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Innovative approaches for sustainable forest and rangeland management in Central Asia

PROCEEDINGS OF ABSTRACTS

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ULAANBAATAR 2024

Innovative approaches for sustainable forest
and rangeland management in Central Asia

Dear Mr./Ms

We are pleased to invite you to the
International Conference on
"Innovative Approaches for Sustainable Forest and
Rangeland Management in Central Asia,"
celebrating the 100th anniversary of
the forestry sector in Mongolia.

Date: 2 October, 2024
Time: 8:30.
Venue: Diamond Hall, The Blue Sky hotel

PLENARY SESSION

08:00-09:00	Registration		
09:00-09:05	Horse head fiddle		
09:05-09:15	Opening	**Dr. Oyunsanaa B.**	National Forest Agency, Government of Mongolia
		Dr. Dashtseren A.	Institute of Geography and Geoecology, Mongolian Academy of Sciences.
	PLENARY SESSION – DIAMOND HALL **Moderator: Dr. Delgerjargal D.**		
09:15-09:35	Forest policy and development of Mongolia	**Dr. Oyunsanaa B.**	National Forest Agency, Government of Mongolia
09:35-09:55	Past, present, and future of Forest Sciences in Mongolia	**Prof. Baatarbileg N.**	Institute of Forestry, National University of Mongolia
09:55-10:15	Forest effect on permafrost existence in the forest-steppe zone of Mongolia	**Dr. Dashtseren A.**	Institute of Geography and Geoecology, Mongolian Academy of Sciences
10:15-10:35	Radial variation modeling of wood properties in Mongolian forestry species	**Assoc. Prof. Futoshi Ishiguri**	Utsunomiya University, Japan
10:35-11:00	**Group photo & Coffee break**		
11:00-11:20	A campaign and collaboration of women foresters in Mongolia	**Dr. Khishigjargal M.**	Forest, sustainability, women NGO
11:20-11:40	How to cultivate society's relationship with forests and forestry: First experiences with forest pedagogy in Mongolia	**Dr. Václav Pecina**	Department of Forest Ecology, Faculty of Forestry and Wood Technology, Mendel University in Brno, Czech Republic
11:40-12:00	**Session discussion**		
12:00-13:00	**Lunch break**		
13:00-16:00	**Session I:** Sustainable management of forest and rangeland in Central Asia Venue – Diamond Hall Moderator: Dr. Gerelbaatar S.		
	Session II: Technology and approaches for monitoring and management in dryland ecosystems Venue – Crystal Hall Moderator: Dr. Delgerjargal D.		
	Session III: Enhancing resilience and adaptation of forest and rangeland to climate change in dryland ecosystems Venue – Topaz Hall Moderator: Dr. Khishigjargal M.		
16:00-16:20	**Coffee break**		
12:00-17:00	**Poster session/ Product exhibition** **Venue - Emarald Hall**		
	Discussion & closing – Diamond Hall **Moderator: Byambagerel S.**		
17:00-17:30	**General discussion**		
17:30-17:40	Closing	**Dr. Gerelbaatar S.**	National University of Mongolia

Radial variation modeling of wood properties in Mongolian forestry species

Futoshi Ishiguri[1], Ikumi Nezu[1] Murzabyek Sarkhad[2], Togtokhbayar Erdene-Ochir[2], Bayasaa Tumenjargal[2], Bayartsetseg Baasan[2], Ganbaatar Chultem[2], Batsaikhan Ganbaatar[3], Gerelbaatar Sukhbaatar[4]
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Abstract: Wood properties, including physical and mechanical properties, usually vary from pith to bark. This variation is known as radial variation. The radial variation patterns from pith to bark differ among species and wood properties. Therefore, radial variation should be clarified for each species and wood property to utilize wood resources effectively. The present study introduces the radial variation modeling in Mongolian forestry species: *Larix sibirica*, *Picea obovata*, *Pinus sylvestris*, *Pinus sibirica*, and *Betula platyphylla*. All sample trees were collected from the natural forests in Mongolia, except for *P. sylvestris*. In the *P. sylvestris*, plantation-grown trees were also used in addition to naturally growing trees. Linear and non-linear (based on logarithmic, quadratic, and other functions) mixed-effects models were applied to each wood property in each species. Radial variations in wood properties of Mongolian forestry species will be evaluated using the selected model. The differences of wood properties between juvenile and mature wood will also be discussed in the coniferous species.

Keywords: *wood properties, radial variation, forestry, wood utilization*

A campaign and collaboration of women foresters in Mongolia

M. Khishigjargal[*1], D. Delgerjargal[1], S. Byambagerel[1], T. Bayasaa[1], D. Tsendsuren[1], D. Tuya[1]
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Abstract: The campaign for women foresters in Mongolia, launched on November 3, 2024, with the support of the Embassy of Slovenia and the Slovenian Forest Institute, aims to empower women in the forestry sector. This study is based on a comprehensive analysis of 280 surveys conducted during training seminars across various aimags and the capital city, involving 187 participants—98% of whom are women actively employed in forestry. The demographic analysis reveals that half of the participants are aged between 31-45 years, with significant representation from governmental organizations (43%) and company executives (25%). Most (78%) have up to 15 years of experience in the sector, yet income levels remain low, with 46% earning between 1-2 million tugrik monthly and 40% earning less than 1 million tugrik. Key challenges identified include low engagement and income (32%), insufficient partnerships (22%), and inadequate technology transfer (10%). The campaign seeks to address these issues through training seminars, mentorship programs, and capacity-building initiatives. Notably, 83% of participants aspire to develop a gender policy for the forestry sector and emphasize the importance of sharing knowledge and experiences. Over the past ten months, the "Forest, Sustainability, and Women" association has conducted eight training seminars, fostering collaboration and best practice sharing. This initiative highlights the critical role of women in ensuring the sustainability of Mongolia's forests while actively seeking to enhance partnerships at local, regional, and international levels.

Keywords: *Women empowerment, women in forestry, sustainability.*

How to cultivate society's relationship with forests and forestry: first experiences with forest pedagogy in Mongolia

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Abstract: Recent experiences from countries with a long history of forestry show how important it is to communicate knowledge of foresters about forests and forestry activities openly with the 'non-forestry' public. Forests are generally seen as a source of national 'wealth', to which every inhabitant is entitled. Every society makes use of forest functions, whether directly or indirectly, and thus have an ingrained close, positive and protective relationship with the forests around them. For this reason, all activities taking place in forests are closely monitored and judged throughout society. One proven and effective tool for establishing communication with the 'non-forestry' public in Central Europe is forest pedagogy, the most common target group being primary school children, though all ages can be involved. Forest pedagogy not only has the potential to communicate information on forestry activities and their importance but also to create a positive relationship with forests, even among groups that have lost, or are losing, contact with them, such as urban residents. Forest pedagogy lessons focus on direct experience, with emphasis placed on the direct involvement of all the body's senses to evoke strong emotional experiences that facilitate memorisation of the information conveyed. The mediator, who should have an appropriate forestry background and be fully trained as a forest pedagogue, should transmit the information directly in a forest environment. Between 2023 and 2024, forest pedagogues from the Czech Republic led 12 forest pedagogy events in Mongolia for primary school children, eco-clubs, foresters and the public as part of public events, and shared their experiences at a workshop for local primary school teachers focused on natural sciences. Approximately 300 children, accompanied by their teachers or relatives, participated in the forest pedagogy events. In addition, 30 foresters participated in expert workshops focused on sustainable management in forests supplemented by forest pedagogy at Tunkhel and Binder. The aim of these pilot events was both to educate and to I) identify topics suitable for this form of education in Mongolia, and II) confirm the interest of target groups (primary school children, primary school teachers and practicing foresters) in forest pedagogy and their involvement in the related activities. A series of games were prepared for forest pedagogy events, with themes related to specific topics and easily observable forest functions in each locality, based on an annual analysis of the local environment by Czech forestry experts. These topics were further communicated within the forest pedagogy events to verify the correct selection of the topics. Issues related to whether and how to protect seedlings from browsing proved to be a universal topic suitable for all sites. Active participation in the games reached 100% for all target groups at all sites and there was a high interest in launching more games beyond the set time. Based on these results, forest pedagogy has proved to be a valuable tool for communicating forestry topics with the public. Consequently, it is highly desirable that such events, aimed at cultivating society's relationship with forests and forestry, be further developed in Mongolia.

Acknowledgements: The activities outlined here were financially supported by the ‘Sustainable Resilient Ecosystem and Agriculture Management in Mongolia’ (STREAM) project, co-financed by the European Union and the German Federal Ministry for Economic Cooperation and Development, and by Mendel University in Brno. The activities were further supported by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

Keywords: *Forest pedagogy, public awareness of forestry, environmental education, forestry communication, forest–society relationship, sustainable forest management*

SESSION I: SUSTAINABLE MANAGEMENT OF FOREST AND RANGELAND IN CENTRAL ASIA MODERATOR: Dr. Gerelbaatar S.			
13:00-13:15	Classification of forests: An important tool for sustainable management	Dr. Antonín Kusbach	Department of Forest Ecology, Faculty of Forestry and Wood Technology, Mendel University in Brno, Czech Republic
13:15-13:30	Post-fire succession of pseudotaiga larch forest in Tarvagatai mountain range, Mongolia	**MSc. Undraa M**. Dr. S.N. Bazha Dr. Oyunsanaa B Dr. Dorjsuren Ch.	Botanic Garden and Research Institute, Mongolian Academy of Sciences
13:30-13:45	Modeling and control of Mongolian forest utilization: Impact of logging	**Dr. Battur G.** Dr. Batchuluun Ts.	Department of Applied mathematics, National University of Mongolia
13:45-14:00	Role, importance and new policies of forests in Mongolia	Dr. Adiyasuren Ts.	Eco-Asia, Ulaanbaatar-Erdem University
14:00-14:15	Reforestation in the Khentii Mountains: Changes needed for success and how to achieve sustainability	Dr. Václav Pecina	Department of Forest Ecology, Faculty of Forestry and Wood Technology, Mendel University in Brno, Czech Republic
14:15-14:30	Comparative assessment of the dynamics and origin of desertification in the border area of Russia and Mongolia	**Dr. Davaadorj D.** Dr. Batchuluun Ts. Dr. Batomunkuev V.S.	National University of Mongolia
14:30-14:45	Scientific data as a basis for sustainable forest management: soil moisture as a decisive factor in forest regeneration	Dr. D. Juřička	Department of Forest Ecology, Faculty of Forestry and Wood Technology, Mendel University in Brno, Czech Republic
14:45-15:00	Changes in water resources and expansion of desertification on the Mongolian Plateau	Assoc. Prof. Yiben Cheng	Beijing Forestry University, China
15:00-15:15	Knowledge of fire history and dynamics for effective management strategies	**Dr. Jan Šebesta** Dr. Pavel Peška Dr. Antonín Kusbach	Department of Forest Ecology, Faculty of Forestry and Wood Technology, Mendel University in Brno, Czech Republic
15:15-15:30	Effects of Site Conditions on Costs and Profitability in the Extraction and Use of Dead Trees in Mongolia	**Dr. Biligt B.** Yuta Ikeda Hiroaki Shirasawa Ganbaatar Ch. Futoshi Ishiguri Kazuhiro Aruga	Training and Research Institute of Forestry and Wood Industry, Mongolian University of Science and Technology
15:30-16:00	**Session discussion**		
16:00-16:20	**Coffee break**		

Classification of forests: an important tool for sustainable management

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Abstract: Vegetation is usually classified into vegetation units, categories with typical species composition. Classifying, e.g., larch, pine, or birch forest types in more detailed units is particularly useful for forestry and nature conservation. Forest types differ in many aspects, for example, wood production, resilience to harmful agents, biodiversity, or provisioning of ecosystem services. In addition to helpful information, ecological classifications have served as significant communication tools and provide an underlying framework for forest policy, decision-making, and practice. In Mongolia, coarse-scale surveys such as ecosystem maps in scales 1:1.5–12 000 000 as outputs of works of, e.g., Lavrenko and Sokolov (1978), Vostokova and Gunin (2005) and recent forest-vegetation zonation of Dorjsuren et al. (2020) do not provide sufficient environmental stratification for the definition of forest classification units. These typological structures used, e.g., in Nyam et al. (2009), are broad and obsolete. The Mongolian forestry sector, especially forestry legislation, planning, education, and extension, is under development in Mongolia. Since no legal tool such as an ecosystem classification system exists, it is impossible to recommend forest management reflecting environmental conditions and implementing political decisions systematically. A national-wide systematic approach to sustainable and adaptive management in the Mongolian forestry sector needs vegetation-environmental information via modern ecological classification. This type of information is partly available e.g., as enhanced data of permanent monitoring in the National Forest Inventory. This plot-by-plot information can be formalized into an ecological classification system. The first step was already done locally, where various vegetation, environmental, soil properties, and forest management data were taken, and a basic structure/framework for Mongolian forests was suggested. Available vegetation, environmental, and soil data were used to assess the geo-vegetation zones and identify their environment thresholds. Then, it is possible to set up lower-level units and appropriate management for relevant forest sites/stands. This geo-vegetation zonation is the first attempt at quantifying vegetation and environment at a macroclimatic level in Mongolia. It provides a framework for building a comprehensive ecological classification and a background for sustainable forest management, currently unavailable in Mongolia and many Central Asian countries. It offers a roadmap for an ecosystem survey and may act as an information platform and reference for current environmental issues, e.g. forest degradation across Mongolian landscapes.

Keywords: *vegetation classification, forest classification, ecological classification, forest management*

The postfire succession of pseudotaiga larch forest in Tarvagatai mountain range, Mongolia

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Abstract. Understanding post-fire recovery and succession is crucial for determining the forest's further re-establishment rate and development tendency, facilitating the restoration and protection of degraded forests, and planning post-fire forest management. The main aim of this study was to evaluate forest regeneration and reveal the tendency of plant succession after large-scale fire in the Tarvagatai Mountains of the Central Khangai mountain range in Mongolia. The assessment on post-fire plant succession and regeneration in the forbs-*Rhytidium* mosses pseudo taiga larch forests was conducted on permanent sample plots between 2007 and 2021, which were damaged by severe fires in 1996 and 2002. Our results indicated that burned forests were regenerated sufficiently through several successive stages of post-fire successions by being replaced by fireweed (*Chamaenerion angustifolium*) community (up to 5 years after fire), fireweed-bonfire moss (*Funaria hygrometrica*) (from 6 to 10 years), forbs (11-16 years), grasses-forbs communities of young larch forest (17-25 years). The species' richness gradually increased over time in burnt forests, whereas it sharply increased ruderal species due to grazing. The post-fire similarity indexes of species composition and genetic percentage were relatively lower than control stands, which indicates a slow rate of pre-fire vegetation recovery in the region.

Keywords: *forest fire, Larix sibirica, forest regeneration, succession, pseudo-taiga forest*

Modeling and control of Mongolian forest utilization: Impact of illegal logging

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Abstract: Deforestation and forest degradation are caused by over-exploitation, forest fires, pests, and improper commercial and illegal logging worldwide. In this paper, we consider two dynamic models. A mathematical Model 1 is proposed considering the forest biomass density x (t), and the density of wood-based industries y(t) with unknown parameter h. Model 2 is an extension of Model 1 with the density of illegal logging z(t) with an unknown parameter n. Forest biomass density is assumed to grow logistically without wood-based industries and illegal logging. In the proposed models, the controlling parameters h and n are crucial parameters for the local stable conditions of the equilibrium points and system control. We also show in this paper that it is possible to control illegal logging by increasing the level of logging by selecting system parameters efficiently and effectively. Our mathematical models demonstrated that overexploitation of forest resources and illegal logging cause deforestation and forest degradation in Mongolia. Therefore, the existing statistics related to forest exploitation show a relatively higher volume of harvested trees under illegal logging than licensed commercial harvesting. We defined

the upper limit of annual available cutting for commercial harvesting based on mathematical modeling and statistical analysis. We selected the most efficient parameters to control the sustainable use of forest resources and suggested that the Mongolian government determine the optimum annual cutting volume based on existing domestic wood demand and available forest resources.

