

Strengthening local
adaptation plans through
integrating
socio-economic
vulnerability assessment
and policy gap analysis in
Mongolia and China

CRRP2022-09MY-MYAGMARSUREN

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Asia-Pacific Network for Global Change Research (APN)

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1. Summary

In order to adapt to climate change effectively, it is important to develop and implement province and soum (county) specific adaptation measures that are grounded in the natural, geographical and socio-economic conditions of each area, that build upon traditional local knowledge and management practices. In the Mongolian context, strengthening the capacity to adapt to climate change ultimately depends on enabling herders and socially vulnerable groups, to overcome risks in the livestock sector, by reducing their vulnerability and exposure, and enhancing their adaptive capacity. On the other hand, climate change adaptation is a cyclical policy process that involves formulation, planning, budgeting, implementation, and monitoring. In this regard, local long-term and medium-term policies and plans should scientifically identify the climate-related issues and challenges faced by each region, and the corresponding adaptation strategies and actions should be research-based and aimed at reducing risks and enhancing resilience.

This project aims to provide climate change adaptation policy recommendation that is science based and spatial characteristics specific through an assessment of climate change risk of “herder-livestock-pasture” system and a policy analysis in Mongolia and China on local level. Firstly, we assessed the environmental, social and economic risk and vulnerability (CCV) of the herders to climate change in Khovd province of Mongolia and Ulaanqab prefecture of China’s Inner Mongolian Autonomous Region and calculated integrated risk index. Secondly, local level climate change adaptation (CCA) related policy documents were analysed using “Adaptation criteria”. These criteria were defined based on the national level policy documents including Nationally Determined Contribution (NDC) and National Adaptation Plan to Climate Change (NAP). Finally, a synthesis analysis combining the CCV and CCA results were conducted to develop adaptation policy recommendation for local governments.

2. Objectives

There are five key objectives:

1. Evaluate environmental, social and economic risk and vulnerability to climate change in case areas, develop risk and vulnerability maps of Khovd province and Ulaanqab prefecture.
2. Identify gaps in local and national level short, middle and long-term development policies on adaptation measures using identified case area specific adaptation criteria for the case areas.
3. Develop recommendations on local province specific science-based development and adaptation plans by synthesizing the results of the vulnerability assessment and the policy gap analysis.
4. Facilitate the formulation of local adaptation plan based on our research findings and local expertise with participation of diverse stakeholders.
5. Disseminate and share knowledge generated from the research to enhance science-based policy making and strengthen stakeholder capacity through meetings, conferences and seminars.

3. Outputs, Outcomes and Impacts

Outputs	Outcomes	Impacts
Environmental, social and economic risk assessment framework in the study areas.	Environmental, social, and economic risk components and indicators (26) were developed and used to assess risk index at local level. Method for assessment as well as the relationship between risk factors were studied.	<p>The project has strengthened climate change adaptation capacity by conducting comprehensive risk assessment and policy gap analysis, thereby supporting local decision makers on identifying necessary adaptation measures that are specific to the natural, geographical, social, and economic conditions of each region.</p> <p>Through workshops and trainings programs, the project has enhanced the knowledge, awareness, and adaptive capacity of local stakeholders including herders, government officials, and researchers.</p> <p>Furthermore, the project has established a strong foundation for long-term international research collaboration through active cooperation among Mongolian, Chinese, and Japanese researchers.</p> <p>Ultimately, the development of science based, locally specific adaptation plans will help to reduce potential losses and damages arising from the increasing</p>
Vulnerability map of Ulaanqab prefecture and Vulnerability Atlas of Khovd province for science based and spatial characteristics specific decision making at local level.	Environmental, social and economic risk and vulnerability maps and atlas of study areas were produced and distributed to local decision makers and researchers. The result of the research has contributed to national and local level adaptation policy documents.	
Climate change adaptation policy recommendation based on the synthesis analysis of risk and vulnerability assessment and adaptation policy gap analysis	Climate change adaptation policy recommendation was developed and distributed to local decision makers which provides information and knowledge on making better suited policy for each soums.	
Build strong international research partnership in Asia – Pacific, enhanced knowledge and data sharing	Research partnership between Mongolia, China and Japan has been strengthened through cooperative field studies and sharing of knowledge and data through the project.	
Capacity development for 60 leaders from herders, local civil society, young researchers, policy-makers, and local government officials who will receive advanced knowledge and experience on local	Capacity development for 60 leaders from herders, local civil society, young researchers, policy-makers, and local government officials has been organized. Knowledge and information of local stakeholders has been increased and necessary documents were provided for	

vulnerabilities, adaptation measures and science based policy making.	scientific based decision making.	frequency and intensity of climate-related hazards across the region.
<p>The research findings published in two international and two domestic journals.</p> <p>Distribution of the project outputs through risk and vulnerability maps, brochures, training materials, and web portal sites.</p>	<p>Three papers were published in scientific journals and three papers are currently under review. Report and atlas was developed and distributed to local stakeholders.</p> <p>Activities of the project was shared through web portals.</p>	

4. Key facts/figures

- Environmental, social and economic risk assessment was conducted in 16 soums of Khovd province, Mongolia.
- Adaptation policy analysis was carried out at both provincial and soum levels based on local policy documents in Khovd Province.
- A synthesis analysis integrating the results of risk assessment and policy analysis was conducted and policy recommendations were developed.
- A Vulnerability Atlas with 46 thematic maps was produced and distributed.
- 3 papers published in international peer-reviewed journals.
- 1 paper published in proceeding of domestic conference, 1 abstract published in proceeding of an international conference.
- 3 papers are currently under review in international journals.
- Project has contributed to the development of 2 policy documents (National Adaptation Plan to Climate Change and Adaptation Plan of Khovd province) and 1 national report (Mongolia Voluntary National Review 2023: Implementation of the Sustainable Development Goals).
- Project findings were presented at 5 international conferences, 1 domestic conference, and 7 workshops and meetings.
- 3 regional workshops were organized in Mongolia, China, and Japan.
- 4 local stakeholder workshops were held in Khovd province, and 1 meeting was organized in Ulanqab prefecture.
- 5 field studies were conducted in Khovd province and 1 field study in Ulanqab prefecture.
- Training was organized for 60 participants, including herders, local government officials, policy-makers, and young researchers.
- The project supported the training of 3 Ph.D. students and 2 Master’s students.

