ANSO-MAS 2026
THE SECOND INTERNATIONAL CONFERENCE ON ENVIRONMENTAL HAZARDS IN ASIA

BUILDING RESILIENCE TO FUTURE HAZARDS

ABSTRACT BOOK

Ulaanbaatar, Mongolia
28-30 July, 2026

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ABSTRACT BOOK:

THE SECOND INTERNATIONAL CONFERENCE ON ENVIRONMENTAL HAZARD IN ASIA :

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JULY 28-AUGUST 3, 2026
ULAANBAATAR, MONGOLIA

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Environmental Hazards in Afghanistan: Risk Assessment, Impacts, and National Preparedness

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Afghanistan is among the countries most exposed to environmental hazards in Asia due to its complex topography, sensitive seismo-tectonic position, fragile ecosystems, and limited institutional capacity for disaster risk management. The country frequently experiences a wide range of hazards, including earthquakes, floods, landslides, droughts, and avalanches, many of which are intensified by climate change and environmental degradation. These hazards pose significant threats to human lives, infrastructure, agricultural production, and long-term socio-economic stability. This study aims to assess the major environmental hazards affecting Afghanistan, evaluate their spatial scale and socio-economic impacts, and examine the current level of national preparedness to manage and mitigate these risks. The research adopts a qualitative and analytical approach based on the existing scientific literature, disaster reports, and available environmental data from national and international organizations. The findings indicate that environmental hazards in Afghanistan are not only frequent but also increasingly severe, largely due to the combined effects of natural factors such as sensitive seismo-tectonic position, complex topography, climate change, environmental mismanagement, and socio-economic fragility. Seismic risks continue to endanger the country by experiencing a significant increase in devastating seismic activity in recent years, largely due to its location at the intersection of the fast moving Indian and Eurasian tectonic plates. Since 2022, the country has been struck by several high-casualty earthquakes; 6.0 magnitude earthquake (Kunar,August–2025) killing over 2,200 people, 6.3 magnitude earthquake (Mazar-i-Sharif, November-2025) causing dozens of deaths, 6.3 magnitude earthquakes (Herat,October-2023) resulting in approximately 2,445 fatalities and the destruction of entire villages as well as 5.9–6.2 earthquake (Paktika, June -2022) killing at least 1,039 people are profound shallow focal depths earthquakes. Seismic risks multiply by prevalence of non-quake-resistant mud-brick

and timber housing. On the other hand, Floods, droughts and slope failures remain the most widespread hazards, affecting millions of people, infrastructure, properties, planting and threatening food security. Although there have been some improvements in humanitarian aid management, national preparedness remains constrained by limited resources, political and social instability, deficiency in risk reduction planning, and gaps in hazard mapping. The study highlights the urgent need for integrated hazard assessment, improved environmental governance, and strengthened disaster preparedness mechanisms.

Managing climate induced disasters and natural resources in the Himalaya

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The Himalaya is topographically fragile and ecologically delicate. Between 1.2 and 3 billion populations, directly or indirectly, depend on the Himalaya for their livelihoods and survival. Human activities such as mass tourism and resultant emissions from aerosols including black carbon collectively exacerbate temperature rise. The fast melting of glaciers, degradation of forests and agri-horticultural landscapes due to frequent cloud bursts, flash floods, land slides, and urban sprawling of local communities have been common features increasing day by day. Frequent cloud bursts or torrent rains, higher magnitude in minimum and maximum temperatures along with an increasing trend, irregular precipitation patterns, positive radiative forcing of the atmosphere, and the cooling effect of the earth's surface have been other features. While glaciers break off through calving result in alike events and turn into flash floods and landslides. The multiplier impacts on various natural resources like loss of forests, degradation of agri-horticultural fields, limiting livelihood options, destruction of houses and human casualties have been the prevalent ones. Adopting ecological measures will

reduce ambient air pollutants and aerosols. These include establishing green belts at all possible levels (houses, schools, parks, and towns), using bio-engineering techniques based on ecosystem approach adaptive to local conditions, such as, planting native grass and geo-coir matting in sloppy eroded areas to stabilize landslides, creating a policy that allows development within carrying capacity, whether tourism or hydro projects, and declaring no construction zone at least 200 metres from the centre of a river or seasonal stream in the Himalaya.

Integrated Prospective Risk Managed Development of Future Community Resilience through Local Adaptive Capacity

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Development of systems, processes, and resources can help minimize disruptions of access to goods and services contributing to people achieving sustaining livelihoods and basic social service delivery. Poorly planned development can also exacerbate this lack of access for some people. The combination of such development with creeping environmental problems such as climate change can result in modifications of everyday and extreme risks of access disruption from hazards and vulnerability that people face. Integrated prospective risk-managed development aims to utilize knowledge and scenario co-creation between internal local knowledge and external knowledge gleaned from climate, social, and ecological scientific analysis to develop community-based adaptive systems that can help identify changes from such natural and human processes and promote proactive decision-making and action to prevent future access disruptions. Emanating from disaster risk reduction, climate change adaptation, poverty reduction, and environmental management approaches, this presentation utilizes a modified sustainable livelihoods framework to address such internal and external changes to a vulnerability and capacity context through adaptive internal and external governance approaches and inter-related strategies for risk-informed livelihoods with those for basic social service delivery and

specific risk reduction capacity. This conceptual framework is then utilized for analysis of case study projects in Southeast Asia. Identified lessons are synthesized into recommendations toward good practices in such strategies for promoting adaptive integrated systems. It should interest government and non-government climate change adaptation, disaster risk reduction, sustainable livelihoods, and basic social service delivery program researchers and practitioners and others wishing to understand and proactively address future risks.

Community Driven Resilience: Co-Creating an Interactive Land and Water Management Model for Climate Smart Agriculture and Water, Sanitation & Hygiene (WASH) in Vulnerable Landscapes, India

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This paper outlines the development of an Interactive Model for Land and Water Management, designed to engage communities and stakeholders in identifying and mapping hazards in vulnerable landscapes, West Bengal, India. These landscapes are characterized by water scarcity, salinity, flooding, soil with low percolation capacity, iron and fluoride contamination, poor water resources management infrastructure and limited access to freshwater.

The fibre-glass model facilitates participatory approaches, enabling communities to discuss threats, impacts, and solutions, and formulate hazard risk reduction plans. These plans aim to reduce the impact of hazards on communities, ecosystems, and infrastructure, promoting a more resilient and sustainable future. The model serves as a vital tool for training and planning, simulating local scenarios to identify hazards, visualize climate impacts, and test strategies. It empowers communities, officials, and community based groups to develop context-specific solutions, boosting resilience and adaptation. The plans involve identifying and assessing potential hazards, evaluating risks and vulnerabilities, developing strategies to prevent or mitigate

hazards, implementing measures to reduce risks, and monitoring effectiveness.

This approach has been effective in Arid and Semi-Arid regions, Gujarat, India where we co-created Watershed and Geo-hydrological Models for Water Resources Planning. Same approach is applied to West Bengal's vulnerable areas. The model's interactive nature allows communities to prioritize issues and develop tailored strategies. By Co-Creating solutions, communities can enhance resilience and adapt to climate change, ensuring self-reliance and a sustainable future. The model's flexibility and scalability make it a valuable resource for policymakers and communities, contributing to a more climate-resilient development trajectory.

Place-based Vulnerability and Mobility Outcomes in Disaster-prone Coastal Communities: Evidence from the Coastal Barangays of Mariveles, Bataan

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Climate change intensifies coastal hazards, but its influence on human mobility is uneven and context specific. While displacement is often framed as climate-induced, growing evidence shows that mobility decisions are shaped more by place-based socioeconomic conditions than by hazard exposure alone. This study investigates how recurring coastal hazards affect mobility outcomes among residents of coastal barangays in Bataan, considering variations in housing tenure, livelihood dependence, and socioeconomic capacity. Using a sequential mixed-methods approach, household survey data from two hazard-prone settlements were analyzed alongside focus group discussions exploring disaster experiences, livelihood impacts, coping strategies, and future mobility intentions.

Findings indicate that mobility largely takes the form of short-term displacement rather than permanent migration, despite frequent hazard

exposure estimated at three to five events annually. Even under repeated climate stress, strong place attachment, dependence on coastal livelihoods, long-term residence, and insecure housing tenure significantly constrain migration. However, mobility is not absent; it is conditional. Factors such as income, household size, and cumulative livelihood disruptions tend to trigger migration intentions. At the same time, perceived security, affordability, and access to employment act as key preconditions shaping actual migration decisions.

Most respondents reported that migration would be feasible if these enabling conditions were met, revealing a persistent gap between aspirations and capacity. Overall, the study reframes climate-induced displacement as a non-linear process influenced by socio-spatial constraints, emphasizing the importance of people-centered and data-driven adaptation strategies in vulnerable coastal contexts.

Debris flow and floods monitoring and emergency warning system

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Based on the analysis of seismic noise generated by a calm flow of water in the bed of the river, as well as during the floods and debris flow, a system for monitoring and emergency warning of the beginning of the movement of accumulated rock material is proposed. The system consists of a set of equipment that allows monitoring the conditions of debris flow formation, the level and concentration of solid components in the water/debris flow, transmitting data to a computing station and, when critical values are reached, sending warning signals about the threat of a debris flow.

The technical essence of the warning system is as follows: in the absence of variable local sources of seismic vibration excitation, the composition and level of ambient noises remain constant, and the polarization of oscillations in a ambient noises, due to the addition of seismic oscillations of different nature and coming from different azimuths to the seismic station, does not have a clearly defined orientation. When a debris flow moves along a riverbed, due to turbulence of the flows and collisions in rocks, elastic vibrations arise, which are recorded by seismic stations and cause an increase in the level and spectral composition and polarization of ambient noise. The effectiveness of the developed warning system is based on the difference in debris flow speeds and the velocity of seismic waves.

Warning Processes for Environmental Hazards Across Asia

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Due to the variety, frequency, and extent of environmental hazards across Asia, as well as the rapid changes they are undergoing, creating and improving warning systems is essential for building resilience to future hazards. Many warnings do not offer the expected positive impacts due to concerns including inadequate data and analysis, insufficient information flow, and lack of adequate training. This presentation defines and describes a template for providing warning systems for changing environmental hazards across Asia that would be tailored to specific national and local resilience needs, especially to incorporate rapidly changing hazards, technologies, data, and analysis tools.

Key elements are data and data analysis being adjustable to cover all hazards and their changes, being aware of technology available and unavailable especially for adequate data and communications, and working with warning recipients to meet their needs which is termed the “First Mile” of warning systems. All these actions are processes, rather than one-off actions which are set in place and then must await a hazard to appear. Instead, warning systems should continue to operate in the absence of a specific hazard, to ensure that data flows continue, technology functions, communications work, and people know how to act. Building resilience to environmental hazards through warning systems also means identifying and acknowledging limitations and gaps in order to continue overcoming them in a never-ending improvement process.

Integrating sensor-based IoT and Satellite Remote Sensing for Comprehensive Water Quality Monitoring

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This project aims to revolutionize water quality assessment in Pakistan by integrating conventional testing methods, IoT sensors, satellite data, and advanced machine learning algorithms. Conventional testing establishes the reliability of results, providing a critical baseline for data accuracy. By integrating data from IoT sensors, satellite imagery, and groundwater sampling, we minimize error factors and gain comprehensive insights into water quality.

The project compares real-time data from sensors with traditional methods to validate the accuracy of IoT sensors. Using machine learning and AI, we develop algorithms to process this data, culminating in an integrated model for predicting the Water Quality Index (WQI). This model not only assesses current water quality but also forecasts future conditions, offering early warnings to facilitate preventive and precautionary measures.

The integration of IoT sensors and satellite data presents significant advantages: IoT sensors deliver real-time data, enabling rapid responses to changes in water quality, while satellite imagery provides extensive spatial coverage and allows for long-term trend analysis. Combining these technologies creates a robust and comprehensive water quality monitoring system.

This system enhances monitoring capabilities, supports early detection of water quality issues, and aids in informed decision-making for water resource management. The project's scalable approach, initially utilizing locally sourced sensors and programming, establishes a foundation for future expansion and adaptation to technological advancements. Our innovative methodology holds the promise of transforming water quality assessment in Pakistan, addressing critical challenges with modern technology and setting the stage for improved water resource management practices.

