ENVIRONMENTAL SCIENCE AND TECHNOLOGY

The Second International Conference

PROCEEDINGS

- **GENERAL ORGANIZER**

INSTITUTE OF GEOGRAPHY AND GEOECOLOGY, MAS

MONGOLIAN ACADEMY OF SCIENCES

- **CO-ORGANIZER**

МОНГОЛ УЛСЫН ЗАСГИЙН ГАЗАР

MINISTRY OF EDUCATION, CULTURE, SCIENCES AND SPORTS

МОНГОЛ УЛСЫН ЗАСГИЙН ГАЗАР

MINISTRY OF ENVIRONMENT AND TOURISM

MERIT
A CESO AND WUSC PROGRAM

HELMHOLTZ
CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

futurearth
MONGOLIAN COMMITTE

CONTENTS

CONCEPT NOTE

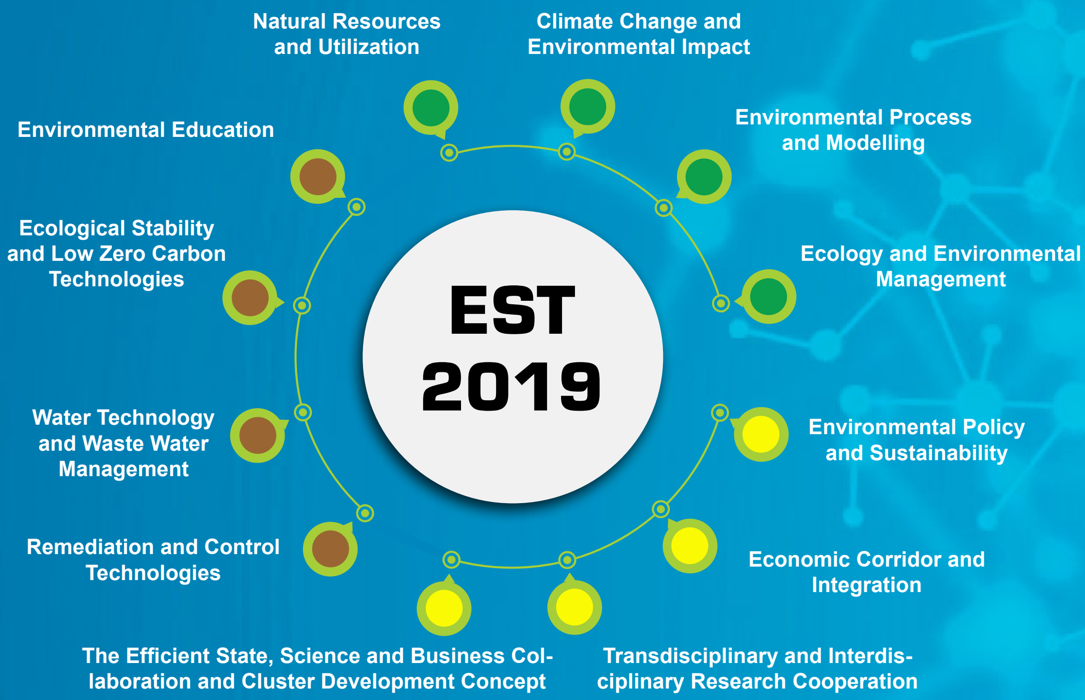
Introduction of the EST 2019

"The first International Conference on Environmental Science and Technology (EST2017)" organized in 2017 and it is anticipated that future Environmental Science and Technology conferences will be organized biannually.

There are a number of negative consequences arising in countries and regions from world climate change, global warming and anthropogenic impacts. It is most effective to develop an overcome strategy by introducing scientifically and unified understanding across the globe and region and solving these issues through introducing new technologies and innovations.

Therefore, the second International Conference on Environmental Science and Technology (EST2019) aims to provide the opportunity to discuss, debate and develop recommendations and common understandings on how to overcome these negative impacts using the latest scientific approaches and technology. It is also a pleasure, to mention that EST2019 conference is focusing to identify the involvement and cooperation of the regional organizations in the implementation of the Sustainable Development Goals adopted by the United Nations. Accordingly, this year's conference sessions are unique in nature by discussing issues related to socio-economic and regional cooperation and development besides environmental and natural sciences.

The EST2019 international conference will be attended by scientists and researchers from China, including Inner Mongolia, Russia, including Buryat, Japan, Korea, Germany, Canada, India, and Mongolia including leaders and representatives from government organizations, research institutes, and universities.



WELCOME MESSAGE

The mission of the Institute of Geography and Geoecology is to conduct research studies on the sustainability of environmental, social and economic fields, as well as to create and spread knowledge and innovation within these sectors. We aim to become a world-class research organization and the leading regional scientific research organization, providing publicly available standards-based research, technology, innovation and knowledge services that provide concrete contributions to the sustainable development of Mongolia.

The Institute of Geography and Geoecology, Mongolian Academy of Sciences celebrated the historic anniversary year in 2017 and under this event the institute initiated “The first International Conference on Environmental Science and Technology” (EST2017) and it is anticipated that future Environmental Science and Technology conferences will be organized biannually with decision of all the participants. Therefore, “The 2nd International Conference on Environmental Science and Technology” (EST2019) planned to organize between 13-16. June.2019 in Ulaanbaatar city, Mongolia.

The main purpose of the International Conference is to provide the opportunity for the international scientific organizations, researchers, scientists and policy makers in the fields of environmental, socio-economic sectors to form a common understanding and recommendations under open discussions and debate by gathering them in one platform. The purpose of this year’s International Conference is to identify the involvement and cooperation of the regional organizations in the implementation of the Sustainable Development Goals adopted by the United Nations and to facilitate knowledge sharing and present unified scientific understanding, solutions and recommendations. “EST2019” international conference comprises three main sessions of Environmental Research Trend and Challenges, Environmental Management and Regional Development and Environmental Innovation and Technology. Moreover, the conference has special future by inviting reputable international scientists and complimenting with their keynote speeches.

“EST2019” international conference co-organized by The Ministry of Culture, Sciences and Sports, The Ministry of Environment and Tourism, Helmholtz Centre for Environmental Research-UFZ Germany, Global Affairs Canada funded MERIT project, Future Earth-Mongolian Committees and attended by 200 scientists and researchers from China, including Inner Mongolia, Russia, including Buryat, Japan, Korea, Germany, Canada, India and Mongolia including leaders and representatives from government organizations, research institutes, and universities.

We would like to express our sincere gratitude to all the participants and the co-organizers of the conference from the government, international and research organizations.

May your knowledge and inspiration flourish!