Keywords*: dynamical systems, equilibrium points, forest management, local stability, an upper limit*

Reforestation in the Khentii Mountains: Changes needed for success and how to achieve sustainability

Václav Pecina

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Abstract: Mongolian forests are changing as they react to the negative influence of climate extremes. For example, the rise in temperatures associated with climate change is causing permafrost to melt and groundwater levels to drop, while more frequent fires limit the time for forests to recover and develop. Furthermore, trees suffering stress from high temperatures and drought are weakened, making them an easy target for insect pests. Additionally, irresponsible logging focused on the selective plundering of valuable tree species has reduced species diversity, and the unique gene pool of high-quality forest trees adapted to extreme climatic conditions. The situation is made even more critical by livestock grazing and browsing, which destroys what nature tries to restore naturally or man artificially. To counteract such climate change-related impacts, and to ensure ecosystem stability, the "Billion Trees" national movement was founded to restore Mongolian forests. The country is actively improving its forest management programs and has increased tree planting; however, plantings carried out to date have suffered from high seedling mortality and are often criticized as unsustainable. This study aimed to identify the main factors influencing i) seedling mortality and ii) the chances of successful artificial forest regeneration restoration while following basic professional forestry standards practiced in Europe for seedling handling, transport, and planting. While such factors are considered key to success, they are often poorly implemented in Mongolia. As part of the STREAM project, reforestation, and afforestation activities were designed, implemented, and evaluated on 32 plots at six sites (Bugant, Javkhlant, Tunhkel, Umnudelger, Binder, and Bayan-Adarga). In 2022, more than 2,100 seedlings of seven species were planted in individual plots, predominating Scots pine (*Pinus sylvestris* L.) and Siberian larch (*Larix sibirica* Ledeb.). In 2023, the seedlings were assessed at the beginning and end of the growing season, and any mortality or damage, along with related causes, was recorded. Seedling mortality ranged between 11 and 100% at the end of the first growing season, with poor seedling quality and livestock browsing identified as the main causes, though other harmful factors, such as pests, were also recorded. Successful and sustainable artificial forest restoration in Mongolia will require (I) improved seedling production at forest nurseries, (II) careful planting at suitable sites, and (III) consistent protection of seedlings. All these conditions must be met to ensure successful restoration in the most threatened parts of the forests, i.e. along the edges. Such measures will be expensive; thus, support for natural forest restoration must be maximized and limiting factors, such as forest grazing, reduced or eliminated. To be sustainable, particularly in the face of ongoing climate change, forest diversity (species and age) must be restored, and regeneration and restoration efforts must focus on remaining, or only recently lost, natural forest sites.

Acknowledgments: Data collection was financially supported by the ‘Sustainable Resilient Ecosystem and Agriculture Management in Mongolia’ (STREAM) project, co-financed by the European Union and

the German Federal Ministry for Economic Cooperation and Development, and by Mendel University in Brno (Czech Republic). The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) further supported the collection.

Keywords: *forest restoration, climate change, forest degradation, tree planting, seedling mortality, forest management*

Scientific data as a basis for sustainable forest management: soil moisture as a decisive factor in forest regeneration

David Juřička
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Abstract: Sustainable forest management requires considering the natural conditions and limits of the local landscapes. Only in this way appropriate management regimes can be put into place, and, on a wider scale, productive and non-productive forest functions can be balanced. In the face of ongoing climate change, it is increasingly evident that sustainable forest management in Mongolia must be based on an evidence-based decision-making process. Such a process could best be applied in establishing and restoring forests, where local natural conditions would indicate whether planting specific tree species would be sustainable over the long term. To increase our understanding of the importance and role of ecosystem determinants in Mongolian forest-steppe conditions, Mendel University in Brno (Czech Republic), in cooperation with the Mongolian University of Life Sciences, the National University of Mongolia and the German Mongolian Institute for Resource and Technology established a long-term simultaneous soil moisture, soil temperature, and climate monitoring network under the STREAM project in 2022. Based on the results of soil moisture and climatic conditions, the six monitoring sites (Bugant, Javkhlant, Tunkhel, Umnudelger, Binder, and Bayan-Adarga) were divided into two groups of I) poorly water-supplied sites strictly dependent on rainfall and II) well water-supplied sites donated mainly by the permafrost-originating groundwater. Soil moisture in 10 cm depth at the poorly water-supplied sites decreased below the wilting point up to the extremely low (0.05 cm^3/cm^3) before the rainy season. On the other hand, soil moisture content at the well water-supplied sites donated by groundwater was found constantly above 0.3 cm^3/cm^3 in the same period. The dry periods were identified based on the rainfall distribution and air temperature. The period with a limited amount of rainfall and the rapidly growing air temperature reaching up to 30 °C at the beginning of the growing season was identified from October to June at the poorly water-supplied sites. It can be assumed that these sites are extremely sensitive and less productive. Their management should be very sensitive to maximize the support of natural processes and regeneration. This approach should be reflected in the large-scale forest management in these areas.

Acknowledgments: The research was financially supported by the Sustainable Resilient Ecosystem and Agriculture Management in Mongolia (STREAM) project, co-financed by the European Union and the German Federal Ministry for Economic Cooperation and Development.

Keywords: *ecosystem services, water balance, soil water content, forest hydrology, forest productivity*

Knowledge of fire history and dynamics for effective management strategies

Jan Šebesta, Pavel Peška, Antonín Kusbach
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Abstract: Biomass burning and resulting fire regimes are major drivers of forest ecosystem dynamics. In Mongolian forests fires are common and frequent disturbance factors. Although fire is generally considered a negative element, it is a natural part of the development cycle of light taiga and boreal forests. Hence, we need reliable information about the woody species composition, and forest dynamics in the past to make the right management decisions for the future. Moreover, the knowledge of fire history enables the implementation of wildfire management strategies to mitigate wildfire risk under diverse environmental conditions. Forest management should incorporate species selection considering flammability, fire resistance, and resilience, and the adoption of silvicultural practices that decrease the fire hazard. Charcoal assemblages in the soil bring preserved information about the forests of that time. The method that deals with reconstructing the woody composition of forests using macrocharcoals is called pedoanthracology. The pedoanthracology allows the investigation of forest dynamics at the local spatial scale potentially everywhere, and for a longer resolution. Based on our results in the Tunkhel site, we revealed the relatively stable species composition in the light taiga forest. However, the pine was not as dominant in the past as nowadays. On the other hand, birch and aspen occur naturally more often and always increase now when a larger fire occurs. Yet, In the Bugant site, the woody species composition was not as stable, and we revealed different tree species in historical periods, e.g., we recorded periods with dominant birch or larch. Again, the increased abundance of birch and aspen related to fire events. It is necessary to continue researching light taiga forests' history because the knowledge gained is very informative. Ongoing research can significantly help the forest return to the landscape where it naturally belongs, following the challenging "Billion Trees" national campaign. As a result, fire regimes depend not only on climatic and biological factors but also greatly reflect the cultural background of how people manage ecosystems and fire.

Keywords: *fire ecology, forest fire, forest history, pedoanthracology, charcoal analysis*

Effects of Site Conditions on Costs and Profitability in the Extraction and Use of Dead Trees in Mongolia

Yuta Ikeda[1], Hiroaki Shirasawa[2], Biligt Battuvshin[3], Ganbaatar Chultem[4], Futoshi Ishiguri[1], Kazuhiro Aruga[1]

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Abstract: The study estimates the costs and profits of extracting dead trees from forests to be sold at provincial centers through sub-provincial centers as lumber and sold at sub-provincial centers as firewood and unused materials for energy production. The effect of site conditions on cost and profit was examined. Forest registration data including subgroup area, tree species, and forest stocks; polygonal data describing province/sub-province, protected/nonprotected, and subgroup boundaries (shape file); point data of provincial/sub-provincial center (shape file); and linear data about roads (shape file) were acquired from the Mongolian government. Subgroups comprising Siberian larch, Scots pine, and Asian white birch trees were analyzed. A positive correlation was found between off-road/primary transportation distance and harvesting/total cost; each subgroup's total cost and ratio of lumber yield resulted from the additional cost of transporting lumber from the sub-provincial center to the provincial center. The strong positive correlation between profitability and the ratio of lumber yield to the total yield of each subgroup means that profits will increase as more lumber is harvested, although lumber costs more than firewood or other unused wood. Therefore, the extent to which lumber can be harvested from each subgroup significantly influences profitability.

Keywords*: Biomass recovery, circular economy, lumber, firewood, unused materials for energy production*

SESSION II: TECHNOLOGY AND APPROACHES FOR MONITORING AND MANAGEMENT IN DRYLAND ECOSYSTEMS – CRYSTAL HALL MODERATOR: DR. DELGERJARGAL D.			
13:00-13:15	Innovative Pathways for Biochar Utilization: Reducing Forest Biomass Waste for Enhanced Environmental Sustainability and Resource Efficiency	Dr. Davaajav D.	Department of Environment and Forest Engineering, School of Engineering and Technology, National University of Mongolia
13:15-13:30	Technologies and Machinery Suitable for Mongolian Forests	Dr. Tomáš Zemánek	Department of Engineering, Faculty of Forestry and Wood Technology, Mendel University in Brno, Czech Republic
13:30-13:45	Use of biochar produced from pine nutshell for conifer seed planting	**Dr. Ariuntsetseg D.** Dr. Khishigjargal M. Dr. Erdenechimeg Z. Dr. Baigal-Amar T. Naranbayar E. Ankhbayar E.	School of Agroecology, Mongolian University of Life Sciences
13:45-14:00	Micropropagation of Siberian larch tree (*Larix sibirica* Ledeb.) and detection of functional endophytic fungi from the larch	**Dr. Enkhchimeg V.** Goomaral A. Urantulkhuur B. Erdene Z Tserendejid L Udaakhbayar J.	Department of Biotechnology and Breeding, Mongolian University of Life Sciences
14:00-14:15	Monitoring the Reforestation. The emerging lesson from the Greenbelt Project suggests a paradigm shift: from planting trees to growing trees	**Prof. Chiatante Donato** Prof. Batkhuu N. Ser-Oddamba B. Gabriealla Stefania Scippa Antonio Montagnoli	Department of Biotechnologies and Life Science, Insubria University, Italy
14:15-14:30	Bark beetle infestation in Zao Mountain, Japan accompanied, analyzed and detected by drone and deep learning since 2021	MSc. Tobias Leidemer	Smart Forest lab., Yamagata University, Japan
14:30-14:45	Treetop detection in a chrono sequential larch plantation using UAV and Maxima Detection Algorithms (MDA)	MSc. Sergi Garcia I Riera	Smart Forest lab., Yamagata University, Japan
14:45-15:00	Restore dry forests in Asia: Landscape Partnership Asia	Dr. Kikang Bae	Team Leader, Strategic Planning Team, Asian Forest Cooperation Organization
15:00-15:15	Forest change analysis in Ulaanbaatar area using multitemporal RS images	**MSc Byambadolgor B.** Dr. Amarsaikhan D. Enkhjargal D. Tsogzol G.	Institute of Geography and Geoecology, Mongolian Academy of Sciences
15.:15-15:30	Examples of rangeland and forest management from Europe and Central Asia	Andrew Mitchell	Expert, World bank
15:30-16:00		**Session discussion**	
16:00-16:20		**Coffee break**	

Innovative Pathways for Biochar Utilization: Reducing Forest Biomass Waste for Enhanced Environmental Sustainability and Resource Efficiency

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Abstract: As global energy demands rise, reliance on fossil fuels exacerbates greenhouse gas emissions, prompting urgent action to combat climate change. Sustainable alternatives, particularly carbon-neutral biomasses, present a viable solution, yet challenges such as low energy density and particulate matter (PM) emissions during combustion hinder their adoption in forestry practices. In Mongolia, significant quantities of forest waste, particularly dead wood, present both a challenge and an opportunity. PM emissions contribute significantly to household air pollution, resulting in millions of premature deaths annually. This study investigates thermochemical carbonization to enhance biomass fuel quality by converting forest waste into energy-dense biochar while reducing PM emissions and addressing methane release. We explored various biochar applications, including its potential as a soil amendment to improve soil health and productivity, and as a solid fuel to enhance livelihoods in local communities. Additionally, biochar can help mitigate methane emissions from organic waste decomposition, thus contributing to climate change mitigation. We assessed seven biomass types, including larch, poplar, miscanthus, bamboo grass, rice straw, rice husk, and dairy manure, alongside dead wood from Mongolian forests. These biomasses were carbonized at 400 °C and combusted at 650, 750, and 850 °C temperatures. Results showed a carbon recovery of over 50% for all biomass types except dairy manure, with PM emissions reduced by up to 95.5%, particularly at lower combustion temperatures. Further analysis indicated that mineral composition, especially sodium (Na) and potassium (K), influenced PM emissions at elevated temperatures. Co-combustion of low-ash biochar with high-alkali biochar demonstrated promise in mitigating PM emissions through mineral dilution. This research underscores the need to optimize combustion conditions, and biochar blends to maximize environmental benefits. By effectively utilizing dead wood and other biomass residues, we enhance the sustainability of biomass energy, improve soil health, reduce methane emissions, and promote livelihood improvement in Mongolia, ultimately contributing to climate resilience and global sustainability goals.

Keywords: *forest biomass, carbonization, utilization, livelihood improvement*

Technologies and Machinery Suitable for Mongolian Forests

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Abstract: In the production processes of forestry in any country, a variety of factors interact with each other. These factors can be grouped into four main thematic areas: people, environment, technology, and machinery. Regarding people, the main factors involved in the production process are their technological and work discipline when implementing the given measure, work experience and expertise, personal characteristics, physical abilities, and age. Environmental

factors are described by the production-technical conditions, which primarily include the terrain characteristics, soil cover, forest stand, and individual trees, as well as the seasons, climate, spatial organization, and accessibility of the forest stand. Selecting the appropriate technology for a given production process involves optimizing suitable work methods, procedures, economic costs, the measure's timing, and the direction of machinery movement across the work area. It is also necessary to consider the proportion of manual labor and the related need for workers. The selection of suitable machinery for the chosen technology depends on operating costs and the technical parameters of the machine, which are determined by the design of its individual functional parts, such as the chassis, engine section, cabin, hydraulic crane, loading space, harvester head, planting mechanism, etc. In core forestry activities, the presentation focuses on technologies and machinery suitable for Mongolian forests, highlighting their advantages and potential drawbacks. This includes topics such as the production of bare-rooted and container-grown seedlings in forest nurseries, mechanized soil preparation for reforestation, and large-scale afforestation, which is a big challenge, especially in terms of logistics, productivity, work quality, and subsequent survival of new seedlings. The presentation also addresses the protection of forest stands from wildlife and competing vegetation, technical means for forest stand tending, and logging operations.

Keywords: *forest management, forest technology, forest machinery, forest production, sustainable forestry*

Micropropagation of Siberian larch tree (*Larix sibirica* Ledeb.) and detection of functional endophytic fungi from the larch

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Abstract: There are more than 20 species of larch trees worldwide. In Mongolia, there are three species of larch trees are growing: Siberian larch (*Larix sibirica* Ledeb.), Chekanovsky larch (*Larix sukaczewii*), and Dahurian larch *(Larix gmelinii*). These are the most widely distributed trees and more than 70% of the coniferous forests of Mongolia. Due to climate change, our country's coniferous forests continue to decrease, so we need to introduce advanced methods and technologies for rapidly growing coniferous trees. The main purpose of this research is firstly to achieve rapid multiplication of larch trees in a short period of time using zygotic embryo culture which plays an important role in the rapid *in vitro* propagation of an endangered forest tree species to overcome physical and biotic interference. Secondly, determine the endophytic fungi strains to promote and improve the larch trees' growth rate and abiotic stress tolerances. The seed zygote embryos of the Siberian larch tree (*Larix sibirica* Ledeb.) were used as plant material. The surface of mature seeds was rinsed with 70% ethanol for 1 min, sterilized with 2.5% NaOCl for 15 min, and then rinsed 3 times by SDW. After soaking the sterilized seeds in water for 1 day, the seed coat softens, and the seeds are expelled. After that, cut the seed coat with a sharp knife and remove the seed embryo from the inside. For shoot regeneration, MSGm medium supplement with 2.4-D, BAP, agar, sucrose, and activated carbon with the pH adjusted to 5.8

before autoclaving was used. The most convenient *in vitro* culture for Siberian larch tree for shoot formation was MSGm medium supplemented with 2 mg/L BAP, 1 mg/L 2.4-D, 7 g/L activated carbon. Root was formatted on MSGm medium with 1 mg/L BAP, 2 mg/L 2.4-D, 7 g/L activated carbon. Embryo size was an effective on-shoot regeneration rate of larch. And approximately 4 mm embryos were suitable for the culture. The adventitious shoot regeneration rate was about 90%. Endophytic fungi can improve the uptake of macronutrients, micronutrients, and organic matter from the soil and increase the supply of these nutrients to the plant host. The twelve-seedling tree with a height shorter than 20 cm was collected from the Tuv aimag, Erdene soum to isolate endophytic fungi. Iron is an essential microelement for all living cells. Siderophores are small molecules with iron-chelating properties and are produced by some microorganisms, including endophytic fungi, to bind ferric ions in the rhizosphere. We detected the production of siderophores from endophytic fungi strains of the Mongolian larch tree. In further study, we need to identify the strains using sequencing analysis.