5. Publications

1. Galtbayar, S., Myagmarsuren, A., Tsedev-Ish, O., Gankhuyag, U., Suocheng, D., Shinoda, M., Zambuu, B., & Erdenebadrakh, M. (2025). Environmental, Social and Economic Risk Assessment at the Soum Level to Support Local Adaptation Planning in Khovd Province, Mongolia. Submitted to APN Science Bulletin.
2. Davaa, L., Myagmarsuren, A., Galtbayar, S. (2025). Strengthening local adaptation resilience through identifying the local policy gap in Mongolia. Submitted to APN Science Bulletin.
3. Tsedev-Ish, O., Myagmarsuren, A., Duudgai, B. (2025). Estimating Livestock Mortality Risk during the 2023–2024 Dzud in Mongolia at the Soum Level Using Climate and Management Scenarios. Under review at Natural Hazards and Earth System Sciences
4. Galtbayar, S., Myagmarsuren, A., Gankhuyag, U., Tsedev-Ish, O., Suocheng, D., Shinoda, M., Erdenebadrakh, M. (2025). Assessing climate hazard risks for Mongolian herders: A county-level study in Khovd, Bayankhongor, and Dundgovi provinces. Mongolian Journal of Geography and Geoecology, Special issue on EST 2025. <https://doi.org/10.5564/mjgg.v62i46.4124>
5. Myagmarsuren, A., Galtbayar, S., Tsedev-Ish, O., & Gankhuyag, U. (2024). Risk and vulnerability assessment of livestock sector, and adaptation issues. In Proceedings of the Scientific Conference “Development Concept of Livestock Sector under Climate Change” (April 4, 2024). Ulaanbaatar, Mongolia.
6. Tsedev-Ish, O., & Myagmarsuren, A. (2023). Preliminary results of determining the social variables of rural population’s vulnerability to climate change. Mongolian Journal of Geography and Geoecology, 44. <https://doi.org/10.5564/mjgg.v60i44.3067>
7. Galtbayar, S., Myagmarsuren, A., & Bayarjargal, M. (2023). Analyzing environmental and economic variables of climate change vulnerability in Mongolia. In Proceedings of the Environmental Science and Technology – The Fourth International Conference. Ulaanbaatar, Mongolia.
8. Galtbayar, S., Myagmarsuren, A., Bayarjargal, M., Tsedev-Ish, O., Munguntuul, U., & Gankhuyag, U. (2022). Determining variables of social, economic, and ecological vulnerability to climate change. Mongolian Journal of Geography and Geoecology, 42, 30–42. <https://doi.org/10.5564/mjgg.v59i43.2510>

6. Media reports, videos and other digital content

- Risk and vulnerability atlas of Khovd province
Link: <https://online.fliphtml5.com/oebwf/kiui/>
- Agency of Nature and Environment, Khovd province. Media post. Facebook.com. 2025.09.18. [In Mongolian language]
Link: <https://www.facebook.com/share/p/1CV7VjH9BX/>
- Altanbagana M. “Lessons from Zud: 2023-2024”. Interview. Agency of Emergency and Disaster of Mongolia. 2024.09.13
Link: <https://www.facebook.com/share/v/1HV5QAafbQ/>
- Altanbagana M. “Sanchir garigiin zochin”. Interview. Facebook.mn. 2024.01.11
Link: <https://www.youtube.com/watch?v=hBIMX9crO78>
- Altanbagana M. “Impacts of climate change on environmental, social and economic vulnerability and science-based policy making Western region stakeholder workshop has been organized”. News interview. NewKhovd.mn. 2023.01.11.
Link: <https://www.facebook.com/watch/?v=1307970160055596>

- We added APN project tab to the official website of Institute of Geography and Geoecology, MAS.

Link to project news on the website: <https://igg.ac.mn/5f373f85>

Link to project information on the website: <https://igg.ac.mn/e9d2439c>

7. Pull quotes

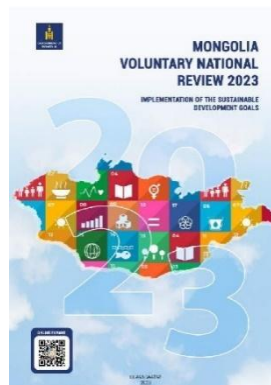
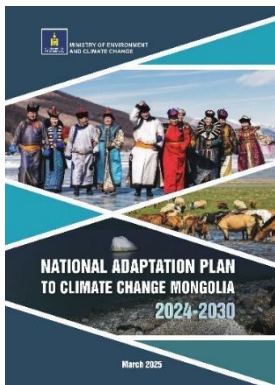


Altanbagana M. (Ph.D), Associate Professor, Project leader,
Head of Social and Economic Geography Division, Institute of Geography and Geoecology, Mongolian Academy of Sciences

With the support of the Asia-Pacific Network for Global Change Research (APN), the Institute of Geography and Geoecology of the Mongolian Academy of Sciences successfully implemented the international research project titled “Strengthening local adaptation plans through integrating socio-economic vulnerability assessment and policy gap analysis in Mongolia and China (CRRP2022-09MY-Myagmarsuren)”.

By the Government Resolution No. 01 of March 11, 2024, the National Committee on Climate Change of Mongolia approved and submitted the National Adaptation Plan for Climate Change (NAP) to the Secretariat of the UN Framework Convention on Climate Change (UNFCCC). In addition, Mongolia prepared its Voluntary National Review (VNR) report on the implementation of the Sustainable Development Goals (SDGs) and presented it to the United Nations in July 2023.

As a project leader, I participated in the working group and advisory team for the preparation of these two national documents. In doing so, I had the honor to present the climate change risk and vulnerability assessment results from our project, and contributed to developing documents for strengthening sustainable adaptation to climate change and strengthening capacity at the national, regional, and local levels. I would like to express my sincere gratitude to the APN-GCR for their valuable cooperation and support.