Dorjgotov BATTOGTOKH (PhD)

Director General,
The Institute of Geography and Geoecology, MAS

CONGRATULATORY MESSAGE

Currently, there are 1720 researchers in Mongolia, of which 1544 are working in 23 research institutes of the state. All of these academic research organizations seek to conduct studies on an international level and create knowledge of wealth with innovative solutions.

The Institute of Geography and Geoecology of the Mongolian Academy of Sciences is the leading research institute in the study of our country's natural resources, special characteristics and environmental properties. Using advanced technologies and methods, the esteemed scientists and researchers in the Institute have published numerous scientific works in the critical fields of physical geography, water, soil, permafrost, forestry, socioeconomic development and land-use studies, as well as GIS and remote-sensing. The results of these studies have contributed to the development of scientific theory and practice in Mongolia and in the world. Furthermore, the Institute has been successful in implementing applied research in order to drive innovation in the areas of environmental pollution, including soil and water pollution, reduction technologies for desertification, methods of reduction of the negative impacts of human and environmental factors.

I am pleased to announce that scientists from the natural science sectors of Mongolia are keen to implement their studies in line with global trends of "Green Development" and "Sustainable Development" concepts and policies.

Mongolia is characterized by a variety of unique natural features which create compelling opportunities for world-class research in natural science, the results of which will contribute to regional and global solutions to environmental issues (and climate change).

The "Environmental Science and Technology - 2019" conference, jointly organized by the Mongolian Government, Minister of Education, Culture, Sciences and Sports and the Institute of Geography and Geoecology, provides an opportunity to decision makers, scientists and international organizations to meet in one area and discuss recent regional developments and issues in environmental science. I believe that the conference will bring tangible results for the region's science sector.

Finally, on behalf of the Ministry and as Minister of Education, Culture, Sciences and Sports, I would like to express my deep gratitude to the scientists, researchers and delegates who are in attendance today and wish success to this international conference.

Yo. BAATARBILEG
Minister, Ministry of Education, Culture, Sciences and Sports, Mongolia

CONGRATULATORY MESSAGE

On behalf of the Mongolian Government and Ministry of Environment and Tourism, I would like to express my sincere gratitude to all distinguished scholar and honorable guests participating in the Second International Conference on Environmental Science and Technology 2019, which is initiated by the Institute of Geography and Geoecology, Mongolian Academy of Sciences and co-organized with Ministry of Environment and Tourism.

Nowadays, ecosystem disequilibrium is occurring and many countries facing sustainability challenges due to the global warming, climate change, economy, rapid population growth, extravagant use, environmental pollution, and degradation. In Mongolia, economic sectors which are directly dependent by the natural phenomena, climate change and weather tend to be in more risk and frequency of the natural disaster and range are increasing as well. The The Secretariat of the State Great hural of Mongolia approved the “Mongolia Sustainable Development Vision-2030” and the “Green Development Policy” documents and identified the three main pillars of sustainable development of environment-socio-economic interrelated and balanced development goals. The Institute of Geography and Geoecology has been focusing on scientific baseline and applied studies of environmental protection, ecological balance, conservation of natural resources, rational use and restoration of Mongolia in accordance with the Sustainable Development concepts and Green Development trends, drafting policies and procedures, developing conclusions and recommendations on critical ecological issues in the country and adjacent regions, norms and standards and support the implementation of the process, as well as your research findings are used as a base for Mongolian policy documents.

The Ministry of Environment and Tourism’s policy documents will use the findings of your researches as a fundamental basis, and we will be cooperated closely in many directions in the future. The significance of the “Second International Conference on Environmental Science and Technology” is particularly important to understand the future environmental changes and its consequences. The Ministry of Environment and Tourism regularly cooperates with the international organizations in the fields of natural resources, foreign and domestic research organizations, scientists and researchers to improve the legal and regulatory environment of the sector, aligning the sector’s development into sustainable development policy, and pursuing research-based policies and decisions.

Finally, I would like to wish you all the best of luck and every success in your future research work.

N.TSERENBAT
Minister, Ministry of Environment and Tourism, Mongolia

CONGRATULATORY MESSAGE

Institute of Geography-Geoecology, Mongolian Academy of Sciences has been organizing the 2nd international conference of "**Environmental Science and Technology**", within diverse and beneficial cooperation among scientists from all neighboring countries, which will held on 13-16 June, 2019.

I'm pleased to note that the conference contributes scientists to gather and to share the latest findings and facing challenges of emerging issues such as climate change, global warming and phenomenon of environmental changes. The Mongolian Academy of Sciences emphasize the importance of identifying scientific evidence of environmental degradation issues related to rational use of natural resources, conservation of resources and development of environmental-friendly technologies.

In the challenge of natural phenomenon, the contexts such as "Green Development" and "Sustainable Developments", there has been extensive dialogue on sustainable use of natural resources and conditions to involve global warming, climate change. You are the ones, the intellectual scientists who contributes and explains the understanding of scientific evidence of all those means such as rational use of natural resources, development of environmental-friendly technologies and who widely disseminates the right raise to society.

Scientists from all generations have been contributing hard work and their achievements of research findings are growing year by year and quality of scientific work is enriched.

I would like to express my sincere gratitude to organizing and participating parties and wish you all to have fruitful scientific cooperation and future academic achievements

Wish you successful and fruitful conference!

Academician D. REGDEL
President of Mongolian Academy of Sciences

DETAILED PROGRAM

Date: 13-14 June, 2019
Venue: Main Hall, Holiday Inn Hotel, Ulaanbaatar

<table>
<tr><th>Time</th><th>Activities</th></tr>
<tr><td>08:00-09:00</td><td>Registration</td></tr>
<tr><td colspan="2">Plenary Event</td></tr>
<tr><td colspan="2">Timeframe: 09:00-12:20</td></tr>
<tr><td colspan="2">Room: Main Hall</td></tr>
<tr><td>09:00-09:30</td><td>Opening Ceremony
▪ Welcoming speech
Dr. Battogtokh, D.
Director, Institute of Geography and Geoecology, Mongolian Academy of Sciences, Mongolia
▪ Congratulatory Remark
Baatarbileg, Yo.
Minister, Ministry of Education, Culture, Sciences and Sports, Mongolia
Tserenbat, N.
Minister, Ministry of Environment and Tourism, Mongolia
Academician Chuluunbaatar, G.
Vice President, Mongolian Academy of Sciences, Mongolia</td></tr>
<tr><td colspan="2">Keynote presentations</td></tr>
<tr><td>09:30-09:50</td><td>Theory and Key Technology Application on Wind-sand Disaster Preventing and Control
Prof. Wang Tao
President, Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, China</td></tr>
<tr><td>09:50-10:10</td><td>Sustainable Grassland Management and its Challenges
Prof. Tsunekawa Atsushi
Arid Land Research Center, Tottori University, Japan</td></tr>
<tr><td>10:10-10:30</td><td>Research on the Eco-Environmental Risks in China-Mongolia-Russia Economic Corridor and Green International Cooperative Mode
Prof. Dong Suocheng
Leading Professor, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences; Director, Center for Sustainable Development of North Asia; Center for Regional Ecological and Planning, China</td></tr>
<tr><td>10:30-10:50</td><td>Coffee break</td></tr>
<tr><td>10:50-11:10</td><td>Disruptive Technology Applications in the Water Sector
Dr. Mahesh Patanker
Technical Expert, 2030 Water Resources Group, World Bank, India</td></tr>
<tr><td>11:10-11:30</td><td>UN SDGs and Global Development Cooperation in Mongolia
Dr. Sung Gyu Kim
Senior Research Fellow, Seoul National University Asia Centre; Chair of General Affairs, Korea Association of International Development and Cooperation, South Korea</td></tr>
</table>