Keywords: *micropropagation, siberian larch, endophytic fungi, in vitro propagation, zygotic embryo culture, nutrient uptake, siderophores, abiotic stress, plant materials.*

Monitoring the Reforestation. The emerging lesson from the Greenbelt Project suggests a paradigm shift: from planting trees to growing trees

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Abstract. The damage directly caused by humans to forest ecosystems through rampant deforestation exacerbates the effects of global changes resulting from the increase in greenhouse gas concentrations in the atmosphere due to human activities. Fully justified by this situation are the global efforts to plant trees aimed at sequestering atmospheric carbon. In the case of Mongolia, the project called Greenbelt aims to counteract the advancement of desertification in territories affected by severe aridity. After 15 years since the beginning of this reforestation activity, it became necessary to implement specific monitoring of the growth of the planted trees.

The goal was to better understand the effect of the growth support activity, which consisted of using different qualities of soil fertilization and varying amounts of irrigation.
However, this monitoring was carried out innovatively, as it sought to investigate growth and development trends not only of the above-ground organs (trunk, branches, leaves) but also of the underground ones (roots of various degrees of branching) of the trees. The differences observed between the growth and development trends of the roots of the various tree species used provide interesting insights into the adaptability of the species studied for reforesting these highly arid lands. These findings will be used to plan future reforestation interventions. The insights that emerge from our innovative reforestation monitoring method are also functional in understanding the type of relationship established between the physical-chemical nature of the soil and the growth potential of different tree species. This specific aspect of monitoring has not been

considered by most reforestation projects carried out so far, which have mainly focused on the growth and development of the above-ground organs of trees, regardless of whether monitoring was conducted at the individual or population level.

The results of our work indicate that monitoring the growth and development of underground organs is strategic and necessary because it provides clear indications of the ability of the selected tree species to continue growing under these environmental conditions without risking anchorage to the soil or the exploration of nutritional needs of the deeper soil layers. We believe it is necessary to implement a paradigm shift in monitoring the performance of a reforestation project, by including in the design phase not only the extension of monitoring until the end of the juvenile development phase of a tree but also the exploration of underground organ trends. In this way, the concept of monitoring would shift from assessing the success of tree planting to verifying the correct growth trend. The absence of this approach in monitoring activities could have been the cause of the failure of many reforestation projects that have failed because trees were abandoned and neglected immediately after the establishment phase was confirmed.

Keywords: *Root system development, tree growth assessment, arid land restoration, soil–tree interactions, paradigm shift in reforestation*

Forest change analysis in Ulaanbaatar area using multitemporal RS images

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Abstract: Forests are essential natural resources critical in environmental stability, ecological balance, and sustainable development worldwide. However, deforestation and forest degradation have become pressing concerns for ecologists and policymakers. Key drivers of forest loss include shifting cultivation, legal and illegal logging, forest fires, and increased agricultural activities. In Mongolia, where forest cover is relatively low, forests are vital for maintaining water quality, preventing soil degradation, preserving permafrost, and mitigating greenhouse gas emissions. Unfortunately, illegal logging, wildfires, pest infestations, and other disturbances threaten these limited forest resources. The green areas surrounding Ulaanbaatar, the capital of Mongolia, have undergone significant changes in recent years. The forests in this region primarily consist of evergreen pines, deciduous larch, and birch trees. Riverine forests along the Tuul River feature broad-leaved species such as poplar and willow. These forests provide essential social and recreational benefits by enhancing the microclimate and reducing noise pollution.

The transition from a centrally planned economy to a market economy has intensified illegal logging activities in Ulaanbaatar's forests. Although the rate of illegal logging has decreased over time, small-scale logging continues to impact forest health. Additionally, deforestation in the green zones is largely driven by forest fires and pest infestations. Recent advancements in remote sensing (RS) technology have proven effective for monitoring forest changes. This study aims to conduct a forest change analysis in the area surrounding Ulaanbaatar

using multitemporal optical data sets from Landsat images captured in 2001 and 2024. A maximum likelihood classification approach was employed to produce land cover maps and assess the extent of available forest area.

The analysis revealed significant changes in forest cover around Ulaanbaatar over the study period. These findings highlight the urgent need for updated forest management practices integrating Geographic Information Systems (GIS) for effective conservation strategies. By leveraging remote sensing data, policymakers can better understand forest dynamics and implement measures to protect these vital ecosystems against ongoing threats.

Keywords: *Forest area, change analysis, Landsat, classification*

Examples of WB support for rangeland and forest management from Europe and Central Asia

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Abstract: Forestry and land management in the Europe and Central Asia (ECA) region has over the recent decades faced a number of challenges including, among others: a changing climate, economic transition, leading to pressures for privatization, decentralization, and government spending cutbacks, which often led to a resultant loss of institutional capacity; and demographic change.

In Albania, for example, following the fall of communism, unemployment rose, and local rural residents had few alternatives to letting their livestock graze on state-owned forests and pastures, leading to extensive over-grazing and landscape degradation. In many parts of ECA, people are moving away from rural areas to cities or even other countries in search of better-paying jobs and different lifestyles. This leaves fewer (and frequently older) people to manage the landscape, often resulting in an increasing spread of forest and scrub, but as the challenges in managing this area increase, so does the likelihood of landscape fires.

In Kazakhstan, huge areas (680,000 ha) of the Semey and Irtysh region were affected by forest fires. The dominant natural tree species was Scots pine, but in harsh conditions, natural regeneration would take centuries to reforest the area, assuming a reasonably benign climate. At the same time, the drying of the Aral Sea is an environmental catastrophe, rendering large, barren open areas susceptible to wind erosion.

In Belarus, the quite well-developed forest economy was not capturing all the benefits sustainable forest management of their forests could offer. Frequently, the forests are too densely stocked, leading to many stems self-thinning, leaving unutilized biomass to die and rot, or in the worst instances, increasing the risk of fires. This study will show some of the interventions these countries made (with World Bank support) to help address these issues.

Keywords: *sustainable forest management, rangeland degradation, post-socialist transition, landscape resilience.*

SESSION III: ENHANCING RESILIENCE AND ADAPTION OF FOREST AND RANGELAND TO CLIMATE CHANGE IN DRYLAND ECOSYSTEMS - TOPAZ HALL
MODERATOR: DR. KHISHIGJARGAL M.

13:00-13:15	Advancing Biomass Utilization and Moisture Measurement for Sustainable Forest Management in Mongolia	**Bat-Uchral B.** Taekyeong LEE Hwanmyeong Yeo	Department of Agriculture, Forestry and Bioresources, Seoul National University, Republic of Korea
13:15-13:30	Geographical variations of lumber quality in *Larix sibirica* trees naturally grown in Mongolia	Dr. Bayasaa T.	School of Industrial Technology Mongolian University of Science and Technology
13:30-13:45	Forest climate projects: economic and ecological components to achieve carbon neutrality	**Dr. Onuchin A.A.** Dr. Danilin I. M.	Sukachev Institute of Forest, Russian Academy of Sciences, Siberian Branch, Russian Federation
13:45-14:00	Biodiversity as a pillar of protection and adaptation to climate change	Dr. Vladimír Hula	Department of Forest Ecology, Faculty of Forestry and Wood Technology, Mendel University in Brno, Czech Republic
14:00-14:15	Enhancing Nature-Based Carbon Projects through Public-Private Partnerships: The Darkhan	**Kherlenchimeg A.** Dr. Batchuluun Ts. Ulambayar Ts.	Director of Finance, Orda Wealth Tech Steppe Group
14:15-14:30	Assessment of the carrying capacity and stocking rate of livestock in the Gobi Desert, Mongolia	**Dr. Sainchuluu A.** Ariuntsetseg L. Byambasuren D. Batbileg B.	Department of Ecology, Mongolian University of Life Sciences, Ulaanbaatar, Mongolia
14:30-14:45	Short-term effects of thinning on the stand characteristics, vegetation and soil properties of Scots pine (*Pinus sylvestris* L.) plantations in northern Mongolia.	**Dr. Um Tae Won** Gerelbaatar S. Batsaikhan G. Lyankhua B. Byambaa G. Ser-Oddamba B, Batkhuu N	Director, Korea Forest Restoration Association Institute, Republic of Korea
14:45-15:00	Enhancing Resilience of Scots Pine Forest in Eastern Khentii: The Role of Fire History	**MSc. Byambagerel S**. Dr. Oyunsanaa B. Dr. Peter M. Brown, Prof. Baatarbileg N Dr. Tsengel B	Department of Environment and Forest Engineering, National University of Mongolia
15:00-15:15	Assessing the Ecological Integrity of Ulaanbaatar's Green Zone Forest Ecosystem: Current Challenges and Implications	**Dr. Udval B.** Azzaya B.	Institute of Geography and Geoecology, Mongolian Academy of Sciences
15:15-15:30	Crucial strategic issues for enhancing the adaptation and resilience of the forests of Mongolia to climate change	**Dr. Banzragch Ts.**	Training and Research Institute of Forestry and Wood Industry, Mongolian University of Science and Technology
15:30-16:00		**Session discussion**	
16:00-16:20		**Coffee break**	

Advancing Biomass Utilization and Moisture Measurement for Sustainable Forest Management in Mongolia

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Abstract: Mongolia's forests are facing declining vitality due to heavy logging, the accumulation of forest by-products such as discarded branches and other organic matter, and the aging of tree populations. Significant amounts of dead wood in Mongolia's forest resources also lack appropriate utilization technologies. These factors have reduced natural regeneration rates, making the forests more vulnerable to pests, diseases, and wildfires. To reverse these trends, there is an urgent need for sustainable management practices and efficient biomass utilization strategies.

By processing and converting aging trees, dead wood, and excessive biomass, including forest by-products, into valuable products (e.g., biofuels, wood materials), it is possible to support sustainability that balances ecological, economic, and social aspects, thus maintaining forest ecosystems. The moisture content of woody biomass, derived from sustainable forest management, is a crucial factor affecting the quality and efficiency of biomass. High moisture content significantly lowers biomass's calorific value and combustion efficiency, leading to increased transportation costs and operational inefficiencies. Therefore, utilizing advanced technologies like Near-Infrared (NIR) spectroscopy to monitor and manage biomass's moisture content and condition can ensure that harvesting aging trees and by-products is done efficiently and sustainably.

In this study, we sought to develop a method to measure the moisture content of unutilized biomass under different conditions using near-infrared spectroscopy. Experiments were conducted on unused forest biomass samples cleared of forest debris. The biomass samples were mixed with a predefined amount of soil to estimate the soil and water content in the mixture. Near-infrared spectroscopy was used to accurately measure the moisture content and estimate the soil and moisture content, providing a more efficient alternative to traditional methods such as electrical resistance and wood moisture meters. This method offers a reliable approach to moisture management in biomass, which is essential for efficiently utilizing biomass in sustainable forest management practices in Mongolia and throughout Central Asia..

Keywords: *NIR spectroscopy, moisture content, soil content, unused woody biomass, biomass utilization*

Geographical variations of lumber quality in *Larix sibirica* trees naturally grown in Mongolia

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Abstract: Siberian larch (*Larix sibirica* Ledeb.) is a major tree species in Mongolia. It covers more than 70% of the total forest area in the country, and *L. sibirica* wood has been utilized for many purposes, especially for structural lumber in construction, due to its high mechanical strength properties. This study evaluated lumber quality for *L. sibirica trees* naturally grown in five different geographical locations (Arkhangai, Zavkhan, Khuvsgul, Khentii, and Selenge) of Mongolia. The five trees collected from each provenance were used in this study. A total of 111

logs with two-meter lengths were collected from 25 trees. The logs were sawn into lumbers with 100 × 50 mm in cross-section. A total of 190 lumbers were obtained from the logs. Lumber quality was measured before and after air-drying: annual ring width, moisture content, warp, and dynamic Young's modulus ($DMOE_L$). After air-drying, the lumbers were planned into 89 × 38 mm in cross-section. The planed lumbers were visually graded according to the Japan Agriculture Standard for structural lumber for wood frame construction. After grading, a four-point load static bending test was conducted to obtain the modulus of elasticity (MOE) and modulus of rupture (MOR) under the following conditions: load speed = 14 mm/min, support span = 1602 mm, and distance between load points = 534 mm. Mean values of annual ring width and air-dry density were 2.1 mm and 0.60 g/cm^3, respectively. Mean values of $DMOE_L$, MOE, and MOR of lumbers ranged from 9.89 to 14.46 GPa, 6.25 to 10.96 GPa, and 33.0 to 68.7 MPa, respectively. Significant differences were found in all examined properties of lumber among the five stands.

Keywords: *Larix sibirica, lumber quality, geographical variation*

Forest climate projects: economic and ecological components to achieve carbon neutrality

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Projects for forming carbon farms are distinguished as one of the varieties of forest climatic projects. It is proposed to create carbon farms based on highly productive pine stands by forming plantations of optimal structure throughout the entire forest growing cycle. The effect of enhancing the carbon depositing functions of stands begins to manifest itself almost immediately after forestry measures have been carried out, rather than after 10-15 years as in the case of implementing afforestation and forest planting projects. The creation of carbon farms using pine stands provides certain advantages over those based on other fast-growing plants, including neophytes, whose high rate of CO_2 absorption does not guarantee reliable and long-term retention of deposited carbon in the phytomass of plants, primarily perennial grasses.

By analyzing experimental data on the current wood increment in pine forests of I and Ia quality classes (bonitet) of different ages of fullness and density, as well as literary and reference data, the dependences of pine forest increment on density and fullness have been identified. Using the identified dependencies, the response of increment and, consequently, the amount of CO_2 deposition in stands of different structures have been estimated. Optimal density values at the maximum possible fullness for stands of each age group have been determined.

By assessing growth dynamics, it is possible to plan and carry out forestry measures (thinning) to enhance the carbon depositing functions of stands at each growth stage of the formed carbon farms. The greatest effect of depositing atmospheric carbon through the formation of carbon farms is manifested at the age of 20 to 60 years, during the period of the most intensive growth of pine stands associated with the biological characteristics of this type of woody plant.

The method for forming forest carbon farms proposed by the authors is protected by a national patent of the Russian Federation for invention.

Keywords: *forest climate projects, carbon farms, carbon sequestration, pine stands, forestry measures*

Biodiversity as a pillar of protection and adaptation to climate change

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Abstract

Ongoing climate change is having a significant impact on biodiversity, potentially leading to rapid landscape-level changes in species, including those considered as pests in agriculture and forestry. Boreal forests are probably most threatened by such biodiversity changes, particularly in relation to large forest cycles, such as those associated with pest outbreaks. Increasing temperatures have been a contributing factor to an increase in pest outbreaks, leading to ecosystem change and forest destruction. As part of the STREAM project, the author examined lepidoptera assemblages in relation to forest density and species spectrum in the marginal forest-steppe zones of the Mongolian Khentii Mountains (Tunkhel, Sharyn Gol, Javkhlant I and II, Umnudelger, Binder and Bayan Adarga). In June 2023 and 2024, butterflies were observed during the day along fixed zig-zag transects, while moths were observed using at night LED light traps. All “Macrolepidoptera” were identified to species level based on available literature and relative species rarity calculated. In total, 56 butterfly species and 241 other lepidoptera were registered, with species spectrum varying strongly based on tree density. Forest butterfly species appeared not to prefer forests habitat but instead concentrated within open forest structures. All species preferred fine-scale patch mosaics with high tree species diversity. Even in former forest areas that had lost most of their species diversity, lepidopteran species survived (even in large numbers) where forest refuges remained. Such sites even harboured rare species, such as the Lesser Purple Emperor *Apatura ilia* (Denis & Schiffermüller, 1775), previously only reported from the northernmost part of Khentii aimag. Highest lepidopteran diversity was recorded at the most habitat-diverse site (Sharyn Gol), including a new species for the Mongolian fauna, *Neptis tshetverikovi* Kurentzov 1936. Such new findings highlight the general lack of knowledge around Mongolian fauna, even relatively well-known and attractive butterfly species. Even less is known about Mongolian moth species. Here, I provide the first overview of Mongolian forest moth fauna. Overall, moth species appeared to be spread more evenly across forest density, with no important differences in species numbers. Interestingly, dense forests appeared to harbour a more

diverse and rich moth fauna than that commonly found in more open habitats, such as pasture meadows, with moth diversity strongly linked with habitat diversity. Interestingly, I registered almost no pest species, with just a few specimens of White Satin Moth *Leucoma salicis* (Linnaeus, 1758) and Siberian Moth *Dendrolimus superans sibiricus* (Tschetverikov, 1908), and presence of the Rusty Tussock Moth *Orgyia antiqua* (Linnaeus, 1758) confirmed based on just one caterpillar (taxonomic status discussed within the presentation).