Integrated Remote Sensing Assessment of Mine Tailings Storage Facilities in Mongol Uls: Resources and Environmental Impact

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Extraction of coal, gold, copper, and fluorspar have generated a widespread network of tailings storage facilities that represent both potential environmental liabilities and largely unrealized secondary resource opportunities worldwide. This study presents an integrated framework to systematically map and characterize tailing storage facilities at the national scale in Mongolia. By anchoring remote sensing outputs to the historical and geological context of each mining district, the research infers the likely mineralogical and elemental composition of tailings, including concentrations of rare earth elements, lithium, and cobalt, providing a spatially explicit inventory of critical and energy-transition minerals held within legacy mine waste.

The framework simultaneously evaluates associated environmental risks, including structural failure, acid mine drainage, and heavy metal mobilization into surrounding surface and groundwater systems, with consideration to temperature variability, episodic precipitation, and limited mine water management infrastructure.

Building on this hazard assessment, the study discusses potential pathways for reprocessing tailings as secondary sources of energy-critical minerals. By embedding resource recovery within an environmental remediation strategy, the proposed framework reframes tailings storage facilities from long-term liabilities to strategic assets, contributing to both responsible mine closure and domestic critical-mineral supply chains.

Towards Resilience Urban Development in Ulaanbaatar: A Flood Hazard Mapping and Urban Disaster Risk Indexing

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Rapid urbanization in Mongolia's major cities, particularly Ulaanbaatar, together with climate change, is increasing flood risk, air pollution, and overall urban disaster vulnerability. These pressures highlight significant gaps in resilience planning and the need for integrated, evidence-based urban risk management. This study develops a spatial decision-support framework for urban disaster risk reduction and climate-resilient city planning, aligned with the Paris Agreement (2015), the Sendai Framework for Disaster Risk Reduction (2015–2030), Sustainable Development Goal 11, and UN-Habitat resilience principles.

This study develops a flood hazard mapping system and an urban disaster risk index to support risk-informed planning, integrating climate risk, vulnerability, resilience, and governance. The methodology integrates Ulaanbaatar's precipitation analysis, land-use–based hotspot detection, and a disaster damage calculator.

Flood risk zones are delineated using high-resolution geospatial datasets, while exposure, sensitivity, and adaptive capacity are combined to construct a spatially explicit disaster risk index. This enables identification of high-risk hotspots and priority areas for intervention. The study also analyzes temporal and spatial patterns of climate-related hazards to identify emerging risks and evaluates existing early warning and disaster preparedness systems to detect policy and operational gaps.

Based on the findings, an integrated urban resilience framework is proposed to strengthen governance coordination and adaptive capacity across sectors. The expected outputs include flood hazard maps, a composite flood disaster risk index, and a decision-support framework for sustainable urban development.

Overall, this research supports climate-resilient and disaster-resilient urban planning in Mongolia and contributes to broader resilience-building efforts in Asia.

Site exploration for the design of base isolated structures based on Microtremor methods

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This study shows the use of microtremor survey for site exploration and site-specific seismic response evaluation for designing the base-isolated structure for Nepal. This research has been performed for Bhaktapur Traditional Craft and Culture Center (BTCC), and a triple friction pendulum base isolation system was proposed to make the center more resilient to earthquakes. The ambient vibration measurements were carried out using multiple circular arrays with SmartSolo sensors and a number of different radii and the data were analyzed to obtain dispersion curves and a shear-wave velocity (Vs) profile that extends to about 767 m depth. The obtained Vs model was then combined with borehole data and used to conduct one dimensional nonlinear site response analyses under representative strong-motion records with the Hybrid Hyperbolic (HH) constitutive model. The response spectra generated for the site were compared with the expected response of the system to the site to check the effectiveness of the base isolating system. The results show that using microtremor for site characterization is reliable for input into seismic site response analysis and that base isolation can be adopted or not on this basis. It also notes that the actual performance of base isolation will depend on the site conditions in the area and the need to combine the geophysical investigations with earthquake engineering in the seismic design of critical facilities.

Risk Assessment of Potential Ground Ice Contents in the Permafrost Region of Mongolia

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Mapping of ground ice distribution at regional and global scales remains a major challenge. Under a warming climate, thawing of ice-rich permafrost possibly triggers various thaw-induced hazards, which include extensive thermokarst development, ground-surface

subsidence, and thaw settlement. These processes pose substantial risks in engineering infrastructure, i.e., damaging roads and buildings, leading to economic losses and environmental degradation. In Mongolia, risk assessments across continuous and discontinuous permafrost zones are particularly critical due to the high sensitivity of degradation of ice-rich permafrost. To address this, we applied the Random Forest (RF) model to predict the spatial distribution of potential ground ice contents. The model was trained with compiled ground ice content data acquired from on-site observations that have been maintained by the Institute of Geography and Geoecology (IGG) since 1968. We referred to archival records of 37 boreholes from the Circumpolar Active Layer Monitoring (CALM) program and 62 boreholes from the internal reports of the Division of Permafrost Research, IGG. To increase the amount of data in the Altai and Khentii mountains, we incorporated ground ice content from 13 additional boreholes through Electrical Resistivity Tomography (ERT) surveys into the analysis. The model considered 14 environmental variables, and model accuracy was assessed by comparing the predicted ground ice content with measurements from 14 ERT profiles that were used only for model testing. Permafrost risk was considered to be the arithmetic mean of the predicted ground ice content and permafrost distribution. The trained model demonstrated strong predictive performance, showing a root-mean-square greater than 0.72. Also, validation with the test set of ERT data revealed a correlation of 0.90 (i.e., 90% of prediction accuracy). The areal extent of the highest ice content underlies approximately 7,142.1 km², and very high-risk permafrost zones are mainly concentrated in the northern Khuvsgul mountains and a small part of the Khangai mountains. Based on the permafrost risk assessment, approximately 34-37% of Mongolia's permafrost regions are classified as high-risk. Consequently, when planning future activities such as the construction of engineering structures and roads, it is important to implement measures to prevent or mitigate permafrost thaw. Overall, this study presents the first detailed, field-validated regional map of potential ground ice content in Mongolia, providing essential baseline data for assessing ice content and permafrost risk in this climate-sensitive region.

Session 2: Environmental Hazards

Chairs: Dr. Maral Bayaraa and Prof. Ken Xian Sheng Hao

1. “Climate Justice: Overdue but Not Impossible”, **Mangala Namasivayam**
2. “Analysis of Damage Effects of the Strong Wind and Storm Event in Mongolia”, **Bazarragchaa Duudgai**
3. “Plastic waste management in Nepal”, **Anjana Singh**
4. “A Looming Mega-El Niño and Pakistan's Summer Monsoon: Cascading Risks for Food Security”, **Waheed Ullah**
5. “Geomagnetic Variations and Space Weather Hazard Assessment in the Mongolian Region”, **Munkhzul Jargalnemekh**
6. “The Uzon caldera (Kamchatka, Russia): from the catastrophic eruption to the modern hydrothermal Hg-Sb-Hg mineralization”, **Andrey Bychkov**
7. “Explosive eruptions as a result of magma mixing on example of Changbaishan (China-North Korea) and Udokan (Russia) volcanoes”, **Olga Andreeva**
8. “Constraints on the magmatic system beneath Mt. Paektu Volcano (Changbaishan) from magnetotellurics”, **James Hammond**

Chairs: Dr. Mungunsuren Dashdondog and Dr. Anna Dobrynina

9. “Geodetic strain rate mapping in continental interiors”, **Lidong Bie**
10. “Map of modern geodynamics of the Mongolian-Siberian region (new version)”, **Sankov Vladimir**
11. “Earthquakes in the Nepal Himalaya as an Environmental Hazard: Insights from the 2015 Gorkha Earthquake”, **Lok Bijaya Adhikari**
12. “The impact of multi-millenial temporally variable fault slip rates on Probabilistic Seismic Hazard Assessment (PHSA) and water infrastructure, a case study approach”, **Jenni Robertson**
13. “Southern Baikal earthquake of October 14, 2022 (Mw 5.4): macroseismic observations and intensity patterns”, **Larisa Ochirova**
14. “Interseismic and Coseismic Seismicity Patterns of Seismicity and Fault Networks in the Central Part of the Baikal Rift”, **Tsyren Tubanov**

Climate Justice: Overdue but Not Impossible - The impact of climate change on health in Asia

Mangala Namasivayam

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Climate change poses a fundamental threat to human health, affecting both the physical environment as well as aspects of natural and human systems. The Asia-Pacific region is particularly vulnerable due to its geographic and climatic diversity, ecosystem variations, dependence on natural resources and agriculture sectors, high poverty rates, population density, susceptibility to natural disasters, and, most importantly, the lack of adaptive capacity to the impacts of climate change.

This talk will examine the heightened vulnerabilities to climate change faced by the most vulnerable communities including women and girls, children, people of diverse sexuality, Indigenous and tribal communities, forest dependent communities, ethnic minorities, low-income communities, people with disabilities, migrants and displaced persons, older populations, and those with underlying or existing health conditions. It will share some recommendations to address the health impact of climate change with equity and climate justice at its core, ensuring that those most responsible bear the highest mitigation and adaptation costs, while recognizing the existing imbalance between causation and harm and the unequal historical responsibility that countries and communities bear in relation to the climate crisis. Case studies from countries in Asia such as Mongolia, Indonesia, Pakistan, Cambodia and Philippines will be shared during the session.

Analysis of Damage Effects of the Strong Wind and Storm Event in Mongolia

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Strong storms are the most common natural hazards in Mongolia and their frequencies, intensities, scope, damage, and negative consequences are likely to increase further due to the effects of climate change. The paper aims to analyze in detail the features of the strong wind and storm event that occurred on 13-15 March 2021 and to identify issues that are critical to the prevention and reduction of potential damage caused by further severe events. The Pearson's correlation analysis is used for determining features of the disastrous characteristics and damage effects of the strong wind and storm event, resulting from the following findings. Firstly, we have observed, that the loss of livestock is much higher with longer-duration strong winds and storms. Secondly, high wind speeds and longer-duration events are associated with noticeably negative impacts on herders and their livestock. Lastly, property damage demonstrates much escalation with instantaneous high wind speeds. It presents practical results in the smallest damage effects through receiving weather forecasts carefully for herders, forecasting wind speeds, and gaining awareness regarding the importance of getting ready for hazards.

Plastic waste management in Nepal

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Plastic waste management brings together policymakers, researchers, industry professionals, and environmental advocates to address one of the most pressing environmental challenges of the time—plastic pollution. It might serve as a dynamic platform to share knowledge, strategies, and innovations aimed at sustainable plastic management across the country. Bacterial isolates from the dumping areas was tested for the characterization of tensile strength, surface corrosion, percentage of weight are the parameters analyzed. The sample exposed under the experimental condition for three months of the polythene discs showed surface corrosion, reduction in tensile strength, and a weight loss by *Pseudomonas* spp. was identified using biochemical tests and morphological keys, actively involved in this degradation experiment. Biodegradation of degradable plastic polyethylene by fungi Phanerochaete and bacteria *Streptomyces* species have been reported by Lee et al. (1991). The methods used for testing plasticde gradation are molecular weight distribution, weight loss, change in tensile strength and changes in percentage of elongation. The type of microorganism can be used as lignocellulose degrading fungal and bacterial strains.

A Looming Mega-El Niño and Pakistan's Summer Monsoon: Cascading Risks for Food Security

Waheed Ullah

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Operational seasonal forecasts and ocean-heat-content diagnostics indicate an approximately 80% likelihood of El Niño conditions during 2026, raising the prospect of a mega-El Niño (peak ONI ≥ +2.0 °C) within the next 12–18 months. For Pakistan, where agriculture anchors roughly one-fifth of GDP and two-fifths of employment, such an event would compound an already destabilized monsoon system and a fragile post-flood food economy. Synthesizing observational reanalysis, crop-yield modelling and regional impact studies, this review traces a cascading climate hazard. We outline the dynamical pathway by which El Niño, often amplified by a positive Indian Ocean Dipole, weakens the South Asian summer monsoon and suppresses moisture over Pakistan's western breadbasket, driving JJAS precipitation deficits of 8–22% across climatic zones alongside compound warming of 0.6–1.2 °C and a doubling of extreme-heat days. These shocks propagate into Kharif and Rabi systems, cutting rice, cotton, maize and wheat yields by 3–10%, and into food-price inflation, water and energy stress, and rising food insecurity in the most exposed districts. We situate the hazard within compounding geopolitical and macroeconomic stressors, including the unsettled Indus Waters Treaty, declining transboundary inflows, an IMF-constrained fiscal position, and 2026 energy-supply disruptions. Because skillful forecasts exist at six-to-nine-month lead times, we set out no-regret, forecast-based interventions across climate services, agronomic adjustment and social protection. The resilience message is clear: treat the next El Niño as a predictable trigger for pre-emptive action, not a meteorological surprise.