11:30-12:10	**Panel Discussion** **Moderator:** Dr. Battogtokh, D., Director, Institute of Geography and Geoecology, Mongolian Academy of Sciences, Mongolia **Panelists:** Prof. Wang Tao, Prof. Tsunekawa Atsushi, Prof. Dong Suocheng, Dr. Mahesh Patanker, Dr. Sung Gyu Kim
12:10-12:20	**Group Photo**
12:20-13:30	**Lunch**

DAY-1 (13 JUNE 2019)

SESSION 1: ENVIRONMENTAL RESEARCH TREND AND CHALLENGES	
Room: Main Hall	
Sub-section: Natural Resources and Utilization	
Chair: ▪ Academician, **Amarsaikhan Damdinsuren**, Leading Researcher, Head, Division of Remote Sensing and Spatial Modelling, Institute of Geography, Geoecology, Mongolian Academy of Sciences, Mongolia ▪ Dr. **Pintaeva Evgeniya**, Scientific Secretary, Baikal Institute of Nature Management SB, Russian Academy of Sciences, Russia	
13:30-13:45	**Water Policy in Mongolia** Mr. Myagmar Shar Director, Department of Land Management and Integrated Water Policy Coordination, Ministry of Environment and Tourism, Mongolia
13:45-14:00	**Integrate Combating Desertification and Poverty Relief to Prompt Sustainable Development in Dry Lands** Prof. Xueyong Zhao Executive Director, Northwest Institute of Eco-environment and Resources, Chinese Academy of Sciences, China
14:00-14:15	**Impacts of Land Use/Cover Changes on Pasture Carrying Capacity and its Vulnerability in Mongolia** Prof. Qinxue Wang Principal Researcher, National Institute for Environmental Studies, Japan
14:15-14:30	**Dot-Grid Assessment for Saxaul Forest Area Estimates** Dr. Khongor Tsogt Researcher, Institute of General and Experimental Biology, Mongolian Academy of Sciences; Wildlife Traffic & Law Enforcement Expert, WWF-Mongolia, Mongolia
14:30-15:00	**China-Mongolia-Russia Forest Resources Cooperation Under the Belt and Road Initiative** Associate Prof. Yulong Yao Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, China
15:00-15:15	**The Assessment of Soil Loss and Gully Erosion Using Remote Sensing, GIS in the Kuitunka River Basin (Western Transbaikalia Russia)** Dr. Yurij Ryzhov Head of Laboratory, Institute of the Earth's Crust of the Siberian Branch, Russian Academy of Sciences, Russia
15:15-16:00	**Coffee Break**
15:15-16:00	**POSTER SESSION**

<table>
<tr><th colspan="2">Sub-session: Climate Change and Environmental Impact</th></tr>
<tr><td colspan="2">Chair:
▪ Prof. Shuwen Zhang, Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, China
▪ Dr. Dashtseren Avirmed, Head, Division of Permafrost Study, Institute of Geography and Geoecology, Mongolian Academy of Sciences, Mongolia</td></tr>
<tr><td>16:00-16:15</td><td>Humic Preparations to Counteracting Desertification
Sc.D. Sergey Zherebtsov
Head of the Laboratory Chemistry of Lignites, Federal Research Center of Coal and Coal Chemistry, Kemerovo, Russia</td></tr>
<tr><td>16:15-16:30</td><td>Integrated Assessment of Climate Change Vulnerability and Risk in Mongolia
Dr. Gomboluudev Purevjav
Head, Climate Change and Resources Research Division, Information and Research Institute Meteorology, Hydrology and Environment, Mongolia</td></tr>
<tr><td>16:30-16:45</td><td>Contrasting Changes in Vegetation Growth Due to Different Climate Forcings over the Last Three Decades in the Selenga-Baikal Basin
Associate Prof. Ping Wang
Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, China</td></tr>
<tr><td>16:45-17:00</td><td>Modeling Soil Hydro-Thermal Coupled Response To Warming and Degradation in the Permafrost Region of the Qinghai-Tibet Plateau
Prof. Xian Xue
Northwest Institute of Eco-environment and Resources, Chinese Academy of Sciences, China</td></tr>
<tr><td>18:30-22:00</td><td>Welcome Reception</td></tr>
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<tr><th colspan="2">SESSION 2: ENVIRONMENTAL MANAGEMENT AND REGIONAL DEVELOPMENT</th></tr>
<tr><td colspan="2">Room: Conference room 2</td></tr>
<tr><th colspan="2">Sub-session: Environmental Policy and Sustainability</th></tr>
<tr><td colspan="2">Chair:
▪ Prof. Chuluun Togtokh, Director, Sustainable Development Institute, National University of Mongolia, Mongolia
▪ Prof. Dong Suocheng, Leading Professor, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences; Director, Center for Sustainable Development of North Asia; Center for Regional Ecological and Planning, China</td></tr>
<tr><td>13:30-13:45</td><td>Legal Status of Natural Resources Management and It’s Implementation of Mongolia
Dr. Tsogtsaikhan Purev
Director General of Environment and Natural Resources Department, Ministry of Environment and Tourism, Mongolia</td></tr>
<tr><td>13:45-14:00</td><td>Toward Better Water Governance in River Basins of Mongolia
Dr. Saulyegul Avlyush
Mongolia Partnership Coordinator, 2030 Water Resources Group, Mongolia Program</td></tr>
<tr><td>14:00-14:15</td><td>Variations in Ecosystem Services in Response to Wetland Loss in a Cold Region
Dr. Fengqin Yan
Postdoctor, Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, China</td></tr>
</table>

