, desertification, water stress, dust storms, biodiversity decline, and permafrost thaw are accelerating environmental change across the region. Because these processes influence atmospheric circulation, carbon dynamics, dust transport, and ecosystem resilience beyond national boundaries, the Mongolian Plateau has emerged as a strategic region for global climate and sustainability research.

To address these challenges, this presentation proposes the Mongolian Plateau Resilience Initiative (MPRI), a regional scientific cooperation platform designed to advance long-term, integrated, and transdisciplinary research across the plateau. Building upon the principles of Long-Term Ecological and Socio-Economic Research (LTESER), the initiative aims to establish a coordinated network of observation sites, harmonize environmental and socio-economic monitoring, promote open data sharing, strengthen research

infrastructure, and foster collaboration among scientists, policymakers, and local communities.

The proposed initiative will serve as a platform for collaborative science and regional cooperation among Mongolia, China, Russia, and international partners. By integrating Earth observation, field monitoring, big data analytics, artificial intelligence, and stakeholder engagement, MPRI seeks to enhance resilience, support sustainable land management, combat desertification, and contribute to global sustainability goals. Ultimately, safeguarding the Mongolian Plateau is not only a regional responsibility but also a global imperative for climate resilience, ecological security, and sustainable development in the 21st century.

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PRESENTATIONS

1 SESSION

Topic 1: Geographical research trends and emerging challenges

Topic 2: Environmental sustainability and natural resource management

Topic 3: Climate change ana adaption strategies

SATELLITE-BASED ANALYSIS OF SPATIOTEMPORAL VARIATIONS IN ATMOSPHERIC CO_2 AND CH_4 OVER MONGOLIA

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Abstract: Mongolia is an important arid and semi-arid region in inland Asia, where rapid climate warming, fragile grassland ecosystems, and livestock-based land use strongly interact with the atmospheric greenhouse gas cycle. This study analyzes the spatiotemporal variability of atmospheric greenhouse gases over Mongolia by integrating satellite observations, ground-based validation, vegetation indicators, climate-zone information, and livestock-related auxiliary data. Near-surface carbon dioxide (CO_2) concentrations from GOSAT were used to examine changes during 2010–2019, while column-averaged methane concentrations (XCH_4) from GOSAT and GOSAT-2, combined with machine-learning-based gap filling, were used to investigate methane dynamics during 2010–2022.

The results show that atmospheric greenhouse gas concentrations in Mongolia have increased significantly over the past decade. Near-surface CO_2 rose from 389.48 ppmv in 2010 to 409.72 ppmv in 2019, with an annual growth rate of 2.24 ppmv yr^{-1}. Spatially, the highest annual average CO_2 concentrations occurred in the southeastern Gobi Desert, whereas the strongest increasing trend was found in the northwestern alpine and meadow steppe regions. CO_2 also showed clear seasonal variability, reaching its maximum in spring and minimum in summer. The negative relationship between CO_2 and vegetation parameters such as NDVI, GPP, and LAI in summer indicates the important role of vegetation photosynthesis and carbon uptake, especially in northern forest-steppe and meadow-steppe areas. Methane concentrations also exhibited a strong increasing trend. The reconstructed monthly XCH_4 dataset showed an average increase of 9.16 ppb yr^{-1} from 2010 to 2022. XCH_4 reached its seasonal maximum in autumn and minimum in winter. Spatially, methane variation was closely linked to the distribution and type of ruminant livestock. Cattle showed the strongest correlation with XCH_4, particularly in the Khangai and Khentii mountainous regions, while sheep and goats had stronger influences in central grasslands and southern Gobi areas, respectively. These findings indicate that Mongolia's greenhouse gas dynamics are jointly controlled by vegetation carbon uptake, arid-zone climate conditions, livestock distribution, and human activities. The study provides scientific support for regional carbon-cycle assessment, grassland management, and greenhouse gas mitigation policies in Mongolia.

THE ECOLOGICAL STATUS OF WATER BODIES IN THE BAIKAL REGION: THE CURRENT STATE AND ENVIRONMENTAL RISK ASSESSMENT

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Abstract: This study synthesizes over two decades of monitoring by the Baikal Institute of Nature Management SB RAS, focusing on conceptual frameworks to monitor extreme geological and ecosystem-geochemical processes across the Baikal Natural Territory (BNT) as a crucial part of the surrounding territories of the Mongolian Plateau. The research encompasses Lake Baikal, its primary tributaries (Selenga and Barguzin rivers), and key lacustrine systems (Gusinoye, Kotokel, Bormashovoye, Dukhovoye).

Shifting hydroclimatic trends strongly govern the region's lotic networks. Following prolonged droughts (2010–2020), annual runoff peaked: Selenga River discharge spiked in 2022 (53.9 km^3), while the Barguzin River exceeded its average in 2020. Principal Component Analysis (PCA) indicates that dissolved heavy metal (HM) dynamics are driven by seasonal hydrological regimes rather than interannual variations. High-water phases diluted anthropogenic metals (Zn, Pb) but mobilized geogenic Fe and Mn, shifting environmental challenges to diffuse inputs. This mirrors the Barguzin River, where chronically elevated background Fe, Mn, and Cu reflect basin-specific geochemistry, intensified indirectly by catchment erosion without identifiable point sources.

Lacustrine water-exchange retardation heightens sensitivity to environmental shifts. In Lake Gusinoye, historical mining and power generation caused permanent sulfate and sodium accumulation. On the eastern shore, small lakes occupy tectonic basins within the Baikal Rift Zone, shaped by fissure-vein water discharge. Climatic anomalies in 2024 (~3°C warming, high rainfall) triggered massive phytoplankton blooms in lakes Kotokel and Bormashovoye. Correlation analysis confirmed distinct drivers for seasonal dynamics: biological cycles dominate Lake Kotokel, redox cycles govern Lake Dukhovoye, and suspended matter controls Lake Bormashovoye. Long-term (15-year) evaluation using SCWPI, CCME WQI, and CTSI revealed historical quality improvements in Lake Kotokel, but recent climate-driven degradation to hypertrophic status. Sediment analyses across all lakes revealed a uniform grain-size distribution, where HM accumulation is governed by lithogenic inputs and sorption barriers.

To systematically manage these risks, baseline levels of HMs, persistent organic pollutants, and priority phthalates were established, and robust ArcGIS databases were implemented for spatial

tracking. Bioaccumulation models were developed for integrated forecasting. While ecotoxicological assessments identified moderate-to-high risks to aquatic biota from diethylhexyl phthalate and dibutyl phthalate, human health risk indices (THQ, HQ, HI) demonstrate no excessive non-carcinogenic threats.

This research was funded by the framework of the State Assignment of the Baikal Institute of Nature Management SB RAS (project № 126020516704-6).

TOWARD RETRIEVAL OF DEAD FUEL MOISTURE IN BOREAL FORESTS: INTEGRATING MULTISOURCE MICROWAVE REMOTE SENSING WITH PHYSICAL CONSTRAINTS

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Abstract: Dead fuel moisture content (DFMC) serves as a critical determinant influencing wildfire ignition, spread, and overall intensity. Despite its vital role in ensuring ecological security and enhancing fire prevention strategies, high spatiotemporal resolution DFMC products continue to be scarce on global scales. This limitation arises because traditional fire risk assessments typically depend on indirect meteorological indices or soil moisture content (SMC), which do not directly capture the nuanced drying dynamics of fuel materials.

To bridge this gap, this study proposes a robust framework for daily DFMC retrieval by integrating multi-source microwave remote sensing with machine learning and physical modeling. We first developed a retrieval algorithm by systematically evaluating six candidate models across four boreal forest types, in which the Extreme Gradient Boosting (XGBoost) algorithm demonstrated the strongest adaptability, achieving an average R2 of 0.78. SHAP-based feature importance analysis further identified SMC and evapotranspiration process as the two dominant drivers of fuel drying dynamics, providing physical justification for the model structure.

Building upon this, we addressed temporal inconsistencies across multi-source passive microwave observations (SMAP, AMSR2, and FY-3D) by introducing a physical temporal fusion model based on diurnal DFMC response mechanisms, effectively normalizing satellite overpasses at different local times to the daily minimum DFMC reference time. This physically constrained, multi-source microwave-driven framework enables the generation of accurate, daily, high-resolution DFMC products, validated against in-situ observations with R2 =0.68 and RMSE =16.63%.

Crucially, the retrieved DFMC products exhibit stable and interpretable spatial patterns with significant correlations to ERA5-Land meteorological variables, and demonstrate superior fire risk indication capabilities compared to traditional SMC metrics, successfully capturing anomalous pre-ignition drying signals at the pixel level. By integrating microwave remote sensing, physical modeling, and machine learning, this framework provides a scalable technical pathway for DFMC retrieval, offering new opportunities for advancing fire danger assessment and early warning systems in boreal regions under a changing climate.

FLASH DROUGHTS INCREASINGLY ASSOCIATED WITH GLOBAL WILDFIRE ACTIVITY

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Abstract: Flash droughts (FDs), an increasingly frequent form of extreme drought, can rapidly deplete soil moisture and accelerate desiccation of surface fuels, thereby creating conditions conducive to large-scale wildfires. However, the global characteristics of the flash drought-to-fire cascade (FDFC) and its response to climate change remain largely unexplored. Here, we present the first global dataset of flash drought fire (FDF) spanning 2003-2023, constructed by integrating satellite-derived soil moisture and burned area records. Globally, 61.2% of FDF affected area occurs in central and southern Africa, where 85.3% of FDF are grassland fires, reflecting grasslands' rapid turnover of fine fuels and their high sensitivity to FDs.

The global FDF burned area and its fraction in global burned area decreased from 2003 to 2014, but increased significantly ($p < 0.05$) after 2014 under accelerated warming, peaking in 2023. The FDFC responds much faster than traditional drought-driven fires, with 90.6% of FDF area occurring within three months of FD onset and the lag from FD termination to fire onset shortening by 2.4 days over the past 21 years. Driven by global warming and more frequent FDs, this accelerating cascade shortens warning and response times, heightening risks to ecosystems and society and posing critical challenges for global change research and policy.

NOAHPY: A DIFFERENTIABLE NOAH LAND SURFACE MODEL FOR SIMULATING PERMAFROST THERMO-HYDROLOGY

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Abstract: Accurately representing permafrost in Earth System Models is a grand challenge that creates major uncertainty. A promising path forward is to create hybrid models that synergize process-based physics with deep learning, but this is fundamentally hindered by the non-differentiable nature of traditional land surface models (LSMs), which are incompatible with modern AI workflows. To overcome this limitation, we present NoahPy, a differentiable LSM developed by reconstructing the Noah LSM's governing partial differential equations into a process-encapsulated Recurrent Neural Network (RNN), with the heat, moisture solver forming the computational core.

We first demonstrate that NoahPy very closely replicates the numerical behaviour of the modified Noah LSM, achieving Nash-Sutcliffe Efficiency (NSE) coefficients above 0.99 for both soil temperature and liquid water. We then show that at a permafrost site, the calibrated NoahPy achieves robust simulation performance for soil temperature (NSE > 0.9) and liquid water (NSE > 0.8). Critically, the differentiable workflow, when combined with the Adam optimizer, is significantly faster, more stable, and yields simulations with lower uncertainty compared to traditional Shuffled.

Complex Evolution (SCE-UA) calibration algorithm. NoahPy thus provides a foundational, "glass-box" framework that closes a key technical gap, enabling the development of the next generation of hybrid AI-physics models needed to more reliably predict the future of the cryosphere.

IDENTIFYING AND ANALYZING THE KEY DRIVERS OF DROUGHT PROPAGATION UNDER CLIMATE CHANGE

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Abstract: This study focuses on the Mongolian Plateau and the Beijing–Tianjin–Hebei region. By integrating the Standardized Precipitation Index (SPI), Standardized Runoff Index (SRI), and Standardized Soil Moisture Index (SSI), and combining run theory, Copula function models, drought propagation identification methods, migration models, and machine learning methods, this study systematically analyzed the cascading propagation mechanism of meteorological drought–hydrological drought–soil moisture drought on the Mongolian Plateau during 1982–2021.

APPLICATION OF REMOTE SENSING MONITORING AND REHABILITATION TECHNOLOGY DEMONSTRATION OF DEGRADED GRASSLAND IN MONGOLIA

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Abstract: More than 70% of Mongolia's rangelands have experienced varying degrees of degradation, contributing to the expansion of desertification, disrupting ecological balance, and adversely affecting the country's socio-economic sustainability and the gradual decline of traditional nomadic grazing practices have emerged as major drivers of rangeland degradation. These factors have intensified grazing pressure, resulting in changes in vegetation community composition, alterations in seasonal phenological stages, and a deterioration of overall rangeland ecosystem condition.

The integrated assessment of degraded grassland and land degradation severity through the combined use of long-term multi-temporal, multispectral satellite remote sensing data and field-based survey methods is of significant socio-economic importance. Such an approach enables the comprehensive evaluation of degradation processes, supports the identification of affected areas, and provides a scientific basis for developing and implementing effective grassland repairn technology and rehabilitation strategies.

For this study, Gurvanbulag Soum of Bulgan Province, located within the dry steppe zone characterized by limited moisture and heat availability, was selected as the research site. Within the framework of a project aimed at assessing degraded rangelands through remote sensing techniques and introducing rangeland restoration technologies, a 30-hectare rangeland area (Khevteegiin Ar) was fenced and monitored. The study yielded the following results.

Correlation analysis between precipitation and vegetation productivity revealed a strong positive relationship, with a correlation coefficient of $R = 0.89$, a coefficient of determination of $R^2 = 0.7894$, and high statistical significance ($p = 0.000$). These results indicate that approximately 60–80% of the spatial variability in vegetation productivity within the study area can be explained by precipitation.

In contrast, NPP exhibited a weak negative correlation with air temperature across most of the study area ($R = -0.20$ to -0.40, $p < 0.05$), suggesting that temperature was not a dominant controlling factor of vegetation productivity during the 34-year study period and that NPP showed limited sensitivity to temperature variations.

The results indicate that protecting degraded rangelands through fencing for a period of three years contributed to noticeable ecological recovery. Most plant species exhibited increases in height, vegetation cover, and biomass production, while regeneration through reproductive organs was enhanced, demonstrating improved natural restoration capacity of the rangeland ecosystem.

MODERN DEVELOPMENT OF THE COAL INDUSTRY IN SOUTHERN MONGOLIA

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Abstract: The study was carried out within the framework of a joint Russian-Mongolian project of the Russian Science Foundation (№ 24-47-03004) following a scientific expeditions to southern Mongolia in July-August 2024 and June 2025. The purpose of the study is to analyze the rapidly developing coal industry in the Umnugovi aimag.

All coal deposits and fields being developed in the aimag (Tavan Tolgoi, Ukhaa Khudag, Baruun Naran, Ovoot Tolgoi, Nariin Sukhait) were characterized. Thus, the aimag's total coal reserves were estimated at 9.36 billion tons, which is quite significant on a global scale, given that the overwhelming majority of them are coking grades valuable for steelmaking.

The southern Mongolian coal industry provides more than 70% of all mined and exported coal in the country. Coal processing issues were touched upon: coal preparation plants and coal-fired power plants. Coal export routes and proportions between them have been determined. Thus, almost all (98%) of the aimagâ€™s mined coal is exported in raw (80%) or processed (20%) form, almost entirely to China.

The problems of the Umnugovi's coal industry are considered: problems with water supply to mining and processing industries, which arose due to the arid climate and the lack of permanent watercourses; problems with electricity supply to industries; lack of deep processing of extracted resources; almost entire export of extracted resources abroad with a shortage of processing industries in the aimag; environmental problems; nuances of interaction between mining companies and shepherds - local residents engaged in traditional sectors of the economy.

The prospects for the south Mongolian coal industry are determined as favorable.