Geomagnetic Variations and Space Weather Hazard Assessment in the Mongolian Region

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In this study, a long-term geomagnetic storm catalog for Mongolia was newly compiled and analyzed to evaluate the frequency, intensity, and risk characteristics of space weather hazards over the region. The investigation utilized data from the OMNI database, the International Real-time Magnetic Observatory Network (INTERMAGNET), and the Magnetic Data Acquisition System (MAGDAS) network operating in Mongolia region. These datasets were employed to examine solar terrestrial interactions and the temporal and spatial variations of the geomagnetic field over the Mongolian region.

The results reveal that the occurrence and intensity of 356 geomagnetic storms observed in Mongolia are strongly correlated with the 11 year solar activity cycle. Furthermore, a detailed case study of the intense geomagnetic storm that occurred on 5-6 December 2020 showed that the dynamic pressure associated with a coronal mass ejection (CME) significantly increased, compressing the Earth's magnetopause to approximately 7 Earth radii (7Re). This compression generated a pronounced Sudden impulse (SI) in the geomagnetic field of Earth. During the event, the southward orientation of the interplanetary magnetic field (IMF) Bz component facilitated geomagnetic reconnection, which served as the primary mechanism for transferring solar wind energy into the Earth's magnetosphere.

The findings provide a scientific basis for assessing space weather hazards across the vast territory of Mongolia and contribute to the evaluation of geomagnetic storm risks affecting critical technological infrastructures, including electric power systems, GNSS navigation services, and satellite communication networks. The compiled catalog and analysis establish a fundamental database for future space weather monitoring, risk assessment, and early warning applications in Mongolia.

The Uzon caldera (Kamchatka, Russia): from the catastrophic eruption to the modern hydrothermal Hg-Sb-Hg mineralization

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The Uzon-Geysernaya Depression is located in east of Kamchatka peninsula, Russia. The Uzon caldera is the youngest western part of the depression. The caldera formed in the Middle Pleistocene due to a catastrophic eruption. Pre-caldera rocks are represented by olivine and two-pyroxene basalts (flows up to 10-17 m thick) and tuffaceous breccias. They formed the edifice of the Uzon stratovolcano. The caldera-forming phase complex is represented by ignimbrites interbedded with felsic pyroclasts. A lake appeared after the caldera's formation. Lake deposits are aleuropelitic tuffs and various pumice sands. Dacite extrusions formed simultaneously with the lake deposits. Active thermal activity is observed in the Uzon caldera today. The modern mineralization zones of cinnabar, antimonite, realgar, and orpiment are forming in the surface layer. The Uzon caldera is a unique phenomenon in the world. The hydrothermal system is genetically related to a silicic magma chamber. There were determinate the possible dimensions and depth of the chamber throughout its geological history. Currently, the chamber is slightly larger in diameter than the Uzon-Geyser depression and is located at a depth of 8 km. The evolution of volcanism in the area can be explained by the chamber's activation by injections of deep-seated basaltic melt, which have continued to the present day. The hydrothermal system associated with the magma chamber existed in Uzon for 100,000-150,000 years and in the Valley of Geysers for 200,000-300,000 years. The Uzon caldera is an excellent natural model for understanding the formation of hydrothermal ore deposits associated with volcanism.

Explosive eruptions as a result of magma mixing on example of Changbaishan (China-North Korea) and Udokan (Russia) volcanoes

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The Late Cenozoic intraplate volcanic province of Central and East Asia is characterized predominantly by alkaline basaltic magmatism. Silicic rocks are rare and related to Changbaishan and Udokan volcanoes.

Trachy pumices of Changbaishan Millenium eruption and Udokan Holocene eruption were studied. The results of melt inclusion studies suggest to believe that plagioclase of Udokan trachyte pumices and olivine from Changbaishan trachyte pumices are nonequilibrium and, apparently, represents a crystalline fragments of basaltoids. The obtained temperatures for the melt inclusion homogenization are T = 1140 – 1180 °C for Udokan and up to 1230°C for Changbaishan. The glass compositions of homogenized melt inclusions in plagioclase from Udokan pumices correspond to phonotephrite and compositions of the glasses of melt inclusions in olivine from Changbaishan pumices correspond to trachybasalt.

Portions of alkaline mafic melt transports previously crystallized mineral assemblage from the deep magma chamber. Then alkaline mafic melts invade a shallow magma chamber. The interaction of alkaline mafic and felsic alkaline melts lead to an increase in pressure in the chamber and the boiling of trachyte melt. This catalyzes an explosive eruptions, resulting in the release of trachyte pumices containing a mineral assemblage xenogenic to felsic magmas, consisting of crystalline fragments of basaltoids. The studied trachyte pumices of Changbaishan and Udokan volcanoes are hybrid rocks formed by the interaction of mafic and trachyte magmas.

Constraints on the magmatic system beneath Mt. Paektu Volcano (Changbaishan) from magnetotellurics

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Mt. Paektu (also called Changbaishan) volcano, located at the border of the Democratic People's Republic of Korea (DPRK) and China, is renowned for its past explosive activity. Previous studies have covered its origin, the great Millennium eruption of 946 CE, as well as the depth and geometry of the crust magmatic system. Such studies have mostly been restricted to the Chinese side of the volcano and conducted at regional scales. To delineate the detailed resistivity structure beneath the DPRK side of the volcano, we collected magnetotelluric (MT) measurements in the frequency range of 320 – 0.0017 Hz at ~60 sites to produce a 3D resistivity model, showing the presence of 3 conductors within the top 20 km of crust. Conductive regions in the top 2 km are likely related to the trend of the NW-SE Paektu Great Fault (PGF). The deepest conductor reflects a crust magmatic system at about 10-18 km depth (8-16 km below sea-level) beneath the caldera center, extending horizontally by 5 km and 8 km in E-W and N-S directions, respectively and having 6-20% melt fraction. Such conclusions are consistent with previous MT and seismic studies showing an extensive magma reservoir extends beneath the volcano. This motivates an extended, ideally cross border MT study to fully constrain the magmatic system.

Geodetic strain rate mapping in continental interiors

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The development of geodetic tools, such as Interferometric Synthetic Aperture Radar (InSAR), has revolutionized the study of earthquake physics and seismic hazard assessment. Over the past two decades, InSAR has been increasingly used to determine interseismic strain rates across major seismogenic faults. This emerging paradigm in seismic hazard assessment uses geodetically-mapped crustal deformation rates to construct the strain rate tensor, which serves as a proxy for seismic hazard. However, the relatively short duration of geodetic observations, compared with the much longer recurrence intervals of large earthquakes, raises concerns about how well the geodetic strain rates represent long-term strain accumulation. These challenges are particularly pronounced in slow-deforming continental interiors, where InSAR measurements often have a low signal-to-noise ratio.

Here, we examine the 2021 Mw 7.4 Maduo earthquake in northern Tibet, which ruptured a slow-moving, left-lateral strike-slip fault approximately 70 km south of the major block-bounding East Kunlun fault. Using six years of Sentinel-1 data, we investigate whether the geodetic strain rates vary over time and, if so, how these variations manifest. Specifically, we assess the sensitivity of inferred deformation rates to the choice of temporal observation window. Our results show that transient variations in deformation vary in a spatial pattern that cannot be unequivocally attributed to tectonic motion, given the uncertainties of InSAR data in the region. Overall, our analysis indicates consistently low strain rates along the seismogenic fault and suggests the geodetically derived strain rates may not remain constant over time, depending on the selected observation period.

Map of modern geodynamics of the Mongolian-Siberian region (new version)

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The basis of the modern geodynamic map of the Mongolian-Siberian region is the late Cenozoic fault-block structure of the region and the lithospheric thickness map, which serve as a matrix for the manifestation of modern deformations. Faults form mobile zones (the Baikal Rift System, the Altai-Sayan, West Mongolian, and Gobi-Altai transpression zones, etc.), which develop primarily along the boundaries of blocks with contrasting lithospheric thicknesses.

The reaction of the crust to block movements and interactions is seismic activity, which can be reflected as released energy—the distribution of the released total seismic moment. The map was constructed using epicenter coordinates and magnitude data from the International Seismological Center. A unique element of the map is the symbol showing the direction of seismic front advance along mobile zones during short-period selective fault activation, proposed by prof. S.I. Sherman. Holocene volcanoes and thermal springs are included in the map as indicators of subsurface activity.

Modern trends in the movement of lithospheric masses reflect horizontal movement vectors calculated based on long-term measurements of modern movements using GPS geodesy.

The nature of block interactions determines the stress-strain state in the interblock spaces. The map shows the type of crustal stress state and the direction of maximum horizontal compression, calculated using data on earthquake focal mechanisms.

The map of modern geodynamics can serve as a basis for strategic security decisions when planning the placement of high-risk facilities in the Mongolian-Siberian region.

Earthquakes in the Nepal Himalaya as an Environmental Hazard: Insights from the 2015 Gorkha Earthquake.

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The Nepal Himalaya is one of the most seismically active regions in the world due to the ongoing convergence between the Indian and Eurasian plates along the Main Himalayan Thrust (MHT). Earthquakes in this region pose a major environmental hazard, threatening lives, infrastructure, economic stability, and sustainable development. Continuous seismic monitoring in Nepal has begun in 1994 and continuing with nation wide seismic network consisting of 42 seismic stations. Research has shown that most earthquakes nucleate along the downdip edge of locked segments of the MHT, where tectonic stress accumulates before any large ruptures.

The Mw 7.9 Gorkha Earthquake of April 25, 2015 was one of the most devastating natural disasters in Nepal's history, causing widespread destruction, nearly 9,000 fatalities, and severe environmental and socio-economic impacts. Following the mainshock, more than 55,000 aftershocks has been recorded, including a Mw 7.3 aftershock on May 12, 2015. Detailed analyses of the aftershock sequence indicate an overall exponential decay in seismic activity associated with post-seismic slip and crustal relaxation processes. However, the persistence of seismicity several years after the earthquake, with activity levels remaining significantly above the pre-earthquake background rate, demonstrates the continuous adjustment process of the Himalayan crust following a major rupture.

In addition, clusters and swarms of earthquakes occurring both within and outside the rupture zone suggest complex interactions involving stress transfer, geological heterogeneity, and fluid diffusion in the crust. Understanding these diverse seismic patterns is essential for assessing seismic hazard and improving earthquake preparedness.

The impact of multi-millenial temporally variable fault slip rates on Probabilistic Seismic Hazard Assessment (PHSA) and water infrastructure, a case study approach.

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Recent insights demonstrate that faults exhibit episodic behaviour whereby they display alternating clusters of earthquakes resulting in periods of rapid surface slip separated by periods of relatively slow slip or even quiescence lasting multiple millennia. Over tens of thousands of years, this behaviour translates to temporally variable fault slip rates. However, variable fault slip rates and anti-cluster durations are challenging to consider when undertaking probabilistic seismic hazard assessment.

We examine this challenge using a case study of the Thriasio normal fault (central Greece), located adjacent to the city of Athens, within the Attica region (population ~3.7 million). Our 36Cl fault scarp dating and Bayesian Inference modelling on the Thriasio fault suggests that an earthquake cluster between 56-50 ka and a more recent earthquake cluster from 3 ka-present day are separated by an anti-cluster period ~47 kyrs in duration. We examine the implications of temporal slip-rate variability over two orders of magnitude on recurrence parameters and earthquake rates and, on the ground shaking probabilities of exceedance for key infrastructure sites located in the hangingwall of the fault on the Thriasio Plain. Specifically, we focus on the water supply

and treatment infrastucture which is closely located to the Thriasio fault and provides >80% of water to the Attica region, considering the public health implications of a disruption to water supply in the event of a surface rupture on the Thriasio fault.

Southern Baikal earthquake of October 14, 2022 (Mw 5.4): macroseismic observations and intensity patterns

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The article presents macroseismic analysis results for the October 14, 2022, Mw 5.4 earthquake, which occurred in Lake Baikal near the Goloustnaya River delta. Two earlier strong events with similar parameters were recorded in the same area: May 22, 1981 (Mw 5.4) and June 8, 2022 (Mw 5.2), now known as Goloustnoye-I and Goloustnoye-II. The October 14 event, named Goloustnoye-III, caused widespread public concern, was felt over a large area, and produced building damage within the near-field.