14:15-14:30	**Forest Management Development of Special Protected Area in Mongolia** Dr. Battulga Purevragchaa Division of Forest Resources and Forest Protection, Institute of Geography and Geoecology, Mongolian Academy of Sciences, Mongolia
14:30-15:00	**Policy Comparison on Environmental Management between Central Asia and China Arid Region** Associate Prof. Xueqin Zhang Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, China
15:00-15:15	**Negative Consequences of Flooding in the Selenga River Basin** Dr. Borisova Tatyana Anatolyevna Senior Research Scientist, Baikal Institute of Nature Management of the Siberian Branch, Russian Academy of Sciences, Russia
15:15-16:00	**Coffee Break**
15:15-16:00	**POSTER SESSION**
Sub-session: Economic Corridor and Integration	
Chair: ▪ Mr. **Gunbold Baatar**, Director of Department of Urban Development and Land Affairs, Ministry of Construction and Urban Development, Mongolia ▪ Dr. **Li Shengyu**, Director, Desert Environment Research Laboratory, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, China	
16:00-16:15	**An Evaluation of the Economic, Social, and Ecological Risks of China-Mongolia-Russia High-Speed Railway Construction and Policy Suggestions** Prof. Dong Suocheng Leading Professor, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences; Director, Center for Sustainable Development of North Asia; Center for Regional Ecological and Planning, China
16:15-16:30	**The Determining Cities and Soums with Development Potential along the Economic Central Corridor** Dr. Altanbagana Myagmarsuren Head, Division of Social Economic Geography, Institute of Geography and Geoecology, Mongolian Academy of Sciences, Mongolia
16:30-16:45	**An Approach to Economic Growth and Environment Effects in Northeast Asia and China-Mongolia Economic Corridor** Visiting Prof. Fei Li Researcher, China-ASEAN Collaborative Innovation Center for Regional Development; Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences; Hebrew University, China
16:45-17:00	**Human Settlement Plan of Mongolia Based on Migration Factors and Sustainable Land Use** Dr. Davaanyam Surenjav Head, Department of Human Settlement and Regional Study, Construction Development Center, Ministry of Construction and Urban Development, Mongolia
18:30-22:00	**Welcome Reception**
SESSION 3: ENVIRONMENTAL INNOVATION AND TECHNOLOGY	
Room: Conference room # 3	
Sub-session: Remediation and Control Technologies	

Chair: ▪ Dr. **Batkhishig Ochirbat**, Head, Division of Soil Science, Institute of Geography and Geoecology, Mongolian Academy of Sciences, Mongolia ▪ Ms. **Jennifer Adams**, Country Director, MERIT Project	
13:30-13:45	**Desertification Mitigation by Transgenic Plants with Drought Resistance Genes From Endocarpon Pusillum** Dr. Qian Xu State Key Laboratory of Mycology, Institute of Microbiology, Chinese Academy of Sciences, China
13:45-14:00	**Adaptation and Mitigation Technology to Climate Change: Infrastructure in Permafrost Region, Mongolia** Dr. Jambaljav Yamkhin Senior Researcher, Division of Permafrost Study, Institute of Geography and Geoecology, Mongolian Academy of Sciences, Mongolia
14:00-14:15	**Key Techniques of Fast Artificial Restoration of Biocrusts and Its Application in the Field** Dr. Chongfeng Bu Institute of Soil and Water Conservation Northwest A & F University / Chinese Academy Sciences; Ministry of Water Resources, China
14:15-14:30	**Features of Spatial and Temporal Dynamics of Lake Baikal Basin Vegetation Cover** Mr. Tsydypov Z.Bair Researcher, Baikal Institute of Nature Management of Siberian Branch of the Russian Academy of Science, Russia
14:30-15:00	**Ecological Restoration in Degraded Land Restoration—Using Microbial Organic Compound** Associate Prof. Shaokun Wang Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, China
15:00-15:15	**Highway Sand Control Technology in Strong Wind and High Salt Area – Taking the Dry Lake Basin of Taitema Lake as an Example** Prof. Li Shengyu, and Dr. Liu Guojun Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, China
15:15-16:00	**Coffee Break**
15:15-16:00	**POSTER SESSION**
Sub-session: Water Technology and Waste Water Management	
Chair: ▪ Dr. **Chinzorig Sukhbaatar,** Head, Division of Water Resources and Water Utilization, Institute of Geography, Geoecology, Mongolian Academy of Sciences, Mongolia ▪ Dr. **Mahesh Patanker**, Technical Expert, 2030 Water Resources Group, World Bank	
16:00-16:15	**“Waste Management and Water Technology” ADB project: The Determination of Bacterial Soil Pollution Near The Latrines of Some Ger Area, Bayanzurkh District, Ulaanbaatar** Dr. Amgalanbaatar Avarzed Lecturer and Researcher, Urban Development & Innovation Institute NGO; Department of Microbiology, School of Bio-Medicine, Mongolian National University of Medical Sciences

16:15-16:30	**Air Pollution in Ulaanbaatar, Mongolia and Resulting Implications for Public Health: a Review** Prof. Daniel Karthe Engineering Faculty, German-Mongolian Institute for Resources and Technology, Mongolia
16:30-16:45	**Egiin Gol Hydropower Plant: Prospect of Development and Future Challenges** Ms. Tumurchudur Sodnom EIA specialist, "Eg-HPP" Government Owned Company Under of the Ministry of Energy, Mongolia
16:45-17:00	**Development of Immersed Boundary Lattice Boltzmann Method for Open Channel Seepage Flows** Dr. Ayurzana Badarch Lecturer, Mongolian University of Science and Technology, Mongolia
18:30-22:00	**Welcome Reception**

DAY-2 (14 JUNE 2019)

SESSION 1: ENVIRONMENTAL RESEARCH TREND AND CHALLENGES	
Room: Main Hall	
Sub-session: Environmental Process and Modelling	
Chair: ▪ Dr. **Khaulenbek Ahmadi**, Scientific Secretary, Institute of Geography and Geoecology, Mongolian Academy of Sciences, Mongolia ▪ Prof. **Wang Tao**, President, Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, China	
09:00-09:15	**Environmental Studies of Mongolia Using Advanced Spatial Technologies** Academician, Amarsaikhan Damdinsuren Leading Researcher, Head, Division of Remote Sensing and Spatial Modelling, Institute of Geography and Geoecology, Mongolian Academy of Sciences, Mongolia
09:15-09:30	**Monitoring Marsh Changes in the Sanjiang Plain Since the 1950s Based on Multi-Source Data** Prof. Shuwen Zhang Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, China
09:30-09:45	**Plant Biomass Dynamics in a Desert Ecosystem, NW China: Present Condition and Climate Change Scenarios** Prof. Xinping Wang Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, China
09:45-10:00	**Global NDVI Patterns in Response to Atmospheric Water Vapor Anomalies Over the Indo-Pacific Warm Pool during Apr-May-June** Dr. Zhaosheng Wang Assistant Researcher, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, China
10:00-10:15	**Coffee break**