GRASSLAND CHANGES ACROSS THE CHINA–MONGOLIA BORDER OVER THE PAST 40 YEARS AND THE SPATIAL SCALE EFFECTS OF FENCED GRAZING

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Abstract: The regions along the China-Mongolia border share a highly similar natural environmental baseline but exhibit significant differences in grassland utilization policies, making this area an ideal natural laboratory for exploring the impacts of human activities and climate change on steppe ecosystems. Based on a 40-year time-series remote sensing dataset of vegetation indices (e.g., NDVI), this study systematically evaluated the spatiotemporal characteristics of grassland dynamics in Mongolia and the Inner Mongolia Autonomous Region of China using a transboundary spatial comparative analysis. By combining concurrent meteorological factors with the evolutionary history of grassland management policies in both countries, we quantitatively analyzed the primary driving factors triggering regional grassland degradation.

The results demonstrate that: (1) Over the past 40 years, grassland changes across the border have exhibited significant spatial divergence, with the degradation trends and evolution rates presenting a clear asymmetry between the two sides; (2) Although climate change (e.g., precipitation fluctuations and temperature increases) forms the fundamental natural background for grassland evolution, shifts in grassland management policies and utilization modes are the core driving forces behind the discrepancies in degradation. Based on these findings, this paper innovatively proposes the concept of the "Spatial Scale Effects of Fenced Grazing." This effect posits that rigid physical fences fragment traditionally vast, continuous open rangelands into confined patches, drastically compressing the roaming and foraging ranges of livestock.

Such artificial reduction in spatial scale fundamentally alters the traditional spatial interactions between livestock and pasture, leading to an excessive concentration of selective grazing and trampling pressures within confined local spaces. Consequently, this acts as a critical factor accelerating grassland degradation in Inner Mongolia.

This study not only deepens the theoretical understanding of grassland degradation mechanisms in arid and semi-arid regions but also provides a scientific basis for rethinking and optimizing current grassland management policies to achieve sustainable ecological development in cross-border regions.

PRELIMINARY RESULTS OF THE RESEARCH ON WATERFALLS IN MONGOLIA

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Abstract: Waterfalls represent unique geographical features that illustrate riverbed evolution and neotectonic movements, while also serving as crucial resources for geo-tourism. In Mongolia, a comprehensive inventory and catalog detailing their precise locations, accessible routes, and aquatic environments have not yet been fully established.

The objective of this study is to scientifically register the waterfalls of Mongolia, map their geographic coordinates and route accessibilities, measure their primary morphometric characteristics, and provide a preliminary assessment of the chemical composition and quality of some of their aquatic environments. To achieve this, the study integrated traditional geographical field description, stationary topographic measurements and hydrochemical analysis based on the previous works of Mongolian researchers.

During the field expeditions, the height, width, and plunge intensity of some of the waterfalls were measured. Furthermore, a comprehensive assessment for some waterfalls was conducted on the studies in geology, vegetation, soil cover, and socio-economic impacts within the surrounding areas for some waterfall. The preliminary results of the study precisely documented the spatial locations and morphometric data of key features, including most of the 50 waterfalls, which we have brought into our study, located in the Western, Northern, an Zavkhan provinces, Southern and Northern Khangai and the Altaimountain regions. Hydrochemical analyses revealed that the rivers feeding these waterfalls possess pristine water quality with low natural mineralization, classifying them into a high-quality status grade.

Ultimately, this work lays the theoretical and methodological foundation for waterfall science (cataractology) in Mongolia and provides essential baseline data for protecting natural heritage and developing new geo-tourism routes.

LONG-TERM DYNAMICS OF ICINGS AND ITS IMPACT ON VEGETATION COVER: A CASE STUDY

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Abstract: The report examines the long-term influence of icings on the state and dynamics of vegetation cover in river valleys. Icings play an important role in local hydrological regimes and soil moisture redistribution. They form specific cryogenic and hydroecological conditions that affect plant growth. Under current climate change, the response of plant communities to changes in icing processes is of particular relevance.

The study was conducted at a model site in the Chuluut River valley, Mongolia. The analysis is based on Landsat satellite imagery for the period 1986–2025. The Normalized Difference Snow Index (NDSI) was applied to detect icings. On this basis, maps of long-term icing dynamics and occurrence frequency were produced.

Three categories of areas were distinguished according to icing occurrence: infrequent, intermittent, and frequent. The results show that the mean long-term icing area is approximately 12 km^2. The icing fields are characterized by pronounced interannual variability, a general tendency toward reduction, and spatial redistribution within the valley.

The relationship between the long-term icing regime and vegetation condition was assessed with the Normalized Difference Vegetation Index (NDVI). Key phenological dates were also analyzed, including the start and peak of the growing season.

As an additional dendroecological component, the influence of icings on tree radial growth was examined in the Zaigraevsky District of the Republic of Buryatia. This part of the study made it possible to identify the response of woody vegetation to long-term cryogenic and hydrothermal conditions associated with icing formation.

The study was carried out with financial support from the Russian Science Foundation, grant No. 24-47-03008, https://rscf.ru/project/24-47-03008/

SPATIOTEMPORAL ANALYSIS OF DROUGHT CONDITIONS AND TRENDS IN MONGOLIA USING MODIS VEGETATION INDICES FOR THE PERIOD 2001-2025

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Abstract: This study aimed to assess the spatiotemporal dynamics of drought conditions across Mongolia using remotely sensed time-series data collected during the growing season from 2002 to 2025.

The analysis was based on the Normalized Difference Vegetation Index (NDVI) derived from MODIS satellite imagery. Drought occurrence, intensity, and frequency were evaluated using the NDVI anomaly approach, which compares annual growing-season NDVI values against the long-term mean to quantify deviations associated with vegetation stress and drought conditions. This method provides an effective means of monitoring vegetation dynamics over large geographic areas and assessing the spatial impacts of drought.

The results revealed that drought frequency intensified during specific periods across Mongolia. Severe drought events were identified during 2000–2002, 2004–2007, 2009, and 2017, which were characterized by substantial reductions in vegetation productivity during the growing season. In particular, the prolonged droughts of 2000–2002 and 2004–2007 affected extensive areas of the country and resulted in pronounced declines in NDVI values. Spatial distribution maps indicated that drought intensity and recurrence were highest in the Gobi Desert, desert-steppe, and dry-steppe regions. These findings suggest that these ecosystems are especially vulnerable to increasing aridity, limited water availability, and ongoing land degradation processes.

The study further demonstrated that the NDVI anomaly method is an effective tool for identifying drought years and evaluating changes in vegetation condition and ecosystem health. The results indicate that increasing drought frequency is closely associated with land degradation, declining rangeland productivity, accelerated soil erosion, and reduced ecosystem stability.

Consequently, long-term drought monitoring based on remotely sensed vegetation indices provides valuable information for assessing environmental change, land degradation, and desertification processes in Mongolia. Such information is essential for supporting sustainable land management and climate change adaptation strategies in arid and semi-arid regions.

COMPOUND DROUGHT–DUST STORM EVENTS ON THE MONGOLIAN PLATEAU

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Abstract: Global climate change amplifies risks of compound multi-hazard events. As a climate-vulnerable region, the Mongolian Plateau (MP) confronts escalating ecological and socioeconomic threats from compound drought-dust storm events (CDDEs).

However, current research predominantly examines these hazards discretely, overlooking synergistic mechanisms, interconnections and joint-risk quantification. We bridge this through an integrated framework employing wavelet coherence, geospatial analysis, and copula modelling to dissect CDDEs in MP. Results demonstrate significant drought-dust storm synergy, featuring 1–3 months lag effects and multiscale resonance cycles.

Spatially, a strong positive correlation is observed, with high-risk clusters dominate central/southern desert and partially steppe areas in the MP and southeastern border areas of Mongolia, contrasting with low-risk zones in northern forest-steppes.

The Frank Copula optimally characterizes their joint distribution, revealing weak positive dependence. Return period analysis indicates frequent single-extreme events versus rare but ecologically consequential compound extremes. Crucially, we establish, for the first time, a quantitative linkage between drought severity and dust intensity, showing that drought acts as amplifiers for dust storms.

Under extreme drought, dust storms likelihood rises by approximately 30 % above climatological baselines, and >60 % of high-intensity dust storms can be attributed to drought. Our findings advance understanding of compound hazards in drylands, offer a transferable modelling framework for arid regions worldwide.

SOIL BACTERIAL EPS ACROSS A PRECIPITATION GRADIENT IN MONGOLIAN GRASSLANDS: ENVIRONMENTAL DRIVERS AND PRACTICAL APPLICATIONS

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Abstract: Extracellular polymeric substance (EPS) production by soil microorganisms is an important adaptive strategy for alleviating drought stress and nutrient limitation. In addition, EPS released into soils contributes to soil health by promoting aggregate formation and enhancing water-holding capacity, highlighting its potential for environmental applications.

In this study, we investigated variations in EPS concentrations and their relationships with soil properties and microbial communities along climatic and resource gradients in Mongolian arid grasslands. We also combined high-throughput sequencing with traditional cultivation approaches to identify and characterize EPS-producing bacterial strains.

Our results showed that EPS concentrations increased with mean annual precipitation (MAP) across ecosystems, whereas the relationship between EPS and soil organic matter (SOM) was significant only in relatively resource-rich environments. These findings suggest that EPS accumulation in arid grasslands is strongly influenced by climatic variability, while its ecological and adaptive functions may be better understood through the study of individual microbial taxa. The results provide valuable insights into soil microbial processes involved in carbon stabilization and accumulation in arid grasslands. Furthermore, we isolated several EPS-producing bacterial strains from soil samples and demonstrated their potential applications in improving soil structure and removing pollutants from wastewater. Importantly, the effectiveness of EPS in promoting soil aggregation depended on both soil clay mineralogy and structural characteristics of the EPS.

Specific examples will be presented to illustrate how selected bacterial strains exhibit soil-specific effects on aggregate reformation. Overall, our study demonstrates that EPS-producing bacterial strains represent valuable natural resources and highlights their potential for practical applications in environmental remediation, soil quality improvement and sustainable land management across the Mongolian Plateau.

THE GREEN DEVELOPMENT PATTERN OF THE EURASIAN CONTINENT AND ITS DRIVING MECHANISM

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Abstract: As the international community transitions from the SDG era toward the post-2030 sustainability agenda, a critical diagnostic gap persists: existing frameworks measure whether countries are "green enough" (stock) or "greening fast enough" (speed), yet fail to assess whether speed actually accumulates into stock.

This study introduces a dual-track diagnostic framework for 59 Eurasian economies (2005–2020), with static stock scored via CRITIC-Winsorization robust weighting and dynamic speed anchored to the 2019 pre-pandemic baseline.

XGBoost-SHAP intra-system diagnostics reveal that knowledge capital (scientific publications per capita) dominates green stock determination (R^2=0.985), while renewable energy expansion (excluding hydro) serves as the super-lever of transition speed (SHAP=3.5, R^2=0.929).

Panel Granger causality testing rejects the hypothesis that speed Granger-causes stock (p=0.601), while PECM estimation confirms a significant negative-feedback equilibrium (γ=−0.194, p<0.001) wherein deviations correct at 19.4% annually–but toward a zero-conversion steady state rather than progressive accumulation. Strikingly, heterogeneity analysis reveals a "green catch-up vulnerability": developing economies exhibit rapid error correction (−0.282, 28.2%/year), indicating high institutional fragility, whereas developed economies show slower correction (−0.087, 8.7%/year), reflecting systemic buffering capacity. A four-quadrant typology–Resilient Stewards, Inertia-Locked, Vulnerable Catch-Uppers, and Deprived–provides differentiated cleaner production policy archetypes.

The framework directly informs the post-2030 agenda's imperative: beyond accelerating speed, governance must build institutional shock absorbers for vulnerable transition economies.

CLIMATE CHANGE EFFECTS ON HIGH MOUNTAIN LAND COVER: A CASE STUDY OF "IKH BOGD" NATIONAL PARK, MONGOLIA

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Abstract: This study investigates the impact of climate change on high-mountain land cover dynamics in the Ikh Bogd Natural Park Protected Area, Bayankhongor Province, Mongolia, by analyzing summer (June–August) averages for the years 2000, 2005, 2010, 2015, 2020, and 2025. Climatic data indicate a pronounced warming trend, particularly in winter. The absolute maximum temperature in January increased from −6.34°C in 2000 to −0.86°C in 2025, while the absolute minimum temperature rose from −30.4°C to −22.9°C, reflecting a stronger warming in the cold season. Annual precipitation increased substantially from 60.3 mm to 167.1 mm, with recent years showing higher variability and more frequent extreme precipitation events.

Vegetation dynamics assessed using NDVI reveal an overall degradation trend. Maximum NDVI values declined from approximately 0.39 in 2000 to 0.33 in 2010, alongside decreasing minimum values, indicating reduced vegetation density and increased fragmentation. Although partial recovery was observed in 2015–2025, vegetation remained sparse. Land surface temperature (LST) analysis shows elevated surface temperatures, with peak values recorded in 2005 and 2010, and continued warming in high-altitude zones (>3000 m), where temperatures increased by approximately 0.9°C between 2015 and 2025. A moderate negative correlation ($r = -0.46$) between LST and NDVI suggests that rising temperatures adversely affect vegetation cover, particularly during drought conditions.

However, increased precipitation in recent years appears to partially offset thermal stress. Land cover analysis indicates a substantial increase in sparse vegetation (7.8% to 40%) and a sharp decline in dense vegetation (20.29% to 2%), confirming ecosystem degradation.

Overall, the findings demonstrate clear evidence of climate warming and its significant influence on vegetation cover, land surface temperature, and ecosystem dynamics in the Ikh Bogd region. These changes have important implications for future environmental conditions, including snow cover, soil freezing processes, hydrological regimes, and seasonal ecosystem stability.

RESEARCH ON OBSERVATION CHARACTERISTICS AND FOREST COMBUSTIBLE PARAMETER INVERSION TECHNOLOGY OF MULTI-SOURCE MICROWAVE REMOTE SENSING IN FOREST AREAS ALONG THE CHINA–MONGOLIA BORDER

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Abstract: This study focuses on the application of multi-source microwave remote sensing in the forested region along the China–Mongolia border, with particular emphasis on vertically stratified forest temperature retrieval and its potential for wildfire risk warning.

The research was designed around two core objectives: evaluating the feasibility of microwave observations in complex forest environments and developing a temperature retrieval framework for different vertical forest layers. Because microwave signals have the physical characteristic that longer wavelengths penetrate deeper into vegetation, different frequency bands can provide sensitivity to distinct forest layers, offering an opportunity to observe both canopy and near-surface thermal conditions that are difficult to capture using conventional meteorological products alone. Field experiments were conducted in representative coniferous, broadleaf, and mixed forests, where in situ monitoring systems were deployed to continuously measure temperature, humidity, soil moisture, and dead fuel moisture-related variables at multiple heights.

These ground observations were combined with multi-source satellite microwave brightness temperature products, including FY-3D MWRI and SMAP, as well as ERA5 meteorological data, to analyze frequency dependent sensitivity and construct layered temperature retrieval models under different weather conditions. The results indicate that the L-band is more strongly correlated with surface temperature, while X-band observations show stronger sensitivity to canopy temperature. Precipitation was found to weaken the penetration capability of high frequency microwave signals, particularly at 36.5 GHz. Model experiments further demonstrate that multi-source data fusion outperforms single-source approaches and that canopy temperature retrieval is generally more accurate than forest-floor temperature retrieval. Under both clear and rainy conditions, the optimal models achieved R2 values above 0.80, confirming the effectiveness and robustness of the proposed framework. Building on these findings, the study proposes a forest fire early warning strategy based on vertically layered temperature information and related environmental factors.