Acknowledgements: This research was financially supported through the 'Sustainable Resilient Ecosystem and Agriculture Management in Mongolia (STREAM)' project, co-financed by the European Union and the German Federal Ministry for Economic Cooperation and Development.

Keywords: *Biodiversity and climate change, Lepidoptera diversity, Mongolian forest-steppe, Forest structure and species richness, Habitat mosaics, Pest species monitoring.*

Enhancing Nature-Based Carbon Projects through Public-Private Partnerships: The Darkhan Project Experience

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Abstract: Nature-based carbon projects, which focus on protecting, restoring, and sustainably managing ecosystems such as forests, wetlands, and mangroves, are essential for mitigating climate change. These initiatives sequester carbon and provide additional benefits, including biodiversity conservation, water regulation, and support for local communities. However, their complexity and scale often exceed the capacity of individual actors. Public-Private Partnerships (PPPs) offer a collaborative model by leveraging the expertise, resources, and risk-sharing capabilities of governments, the private sector, and NGOs. This project examines how PPPs accelerate the development and scaling of nature-based carbon projects through case studies across diverse ecosystems and regions. It highlights the roles of governments in establishing policy frameworks and incentives, the private sector in providing capital and technical expertise, and NGOs and local communities in ensuring ecological and social integrity.

Key factors for successful PPPs include clear governance structures, transparent carbon accounting, and aligned interests through mechanisms like carbon credits. The research also evaluates financial tools such as carbon pricing and blended finance models and explores how PPPs maintain carbon market integrity by preventing double-counting and ensuring verifiable sequestration. Beyond climate mitigation, these projects promote biodiversity preservation,

improve livelihoods for indigenous and local communities, and enhance climate resilience. Findings indicate that well-structured PPPs offer scalable solutions for financing and implementing large-scale nature-based climate initiatives while advancing sustainable development goals. This work is part of the Darkhan Project, which demonstrates the effectiveness of PPPs in rehabilitation and reforestation across various contexts, highlighting their potential for replication in different regions and ecosystems.

Keywords: *carbon credit, nature-based project, financial sustainability, public-private partnership, carbon sequestration, carbon financing.*

Assessment of the carrying capacity and stocking rate of livestock in the Gobi Desert, Mongolia

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Abstract: Understanding the carrying capacity of an ecosystem is crucial for assessing its health and sustainability and managing human activities impacting it. Factors like food, water, shelter, and resources essential for survival and reproduction influence the carrying capacity. Carrying capacity involves various methods for comprehending biotic interactions in ecosystems, often without considering its historical background explicitly.

Livestock carrying capacity assesses how many livestock rangelands can sustainably support over time without harming the ecosystem or reducing land productivity. Using the "Integrated Methodology for Calculating Pasture Capacity," issued by relevant authorities, we estimated carrying capacity and assessed capacity. Livestock grazing capacity, calculated as the number of livestock grazing on one hectare for a specified period without affecting rangeland vegetation growth, is integral to this assessment.

The number of livestock is calculated by adjusting the year-end count with offspring additions and winter-spring consumption reductions. Grazing capacity is expressed per hectare, with values indicating reserve, good rangeland, or various levels of excess capacity. Recent assessments utilize remote sensing approaches based on satellite data, like GIMMSNDVI, to monitor rangeland productivity and assess carrying capacity.

Our study focused on Khanbogd soum in the Gobi Desert, where herders follow a migratory pattern based on water availability, covering shorter distances than other regions. Our findings reveal that the carrying capacity of winter-spring and summer-autumn rangelands in Khanbogd soum remains unexceed, aligning with non-equilibrium ecosystem dynamics. Biomass, vegetation cover, and species richness are primarily influenced by abiotic factors, such as annual precipitation, rather than livestock numbers. Notably, increased precipitation in 2020 boosted carrying capacity compared to 2019.

Our research indicates a 50% grazing intensity as most suitable for the desert steppe ecosystem, emphasizing the importance of developing livestock health skills, maintaining appropriate herd structures, and improving animal breeds at household and cooperative levels before implementing a grazing plan.

Keywords: *ecosystem sustainability, grazing intensity, livestock grazing, rangeland management*

Short-term effects of thinning on the stand characteristics, vegetation and soil properties of Scots pine (*Pinus sylvestris* L.) plantations in northern Mongolia.

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Abstract: This study was conducted to investigate the effects of thinning on tree growth, vegetation, and soil properties in Pinus sylvestris plantation forests in northern Mongolia. Three study sites were located Tujiin nars area, in 18- to 20-year-old plantation forests that were thinned in 2016 and 2017, respectively. In each site, three plots with different thinning intensities and an unthinned (control) plot were established to examine stand characteristics, vegetation, and soil properties changes. Thinning induced diameter increment but not height growth, and it was strongly correlated with annual precipitation at all sites. Thinning positively affected basal increment and the growing stock of studied sites. Species richness, total coverage, and biomass accumulation in the oldest plantation were significantly higher than in younger plantations, and the similarity index of dominant species indicated that vegetation of older planted forests was more similar to naturally regenerated stands. Soil pH was not significantly changed after thinning; soils of steppe and forest edge sites were alkaline, compared to the slightly acidic soils in plantation forests. Available nitrogen (3.16 mg kg^{-1}), soil organic carbon (10.1 g kg^{-1}), and carbon stock (9.16 Mg ha^{-1}) were higher in topsoil and decreased by the depth of profile and differed in plantations by year-of-planting and between thinned and unthinned stands planted in 2003. Furthermore, the change in understory vegetation was significantly correlated with soil moisture, fertility, and species composition was driven by overstory density and crown parameters.

Keywords: *thinning, understory vegetation, forest-steppe, tree crown properties, natural regeneration*

Enhancing Resilience of Scots Pine Forest in Eastern Khentii: The Role of Fire History

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Abstract: Chronologies of fire events were reconstructed from cross-dated fire-scarred Scots pine (*Pinus sylvestris*) trees for six clusters of sites (16 locations) in the Eastern Khentii Mountain in Northeastern Mongolia. Compared to other forest fire sites in Mongolia, these communities burned frequently. For all sites combined, and using all fires detected, the mean fire interval (MFI), or number of years between fire years, was 10 years (± 8SD) from 1700 to 2020. When a yearly minimum percentage of trees recording scars of ≥ 20% is imposed, the MFI was years 15 (±10SD). The length of the most recent fire-free period was 54 years, from 1944 to 1996 exceeds the longest intervals 35 years, and is likely the result of human-induced land use changes. Based on fire scar position within annual rings, most past fires occurred early in the growing season or before growth had started for the year. These findings have important implications for management of Scots pine forests in the northeaster Mongolia and for understanding the role of fire this ecosystem function and its resiliences.

Keywords: *fire history, fire scars, Scots pine, fire free interval, land use change, growing season.*

Assessing the ecological integrity of Ulaanbaatar's green zone forest ecosystem: current challenges and implications

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Abstact: The Ulaanbaatar green zone forest, where the research was conducted, oversees water regulation, soil protection, climate mitigation, and reduced air pollution, resulting in healthier and more comfortable living conditions for inhabitants. For Mongolia, over the past eighty years, the average annual temperature has increased by 2.2 degrees, and the amount of precipitation has decreased by 7-10 percent every year. Although the forests of Mongolia have a relatively good ability to adapt to the extreme climatic conditions of the mainland, their growth is slow, they easily lose their ecosystem balance due to natural and external negative effects, and their ability to regenerate and grow naturally is relatively low. Therefore, the study was carried out to evaluate the state of the forest ecosystem in the green zone of Ulaanbaatar, to detect the growth and regularity of trees, and to develop a rationale for the restoration and afforestation of degraded forests. The research area belongs to Tuul-Barkh Region, Eastern Khentii County,

Inner-Baygal Forestry Region, Mongolia. According to the results of the research, the forest in the green zone of Ulaanbaatar is classified as degraded and slow in growth. Forests are deteriorating due to factors such as climate change, recreational use of forests, proliferation of pests, and forest fires. Experiments and research on reforestation of forest areas degraded by forest fires, pests and logging were carried out. According to the results of the research, the survival rate of the potted seedling is 85.8%, and 77.5% of the seeds with bare root system. According to the growth process of forest trees in the green zone, the growth of cedar, spruce and larch trees tends to decrease from 1960, and the growth of birch and pine trees varies depending on the climatic conditions of that year.

Keywords: *Urban forest degradation, Ulaanbaatar green zone, climate change impacts, forest restoration, tree growth monitoring, seedling survival rate, reforestation*

Crucial strategic issues for enhancing the adaptation and resilience of the forests of Mongolia to climate change

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Abstract: This paper evaluates Mongolian forest policy documents, contrasting them with the policies of international forest organizations, and identifies essential ways of strengthening the resilience and adaptation of Mongolia's boreal forests to climate change. A primary strategy to enhance the resilience of Mongolia's boreal forests to climate change is the efficient execution of sustainable forest management. This encompasses measures such sanition cut, thining, sustainable timber harvesting, enhancement of technical processes, and reforestation within forest management operations.

Implementing these measures would enhance forest health, optimize water and light conditions, reduce competition among trees, lower vulnerability to detrimental insects, mitigate fire hazards such as fallen trees, and improve reforestation initiatives in critical areas like watersheds through the planting of ecologically valuable tree species. This strategy would enhance the overall ecosystem and enhance the resilience of forest ecosystems. The article proposes that these measures should be key components of the forest sector's development strategy aimed at enhancing forest ecosystem resilience.

Keywords: *selective breeding, seed plantation, sanition cut, thining*

POSTER SESSION

TIME: 12:00-17:00 EMERALD HALL

Presentation title	Authors	Affiliations
A pilot survey study on the estimation of cone counts for Scots pine seed stand by drone image analysis and binocular cone counting of sampled trees	Min-Kyu Cha Nomin B. Munkhjin B. A-Yeon Lee Yong-Yul Kim	Korea-Mongolia Greenbelt project, Ulaanbaatar, Mongolia
A Data-Driven Approach to Support Decision-Making for Forest Restoration	Khongor Tsogt	Mongolian Forest Research Association NGO
Achievement of afforestation for Populus diversifolia	Gan-Erdene G. Mungunkhonkh M. Tuguldur N.	Energy Resources LLC, Environmental section
A study on the effect of wind shelterbelts in central Mongolia	Ganchudur Ts. Khaulenkbek A.	Institute of Geography and Geoecology, Mongolian Academy of Sciences
Bird biodiversity of tree strip line in the semi-arid region in South Gobi, Mongolia	Tsegmid N. Malovichko L.V	Department of Ecology, Mongolian University of Life Sciences
Case study on responses of tree ring growth from Tuul River riparian forest to climate warming	Munkhbat G. Khishigjarga M. Enkhbayasgalan B. Battulga P.	Department of Ecology, Mongolian University of Life Sciences
Caterpillar development, growth rate, and potential outbreak tendencies of the Siberian moth (*Dendrolimus sibiricus* Tschetv.) in Mongolia.	Enkhnasan D. Altanchimeg D.	Institute of Biology, Mongolian Academy of Sciences
Classification of Mongolian forest using satellite imagery	Byambadolgor B. Amarsaikhan D. Enkhjargal D. Tsogzol G.	Institute of Geography and Geoecology, Mongolian Academy of Sciences
The composition and distribution of the tachinid fly (Diptera, Tachinidae) in Mongolia.	Enkhnasan D. Altanchimeg D.	Institute of Biology, Mongolian Academy of Sciences
Comprehensive forest education as a starting point for sustainable forest management in Mongolia	Vaclav Pecina David Jurucka Jan Sebesta Antonin Kusbach	Faculty of Forestry and Wood Technology, Mendel University in Brno, Czech Republic
Coniferous tree disease spread of in some botanical gardens of the capital	Byambasuren M. Gerelchuluun Ya. Enkhjargal B. Uuganchimeg O. Munkhbold B. Narantsatsralt T.	Forest Protection Laboratory, Institute of Plant Protection Research, Mongolian University of Life Sciences
Contribution of Russian, Belarusian, and Mongolian scientists to the development of the forest industry in Mongolia	I.A. Lobanov, I.M. Danilin, V.V Kopytkov. Oyunsanaa B. Dugarjav Ch. Dorjsuren Ch.	Research Institute of Agrarian Problems of Khakassia, Republic of Khakassia

	Tsogt Z., Tushigmaa J. Gerelbaatar S. Tsogt-Erdene D. Jagdag D.	
Determines of biochar from pine nutshell the ability to activate and absorb various chemical compounds	Bayarmaa D. Pagmadulam N.	Department of Chemistry, Mongolian University of Life Sciences
Differences in carbon and nitrogen isotope ratios of woody species growing in forests and grasslands of the Mongolian Forest Steppe, Asia	Ayumi Oda Koh Yasue Tetsuoh Shirota Gerelbaatar S. Baatarbileg N.	Shinshu University, Japan National University of Mongolia
Ecophysiological study of Siberian larch (*Larix sibirica* Ldb.) seedlings planted in the degraded areas of the green zone in Ulaanbaatar	Enkhchimeg Ts. Udval B. Tsendsuren D. Sarantuya B. Ser-Oddamba B. Azzaya B. Anudari B. Tuguldur N.	Institute of Geography and Geoecology, Mongolian Academy of Sciences Laboratory of Forest Genetics and Ecophysiology, National University of Mongolia
Effects of forest fire on soil properties in Larch Forest of the Central Khangai in Mongolia	Bolormaa Ts. Purevdorj Ts.	Institute of Geography and Geoecology, Mongolian Academy of Sciences
Effects of thinning on the growth of young larch (*Larix sibirica* Ldb.) forests of Khentii, Mongolia	Uuganbayar Z. Delgerjargal D.	Department of Ecology, Mongolian University of Life Sciences
Estimating DBH from stump diameter and height for *Larix sibirica* and *Larix czekanowskii i*n Mongolia	Dorjsuren Ch. Baljinnyam U. Munkh-Ireedui D. Undraa M.	Botanic Garden and Research Institute, Mongolian Academy of Sciences
Forest classification of northern Mongolia using optical and radar images	Amarsaikhan D. Jargaldalai E. Enkhjargal D. Tsogzol G.	Institute of Geography and Geoecology, Mongolian Academy of Sciences
Greenhouse Gas Emissions inventory of Mongolian Mining Corporation 2023	Mungunkhonkh M. Adiyasuren D. Khash-Erdene D. Hulan B. Batbold P. Margad-Erdene T.	Energy Resource LLC
Growth dynamics and assessment of internal stem decay of Siberian Pine Forest in green zone	Batsaikhan G. Udval B. Naranbayar E. Ganbold B. Dulamsuren Ch.	Institute of Geography and Geoecology, Mongolian Academy of Sciences
Growth parameters of Poplar seedlings grown from geographically different seeds in Mongolia	Batdorj E. Delgerjargal D. Bilguun Kh. Tsendsuren D.	Institute of Geography and Geoecology, Mongolian Academy of Sciences. Mongolian Association of Poplar Researchers

Healthy Forest Project	Maralgoo G. Khishigdelger D. Steve Munson	International Conservation Caucus Foundation
Livestock grazing pressure on woody shrubs in the Darhad Depression	Khishigjargal M. Temuulen A. Munkhdul D. Namuunaa M.	Department of Ecology, Mongolian University of Life Sciences
Organic carbon stock main soils in Mongolian forest	Byambaa G. Batkhishig O.	Institute of Geography and Geoecology, Mongolian Academy of Sciences
Physical and mechanical properties of four softwood tree species naturally grown in Mongolia	Murzabyek S. Futoshi Ishiguri Ikumi Nezu Yusuke Takahashi Shinso Yokota Bayartsetseg B. Ganbaatar Ch.	Training and Research Institute of Forestry and Wood Industry, Mongolian University of Science and Technology
Research outputs on conservation and high-quality seedlings production of *Haloxylon ammodendron* (C.A. Mey.) Bunge	Batkhuu N. Enkhchimeg Ts. Ser-Oddamba B. Khaulenbek A.	Laboratory of Forest Genetics and Ecophysiology, National University of Mongolia Institute of Geography and Geoecology, Mongolian Academy of Sciences
Some natural enemies of the Siberian Moth (*Dendrolimus sibiricus* Tschetv.) in Mongolia	Enkhnasan D. Altanchimeg D.	Institute of Biology, Mongolian Academy of Sciences
Shrubs suitable for cultivation in arid steppe regions	Bayarmaa Kh. Buyanjargal M. Odgerel B.	Ecology and Agriculture-Soil Study Department, Mongolian University of Life Sciences
Science as basis for forestry policy in Mongolia: Complex data for simple conclusions and actions	David Juřička Vaclav Pecina	Department of Geology and Soil Science, Faculty of Forestry and Wood Technology, Mendel University in Brno, Czech Republic
Stand structure and Aboveground biomass of the larch-birch mixed forests in Khentii region	Tetsuoh Shirota Kai Moriguchi Koh Yasue Ayumi Oda Gerelbaatar S. Baatarbileg N.	Faculty of Agriculture, Shinshu University, Japan National University of Mongolia, Ulaanbaatar, Mongolia
Status of Siberian Pine (*Pinus sibirica* Du Tour.) forests in the Green Zone of Ulaanbaatar City	Tsendsuren D. Udval B. Batsaikhan G.	Institute of Geography and Geoecology, Mongolian Academy of Sciences
The preliminary result of tree forest species spatial distribution in the northern part of Mongolia (Selenge) using sentinel-2 and machine learning approach	Erdenetuya B. Piotr Wężyk Wojciech Krawczyk	Department of Forestry, University of Agriculture in Krakow, Krakow, Poland
Thermal tolerance tipping point in the Eurasian boreal forest	Mukund Rao Lhagvajargal O. Byambagerel S. Baatarbileg N. Jargalan B. Tsengel B.	Lamont Doherty Earth Observatory, Columbia University, USA Tree ring laboratory, National University of Mongolia

Twenty years changes on forest regeneration in eastern shore of the lake Hovsgol	Enkh-Bayasgalan B. Baigal-Amar T. Khishigjargal M.	Department of Ecology, Mongolian University of Life Sciences
Urban green space planning based on the local climate zoning	Delgerjargal D. Erdenetsogt S.	Mongolian Association of Poplar Researchers Public Lab Mongolia

A PILOT SURVEY STUDY ON THE ESTIMATION OF CONE COUNTS FOR SCOTS PINE SEED STAND BY DRONE IMAGE ANALYSIS AND BINOCULAR CONE COUNTING OF SAMPLED TREES

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Abstract: This study was conducted to determine the feasibility of estimating the number of cones for a Scots pine seed stand (No. 26 sub-stand, 14ha) in Khuder soum district by drone image analysis and binocular cone counting of sampled trees.