10:15-10:30	**Review of Possibilities of World Park Special Status on Some Representative Protected Areas of Mongolia** Sc.D Oyungerel Baast Head, Division of Physical Geography, Institute of Geography and Geoecology, Mongolian Academy of Sciences, Mongolia
10:30-10:45	**Grassland Ecosystem Productivity Dynamics and State Transitions Across a Regional Precipitation Gradient** Prof. Shenggong Li Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, China
10:45-11:00	**Comparative Analysis of Driving Forces of Land Use/Cover Change in the Upper, Middle and Lower Reaches of the Selenga River Basin** Associate Prof. Zehong Li Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, China
Sub-session: Ecology and Environmental Research Approach	
Chair: ▪ Prof. **Daniel Karthe**, Engineering Faculty, German-Mongolian Institute for Resources and Technology, Mongolia ▪ Dr. **Urtnasan Mandakh**, Division of Geographical Information System and Cartography, Institute of Geography, Geoecology, Mongolian Academy of Sciences, Mongolia	
11:00-11:15	**Possibilities of the GC-MS Method in Studying the Bottom Sediments of Gusinoe Lake** Dr. Pintaeva Evgeniya Scientific Secretary, Baikal institute of Nature Management SB, Russian Academy of Sciences
11:15-11:30	**Soil Erosion Study Using Fallout Radionuclide Techniques in Southern Mongolia, Orog Lake Area** Dr. Batkhishig Ochirbat Head, Division of Soil Science, Institute of Geography and Geoecology, Mongolian Academy of Sciences, Mongolia
11:30-11:45	**Crisis of Tiger Population in the World** Assistant Prof. Bhanwar Vishvendra Raj Singh Department of Geography, Faculty of Earth Sciences, Mohanlal Sukhadia University, Udaipur, India
11:45-12:00	**Using Biodiversity for Degraded Rangeland Restoration in China** Associate Prof. Keyu Bai Institute of Agricultural Resources and Regional Planning, Chinese Academy of Agricultural Sciences, China
12:00-12:10	**Best Paper and Persantation Awards for Young Researchers**
12:10-12:30	**Concluding remarks and recommendation**
12:30-13:30	**Lunch**
14:00-17:30	**City tour (Ulaanbaatar)**
SESSION 2: ENVIRONMENTAL MANAGEMENT AND REGIONAL DEVELOPMENT	
Room: Conference room # 2	
Sub-session: Transdisciplinary and Interdisciplinary Research Cooperation	

Chair: ▪ Dr. **Navchtsetseg Nergui**, Director of International Relation and Cooperation Division, Mongolian Academy of Sciences, Mongolia ▪ Prof. **Tsunekawa Atsushi**, Arid Land Research Center, Tottori University, Japan	
09:00-09:15	**Transformative Adaptation of Nomad's Land Systems in Different Ecological Zones of Mongolia** Prof. Chuluun Togtokh Director, Sustainable Development Institute, National University of Mongolia, Mongolia
09:15-09:30	**The Background, Conditions and General Situation of the Establishment of the Joint Research Center on Grassland Ecological Civilization** Prof. Liang Jin School of Resources and Environmental and Economics, Inner Mongolia University of Finance and Economics, China
09:30-09:45	**Permafrost Study in Relation to Spatial Development Planning of Mongolia** Dr. Dashtseren Avirmed Head, Division of Permafrost Study, Institute of Geography, Geoecology, Mongolian Academy of Sciences, Mongolia
09:45-10:00	**Economic Effects of the USA-China Trade War: CGE Analysis with the GTAP 9.0a Data Base** Dr. Enkhbayar Shagdar Senior Research Fellow, Economic Research Institute for Northeast Asia (ERINA), Japan
10:00-10:15	**Coffee break**
10:15-10:30	**A Circular Economy System for Breaking the Development Dilemma of Ecological Fragility-Economic Poverty Vicious Circle: A CEEPS-SD Analysis** Associate Prof. Fujia Li Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, China
10:30-10:45	**Evaluation of the Contribution of the Tourism Industry to the Economy of the Regions of the Great Tea Road (on the Example of the Border Territories of Asian Russia)** Dr. Sanzheev Erdeni Senior Researcher, Baikal Institute of Nature Management of Siberian Branch of the Russian Academy of Sciences, Russia
10:45-11:00	**Relationship between Resource Consumption and Urbanization in a Coal-based Region-Case of Shanxi, China** Dr. Xiaojia Guo Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, China
Sub-session: The Efficient State, Science and Business Collaboration and Cluster Development Concept	
Chair: ▪ Prof. **Battsengel Vandansambuu**, Head of Geography Department, National University of Mongolia, Mongolia ▪ Dr. **Odgerel Dorjgochoo,** Head of the Innovation Department, Ministry of Education, Culture, Science and Sports, Mongolia	

11:00-11:15	**The Public-Private Partnership Policy Issues for Sustainable Development** Dr. Munkhbold Adiya Director, Department of Research and Analysis, National Development Agency, Mongolia
11:15-11:30	**Comparative Analysis of the Land Fund Structure of the Border Areas of Russia and Mongolia: Risks of Desertification Development** Dr. Sanzheev Erdeni, Dr. Batomunkuev Valentin, Dr. Zhamyanov Daba Senior Researcher, Baikal Institute of Nature Management of Siberian Branch of the Russian Academy of Science, Russia
11:30-11:45	**Mongolian Business in Adjacent Regions of Russia** Dr. Sysoeva Natalia Mikhajlovna Head of Department, Irkutsk Scientific Center, the Sochava Institute of Geography, Siberian Branch of Russian Academy of Sciences, Irkutsk, Russia
11:45-12:00	**The Assessment and Optimization for Regional Sustainable Development Based on the Human-Land System** Assistant Prof. Hao Cheng Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, China
12:00-12:10	**Best Paper and Persantation Awards for Young Researchers**
12:10-12:30	**Concluding remarks and recommendation**
12:30-13:30	**Lunch**
14:00-17:30	**City tour (Ulaanbaatar)**

SESSION 3: ENVIRONMENTAL INNOVATION AND TECHNOLOGY

Room: Conference room # 3

Sub-session: Ecological Stability and Low Zero Carbon Technologies

Chair:

- Sc.D. **Sergey Zherebtsov**, Head of the Laboratory Chemistry of Lignites, Federal Research Center of Coal and Coal Chemistry, Kemerovo, Russia
- Dr. **Qinxue Wang**, Principal Researcher, National Institute for Environmental Studies, Japan

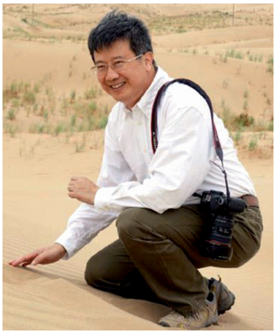
09:00-09:15	**GOSAT CO2 and CH4 Emissions from Thawing Permafrost Regions in Central Asia** Dr. Saruulzaya Adiya Senior Researcher, Division of Permafrost Study, Institute of Geography and Geoecology, Mongolian Academy of Sciences, Mongolia
09:15-09:30	**Temporal Variations of Traffic CO2 Emissions and its Relationship with CO2 Fluxes in Beijing, China** Associate Prof. Yu Li and Ji Zheng Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, China
09:30-09:45	**Exploring the Application of Lichen Resource in Arid and Semi-Arid Deserts of China** Prof. Xinli Wei State Key Laboratory of Mycology, Institute of Microbiology, Chinese Academy of Sciences, China

09:45-10:00	**Strategies for Soil Phytoremediation: Lessons from Metal Hyperaccumulation** Dr. Munkhtsetseg Tsednee Senior Specialist, International Cooperation Department, Mongolian Academy of Sciences, Mongolia
10:00-10:15	**Coffee Break**
10:15-10:30	**Hydropeaking Structural Mitigation Measure: a Case Study of the Eg Hydropower Plant, Mongolia** Dr. Sukhbaatar Chinzorig Head, Division of Water Resource and Water Utilization, Institute of Geography and Geoecology, Mongolian Academy of Sciences, Mongolia
10:30-10:45	**Successful Results of the Korea-Mongolia Green Belt Project and Afforestation Expansion Methods in Mongolia** Dr. Seong Inkyeong Director, Korea-Mongolia GreenBelt Project, Korea Forest Service
10:45-11:00	**Aeolian Desertification and Its Driving Mechanism of the Middle of Inner Mongolia, Northern China** Prof. Liu Shulin Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, China
Sub-session: Environmental Education	
Chair: ▪ Dr. **Sung Gyu Kim**, Senior Research Fellow, Seoul National University Asia Centre; Chair of General Affairs, Korea Association of International Development and Cooperation, South Korea ▪ Dr. **Sonomdagva Chonokhuu**, Head of the Department of Environment and Forest Engineering, National University of Mongolia	
11:00-11:15	**Environmental Education Practice in Mongolia: Mongolia Between Tradition and Civilization** Dr. Sunjidmaa Renchin Environmental Education Center, National University of Mongolia, Mongolia
11:15-11:30	**The Role of Academic Institute in Ecological Education (the Case of BINM SB RAS)** Dr. Pintaeva Evgeniya Scientific Secretary, Baikal Institute of Nature management SB, Russian Academy of Sciences, Russia
11:30-11:45	**How Are Gender and Environment Connected** Ms. Misha Goforth Gender Advisor, MERIT Project, Canada
11:45-12:00	**Impact of Pastoral Ecology Vulnerability on Grazing Livestock: Case of Govi-Altai Aimag** Mr. Kherelenbayar Bolor Institute of Geographic and Geoecology, Mongolian Academy of Sciences, Mongolia
12:00-12:10	**Best Paper and Persantation Awards for Young Researchers**
12:10-12:30	**Concluding remarks and recommendation**
12:30-13:30	**Lunch**
14:00-17:30	**City tour (Ulaanbaatar)**

EST 2019

KEYNOTE PRESENTATIONS

THEORY AND KEY TECHNOLOGY APPLICATION OF WIND-SAND DISASTER PREVENTING AND CONTROL



Prof. WANG Tao
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Abstract: Around wind-sand disaster prevention and control research in China, research group established the theory of sand control and restoration ecology, developed the Chinese Wind-Sand Prevention and Control Engineering, and developed a series key technology to prevent and control wind-sand disaster. These key technologies include: a rapid and stable recovery technology system for exposed surfaces in semi-arid sandy areas, the technique and model of shifting dune fixation for stable vegetation establishment in arid sand area, a wind-sand disaster prevention and control technology system for world-class cultural heritage (DunHuang) in extreme arid region, the technical system for prevention and control of sand disasters in the World Geopark of Extremely Arid Regions, the Prevention and Control Key Technologies for Wind-sand Disaster along Railway in High-altitude Cold regions, a key technical system for prevention and control of wind and sand in the Gobi windy area, industrialization technology system and paradigm for Wind-sand Disaster Prevention and Control (KuBuQi model). The successfully application of these technologies solved the of wind-sand disaster prevention and control problems in special sandy environment in the north of China. The result has been applied to more than one million hectares, with direct economic benefits of more than 30 billion Yuan.

SUSTAINABLE GRASSLAND MANAGMENT AND ITS CHALLENGES

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Abstract: Sustainable Grassland Management (SGM) plays an essential role in achieving a land degradation-neutral world through preventing grassland degradation and restoring degraded grasslands. SGM can be defined as a knowledge-based combination of technologies, policies and practices that integrate land, water, biodiversity, and environmental concerns to meet rising food and fiber demands while sustaining ecosystem services and livelihoods of grasslands. Grassland can provide various ecosystem services including supporting services such as soil development, nutrient cycling and primary production; regulating services such as water regulation and climatic regulation; provisioning services such as provisions derived from biological production and freshwater provision; cultural services such as recreation and tourism. We need to seek synergies and avoid trade-offs between those ecosystem services. The most serious trade-offs may be conflict between nature (ecology) and society (socioeconomics). It is necessary to try to avoid both red trap (degradation of ecosystems due to overuse of grassland to sustain increased population and human demand) and green trap (ecologically sound, but unstable society due to reduced production to conserve nature). Grassland management practices may enhance the trade-offs and synergies. For long periods of time, herders have been keeping grasslands sustainably by balancing its use and conservation through indigenous knowledge such as nomadism. However, the situation is rapidly changing. According to the progress of world economy and globalization, the life standard required by villagers have been increased and rural society is getting unstable. The environment is also changing due to climatic change and land degradation. Thus, we have to find appropriate SGM practices which meet increasing demand of people under changing environment.