The planned extension of experiments to the China-Mongolia border region will further support the development of a scalable and operational microwave-based fire risk monitoring system for boreal and temperate forest regions

RESEARCH ON FIRE RISK EARLY WARNING TECHNOLOGY IN FOREST AREAS ALONG THE CHINA–MONGOLIA BORDER BASED ON MULTI-SOURCE MICROWAVE REMOTE SENSING

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Abstract: Accurate estimation of fire weather indices (FWI) continues to face substantial challenges in regions with complex topography and diverse vegetation. This difficulty primarily arises from the over-reliance of traditional assessment methods on coarse reanalysis meteorological data, coupled with an insufficient characterization of the high spatial heterogeneity of surface moisture. To address these critical limitations, this study focuses on the expansive and ecologically vulnerable border region between China and Mongolia. We construct a robust, multi-source data fusion framework dedicated to the precise retrieval of the Canadian Fire Weather Index. This framework comprehensively integrates ground meteorological observation data, ERA5-Land reanalysis datasets, and multi-source microwave soil moisture products derived from advanced satellite sensors such as SMAP, AMSR2, and FY-3D. Based on rigorous data preprocessing and stringent quality control protocols, daily site-specific reference values for the six core components of the FWI system–Fine Fuel Moisture Code (FFMC), Duff Moisture Code (DMC), Drought Code (DC), Initial Spread Index (ISI), Buildup Index (BUI), and the final FWI–are systematically calculated utilizing standard physical equations. To rigorously evaluate the retrieval capabilities, we conducted a comprehensive comparative analysis of six distinct machine learning and statistical models: Extreme Gradient Boosting (XGBoost), Random Forest (RF), Convolutional Neural Networks (CNN), Long Short-Term Memory (LSTM) networks, Linear Regression (LR), and Generalized Additive Models (GAM). The comparative results conclusively demonstrate that tree-based ensemble methods significantly outperform deep learning and traditional statistical algorithms in this context. Specifically, XGBoost exhibited the optimal predictive performance, achieving the highest correlation and lowest error rates across all six FWI parameters by effectively capturing the complex, non-linear dynamics of fuel moisture and environmental drivers. Finally, leveraging the superior capabilities of the XGBoost model, we successfully generated high-resolution spatial distribution maps of forest fire danger ratings for the China-Mongolia border region. This study provides a scalable, highly accurate technical framework for regional fire monitoring and early warning systems under complex environmental conditions.

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SPATIAL ASSESSMENT OF WIND ENERGY POTENTIAL IN KOSOVO USING GIS

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Abstract: The spatial assessment of renewable energy resources has become a critical component of sustainable development strategies. This study focuses on evaluating wind energy potential in Kosovo through the application of Geographic Information Systems (GIS). Given the increasing demand for clean and renewable energy sources, identifying suitable areas for wind power development represents an important national priority.

Kosovo's geographical setting, characterized by diverse topography and climatic variability, significantly influences wind distribution patterns. Mountain ranges such as the Sharr Mountains and the Accursed Mountains, together with the Dukagjini and Kosovo Plains, create spatial heterogeneity in wind speed and energy potential. Understanding these spatial variations is essential for determining optimal locations for wind energy exploitation.

The methodology is based on the integration and analysis of multiple spatial datasets within a GIS environment, including wind speed and wind energy parameters at turbine-relevant heights. Additional geographical and environmental factors are incorporated to ensure a comprehensive spatial evaluation aligned with sustainable development principles. Through spatial modeling and geospatial analysis, the study identifies and delineates areas with high suitability for wind energy development

The results are presented in the form of thematic maps and spatial models, providing a strategic decision-support tool for policymakers, planners, and investors. These outputs contribute to informed decision-making processes, promoting efficient allocation of resources and supporting the transition towards renewable energy systems. Furthermore, the study highlights the importance of GIS as a powerful analytical framework for renewable energy assessment and sustainable energy planning.

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PRESENTATIONS

SESSION 2

Topic 1: Socio-economic geography and regional development

Topic 2: Big Data and Artificial Intelligence in Geography

THE ROLE OF BORDER PORT ECONOMIC DIVERSIFICATION AND REGIONAL AND LOCAL DEVELOPMENT

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Abstract: Mongolia is a landlocked country characterized by limited infrastructure and borders with neighboring countries through road and railway border ports. Nevertheless, border ports can be regarded as a "funnel" for economic development, serving as a catalyst for growth by generating direct, indirect, and induced effects. Mongolia's economy is highly dependent on foreign trade, particularly on the export of mining products. Therefore, there is a growing need to promote economic diversification by reducing dependence on a single source of income and creating multiple sources of revenue across expanding sectors and markets. Based on this necessity, it is essential to determine the role and level of contribution of border port economic diversification to regional and local development. Within the framework of the currently effective legal acts, relations concerning border ports are regulated by the Law on the Border of Mongolia. The provisions of this law are primarily aimed at ensuring the inviolability and security of the state border by regulating border regimes and the inspection and passage of passengers and vehicles crossing the national border. In reality, border ports are geographically strategic structures that play a key role in the socio-economic development of regions and local areas. They also support production and services, create geographical connectivity, and increase trade turnover through exports and imports. From this perspective, the legal regulations provided in the current Law on the Border are insufficient. Therefore, there is a need for an independent law regulating the legal status of border ports. Such a law should address the classification and functional system of border ports, economic diversification, and the differences in their roles in regional and local development. This study proposes a framework for identifying border ports that play significant roles in the socio-economic development of Mongolia. It suggests a three-tier classification system based on the level of contribution to development, including: ports that play a leading role in national and regional development, ports that play a leading role in regional development, and ports that play a leading role in local development. Furthermore, the study defines transportation functions, economic diversification measures, and trade expansion roles appropriate to each level of border port classification, operational regime, and development function. These functions provide the basis for determining the role and contribution of border ports to national, regional, and local socio-economic development.

AN EMPIRICAL STUDY ON SERVICE QUALITY AND TOURIST SATISFACTION IN MONGOLIA

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Abstract: This study investigates the relationships among destination image, service quality, tourist satisfaction, and revisit intention of South Korean tourists visiting Mongolia. Understanding international tourists' expectations, perceptions of destination image, satisfaction, and behavioral intentions is essential for enhancing destination competitiveness and developing effective tourism marketing strategies. A quantitative research approach was adopted, utilizing a structured questionnaire as the primary data collection instrument.

The survey targeted South Korean tourists visiting Mongolia through both package tours and independent travel arrangements. Data were collected during the summer season of 2025 in major tourist destinations, tourist camps, National parks and major tourist sites in Ulaanbaatar. A total of 432 valid questionnaires were obtained from the South Korean tourists who travelled in Mongolia.

The conceptual framework was developed based on an extensive review of tourism marketing and consumer behavior theories, integrating the constructs of pre-visit destination image, post-visit destination image, perceived service quality, tourist satisfaction, and revisit intention. To evaluate tourists' expectations and perceptions of Mongolia, a structured questionnaire incorporating 48 destination image attributes was employed, with responses measured using a seven-point Likert scale.

The findings revealed that perceived service quality had a significant positive effect on overall tourist satisfaction. Furthermore, tourist satisfaction was found to be a significant predictor of destination loyalty and revisit intention. The results confirmed the importance of destination image in shaping tourists' evaluations and future behavioral intentions.

The study provides practical implications for destination management organizations, tour operators, and travel agencies in improving tourism products and services for the South Korean market. Recommendations for enhancing Mongolia's destination image and increasing tourist satisfaction are presented. Finally, directions for future research are discussed to further advance understanding of international tourist behavior in emerging destinations.

RTSEVO V1.0: A RETROGRESSIVE THAW SLUMP EVOLUTION MODEL

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Abstract: Widespread thermal degradation in permafrost regions is accelerating the development of retrogressive thaw slumps (RTS), severely threatening ecological stability and critical infrastructure.

Current RTS modeling efforts, however, are largely confined to static susceptibility mapping, lacking the capacity to predict their spatiotemporal evolution. To bridge this gap, we developed RTSEvo, a novel dynamic RTS evolution model that couples three modules: (1) a time-series forecast of regional RTS area demand, (2) a machine-learning module for pixel-level probability mapping, and (3) a physically constrained spatial allocation module that simulates RTS expansion by integrating neighborhood effects, stochasticity, and a novel retrogressive erosion factor.

Validated using manually interpreted RTS maps for 2021 and 2022 in the Beiluhe Basin on the Qinghai-Tibet Plateau, the model successfully simulated dynamic RTS growth, with the Logistic Regression-based model showing superior stability and accuracy.

Furthermore, cross-regional validation confirmed the framework's structural generalizability. An interesting finding is that predictive skill is significantly enhanced by integrating process-based rules with statistical probability.

Specifically, the inclusion of the retrogressive erosion factor, which mechanistically simulates upslope headwall retreat, proved critical, improving model performance by up to 29.3% as measured by the Figure of Merit.

The primary innovation of this study is the successful realization of a regional-scale dynamic simulation and prediction of RTS expansion. RTSEvo offers a highly robust scientific tool for informing proactive RTS-related risk mitigation strategies.

A SPATIO-SEMANTIC FRAMEWORK FOR ECO-NATIONAL PARKS: INTEGRATING FLICKR SPATIO-TEMPORAL DATA WITH NLP-BASED ANALYSIS OF YOUTUBE PERCEPTIONS

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Abstract: Protected areas are increasingly central to both ecotourism development and climate-resilient systems. They provide biodiversity conservation, microclimate regulation, and recreational ecosystem services while also generating economic and cultural value.

In Thailand, national parks function as ecological reservoirs and green-blue infrastructure, yet rising visitation, accelerated in the post-COVID period raises questions about how these landscapes are experienced, perceived, and sustained within the broader discourse of ecotourism and resilience.

This study introduces a spatio-semantic framework integrating Flickr geotagged photographs with natural language processing (NLP) of YouTube reviews to evaluate six representative eco-national parks.

Flickr data capture spatio-temporal visitation patterns, seasonal dynamics, and landscape preferences, while NLP-based sentiment and thematic analysis reveal perceptions of ecosystem services, accessibility, and management challenges.

Linking quantitative spatial indicators of visitation with qualitative insights into visitor experiences provides a multidimensional assessment of ecotourism dynamics and urban-nature interactions.

Findings highlight persistent concerns over overcrowding and infrastructure stress, and unevenly distributed benefits across ecological landscapes.

The results demonstrate the value of user-generated content as a participatory informatics approach to complement traditional surveys and remote sensing, advancing methodological innovation in ecotourism research and offering actionable insights for embedding resilience, equity, and adaptive design into sustainable planning of peri-urban protected areas.

ECONOMIC AND GEOGRAPHICAL FACTORS OF MIGRATION ACTIVITY OF THE POPULATION OF THE NORTHERN MONGOLIAN PLATEAU

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Abstract: This study examines the economic-geographical factors driving migration activity among the population of the northern Mongolian Plateau – a transboundary macro-region encompassing the border aimags of Mongolia and the adjacent federal subjects of the Russian Federation (Buryatia, Zabaykalsky Krai, Tyva, and Altai). The study period spans 1990 to 2025.

The research objective is to identify the patterns, determinants, and consequences of migration processes in this cross-border region, conceptualised as a Territorial Migration System (TMS). The theoretical framework integrates Lee's push-pull model, the Todaro–Harris urban migration model, Savosk'ul's TMS concept, and Ivakhnuk's Eurasian Migration System theory. Methods include spatial-temporal GIS analysis, comparative-geographical and statistical approaches, push-pull factor analysis, and normative-legal analysis of the bilateral Russia–Mongolia regulatory framework.

Key findings reveal a persistent demographic asymmetry: Zabaykalsky Krai lost 334,100 residents – a 25 per cent decline – while Mongolia maintains natural population growth alongside hyper-concentration in Ulaanbaatar, which grew from 27 to 55 per cent of the national population. Five factor clusters are identified: natural-geographical (mountainous steppe terrain, sharply continental climate); economic (GRP and unemployment differentials – from 2.8% in Zabaykalsky Krai to 23% in remote aimags in 2000); infrastructural (railway accessibility as the primary determinant of settlement concentration – the 'corridor principle'); institutional (visa-free regime and eight intergovernmental agreements, 1995–2025); and geopolitical (relocation wave of 2022–2025 and Mongolia's enhanced transit function).

The study demonstrates the structural resilience of the Russia–Mongolia TMS: the COVID-19 pandemic temporarily reduced flows but did not destroy the system, which recovered within 12–18 months. Educational migration – approximately 2,000 Mongolian students enrolled at Russian universities – is identified as a strategically stable sub-flow. Policy recommendations address four domains: labour migration governance, educational exchange expansion, transport infrastructure modernisation, and development of special economic zones along the China–Mongolia–Russia corridor. A five-indicator monitoring framework is proposed for evaluating migration policy effectiveness. The findings contribute to the theoretical understanding of border migration systems in continental Asia and carry direct implications for regional development policy in both countries.

SPATIAL COMPARATIVE ANALYSIS OF PLANNED RAILWAYS IN MONGOLIA

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Abstract: Railway transport infrastructure is the most efficient mode of land transportation, capable of transporting large volumes of goods over long distances at relatively low cost simultaneously.

On the other hand, the development of railway transportation is of particular importance for landlocked countries, as it serves as a bridge connecting inland regions with seaports, markets, and industrial centers. In the case of Mongolia, rail transport plays a leading role not only in international and transit freight transportation, but also exerts a significant influence on the country's external economic relations. For instance, a total of 45.9 million tons of freight is transported by rail, of which 5.3 million tons accounts for transit transportation.

The Government of Mongolia, international research organizations, and scholars have proposed various alternatives for the development of the railway network, and determining which alternatives should be prioritized has become a critical issue.

This study attempts to optimize the prioritization and allocation of investments by conducting a comparative analysis of 13 potential railway corridor development alternatives while considering Mongolia's domestic and external conditions. To achieve this, a spatial comparative analysis was conducted using the MCA (Multi-Criteria Analysis) method based on 22 evaluation indicators representing transportation infrastructure, environmental, social, and economic conditions across the proposed alternatives. Based on the comparative analysis, the evaluation results indicate that the Artssuuri – Shiveekhuren and Ereentsav – Choibalsan – Baruun-Urt – Bichigt corridors should be prioritized in the first stage of development. In the second stage, the Artssuuri – Erdenet – Zamyn-Uud, and Bulgan – Altai – Mandalgovi – Baruun-Urt – Sumber corridors should be developed.

The remaining corridors are considered to have relatively lower significance and may therefore be developed in the third stage.

ANALYSIS OF THE ECOLOGICAL AND ECONOMIC CONDITION OF THE ASIAN RUSSIA REGIONS (USING THE REGIONS OF SIBERIA AND THE FAR EAST AS AN EXAMPLE) BASED ON INTEGRATED INDICATORS

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Abstract: An assessment of the environmental and economic condition of the regions of Siberia and the Far East based on a system of integrated indicators characterizing the anthropogenic load on the atmosphere and the effectiveness of environmental protection expenditures are presented in the paper. Calculations were made of the impact of pollutant emissions on the population, the density of anthropogenic load on the territory, and the effectiveness of environmental protection expenditures aimed at air protection.

It was established that the environmental and economic dynamics of the regions are characterized by pronounced spatial heterogeneity in terms of the anthropogenic load on the atmosphere and the effectiveness of environmental protection expenditures.

A trend towards a decrease in the effectiveness of air protection expenditures is revealed, while a significant load on the natural ecosystem and the population remains. At the same time, these regions are seeing an increase in the need for investment and ongoing environmental spending.

This finding is consistent with international studies, which have identified the critical importance of institutional conditions and the structural focus of environmental spending in achieving the maximum reduction in regional air emissions.

In this regard, available financial resources must be concentrated on the modernization of the fuel and energy complex, the development of low-carbon energy, and the strengthening of control and supervisory measures at emission sources.