In this study, a drone (DJI MINI 4 Pro) was used to capture images of the stand, ArGIS Pro program and watershed function were used to estimate the number of existing Scots pine trees for the stand, and binocular cone counting of cone-bearing individuals was conducted in five survey plots (20m x 20m) randomly installed within the stand. Drone image analysis using the watershed function showed that 703 trees were estimated to be present in the stand, with an individual tree identification accuracy of 96.3%.

The mean number of cones per individual cone-bearing tree within the stand was 57.4 from the binocular cone counting, with a standard deviation and standard error of 30.7 and 13.7, respectively. The total number of cones per tree for the stand was estimated as 40,352 by multiplying the estimated total number of individuals (703) by the mean number of cones per individual (57.4).

The survey method using the drone image analysis and binocular cone counting of sampled trees is considered effective and practicable for quickly estimating the total number of cones in the Scots pine stand of 14ha area. Nevertheless, the effective planning of practical afforestation requires the total seed weight to be considered for each stand. This necessitates supplementary analysis, such as the 'cone analysis' methodology established by the Southern Forest Experimental Station, USDA Forest Service, to ascertain the mean number of seeds and mean seed weight per cone. Subsequently, these figures are multiplied by the total number of cones estimated by the methodology employed in this survey study to determine the total seed weight for the stand.

A DATA-DRIVEN APPROACH TO SUPPORT DECISION-MAKING FOR FOREST RESTORATION

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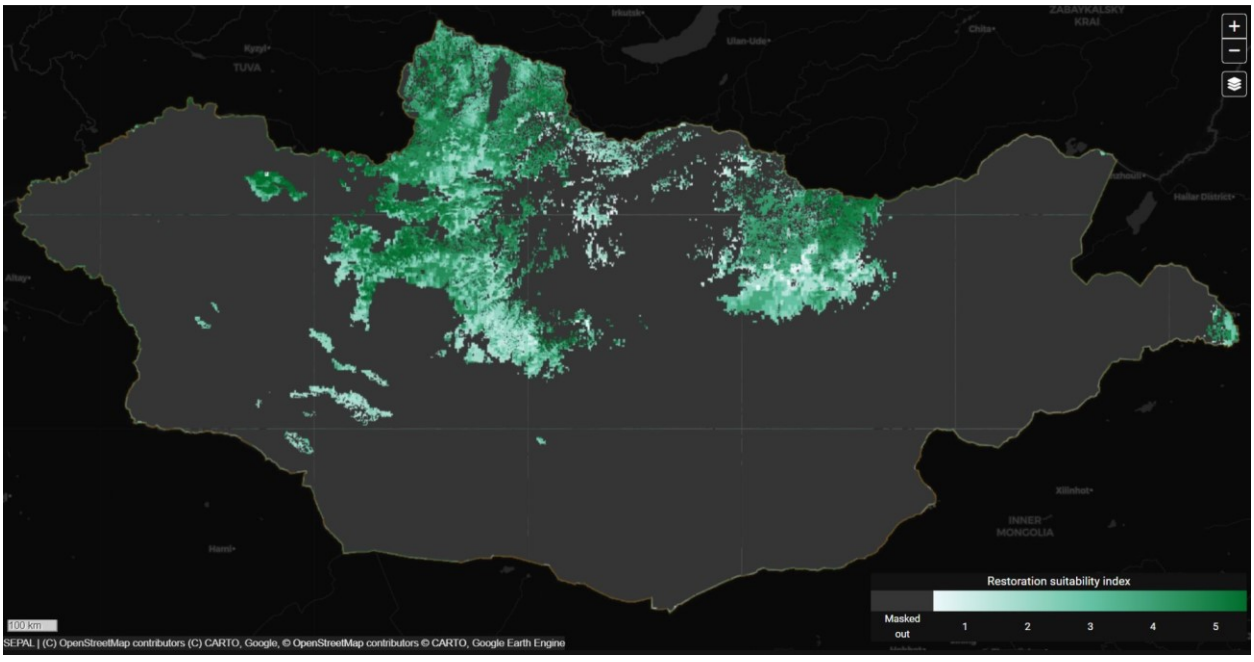
Abstract: Forest restoration plays a critical role in mitigating climate change and enhancing ecosystem services. However, effective restoration requires careful site selection and prioritization based on ecological and socioeconomic factors. The se.plan tool, developed by FAO and integrated within the SEPAL platform, is a spatially explicit, cloud-based decision support system designed to optimize forest restoration planning. se.plan allows users to identify areas with the highest restoration potential by evaluating factors such as biodiversity conservation, carbon sequestration, local livelihoods, and wood production. This poster explores the application of the se.plan tool in assessing restoration suitability across Mongolian landscapes. Using a combination of global data layers and customizable parameters, se.plan generates restoration suitability indices, identifying locations where the benefits of restoration outweigh implementation costs. Our case study highlights the use of se.plan in Mongolia, where the tool's analysis has helped stakeholders prioritize areas for afforestation and reforestation, taking into account ecological constraints, socioeconomic needs, and restoration costs. We present the generated suitability maps alongside key statistical findings to demonstrate how se.plan can guide decision-making for forest restoration. By integrating this tool into restoration planning, we can enhance efficiency, reduce costs, and maximize the ecological and social benefits of restored forest landscapes.



The study indicates that there are 1.2 million hectares of potential forest areas that currently have no forest cover which can be restored. Results: https://shorturl.at/FHzCJ

ACHIEVEMENT OF AFFORESTATION FOR *POPULUS DIVERSIFOLIA*

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Abstract: About 40 percent of Mongolia's territory is occupied by gobi and desert areas, and among these are Bayan Burds, which are like mainland islands. Bayanburd (Oasis) occupies 0.5-1.0% of the desert area, but it plays an important role in the ecosystem of the region, and the main lifeblood of the Bayanburd is the Tooroi (*Populus diversifolia*) . *Populus diversifolia* is the largest woody plant in the Gobi region of our country and is of special importance for ensuring ecological balance, but its ability to regenerate under natural conditions is decreasing and population is becoming less in every year. Therefore, our country included the *Populus diversifolia* in the list of extremely rare plants. The main goal of our research is to afforest this plant, which is included in the list of very rare plants, and to contribute to maintaining its ecologycal balance by establishing a afforestated Tooroi's population grove.

This research work was carried out in 2020 at the tree nursery area of Energy Resources LLC in Tsogtsetsii Sum, Umunogov province. The seeds used in the study were collected manually from June 29th to July 4th in the area of Ekhiin gol, Shinejinst soum, Bayankhongor Province. The soil mixture for planting poppy seeds was 1.8 kg of natural yellow sand and 200 grams of biohumus. Prepared seeds were planted in seedling pots, placed in a greenhouse, and watered with a misting irrigation system for 10 minutes every 2 hours until the first sprouts appeared. In the 3 months after planting, the upper part of the seedling had grown up to 13 cm. In 2022, the survival rate was 87% when 500 Tooroi seedling were transplanted into the forest belt area established by the company to create a small population of afforested *Populus diversifolia*.

A STUDY ON THE EFFECT OF WIND SHELTERBELTS IN CENTRAL MONGOLIA

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Abstract: The purpose of this research is to estimate the wind force reduction effects of different type of tree species in wind shelterbelts based on monitoring results. Field experiments were carried out during 2010–2017 at the Elsen Tasarkhai station of the Research and Experimental Center for Combating Desertification (47°27′N, 103°68′E; 1967 m a.s.l), located in Khugnu-Tarna National Park in Rashaant soum of Bulgan province, central Mongolia. The tree species studied are *Acer tataricum*, *Populus sibirica*, *Malus Pallasiana*, *Ulmus pumila*, *Salix Ledebouriana* and *Caragana arborescens*. The wind data collected by the Hobo loggers were downloaded using Onset HOBOware® Lite Software Version 2.2.1 (Onset Computer Corporation, Pocasset, MA). The estimation procedure incorporates the 1999 version of windbreak sub-model of the Wind Erosion Prediction System (WEPS). Wind shelterbelt effects is estimated in terms of friction velocity reduction, which is a function of wind speed and direction, distance from the barrier, trees height, porosity, width, and orientation. Wind

shelterbelt characteristics (windbreak type, height, width, porosity, and location) were recorded. A significant effect of wind shelterbelt on airflow reduction was proven on the leeward side of windbreak in a belt corresponding to approximately 15-30 times the height of the windbreaks depending on the optical porosity. During the monitoring period, the impacts have varied, but all species have reduced the wind speed to a certain distance. As a result, the annual growth rate of tree species showed the significant importance of wind protection. By identifying the effect of shelterbelts on living windbreaks and wind data used long-term monitoring in sandy soil regions of central Mongolia, advanced tree planting and forest strip establishing methods will be developed.

BIRD BIODIVERSITY OF TREE STRIP LINE IN THE SEMI-ARID REGION IN SOUTH GOBI, MONGOLIA

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Abstract: In Mongolia, since 1966, as part of comprehensive measures to protect agricultural soils from erosion and damage, protective forest belts have been created. Ts. Davaayamts (1965) studied the method of propagating *Ulmus pumila* by seeds in the Gobi and steppe regions of Mongolia, experimental research work was carried out in Bulgan-Sum of South Gobi Province, and seedlings were transplanted into the forest belt protecting vegetable fields and the center of the sum (Tsegmid, 2018). Currently, Bulgan sum has four districts: Hadat, Dal, Naran and the center of the sum.

The goal of the work: analysis of data on the number and diversity of birds living of the forest belt of Dalanzadgad, Sevrey and Bulgan somons in the South Gobi aimag. In this region, from 15 to 17 August 2017, 3 route surveys were conducted. In the Dalanzadgad, Sevrey and Bulgan somons of land planted with *Hippophae, Caragana arborescens, Ulmus pumila* and *Populus laurifolia* trees. In the barren steppe region, such a place serves as a resting, feeding and drinking place for many species of birds.

In the of tree strip line in the semi-arid region in Dalanzadgad, Sevrey and Bulgan somons 27 species of birds belonging to 4 orders, 14 families and 22 genera are recorded. By presence type 7 resident species and 20 migrant species are noted. The taxonomical classification of avifauna of the Northern Gobi is following: Falconiformes – 4, Pteroclidiformes – 1, Columbiformes – 2, Passeriformes – 20 species. The dominant ecological group of the avifauna of the Northern Gobi is arboreal-shrub birds (dendrophils), which account for 14 species. In open habitats (steppe, desert) 6 species of birds (campophiles) are noted, 5 species are sclerophylls. In wetland areas 2 species are found – (limnophiles).

CLASSIFICATION OF MONGOLIAN FOREST USING SATELLITE IMAGERY

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Abstract: Forest cover occupies a noticeable part of the planet's land area and generates nearly half of net primary products and stores more than 80% of terrestrial plant carbon. Utilization of forest resources has an impact on the environment and on the economies of the world nations. Forests have a history of being exploited either adequately, but more efforts are now being made towards their sustainable use. The assessment of forests in terms of their extent, condition, use and value is periodically realized at both global and national levels.

Historically, forestry has been concerned mainly with the assessment of timber resources and the management and utilization of closed forests for the production of wood. The applications of satellite data for effective forest management on a more scientific basis is consistent with the priorities set at different levels of studies. The shift in priority of forest management towards ecologically sustainable forest resources management calls for reliable thematic spatial information with a provision to update and retrieve for management decisions at various levels.

Remote sensing (RS) is used in a wide array of forestry applications, including forest cover updating, depletion monitoring and measuring, forest type discrimination; determination of biophysical properties of forest stands; collecting harvest information; updating of inventory information for timber supply, biomass estimation, species inventory, regeneration assessment; monitoring the quantity, health and diversity of the forests. In addition, RS techniques can identify, distinguish, classify, assess and measure different timberland attributes both qualitatively and quantitatively.

Mongolia may be known for its deserts and steppes, but the country has a large cover of forest area compared to its population. The forests are mainly located in the central and northern parts of the country, forming a transition zone between the Siberian boreal forest and the Central Asian desert steppe. The country 's forests are primarily found in the Khangai, Khentii and Khuvsgul mountains. They are part of the taiga biome, characterized by coniferous trees such as siberian pine, siberian larch, and fir, as well as birch and aspen in some areas.

The forested regions of Mongolia are crucial for biodiversity, providing habitat for various species of mammals, birds, and plants. They also play a significant role in regulating the local climate and maintaining soil stability. As known from the statistics, Mongolia has about 18.6 million ha of forestlands occupying 11.8% of the country's total land area, but 12.4 million ha, or 7.85% of the country's territory, is actually covered by forests. A study has also shown that as of January 2022, forest cover was approximated at 8-15% of Mongolia's land area, a figure subject to change due to dynamic influences such as climate shifts, desertification, and deforestation.

The aim of this study is to conduct a forest area classification and determine the amount of current forest cover in Mongolia using satellite imagery. For this purpose, MODIS satellite 16 day average data acquired from 16 May to 01 June 2024 has been used. To define the amount of current forest cover, a support vector machine (SVM) and maximum likelihood classification (MLC) techniques were compared. The overall classification accuracies indicated 94.28% and

96.17% for the SVM and MLC, respectively. Overall, the study showed that the RS data along with accurate classification techniques could be successfully used for a forest class determination.

RESPONSES OF TREE RING GROWTH FROM RIPARIAN FOREST TO CLIMATE WARMING

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Tuul riparian forests ecosystem has been affected by climate change, particularly during droughts, as well as by significant negative environmental effects of industries, a decrease in the natural water cycle, and a lack of water resources. But there haven't yet been any comprehensive investigations into the riparian forest species in Mongolia. This research intends to examine tree rings in order to evaluate how the Tuul River basin's radial growth has responded to recent climatic warming. 40 Populus Laurifolia L tree core samples total were gathered from two distinct sites. A computer-based measuring apparatus is used to measure tree rings, and the TSAP-Win program is used to record the data and evaluate it. We will provide some findings on climate response analyses that are relevant to from the outcomes of the ongoing research. We will provide some climate response analysis findings from the ongoing study that are relevant to the last few decades. Furthermore, as the riparian forest is naturally quite sparse and inhabitants living nearby rely heavily on the forest ecosystem services in Mongolia, attention must necessarily be paid to long-reaching socioeconomic effects.