RESSEARCH ON THE ECO-ENVIROMENTAL RISKS IN CHINA-MONGOLIA-RUSSIA ECONOMIC CORRIDOR AND GREEN INTERNATIONAL COOPERATIVE MODE

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Co-author: Li Yu, Li Zehong, Li Fujia, Cheng Hao, Yang Yang, Bilgaev Alexey, Boldanov Tamir, Zheng Ji, Bazarzhapov Tcogto

Abstract: Towards a sustainable ecological-socio-economic development of the China-Mongolia-Russia Economic Corridor, this research investigated the temporal and spatial pattern of the ecological, environmental, and socio-economic factors of China-Mongolia-Russia Economic Corridor. To implement the United Nation's Sustainable Development Goals along the China-Mongolia-Russia Economic Corridor, the green international cooperative mode is proposed. The green international cooperative mode includes ecological civilization mode, four-hierarchy circular economy mode, green and low-carbon eco-tourism mode, ecological city mode. In addition, the four-hierarchy circular economy mode has been implemented in Dingxi City and Kongtong District, Pingliang City, Gansu Province, China, and achieved economic, social and environmental benefits.

Keywords: China-Mongolia-Russia Economic Corridor; green international cooperative mode; eco-environmental risk

DISRUPTIVE TECHNOLOGY APPLICATIONS IN THE WATER SECTOR

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Abstract: Need for water conservation in the municipal, industrial, commercial and the agriculture sector is a global priority. In order to provide reliable, affordable, clean and equitable water to multiple sectors, it is important to use advanced treatment, monitoring and evaluation techniques. Disruptive technologies water treatment, recycle and reuse sector involve a combination of natural and contemporary techniques that result in reduced organic, bacteriological and heavy metal discharges. In the recent past, a host of digital technologies have merged that include advanced smart metering, Internet of Things, cloud computing, machine learning for fault detection and predictive analyses with artificial intelligence algorithms. In more recent times, blockchain techniques involving distributed ledger that are tamper-proof. This presentation summarizes disruptive technologies in the treatment and digital space, their costs, technical merits and demerits, and socio-economic benefits leading to equitable service leading to social welfare.

Dr. Sung Gyu Kim
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Abstract: The 17 Sustainable Development Goals adopted by all United Nations in 2015 provides a shared blueprint for peace and prosperity for people and our planet and into the future. In detail SDGs specially address the global challenges we face, including those related to poverty, inequality, environmental degradation and climate change, which is a particularly important theme for Mongolia and the Korean peninsula. The Goals are interconnected with our past, present and future. It also address an important challenge, developed and developing countries are not isolated from each other, but how they must form a global partnership for our better future.

In order to implement SDG, we need to consider some important key words. First issue is inclusiveness. In other words, it is necessary to consider various interests in society and in particular the interests of the poor and the vulnerable. The second issue is solidarity, which is related to the formation of partnerships to increase social and economic sustainability. Finally, accountability of each government should be emphasized. Through this, the social value pursued by SDGs, such as peace, equality, and justice, can be more meaningful.

The most important and frequently mentioned issues in terms of sustainable development in East Asia are environmental problems including air pollution, water, immigrant workers, job opportunity, and sustainable Community Development etc. This is not only social and economic issues for South Korea and Mongolia, but also for the whole of East Asia and the future earth. In order to share and resolve these themes, now we have to start to seriously discussion about SDG's philosophy: inclusiveness, solidarity, and accountability.

EST 2019

SESSION 1:

ENVIRONMENTAL RESEARCH TREND AND CHALLENGES

Session Description

Generally, the quality of human life and health directly relates with current natural environmental conditions. Our planet is witnessing the global environmental changes caused by natural influences and human activities. Increased level of greenhouse gases is warming the planet, main renewable resources such as forest and water are being degraded, animals are changing migration patterns and plants are changing the dates of activity. Extensive mining and exploration of natural resources are having widespread negative impacts on fragile natural systems. In order to keep the planet for our next generations, we should clearly understand these impacts to understand and solve environmental constraints caused by natural influences and human activities. Considering the above issues, we will discuss the current issues of the natural resources, its utilization and the latest findings and facing challenges of climate and environmental changes in the session.

Understanding the environmental processes is critical to the successful and sustainable management of the natural resources. Managing the natural resource today inevitably involve impact prediction, which increasingly involves modelling. Therefore, the latest findings of environmental process, modelling, ecological and environmental research approach are also addressed in this session. Finally, the session hopefully to encourage research, disseminate information, and support the development of policies to understand and solve environmental problems and sustainable management of the natural resources.

EST 2019

Sub-Session:

Natural Resources and Utilization

IMPACTS OF LAND USE/COVER CHANGES ON PASTURE CARRYING CAPACITY AND ITS VULNERABILITY IN MONGOLIA

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Abstract: Pasture carrying capacity and its vulnerability can be recognized as the integrated indicators for SDGs in Mongolia. Our pervious study revealed that climate change in past few decades in Mongolia caused the degradation of permafrost, water deficit of land surface and decrease of grassland productivities. Beside climate change, land use/cover changes caused by human activities such as urbanization, cultivation and mining industry may also have a large influence on pasture carrying capacity and its vulnerability. In this study, we have developed an integrated model to evaluate the pasture Carrying Capacity (CC), Grazing Pressure (GP) and Vulnerability Index (VI) under the influences of both climate change and land use/cover changes, such as urbanization, cultivation and mining & so on. To evaluate the impact of land use/cover changes, we applied the model to four target areas: urban area (Ulaanbaatar City) and steppe area (Altanbulag Soum) in semi-arid regions of northern Mongolia and mining area (Khanbogd Soum) and desert (Manlai Soum) in arid regions of southern Mongolia, and the results show:

(a) Carrying Capacity (CC): steppe area > urban area > desert area > mining area

(b) Grazing Pressure (GP): urban area > steppe area > mining area > desert area

(c) Vulnerability Index (VI): urban area > mining area > desert area > steppe area

We also applied the model to whole Soums in the country and found that the areas with high vulnerability expanded rapidly in last decades in Mongolia. Finally, based on the sensitivity analysis to parameters, such as ground water use, hey harvest and so on, we proposed several adaptation strategies and technologies, such as: (a) to develop an Early Warning System (EWS) to provide timely information about climatic hazards and effects on livestock and pastures; (b) to train herders to keep suitable livestock number based on precision evaluation of pasture carrying capacity; (c) to improve livestock water supply systems and water points or wells in the most vulnerable areas; (d) to support fodder production and haymaking in rain fed areas through seed production, storage systems, market promotion, irrigation improvement, etc.

This study was supported by the project: “Evaluation of Pasture Carrying Capacity and its Vulnerability based on Water Resources in Arid and Semi-arid Regions”, funded by NIES, Japan.