The obtained results allow us to differentiate the regions of Siberia and the Far East based on the environmental and economic status of the regions in terms of air protection and substantiate the need to adjust regional environmental policy taking into account the integrated assessment of the air load and environmental protection costs.

The study was carried out within the framework of the state assignment of the Baikal Institute of Nature Management SB RAS No. 126021117027-6.

TOURISM DEVELOPMENT AND LAND USE/LAND COVER CHANGES IN KHATGAL, KHUVSGUL AIMAG, MONGOLIA

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Abstract: In this paper, we aim to improve our understanding of the impact of rapid tourism growth on land use/land cover in Khatgal, Khuvsgul Aimag, Mongolia. To better understand these processes, it is necessary to trace the history of tourism development in the region over the past thirty years.

This area has transformed from an important shipping port and transport hub into the most interesting tourist destination. We use remote sensing methods to quantify the development of tourism infrastructure in the region and develop machine learning algorithms to detect semi-permanent tourism infrastructure.

IMPLEMENTATION ASSESSMENT OF THE NEW URBAN AGENDA (2020–2024): EXPERIENCES, CHALLENGES AND FUTURE DIRECTIONS IN MONGOLIA

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Abstract: The "New Urban Agenda" adopted by the UN-HABITAT III Conference in 2016 is a global policy framework for the development of sustainable, accessible, safe and resilient cities and towns. Mongolia has consistently fulfilled its international obligations and has submitted its National Reports (1996, 2016, and 2022) to UN-HABITAT on its progress and development in the field of population and urban development. The purpose of this study is to assess the implementation of the "New Urban Agenda" in Mongolia for 2020–2024, as well as to determine the current status of the monitoring and statistical system for measuring implementation.

The study conducted a documentary analysis of national implementation reports, relevant legal documents, development policies, official statistics, and 77 UN-Habitat implementation assessment indicators. The results show that Mongolia has made significant progress in urban development policy in 2020–2024. For example, the revised Law on the Legal Status of Cities and Villages was approved, which established the legal status of 53 cities with state and local ranking. The "Regional Development Concept of Mongolia (2024–2050)" was also approved, identifying 7 economic regions and 91 local development centers, which laid the new foundation for a multi-center development system. However, major challenges remain in Mongolia's urbanization development. For example, half of the population is concentrated in Ulaanbaatar city, which produces the majority of the country's gross domestic product, creating an imbalance in spatial development. On the other hand, economic diversification, investment capacity, and institutional development in local cities and villages remain relatively weak.

A notable result of the study is the assessment of the applicability of 77 indicators for assessing the implementation of the "New Urban Agenda" in Mongolia. The analysis revealed that while some indicators are fully measured in the national statistical system, many indicators have limited measurement capabilities due to the lack of city-level data, inadequate spatial databases, and the incomplete development of the urban development statistical system.

Based on the results of the study, recommendations are provided for future policy directions in the urban development sector. This will enable Mongolia to implement the goals and objectives of the UN-Habitat "New Urban Agenda" and the "Sustainable Development Goals," as well as the goals and objectives of the "Vision 2050" long-term development policy of Mongolia adopted by the Parliament in 2020, improve the quality of the living environment of the population, and strengthen the sustainable development of cities and villages.

SPATIOTEMPORAL DROUGHT DYNAMICS AND FUTURE TRENDS ON THE MONGOLIAN PLATEAU

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Abstract: The largest warming during the last 100 years was observed over drylands, including the Mongolian Plateau, a vast dryland spanning over 2.7 million km^2.

Under ongoing climate change, drought has become one of the most pressing threats to the region's grassland ecosystems, pastoral livelihoods, and water resource security. In particular, rising temperatures have exacerbated evapotranspiration, further straining already limited soil moisture and surface water supplies across the plateau.

Over 83% of the plateau is characterized by persistent mild drought, with moderate to severe drought concentrated in the central and southwestern regions. Although a slight overall alleviation trend is detected between 2000 to 2021, projections indicate that nearly half of the plateau may face intensifying drought in the coming decades, with 21% of the region shifting from mitigation to deterioration.

These findings highlight the increasing vulnerability of dryland ecosystems on the Mongolian Plateau to compound climate risks, including heatwave-drought interactions and monsoon variability.

This presentation provides critical scientific evidence for drought monitoring, drought risk assessment and ecological conservation strategies essential for the sustainable development of drylands under a changing climate.

Strengthened early warning systems and adaptive land management practices are therefore urgently needed to mitigate these emerging threats.

STRENGTHENING LOCAL ADAPTATION RESILIENCE TO CLIMATE CHANGE THROUGH IDENTIFYING THE GAP BETWEEN NATIONAL AND LOCAL POLICY DOCUMENTS IN MONGOLIA

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Abstract: In recent years the climate change has led to an increased frequency of natural disasters such as drought and dzud (heavy snow disaster) in Mongolia. To enhance resilience and mitigate the impacts of climate, change, national-level programs have been developed. Consequently, these programs should be integrated into the action programs of the soum (counties) government.

This study investigates the extent to which soum governors have incorporated national-level climate adaptation programs into their action plans. The analytical framework was developed by establishing Adaptation Policy Criteria (APC) derived from national-level programs. The action plans of 17 soums in Khovd Province were then evaluated against these criteria through a clause-matching and scoring process.

The results indicate that the action plans demonstrate a substantial degree of alignment with national priorities, particularly in relation to pastureland conservation and degradation prevention, protection of water resources, and enhancement of resilience to natural disasters.

Several soum governors have incorporated locally tailored measures into their action plans, which may be considered examples of good practice. These measures include regular monitoring of pasture vegetation and the development of renewable energy infrastructure, such as solar and hydropower systems, to reduce greenhouse gas emissions. Nevertheless, additional emphasis should be placed on promoting livestock insurance among herders, establishing steppe fire detection networks, and enhancing the protection of groundwater resources and biodiversity.

Furthermore, some action plans included relatively few measures aimed at strengthening resilience and advancing climate change adaptation. These gaps have therefore been addressed through recommendations for future action. The findings of this study provide a valuable baseline for the formulation of climate change adaptation plans at the provincial and soum levels.

WATER USE AND THE LAKE BAIKAL LEVEL: ASSESSMENT OF DRINKING WATER QUALITY AND PUBLIC HEALTH RISKS

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Abstract: This paper examines the pressing issue of ensuring high-quality drinking water for the population of the Baikal region, using the Republic of Buryatia as an example.

The Baikal region traditionally boasts one of the highest specific water availability rates in the Russian Federation, owing to the presence of a unique body of water – Lake Baikal, which contains approximately 20% of the world's freshwater reserves–and the extensive river network of the Selenga, Barguzin, and Upper Angara basins. However, despite this significant hydrological potential, actual access to adequate water remains uneven and, in some municipalities, significantly limited.

This situation is due to the spatial heterogeneity of surface and groundwater distribution, the unique geological and hydrogeological conditions of the region, and the hydroclimatic fluctuations characteristic of the Lake Baikal basin. A significant portion of rural settlements in Buryatia are located in areas with a shortage of local water sources, resulting in dependence on imported water or the use of water intakes with unstable quality.

The study focuses on the impact of low- and high-flow periods, as well as annual and long-term fluctuations in Lake Baikal's water level, on the qualitative and quantitative characteristics of water sources. It is shown that in years with extreme water levels, water pollution, mineralization, and eutrophication intensify, the recharge regime of underground aquifers changes, the operating conditions of water intake and hydraulic structures deteriorate, and the reliability of centralized water supply systems to coastal and inland areas of the region decreases.

During periods of low water levels, competition among water users intensifies, while during high-flow periods, the risk of flooding and secondary contamination of water intakes increases.

The relationship between the shortage of high-quality drinking water and public health is analyzed, including the prevalence of diseases caused by the chemical and microbiological properties of drinking water–gastrointestinal and endocrine diseases, as well as pathologies associated with elevated or deficient levels of certain micronutrients.

It is emphasized that environmental and sanitary aspects of water supply directly impact quality of life and demographic stability in the region.

The study concludes that it is necessary to improve water resource monitoring systems, rationalize water use, modernize water treatment systems, and develop adaptation measures that take into account Lake Baikal's hydrological regime and climate trends of recent decades. The findings can be used in developing regional programs for sustainable water use and public health protection.

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DETERMINANTS OF HERDER HOUSEHOLD MIGRATION DECISIONS AND POLICY COHERENCE: A CASE STUDY OF KHOVD AIMAG

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Abstract: Livestock is the primary pillar of livelihood for rural herder households in Mongolia. Natural disasters, such as droughts and dzud, trigger significant livestock mortality, which subsequently deteriorates livelihoods and leads to an established pattern of increased migration to urban settlements.

This study aims to identify the key determinants influencing herder households' migration decisions and evaluate their alignment with local soum (district) policies and programs in Khovd aimag.

Adopting a mixed-methods approach, the study utilized survey data from 369 herder households across nine soums of Khovd aimag and conducted a qualitative content analysis of the Soum Governors' Action Programs (SGAP). Logistic regression analysis was employed to quantify the factors influencing migration probability, while content analysis assessed the integration of these factors within local policy frameworks.

The findings indicate that 25.2 percentof the surveyed households plan to migrate in the near future. Migration decisions are significantly influenced by a combination of demographic, environmental, and socio-economic factors. Specifically, owning property in an urban center (OR = 1.9) and the scarcity of suitable pastureland (OR = 1.8) substantially increase the likelihood of migration.

Conversely, having financial savings and employing assistant herders reduce the probability of migration by 55.9 percent and 52.2 percent, respectively. Policy analysis reveals that while local action programs prioritize social protection and support for young herders, there is a significant gap regarding pasture management and urban property ownership which are the primary drivers of migration.

This indicates weak policy coherence. Therefore, it is necessary for future local development policies to move beyond declarative provisions and address the underlying structural causes of migration to effectively manage herder out-migration.

INTEGRATING INVEST HABITAT QUALITY AND GLUE UNCERTAINTY ANALYSIS FOR CONSERVATION TARGET-BASED HABITAT ASSESSMENT IN IKH GAZRIIN CHULUU NATIONAL PARK, MONGOLIA

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Abstract: Assessing habitat quality in protected areas requires an integrated approach that accounts for land cover conditions, anthropogenic pressures, parameter uncertainty, and the spatial vulnerability of conservation targets.

This study evaluated habitat quality and degradation in Ikh Gazriin Chuluu National Park by integrating the InVEST Habitat Quality model, Generalized Likelihood Uncertainty Estimation (GLUE),

Random Forest land-cover classification, and spatial overlay analysis. Key anthropogenic threats included roads, settlements, herder camps, tourist camps, camping sites, travel routes, and hay fields. To reduce subjectivity in InVEST parameterization, threat weights, maximum impact distances, decay functions, and the half-saturation constant were calibrated using a Monte Carlo–based GLUE approach.

Among 1,200 model runs, approximately 4% were identified as behavioral parameter sets, indicating considerable sensitivity of habitat quality outputs to parameter uncertainty. The best-performing model identified roads, settlements, and herder camps as the main drivers of habitat degradation. Settlements showed the widest impact distance, reaching 4,081 m, while roads had a relatively high threat weight of 0.53. Overall habitat quality was moderate to high, with a mean value of 0.62 and a standard deviation of 0.19. However, habitat quality varied clearly among management zones, being lowest in the tourism zone and highest in the limited-use zone.

Substantial differences were also observed among conservation targets. Feather-grass steppe and Mongolian marmot habitats had the highest mean habitat quality values, at 0.676 and 0.662, respectively, with high-quality habitats covering 63.42% and 51.85% of their areas.

Conversely, cultural and historical heritage sites had the lowest mean habitat quality value of 0.376, with 28.18% classified as low-quality habitat. Habitat degradation was highest for cultural and historical heritage sites, where 98.0% of the area was affected by high degradation, followed by Mongolian marmot habitat at 41.0% and lake ecosystems at 33.0%.

Roads were the dominant pressure across all conservation targets, overlapping with 94.6% of affected Mongolian marmot habitat, 86.5% of feather-grass steppe, 82.3% of lake ecosystems, and 76.8% of cultural and historical heritage areas.

These findings indicate that habitat degradation in Ikh Gazriin Chuluu National Park is primarily driven by the combined effects of road networks, settlements, tourism, and livestock-related land use.

The results emphasize the need to reduce road-related disturbance, regulate tourism pressure, establish buffer zones around lake ecosystems and cultural heritage sites, and designate high-quality feather-grass steppe and Mongolian marmot habitats as ecological core areas. By integrating InVEST-HQ with GLUE-based uncertainty assessment, this study provides a robust spatial basis for conservation zoning, protected area management, and land-use planning.

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IMPLEMENTATION OF THE "POWER OF SIBERIA" MAIN GAS PIPELINE PROJECTS IN THE CONTEXT OF THE INTERNATIONAL TRANSPORT CORRIDORS CREATION: THE EXPERIENCES OF RUSSIA AND MONGOLIA

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Abstract: The work was funded by RSF grant No. 24-47-03004, https://rscf.ru/project/24-47-03004/.

Considering an ongoing active discussion regarding the joint Mongolian-Russian-Chinese "Power of Siberia-2" main gas pipeline project, it is necessary to lay the groundwork for future research into the strengths and challenges of the pipeline's impact on the socioeconomic development of the territory along its potential route. Presumably, the project will affect Mongolia's regions formed under fundamentally different natural conditions (coniferous forests, meadows, steppe and desert ecosystems). The experience of working within a comparative paradigm of the joint Russian-Mongolian project "Geoeconomic and geoecological priorities of new resource-industrial development of the regions of eastern Russia and Mongolia in the context of an aggravated geopolitical situation and the creation of international transport corridors" shows that both the southern and northern resource-rich territories face a number of similar challenges. We propose applying this research method to the existing and planned "Power of Siberia" projects, and thus taking into account the experience of the Russian territory transformation under the influence of "Power of Siberia-1" for the geographic forecasting of Mongolia's socioeconomic transformation.

In particular, we propose taking into account the limited impact along most of the "Power of Siberia-1" route due to the lack of gasification in small and medium-sized settlements, despite their location along the pipeline's path. On the other hand, the development of the southern Amur Region demonstrates the positive impact of the comprehensive international transport corridor development, accompanied by the industrial facilities establishment and the utilization of well-established cross-border cooperation. For Mongolia, the gas pipeline will potentially run along the main settlement framework which offers broad opportunities. In our view, the focus should be not only on the gasification of Ulaanbaatar, which is undoubtedly important, but also on all the aimags along the main vertical axis of development. This fits well with Mongolia's Concept for Regional Development: energy and industry as sectors of specialization for the Gobi region, and industry as one of the sectors of specialization (alongside tourism) of the Central Region. Among the challenges, we note the need to branch out the gas pipeline so that its secondary routes align with the biggest possible number of proposed horizontal transport corridors. We recommend starting with a branch in the south of the country, toward the mining regions, the gasification of which will significantly improve the quality of life for the population in the periphery.

CLIMATIC AND SOCIOECONOMIC RISK FACTORS FOR LIVESTOCK MORTALITY DURING WINTER DISASTERS IN WESTERN MONGOLIA

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Abstract: In recent decades, the majority of natural disasters globally have been caused by extreme climatic events, such as floods, extreme temperatures, droughts, heavy precipitation, and storms, with such events projected to intensify with ongoing climate change.

The Mongolian livestock sector is highly susceptible to extreme climatic events, notably drought and dzuds (harsh winter conditions), which cause large-scale livestock mortality, with significant socioeconomic impacts. Applying a fixed-effects negative binomial regression model to data at the soum (district) level, we investigated the climatic and socioeconomic determinants of livestock mortality in Khovd Province, Western Mongolia.

Ten indicators encompassing climate hazard (drought, cold temperature, and snow), exposure to hazards (livestock numbers), herders' vulnerability (age and sex of herders and household herd size), and herders' responses (hay production, barn availability, and livestock insurance) were included in an analysis of 16 soums in Khovd Province during the period 2014–2024.