Macroseismic data were collected by the Baikal and Buryat Branches of the Geophysical Surveys of the Russian Academy of Sciences and Dobretsov Geological Institute of the Siberian Branch of the Russian Academy of Sciences. The use of Internet-based questionnaires proved highly effective, yielding information from 248 intensity data points with a relatively uniform azimuthal distribution around the epicenter. This makes Goloustnoye-III one of the most thoroughly studied seismic events in the Southern Baikal region. The maximum shaking intensity, estimated at VI–VII MSK-64, was recorded in the town of Babushkin (41 km from the epicenter). An abnormally

high intensity of VI MSK-64, apparently due to local engineering-geological conditions, was observed in Gusinoozersk (104 km). Intensity V MSK-64 was noted at epicentral distances from 17 to 223 km, while intensity IV was recorded between 69 and 325 km. The analysis shows that the observed intensity attenuation does not match any version of the regional macroseismic field equation, indicating the need for further refinement of local seismic hazard models.The work was supported by Ministry of Science and Higher Education of the Russian Federation (No.126020216348-5, 075-00609-26, 124020900029-7).

Interseismic and Coseismic Seismicity Patterns of Seismicity and Fault Networks in the Central Part of the Baikal Rift

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The expansion of the seismic station network in the central part of the Baikal Rift has improved the class of completeness and the accuracy of earthquake focal depth determination [Suvorov, Tubanov, 2008]. Earthquakes, particularly small and medium-sized ones, typically occur in active fault zones. Although weak earthquakes are not seismically dangerous, they are an indicator of the state of the earth's crust at seismogenic depths that cannot otherwise be studied or directly measured [Ouillon, Sornette, 2011].

In our study, we used the nearest-neighbor method [Zaliapin, Ben-Zion, 2013], which is currently widely used for seismicity declustering, to identify clustered seismicity. As a result, it was shown that the peculiarities of the character and spatio-temporal ordering of seismicity in local areas of fault structures can be a unique source of information about the patterns of deformation of the earth's crust of the Baikal rift.

Session 3: Earthquakes & Cities

Chairs: Dr. Odonbaatar Chimed and Dr. Lok Bijaya Adhikari

1. “Challenges in Earthquake Hazard Assessment in Ulaanbaatar”, **Yasuhiro Suzuki**
2. “Investigations on active faults and site effects for Ulaanbaatar seismic hazard assessment”, **Antoine Schlupp**
3. “Strong-Motion Information Infrastructures for Ground Motion Models in Japan (GMM-PJ)”, **Nobuyuki Morikawa**
4. “Seismic monitoring and the results of its application in Kazakhstan to study seismic events of various nature”, **Abylay Uzbekov**
5. “Challenges in Strong Ground Motion Prediction in the Near-Fault Region”, **Hiroyuki Fujiwara**

Chairs: Dr. Bayasgalan Amgalan and Dr. Antoine Schlupp

6. “Assessing the Dynamic Influence of the Karjantau Active Fault Zone through Horizontal Deformation Field Analysis”, **Zukhriddin Shukurov**
7. “Mitigating Mining-Induced Hazards: A Continuous Surface Monitoring System using Kriging or Deep Learning”, **Unubold Erdenebeleg**
8. “Archaeoseismological Studies at Shativank Monastery: Evidence of a Strong Historical Earthquake, Vayots Dzor, Armenia”, **Gor Ghazaryan**
9. “Lessons from the Past: Scoping Review of the Seismic Performance of Ancient Masonry Structures in Sri Lanka”, **Hiran Tillekaratne**
10. “Geotechnical assessment and numerical modeling of Pit-3 at Khan Altai deposit”, **Sodnom Bayarsaikhan**
11. “Seismic source model for seismic hazard analysis of Mongolia”, **Ankhtsetseg Dorjsuren**
12. “Seismic Hazard and Source Characterization of the Egiin Davaa Active Fault, Central Mongolia”, **Mungunsuren Dashdondog**
13. “GIS-Based Seismic Hazard Assessment of the Northern Algerian Tell Atlas Using Historical Seismicity and Active Fault Analysis”, **Sahra Aourari**

14. “Probabilistic Seismic Hazard Assessment of Himalayan region Using Zoning, Zone-Free and Moment Slip Approaches”, **Madan Mohan Rout**
15. “A Hybrid Data-Driven and Next-Generation Algorithm Framework for Optimizing Uttarakhand’s Earthquake Early Warning System, India”, **Sandeep**

Challenges in Earthquake Hazard Assessment in Ulaanbaatar

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The Ulaanbaatar Fault, inferred to traverse the city in a northwest–southeast orientation, was not identified until 2018 (Suzuki, 2020), largely due to survey methodologies that did not adequately emphasize tectonic geomorphology. Since the identification of active faults is a fundamental dataset for seismic hazard assessment, it is essential to reexamine such structures with stronger emphasis on geomorphic evidence.

In Japan, geomorphology-based methodologies have enabled highly reliable seismic hazard assessments, supported by more than three decades of systematic mapping of active faults at a scale of 1:25,000. These differ from conventional lineament analysis, which emphasizes linear surface features and trench-based investigations. However, recent studies show that fault-related landforms are not necessarily expressed as linear features, indicating that lineament clarity alone is not a reliable criterion for identifying active faults.

In cold-region environments, freeze–thaw processes can generate fractures and disturbances within near-surface strata. Therefore, identifying active faulting requires confirmation of regional-scale ground deformation, rather than reliance on localized structural features. Faults active during the late Quaternary should show clear geomorphic expressions, while lineaments lacking such evidence should not be classified as active faults.

Based on these considerations, the Ulaanbaatar Fault requires reassessment. Investigations since 2019 confirm multiple fault activities at five locations over the past ~30,000 years, with the most recent activity after 14,000 years ago (possibly after 2,500 years ago in the northern region).

Investigations on active faults and site effects for Ulaanbaatar seismic hazard assessment

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The seismic hazard assessment is a strategic issue for Ulaanbaatar, the capital city of Mongolia, where nearly half of the country's population lives. In 1999, thirty years after the previous microzoning map of Ulaanbaatar had been produced, the Agency of Land Affairs requested that the RCAG (now the IAG) of the Mongolian Academy of Sciences update it.

The RCAG-IAG and French teams took up this challenge by developing observation networks, including permanent and temporary seismic stations, GPS stations, and radon monitoring stations. They also improved the seismic catalogue through 3D tomography and precise earthquake relocations, and refined the estimation of site effects associated with the Ulaanbaatar basin based on both seismic records and numerical modelling. A first reassessment report was completed in 2006.

At that time, one of the main challenges was the study of active faults in the Ulaanbaatar region, when most researchers were primarily focused on the large active faults that had generated magnitude 8 earthquakes far from the capital. We therefore initiated investigations of the previously known Hustai Fault as well as newly identified active faults discovered by our teams, including the Sharkhai, Avdar, and

Emeelt faults. The numerous earthquake swarms that have occurred in the Emeelt area since 2005 are being analysed and precisely relocated.

This presentation will focus on our investigations of active faults and on the extensive surveys and analyses of site effects. The results have been regularly incorporated into the probabilistic seismic hazard assessment (PSHA) of Ulaanbaatar, carried out by IAG researchers.

These achievements have been made possible through the contributions of researchers, students, engineers, and administrative staff from all the participating organizations and universities, as well as through sustained financial support from both countries, with particularly strong and continuous support from Mongolia. Despite the continuous improvement of our data, observations, and interpretations, many scientific challenges remain.

Strong-Motion Information Infrastructures for Ground Motion Models in Japan (GMM-PJ)

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Empirical ground motion models, which are based on strong-motion records, can be subject to significant uncertainty when evaluating ground motions near the source fault or during large earthquakes. This is important for earthquake damage mitigation. This uncertainty arises from the limited number of records. This uncertainty can be addressed in seismic hazard assessments by using multiple models based on a common dataset. In the magnitude–distance range where data is extremely scarce, it is essential to devise methods and metrics to understand the characteristics of each model. Our aim is to establish a “strong-motion information infrastructures for ground motion models” to make these capabilities possible.

Seismic monitoring and the results of its application in Kazakhstan to study seismic events of various nature

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Historical earthquakes on the territory of Kazakhstan. Over the past twenty years of observations by the seismic monitoring network of the National Nuclear Center of the Republic of Kazakhstan, seismic events of a different nature have been registered on the territory of Kazakhstan.

But there are also tectonic earthquakes and natural-technogenic events induced by prolonged explosive activity in the field. Despite the fact that earthquakes are rarely recorded in such 'weakly seismic' areas, quite strong earthquakes can occur there, causing damage to the existing infrastructure near their sources.

Map of seismic zoning of Kazakhstan was update in 2017 by Institute of Seismology and Institute of Geophysical Research Republic of Kazakhstan.

Recorded seismic events of different nature and associate with seismic risks.

Study of the nature of seismic events and their interrelations with the deep structure of the environment, geophysical fields and the tectonics of Central Kazakhstan.

Challenges in Strong Ground Motion Prediction in the Near-Fault Region

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Understanding the characteristics of strong ground motion in the vicinity of a source fault is critical for earthquake disaster mitigation. The 2016 Kumamoto earthquake occurred along active fault zones that had been previously evaluated, prompting a reassessment of the discrepancies between pre-event simulations and observed ground motion. This presentation evaluates how the configuration of fault geometry and kinematic parameters impacts near-fault ground motion predictions within the "Recipe for Strong Ground Motion Prediction"—a method widely used in Japan. Based on an analysis of Kumamoto earthquake data, we will outline current challenges for this framework. Furthermore, this earthquake revealed phenomena that traditional prediction methods fail to capture. In Mashiki Town, approximately 80% of building collapses were concentrated within 200 meters of the surface fault trace. Conventional fault models cannot adequately explain such localized, extreme damage. To refine prediction methodologies, we focus on small-scale mechanisms within the fault zone, specifically localized "ground deformation" near the surface. By modeling this deformation as a "single force" that partially cancels displacements from faulting and integrating it into ground motion simulations, we demonstrate the potential to reproduce the intense concentration of ground motion near the fault—a feat previously difficult to achieve with traditional models.

Assessing the Dynamic Influence of the Karjantau Active Fault Zone through Horizontal Deformation Field Analysis

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This study presents the results of recent geodynamic investigations conducted in the Karjantau active fault zone in Eastern Uzbekistan and prepared for presentation at an international scientific conference. The main objective is to evaluate the horizontal deformation field of the Earth's crust using GNSS observations and to improve seismic hazard assessment in the region. The study also enables the exchange of results with the international scientific community and supports future collaboration in seismic safety research.

Deformation rates (strain rate) were calculated from annual horizontal velocity components-eastward (VE) and northward (VN) - obtained from GNSS stations. The methodology includes several stages. First, the velocity field was interpolated onto a spatial grid. Second, the components of the two-dimensional deformation tensor (εxx and εyy) were derived from spatial gradients and converted into physical units. The dilatation parameter, representing volumetric changes, was then calculated to identify zones of extension and compression.

The resulting strain rate maps show that the present-day geodynamic regime of the Karjantau and Northern Fergana fault zones is active. The uneven distribution of dilatation values indicates heterogeneous tectonic stress. Positive dilatation corresponds to extension, where fault formation or reactivation is possible, while negative dilatation reflects compression and stress accumulation, increasing the probability of seismic events.

The results demonstrate that maximum deformation is concentrated near active faults, indicating zones of tectonic energy accumulation. Analysis of the spatial distribution and migration of deformation fields is essential for improving seismic hazard assessment and ensuring infrastructure stability and sustainable regional development.

Mitigating Mining-Induced Hazards: A Continuous Surface Monitoring System using Kriging or Deep Learning

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Mineral exploration and extraction in Mongolia and Central Asia often lack required inspections, ecological assessments, or regulatory follow-up. Unauthorized artisanal mining operates outside oversight, and even licensed drilling outpaces safety and environmental checks, causing stripped topsoil, contaminated runoff, and heavy-metal tailings that migrate into rivers and pastures long after activity ceases. These slow, remote impacts are difficult to capture through field inspection alone, and remediation costs exceed prevention costs by orders of magnitude. Earth observation offers the only practical way to monitor such disturbances at scale and cadence.

Two complementary detection capabilities, built entirely on freely accessible, routinely updated imagery streams, address these risks. The first utilizes 10-meter Sentinel imagery to establish a historical baseline of natural landscape and vegetation cycles, allowing the system to distinguish seasonal changes from unauthorized excavations and disturbed ground so that regulators can prioritize enforcement.