National Adaptation Plan to Climate Change: 2024-2030

Ministry of Environment and Climate Change, Mongolia

Link: <https://unfccc.int/documents/646367>

“Mongolia’s Voluntary National Review 2023: Implementation of the Sustainable Development Goals”

Ministry of Economy and Development, Mongolia

Link: <https://med.gov.mn/post/132440>

Ulaanbaatar, 2025.10.28



Nergui Ch., Director, Agency of Nature and Environment of Khovd province, Mongolia

The international research project titled “Strengthening local adaptation plans through integrating socio-economic vulnerability assessment and policy gap analysis in Mongolia and China (CRRP2022-09MY-Myagmarsuren)”, implemented by the Institute of Geography and Geoecology of the Mongolian Academy of Sciences with the support of the Asia-Pacific Network for Global Change Research (APN), holds significant importance for us.

Within the framework of the project, 26 environmental, social, and economic variables related to climate change were identified and a risk and vulnerability assessment was conducted at the 17 soums of Khovd province. Based on the geographically mapped results of this assessment, policy recommendations and practical measures have been proposed to strengthen local adaptive capacity and enhance resilience to climate change impacts at the local level.

By the Order No. A/164 of March 14, 2025 issued by the Governor of Khovd Province, a working group was established to develop the “Provincial Plan for Climate Change Adaptation and Mitigation”. Therefore, we are pleased to note that the research results and policy recommendations derived from this APN-supported project are being considered in evidence-based policymaking and in strengthening the capacity of local government officials in the agriculture and environment sectors. These findings are also being integrated into the Khovd Province Climate Change Adaptation Plan, in close collaboration with the research team.

We would like to express our sincere appreciation to the APN Secretariat and the research team of the Institute of Geography and Geoecology, MAS, and wish them continued success in their valuable scientific work.

Khovd province, 2025.09.18



***Burma Z. (Ph.D), Associate professor at Western Regional Branch of National University of Mongolia,
Director of the Western Regional Center for Ecological Research***

As a researcher and lecturer at the Western Regional Branch of National University of Mongolia, I am pleased to have collaborated in the international research project “Strengthening local adaptation plans through integrating socio-economic vulnerability assessment and policy gap analysis in Mongolia and China (CRRP2022-09MY-Myagmarsuren)”, implemented by the Institute of Geography and Geoecology of the Mongolian Academy of Sciences with the support of the Asia-Pacific Network for Global Change Research (APN).

I would like to express my sincere appreciation for the project’s efforts to actively involve faculty members, researchers, and students from our school in various field surveys, seminars, and capacity-building training activities conducted within the framework of the project. Through our participation, we gained valuable knowledge and experience.

Looking ahead, I would like to emphasize the importance of continuing collaboration to advance scientific and technological research on climate change and adaptation in Western Mongolia, particularly in Khovd Province, and to support regional socio-economic development through research-based knowledge and outcomes.

I wish Dr. M. Altanbagana, the project leader, and the APN-GCR continued success in their important scientific endeavors.

Khovd province, 2025.09.18

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8. Acknowledgments

We would like to express our sincere gratitude to the Asia-Pacific Network for Global Change Research (APN-GCR) for funding this project. We also extend our heartfelt thanks to our project collaborators and fellow researchers, Prof. Suocheng Dong, Prof. Masato Shinoda, Prof. Chuluun T., Dr. Dagvadorj D., Dr. Gomboluudev P., Dr. Dashtseren A., and Dr. Burmaa Z for their invaluable contributions and cooperation throughout the study. We are deeply grateful to all the local stakeholders and partner institutions who supported this project and provided essential data, information, and insights, including the Western Branch of the National University of Mongolia, the Khovd province's Agency of Nature and Environment, the Agency of Agriculture, the Department of Statistics, and the Meteorology and Environmental Monitoring Center.

9. Appendices

Appendix 1. Workshops

Appendix 2. Field studies

Appendix 3. Journal Articles

Appendix 4. Presentations at conferences

Appendix 5. Presentations at regional workshops and seminars

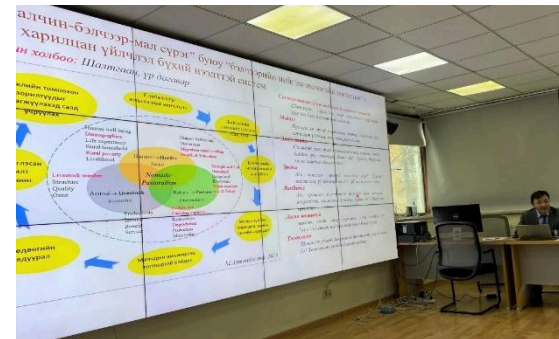
Appendix 1. Workshops, meetings and trainings

1. Project kick off meeting

Theme	Identifying Environmental, Social, and Economic Vulnerability to Climate Change
Objective	The main objective of the meeting was to introduce goals and activities of the project, research methodology and proposed risk assessment framework to local collaborators and researchers in the related field to hold discussion.
Date	December 20, 2022
Location	Ministry of Economic and Development, Ulaanbaatar, Mongolia
Participants	17 participants including project team, collaborators, and experts and researchers from relevant sectors
Outcome	During the meeting, the project's goals and activities were introduced. The variables/indicators used to determine environmental, social, and economic vulnerability to climate change were presented, along with the assessment framework and methodology. A discussion was held to exchange information and collect feedback and recommendations from collaborators.



Opening remark by Dr. Bayartungalag, Science Secretary of Institute of Geography and Geocology (IGG), MAS



Introduction of the project by Dr. Altanbagana, Project leader



During the discussion

Taking questions and suggestions from the experts

2. Stakeholder workshop in Khovd province

Theme	Impacts of Climate Change on Environmental, Social, and Economic Vulnerability and the Role of Science-Based Adaptation Policy Formulation
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Objective	i) Present to relevant organizations and stakeholders the variables influencing environmental, social, and economic vulnerability to climate change at the county (soum) level in Khovd province, exchange information, and gather feedback through open discussion; ii) Showcase changes in the climate and cryosphere of the Western region and their socio-economic impacts;
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Date	January 11, 2023
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Location	Khovd province, Mongolia
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Participants	40 participants including researchers from the Institute of Geography and Geoecology, Mongolian Academy of Sciences; representatives from the Governor's Office of Khovd Province; the Department of Environment and Tourism; the Department of Food and Agriculture; the Department of Labor and Social Welfare; the Western Branch of the National University of Mongolia; the Department of Education and Science; the Statistical Office; and the Department of Health of Khovd Province.
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Outcome	<p>The meeting was opened with welcoming remarks by Dr. A. Dashtseren, Director of the Institute of Geography and Geoecology (MAS), and Mr. L. Batbayar, Head of the Department of Environment and Tourism of Khovd Province.</p> <p>Seven researchers from the Institute presented their respective methodologies and preliminary findings. An open discussion followed, during which participants exchanged views on collaborative opportunities between local institutions and researchers, particularly in relation to ongoing research projects and the implementation of the national "Billion Trees" program.</p>
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“БАЙГАЛЬ ОРЧИН, НИЙГЭМ, ЭДИЙН ЗАСГИЙН ЭМЗЭГ БАЙДАЛД ҮЗҮҮЛЭХ УУР АМЬСГАЛЫН ӨӨРЧЛӨЛТИЙН НӨЛӨӨ БА ШИНЖЛЭХ УХААНД СУУРИЛСАН БОДЛОГО ТОДОРХОЙЛОХ НЬ” баруун бүсийн оролцогч талуудын хамтарсан хурал