The results revealed that heavy snow and severe drought were associated with high livestock mortality, indicating an elevated mortality risk associated with summer drought conditions coupled with snow-intensive winters. Greater hay production, a relatively high proportion of younger herders, and small household herd size were associated with lower livestock mortality, suggesting that these socioeconomic factors play a critical role in enhancing dzud resilience.

Thus, a heightened risk of livestock mortality is associated with a distinct set of climatic and socioeconomic conditions in individual soums in Khovd Province.

These findings highlight the compounded effects of extreme climatic conditions and demographic changes on pastoral livelihoods in Western Mongolia, underscoring the need for integrated and targeted risk-reduction strategies.

URBAN DEVELOPMENT PERCEPTION ALONG THE TRANSPORTATION CORRIDORS OF THE MONGOLIAN PLATEAU SUPPORTED BY SDGSAT-1 & VIIRS NTL DATA

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Abstract: Urban agglomerations in Mongolian Plateau are very important transportation nodes in North-East Asia area. While, these cities sparsely distributed in the vast grassland areas, posing challenges for detecting urban changes in the transboundary regions.

This study proposes a method for characterizing urban development supported by multi sources remote sensing data including nighttime light (NTL) data with superior resolution, fo-cusing on 11 major cities along the China-Mongolia-Russia Economic Corridor within the Mongolian Plateau from 2022 to 2023. Additionally, we have obtained results for 2015 and 2020 using VIIRS NTL data for long-term time series analysis in our study.

A City Development Index (CDI) is introduced, utilizing "temporal information entropy" with the entropy weight method to effectively incorporate temporal dynamics.

The development status of 11 cities in the study area was analyzed using fractal dimensions, compactness, standard deviation ellipse, and the CDI. Results in 2023 show Hohhot has the highest CDI (0.83), followed by Baotou (0.63), Ordos (0.62), and Ulanqab (0.57).

In contrast, Mongolian cities exhibit significantly lower CDIs relatively. The capital, Ulaanbaatar, has a CDI of 0.38, while no other Mongolian city exceeds 0.30, correlating with their scatter populations.

The results of the long-term time series analysis from 2015 to 2023 indicate that Inner Mongolia and Mongolia exhibit differences in both the quality and speed of development. This approach provides a quantitative method for detecting and assessing urban development of the arid and semi-arid regions using NTL satellite data.

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PRESENTATIONS

INFORMAL SOCIAL NETWORKS IN TOURISM IN KHUVSGUL AIMAG OF MONGOLIA

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Abstract: After the socialist period in Mongolia, social ties acquired a new meaning. They became the main instrument of economic survival during the transition period. Due to the suddenness of shock therapy and privatization reforms in the post-socialist period, many public institutions were not given the time and opportunity to develop into full-fledged, independent systems, prolonging local dependence on Soviet-era private networks.

For a number of regions of Mongolia, the transition to a market economy was closely linked to the development of the tourism sector.

One of these territories is Khuvsgul aimag, the northernmost province of Mongolia, where Lake Khuvsgul is located.

The settlement of Khatgal, located on the southern shore of Lake Khuvsgul serves as a striking example of this transformation. During the socialist era, it functioned as a strategic transport port serving the northern regions of the country; however, in the post-socialist period, its economic specialization shifted towards tourism. Here tourism is closely linked to and dependent on informal social networks.

MACHINE LEARNING CLASSIFICATION OF PRISMA HYPERSPECTRAL DATA FOR LAND COVER MAPPING

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Abstract: Over the years, digital classification methods have demonstrated remarkable effectiveness in the analysis of hyperspectral imagery, enabling the accurate discrimination of pixels into distinct and meaningful classes. Careful selection of the most informative spectral bands can significantly improve classification accuracy by emphasizing relevant features while minimizing noise and redundancy.

This optimized band selection not only enhances computational efficiency but also increases the reliability and robustness of predictive models. Consequently, the improved classification results provide a stronger scientific basis for applications such as environmental monitoring, land-use planning, and natural resource management.

To differentiate the existing land cover classes, we applied 2 widely used machine learning approaches: an artificial neural network (ANN) and a support vector machine (SVM), and compared their performances under 4 different spectral band combinations.

The classification results were evaluated using overall accuracy and the Kappa coefficient. Among the tested methods, in most cases the SVM achieved the highest performance across all band combinations, yielding Kappa coefficients ranging from 0.90 to 0.96. The ANN also produced strong results, with overall accuracies exceeding 90% and Kappa coefficients greater than 0.90.

The findings demonstrate that different band combinations of hyperspectral imagery can improve the discrimination of land cover types, while the SVM approach provides the more reliable and accurate performance for land cover mapping in the study area.

SPATIAL ASSESSMENT AND MAPPING OF HUMAN PRESSURE ON DRY STEPPE PASTURE

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Abstract: Mongolia acceded to the United Nations Convention to Combat Desertification in 1996 and subsequently adopted the "National Action Programme to Combat Desertification" in 2010 and the "National Programme on Biological Diversity" in 2015, with the aim of protecting and sustainably utilizing biological resources within ecosystems. However, numerous studies have shown that global warming and climate change are intensifying aridity, desertification, and land degradation, while human activities are further accelerating these processes and contributing to ecosystem instability.

According to the National Statistics Office of Mongolia, the country's population has increased by more than 40% over the past two decades, while livestock numbers have risen by 120%. At the same time, rapid urbanization, infrastructure expansion, and mining activities have significantly increased pressure on pasture ecosystems. National land-use reports further indicate that agricultural land and forest areas declined by 15% and more than 20%, respectively, while urban settlements, transport infrastructure, and utility networks expanded by approximately 130–140%.

Pastureland covers more than 80% of Mongolia's territory and supports highly diverse biological resources. Nevertheless, the "Second National Report on the State of Rangelands of Mongolia" concluded that 57% of pastureland has been affected by degradation. In addition, the 2020 State of the Environment Report found that intensive grazing in the dry steppe region has reduced the abundance of palatable perennial forage species while increasing the distribution of degradation-indicator plants. The dry steppe ecosystem is therefore considered highly vulnerable to both climate change and anthropogenic impacts.

This study assessed human-induced factors contributing to pasture degradation across 44,704.9 km^2 in 14 soums of Bulgan Province and Töv Province, representing Mongolia's dry steppe zone, where pastureland accounts for 95.6% of the total area. An integrated human impact map was developed using spatial analysis methods. Eight major factors were analyzed, i.e., settlements, road networks, mining activities, cropland, winter and spring camps, wells, rivers and lakes, and livestock density. GIS-based Multi-Criteria Decision Analysis (MCDA) and the Analytic Hierarchy Process (AHP) were applied to evaluate the spatial extent and intensity of each factor.

The results indicate that winter and spring camp areas experienced the highest level of impact, with 64% classified as highly affected. Mining-related impacts affected 44.6% of the study area, while areas surrounding rivers and lakes accounted for 42% of human-induced impacts, and zones around wells accounted for 39%. The integrated assessment map showed that 64.2% of the study area was subject to low-level impact, 33.2% to moderate impact, and 2% to high impact.

ASSESSING GEO-ECOLOGICAL CONDITIONS: (A CASE STUDY IN ERDENET AREA)

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Abstract: In the context of intensifying global warming and climate change, the sustainable utilization of natural resources, prevention of environmental degradation, and maintenance of ecological balance have become increasingly important. In this study, the geoecological conditions of the Darkhan urban area were evaluated using the Entropy-Based TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) multi-criteria decision analysis for spatial geoecological assessment.

A total of 20 variables were selected for the analysis, including maximum temperature of the warmest month (Warmest), annual precipitation (P), Mezentsev moisture coefficient (MI), climatic biological productivity index (TK), rainfall erosivity factor (Rfactor), digital elevation model (DEM), slope, terrain ruggedness index (TRI), drainage roughness degree (DRD), topsoil grain size index (TGSI), soil organic carbon (SOC), normalized difference water index (NDWI), fractional vegetation index (FVI), change in normalized difference vegetation index (âˆ†NDVI), habitat quality index (HQ), line pressure (LP), area pressure (AP), point pressure (PP), air pollution index (API), and earthquake (EQ). The weights of these variables were determined using the entropy weighting method. Subsequently, the distances from the positive and negative ideal solutions were calculated using the TOPSIS method, and a Geoecological Condition Index (GCI) was developed. The results showed that GCI values ranged from 0.34 to 0.70, with most parts of the study area classified as having moderate to good geo-ecological conditions.

However, relatively low GCI values were identified in areas surrounding mining operations, industrial zones, and agricultural lands. The entropy weighting results indicated that climatic variables and area-load indicators had relatively high weights, suggesting their significant influence on geo-ecological conditions. Furthermore, the sensitivity analysis revealed only minor changes in GCI values, confirming the stability and robustness of the developed index.

Therefore, the Entropy-Based TOPSIS approach proved to be an effective method for reducing subjective bias and assessing geoecological conditions at a medium scale based on remote sensing data.

ASSESSMENT OF SUSTAINABLE TOURISM CARRYING CAPACITY IN KHYARGAS LAKE NATIONAL PARK, MONGOLIA

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Abstract: In recent years, the tourism sector in Mongolia has been developing rapidly and has become one of the important contributors to the country's economic growth. In particular, the western region of Mongolia, distinguished by its pristine natural landscapes, unique ecological formations, and nomadic cultural heritage, has increasingly attracted the attention of both domestic and international tourists. Among the major tourism destinations in this region, Khyargas Lake National Park possesses exceptional significance due to its scenic beauty, rich biodiversity, rare flora and fauna, and the ecological value of its surrounding ecosystems. Therefore, the area was placed under state protection in 2000.

This study aimed to evaluate the recreational suitability of natural tourism areas and determine their tourism carrying capacity. The study applied the methodology entitled "Criteria for Assessing the Suitability of Natural Tourism and Recreational Areas," approved by the Implementing Agency of the Government of Mongolia, the General Authority for Land Administration, Geodesy and Cartography. Within the framework of the study, the natural resources around Khyargas Lake, the current state of tourism, recreational use patterns, tourist movements, travel routes, and tourism service types were thoroughly analyzed.

As a result of the study, the carrying capacities of several tourism activities in the tourism center of Uvs aimag were quantitatively determined. These activities include Khyargas Lake sightseeing tours, ecotourism forest hiking, horseback riding on sand dunes, wildlife observation tours, and off-road motorsport tourism activities. The total carrying capacity for these tourism services was estimated at 6,040 visits per day within a 1,500 km tourism zone. In addition, the recreational carrying capacity of the local beach area within the Khyargas Lake tourism center was estimated at 960 visits per day within a 230 km zone.

The results of this study are highly significant for organizing tourism development in the region without compromising environmental sustainability. The identified carrying capacity indicators can serve as fundamental baseline information for improving tourism management, distributing tourist flows appropriately, protecting natural resources, enhancing tourism service quality, and increasing local community participation. Furthermore, the findings of this research may serve as preliminary benchmark indicators for the long-term sustainable tourism development planning of Uvs aimag and Khyargas Lake National Park.

SPATIAL OPTIMIZATION AND ECONOMIC INTEGRATION OF TOURISM DEVELOPMENT IN MONGOLIA

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Abstract: In Mongolia, there is a growing imperative to develop sustainable tourism, mitigate regional development disparities, stimulate local economies, and preserve cultural and natural heritage.

Addressing these needs, this study delivers a scientifically grounded spatial framework to identify and delineate national tourism zones. Utilizing a comprehensive set of indicators across environmental, geographical, landscape, protected area, socio-economic, infrastructural, and logistics dimensions, the spatial modeling was executed using Geographic Information Systems (GIS) coupled with Multi-Criteria Decision Analysis (MCDA) and the Analytic Hierarchy Process (AHP), alongside Hotspot and Service Area Analyses.

Through this approach, 91 potential tourism locations across the country were identified, mapped, and evaluated based on their spatial suitability, resource capacity, and future development prospects.

As a primary outcome of this research, the Government of Mongolia officially designated 17 locations across 12 provinces within six economic regions as National Tourism Zones for the first time. These designated zones serve as strategic hubs for natural, cultural, special interest, and cross-border tourism.

The findings demonstrate that aligning tourism development with economic zoning, transport corridors, transboundary cooperation, and infrastructure networks significantly enhances regional economic integration, boosts local revenue, creates jobs, and attracts sustainable investments. Moving forward, a phased implementation is recommended to formalize the remaining potential sites, refine zone-specific functional specializations, formulate management blueprints, conduct ecological carrying capacity assessments, and prioritize investment pipelines.

This study serves as a foundational scientific rationale for implementing Mongolia's regional development concepts and spatial tourism policies.

EARTHQUAKE-INDUCED ROCKSLIDES AND LAKE DEPRESSION GEOMORPHOLOGY IN THE GOBI-ALTAY RANGE, MONGOLIA

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Abstract: This study investigates the geomorphic characteristics of lake depressions and the impacts of earthquake-induced rockslides in the Gobi–Altay Range, southern Mongolia. The study focuses on three rockslide-dammed lakes–Oyu, Nomin, and Binderya–formed following the 1957 Mw 8.1 earthquake. The earthquake triggered large rockslides that blocked narrow valleys, creating natural dams and altering hydrological connectivity across this arid mountain region.

Remote sensing data, morphometric analysis, terrain classification, and field measurements were integrated to examine lake depression morphology, rockslide characteristics, and hydrodynamic behavior.

The results identify three major rockslide deposits, with the largest near Binderya Lake (2.49 km^2; 0.417 km^3), while smaller deposits (0.12–0.71 km^2) occur at Oyu and Nomin Lakes. Steep valley slopes (average 35–43°, maximum 65–68°), combined with tectonic control, strongly influence rockslide initiation and downslope movement. Between 2016 and 2025, all lakes exhibited declining area and volume, particularly Oyu and Nomin Lakes, although modest R^2 values (0.16–0.26) suggest substantial interannual variability and indicate that the observation period remains too short to distinguish long-term trends from short-term fluctuations.

Terrain classification further reveals high surface heterogeneity, providing important constraints for realistic rockslide modeling. The lake depressions display distinct morphometric characteristics shaped by tectonic deformation and earthquake-induced slope failures, influencing sediment storage and regional arid region geomorphic features.

ECOLOGICAL RISK ASSESSMENT AND SPATIAL DISTRIBUTION OF TOXIC HEAVY METALS IN THE PASTURE SOILS OF TSENKHER SOUM, ARKHANGAI PROVINCE, MONGOLIA

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Abstract: The objective of this study was to assess the spatial distribution and ecological risk of heavy metals in agricultural and pasture soils in Tsenkher soum, Arkhangai province, Mongolia.

A total of 66 soil samples (representing both horizontal and vertical profiles) were analyzed for arsenic (As), chromium (Cr), copper (Cu), zinc (Zn), molybdenum (Mo), lead (Pb), and uranium (U). The mean concentrations were 716.1 (As), 60.3 (Cr), 26.0 (Cu), 81.8 (Zn), 6.3 (Mo), 19.1 (Pb), and 28.1 (U) mg/kg, respectively.

Compared to the Mongolian Soil Quality Standard (MNS 5850:2019), arsenic (As) concentrations exceeded the permissible limit in all samples, while molybdenum (Mo) exceeded the limit in 29.8% of samples. Cr, Cu, Zn, and Pb levels remained within the threshold limits.

Although uranium (U) is not included in the MNS 5850:2019 standard, its concentrations (ranging from 2.3 to 225.2 mg/kg) were significantly elevated compared to the Earth's crust average (2.5 mg/kg). The Pollution Index (PI) and Potential Ecological Risk Index (PER) were used to assess the degree of soil pollution.