The second detects drilling-induced disturbance. Because 30 cm drill holes are too small to detect directly, the system uses Google Earth imagery to target the much larger drill rig stop areas and associated signatures. Relying on these accessible sources allows the entire framework to support continuous, long-term monitoring.

Combining these streams links extractive activities to downstream consequences: soil erosion, river and groundwater contamination, habitat fragmentation, and lost productivity. Continuous monitoring creates a longitudinal record for early warning, evidence-based enforcement, and verification of rehabilitation. Pairing direct detection of illegal mining with indirect detection of drilling disturbance provides a scalable tool for protecting ecosystems and supporting sustainable resource development in mineral-rich regions.

Archaeoseismological Studies at Shativank Monastery: Evidence of a Strong Historical Earthquake, Vayots Dzor, Armenia

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Shativank Monastery is located in the Vayots Dzor region of the Republic of Armenia, 7 km north of Yeghegnadzor, on the left bank of the Yeghegis River. The monastery was built in the 10th century and consists of a church and adjacent buildings. Field archaeoseismological studies reveal well-expressed evidence of earthquake impact, covering the entire monument complex. The roof slabs have fallen and are displaced. Several cornerstones have been ejected from their original positions by about 3–4 cm. The width of a crack on the wall of one of the corner towers of the outer fortification wall reaches 5 cm. Some stones of the arched passages are clearly disturbed and tilted. Numerous strong earthquakes have occurred in this area throughout history, severely damaging many architectural monuments. A well-known earthquake in Vayots Dzor is the 735 AD event with a magnitude of 7.1, which claimed about 10,000 lives and completely destroyed the flourishing town of Moz. The most dangerous impact on the study area comes from the Pambak-Sevan-Syunik (Mmax=7.4) and Garni (Mmax=7.1) fault zones. The Vayots Dzor region has a population of about 60,000. Several national and international communication routes pass through it. Therefore, the study of geological hazards in this region is of great importance for a small country with limited territory such as the Republic of Armenia, as this region constitutes about 8% of its territory. In this report, we focus on the archaeoseismological studies conducted at the monastery complex, their possible connection with adjacent active faults, and historical records. This work aims to deepen the study of geological hazards in the region, including possible manifestations of active tectonics.

Lessons from the Past: Scoping Review of the Seismic Performance of Ancient Masonry Structures in Sri Lanka

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Sri Lanka, situated in a region of low-to-moderate seismicity, faces a non-negligible seismic risk, underscored by historical events such as the 1615 earthquake. While Modern Unreinforced Masonry (URM) buildings are widely recognized for their high vulnerability, the island's ancient architectural heritage—particularly monumental stupas like Jetavana and Abayagiri—has demonstrated remarkable longevity. This scoping review systematically maps the key concepts and synthesizes evidence regarding the seismic performance of these ancient structures, investigating the inherent material properties and design features that underpin their documented resilience. A comprehensive synthesis was conducted, drawing from archaeological reports, materials engineering studies, and computational structural analyses.

The findings reveal that seismic resilience is not attributable to a single factor but to a synergistic combination of superior material science and sophisticated design. A key material advantage is the use of high-density brick and durable lime mortar with pozzolanic properties, which exhibit greater flexibility and energy dissipation. Structurally, the massive, dome-shaped form facilitates optimal stress distribution, while robust ring-beam foundations and the cohesive, monolithic behaviour of the entire assembly mitigate stress concentrations. Advanced computational models, including finite element analysis, suggest that these integrated features would allow such structures to withstand major seismic events, contrasting sharply with the brittle failure modes predicted for modern URM buildings.

The findings demonstrate that ancient Sri Lankan builders achieved a level of seismic resilience that surpasses that of many contemporary structures. This study concludes that preserving this architectural

heritage provides a valuable, field-tested benchmark. Critically, understanding and adapting these traditional, durable techniques offers a crucial pathway for developing more resilient, context-appropriate construction practices and enhancing community preparedness in Sri Lanka today.

Geotechnical Assessment and Numerical Modelling of Pit 3 at the Khan Altai mine

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The paper presents the geotechnical condition, rock mass characterization, and two-dimensional slope stability assessment of Pit-3 at the Khan Altai Mine. Geological and structural information, geotechnical core logging, RQD, discontinuity infill, surface condition, field hardness, and representative mechanical properties were screened through a QA/QC process. Of 120 registered drillholes, 18 holes with usable coordinates, geotechnical logging, structural data, and RQD data were retained for rock mass characterization and modelling. RMR89 and GSI-based rock mass characterization were combined with generalized Hoek-Brown and Mohr-Coulomb parameters. Poisson's ratio and Young's modulus were estimated for representative lithological domains and applied in the numerical models. Two-dimensional analyses were performed along representative A-B and C-D sections using limit equilibrium methods and finite element strength-reduction modelling. The results indicate that the A-B south wall is comparatively stable, whereas the A-B north wall remains close to a marginal Factor of Safety. Along section C-D, the north wall approaches the limit-equilibrium condition because the Tsakhir fault intersects the pit toe. The combined empirical, analytical, and numerical approach provides a more reliable interpretation of pit slope behaviour than any single method alone.

Seismic source model for seismic hazard analysis of Mongolia

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Earthquakes are one of the major natural hazards in Mongolia and can cause serious damage to infrastructure and communities. Reliable seismic hazard assessment is therefore important for disaster risk reduction and preparedness. A seismic source model is a key component of this assessment because it describes the locations and characteristics of potential earthquake sources.

The seismic source model of Mongolia has been developed using earthquake catalogs, geological information, tectonic features, and active fault studies. The model includes two source types: area sources and fault sources. Area sources are defined from earthquake distribution patterns and characterized by Gutenberg–Richter a- and b-values, which describe seismic activity and recurrence. Fault sources are based on mapped active faults with evidence of recent tectonic activity.

Recent geological and seismological studies have improved the understanding of Mongolia's active tectonics. The current model consists of 14 seismic source zones and approximately 80 active fault rupture sources. The integration of these sources provides a comprehensive representation of the country's seismicity and tectonic setting.

The model provides essential input for probabilistic seismic hazard analysis and supports seismic design, infrastructure planning, and disaster risk management. It also helps identify regions that may be exposed to potential strong earthquake hazards in Mongolia.

Seismic Hazard and Source Characterization of the Egiin Davaa Active Fault, Central Mongolia

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The seismic active Egiin Davaa fault zone, situated within the Hangay Dome of Central Mongolia, represents a critical structure for understanding intraplate tectonics and regional seismic hazards. While geomorphological investigations underscore its long-term geological role as a prominent normal fault, its contemporary kinematic behavior and seismogenic source properties require refined characterization for modern seismic hazard assessment. This study presents a comprehensive seismic source evaluation by integrating high-resolution earthquake relocation with newly constrained focal mechanisms. Using local earthquakes recorded by a dense 72 broadband seismic station network deployed during the Hangay Experiment (2012–2014), we relocated eartquake hypocenters using the double-difference algorithm (HypoDD). The relocated seismicity achieved a reduced residual RMS error of ~0.34s, delineating a steeply dipping, near-vertical fault plane at depth. Notably, a localized deepening of seismicity down to 30 km suggests that deep fluid migration and high thermal anomaly, potentially driven by the underlying Hangay mantle plume, lower the effective normal stress and facilitate brittle faliure in the lower crust. To characterize the earthquake sources, focal mechanisms were determined using both the HASH and FOCMEC programs. The focal mechanism solutions reveal three distinct clusters exhibiting extensional normal faulting, strike-slip, and dominant oblique transtensional mechanisms. This segmented transtensional behavior drives complex structural reactivation along the fault zone, significantly elevating the regional seismic hazard potential with a maximum expected magnitude of ~Mw7.2.

GIS-Based Seismic Hazard Assessment of the Northern Algerian Tell Atlas Using Historical Seismicity and Active Fault Analysis

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The present study provides examples of seismic hazard assessment in the northern Algerian seismic domain, a region characterized by numerous historical earthquakes. Seismic activity across several areas of the Tell Atlas is closely associated with an active tectonic setting and is primarily controlled by a network of active faults. These faults generally correspond to Miocene fault systems that affect the Tell Atlas and largely control the regional seismicity.

Within this tectonic and seismotectonic framework, historical seismicity is analyzed together with neotectonic indicators to improve the understanding of the seismic behavior of selected regions of the Tell Atlas.

Several thematic maps, including seismicity, neotectonic, and seismic zonation maps, were produced by integrating topography, tectonic structures, and earthquake data within a Geographic Information System (GIS), thereby enhancing seismic hazard assessment through improved spatial analysis and the identification of areas potentially affected by future earthquakes.

Probabilistic Seismic Hazard Assessment of Himalayan region Using Zoning, Zone-Free and Moment Slip Approaches

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The Himalayan arc, forming part of the Alpine–Himalayan convergent tectonic belt, is among the most seismically active regions in the world. Due to its history of strong earthquakes and increasing developmental activities in mountainous areas, there is a critical need to update seismic hazard assessments using improved methodologies and recent data on earthquake occurrence and ground-motion behavior.

This study presents an updated Probabilistic Seismic Hazard Assessment (PSHA) for the northwest and central Himalayan region using multiple approaches. It integrates improved magnitude conversion methods, updated ground-motion prediction equations, and three hazard computation techniques: Cornell's zoning method (1968), Woo's zone-free method (1996), and Bungum's moment-slip method (2007). Seismic activity rates were estimated using established techniques, and peak ground accelerations (PGAs) were calculated for return periods of 475 and 2475 years, corresponding to 10% and 2% probability of exceedance in 50 years.

The zoning method defines seismogenic zones based on earthquake clustering and tectonic features. The zone-free method applies kernel density estimation to capture spatial variations in seismicity, aligning hazard patterns with geological structures. The moment-slip method uses fault slip data, often resulting in higher hazard estimates due to uncertainties in fault parameters.

Results indicate maximum PGAs ranging from about 0.545g to 0.749g across regions like western Nepal, Uttarakhand, Himachal Pradesh, and Kashmir. Overall, the estimated ground motions for Design Basis Earthquake (DBE) and Maximum Considered Earthquake (MCE) are consistent with the known seismic potential of the Himalayan region.

A Hybrid Data-Driven and Next-Generation Algorithm Framework for Optimizing Uttarakhand's Earthquake Early Warning System, India

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The Uttarakhand Himalaya, located within the central seismic gap, is one of India's most seismically active zones. Although a state-specific Earthquake Early Warning System (UEEWS) is currently operational, its reliance on generic magnitude scaling relations and the conventional algorithms for P-wave detection limits its accuracy and speed—particularly given the complex tectonic and site conditions of the Garhwal and Kumaon regions. This study proposes a two-pronged strategy to enhance the UEEWS. First, we develop region-specific magnitude scaling relations using a hybrid dataset of observed and simulated seismograms, reducing real-time magnitude estimation uncertainties by accounting for local attenuation and source characteristics. Second, we introduce APPNA (Auto Picking of P-wave Onset using Next-Gen Algorithm), a novel computational method that improves onset detection accuracy, enhances noise resilience, and reduces false triggers compared to existing algorithms. Validated on both real and synthetic data, our results show that integrating tailored scaling relations with an advanced picking algorithm significantly optimizes early warning performance in high-hazard regions. These findings highlight the potential of leveraging UEEWS data, regionally calibrated relations, and innovative algorithms like APPNA to improve the operational effectiveness of the Uttarakhand warning system.