 <p>Сэдэв: Баруун бүс нутгийн хүйтэн маялал, нийгэм эдийн засагт үзүүлэх уур амьсгалын өөрчлөлтийн нөлөө</p> <p>А.Даштсэрэн, ШУА-ийн Газарзүй, геоэкологийн хүрээлэнгийн захирал, доктор (Ph.D)</p>	 <p>Сэдэв: Уур амьсгалын өөрчлөлтөөс нийгэм, эдийн засагт үзүүлэх нөлөө, эмзэг байдлын судалгаа & APN төслийн товч танилцуулга</p> <p>М.Алтанбагана, ШУА-ийн Газарзүй, геоэкологийн хүрээлэнгийн Нийгэм, эдийн засгийн газарзүйн салбарын дарга, доктор (Ph.D), дэд профессор</p>
 <p>Сэдэв: Ховд аймгийн төв суурин газрын үндэс усны чанар, найрлага</p> <p>С.Чинзориг, ШУА-ийн Газарзүй, геоэкологийн хүрээлэнгийн Усны нөөц, ус ашиглалтын салбарын дарга, доктор (Ph.D)</p>	 <p>Сэдэв: Монгол орны цөлжилт, газрын доройтлын асуудлууд</p> <p>Ц.Ганчөдөр, ШУА-ийн Газарзүй, геоэкологийн хүрээлэнгийн Цөлжилтийн судалгааны салбарын дарга, доктор (Ph.D)</p>
 <p>Сэдэв: Уур амьсгалын өөрчлөлтөд байгаль орчин, мал яж ахуйн эмзэг байдлыг нөхцөлдүүлэх хувьсагчууд</p> <p>Г.Саруул, ШУА-ийн Газарзүй, геоэкологийн хүрээлэнгийн Нийгэм эдийн засгийн газарзүйн салбарын ЭШЦА</p>	 <p>Сэдэв: Уур амьсгалын өөрчлөлтөд нийгэм, эдийн засгийн эмзэг байдлыг нөхцөлдүүлэх хувьсагчууд</p> <p>М.Баяржаргал, ШУА-ийн Газарзүй, геоэкологийн хүрээлэнгийн Нийгэм эдийн засгийн газарзүйн салбарын ЭШЦА</p>
 <p>Сэдэв: Алтайн нурууны зарим өндөр уулсын уур амьсгал</p> <p>Х.Тэмүүжин, ШУА-ийн Газарзүй, геоэкологийн хүрээлэнгийн Цөвдөг судлалын салбарын ЭШЦА, докторант</p>	

*Хууцав: 2023 оны 01 сарын 11-ны өдрийн 08.30-13.00 цагт.
Хяана: Ховд аймгийн Засаг даргын Тамгын газрын хурлын их танхимд*

Poster of the event



Opening remark by Dr. Dashtseren, Director of IGG, MAS



Project introduction by Dr. Altanbagana, Project leader



Group photo for participants



During the workshop

3. Project meeting with collaborators from China

Theme	Project meeting
Objective	The purpose of this meeting was to review the progress of the joint project by the Institute of Geographic Sciences and Natural Resources Research (IGSNRR), Chinese Academy of Sciences (CAS), and the Institute of Geography and Geoecology (IGG), Mongolian Academy of Sciences (MAS).
Date	May 9, 2023
Location	Beijing, China
Participants	15 participants including researchers from the Institute of Geography and Geoecology, Mongolian Academy of Sciences; collaborating researchers from the Chinese Academy of Sciences; and experts from relevant research sectors.
Outcome	Both research teams from the Institute of Geographic Sciences and Natural Resources Research, CAS, and the Institute of Geography and Geoecology, MAS, discussed the project's progress, results, and future plans. Both sides agreed to organize a joint Mongolia–China scientific expedition to further advance field investigations and strengthen collaborative research efforts.



Group photo



Introduction of projects and researches in IGG by Dr. Dashtseren, Director of IGG, MAS



Project introduction by Dr. Altanbagana, Project leader



Presentation by Prof. Dong

4. Stakeholder meeting in Khovd province

Theme	Identifying Environmental, Social, and Economic Vulnerability to Climate Change and Strengthening local adaptation plans
Objective	To present the progress and findings of the study on environmental, social, and economic vulnerability to climate change in Khovd Province to relevant professional organizations and stakeholders, gather feedback, exchange information on the current environmental, social, and economic conditions of Khovd Province, and facilitate an open discussion.
Date	August 17, 2023
Location	Khovd province, Mongolia
Participants	Researchers from the Institute of Geography and Geoecology, Mongolian Academy of Sciences; collaborating researchers from the Chinese Academy of Sciences; and experts and researchers from relevant sectors.
Outcome	Discussions were held on the current environmental, social, and economic conditions of Khovd Province, as well as on future collaboration opportunities. Participants were introduced to the ongoing research activities under the project and provided constructive feedback and suggestions for improvement and further cooperation.