PI indicated that soils were moderately to highly enriched with As, U, and Mo (PI order: As > U > Mo > Cu > Ni > Zn > Pb). Ecological risk assessment revealed a low risk for Cu, Ni, Zn, and Pb (Eri < 40), while As and U exhibited very high ecological risk index (Eri > 320). With a mean comprehensive risk index (RI) of 4049, the study areas an extremely high ecological risk.

COMPARATIVE EVALUATION OF SPECTRAL INDICES FOR SURFACE WATER MAPPING: A CASE STUDY OF UVS LAKE REGION, WESTERN MONGOLIA

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Abstract: Accurate and up-to-date information on surface water is essential for understanding hydrological responses to global climate change and human activities in arid regions. Remote sensing technology is considered an effective way of obtaining surface water information.

Currently, numerous surface water extraction techniques have been developed and applied for various regions. Among them, spectral water indices derived from optical satellite data are commonly used for surface water body extraction due to their simplicity and efficiency. However, it's challenging to select the most suitable index and determine an appropriate threshold that accurately extracts surface water bodies under local environmental conditions.

This study assesses the performance of 6 widely used spectral water indices for surface water information extraction in the Uvs Lake region of Western Mongolia. The spectral water indices, including NDWI, MNDWI, AWEIsh, AWEInsh, WI2015, and MBWI, were computed from median images of Landsat 8 OLI of 2025 from May to September.

To delineate water bodies, the Otsu automated thresholding and fixed thresholding methods were applied. All indices achieved high overall accuracy (0.934-0.968) and Kappa values ranging from 0.835 to 0.920, with AWEIsh, AWEInsh, WI2015, and MBWI consistently outperforming NDWI and MNDWI across both thresholding methods.

Omission errors for the water class substantially exceeded commission errors across all indices, indicating a systematic tendency to under-detect water rather than over-classify it, while commission errors for the non-water class remained modest (0.030-0.081). Otsu thresholding yielded superior Kappa and F1 scores for AWEIsh, AWEInsh, WI2015, and MBWI-indices with well-separated bimodal distributions-whereas fixed thresholding performed better for NDWI and MNDWI.

This result suggested that threshold selection should be matched to the spectral characteristics of each index to achieve optimal water-mapping accuracy.

THE FACTORS CONTRIBUTING TO THE WILDFIRE OCCURRENCE IN THE BORDER AREA OF MONGOLIA AND CHINA

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Abstract: Wildfires are natural disasters that represent a significant threat to ecological, economic, and social systems. One of the most devastating effects of wildfires is serious damage to pastureland, which is one of the main components of Mongolian ecosystems.

Analyzing the spatial distribution and time frequency of wildfires is critical to the environment and the socioeconomics of the country. In recent years, forest and grassland fire surveys have been intensively conducted using remote sensing data. The main objective of our research was to examine the contribution of the human-environmental factor to forest and grassland fires, and their spatial distribution and time frequency.

The study area was a border area of Mongolia and China, a region with some of the highest frequency distribution of wildfires. In this paper, the frequency of burnt areas was characterized by MODIS (Moderate Resolution Imaging Spectroradiometer) satellite imagery, burnt area data (MCD45) and vegetation cover (MOD13A2), where fire occurred in the study area in the last 15 years. In addition, a human influence index and the aridity index were analyzed to explore their contribution to wildfire occurrence in the study area.

Our results indicated that an area of 111126.11 square km (40.79% of the study area) was burned. According to the classification results of the aridity index, the study area is entirely within the arid category.

Finally, the correlation between three variables shows that wildfires regularly occurred in certain small settlements near the border area, less developed infrastructure areas and protected areas based on their landscape, geomorphological structure and vegetation cover as well as depending on the type of land use and the different patterns of animal husbandry, pastoral management, population density, population distribution and settlement of the two countries.

SPATIOTEMPORAL PATTERNS AND DRIVING FORCES OF LAND DEGRADATION IN MONGOLIA FROM 1985 TO 2022: INSIGHTS FROM LONG-TERM NDVI TIME SERIES AND GEOSPATIAL ANALYSIS

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Abstract: Land degradation is among the most pressing environmental challenges threatening ecosystem sustainability, biodiversity conservation, and pastoral livelihoods across the Mongolian Plateau. Mongolia's dryland ecosystems are particularly vulnerable to climate variability and increasing anthropogenic pressures; however, the relative contributions of these factors to long-term land degradation remain insufficiently understood.

Identifying the dominant drivers of degradation is therefore essential for developing effective strategies for sustainable land management, ecological restoration, and climate adaptation.

This study investigated the spatiotemporal dynamics and driving forces of land degradation across Mongolia during 1985–2022 using integrated long-term remote sensing observations and geospatial analysis. Vegetation dynamics were assessed by combining GIMMS NDVI3g (1985–2000) and MODIS MOD13Q1 (2001–2022) datasets.

To ensure temporal consistency, MODIS data were resampled to an 8-km spatial resolution and harmonized with GIMMS observations using regression-based sensor calibration and bias-correction procedures during the overlapping period. Growing-season (April–September) NDVI composites were generated using the Maximum Value Composite (MVC) approach and analyzed using the Theil–Sen slope estimator and Mann–Kendall trend test.

The results revealed substantial spatial and temporal heterogeneity in vegetation dynamics across Mongolia. Approximately 50.2% of the national territory exhibited increasing NDVI trends, whereas 49.7% showed declining trends during the study period.

Three distinct phases of ecosystem change were identified: vegetation improvement during 1985–1994, widespread degradation during 1995–2007, and partial recovery during 2008–2022. Spatially, vegetation improvement was concentrated in northern forest-steppe and eastern grassland regions, while persistent degradation was observed in southern and western dryland ecosystems.

To identify the mechanisms underlying these patterns, climatic variables, including temperature and precipitation, together with anthropogenic factors such as livestock density, population density, road networks, settlements, mining activities, cropland expansion, and water-resource distribution, were integrated within a GIS framework. Partial Order Theory and Hasse Diagram analysis were employed to evaluate the hierarchical relationships and relative importance of degradation drivers.

The findings indicate that land degradation in Mongolia is driven by the interaction of climate variability and human activities rather than by a single dominant factor, with livestock pressure, precipitation variability, and increasing human disturbance emerging as key controlling drivers.

This study provides a novel framework for understanding long-term land degradation processes and offers scientific evidence to support sustainable rangeland management, ecological restoration, and climate adaptation strategies in Mongolia and other dryland regions.

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WATERSHED-BASED MORPHOMETRIC ANALYSIS OF THE SELENGE RIVER BASIN

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Abstract: This study presents a morphometric analysis of the hydrographic network and drainage basin of the Selenge River using the HydroSHEDS digital elevation model (DEM).

The main objective is to delineate the natural watershed boundary with higher accuracy and to evaluate the structural organization and developmental patterns of the drainage network using morphometric parameters.

Morphometric analysis was first introduced into hydrological studies by Horton (1945). This approach enables the quantitative characterization of drainage basin morphology, the structure of stream networks, and their spatial organization. It is widely used to assess the evolutionary characteristics of fluvial systems. In this study, a total of 24 morphometric parameters were calculated, including linear, areal, and relief-based variables of the Selenge River basin.

The results indicate that the currently adopted classification of Mongolia's 29 river basins does not fully correspond to actual watershed boundaries in several areas. Therefore, using the HydroSHEDS DEM, the watershed boundaries were redefined, and the Selenge River basin and its sub-basins were reclassified accordingly. The Selenge River basin consists of stream orders ranging from 1 to 9. According to Horton–Strahler's laws, the mean ratios of stream length, drainage area, and stream number are 2.2, 2.1, and 4.4, respectively. This indicates that with increasing stream order, the average stream length increases by approximately 2.2 times and drainage area increases by 2.1 times, whereas the number of streams decreases by a factor of 4.4. The total drainage area of the Selenge River basin is 461343.3 km^2, of which 310610.2 km^2 lies within Mongolia and 150733.1 km^2 within the Russian Federation.

The novelty of this study lies in the application of a high-resolution digital elevation model to perform morphometric analysis and to re-delineate the boundaries of the Selenge River basin and its sub-basins.

This correction addresses inconsistencies in previous basin classifications. The findings suggest that the currently used delineation of Mongolia's 29 river basins requires revision based on more accurate geomorphometric data.

SPATIAL DISTRIBUTION OF HEATWAVES IN ARKHANGAI PROVINCE ASSESSED USING MACHINE LEARNING METHODS

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Abstract: In recent decades, the frequency, intensity, and duration of heatwave events have increased in many regions of the world due to the impacts of climate change. These extreme temperature events pose significant threats to natural ecosystems, agricultural production, water resources, and human health. Therefore, accurately assessing the spatial distribution of heatwaves and identifying the environmental factors influencing their occurrence has become increasingly important.

This study detected heatwave events in Arkhangai Province, Mongolia, using MODIS land surface temperature (LST) data acquired between 2002 and 2025. Heatwave events were defined as periods during which land surface temperature exceeded the 90th percentile threshold for at least three consecutive days.

The spatial distribution of daytime land surface temperature during the identified heatwave periods was modeled using Random Forest (RF) and Extreme Gradient Boosting (XGBoost) machine learning algorithms. Predictor variables included nighttime land surface temperature, vegetation indices (NDVI, EVI, SAVI, and NDWI), surface albedo, land cover, elevation, slope, aspect, and geographic location variables.

The results revealed distinct heatwave events in 2002, 2007, and 2015. Among the evaluated machine learning models, XGBoost consistently outperformed Random Forest in all cases. The XGBoost model achieved coefficients of determination (RÂ^2) of 0.8322 and 0.8610 for the 2002 and 2015 heatwave events, respectively, indicating a high capability for explaining the spatial variability of land surface temperature during extreme heat conditions.

Feature importance analysis demonstrated that nighttime land surface temperature and vegetation indices were the most influential predictors controlling heatwave-related temperature patterns.

The findings provide a scientific basis for identifying heatwave-prone areas, assessing climate-related risks, and supporting the development of climate adaptation and mitigation strategies. Furthermore, the study demonstrates the effectiveness of integrating remote sensing data and machine learning techniques for monitoring and spatially modeling heatwave dynamics in Mongolia.

METHODOLOGICAL ISSUES IN DELINEATING TOURISM REGIONS USING CLUSTER ANALYSIS

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Abstract: Articles 16.1 and 16.2 of the Tourism Law of Mongolia provide for the establishment of National Tourism Regions and Local Tourism Regions through appropriate spatial planning to promote sustainable tourism development, attract domestic and foreign investment, and diversify tourism products and services.

Tourism is one of Mongolia's leading economic sectors, with national targets of receiving 2 million international tourists by 2030 and 6 million by 2050. Achieving these ambitious goals requires the identification of national and local tourism regions based on tourism resources, their geographical distribution and comparative advantages, the Regional Development Concept, transportation infrastructure corridors, transport and logistics networks, border crossings, and national and local urban centers. Such regionalization provides a foundation for strategic planning and investment allocation.

The scientific delineation of tourism regions is of strategic importance for regional development, infrastructure provision, and investment planning. This paper examines the methodological issues of identifying tourism regions in Mongolia using cluster analysis. The study was conducted within the framework of the fundamental research project "Renewing the Theoretical Foundations, Integrated Methodology, and Methods of Regional Development in Mongolia (2019–2021)", funded by the Ministry of Education and Science and the Science and Technology Fund, and implemented by the Institute of Geography and Geoecology of the Mongolian Academy of Sciences.

Cluster analysis was carried out using a set of indicators, including natural tourism resources, cultural tourism resources, historical tourism resources, special-interest tourism resources, tourism service facilities, transportation infrastructure corridors, transport and logistics networks, border checkpoints, and national and local urban centers. Based on these criteria, seven tourism cluster regions and fifty-six sub-regions were identified at the national level. The resulting tourism regionalization framework provides an important basis for the spatial organization of tourism activities, enabling the efficient accommodation and management of the projected tourist flows while enhancing private-sector investment and improving the productivity and competitiveness of Mongolia's tourism sector.

REMOTE SENSING-BASED ESTIMATION OF SOIL ORGANIC CARBON STOCK (SOC) IN CROPLANDS

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Abstract: Mongolia is Central Asian country with extra-continental climate conditions and domination of dry steppe and Gobi-desert nature. Soil organic carbon (SOC) is an important soil parameter of cultivated soils that needs to be monitored and mapped regularly to enhance soil health and productivity. The study was aimed at computation of soil organic carbon stock (SOC) and soil Quality index (SQI) in gropland of Mongolian forest steppe area and their mapping using remote sensing inputs employing machine learning techniques. Soil sample analysis database from Mongolian forest steppe area was used for the computation of SOC making use of different pedotransfer functions. Principal Component Analysis was conducted to identify the most influential parameters for soil quality, and their weights were determined using Factor Analysis. The Soil Quality Index was computed by integrating these scores and their corresponding weights. The SOC and SQI values calculated for each sampling location were further used to map their spatial distribution using the Random Forest regression technique. Various environmental variables, such as land use/land cover, long-term remote sensing derived vegetation indices, DEM-based terrain parameters, geological information, spectral indices, and bioclimatic parameters, were integrated into the RF model for spatial mapping of SOC and SQI. Topographic Position Index and aspect were derived from ALOS PALSAR DEM data. Soil sampling was conducted using both transect and random sampling methods at 210 locations in croplands. Soil organic matter (SOM) is a key soil quality parameter that influences soil health and productivity.

Five spectral vegetation indices were generated monthly using Sentinel data (2019-2021) on the Google Earth Engine platform. The Normalized Difference Vegetation Index (NDVI) ranged from -0.02 to 0.89, with a mean of 0.32. The Enhanced Vegetation Index (EVI) varied from 0.219 to 0.83, with a mean of 0.277, while the Soil Adjusted Vegetation Index (SAVI) ranged from 0.01 to 0.621. SOC stock varied widely across the study area, ranging from 18.20 to 90.98 Mg/ha. The Soil Quality Index (SQI), computed using the Minimum Data Set (MDS), ranged from 16 to 68, with an average value of 40.

Spatial mapping of SOC stock (R^2 = 0.73) and SQI (R^2 = 0.82) was achieved with considerable accuracy using Random Forest (RF) regression. NDVI, Hue Index, Coloration Index, elevation, and Compound Topographic Index (CTI) were identified as the most important variables for SQI prediction. For SOC prediction, the most influential variables included elevation, slope, Coloration Index (CI), NDVI, annual mean temperature, annual precipitation, and CTI. However, the use of high-resolution input data over large areas posed computational challenges.

EVALUATING THE SPECTRAL REFLECTANCE CHARACTERISTICS OF ARID STEPPE VEGETATION IN RELATION TO LONG-TERM TRENDS IN VEGETATION COVER CHANGES

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Abstract: To accurately and rapidly assess pasture degradation using remote sensing, it is essential to determine the spectral reflectance characteristics of individual plant species. The objective of this study is to characterize the spectral reflectance of dominant species and indicator species of degraded pastures in the arid steppe region of Mongolia and to evaluate them in relation to long-term trends in vegetation cover. In this study, we selected 14 reference sites representing the arid steppe region and measured the spectral reflectance of dominant species (Caragana microphylla, Stipa krylovii, Achnatherum splendens, Cleistogenes squarrosa) and degraded pasture indicator species (Artemisia adamsii, Leymus chinensis, Artemisia frigida) using an ASD HandHeld 2 spectrometer. To evaluate long-term vegetation changes, we used MODIS NDVI data from 2000 to 2022, calculating pixel-based trends using the Mann-Kendall test and Sen's slope estimator. The results were mapped and classified into five categories based on the intensity of change: normal, slightly decreased, moderately decreased, decreased, and severely decreased. Finally, the spectral reflectance measurement results were analyzed in comparison with vegetation cover trends.