CATERPILLAR DEVELOPMENT, GROWTH RATE, AND POTENTIAL OUTBREAK TENDENCIES OF THE SIBERIAN MOTH (*DENDROLIMUS SIBIRICUS* TSCHETV.) IN MONGOLIA

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Abstract: The Siberian moth, *Dendrolimus sibiricus* Tschetverikov, 1908 (Family Lasiocampidae), is a significant pest of conifer forests in Northern Asia, including Russia, Northern Kazakhstan, Mongolia, and China. The larvae feed on a variety of conifers, such as fir, spruce, Siberian pine, and larch. The life cycle of the Siberian moth typically spans 1 to 2 years, but it can extend up to 4 years under unfavorable conditions. The larva’s ability to cause extensive damage makes it a major concern for forest management. Our research was carried out at 14 places in the Khentii mountain range, a renowned hotspot for Siberian moth outbreaks. We measured different body sections of the caterpillars and assessed their population density.

The results of spring and fall surveys describing the features of the Siberian moth are reported in density. Caterpillars at various instar stages were seen throughout the research period, with pupation increasing significantly in the beginning of July. We provide basic body measurements for the caterpillars. The caterpillars' body weight varies 3.0-5.7 times, while their

body length grows 1.4-1.9 times between instars. Throughout the molting process, body weight grows by up to 1530 times, while body length increases by 12.5 times. One-year-old larvae develop relatively fast, increasing in body weight by 5.7% after around 10 days.

As a result, the body weight of two-year-old larvae grows dramatically. Furthermore, the time of the first molt in these larvae varies by geographical location. During the study, the age of the caterpillars and the weather parameters were compared. The spring monitoring survey revealed that two-year-old larvae made up 87.2% of all caterpillars. A graph displaying their growth and development indicates that 95% of 2-year-old larvae experienced an average air temperature of 19.6^0 C and a total rainfall of 16.5 mm on June 10-15, and subsequently leading to their molting. The peak period for molting larvae from the third to the fourth and fifth instars typically occurs in mid-June, while the peak period for transferring larvae from the fourth to the fifth instar occurs near the end of July (average air temperature: 16.1^0 C, total precipitation: 104.1 mm).

The peak molting phase for sixth instar larvae occurred at the end of August, when the average air temperature was 15.6^0 degrees Celsius and the total precipitation was 104.1 millimeters. It supports previous research results that local climate and environmental variables have the greatest influence on caterpillar growth and development. These discoveries support prior findings, emphasizing the importance of local climatic and environmental conditions on caterpillar growth and development.

We used a continuous series of data on the hotspot areas and the CCCMA A2A model of the IPCC's Fourth Report until 2040 to anticipate the future distribution and outbreak range of the Siberian moth. Future trends for the Siberian moth are predicted using data on the moth's distribution and outbreak range from 2005 to 2018 in Mongolia. It is expected to peak in 2024–2026 and 2032–2034. The outbreaks are expected to last for two to three years, with 7–8-year intervals in between. Since Siberian moth outbreaks are cyclical, these findings may help with early damage prevention management strategies. Based on 14 years of data, these parameters had a significant impact on the Siberian moth outbreak, indicating that these parameters are necessary for trustworthy simulations.

CLASSIFICATION OF MONGOLIAN FOREST USING SATELLITE IMAGERY

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Abstract: Forest cover occupies a noticeable part of the planet's land area and generates nearly half of net primary products and stores more than 80% of terrestrial plant carbon. Utilization of forest resources has an impact on the environment and on the economies of the world nations. Forests have a history of being exploited either adequately, but more efforts are now being made towards their sustainable use. The assessment of forests in terms of their extent, condition, use and value is periodically realized at both global and national levels.

Historically, forestry has been concerned mainly with the assessment of timber resources and the management and utilization of closed forests for the production of wood. The applications of satellite data for effective forest management on a more scientific basis is

consistent with the priorities set at different levels of studies. The shift in priority of forest management towards ecologically sustainable forest resources management calls for reliable thematic spatial information with a provision to update and retrieve for management decisions at various levels.

Remote sensing (RS) is used in a wide array of forestry applications, including forest cover updating, depletion monitoring and measuring, forest type discrimination; determination of biophysical properties of forest stands; collecting harvest information; updating of inventory information for timber supply, biomass estimation, species inventory, regeneration assessment; monitoring the quantity, health and diversity of the forests. In addition, RS techniques can identify, distinguish, classify, assess and measure different timberland attributes both qualitatively and quantitatively.

Mongolia may be known for its deserts and steppes, but the country has a large cover of forest area compared to its population. The forests are mainly located in the central and northern parts of the country, forming a transition zone between the Siberian boreal forest and the Central Asian desert steppe. The country 's forests are primarily found in the Khangai, Khentii and Khuvsgul mountains. They are part of the taiga biome, characterized by coniferous trees such as siberian pine, siberian larch, and fir, as well as birch and aspen in some areas.

The forested regions of Mongolia are crucial for biodiversity, providing habitat for various species of mammals, birds, and plants. They also play a significant role in regulating the local climate and maintaining soil stability. As known from the statistics, Mongolia has about 18.6 million ha of forestlands occupying 11.8% of the country’s total land area, but 12.4 million ha, or 7.85% of the country’s territory, is actually covered by forests. A study has also shown that as of January 2022, forest cover was approximated at 8-15% of Mongolia's land area, a figure subject to change due to dynamic influences such as climate shifts, desertification, and deforestation.

The aim of this study is to conduct a forest area classification and determine the amount of current forest cover in Mongolia using satellite imagery. For this purpose, MODIS satellite 16 day average data acquired from 16 May to 01 June 2024 has been used. To define the amount of current forest cover, a support vector machine (SVM) and maximum likelihood classification (MLC) techniques were compared. The overall classification accuracies indicated 94.28% and 96.17% for the SVM and MLC, respectively. Overall, the study showed that the RS data along with accurate classification techniques could be successfully used for a forest class determination.

THE COMPOSITION AND DISTRIBUTION OF THE TACHINID FLY (DIPTERA, TACHINIDAE) IN MONGOLIA

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Abstract: The forests and pasture land of Mongolia are affected by pests. Their predatory and parasitic insects (entomophaga) are employed more efficiently and without causing harm to certain groups, among other methods of reducing the quantity of harmful insects. Insects are a parasitic life form found across the planet, with tens of thousands of species in 87 families in 5 orders (Coleoptera, Strepsiptera, Hymenoptera, Diptera, and Lepidoptera) (Vorontsov, 1984).

We have been doing research to find parasitoids in some forest pests since 2011. Tachinids (Diptera, Tachinidae) are the most common parasitoids on moths (Lepidoptera) and grasshoppers (Orthoptera). For our work, we have focused on them. Our research aims to choose parasitoids that suppress pests while conducting basic research and to compile the species composition of Mongolia's tachinids from published works as well as results of our study.

Many studies on Mongolia's tachinids (Diptera, Tachinidae) have been published. Researchers Herting (1968, 1973), V.A. Richter (1969, 1972, 1974, 1976), A.F. Emelyanov, V.A. Zaitsev, I.M. Kerjner (1967), and subsequently B. Namkhaidorj et al. (2008) have collated 317 species belonging to 166 genera. Of those, seven genera and fifty-nine species are indigenous to Mongolia. Grechkin reported in 1960 that 20% of Siberian moth cocoons were destroyed by saprophaga tachinid larvae that parasitized them.

We collected 2000 insect samples during our fieldwork, of which 190 were tachinid specimens from Urtiin am at Tsenkhermandal sum, the pine forest at Dadal sum in Khentii province, and the Khurkhree valley of Bogd Khan Mountain. We further utilized a collection of tachinids housed at the Institute of Biology, MAS. Based on literature sources and our research, we compiled a list of all 327 species of tachinids found in Mongolia, including 169 genera that belong to 4 subfamilies. Thirty species of 19 genera belong to subfamily Phasiinae, 52 species of 35 genera to Dexiinae, 130 species of 74 genera to the Exoristinae, and 115 species of 41 genera to Tachiinae respectively.

According to published records, the Bogdkhan Mountain strictly protected region is home to 14 species of tachinids. Our investigation resulted in the addition of three new species to the species makeup of this area: *Macroprosopa atrata* Fall., *Tachina magna* Gig., and *Linnaemyia perinealis* Pan, it's making the total number of species to 17. Additionally, 24 adult tachinids emerged from the 72 Siberian moth larvae that we raised. They make up 36.1% of the all parasitoids. *Macroprosopa atrata, Tachina magna, Linnaemyia perinealis, Picconia incurva,* and *Isomera cinerascens* are the five species of tachinids that we have identified as parasitizing the Siberian moths.

CONIFEROUS TREE DISEASE SPREAD OF IN SOME BOTANICAL GARDENS OF THE CAPITAL

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Introduction: Diseases of woody plants can spread in green spaces such as protective and ornamental plantings, forest reserves, and tree nurseries. These diseases vary greatly in their origins and characteristics. In Mongolia, the decline of coniferous trees is caused by the interaction of multiple factors. Abiotic factors such as drought, frost, and pests, as well as biotic factors, especially pathogenic fungi, play a significant role in this decline (Lixiang Wang 2021). According to the research conducted by the Institute of Plant Protection in 2018, non-infectious diseases (chlorosis, scorching) affected 5.5-13.5% of trees, needle cast disease affected 4.0-28.5%, leaf spot disease affected 7.0-26.0%, and gall disease affected 5.0-36.0% of the trees in public green spaces. The investigation prompted the implementation of plant protection measures (Byambasuren et al.). In recent years, the incidence of tree diseases in green spaces has increased. Consequently, it's critical to do ongoing research on pests and diseases that impact trees in green areas and to put into practice plant protection strategies that are grounded on science.

Objectives of the Study : The objective of this study was to identify and investigate diseases affecting coniferous trees in selected botanical gardens in the capital, such as Peace Avenue, Sansar Linear Garden, Asashoryu Garden, Uchral Garden, Revolutionary Street, Bell Garden, and the Turkish Mongolian Garden.

Materials and Methods: A survey was conducted on approximately 1,500 specimens of *Pinus sylvestris* L. and *Picea obovata* Ldb. growing in seven gardens in central Ulaanbaatar. A total of 258 samples from 86 trees were collected, resulting in 1,681 data points. The spread and development of the disease were analyzed using methods developed by M.N. Dementieva (1970-1985) and E.E. Geshele (1971), and data analysis performed using MS Excel and R programs in the Institute's Forest Protection Laboratory.

Results of the Study: The spread of the disease was calculated as a percentage of infected plants in each site. Needle cast disease was detected in four gardens on Scots pine and in three gardens on Firuce. Significant differences in disease severity among *Pinus sylvestris* L. were observed across study sites (ANOVA; $P = 0.007$). Specifically, the severity of infection per tree was highest along Peace Avenue (3.27), while no infection was recorded in Asashoryu Garden and Revolutionary Street. Using the Chi-square test to assess differences in disease development and spread between sites, no significant difference was found in disease development ($x^2 = 0.96$, $df = 6$, $P = 0.98$), but there were differences in disease spread between sites. Infected *Pinus sylvestris* L. and *Picea obovata* Ldb. in the botanical gardens exhibited a disease spread rate of 1.6-9.6%.

The highest spread was observed along Peace Avenue and in the Sansar Linear Garden, while disease development, or needle damage, was most severe along Peace Avenue. Disease severity *Pinus sylvestris* L. and *Picea obovata* Ldb. in the study sites ranged from 2-3 on a scale of 0 to 4, indicating increasing disease severity. In 2018, plant protection measures were implemented in the botanical gardens where coniferous tree diseases were prevalent. A study conducted in 2023, five years later, showed that the spread of needle cast disease in *Pinus sylvestris* L. and *Picea obovata* Ldb. had decreased by 2.4-18.9%, and some gardens had no infected trees, indicating that the plant protection measures were effective.

Conclusion: The study discovered that 7 out of 424 Picea obovata Ldb and 79 out of the 999 Pinus sylvestris L. investigated had disease-related symptoms. In Pinus sylvestris L. and Picea obovata Ldb, the needle cast disease spread in a range of 1.6–9.6%.
The highest spread was observed along Peace Avenue and in the Sansar Linear Garden, with the most severe needle damage occurring along Peace Avenue.
The severity of needle damage ranged from 2 to 3 points, indicating an increasing trend of infection.
There was a decline of 2.4–18.1 percent in the spread of needle cast disease from 4.0–28.5% in 2018 to 1.6–9.6% in 2023.
UDC 630.52:504.732

CONTRIBUTION OF RUSSIAN, BELARUSIAN AND MONGOLIAN SCIENTISTS TO THE DEVELOPMENT OF THE FOREST SECTOR OF MONGOLIA

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Abstract: On the occasion of the 100th anniversary of forestry in Mongolia, the main contribution of Russian, Belarusian and Mongolian scientists to the study of the country's forests is highlighted. The tasks of studying forest ecosystems for the near future are outlined.

Mongolia's forests play an important role in ensuring the country's environmental and food security. As a result of climate change, anthropogenic and biogenic impacts, the forest cover of the territory has been steadily declining and currently stands at 7.1%. However, the II National

Forestry Forum, held on 5 March, 2024, set a goal to increase the area covered by forests in Mongolia to 9% by 2030, which is in line with the national Billion Trees movement and the long-term development program document Vision 2050. The beginning of the development of the forestry sector in Mongolia is associated with the formation of the Mongolian People's Republic in 2024. The first studies in the forests of Mongolia were carried out by the Russian Geographical Society, expeditions of the USSR Academy of Sciences and the Mongolian Science Committee. In order to study the nature and forests of Mongolia, the Joint Russian-Mongolian Complex Biological Expedition of the Russian Academy of Sciences and the Academy of Sciences of the Russian Federation (JRMBBE RAS and ASM) was organized in 1969. It has been operating since 1970 and is currently in operation. The scientific leaders of the expedition from the Russian side were Academicians E.M. Lavrenko, V.E. Sokolov, D.S. Pavlov, Corresponding Member of the Russian Academy of Sciences R.V. Kamelin, and currently Academician V.V. Rozhnov, and from the Mongolian side - Academicians N. Ulziyhutag, Ts. Zhanchiv, and currently Academician Ch. Dugarjav. The heads of the Russian part of the expedition were P.B. Vipper, E.V. Rothschild, L.N. Medvedev, P.D. Gunin, and currently S.N. Bazha. From 1970 to 1990, the forestry detachment of the SRMBC RAS and the ASM was headed by forester, prof. E.N. Savin from the Russian side, and from 2012 to 2019 - by forester, candidate of biological sciences A.I. Lobanov; from the Mongolian side - academicians Ch. Dugarjav and Ch. Dorzhsuren.

A significant contribution to the study of Mongolian forests was made by scientists from the V.N. Sukachev Institute of Forestry SB RAS, the V.L. Komarov Botanical Institute RAS, the A.N. Severtsov Institute of Ecology and Evolution Problems RAS, the National Forestry Agency of Mongolia, the Botanical Garden-Institute of the ASM, the Mongolian State University, the Institute of Geography and Geoecology of the ASM and others. Since 2013, joint scientific research on Mongolian forests has been carried out by scientists from the Institute of Forestry of the National Academy of Sciences of Belarus and scientists from the Republic of Kazakhstan.

In connection with the development of international scientific cooperation, it is time to expand the Joint Russian-Mongolian-Belarusian-Kazakhstan Complex Biological Expedition of the Russian Academy of Sciences, the Academy of Sciences of Mongolia, the National Academy of Sciences of Belarus and the National Academy of Sciences of the Republic of Kazakhstan (JRBCBE RAS, ASM, NASB and NANRK), which could make an even greater contribution to the study of Mongolian forests and their intensive reproduction.

Over the period from 1970 to 2024, scientists from Russia and Mongolia published more than 20 monographs and countless scientific articles on forest topics, compiled digital forest maps, improved forest vegetation zoning, and studied the patterns of the structure of biological productivity of forests. For the effective development of the forestry industry of Mongolia in the near future, it is necessary to develop a concept of rational use of forest resources, protection of forests from fires and intensive reproduction of forests, develop forestry (dendrological) and agroforestry zoning.

In conclusion, on behalf of the team of authors, Russian, Belarusian and Mongolian scientists, I would like to sincerely congratulate the leadership and all workers of the forestry industry of Mongolia on the glorious anniversary - the 100th anniversary of its formation and development.

We wish everyone good health, happiness, prosperity and creative success for the benefit of the preservation and reproduction of the Mongolian forest.

DETERMINES OF BIOCHAR FROM PINE NUT SHELL THE ABILITY TO ACTIVATE AND ABSORB VARIOUS CHEMICAL COMPOUNDS

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Abstract: The purpose of the research work was to absorb various chemical compounds into various types of carbon adsorbents and determine their adsorption properties. Activated carbon was used as a control, and pine nut shell biochar was selected as a sample. Pine nut shell obtained from "Khushkhan" company, pyrolysis at 500°C and biochar was obtained.