Group photo



During the meeting



Research teams from IGG and IGSNRR



Presentation by Prof. Dong

5. Project seminar with collaborator from Japan

Theme	Environmental, social and economic vulnerability to climate change and adaptation measures
Objective	To present the research process and results of the assessment of environmental, social and economic vulnerability of Hovd Province to climate change to the collaborators and researchers at Nagoya University, exchange information and hold discussions on the topic.
Date	March 7, 2024
Location	Nagoya, Japan
Participants	12 participants included Dr. D. Battogtokh, Director of the Department of Science, Technology Policy, Innovation Development and Implementation Coordination at the Ministry of Education and Science of Mongolia; Dr. A. Dashtseren, Director of the Institute of Geography and Geoecology, MAS; Dr. M. Altanbagana, Head of the Department of Socio-Economic Geography, IGG; Professor Masato Shinoda and Professor Masahiro Takahashi from the Graduate School of Environmental Studies, Nagoya University; and Assistant Professor M. Asano from the University of Tsukuba, along with other researchers from related fields.
Outcome	During the conference, participants presented and discussed research findings related to climate change, natural disasters, dust storms, and soil erosion in Mongolia and Central Asia. The meeting also provided an opportunity to share knowledge and information on the project's progress and to exchange ideas for enhancing future scientific collaboration.



Opening remark by Dr. Dashtseren



Presentation by Prof. Shinoda



Introduction of the project by Dr. Altanbagana, Project leader



Group photo

6. Project workshop and training of local stakeholders

Theme	Assessment of Environmental, Social, and Economic Vulnerability to Climate Change and Strengthening Local Adaptive Capacity
Objective	To organize a training workshop in Khovd Province on the science-based decision making in Khovd province, to present results of risk and vulnerability assessment and the policy gap analysis, and to hold consultations with relevant professional organizations.
Date	September 18, 2025
Location	Khovd province, Mongolia
Participants	More than 60 participants including researchers from the Institute of Geography and Geoecology, Mongolian Academy of Sciences; representatives from the Department of Environment and Tourism of Khovd Province; Meteorology and Environmental Monitoring Department, Department of Food and Agriculture; Western Branch of the National University of Mongolia; herders; and agricultural specialists from various soums.
Outcome	The findings of the environmental, social, and economic vulnerability and risk assessments, as well as the results of the climate change adaptation policy analysis was presented. Also, discussion session was held to share conclusions and recommendations from the project, as well as take questions and comments from local participants. The training strengthened the capacity of local policymakers, specialists, researchers, citizens, and herders, and facilitate an open, multi-stakeholder policy dialogue.



Group photo



During the training



Presentation of the draft Adaptation Plan of Khovd province by Mr. Tseyen-Oidov, specialist at Agency of Nature and Environment of Khovd province



Dr. Altanbagana moderating the discussion session of the training

Appendix 2. Field studies

1. Focus group interview from herders of Erdeneburen soum, Khovd province

Theme	Impacts of Climate Change and the Vulnerability of Herders
Objective	The purpose of this meeting was to conduct interviews and focus group discussions with residents of Erdeneburen soum within the framework of the study on social, economic, and environmental vulnerability in Khovd Province.
Date	January, 13, 2023
Location	Khovd province, Mongolia
Participants	A total of 19 participants including research team; and representatives from the Erdeneburen Soum Governor's Office, including the officers responsible for social welfare, social insurance, and environmental affairs, as well as the Deputy Governor, bag (subdistrict) leaders, Chair of the Citizens' Representative Khural, environmental rangers, representatives of civil society, and local herders.
Outcome	Participants discussed and responded to questions related to variables influencing social, economic, and environmental vulnerability to climate change. Additionally, individual interviews were conducted with herders to collect information on socio-economic issues, environmental conditions, and the impacts of drought and dzud (harsh winter disasters). These discussions provided valuable insights into local realities and community-level adaptation challenges.



Meeting with the Governor of Erdeneburen soum



Introducing the interview content for herder's adaptation capacity



Introduction of the project and discussion for Interview with local herder household local adaptation issues by Dr. Altanbagana

2. Joint field investigation in Inner Mongolia Autonomous Region, China

Theme	Impacts of Climate Change and the Vulnerability in the Livestock sector in China
Objective	The mission involved discussions on ongoing research activities and field visits to the study sites in Xilingol and Ulanqab prefectures of the Inner Mongolia Autonomous Region (IMAR), China to examine local climatic, social, and economic conditions and to collect relevant data and information.
Date	May 9-16, 2023
Location	Xilingol and Ulanqab Prefectures, Inner Mongolia Autonomous Region, China
Participants	Dr. A. Dashцeren, Director of the Institute of Geography and Geoecology; Dr. M. Altanbagana, Head of the Socio-Economic Research Division; Dr. A. Saruulzaya, Head of the Permafrost Research Division and researchers from the same division. From the Chinese side, Professor Dong Suocheng and researchers from the Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, participated.
Outcome	<p>During the visit, the research team visited local herders, sheep and cattle farms, dairy and meat processing plants, airag (fermented mare’s milk) production facilities, veterinary clinics, hay storage sites, agricultural markets, and farm machinery companies in Ulanqab prefecture.</p> <p>Also met with specialists from the local environmental, meteorological, livestock, and agricultural bureaus of Xilingol Prefecture to gather information on the current situation, climate change impacts, and herders’ livelihoods. The team met with officials from the environmental, meteorological, livestock, agriculture, tourism, development policy, forestry, and pasture bureaus of Ulanqab Prefecture to discuss the local situation, climate change issues, and herders’ living conditions. Then, visited herders, sheep and cattle farms, dairy and yogurt processing factories, and rural tourism resorts in Ulanqab. Finally conducted a joint seminar at the Inner Mongolia University of Finance and Economics, where researchers from both institutions presented progress updates and discussed future collaborative research directions.</p>



Meeting with the Governor of Ulanqab prefecture, Inner Mongolia, China



Introducing the interview content for herder farm



Lecture and Introduction of the project by Dr. Altanbagana in University of Finance and Economy, Inner Mongolia, China



Interview with local herder household

3. Joint field investigation in Khovd province

Theme	Identifying Environmental, Social, and Economic Vulnerability to Climate Change of Livestock sector in Khovd province
Objective	The purpose of this field study was to conduct interviews with herders and farmers in Buyant soum within the framework of the study on social, economic, and environmental vulnerability in Khovd Province. The field visit also aimed to observe the Western Regional Ecological Research Station, and to visit the “Altain Meat” factory to collect data and information relevant to local livelihoods and industries.
Date	August 18–19, 2023
Location	Khovd province, Mongolia
Participants	Researchers from the Institute of Geography and Geoecology, Mongolian Academy of Sciences; herders and farmers of Buyant soum; and researchers from the Western Branch of the National University of Mongolia.
Outcome	Research team interviewed local herders and farmers regarding the social, economic, and environmental vulnerability to climate change. Information was gathered on local socio-economic challenges, environmental issues, and experiences with drought and dzud (severe winter disasters). The research team also visited the Western Regional Ecological Research Station - a key monitoring site for the Mongolian Altai and Great Lakes Depression

region, covering an area of 4 hectares and equipped with an automatic weather station. In addition, the team visited Altain Meat, a representative small and medium-sized enterprise in the region, to learn about local meat production, processing, and market distribution practices.