The study results show that spectral reflectance measurements from plants within a fenced pasture restoration area in Gurvanbulag soum, Bulgan province, fall into the "normal" category, indicating clear pasture regeneration. For instance, at the "normal" site P3, Stipa krylovii showed low reflectance in the red light region (0.177) and the highest NDVI value (0.630), indicating biomass recovery. Conversely, Artemisia adamsii in this same fenced area exhibited the lowest NDVI (0.275) and high red reflectance (0.419), suggesting it is being suppressed by the dominant vegetation community. At site P6, categorized as "moderately decreased," Caragana microphylla exhibited the lowest red reflectance (0.071) and the highest NDVI (0.802), demonstrating maximum vegetation potential. Meanwhile, at sites P7 and P8, categorized as "severely decreased" over the long term, Artemisia frigida showed a sharp increase in red reflectance (0.352–0.557) and near-infrared reflectance (0.952–1.179), confirming that sparse vegetation cover has led to significant soil background interference in the spectral reflectance.

The plant spectral reflectance database established in this study provides ground-truth data free from atmospheric interference and can serve as a baseline for the calibration and validation of Sentinel-2 and Landsat satellite data in the context of the Mongolian arid steppe. This study demonstrates a scientifically sound methodology for assessing pasture degradation and performing regional monitoring by integrating ground-based spectral measurements with long-term satellite time-series data.

ESTIMATING SOIL TOTAL NITROGEN AND TOTAL PHOSPHORUS USING MACHINE LEARNING METHODS

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Abstract: Soil total nitrogen (TN) and total phosphorus (TP) are essential macronutrients that play fundamental roles in plant growth, soil fertility, biogeochemical cycling, and ecosystem sustainability. Variations in TN and TP concentrations directly influence agricultural productivity, vegetation development, and land degradation processes, making their spatial assessment critically important for sustainable land and environmental management. This study presents a machine learning-based approach for predicting the spatial distribution of TN and TP using Landsat-8 multispectral imagery and the Random Forest (RF) algorithm. Remote sensing-derived variables, including spectral reflectance bands, vegetation indices, soil indices, and land cover information, were incorporated as predictor variables. The modeling framework utilized 128 TN samples and 122 TP samples obtained through field surveys and laboratory analyses.

The RF algorithm was employed to construct predictive models for TN and TP estimation. The dataset was randomly partitioned into training (80%) and testing (20%) subsets to ensure robust model validation. Model performance was evaluated using the coefficient of determination (RÂ²), mean absolute error (MAE), and root mean square error (RMSE). The TN model achieved a testing RÂ² of 0.502, with MAE and RMSE values of 0.162% and 0.222%, respectively, whereas the TP model yielded a testing RÂ² of 0.522, with corresponding MAE and RMSE values of 3.032 mg/100 g and 4.152 mg/100 g. These results demonstrate that the RF algorithm provides reliable predictive capability for estimating the spatial variability of soil nutrients under heterogeneous environmental conditions.

The analysis further revealed that remote sensing-derived variables, particularly land cover characteristics, vegetation indices, soil-related indices, and spectral reflectance features, exerted substantial influence on model performance. Based on the optimized RF models, spatial distribution maps of TN and TP were generated for the study area. The predicted TN concentrations exhibited an average value of 0.46 Â± 0.38%, while TP concentrations showed an average value of 9.83 Â± 3.24 mg/100 g. The spatial patterns indicated considerable heterogeneity in nutrient distribution, reflecting the combined effects of land cover conditions and surface biophysical properties.

Overall, the findings highlight the strong potential of integrating optical remote sensing data with ensemble machine learning techniques for efficient and large-scale assessment of soil nutrient dynamics. The proposed framework provides a cost-effective and scalable approach for soil fertility monitoring and offers valuable support for sustainable agricultural management, ecosystem conservation, and environmental decision-making.

ASSESSMENT OF CORROSION POTENTIAL IN DRINKING WATER DISTRIBUTION NETWORKS USING WATER STABILITY INDICES: A CASE STUDY OF KHAN-UUL DISTRICT, ULAANBAATAR, MONGOLIA

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Abstract: Corrosion and scale formation in drinking water distribution systems represent significant challenges affecting infrastructure integrity, operational efficiency, and public health. Ensuring the reliability of drinking water supply systems and consumer safety requires a comprehensive assessment of water quality and its corrosive characteristics. In recent years, rust-related problems in household water supplies, accompanied by deterioration in water color, odor, and overall quality, have raised concerns regarding the condition of the drinking water distribution network in Ulaanbaatar, Mongolia. This study was conducted within the framework of the project entitled "Consultancy Service for Developing a Long-Term Plan and Recommendations for Rust Mitigation in Drinking Water Systems of Ulaanbaatar City.

Field sampling was carried out in September 2025. A total of 72 household tap water samples were collected from residential areas of Khan-Uul District using a random sampling approach and analyzed for their physicochemical and hydrochemical characteristics. Water stability and corrosion potential were assessed using the Langelier Saturation Index (LSI), Ryznar Stability Index (RSI), Larson–Skold Index (LS), and Aggressive Index (AI).

Hydrochemical analysis showed that Ca-HCO_3 was the dominant water type, accounting for 93.0% of the samples, followed by Ca–(HCO_3–SO_4) (4.2%), Ca–SO_4 (1.4%), and mixed Ca-type waters (1.4%). Total dissolved solids (TDS) ranged from 80 to 660 mg/L, indicating predominantly low-mineralized groundwater, while total hardness varied between 0.82 and 9.83 meq/L.

The mean values of LSI, RSI, LS, and AI were −1.61 (±0.470), 9.99 (±0.814), 0.38 (±0.278), and 10.35 (±0.496), respectively. According to the calculated indices, 98.6% of samples were classified as corrosive by LSI, 100% by RSI, 9.8% by LS, and 23.6% by AI.

Groundwater, which serves as the primary source of water supply for Ulaanbaatar, is relatively soft and characterized by low concentrations of calcium (Ca^{2+}) and low alkalinity, resulting in insufficient carbonate stability. The study results indicate that most water samples exhibit LSI < 0, RSI ≥ 8.5, and AI<10, suggesting that the water is undersaturated with respect to calcium carbonate and predominantly exhibits mildly acidic characteristics. Under such conditions, the precipitation of calcium carbonate ($CaCO_3$) is limited. As a result, the formation of a protective carbonate-based coating on the internal surfaces of water distribution pipes is slowed, since the conditions required for calcium carbonate deposition are not favorable.

ASSESSMENT OF THE CURRENT CONDITION OF MONGOLIAN BORDER PORTS

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Abstract: The formation and development of border ports is the result of the development of regional economy and world economy. The border port is the gateway of land opening and the hub node of international trade and social-cultural exchanges among the countries. Mongolia is a landlocked country, connected to neighboring countries by airports, road border ports, and railway border ports.

As of 2024, Mongolia's total foreign trade reached 27.3 billion USD. Of this total, 34.5% was conducted through the Zamyn-Uud border port, 30.4% through Gashuunsukhait, 9.5% through Sukhbaatar, and 8.9% through Shiveekhuren. The share of foreign trade conducted through other border port remained below 5%. Limited infrastructure and reliance on a single port contribute to elevated costs and delays, particularly during peak seasons. This logistical bottleneck hinders economic growth and raises consumer prices. Therefore, it is essential to identify, from an economic geographical perspective, the border ports that will play a key and beneficial role in the national, regional, and local socio-economic development in the short and medium term.

This study aims to assess the current condition of Mongolia's border ports and to to identify those that play a key role in regional socio-economic development. Within the scope of the study, the current conditions of road border ports were evaluated using 27 indicators across 9 categories, railway border ports using 22 indicators across 8 categories, and air border ports using 14 indicators across 5 categories, through the application of the Multi-Criteria Analysis (MCA) method.

The assessment of 20 road border ports in Mongolia revealed that the Zamyn-Uud, Altanbulag, Bulgan, Tsagaannuur, Bichigt, and Ereentsav ports received the highest scores. Among Mongolia's 20 road border ports, Zamyn-Uud, Altanbulag, Tsagaannuur, Bulgan, Borshoo, Ereentsav, and Bichigt ports received high evaluation scores. Among the six railway border ports, Sukhbaatar, Zamyn-Uud, and Ereentsav ports were highly rated. In addition, among the six air border ports, Chinggis Khaan and Ulgii ports also received high evaluation scores. These ports demonstrate favorable conditions in terms of regional cooperation, basic infrastructure, border port classification, and operational regime. Based on the findings of this study, it is possible to identify the border ports that require priority development as well as to determine opportunities for economic diversification.

RESULTS OF INTEGRATING FIELD VEGETATION SURVEY AND REMOTE SENSING ANALYSIS OF PASTURELANDS IN THE KHERLEN RIVER BASIN

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Abstract: Pasture vegetation is formed through complex interactions between environmental factors and plant communities. Species composition, biomass, and vegetation cover are important indicators of plant community characteristics.

This study aimed to compare and evaluate plant species composition, biomass yield, and vegetation cover among different pasture types in the Kherlen River Basin and to determine the relationships among these variables. A total of 50 sampling sites representing the vegetation communities of the study area were selected. Vegetation surveys were conducted using the Braun–Blanquet method within 1×1 m plots. Biomass samples were collected from 0.5 × 0.5 m quadrats, dried at 60°C for 24 hours under laboratory conditions, and weighed to determine dry biomass.

The study was carried out in intermountain valleys, mountain slopes, plains, and river valleys. The number of plant species ranged from 3 to 8.5 species in intermountain valley and mountain slope pastures, 4 to 6 species in plain pastures, and 4 to 7.5 species in river valley pastures. Biomass yield ranged from 54–110 g/m^2 in intermountain valley and mountain slope pastures, 60–150 g/m^2 in plain pastures, and 40–220 g/m^2 in river valley pastures.

Tukey's multiple comparison test revealed no statistically significant differences in mean species richness among the different pasture environments ($p > 0.05$). A positive correlation was observed between biomass yield and vegetation cover ($r=0.6$), while a moderate positive correlation was found between species richness and vegetation cover ($r=0.5$).

However, some sites exhibited high vegetation cover despite low species richness, mainly due to the dominance of grazing-resistant species such as Artemisia adamsii, Artemisia frigida, and other disturbance-tolerant plants.

The results indicate that pasture location had little influence on plant species richness, whereas vegetation cover and biomass were closely associated with pasture condition and plant community structure. These findings suggest that vegetation cover and biomass are more sensitive indicators of pasture condition than species richness alone.

HYDROCLIMATIC DRIVERS OF LAKE AREA DYNAMICS IN THE KHAR-US LAKE BASIN, WESTERN MONGOLIA

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Abstract: Lake systems in arid regions are highly sensitive to hydroclimatic variability and play a critical role in regional water-resource sustainability. However, long-term dynamics of hydrologically interconnected lake systems and their controlling mechanisms remain insufficiently understood. This study investigated spatiotemporal changes in the surface areas of Khar-Us, Khar, and Durgun lakes in western Mongolia from 1992 to 2022 and quantified the relative contributions of climatic and hydrological factors driving these changes. Lake areas were derived from Landsat imagery using the Normalized Difference Water Index (NDWI). Climatic variables and river discharge data were analyzed using the Mann–Kendall (MK) trend test, Innovative Trend Analysis Method (ITAM), Sen's slope estimator (SSE), statistical analyses, Partial Least Squares Structural Equation Modeling (PLS-SEM), and Autoregressive Integrated Moving Average (ARIMA) forecasting.

The results revealed statistically significant declines in lake surface area, with annual reduction rates of 1.15 km^2 yr^{-1} for Khar-Us Lake, 0.59 km^2 yr^{-1} for Durgun Lake, and 0.22 km^2 yr^{-1} for Khar Lake. Basin-scale evaporation ($Z = 5.17$, $p < 0.001$) and wind speed ($Z = 4.26$, $p < 0.001$) showed significant increasing trends, intensifying hydrological water loss. River discharge from the Khovd River emerged as a key control on lake dynamics, explaining 39%, 56%, and 41% of area variability in Khar-Us, Khar, and Durgun lakes, respectively ($p \leq 0.001$). PLS-SEM results further demonstrated that hydrological processes were the dominant drivers of lake-area change, accounting for 64.2–73.2% of observed variability.

Climatic factors exerted limited direct effects but influenced lake dynamics indirectly through hydrological pathways, reflected by a strong climate–hydrology linkage ($\beta = 0.726$, $R^2 = 0.427$). ARIMA projections indicate that declining lake-area trends are likely to continue through 2050, with Khar-Us Lake expected to experience the greatest reduction (−1.27 km^2 yr^{-1}), followed by Khar Lake (−0.27 km^2 yr^{-1}) and Durgun Lake (−0.20 km^2 yr^{-1}), although long-term forecasting uncertainty remains considerable. This study presents an integrated assessment of lake-area dynamics in a hydrologically connected lake system in western Mongolia through the integration of remote sensing, hydroclimatic analysis, structural equation modeling, and time-series forecasting.

EVALUATION OF THE ECOLOGICAL VULNERABILITY IN THE EASTERN REGION OF MONGOLIA

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Abstract: The loss of ecological stability and the increasing trend of ecological vulnerability are being observed in many regions due to factors such as climate change, population growth, and the intensification of livestock production.

The eastern region of Mongolia spans mountain taiga, mountain forest-steppe, meadow steppe, semi-arid steppe, dry steppe, and desert steppe zones, and is considered a zone vulnerable to both natural and human-induced factors. Therefore, assessing the ecological vulnerability of this region and identifying the characteristics of its spatial distribution will serve as an important foundation for sustainable environmental management.

This study evaluated ecological vulnerability across the territories of Khentii, Dornod, and Sukhbaatar provinces using the AHP-PSR model. A total of 13 indicator variables representing climate, land use, soil, and socioeconomic conditions were selected and classified into three groups: Pressure (P), State (S), and Response (R). The relative weights of the indicators were calculated using the Analytic Hierarchy Process (AHP), and the standardized indicators were integrated to develop the Ecological Vulnerability Index (EVI). Spatial autocorrelation analysis was also conducted to identify spatial patterns of vulnerability.

The results showed that 27.3% of the total territory falls under the low ecological vulnerability category, 61.3% under moderate, and 13.4% under high, establishing that the overall level of ecological vulnerability in the eastern region is moderate. Weight analysis identified total precipitation (26.4%), livestock numbers (18.8%), mean air temperature (15.2%), and population density (13.3%) as the factors with the greatest influence on ecological vulnerability.

Spatial autocorrelation analysis revealed concentrations of high vulnerability in Dashbalbar, Darigang, Munkhkhaan, and Batnorov soums, indicating that these areas face a relatively elevated risk of ecosystem degradation.The findings of this study precisely identify the spatial distribution of ecological vulnerability in Mongolia's eastern region and provide a basis for detecting vulnerable zones. They are also of scientific significance for planning environmental conservation measures, sustainable land resource use, rangeland management, and ecosystem restoration.

ASSESSMENT OF HYDROGEOCHEMICAL PROCESSES IN LAKE KHUVSGUL USING SATURATION INDICES

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Abstract: This study aimed to evaluate the hydrogeochemical characteristics, water–rock interactions, and mineral saturation status of Lake Khuvsgul water.

Water samples were collected from 20 locations in Lake Khuvsgul, and their physicochemical parameters and major ion compositions were analyzed. To assess water–rock interactions and mineral saturation state, saturation indices (SI) were calculated using the PHREEQC software.

Hydrogeochemical processes were investigated using Gibbs diagrams, correlation analysis, and ion relationship plots. The results indicated that the water of Lake Khuvsgul is characterized by low mineralization and belongs to the calcium-bicarbonate ($Ca–HCO_3$) freshwater type.

The Gibbs diagram showed that all samples fall within the rock-weathering dominance field, suggesting that the chemical composition of the lake water is mainly controlled by the weathering of carbonate and silicate minerals and by water–rock interactions. Correlation analysis revealed strong positive relationships between total hardness (TH) and HCO_3^- (r = 0.85), TH and Ca^{2+} (r = 0.60), as well as between electrical conductivity (EC) and total dissolved solids (TDS) (r = 0.99).