Nitric acid (HNO_3) activated biochar absorbed water ions at a rate of 7.54 g/mg, close to that of the control activated carbon. Glucose, a monosaccharide, was more adsorbed by hydrochloric acid (HCl) activated biochar at 0.7 g/mL. Starch, a polysaccharide, was more adsorbed by biochar activated with nitric acid (HNO_3) at 0.080 g/ml. Protein was more adsorbed by biochar activated with 43.11 g/ml sulfuric acid (H_2SO_4). The results showed that oil was absorbed by 3 types of biochar in a similar amount (0.42-0.45 g/g).

Three types of acid activated biochar are selectively adsorbing chemical compounds. This indicates that its surface structure and functional groups have changed. It is considered necessary to conduct absorption on various types of oil samples because of the fact that the absorption of oil is related to the chemical composition of the oil.

DIFFERENCES IN CARBON AND NITROGEN ISOTOPE RATIOS OF WOODY SPECIES GROWING IN FORESTS AND GRASSLANDS OF THE MONGOLIAN FOREST STEPPE

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Abstract: The forest-steppe of Mongolia is known to have different forms of soil moisture and nitrogen in the forest and grassland. Since the isotope ratios of carbon and nitrogen provide information on the distribution of water and nutrients and the sources of their absorption, in this study, we measured the stable carbon and nitrogen isotope ratios of leaves and soil of trees growing in the forest and around the grassland, and investigated the differences in water use and nitrogen absorption sources of trees.

The survey area was a forest and grassland on a hillside in the Udleg Experimental Forest of the National University of Mongolia, and soil and leaves from trees growing in the surrounding area were collected from 15 locations in a grid pattern at intervals of approximately 20 to 30

meters. We determined the soil inorganic nitrogen (ammonium and nitrate) concentration in the extract solution by colorimetric analysis, and then measured the isotope ratios of the different forms using a trace isotope ratio measurement system. After drying and grinding the plant samples, we measured the nitrogen concentration and the carbon and nitrogen isotope ratios.

As a result, the amount of ammonium was relatively high in forest soil, and the amount of nitrate was relatively high in grassland soil. The nitrogen isotope ratio of the leaves of tall tree species tended to be higher than that of shrub species, suggesting that tall tree species were more likely to absorb ammonium nitrogen. The carbon isotope ratio, which indicates water use efficiency, was higher in individuals growing in grasslands than in forests, even for the same tree species, suggesting that the soil in grasslands is drier than in forests. These results suggest that there are differences in the moisture conditions and nitrogen cycles of the soil in the underground parts of forests and grasslands, and that these differences may be closely related to the differences in aboveground vegetation.

EFFECTS OF FOREST FIRE ON SOIL PROPERTIES IN LARCH FOREST OF THE CENTRAL KHANGAI IN MONGOLIA

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Abstract: The impact of wildfire on soil properties was examined in the Larch Forest of the Central Khangai region of Mongolia, which experienced significant damage from severe fires in 1996. This study aimed to assess the alterations in soil characteristics resulting from the fire event, focusing on morphological, chemical, and physical properties. Soil sampling was collected from three different sites: Unburned forest (Control), burned forest no regrowth of tree (BOT), and burned forest with regrowth of young larch tree (BWT), at a depth of 0-5, 5-15, 15-30 and 30-60 cm. In total, 44 soil samples were analyzed for the physical and chemical properties of the soil following the standard methods in the Soil Laboratory of the Institute of Geography and Geoecology, MAS. We found a significant difference in soil moisture, temperature and soil bulk density, organic matter content, pH, and available P between Control and burned sites (BOT and BWT). Soil moisture: Control>BOT>BWT, temperature: BWT>BOT>Control, bulk density: BWT>BOT>Control, organic matter content: Control>BWT>BOT, pH: BOT>BWT >Control, available P: BOT>BWT >Control. Furthermore, the chemical properties of the soil organic layer were significantly affected by fire, whereas the mineral horizons exhibited no such changes. This distinction highlights the selective impact of wildfire on soil chemistry, suggesting that the organic layer is more susceptible to fire-induced modifications compared to the underlying mineral horizons. In conclusion, wildfire significantly changes the chemical and physical properties of forest soils, emphasizing the need to understand fire dynamics and their ecological impacts.

EFFECTS OF THINNING ON THE GROWTH OF YOUNG LARCH (*LARIX SIBIRICA* LEDEB.) FORESTS OF KHENTII AIMAG, MONGOLIA

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Abstract: The study aimed at exploring the effects of thinning on the radial growth and canopy light penetration of young larch trees. Thinning was conducted as a part of community based forest management through training of forest user group members. The study area is located in the Binder and Umnudelger soums of Khentii aimag, Mongolia. Both sites have *Larix sibirica* Ledeb. forests, and thinning was done for 2nd and 3rd degree treatment cutting. On each site, 3 sample plots were established, each plot size was 20 m x 20 m, and in addition, each site had control plot. Thinning was done in 2017 and 2019, and the increment core samples were taken in September, 2022. Core samples were measured for radial growth using DendroMeasure software, and the statistical analysis and graphs were made using R software. Canopy light penetration was measure using Fisheye lens and GAP analyzer software.

In young larch forests of Umnudelger, diameter growth showed increasing trend, however there was no significant difference in the diameter growth of trees in treatment and control plots (p-утга>0.05). This could be due to comparatively sufficient nutrient allocations per tree in young forests, before increased competition. In young larch forests of Binder, there was significant difference between diameter growth of trees in treatment and control sites (p-утга<0.05). annual radial growth of trees in treatment cut forests showed increasing trend, while control trees showed decreasing trend in radial growth. This could be due to higher competition between trees in control plots.

In conclusion, treatment cutting has positive effect on the radial growth of young larch trees. Also, thinning increases light penetration through canopy from 35% to 58%, and this will help natural regeneration of light tolerant trees such as larch.

Keywords: *Treatment cutting, canopy light, Binder, Umnudelger, radial growth*

ESTIMATING DBH FROM STUMP DIAMETER AND STAMP HEIGHT FOR *LARIX SIBIRICA* AND *LARIX CZEKANOWSKII* IN MONGOLIA

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Abstract: This article presents the results of a relationship between diameter at breast height (Dbh) and stump diameter (SD), stump's height (Sh) based on the field trees measurement of Siberian and Czekanowskii larch trees in Mongolia. In order to determine the volume of logged trees, equation for estimating diameter at breast height (Dbh) from the stump diameter (SD) and equation for the relationship between tree's height and diameter were developed respectively. The study was carried out in the Khentey, Khangai and Central Asian Forest-Vegetation Regions of Mongolia. During the measurement, diameters at 1.3 m and 0 and 0.2, 0.4, 0.6, 0.8 m, heights

of 71 and 128 standing trees, and the diameters at 0 m and their height were measured for Siberian and Czekanowskii larch trees. The following equation models were tested for predicting the Dbh from stamp diameter and height of trees. The developed regression equation models can be used to determine the volume of logged trunks of trees based on the field measurement of diameter at breast height and stump diameter and height on the logged areas. The best performing regression equation models was found as $Dbh = 0.67253 * SD^{0.94188} * \mathrm{Sh}^{0.12515}$ R^2=98.3% for Siberian larch trees, $Dbh = 0.44379 * SD^{1.00930} * Sh^{0.16956}$ R^2=97.3% for Czekanowskii larch trees.

Keywords: *larch, stump, diameter at breast height, stump height, thrunk volume*

FOREST CLASSIFICATION OF NORTHERN MONGOLIA USING OPTICAL AND RADAR IMAGES

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Abstract: Optical remote sensing (RS) has been efficiently used for different forest studies since the launch of the first Landsat in 1972. Optical sensors usually use visible and infrared radiation for imaging the forest cover. Different studies have provided knowledge on how various forest-related factors influence the reflectance and other properties in the visible and infrared portions of the electromagnetic spectrum. Microwave RS has been widely used for forest mapping and analysis. The radar instruments image an area not depending on solar illumination and are not affected by cloudy or rainy conditions like optical sensors. They usually operate in longer or centimeter wavelengths and provide information on the tree structure of forested areas and are suitable for mapping and monitoring over large areas with high to moderate spatial resolutions.

In recent years, there has been a growing practice of integrated approaches to combine optical and synthetic aperture radar (SAR) images for forest mapping and analysis. The combined application of optical and SAR data sets can provide unique information for different forest studies. Passive sensor images represent spectral variations of the top layer of the forest classes, while microwave data, with its penetrating capabilities, can provide some additional information about forest canopy. Integrating optical and microwave data sets can significantly improve forest class interpretation and analysis, as it can reveal specific forest types that may not be visible on one type of image but are observable on the other due to the complementary information provided by the two sources.

One of the prominent methods to combine RS data from multiple sources is image fusion. It refers to a process that integrates different images from different sources to obtain more information, considering a minimum loss or distortion of the original data. In other words, it is the integration of different digital images in order to create a new image and obtain more information than can be derived separately from any of them. In the case of the present study, the SAR image provides information about forest canopy due to radar's penetrating capabilities, while the optical image provides information about the spectral properties of different land cover classes. Various data fusion techniques have been developed and applied over the years, and they

can be performed at four different stages such as signal level, pixel level, feature level, and decision level.

The aims of this research are to investigate and evaluate different image fusion techniques for the enhancement of spectral and textural variations of forested areas, later to be used for training sample selection, and also apply a refined maximum likelihood classifier (MLC) for the extraction of forest class information from the fused images. The selected pixel level fusion techniques are the modified IHS transformation, PCA method, Gram-Schmidt fusion, and color normalization spectral sharpening. For the refined classification, spatial thresholds defined from the local knowledge were applied. As a test site, an area located in northern Mongolia was selected. For the analysis, geocoded Sentinel-2A multispectral images and Sentinel-1B dual polarisation SAR data both acquired on 11 August 2021 were used. Overall, the research demonstrated that the integrated optical and microwave RS data sets could be efficiently used for the forest area classification.

Keywords: *Forest, optical, radar, image fusion, classification*

GREENHOUSE GAS EMISSIONS INVENTORY OF MONGOLION MINING CORPORATION 2023

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Abstract: Our efforts to address climate change have focused on refining our carbon accounting procedures to better understand and manage our GHG emissions. Since 2017, we have been tracking and reporting our Scope 1 and Scope 2 emissions, and in 2019 we began tracking six categories of Scope 3 emissions, as defined by the GHG Protocol. In 2023, during the emissions verification process, we calculated nine categories of Scope 3 emissions. This voluntary Greenhouse Gas ("**GHG**") Emissions Report ("**GHG Report**") provides detailed Scope 1, Scope 2 and Scope 3 GHG emissions inventory consolidated using operational control boundary for Mongolian Mining Corporation ("**MMC**" and/or the "**Company**") and its subsidiaries (the **"Group**"), for the reporting period between 1 January 2023 to 31 December 2023. It is prepared in line with the requirements outlined in the GHG Protocol Corporate Accounting and Reporting Standard. The purpose of this GHG Report is to demonstrate conformity with WBCSD/WRI Greenhouse Gas (GHG) Protocol and to facilitate GHG inventory verification.

The Company has adopted this standard for measuring and reporting on the GHG emissions that arise from its operations and in order to transparently disclose its GHG emissions. This is the first year we are preparing and disclosing this report, and we intend to publish this report annually going forward. We did not use offsets for the 2023 period in relation to our emissions inventory; therefore, the emissions disclosed do not reflect any use of offsets.

The emissions in this report are consolidated using the operational control approach. Under this approach, we reported on entities that account for 100 percent of emissions from operations over which we or one of our subsidiaries has operational control. We did not account for GHG emissions from operations that we own equity in but do not have operational control over.

Emissions data is separately calculated for each scope and emissions included in this GHG Report comprise of carbon dioxide (CO_2), methane (CH4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), nitrogen trifluoride (NF_3), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6).

As part of our ongoing commitment to environmental stewardship and sustainable operations, our current plans are to focus our efforts on effectively managing and reducing our GHG emissions across various scopes. Our primary objective is to focus on lowering our Scope 1 GHG emissions, which stem directly from sources owned or controlled by our company. Given the direct impact of these emissions, we plan to implement advanced technologies and optimising processes to enhance efficiency and reduce our carbon footprint. Initiatives such as upgrading our equipment to more energy-efficient models, improving operational practices, and investing in cleaner alternative energy sources are at the forefront of our strategy.

GROWTH DYNAMICS AND ASSESSMENT OF INTERNAL STEM DECAY OF CEDAR FORESTS IN THE GREEN ZONE

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Abstract. The study was conducted in the cedar (Pinus sibirica Du Tour) forest impacted by recreational activities in Ulaanbaatar's green zone. Natural forest covers 85.5% of the forest area in the green zone, with an abundance of trees such as larch, cedar, spruce, birch, poplar, willow and aspen. The aim of this study is to observe the growth patterns of cedar forests in the green zone impacted by recreational forest usage and to explore the climate factors in-depth, examine stem decay, and recommend measures to better safeguard cedar forests in the future. The research samples were collected and processed in the 2022-2023 vegetative season, with their results analyzed in this article. The sample area was divided into plots of 20x20m (400m²), with the height and diameter of trees being measured while growth samples were obtained by coories. Also, the internal decomposition of tree stems was measured by ultrasound tomography at the 50 cm and 150 cm heights of each tree with a diameter of more than 30 cm. The international climate database (CRU TS Version 4.06 - Open source) provided the data for the climate indicators of the studied region during 1900-2023. Measuring the cedar trees' diameter growth involved employing the "Lintab 6" device, with the results determined by the "TsapWin-4.64" program. Data processing was performed using the R and XLSTAT statistical software packages. The research findings indicate that the diameter growth of Cedar forests within the green zone increased until 1800, followed by a rapid decline in 1940, and an increase in growth in 2000. The growth process was significantly influenced by climate parameters, with the air temperature at the beginning of the plant growth period and precipitation in the IV and V months having a dominant impact.

GROWTH PARAMETERS OF POPLAR SEEDLINGS GROWN FROM GEOGRAPHICALLY DIFFERENT SEEDS IN MONGOLIA

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Abstract: About 8.2% (12.4 million ha) of the total territory of Mongolia is covered with forests, and poplars and aspen occupy less than 1% of forests. Currently there are 5 native species of *Populus* recorded in Mongolia, including aspen (*Populus tremula*) and desert poplar (*P. diversifolia*), which grow in lower mountains and desert, respectively. The other species mostly grow along the riparian zone: *P. laurifolia, P. suaveolens,* and *P. pilosa*. There have not been many studies on the native poplars in Mongolia, and in this study, we determined the natural distribution of 2 main species, and collected their seeds to test seedlings for the growth difference to define the superior characteristics to use for restoration of degraded riparian forest, which has high adaptation potential.

We collected *P. suaveolens* seeds from Onon, Selenge and Terelj Rivers, and *P. laurifolia* seeds from Khovd, Tamir, Tes and Bulgan Rivers and Zuunsaikhan mountain. Seeds were planted in the nursery in open soil and pots. Seedlings were studied for their growth parameters, and specific leaf areas. Growth and biomass of these seedlings differed (p-value<0.001), and superior growth was observed for the seedlings collected from Selenge river basin. Further, seedlings were transferred to field at 2 years old. Growth parameters and biomass were studied for the destructively sampled 40 seedlings.

Results from this study showed that natural populations of riparian poplar is aged (age class VII and higher). Riparian forests are over exploited for recreation, firewood, and livestock grazing, and therefore need to be restored with the seedlings/cuttings from native species to continue providing ecosystem services and energy for local communities. *P.suaveolens* seedlings have better growth during the initial years (1-2). *P.suaveolens* grown from seeds collected from Eg-Selenge region shows significantly higher growth than the others.

LIVESTOCK GRAZING PRESSURE ON WOODY SHRUBS IN THE DARKHAD DEPRESSION.

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Abstract: The climate change poses great challenges to Mongolia which is one of the most vulnerable countries in the world to adverse impacts of climate change due to its geographical location, weather and climate conditions as well as specific features of socio-economic development.The Darkhad Depression, situated in the northwestern part of Mongoli, Khuvsgul province, has been identified as experiencing land degradation, particularly subsidence.

This case study aims to assess the growth status of woody species under intense grazing pressure. The collected data sets included the number of dead roots, the remaining living stem parts, livestock excrement, and bare soil areas, all measured according to two-dimensional diameter measurements along the transect line. Transect line (1500m x 4 m) established across value, named on “Khamriin togol” plat forest and steppe area.