Interview with local herder household in Buyant soum, Khovd province



Farmer household in Buyant soum, Khovd province



Data collection in Western Regional Ecological Research Station, Western Regional Branch of National University of Mongolia



Altain Meat company delivery car in Khovd province

4. Household survey collection in Khovd province

Theme	Field study and Household survey for Vulnerability and Strengthening local adaptation capacity to Climate Change
Objective	The purpose of this field study was to conduct household surveys among herder households across nine soums in Khovd Province to collect information on drought, dzud (severe winter disasters), and the current socio-economic conditions of rural communities. The mission also aimed to exchange information with local stakeholders, present research progress and preliminary findings to relevant organizations, gather feedback, and strengthen collaboration with local institutions.

Date	May 16–30, 2024
Location	Khovd province, Mongolia
Participants	Researchers from the Institute of Geography and Geoecology, Mongolian Academy of Sciences; herders and farmers from Buyant soum; and researchers from the Western Branch of the National University of Mongolia.
Outcome	<p>Between May 19 and 28, 2024, the field research team conducted surveys across Erdeneburen, Buyant, Chandmani, Mankhan, Zereg, Munkhkhairkhan, Tsetseg, Altai, and Uench soums, covering a total of 369 herder households. The survey gathered detailed data on the impacts of drought and dzud events, natural hazards, and local socio-economic conditions.</p> <p>On May 22, 2024, during the “Rural Revival: Training and Consultation for Herders and Farmers” event held in Erdeneburen soum, Dr. M. Altanbagana delivered a presentation titled “Climate Change and Its Risks and Vulnerabilities.” The presentation contributed to public awareness and knowledge-sharing among local residents regarding climate risks and adaptation challenges.</p>



Research team



Survey collection from herders in Zereg soum



Survey collection from herders in Buyant
soum

Survey collection from herders in Buyant
soum

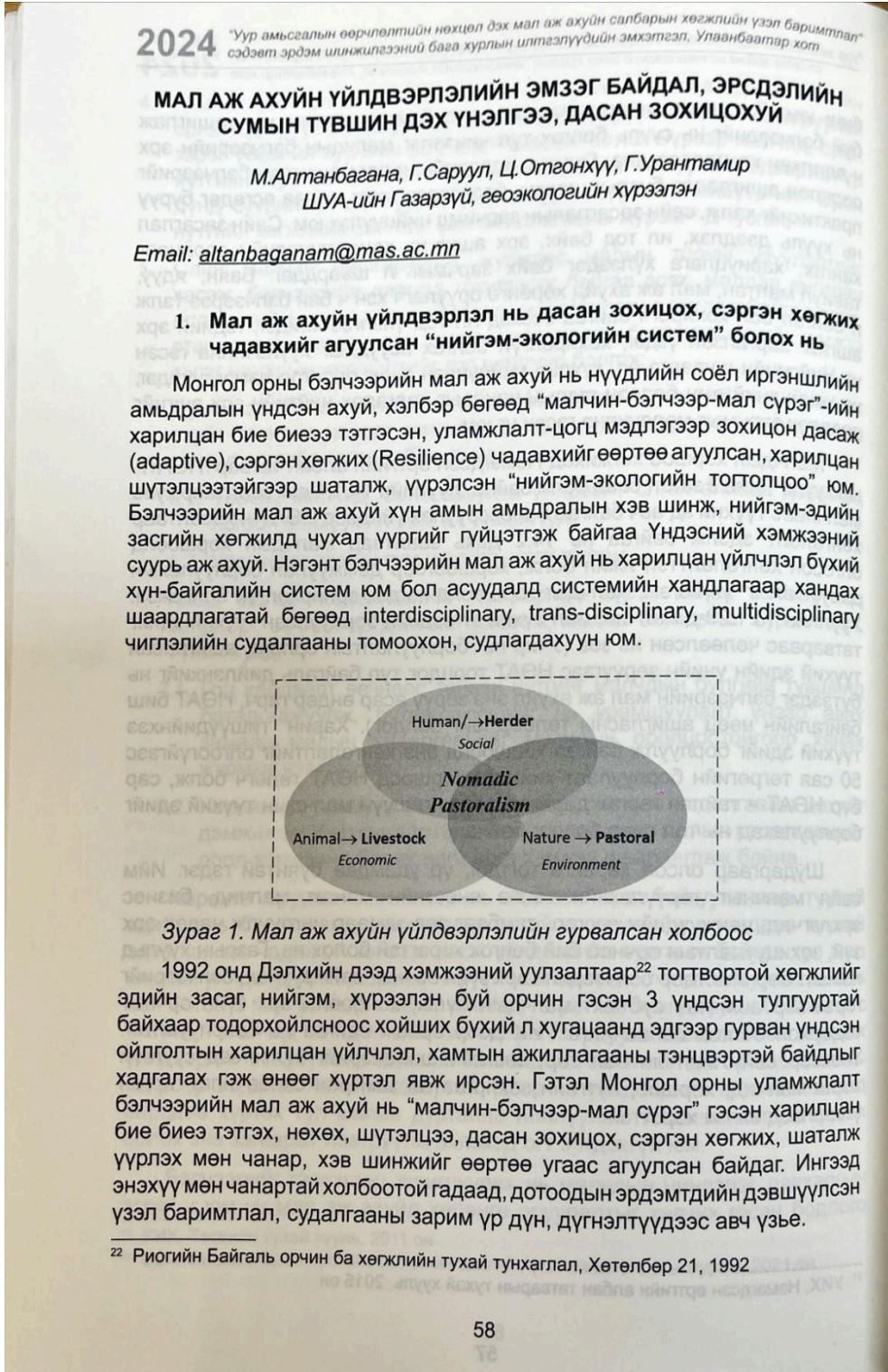
Appendix 3. Journal Articles

1. Assessing climate hazard risks for Mongolian herders: A county-level study in Khovd, Bayankhongor, and Dundgovi provinces (Published in Mongolian Journal of Geography and Geoecology, Special issue on EST 2025)