The saturation index (SI) results revealed that Lake Khuvsgul water is supersaturated with respect to calcite, dolomite, and aragonite (SI > 0), indicating that carbonate mineral precipitation. Conversely, negative SI values for gypsum, anhydrite, halite, and sylvite undersaturated conditions, the predominance of dissolution processes. Furthermore, the SI–pH relationships suggested favorable conditions for the precipitation of carbonate minerals. Therefore, the hydrogeochemical composition of Lake Khuvsgul water is primarily governed by carbonate rock weathering, water–rock interactions, and the saturation state of carbonate minerals.

SUSTAINABLE GREEN SPACE DEVELOPMENT IN KHARKHORUM CITY: SOIL CHARACTERISTICS AND IRRIGATION REQUIREMENTS

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Abstract: New Kharkhorum City, located in the Orkhon Valley of central Mongolia, is being developed as a major regional development project. As part of the city's green infrastructure plan, approximately 1,519.6 ha of green space will be established across eight designated zones, with more than 1.08 million trees and shrubs planned for planting.

This study aimed to assess soil characteristics and irrigation requirements to support sustainable afforestation and urban green space development. Field investigations were conducted in the planned planting areas situated on the back slopes of Kharganat Mountain in the eastern Orkhon Valley. A total of 78 soil samples collected from 29 soil profiles were analyzed to evaluate soil suitability for vegetation establishment.

The results showed that the soils were predominantly sandy loam in texture, with an average humus content of 1.6%. Soil reaction was slightly alkaline (pH ≈ 7.7), while electrical conductivity values remained below 2 dS m^{-1}, indicating non-saline conditions suitable for plant growth. However, the high proportion of sand particles and low organic matter content suggest relatively low water-holding capacity.

Irrigation requirements estimated using the Soil Water Budgeting (SWB) model exhibited considerable seasonal variation. The highest irrigation demand was estimated at 7,119.5 m^3 day^{-1} in June, while the lowest demand was 4,523.4 m^3 day^{-1} in September. During the irrigation period, deciduous tree species require approximately 4.4–7.0 L day^{-1}, whereas coniferous species require 3.6–5.6 L day^{-1}.

These findings highlight the importance of effective irrigation planning and management for the sustainable development of urban green spaces in the semi-arid environment of New Kharkhorum City.

POLLUTION AND DEGRADATION OF UGII LAKE

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Abstract: Lake Ugii, located in Ugii Nuur soum of Arkhangai Province, Mongolia, is a freshwater lake covering an area of 25.7 km^2. Owing to its significant ecological value, it was designated as a Wetland of International Importance under the Ramsar Convention in 1998 and serves as a vital ecosystem supporting biodiversity and ecological functions. However, in recent years, the ecosystem of Lake Ugii has shown increasing signs of pollution and degradation as a result of the combined effects of climate change and anthropogenic activities.

An analysis was conducted using national and international scientific publications, project reports, statistical data, and remote sensing information related to the Lake Ugii basin. The results of the study indicate that the water level of Lake Ugii has been declining due to the combined effects of climate change, increased evaporation, decreased precipitation, and reduced inflow from tributary rivers, leading to disruptions in the ecological balance of the lake ecosystem. At the same time, the degradation of the lakeshore ecosystem has intensified due to the impacts of tourism, livestock husbandry, fishing activities, water use, and transportation-related activities. During the last three decades, approximately 136.2 km of road networks have been established in the vicinity of Lake Ugii, and the area covered by buildings and infrastructure increased by 10.3 hectares between 2004 and 2019. These anthropogenic disturbances have contributed to increased soil erosion and land degradation over more than 70 hectares, while the decline in vegetation cover has further intensified environmental degradation along the lake's shoreline and surrounding areas. Furthermore, tourism has experienced significant growth in recent years. Currently, five tourist camps and around 50 eco-ger facilities operate in the vicinity of Lake Ugii, attracting and accommodating over 30,000 tourists each year. This increasing tourism pressure has become an important factor influencing the local environment and ecosystem. As a consequence, an estimated 250–300 tons of solid waste are generated annually; however, waste collection and management systems remain inadequate. In addition, the presence of open waste disposal sites, uncontrolled dumping of solid waste, and pit latrines has increased pollution in the lakeshore environment, creating potential risks to water quality.

The pollution and degradation of Lake Ugii may have adverse impacts on the sustainability of the aquatic ecosystem, biodiversity, and the habitats of waterbirds. Therefore, it is necessary to implement integrated watershed management, improve land-use and tourism planning, and strengthen waste management practices to ensure the long-term conservation and sustainable use of the lake ecosystem.

A STUDY ON ENVIRONMENTAL DEGRADATION CAUSED BY SOLID WASTE IN ULAANBAATAR CITY

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Abstract: As population growth, urbanization, and consumption levels continue to increase, the amount of municipal solid waste generated in Ulaanbaatar has been steadily rising, becoming one of the major factors contributing to environmental degradation and pollution. The aim of this study was to assess the current status of solid waste management in Ulaanbaatar City, identify the characteristics and impacts of environmental pollution and degradation associated with waste generation, and provide a scientific basis for improving future waste management practices.

Within the framework of this study, surface water samples were collected from the Tuul, Uliastai, Selbe, and Tolgoit rivers in Ulaanbaatar. Macrochemical parameters, sanitary indicators, and heavy metal concentrations were analyzed and compared with the permissible limits specified in MNS 0900:2018 "Drinking Water – Hygienic Requirements, Quality, and Safety Assessment." The results indicated that most macrochemical parameters met the standard requirements. However, ammonium concentrations reached up to 12.2 mg/L in some samples, exceeding the permissible limit and suggesting possible contamination from organic sources. In addition, calcium concentrations in one sample were slightly higher than the standard threshold. Sanitary analysis revealed that the total bacterial count ranged from 1.0×10^2 to 8.2×10^2 CFU/mL. Escherichia coli was detected at four sampling locations, while anaerobic bacteria were identified at one location, indicating the influence of domestic and organic pollution sources. Heavy metal analysis showed that the concentrations of most elements remained within the permissible limits; however, manganese concentrations exceeded the standard level in two samples.

The findings suggest that the current state of solid waste management in Ulaanbaatar has a measurable negative impact on environmental quality. The increasing volume of waste and unresolved management issues contribute to higher risks of soil, water, and air pollution, thereby accelerating environmental degradation. Therefore, improving the waste management system, expanding source separation practices, increasing recycling opportunities, and promoting public participation are essential measures for reducing environmental impacts. The comprehensive implementation of these measures will contribute to improving environmental quality, protecting natural resources, and supporting sustainable development.

ASSESSING HABITAT QUALITY AND DEGRADATION USING THE INVEST HABITAT QUALITY MODEL: A CASE STUDY OF THE ZED-KHANTAI-BUTEEL MOUNTAIN RANGE STRICTLY PROTECTED AREA, MONGOLIA

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Abstract: Protected areas play a crucial role in conserving biodiversity and maintaining ecosystem integrity. However, increasing anthropogenic pressures continue to threaten habitat conditions even within legally protected landscapes.

The aim of this study is to assess habitat quality and habitat degradation (HD) in the Zed-Khantai-Buteel Mountain Range Strictly Protected Area (SPA) in northern Mongolia using the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) Habitat Quality Model. Land use/land cover (LULC) data were derived from Google Earth and Sentinel-2 imagery with a spatial resolution of 0.61 cm and 10 m acquired in August 2024.

Threat factors, habitat sensitivity parameters, and associated weights were defined based on published literature and expert knowledge, and the half-saturation constant was set to 0.5. The analysis identified five habitat types and five major anthropogenic threat factors, including unpaved roads, abandoned mining sites, croplands, livestock grazing, and infrastructure.

Habitat degradation was generally low across the protected area, with 92.2% of the territory classified as having low degradation levels. Furthermore, 98.9% of the area exhibited high habitat quality, indicating that the ecological integrity of the protected area remains largely intact despite localized human disturbances.

These findings suggest that the Zed-Khantai-Buteel Mountain Range SPA continues to provide important habitat for biodiversity conservation and ecosystem functioning. The study demonstrates the effectiveness of the InVEST Habitat Quality Model for quantifying habitat conditions and identifying areas vulnerable to anthropogenic pressures.

The resulting habitat quality and degradation maps provide valuable spatial information for conservation planning, ecosystem monitoring, and evidence-based management of protected areas. This approach offers a practical framework for supporting biodiversity conservation and improving management effectiveness within Mongolia's protected area network.

THE ISSUES OF THE SUSTAINABLE DEVELOPMENT ACHIEVEMENT IN THE MINING AREAS OF UMNUGOVI AIMAG, MONGOLIA

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Abstract: The work was funded by RSF grant No. 24-47-03004, https://rscf.ru/project/24-47-03004/. During 2024-2025 Russian-Mongolian joint fieldwork, an assessment was conducted of the quality of groundwater serving as a water source in areas adjacent to the mineral deposits in the Umnugovi Aimag and at the Mongolia - China Gashuun-Sukhait border port, as well as in the centralized water supply system of the Khanbogd sum. Chemical and analytical work was done in order to assess the ecological condition of soils in Khanbogd and Tsogttsetsii mining sums. Responses for a survey were collected among nomadic herders, local residents, shift workers, and truck drivers, regarding the working and living conditions. Conducted analysis revealed groundwater and soil contamination, as well as instances of accidental wastewater discharges in areas near mining enterprises. In soil and water used by the local population, high concentrations of pollutants, both of natural and anthropogenic origin, have been observed in a number of cases. The adverse environmental situation in the studied areas is largely caused by the release of large amounts of dust into the atmosphere during the transportation of extracted resources. Under conditions of minimal precipitation and strong winds, air pollution creates an unfavorable environmental situation, contributing to soil and vegetation degradation. Large-scale mining projects also result in a transformation of the social structure of local communities: -the emergence of two impermanent new groups (shift workers and truck drivers); -a shift in the social status of the nomadic herders traditional group. The study's findings confirm the need for a systematic approach to managing the mining industry sustainable development. The key points are: -transition to a green economy, accelerating the adoption of green technologies; -strengthening corporate environmental responsibility, addressing the reluctance of businesses to invest in long-term projects; -strengthening the legal framework for environmental activities; -developing a system for environmental monitoring in the Umnugovi Aimag with the Mongolian Academy of Sciences participation, as well as environmental oversight at mining enterprises and within the accompanying infrastructure; -government measures to protect the most vulnerable social groups (e.g., herders). First and foremost, ancestral pastures must be secured so that they cannot be expropriated for industrial development unrelated to traditional farming without the herders' consent; -engaging large businesses that use Mongolian land to extract non-renewable resources in supporting traditional and less economically efficient small and medium-sized businesses that utilize renewable resources (natural grasslands, cultivated forage crops, and soils).

RUSSIAN AND MONGOLIAN CASES IN THE DEVELOPMENT OF THE TERRITORY

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Abstract: The work was funded by RSF grant No. 24-47-03004, https://rscf.ru/project/24-47-03004/.

In Russia and Mongolia, the oil and mining industries are the main sectors of the economy, which provide the countries' economic potential, security and competitiveness in the world market to a large extent. The purpose of our study is to identify and present social problems in the mining areas of Russia and Mongolia. The relevance of the problem under study is beyond doubt, because the main goal of sustainable development is not only to ensure the rate of economic growth, but also to improve the standard and quality of life, the rational use of natural resources and the maintenance of balance in the countries' ecological systems.

Basic materials for the study were obtained from the open public data of the Unified State Register of Real Estate, official responses to inquiries to the territorial authorities, and the results of expeditionary observations. Numerous large-scale cartographic materials and remote sensing data were used.

The following research methods were used in the work: statistical, retrospective and spatial analysis, the method of geoinformation mapping and sociological survey-interviews. The sociological survey-interviews are of great importance in this study. We conducted a survey-interview of local residents, shift workers, nomadic cattle breeders on the problems of interaction between mining companies and local communities, on the standard and quality of the population life, working and living conditions, satisfaction with social infrastructure, the local authorities and company management, on the assessment of the environmental situation, etc.

In 2024-2025, as part of expeditionary research, we conducted a sociological survey-interview for some key research areas (these are the Tsogttsetsii and Khandbogd soums of the Umnugovi aimag, Ust-Kut in the Irkutsk region, Novaya Chara in the Zabaykalsky Krai, Neryungri in the Sakha Republic).

Thus, based on statistical analysis, field survey and sociological interviewing, we have a complete picture of the areas under study, the people living and working here, and the main problems. The attitude towards oil and mining companies is ambiguous. In general, the local population and nomadic cattle breeders are dissatisfied with mining companies. They identified many problems associated with the development of these companies.

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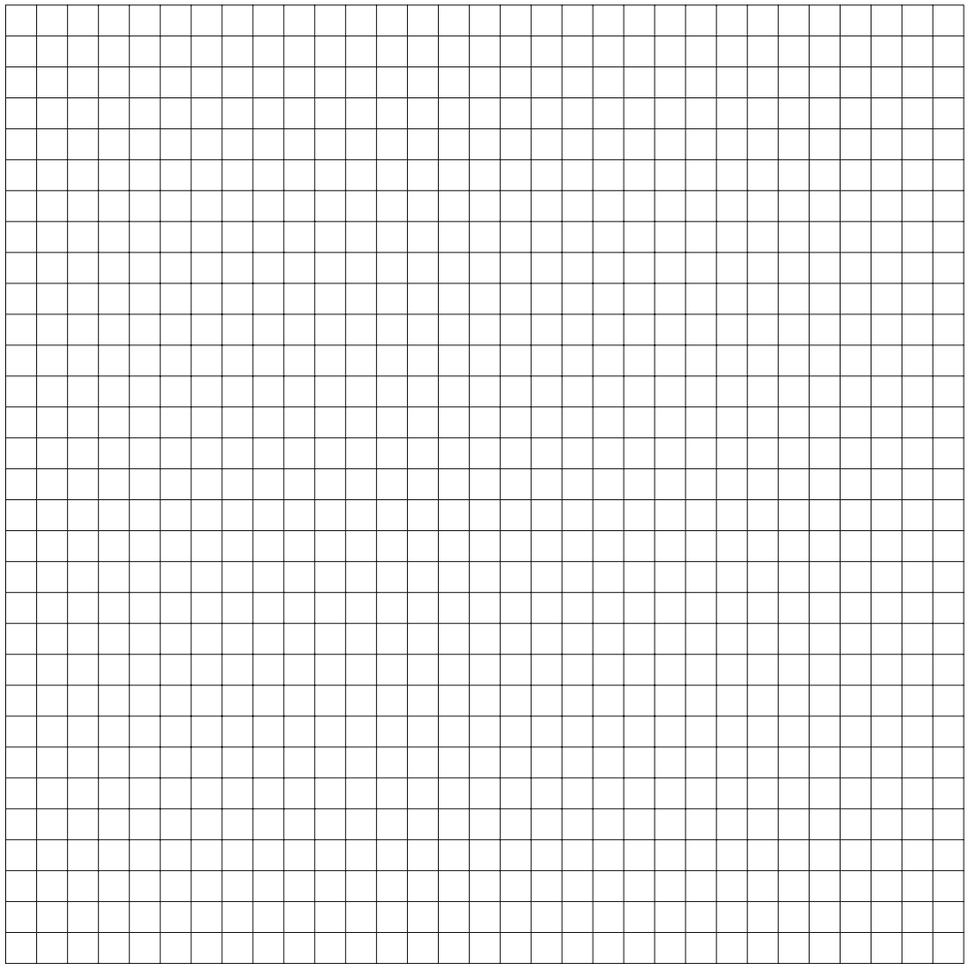

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