As a result, no significant normal growth of woody shrubs remains, with a total of 1,295 dead roots, 784 surviving stem parts (average height of 12.8 cm under browsing pressure), and 210 bare soil patches recorded. The ratio of animal manure to the remaining living stem components is 1:2.5 (256 n/ha to 653 n/ha).

Increasing temperature rise, coupled with persistent grazing pressure, has led to a major decline of woody shrubs, which are heavily grazed by cattle in the plateau region close to the forest border. Sustainable livestock grazing is essential in this region for the natural growth and restoration of woody shrubs in the study area.

ORGANIC CARBON STOCK MAIN SOILS IN MONGOLIAN FOREST

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Abstract: Studied soil organic carbon stock of major forest soils of Mongolia. More than 98.8 % of forest areas of the country distributed Umbrisols (Gelic), Leptic Umbrisols, Gleyic Umbrisols, Mollic Umbrisols, and Podzols (Arenic) soils. For soil organic carbon stocks calculation, we used existing soil data plus additional soil sampling analysis results for some data lack area. Totally used 1071 soil samples data of 210 soil profiles. Soil analysis data was converted to 0-30, 30-60, 60-100, and 0-100 cm constant horizons using weighted average method. The most widespread forest soil of Mongolia is Leptic Umbrisols and average SOC stock for 0-30 cm soils is about 66.9 Mg C ha^{-1}; for 30-60 cm of soils 14.1 Mg C ha^{-1} and 0-100 cm soil 86.3 Mg C ha^{-1} respectively. Gleyic Umbrisols is formed on the lower part of the north-facing taiga forest slopes. Average soil organic carbon stocks of Gleyic Umbrisols is high up to 136.0 Mg C ha^{-1} in 0-100 cm of soils. For 0-30 cm SOC stock is 86.9 Mg C ha^{-1} and for 30-60 cm of soil 38.6 Mg C ha^{-1}. The average SOC in the Umbrisols (Gelic) is 8.0%, Leptic Umbrisols is 4.1%, Gleyic Umbrisols is 3.8%, Mollic Umbrisols is 5.7% and Podzols (Arenic) is 0.65% consequently. Podzols (Arenic) distributed in the lowest part of forest and topsoil organic litter is comparatively less than other soils. The mean value of SOCs of Podzols (Arenic) for 0-30 cm soils was 28.8 Mg C ha^{-1}, for 30-60 cm of soils 18.5 Mg C ha^{-1} and for 0-100 cm soil 55.0 Mg C ha^{-1}, respectively. Up to 52-78.9 % SOC resource in forest soils accumulated in the upper 30 cm of soils. Further needed more forest soil study work to fully coverage the forest area of Mongolia. Especially high mountain taiga area, remote area of Khentei, Khovsgol mountain area not sufficiently studied.

PHYSICAL AND MECHANICAL PROPERTIES OF FOUR SOFTWOOD TREE SPECIES NATURALLY GROWN IN MONGOLIA

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Abstract: In the Mongolia forests, several coniferous species which used for timber production are found: *Larix sibirica* Ledeb., *Pinus sibirica* Du Tour, *Pinus sylvestris* L. and *Picea obovate* Ledeb. The percentage of area againist to total forest area is 63.0, 5.3, 4.3 and 0.2% for *Larix sibirica*, *Pinus sylvestris*, *Pinus sibirica*, and *Picea obovata*, respectively (FRDC 2020). Thus, these four species are mainly utilized as timber species in Mongolia. Trees of *P. sibirica*, *P. obovata*, *L. sibirica*, and *P. sylvestris* were selected from natural forests in Mandal, Selenge, Mongolia (48°49′N, 106°53′E and 48°41′N, 106°38′E). Total 20 trees (five trees in each species) with 20 to 30 cm of stem diameter at 1.3 m above the ground were harvested.

In this study, wood properties including physical and mechanical properties were determined four common Mongolian conifer species. *P. sylvestris* showed higher initial radial growth rate and latewood percentage (LWP). *P. sibirica* presented lower values in the annual ring width (ARW) and basic density (BD). Relatively higher values in modulus of elasticity (MOE), modulus of rupture (MOR), bending work (W), absorbed energy in impact bending (IB), compressive strength parallel to grain (CS), and shearing strength (SS) were obtained in *L. sibirca*. This species, significant correlations were found between MOE and MOR, MOE and CS, and MOR and compressive strength (except for *Picea obovata*). In addition, bending work until breaking in all species except for *Pinus sibirica* was significantly related with MOE or MOR. However, absorbed energy in impact bending in *Pinus sylvestris* and shearing strength in *Larix sibirica* also was significantly correlated with MOR, and MOE or MOR, respectively. These results suggest that MOE is considered as one of the good indicators to predict the mechanical properties of wood from four common Mongolian conifers.

Keywords: *Basic density, latewood percentage, modulus of elasticity, compressive strength parallel to grain, conifers*

SOME NATURAL ENEMIES OF THE SIBERIAN MOTH (*DENDROLIMUS SIBIRICUS* TSCHETV.) IN MONGOLIA

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Abstract: The Siberian moth is extremely harmful to coniferous forests. Many methods have been implemented to decrease their population density and damage to forest. The most effective and ecologically friendly technique is to utilize natural enemies. One of the important enemies are parasitoid insects. There are little study on Siberian moth parasite insects in Mongolia.

Our study's goal was to assemble the major parasite composition of all stages of the Siberian moth from published sources, as well as to reveal the parasites through laboratory rearing of wild populations in Mongolia.

We collected Siberian moth larvae from forest territories of the Khentey mountain range, including Tsenkhermandal, Omnodelger, Batshireet sums, Khentii province, Bogd-Khan Mountain, and some green areas of Ulaanbaatar, as well as Zuunkhangai sum, Uvs province, where the Siberian moth outbreak usually occurs in Mongolia.

The larvae (ages L_{1-2}, L_{3-4}, and L_{4-5}) were gathered by shaking the trees and picking them up off the trees and branches. Then taken to the laboratory. In a rearing box, the specimens were maintained at 21^0-25^0 degrees Celsius with 65-70% humidity while being fed with a larch needle. Based on literature and our study findings, we identified six species of egg parasitoids and ten species of larval and pupal parasitoid insects of the Siberian moth. The following parasitoids that lay eggs have been registered: *Trichogramma dendrolimi, Ooencyrtus pinicola, T. tetratomus, Rhogas dendrolimi, and Telenomus gracilis. Recently, Trichogramma dendrolimi, Telenomus gracilis,* and *Telenomus tetratomus* have been used as pest control agents in neighboring nations.

Furthermore, we detected 10 species of larval-pupal parasitoids in Siberian moths that belong to three families of three orders. In addition, seven species (*Cotesia ordinaia* Ratz., *Therion circumflexum, Tachina magna, Macroprosopa atrata, Linnaemyia perinealis, Picconia incurva, Gonia cinerascens*) belong to seven genera, two families, and two orders (Hymenoptera, Diptera) were identified by raising Siberian moth larvae in the laboratory.

DETERMINES OF BIOCHAR FROM PINE NUT SHELL THE ABILITY TO ACTIVATE AND ABSORB VARIOUS CHEMICAL COMPOUNDS

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Abstract: The purpose of the research work was to absorb various chemical compounds into various types of carbon adsorbents and determine their adsorption properties. Activated carbon

was used as a control, and pine nut shell biochar was selected as a sample. Pine nut shell obtained from "Khushkhan" company, pyrolysis at 500°C and biochar was obtained.

Nitric acid (HNO_3) activated biochar absorbed water ions at a rate of 7.54 g/mg, close to that of the control activated carbon. Glucose, a monosaccharide, was more adsorbed by hydrochloric acid (HCl) activated biochar at 0.7 g/mL. Starch, a polysaccharide, was more adsorbed by biochar activated with nitric acid (HNO_3) at 0.080 g/ml. Protein was more adsorbed by biochar activated with 43.11 g/ml sulfuric acid (H_2SO_4). The results showed that oil was absorbed by 3 types of biochar in a similar amount (0.42-0.45 g/g).

Three types of acid activated biochar are selectively adsorbing chemical compounds. This indicates that its surface structure and functional groups have changed. It is considered necessary to conduct absorption on various types of oil samples because of the fact that the absorption of oil is related to the chemical composition of the oil.

Keywords: *pyrolysis, adsorbent, mineral acid*

STAND STRUCTURE AND ABOVEGROUND BIOMASS OF LARCH-BIRCH MIXED FORESTS IN KHENTII REGION

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Introduction: Mongolia's forests are located at the boundary between boreal forests and arid grasslands, making them highly vulnerable to the impacts of global warming and human disturbances, requiring proper management. In particular, the forests in the Khentii region of Mongolia have a low proportion of pure larch stands and a higher presence of broadleaf and mixed conifer-broadleaf forests. However, these forests' ecological characteristics and ecosystem services, such as carbon storage, still need to be clarified.

This study aims to clarify the stand structure characteristics and evaluate the aboveground biomass (AGB) of larch forests and larch-birch mixed forests in the Khentii region.

Study site and Methods: Inventory surveys and estimates of aboveground biomass were conducted in the Udleg experimental forest at the National University of Mongolia. The target forest stands were classified into four types: A）The Larch Upper and Lower layers, B) The larch Upper layer and the birch Lower layer, C) the Mixed Upper and Lower layers, and D) The birch Upper layer and mixed Lower layer.

We set the 40m quadrat plot for type 1 and the 20m radii circular plots for types 2, 3, and 4. We measured the DBH and tree height and evaluated AGB using allometric equations (The NFI Inventory Report, 2016).

Results: The AGB varied significantly across stands, ranging from 76 to 109 tons/ha. Stands with larger DBH larch trees tended to have higher AGB. The maximum DBH of birch was about 40 cm, significantly smaller than that of larch at 60 cm. The maximum height of birch was about

16 m, significantly lower than that of larch at 26 m. The birch and larch trees with smaller DBH (<20 cm) represent similar tree heights. However, the larch tree with a larger DBH (>20cm) was taller than the birch tree.

Discussions: The aboveground biomass in this region is influenced by species composition and size structure. Birch can rapidly regenerate forests after fires through sprouting, but its lower maximum height or shorter lifespan may limit its ability to increase AGB.

It is essential to actively conserve larch-birch mixed forests for forest regeneration while promoting the conversion to larch forests in appropriate areas to achieve higher carbon storage. This conversion can contribute to Mongolia's policy of enhancing carbon dioxide absorption.

SIBERIAN PINE (*PINUS SIBIRICA* DU TOUR.) FOREST STATUS IN THE GREEN ZONE OF ULAANBAATAR CITY

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Abstract: Siberian pine (*Pinus sibirica* Du Toir.) forests grow on 16520 hectares of the total 95.2 thousand hectares of forest covered area, which is 17.3 percent of the forest covered area of green zone forest foundation area. Siberian pine is known for its high emissions of phytoncides and essential oils, which purify the ambient air, and is an ecologically valuable tree that is a major concern in Ulaanbaatar today. In recent years, the genetic resources of Siberian pine forests have been severely damaged due to climate change, increasing forest pests, forest fires, and the illegal use of non-timber resources. Therefore, this study aimed to assess the state of Siberian pine forests, determine the impact of recreational use, and study the quality of seeds. As a result of this study, the map of Siberian pine forests distribution and the map of the state of the Siberian pine forests of green zone in Ulaanbaatar were developed.

In the green zone of Ulaanbaatar, we used plot sampling method and established sampling plots in areas the harvest of pine nuts for industrial and domestic purposes. The main parameters for the establishing the sample area and the forest measuration were determined by the methodology of N.P.Anuchin. The assessing the condition of forest trees and the recreational digradation were determined by the methodology of D.Tsendsuren. A.A.Korchagin's assessment of seed quality is used for determining the seed yield, and determining seed quality characteristics was based on the International Rule on Seed Testing and the Mongolian Standards for Tree and Shrub Seed Testing. Tree growth samples were collected using increment borer by obtaining cores at the height of 1.3 m and measured with an annual ring growth meter using a Velmex (TA Unislide Model and Encoder System, Bloomfield, NY) and COFECHA programm.

A total of 64.6% of Siberian pine trees in the green zone are damaged with certain levels of mechanical damage, having slow growth, thinning crowns and being dried out. According to the main forest measuration indicators, the oldest Siberian pine forest in the green zone of Ulaanbaatar is growing in the Uliastai, and the youngest pine forest is growing in Baga Bayan. In

the green zone growing Siberian pine forests of the age classes IV-V. By assessment of site index Siberian pine forest in the green zone of Ulaanbaatar classified in II-IV classes, and density determined in 0.5-0.8. The forests of Jigjid, Uliastai and Khandgait are relatively less degraded and the forest environment is beginning to change. Dendii, Bugatiin Davaa in Terelj, Sanzai Siberian pine forests are moderately degraded, Nukht in Bogd Khan and Turgen Siberian pine forest environments and habitats have been changed and severely affected by recreational use. According to the seed yield assessment, the yield is low in Dendii and Jigjid forests, medium in Sanzai, high in Nukht and Turgen, and excellent in Uliastai. In terms of seed viability, it is 82.6 percent or the highest in Nukht and 51.3 percent or the lowest in Dendii. Furthermore, measures, such as enhancing natural regeneration and planning for protection of young trees, to protect Siberian pine forests of green zone in Ulaanbaatar needs to be done in the future.

TWENTY YEARS CHANGES ON FOREST REGENERATION IN THE EASTERN SHORE OF THE LAKE KHOVSGOL

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Abstract: Forests and tree formations play important economic, social, and environmental roles in these regions through a variety of functions. Throughout ongoing time, space, climate and environmental conditions, natural regeneration is characterized by the interaction of multi factors. The highlighting focus of this study is to evaluate forest natural regeneration changes after twenty years in Eastern shore of the Lake Hovsgol, Hovsgol national park. In 2002 long term ecological research project "Dynamics of Biodiversity Loss and Permafrost Thaw in Huvsgul National Park, Mongolia" was implemented in 6 valleys in the Eastern shore of the Lake Hovsgol. We did forest research in 2022 in the same valleys to look for how forest stand differed and how was regeneration of forest going on there.

The average diameter of the forest is 19.8cm, the average height is 12.4m, the resource is 13m^3/ha, and the average number of trees growing in 1ha is 1444 trees, forest stand density is 0.7 and forest site index is third class, showing that the forest has relatively narrow trees, with low density and low productivity, but it shows a high ecological function. Looking at the average annual tree ring growth in the last 100 years from 1922 to 2022 is 37.5-52mm means the single old trees are increasing 0.8 to 1.1 mm per year. In the process of forest regeneration from 2002 to 2022, the average number of seedlings and saplings per hectare increased from 4366 to 5410 compared to 20 years ago. However, this regeneration is different in the valleys, in the valleys where natural regeneration was good in 20 years ago, the number of seedlings was limited, but on the contrary, in places where there was no natural regeneration, the amount of regeneration increased. It could be explained that the number the saplings per area can be one oof the limiting factor of forest seed germination.

URBAN GREEN SPACE PLANNING BASED ON THE LOCAL CLIMATE ZONING

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Abstract: Mongolia is a landlocked country with most of its land falling under arid and semi-arid zone. In this study, we selected the city of Ulaanbaatar, Mongolia. Its geographic location makes it unique, causing environmental degradation and pollution due to limited land resource, and fueled by other factors, such as climate change. Main social factor to affect the environmental condition of the city is the migration from rural areas to Ulaanbaatar over the last three decades. According to NSO, population of Ulaanbaatar city reached 1'499'140 recently, which shows that the city has become metropolitan. This congestion of highly dense population in urban areas is causing many environmental issues, which in return affects quality of life for people and wildlife. According to WHO, urban green area should be a minimum of 9 m^2 per capita to accommodate people and environment. However, as of 2020, the urban green area per capita is 4.8 m^2 in Ulaanbaatar, and we are in urgent need to increase the urban greenspace. We used local climate zoning to help in planning the urban green space development in Mongolia.

We used google satellite images and ArcGIS, QGIS software for the analysis. Altitude, elevation, urban expansion was analyzed using Earthmap. Base maps were obtained from the Information Database of Urban Development. Local climate zone was identified using Google Earth Pro, with methodologies developed by Demuzere et al., and spaces were classified into 2 main groups: built and non-built type. Amongst the built types, majority of the spaces are sparsely built (35%), open low-rise (28%), and compact low-rise (14%), and they are mostly residential areas with limited access to urban green spaces. Hence, the urban green space planning needs to consider the built type to ensure the improvement of environmental condition via accessible green space.

Keywords*: satellite image, spatial analysis, public green space, urban ecosystem, tree equity*