Abstract

Mongolian herders are particularly vulnerable to climate change, as their livelihoods depend heavily on livestock production. Understanding the effects of climate hazards such as drought and dzud is crucial for planning and implementing the appropriate responses and effective adaptive measures. In this research, risk is defined as the potential for adverse consequences for herders due to hazardous climatic conditions, and is explained through 4 components including climate hazard, exposure, vulnerability, and response. The purpose of this study is to assess climate hazard risks of herders at the county (soum) level and explore the varying contributions of risk components. Based on a literature review and data availability, 15 factors of risk were selected including temperature and precipitation change, drought and dzud frequency, pasture use index, livestock loss, ratio of seasonal pastureland, water availability, poverty, dependency ratio, education, bank savings, prepared hay and forage, barns, and index-based livestock insurance. Principal Component Analysis (PCA) was used to aggregate the factors within 4 components of risk, and the composite risk index (RI) was calculated using the principal component scores at the soum level in Bayankhongor, Khovd, and Dundgovi provinces of Mongolia. The average RI was 19.2 in Bayankhongor, 14.2 in Khovd, and 17.0 in Dundgovi province. The results highlight the spatial heterogeneity of risk, emphasizing that the northern soums of Khovd and Bayankhongor, and the northeastern soums of Dundgovi are particularly susceptible to climate-related hazards. On the other hand, better hay and forage preparation in Khovd province contributed to its lower overall risk index. Enhancing long-term preparedness measures, such as hay and forage preparation and barn availability, alongside social and financial support mechanisms for vulnerable herder households is crucial for strengthening resilience.

2. Risk and vulnerability assessment of livestock sector, and adaptation issues (Published in the proceedings of the conference “Development Concept of Livestock Sector under Climate Change”)



3. Preliminary results of determining the social variables of rural population's vulnerability to climate change (Published in the Mongolian Journal of Geography and Geoecology)

Abstract

Mongolia is extremely vulnerable to climate change due to its geographical location, fragile ecosystem, and economic system dependent on nature and climate. Especially, rural people and herders in Mongolia are a social group that is very sensitive and vulnerable to climate change. This study aimed to define the condition of the social and economic vulnerability of rural people to climate change at the soum level in the Bayankhongor, Dundgovi, and Khovd provinces. Socioeconomic data were collected in a continuous series for the last 10 years. Socioeconomic variables of the vulnerability to climate change were calculated and thematic images were created using ArcGIS for each soum of three provinces for comparison of the provincial average. As a result, we identified 8 major social variables including rural poverty; unemployment rate; dependency ratio; population growth and migration (the average annual growth rate of the population and the net migration rate); education level of the rural population; share of male/female headed household in total household; death rate from cardiovascular diseases; and supply of doctors and specialists (number of physicians per 10,000 people). In the future, the study can be further explored by understanding the interrelationships and correlations between social variables of vulnerability and vulnerability assessment. The results can be used for the implementation of climate change adaptation strategies at the local level, and the development of science-based policies can be supported.

4. Analyzing environmental and economic variables of climate change vulnerability in Mongolia. (Published in the Proceedings of the Environmental Science and Technology – The Fourth International Conference)

Abstract

As a result of climatic variability and the impacts of climate change, in the last forty years, Mongolian ecosystems have been altered. Climate change has affected desertification, water supply and natural disasters. Mongolia's livestock sector is more vulnerable to climate change due to its high dependence on weather and climatic conditions. Based on a literature review of the climate change vulnerability studies conducted in Mongolia and around the world, 26 environmental, agricultural, social, and economic variables were previously determined. The purpose of this research is to analyze 13 environmental and economic variables including drought, dzud, aridity, vegetation change, desertification, pasture use, loans, savings, non-performing loans, index-based livestock insurance, health insurance, social insurance, and number of cooperative members in Khovd, Bayankhongor, Dundgovi prefectures at the soum level. Necessary meteorological, environmental, and statistical data were collected for 10-30 years depending on the availability. Different indexes representing above-mentioned variables were calculated and normalized. Research result shows that there are no clear increasing or decreasing trend in the drought-dzud index and the aridity index in most of the soums. As for the loans, savings, non-performing loans, indexed livestock insurance, and number of cooperative members, all of them have an increasing trend. These indexes varied greatly

among different soums of the prefecture depending on their location, administrative role, climate zones etc. It is important to understand the relationship between different vulnerability variables in the future to accurately assess the vulnerability to climate change. This result is the base for conducting integrated climate change vulnerability/risk assessment, as well as understanding the cause of vulnerability in rural areas of Mongolia.

5. Determining variables of social, economic, and ecological vulnerability to climate change. Published in the Mongolian Journal of Geography and Geoecology)

Abstract

Mongolia is sensitive to climate change due to its geographic location, ecosystems, and socioeconomic condition. Climate change in the last forty years has impacted desertification, water supply, and frequency and intensity of the natural disasters in Mongolia. Moreover, the livestock sector is more vulnerable to climate change due to its high dependence on weather and climatic conditions. The purpose of this study was to identify and categorize the most important, pressing, and measurable variables that directly and indirectly affect the social, economic, and ecological vulnerability of rural people, especially herders, to climate change. Based on the literature review, which was conducted on research reports and articles on the social, economic, and ecological impact, vulnerability, and adaptation of climate change in Mongolia and foreign countries, we identified 26 variables determining the vulnerabilities of Mongolia's rural population, including herders. The variables included 3 variables of climate hazard (drought, dzud, and aridity), 5 variables of exposure (vegetation change, pasture use, pasture water supply, four seasons of pasture availability, and desertification), 12 variables for sensitivity (number of livestock, livestock mortality, migration, female-headed households, dependency ratio, herder education level, poverty, unemployment, loans, savings, non-performing loans, and deaths from cardiovascular disease), and 6 variables of adaptive capacity (number of doctors, prepared hay and fodder, indexed livestock insurance, health insurance, social insurance, and number of cooperative members). In the future, there is a need to analyze the interlinkage between these variables as positive and negative, indirect and direct to determine the relationship and overlaps of the variables, conduct vulnerability assessment in different ecological regions and areas using the variables, and identify the causes for vulnerability.