Poster session

1. “Mongolia case study. Climate Justice: Overdue, but Not Impossible”, **Bazarragchaa Tsogt**
2. “Detailed disaster risk assessment and earthquake disaster prevention opportunities in Khovd province”, **Zagdsuren Sainbayar**
3. “To the problems of the Environmental education in the U.S. today”; **Soyolmaa Sukhbat**
4. “Enhancing the technical capacity and operational efficiency of state food reserve warehouses for building disaster resilience” **Badamzaya Myagmarsuren**
5. “Aero-twin Ulaanbaatar: Physics-Informed Neural Networks and IoT-Enabled ground validation for microclimate air-quality downscaling”, **Mandakh Bayanzul**
6. “Space weather hazards and responses of the coupled magnetosphere–ionosphere system during the May 2024 geomagnetic storm”, **Amarjargal Bat-Erdene**
7. “AI-Based geomagnetic activity forecasting using observations from the Khovd geomagnetic observatory, Mongolia”, **Enkhzul Bayartogtokh**
8. “Groundwater contamination risk assessment using a Darcy-Based Uranium Transport Model”, **Myagmarsuren Genden**
9. “Disaster hazards and risks associated with climate change in the Northeast Asia region” **Sugar Ganbaatar**
10. “Space Debris Monitoring at Khureltogoot Observatory within the ISON Network”, **Buyankhishig Rentsenmyagmar**
11. “Combining strong- and weak-motion data, with amplitude ratio as a new State-of-Health Metric”, **Jiandong Wang**
12. “EEW Instrumentation and system considerations”, **Jiandong Wang**
13. “The Impact of new fault structures on the assessment of seismic risk in Bishkek”, **Gulkaiyr Tilek Kyzy**
14. “Active faulting and paleoseismicity of the Alabuga–Naryn Basin, Central Tien Shan”, **Sultan Baikulov**
15. “Seismic hazard assessment of the Naryn depression”, **Rakhmedinov Erkin**

16. “Macroseismic survey and analysis of the strong earthquake that occurred on December 24, 2025, in Bulgan soum, Bulgan province, Mongolia”, **Baldulam Chuluunbaatar**
17. “Seismic regime study of Zavkhan province, Mongolia”, **Dolgorjav Todgerel**
18. “Paleoseismological study of the Bayan-Agt fault, Mongolia”, **Baatarsuren Ganbold**
19. “High-resolution drone-based photogrammetric measurements of syn-tectonic geomorphic marker deformation in an intracontinental transpressional orogen piedmont, Bumbat Nuruu”, **Baatarsuren Ganbold**
20. “A low-cost seismic sensor network in Mongolia: The Raspberry shake 4D Solution”, **Mungunshagai Mendbayar**
21. “Seismic response of buildings using microtremor measurements in Ulaanbaatar, Mongolia”, **Dorjdavaa Myagmar**
22. “Seismic vulnerability assessment of buildings and Its relationship to geological conditions: The case of Bayan-Ölgii province”, **Altanjuldiz Torekhaan**
23. “Active faults and seismic hazard of Ulaanbaatar”, **Oleg Smekalin**
24. “Microseismic anisotropy as an indicator of modern fault activity in the Mongolian–Siberian region”, **Alexey Sankov**

Mongolia case study. Climate Justice: Overdue, but Not Impossible

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Climate change is one of the most profound threats to human health, reshaping environmental conditions and disrupting natural and human systems globally. This is particularly evident in the Asia-Pacific region, a vast and geographically diverse area spanning multiple climate zones—from the Himalayan highlands to small Pacific island states. This diversity exposes the region to a wide range of hazards, including monsoons, cyclones, floods, droughts, and extreme cold. As a result, populations in the Asia-Pacific are up to six times more likely to be affected by disasters than those in other regions.

This collection of case studies explores the human dimension of the climate crisis, moving beyond environmental narratives to examine its impacts on health, livelihoods, and social systems. It highlights how climate change disproportionately affects vulnerable populations, including rural communities, low-income groups, and those dependent on natural resources. Through regional analysis and grounded examples, it shows how climate-related shocks strain health systems, exacerbate inequalities, and challenge adaptive capacity.

Mongolia serves as a key case study of compounded climate vulnerability. Over the past 70 years, the country has experienced a 2.1°C increase in average temperature, alongside growing exposure to drought and extreme seasonal variability. These changes have significantly affected pastoral livelihoods and fragile ecosystems, while harsh winters—with temperatures dropping below −40°C in Ulaanbaatar—further intensify health risks.

At the same time, the case studies emphasize resilience, documenting how communities respond through adaptation, innovation, and collective action. It positions the Asia-Pacific at the forefront of both climate vulnerability and transformative response, offering critical insights for an increasingly uncertain climate future.

Detailed disaster risk assessment and earthquake disaster risk reduction in Khovd province, Mongolia

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A Detailed Disaster Risk Assessment (DDRA) is a comprehensive process for evaluating potential disaster risks to a specific area, buildings, infrastructure, and population using both quantitative and qualitative approaches. Unlike rapid risk assessment, DDRA is based on detailed field investigations, engineering measurements, structural analyses, and numerical modeling.

In 2024, a detailed disaster risk assessment was conducted in Jargalant Soum, the administrative center of Khovd Province, western Mongolia. The assessment identified 49 public, industrial, and commercial buildings within the study area. More than 80% of these buildings were constructed before 2015 and were not designed according to seismic microzonation-based engineering standards. Furthermore, approximately 30% of the buildings lacked formal engineering design documentation, significantly increasing their seismic exposure and structural vulnerability. The assessment also revealed that five buildings had a high Seismic Preliminary Index (SPI), indicating an elevated seismic risk and the need for immediate mitigation measures.

Disaster risk management activities in Khovd Province are coordinated by the Local Disaster Protection Council in collaboration with the Standing Subcommittee for Earthquake Disaster Risk Reduction. Approximately 1% of the provincial annual budget is allocated to disaster risk management and preparedness activities. Since 2015, under the directive of the Deputy Prime Minister of Mongolia, eight Raspberry Shake 4D strong-motion monitoring stations have been installed across Khovd Province, including Jargalant Soum and several rural districts, with a total investment of approximately MNT 65 million. These stations continuously record ground motion and provide instrumental data for estimating earthquake intensity using the Modified Mercalli Intensity (MMI) scale, thereby supporting seismic monitoring, risk assessment, and emergency response.

To the problems of the Environmental education in the U.S. today

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Environmental Ethics is an interdisciplinary subject between natural sciences such as astronomy, physics, geography, ecology, and the humanities and social sciences such as philosophy, ethics, anthropology, and political law studies. Environmental ethics is ethics that considers what is good and bad in the relationships between humans, society, and nature and searches for reasonable solutions of the environmental problems such as air pollution, flooding, hurricanes, etc. Environmental ethics in the U.S. today is taught in three stages: elementary education, secondary and high school, and higher education. In recent years, U.S. schools and universities have placed greater emphasis on climate literacy, sustainability across the curriculum, renewable energy education, environmental justice, including how pollution and climate risks affect different communities unequally, and service-learning projects that connect classroom learning with local environmental action. However, environmental ethics in America is still too factual and pragmatic, not conceptual. Being factual and pragmatic is good, but sometimes it is not reasonable, systematic, or critical. Concepts are so important for the comprehensive education of environmental education. Overall, environmental ethics in U.S. education is interdisciplinary. Rather than being confined to philosophical ethics classes, it is increasingly woven into science, civics, geography, and sustainability education to help students understand both the ecological and ethical dimensions of environmental challenges. So, as a researcher of ethics and philosophy, in the future I would like to develop a curriculum with the above perspective.

Enhancing the technical capacity and operational efficiency of state food reserve warehouses for building disaster resilience

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State reserve commodities and materials are maintained to support emergency response, disaster relief, and urgent recovery operations in the event of major national emergencies, including natural disasters such as droughts, dzud, floods, and earthquakes, as well as large-scale industrial accidents and outbreaks of infectious diseases affecting humans and livestock. Their primary function is to ensure the timely delivery of essential supplies and emergency assistance while maintaining strategic stockpiles at the required types, quantities, and quality standards. In this context, there is an increasing need to introduce advanced warehouse technologies and modernize warehouse infrastructure and management systems to enhance operational readiness, improve storage efficiency, and ensure the reliability of state reserve resources during emergencies.

This study aims to assess the technical capacity and operational efficiency of Mongolia's state food reserve warehouses and identify opportunities for their improvement to strengthen disaster risk reduction. A mixed-method research approach was employed, incorporating document review, comparative analysis, questionnaire surveys, and technical-economic assessment.

The findings indicate that 96.0% of the surveyed warehouses are conventional storage facilities, while only 4.0% operate as semi-automated warehouses, with no fully automated facilities currently in use. Furthermore, 49.7% of the warehouses have been in operation for more than 41 years, demonstrating a high level of infrastructure aging. Compliance with warehouse construction standards reached only 36.0%, whereas compliance with food storage standards was 57.0%. Technical assessment revealed that the performance of temperature and humidity control systems was 49.9%, ventilation systems 39.0%, integrated information systems 42.0%, refrigeration equipment reliability 36.0%, and backup power supply availability 36.0%, indicating

significant vulnerabilities in maintaining food quality and operational continuity during emergencies.

The economic evaluation showed that maintenance performance was relatively satisfactory (71.0%), whereas operational cost efficiency (40.0%) and food loss reduction performance (39.0%) remained insufficient. Survey respondents emphasized the urgent need for warehouse modernization, including equipment upgrades (100%), improvement of storage environments (96.6%), adoption of energy-efficient technologies (93.1%), and implementation of automation and digital warehouse management systems (89.7%).

The study concludes that introducing smart warehouse technologies, Internet of Things (IoT)-based environmental monitoring, automation, energy-efficient engineering solutions, and integrated digital logistics systems would substantially improve operational efficiency, reduce food losses, enhance the reliability of strategic food reserves, and strengthen Mongolia's national capacity for disaster risk reduction and emergency response.

Aero-Twin Ulaanbaatar: Physics-Informed Neural Networks and IoT-Enabled Ground Validation for Micro-Climate Air Quality Downscaling

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Modeling urban air quality within topographically enclosed settings like the Ulaanbaatar valley remains a difficult task. Available satellite observations suffer from coarse spatial resolution, while traditional ground-monitoring networks are too sparse to provide adequate coverage. For instance, although satellite products like MODIS MAIAC (MCD19A2) offer high temporal frequency for Aerosol Optical Depth (AOD) measurements, their 1x1 km spatial grids cannot resolve the micro-scale, street-by-street pollution dynamics driven by complex urban geometries. To bridge this gap between macro-scale satellite data and micro-urban environments, we developed Aero-Twin Ulaanbaatar, a hybrid Digital Twin system. The platform uses Physics-Informed Neural Networks (PINNs) to downscale coarse satellite grids into high-resolution, localized estimations. Unlike standard, purely data-driven machine learning models, our PINN framework embeds foundational fluid dynamics directly into its architecture. By incorporating the Navier-Stokes equations alongside local digital terrain metadata, the model mathematically simulates how particulate matter actually disperses through dense building structures. We also deployed custom-built IoT air quality monitoring units built around ESP8266 microcontrollers to ensure empirical reliability. These stations stream real-time, localized PM2.5 readings, providing an absolute ground-truth matrix used to calibrate the neural network and minimize spatial errors. Early testing shows that coupling fluid mechanics with deep learning yields significantly better downscaling accuracy than standard statistical interpolation. This predictive system serves as a high-fidelity tool for real-time micro-climate tracking, giving municipal authorities a clearer, scientifically grounded basis for targeted environmental interventions in heavily polluted urban basins.

Space Weather Hazards and Responses of the Coupled Magnetosphere-Ionosphere System During the May 2024 Geomagnetic Storm

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A major geomagnetic storm, globally designated as the "Mother's Day Storm," occurred on May 10–11, 2024, marking the most severe geomagnetic storm event observed worldwide since 2003. This study comprehensively investigates space weather hazards by utilizing in situ satellite measurements, a global network of geomagnetic observatories, the regional MAG-HVD magnetic station, and GNSS receiver database inputs to examine the dynamic perturbations within Earth's magnetosphere and ionosphere in detail. The "Mother's Day Storm" was driven by successive coronal mass ejections (CMEs), which caused the solar wind speed to exceed 1000 km/s, proton density to increase above 60 cm^{-3}, and dynamic pressure to sharply escalate up to 60 nPa. Consequently, the interplanetary magnetic field (IMF) Bz component underwent severe fluctuations, plunging to -40 nT, which triggered a robust convection process within the ionosphere and drastically accelerated plasma flow velocities. A profound interaction manifested within Earth's magnetosphere, with the geomagnetic activity SYM-H index dropping to an extremely intense peak of -518 nT (Dst = -412 nT) and the planetary Kp index reaching an extreme value of 9. In the ground based observatories recorded data of magnetic components, electron density significantly depleted at geomagnetic latitudes exceeding 50° during the geomagnetic storms main phase. This high latitude ionospheric particle deficit (negative ionospheric storm) manifested as a dramatic drop in Total Electron Content (TEC) to 10-25 TEC, which rapidly expanded equator ward to encompass the midlatitude zone. Conversely, during the geomagnetic storms recovery phase, an phenomenon was observed where the Total Electron Content (TEC) returned to 40-42.5 TEC. These empirical findings demonstrate that during such severe space weather hazards, the near Earth space environment drastically alters, establishing highly hazardous conditions capable of inducing regional communication blackouts, degrading satellite operations, and causing critical disruptions to the reliability of GNSS/GPS navigation systems.

AI-based geomagnetic activity forecasting using observations from the Khovd geomagnetic observatory, Mongolia

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Geomagnetic disturbances driven by solar activity can influence satellite operations, communication systems, navigation services, and technological infrastructure. Improving the capability to monitor and forecast geomagnetic activity is therefore an important component of space weather research and environmental hazard assessment. This study investigates the application of machine learning techniques for geomagnetic activity forecasting. As an initial stage, a Long Short-Term Memory (LSTM) neural network was implemented using OMNI solar wind data and geomagnetic indices to evaluate the feasibility of deep learning approaches for space weather prediction. The model was developed following previously published methodologies and demonstrated the ability of LSTM networks to capture temporal variations in geomagnetic activity and the potential for short-term forecasting. Building on these initial results, the study is being extended to include observations from the Khovd Geomagnetic Observatory, one of Mongolia's long-term geomagnetic monitoring stations. Unlike global geomagnetic indices, observatory measurements provide direct information on regional geomagnetic responses and local effects of space weather disturbances. The availability of continuous geomagnetic observations in Mongolia offers an opportunity to investigate the applicability of machine learning techniques to local datasets and to evaluate their potential for forecasting geomagnetic field variations under regional conditions. The long-term objective of this work is to develop an AI-assisted framework for geomagnetic monitoring and forecasting using Mongolian observatory data. Such an approach may contribute to future space weather hazard assessment, regional geomagnetic disturbance studies, and data-driven environmental monitoring in Mongolia.

Groundwater Contamination Risk Assessment Using a Darcy-Based Uranium Transport Model

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In-situ recovery (ISR) uranium mining is considered a relatively low-impact extraction method compared with conventional mining; however, the migration of uranium-bearing solutions within groundwater systems remains a potential environmental hazard. This study evaluates uranium transport and groundwater contamination hazards associated with ISR uranium mining in the Dornogovi Basin, Mongolia.

A two-dimensional numerical model was developed by coupling Darcy's law for groundwater flow with the advection–dispersion–reaction (ADR) transport equation. Model parameters and operational conditions were derived from groundwater utilization reports and hydrogeological data associated with the ISR mining operations of Badrakh Energy LLC. Hydraulic conductivity, porosity, groundwater velocity, dispersion coefficients, and first-order reaction parameters were incorporated to simulate subsurface uranium transport under representative field conditions.

Simulation results indicate that uranium migration is primarily controlled by groundwater flow velocity and hydraulic conductivity. Under baseline conditions, the modeled contaminant plume remained largely confined within the mining area, while higher hydraulic conductivity values resulted in greater migration distances and plume expansion. Sensitivity analyses further demonstrated the influence of hydrogeological conditions on potential contaminant pathways and transport rates.

The developed Darcy-based modeling framework provides a practical tool for predicting groundwater contamination hazards associated with ISR uranium mining and identifying areas of potential environmental risk.

The results support environmental monitoring, risk assessment, and groundwater management strategies and contribute to improving resilience against future environmental hazards related to subsurface resource extraction in arid regions of Mongolia.

Disaster hazards and risks associated with climate change in the Northeast Asia region.

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Every year, the world sees a rising number of disasters that devastate lives and local infrastructure, causing significant economic damage. These range from sudden events like earthquakes and floods to prolonged droughts that disrupt agricultural systems.

Asia is warming at twice the global average rate, making the region a hotspot for the climate crisis. The region is experiencing unprecedented extreme weather events, ranging from devastating monsoon floods in India and Pakistan to the dangerous melting of glaciers in the Himalayas, as well as droughts and flash floods caused by torrential rains in inland China.

In this context, there is a significant, compounded risk arising from abrupt climate change, geological activity, and environmental degradation. Consequently, the frequency and intensity of disasters—such as droughts, “zuds” (snow disaster), floods, glacial melting, and soil degradation—have increased dramatically.

Therefore, this study examines the impacts of climate change on Asia—specifically the Northeast Asian region and Mongolia—through the lens of drought, “zud” (snow disaster), and flood risks; it aims to assess the environmental challenges, as well as the future impacts, crises, and consequences arising from climate change, to help nations ensure environmental security.

Space Debris Monitoring at Khureltogoot Observatory within the ISON Network

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The rapid growth of space debris has become an emerging environmental hazard that threatens the long-term sustainability and safety of space activities. Continuous observations are essential for improving debris population models, validating prediction methods, and assessing collision risks, particularly in high Earth orbits. Such information supports effective space traffic management and strengthens resilience against future space environmental hazards.

Since 2012, the Khureltogoot Observatory (Mongolia) has participated in the International Scientific Optical Network (ISON), an international collaboration dedicated to optical observations of near-Earth space objects. The ISON database currently contains more than 230 million astrometric measurements, collected through a global network of optical telescopes, including facilities monitoring the geostationary orbit (GEO) region.

This paper presents an overview of the ISON space debris monitoring program, its observational database, and measurement statistics, together with observation results obtained using the VT-78 telescope at the Khureltogoot Observatory. The study highlights Mongolia's contribution to the global space debris monitoring network and demonstrates the value of long-term optical observations for enhancing space situational awareness and supporting sustainable and resilient use of the near-Earth space environment.

Combining Strong and Weak Motion Data, with Amplitude Ratio as a New State of Health Metric

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Co-locating weak-motion seismometers with strong-motion accelerometers enables comprehensive seismic monitoring across all scales, from major earthquakes to microtremors. Achieving a unified analysis, however, requires comparable data from both instruments, necessitating identical installation depths, precise co-axial alignment within a single package, and rigorous calibration to ensure equivalent, response-corrected ground motion signals.

This poster presents data from recent earthquake sequences in the Hualien region of Taiwan, captured by Cascadia Slim Posthole dual downhole sensors within the Central Weather Administration's (CWA) Downhole Seismic Observation Network. After response correction, the seismometer and accelerometer signals matched within 0.5% on average. This exceptional fidelity enables the synthesis of a combined data stream boasting an unprecedented dynamic range of 220 dB. We discuss and demonstrate algorithms optimized for this data combination.

Furthermore, this integrated processing introduces a novel quality assurance metric for calibration accuracy. Traditional calibration verification is laborious, interrupts data collection, and is typically performed only once a year. By contrast, analyzing a dual-instrument system allows for the continuous measurement and reporting of the response-corrected amplitude ratio between the strong- and weak-motion streams. This serves as an ongoing state-of-health metric, verifying in real time that both instruments are operating correctly and maintaining consistent accuracy in sensitivity and frequency response.

Earthquake Early Warning Instrumentation and System Considerations

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Earthquake early warning (EEW) systems depend heavily on the prompt, reliable arrival of seismic data at network data centers. To allow processing modules to detect events and issue warnings as quickly as possible, network operators must design real-time acquisition systems that ensure maximum data completeness and minimum latency. These mission-critical systems must remain fully operational before, during, and after earthquakes to handle dangerous foreshocks and aftershocks.

To optimize EEW capabilities, monitoring agencies can leverage industry-proven solutions deployed alongside high-quality, ground-motion seismic stations. Meeting the strict service level agreements (SLAs) required for public safety—such as high overall uptime, low-latency data streams, and accurate alerts—demands the careful definition and selection of sensors, dataloggers, power systems, and communication networks. Furthermore, planners must account for the end-to-end workflow, spanning system definition, roll-out, ongoing network operations, maintenance, and continuous validation to ensure long-term mandate compliance.

While deploying an EEW system presents significant technical and operational challenges, leveraging established implementations and technology partners can substantially reduce project risk and implementation timelines. This poster highlights these critical considerations and showcases fielded, real-world solutions designed to address them.

The impact of new fault structures on the assessment of seismic risk in Bishkek

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Bishkek is situated in a region of high seismic activity, where the assessment of seismic risk depends to a large extent on the quality and completeness of information regarding active faults and potential earthquake sources. In recent years, geological and palaeoseismological studies have yielded new data on the geometry and characteristics of active tectonic structures within the Chuy Basin. However, the impact of these newly identified fault structures on the assessment of seismic hazard and risk for the urban area remains insufficiently studied.

The aim of this study is to assess the impact of the newly identified fault structures on the spatial distribution of seismic hazard and risk in Bishkek. The analysis is based on updated information on active faults, parameters of potential earthquakes, local topographical conditions and the characteristics of urban development.

Taking these new fault structures into account significantly affects the spatial distribution of seismic hazard in Bishkek. The most pronounced changes are observed in areas located near active tectonic zones, where higher levels of ground motion and an increased potential for damage to buildings and infrastructure are predicted. Both the geometry and the location of seismogenic structures have a significant impact on risk assessment and may alter the identification of the city's most vulnerable areas.

Active Faulting and Paleoseismicity of the Alabuga-Naryn Basin, Central Tien Shan

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The Alabuga-Naryn Basin in the Central Tien Shan is characterized by active faulting and widespread paleoseismic features associated with ongoing intracontinental deformation. This study integrates regional mapping of active faults throughout the basin with recent detailed investigations conducted along its southern and southwestern margins to improve understanding of fault activity and seismic hazard.

Regional geological and geomorphological studies reveal the presence of reverse, thrust, normal, and strike-slip faults that remained active during the Late Pleistocene and Holocene. Numerous paleoseismic indicators, including fault scarps, displaced river terraces, landslides, rock avalanches, and other seismogenic landforms, indicate repeated strong paleoearthquakes within the basin. Previous investigations indicate that these paleoearthquakes reached magnitudes of 7.0-7.5 and local macroseismic intensities of IX-X (MSK-64), comparable to major historical earthquakes of the Tien Shan.

Recent field investigations focused on the Northern Zhamantoo and Baybichetoo fault zones. High-resolution geomorphic analysis, field mapping, and trenching confirmed thrust-fault kinematics and documented deformation of Late Pleistocene-Holocene terraces. Measured vertical offsets range from approximately 1.5 to 28 m. Estimated long-term fault slip rates are close to 0.9-1.0 mm/yr. Empirical relationships between rupture parameters and earthquake magnitude suggest that these structures are capable of generating earthquakes with moment magnitudes of Mw 6.8-7.1.

The results confirm the significant seismogenic potential of the Alabuga-Naryn Basin and highlight the importance of incorporating paleoseismic and active-fault data into regional seismic hazard assessments and infrastructure planning in the Central Tien Shan.

Seismic hazard assessment of the Naryn Depression

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The main difficulty in assessing the seismic conditions of the eastern part of the Naryn Basin, where the construction of a hydropower cascade is planned, is caused by the sharp discrepancy between the low level of present-day seismic activity in this area and the presence of numerous Late Pleistocene and Holocene ruptures that are interpreted as evidence of strong prehistoric earthquakes (Abdrakhmatov K.E. et al., 2007). In addition to Late Quaternary fault ruptures, large rockslides and rock avalanches are widespread throughout the Central Tien Shan and are commonly concentrated near active fault zones.

Historical data on the seismicity of this region cover a period of no more than 150–200 years. However, a reliable seismic hazard assessment can only be achieved by incorporating information on earthquakes that occurred long before the installation of the first seismic stations. It should be noted that during the last 20–30 years, the importance of paleoseismological data in evaluating long-term seismic hazard associated with rare events recurring once every 1,000–10,000 years has become widely recognized in global seismology (McCalpin, 1996, 2009; McCalpin, 2011). In many regions of the world, particularly where historical records extend over only a short time interval, paleoseismological data provide the most objective basis for estimating the magnitude of large earthquakes and their recurrence intervals.

This was clearly demonstrated by the 1992 Suusamyr earthquake, within whose epicentral zone fault scarps produced by similar prehistoric events were identified. Prior to 1992, however, no significant earthquakes had been documented in this area during the historical period.

Macroseismic Analysis of the Strong Earthquake that Occurred on December 24, 2025, in Bulgan Soum, Bulgan Province, Mongolia

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On December 24, 2025, at 18:38:02 Ulaanbaatar time, an earthquake with a magnitude of ML 4.1 occurred approximately 3 km east of the center of Bulgan Soum, Bulgan Province, Mongolia. The earthquake was strongly felt by residents of Bulgan Soum, the administrative center of Bulgan Province, with a population of approximately 15,000 people, as well as by residents of Orkhon Soum located to the south. This study aims to evaluate the distribution of seismic intensity and the effects of ground shaking associated with this earthquake. A macroseismic survey was conducted to investigate the spatial variation of earthquake effects. Primary macroseismic information was collected from 165 residents through questionnaires, and the collected data were analyzed using the MSK-64 intensity scale. The analysis shows that the strongest shaking effects were concentrated in the epicentral area, with decreasing intensity away from the source region. Based on the estimated intensity values, areas with similar seismic effects were identified and an isoseismal map was developed. The results provide important information on local site effects and the spatial characteristics of ground shaking caused by the earthquake.