Appendix 4. Presentations at conferences

Topic	Presenter	Conference	Year
Assessing climate hazard risks for Mongolian herders: A county-level study in Khovd, Bayankhongor, and Dundgovi provinces.	Saruul Galtbayar	Environmental Science and Technology The Fifth International Conference	2025
Risk and vulnerability assessment of livestock sector, and adaptation issues	Altanbagana Myagmarsuren	Development concept of livestock sector under the climate change scientific conference	2024
Understanding the contributions of climate hazards and socioeconomic vulnerability of herders to dzud risk in Mongolia	Saruul Galtbayar	American Geophysical Union Annual Conference	2024
2023-2024 dzud: Estimation of livestock mortality	Altanbagana Myagmarsuren	“Lessons learned from Dzud” workshop organized by UN FAO and National Emergency Management Agency	2024
Analyzing environmental and economic variables of climate change vulnerability in Mongolia	Saruul Galtbayar	Environmental Science and Technology- The Fourth International Conference	2023
Climate Change impact on Mongolian Socio-Economic Systems and Vulnerability Studies	Altanbagana Myagmarsuren	Sustainability Research + Innovation 2023. Session: Developing science based local adaptation plan through integration of environmental, social, and economic vulnerability assessment	2023
Impacts of climate change and needs for Climate-informed development in Mongolia	Dagvadorj D	Science Summit at UNGA78 Sustainable Development: Back to the Future: A view from Mongolia.	2023

Appendix 5. Presentations at regional workshops and seminars

- Altanbagana M. (2025). "Policies, Strategies, and Needs for Climate Change Adaptation". Assessment of Environmental, Social, and Economic Vulnerability to Climate Change and Strengthening Local Adaptive Capacity Training workshop. 2025.09.18. Khovd, Mongolia.
- Lavdmaa D. (2025). "Analysis and Results of Climate Change Adaptation Policies at the Local Level". Assessment of Environmental, Social, and Economic Vulnerability to Climate Change and Strengthening Local Adaptive Capacity Training workshop. 2025.09.18. Khovd, Mongolia.
- Saruul G. (2025). "Findings of the Environmental, Social, and Economic Vulnerability Assessment to Climate Change". Assessment of Environmental, Social, and Economic Vulnerability to Climate Change and Strengthening Local Adaptive Capacity Training workshop. 2025.09.18. Khovd, Mongolia.
- Tseyen-Oidov A. (2025). "Climate Change Adaptation Policy and Plan (Draft) of Khovd Province". Assessment of Environmental, Social, and Economic Vulnerability to Climate Change and Strengthening Local Adaptive Capacity Training workshop. 2025.09.18. Khovd, Mongolia.
- Burmaa Z. (2025). "Impact of Climate Change on Regional Water and Wetland Ecosystems". Assessment of Environmental, Social, and Economic Vulnerability to Climate Change and Strengthening Local Adaptive Capacity Training workshop. 2025.09.18. Khovd, Mongolia.
- Altanbagana M. (2023). "Project Introduction, climate change vulnerability and adaptation measures". "Impacts of climate change on environmental, social and economic vulnerability and science-based policy making" Western region stakeholder workshop. 2023.08.17. Khovd, Mongolia.
- Saruul G., Altanbagana M., Bayarjargal M. (2023). "Analyzing environmental and economic variables of climate change vulnerability in Mongolia". "Impacts of climate change on environmental, social and economic vulnerability and science-based policy making" Western region stakeholder workshop. 2023.08.17. Khovd, Mongolia.
- Otgonkhoo Ts., Altanbagana M. (2023). "Analyzing social variables of climate change vulnerability in Mongolia". "Impacts of climate change on environmental, social and economic vulnerability and science-based policy making" Western region stakeholder workshop. 2023.08.17. Khovd, Mongolia.
- Urantamir G., Altanbagana M. (2023). "Analyzing agricultural variables of climate change vulnerability in Mongolia". "Impacts of climate change on environmental, social and economic vulnerability and science-based policy making" Western region stakeholder workshop. 2023.08.17. Khovd, Mongolia.
- Altanbagana M. (2023). Climate change impact and vulnerability research & CCVA-CCAP Project Introduction [PowerPoint presentation]. "Impacts of climate change on environmental, social and economic vulnerability and science-based policy making" Western region stakeholder workshop. 2023.01.11. Khovd, Mongolia.
- Saruul G. (2023). Climate change vulnerability variables of the environment and animal husbandry sector [PowerPoint presentation]. "Impacts of climate change on environmental, social and economic vulnerability and science-based policy making" Western region stakeholder workshop. 2023.01.11. Khovd, Mongolia.
- Bayarjargal M. 2023. Climate change vulnerability variables of social and economic sectors [PowerPoint presentation]. "Impacts of climate change on environmental, social and economic vulnerability and science-based policy making" Western region stakeholder workshop. 2023.01.11. Khovd, Mongolia.
- Saruul G. (2022). Methodology for defining and assessing environmental, social, and economic variables to climate change [PowerPoint presentation]. Academic council of Institute of Geography and Geoecology, MAS. 2022.12.22. Ulaanbaatar, Mongolia.
- Altanbagana M. (2022). Project Introduction: Project Objectives, Scope, and Work Plan [PowerPoint presentation]. "Defining environmental, social, and economic vulnerability to climate change"

- project kick off meeting. 2022.12.20. Ulaanbaatar, Mongolia.
- Altanbagana M. (2022). Research methodology: Understanding relationship between vulnerability variables and conducting functional analysis [PowerPoint presentation]. “Defining environmental, social, and economic vulnerability to climate change” project kick off meeting. 2022.12.20. Ulaanbaatar, Mongolia.
- Altanbagana M. (2022). Climate Change impact on Mongolian Socio-Economic Systems [PowerPoint presentation]. Green Development of China-Mongolia-Russia Economic Corridor and the Third Belt and Road Think Tank Forum of the International Union of Scientists. 2022.11.26. Beijing, China.
- Saruul G., Altanbagana M. (2022). Strengthening local adaptation plan through integrating socio-economic vulnerability assessment and policy gap analysis in Mongolia and China: A new project. “Trans Eurasian Workshop: From Vision to Actions Towards Sustainability”. 2022.10.16