Seismic regime study of Zavkhan province, Mongolia

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This study analyzes the seismicity and earthquake frequency–magnitude relationship of Zavkhan Province and its surrounding areas based on the earthquake catalog covering the period 1900–2024. A total of approximately 68,500 earthquakes recorded by the National Data Center of the Institute of Astronomy and Geophysics (IAG), Mongolian Academy of Sciences, were compiled, and events with magnitudes Mw ≥ 1.0 were selected for statistical analysis. The Gutenberg–Richter relationship, 〖log 〗_10 N=a-bM, was applied, and the parameters were determined using a linear regression method. For the entire study area, the parameters were obtained as a = 3.8 and b = 0.78, indicating that Zavkhan Province represents a stress-dominant tectonic environment characterized by moderate seismic activity. For the main active fault zones within the region: Bulnai, Tsetserleg, Teregtiin, Düngen, and Khukh Davaa, the a- and b-values range between a =2.40–3.23 and b=0.70–0.91, respectively. These variations reveal spatial heterogeneity in stress concentration and seismic activity across the province. Lower b-values in the western and central zones suggest higher stress accumulation and a greater likelihood of larger earthquakes, whereas higher b-values in the eastern zones indicate relatively stable tectonic conditions. The results of this study provide important baseline data for seismic hazard assessment and microzonation studies in Zavkhan Province.

Paleoseismological study at the Bayan-Agt fault, Mongolia

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The Bayan-Agt fault is located in west-central Mongolia. Along the fault zone, which extends south of Bayang-Agt soum in Bulgan Province, multiple fault segments and associated scarps with clear morphological expression have developed. Well-defined linear scarps are particularly evident on several segments, especially where they are preserved within the volcanic basalt series that are widely distributed across the study area. Satellite imagery, combined with geological field survey data, indicates that the fault follows the southern piedmont of Bayang-Agt soum, trends predominantly east–west, and can be mapped continuously for approximately 98 km. Guided by field observations and supported by remote sensing analysis of satellite imagery, sites were selected for paleoseismological trenching. Trenches were excavated approximately 550 m south of the Bayang-Agt soum center, at the piedmont of the Dalan-Tolgod hills. Radiocarbon dating of sediments exposed in the Bayan-Agt fault trenches yielded ages ranging from 904 to 28,051 years BP within a lateral distance of ~100 m between trenches. These results indicate a complex depositional history involving reworked Late Pleistocene deposits. Although the data do not permit direct estimation of earthquake recurrence intervals, they confirm long-term seismic activity and highlight the challenges of establishing reliable paleoseismic chronologies in active fault zones. Based on the 98 km long surface rupture of this left-lateral fault and the area affected by surface deformation, it is possible to infer the occurrence of a potential earthquake of approximately magnitude 7 in the region.

High-resolution drone-based photogrammetry measures of syn-tectonic geomorphic marker deformation in an intracontinental transpressional orogen piedmont, Bumbat nuruu range, western Mongolia.

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The Bumbat nuruu range Zereg Basin of western Mongolia is flanked by an intracontinental transpressional strike-slip system of faults that are actively uplifting and deforming the Mongolia Altai. The western piedmont of this range has an actively risinf thrust fault cored anticline with well exposed Neogene growth strata and transverse Quaternary alluvial fans and terraces that can be leveraged to reconstruct a base level fall history rate of fault slip and inform seismic hazard models. We take advantage of this natural laboratory to reconstruct topographic profiles along stratigraphic and geomorphic markers and measure tilts of geomorphic surfaces using high resolution drone-based photogrammetry. A high-resolution digital elevation model (DEM) was generated from aerial images acquired using a phantom 4 pro unmanned aerial vehicle (UAV) flown at an altitude of 100 m. the flight missions were designed to ensure high image quality, with 60-70% lateral overlap between flight lines and 75-80% forward overlap along the flight direction with all image captured at a nadir angle of 90. we focused effort on five swaths transverse to the anticline collecting a total of 2962 aerial photographs resulting in a DEM with a spatial resolution of 2.28 cm per pixel and vertical resolution of 4.91 cm per pixel. The DEM was further processed in ArcGIS to generate a hillshade model for the identification and extraction of geological and structural features and an accompanying orthophoto was used to delineate geological units through visual interpretation. The drone based data is field verified using hand-held differential GPS surveys that were walked along geomorphic marker surface. The resulting topographic profiles indicate that terrace and fan surfaces form in response to upstream knickpoint propagation following near instantaneous base-level fall

associated with thrust faulting and surface rupture along the Zereg Basin fault. Coupled with a soil and luminescence-based age model rate of fault slip of ~1.7 mm/yr. This study illustrates the utility of high-resolution photogrammetry for producing high-resolution datasets in support of field investigations in remote, active tectonic areas with diverse terrain, that are also poorly understood with respect to their seismic hazards.

A low-cost seismic sensor network in Mongolia: The Raspberry shake 4D Solution

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Mongolia is located in a region of high seismic activity, and improving the spatial coverage and data quality of seismic observation networks remains essential for reducing earthquake-related risks. To address this need, low-cost and high-sensitivity Raspberry Shake 4D seismic sensors have been progressively deployed in seismically active regions of Mongolia since 2022. Currently, a total of 46 stations are operating nationwide. These stations enable real-time recording and transmission of earthquake data, contributing significantly to increasing the spatial density and expanding the national seismic monitoring network.

The aim of this study is to evaluate the technical performance, recording quality, sensitivity, frequency response, and data reliability of the Raspberry Shake 4D seismic sensors. In this research, seismic signals recorded by the stations were processed and analyzed to characterize seismic wave propagation, attenuation properties, and recording efficiency. In addition, the performance and applicability of the Raspberry Shake 4D sensors were assessed through comparisons with data from conventional seismic monitoring stations.

The results demonstrate that Raspberry Shake 4D sensors provide a cost-effective solution for continuous seismic data acquisition over large geographical areas and are particularly suitable for earthquake monitoring in remote regions of Mongolia with limited infrastructure. The developed network improves the density of seismic observations and

enhances the accessibility of real-time earthquake information for local communities and relevant organizations. Furthermore, this study provides a scientific basis for expanding the national seismic monitoring network using low-cost sensing technologies and highlights the potential of community-based seismic observations for advancing seismological research and reducing earthquake risks.

Seismic response of buildings using microtremor measurements in Ulaanbaatar, Mongolia

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This study of seismic response of buildings evaluates the seismic response with natural frequencies of buildings in Ulaanbaatar using microtremor measurements. Since 2022, two broadband seismometers installed on seismograph rock base of IAG MAS and on the top floor of a 16-story building nearby IAG as reference for long-term monitoring of continuous recordings of strong earthquakes. Here, we present the result of analysis for microtremor measurement of recorded four strong earthquakes. To assess structural behavior, the Horizontal-to-Vertical, H/V spectral ratio of the building's microtremor data were compared with the Standard Spectral Ratio (SSR) for those strong earthquake records. The dominant frequencies derived from dataset were consistent, demonstrating that the H/V spectral ratio method applied to microtremor data can effectively characterize a building's seismic response. In addition to the long-term monitoring of a single building, a dataset comprising 35 separate site measurements using H/V spectral ratio was conducted on selected buildings ranging from 3 to 35 stories was analyzed using the direct using method to determine further results. Taller buildings exhibit lower natural frequencies (0.52 to 8 Hz) and longer vibration periods (up to 1.9 seconds). The result show that for each specific building, the analyzed natural frequency remains stable regardless of the analysis method or the sensor placement floor.

Seismic vulnerability assessment of buildings and its relation to geological conditions: the case of Bayan-Ulgii Province

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The aim of this study is to assess the seismic vulnerability of the building stock in Bayan-Ulgii Province in relation to geological (soil) conditions and to determine the potential levels of damage under strong earthquake scenarios. The study covers a total of 445 buildings across 13 soums and 1 settlement of the province. A macroseismic vulnerability assessment based on the European Macroseismic Scale 1998 (EMS-98) and an index-based approach was applied. The seismic vulnerability index was determined by integrating structural characteristics, building age, construction quality, foundation type, and soil conditions, and was subsequently normalized. The mean damage grade was then calculated analytically for seismic intensities ranging from V to XII. The results indicate that the seismic vulnerability of buildings in the study area is generally moderate to high, and the mean damage grade increases following a logistic trend as earthquake intensity increases. In particular, wooden structures and old masonry buildings exhibit relatively high vulnerability. Furthermore, the widespread presence of loose (unconsolidated) sediments in Bayan-Ulgii Province contributes to seismic wave amplification, which may significantly influence building damage levels. The findings of this study are important for understanding the relationship between seismic vulnerability and geological conditions and can serve as a practical basis for earthquake risk reduction planning and structural strengthening measures.

Active faults and seismic hazard of Ulaanbaatar

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Features of prehistoric earthquakes have been discovered and studied in detail near Ulaanbaatar. The results of these studies indicate that the regulatory seismic hazard of Ulaanbaatar is underestimated. Based on the parameters of Khustai, Emelt and Gunzhin dislocations, established and studied by geophysical methods and trenching, their magnitude potential is estimated to be close to M=7. This means that during movements along the faults hosting the dislocations in the Ulaanbaatar area, the intensity of shaking could reach 9–10 on the MSK-64 scale. Later, dislocations were studied in the western side of the Verkhnekerulen basin, which in general terms repeats the structural and morphological features of the Tola basin. The system of asymmetrical new depressions, constrained by faults of north-eastern extension, can be traced further to the north-east, spreading to Southern Transbaikalia. The Khustai and Kerulen faults are confined to the western sides of the Mesozoic-Cenozoic basins, to geological boundaries established in the Middle Paleozoic with a general northwestern vergence. The Gunzhin fault is a segment on the line connecting the near ends of the Khustai and Kerulen faults. Although the Gunzhin fault inherits the ancient contact zone, like the Khustai and Kerulen faults, unlike them, the latest stage of its activation began much later, when Cenozoic reverse-thrust faults had already accompanied the closure of the Tola and Verkhnekerulen basins. The development of the connection between the Khustai and Kerulen faults occurs due to the increase in the length of the Gunzhin fault in the north-eastern direction. The “youth” of the Gunzhin fault is evidenced by its indifference to the macroforms of the modern relief.

Microseismic anisotropy as an indicator of modern fault activity in the Mongolian-Siberian region

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The structure of active faults in the Mongolian-Siberian region was studied using the microseismic profiling method based on H/V ratios [Nakamura, 1989], and an assessment of the anisotropic properties of fault zones was made based on frequency and polarization analysis of microseisms [Pischiutta et al., 2012]. The Tunkinsky, Main Sayan (Russia) and Bolnay (Mongolia) faults were chosen as the objects of study. Microseismic sounding of fault zones was carried out using the transverse profiling method, the distance between seismic stations ranged from 25 to 50 m, and the number of stations on the profile varied from 6 to 13.

As a result, two-dimensional sections of H/V ratios in fault zones were obtained. The structure of the medium beneath the profile, the shape of the basement, the position and dip angle of the fault, and the width of the fault zones were qualitatively assessed based on the amplitude and shape of the anomalies in the two-dimensional H/V-ratio sections. Polarization analysis was performed for all measurement points on the profiles in the frequency range from 5 to 15 Hz in order to characterize the upper part of the section. Polarization diagrams show a sharp change in the direction of oscillations of microseismic waves directly in the fault zone.

Moreover, for normal faults (Tunkinsky fault), these vibrations are amplified normally to the strike of the fault, as well as to the strike of the extensional fractures separation cracks formed during seismogenic movement. For strike-slip faults (the Main Sayan Fault), oscillations are directed transverse to the strike of the main fault plane or perpendicular to seismogenic ruptures. For the Bolnai strike-slip fault zone, oscillations are directed at an acute angle to the fault strike. The anisotropy of oscillations in fault zones is due to the predominant heterogeneity in the upper part of the seismogenic fault section. The obtained results can serve as an indicator of the current seismic activity of the fault.

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