DOT-GRID ASSESSMENT FOR SAXAUL FOREST AREA ESTIMATES

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Abstract: The study presents an area estimates of a measurable Saxaul forests using open-source high resolution satellite imagery applying dot-grid method. The result shows that the Southern Saxaul and shrubland area estimated at 2,645,780 ± 26,458 hectare for crown cover more than and equal to 4%.

Keywords: crown cover; high resolution satellite imagery

Introduction

Mongolian forests categorized into two broad zones: Northern boreal forests and Southern saxaul (Haloxylon ammondendron) forests. The saxaul species distributed in semi-arid desert land (Figure 1). Saxaul distribution area identified as forest according to the Mongolian Forest Law (2012) and the country reports the forest resources for both forest zones.

Forest area estimates, or the forest inventory maps contain unknown uncertainties due to administrative unit based rotational forest inventory frequency and conventional forest inventory methodology.

Saxaul forest mapping is impossible with moderate resolution satellite imagery unlike forest masks of boreal forests which contains much higher biomass than the saxaul forests. The OpenForis: Collect Earth tool developed by FAO has been used to estimate forest land use, land use change of Mongolia (CCPIU, 2018). Approximately 123 thousand systematically distributed sample points covering the entire country assessed for the purpose and two strata were developed for forest (boreal) and non-forest (including saxaul) distribution areas. Boreal forest distribution grids were denser 2.25 km x 2.25 km in the northern part of country and non-forest distribution grids were 9 km x 9 km in the southern half of country covers the most grassland types. The assessment was to determine the historical changes in forest and land use from 1990-2016.

According to the Forest Reference Level (FRL) 2018 study, the saxaul forest area estimated as 2.04 million hectares. (See Table 1)

Objective

Because of the saxaul forest area estimates are differs in the reports of Mongolia's Forest Reference Level (Government of Mongolia, 2018) and the Mongolia's Forest Resources - 2016 (FRDC, 2017), we need to re-estimate the saxaul forest areas to better determine with denser dot-grid method.

Materials & Methods

Reference area

549 plots among 123 thousand recorded saxaul tree elements in the dot-grid assessment database in the Forest land use, land use change study (2018) thus we further used these plots to identify potential saxaul distribution area correlating their existence with precipitation, temperature and elevation ranges.

To determine meteorological factors, we used

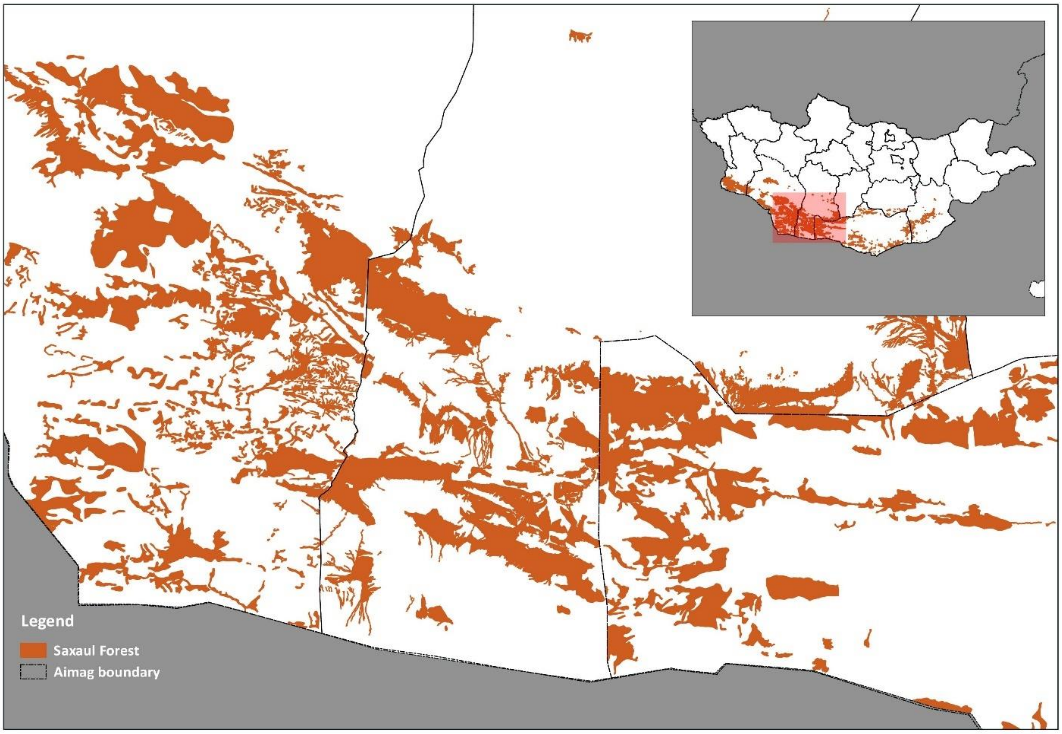


Figure 2. Saxaul Forest Distribution Map (FRDC 2016)

recorded weather data to construct mean annual precipitation map and average temperature map with the spatial accuracy of 1km in ANUSPLIN software at Research Division of Climate Change and Resources, Information and Research Institute of Meteorology, Hydrology and Environment. The meteorological data ranges between year 1950 to 2012, recorded in 72 weather station and 3 glacier automatic station (See Figure 2).

Table 1. Forest Land use subdivision (Government of Mongolia, 2018)

Forest land	Total area (ha)
Boreal	13,411,592
Saxaul	2,048,003
Shrub	766,740
Total forest	16,226,335

The descriptive statistics of precipitation of saxaul forests area shown in Table 2 and we used minimum, 24.8 mm and maximum, 145.3 mm precipitation range to avoid excluding potential saxaul distribution area. We used minimum, 0.015 ^{0}C and maximum, 7.64 ^{0}C temperature for the temperature range (Table 3).

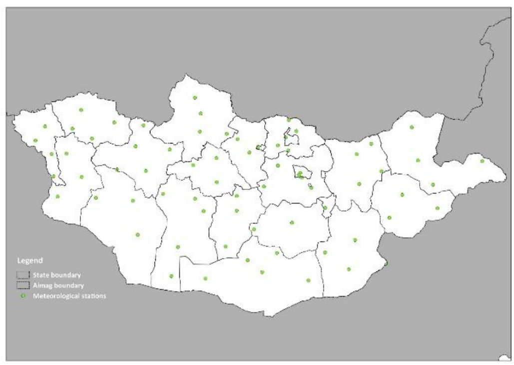


Figure 2. Weather stations location

Table 2. Descriptive statistics of annual precipitation within saxaul distribution area

Mean	72.34
Standard Error	0.97
Median	69.73
Standard Deviation	22.70
Sample Variance	515.24

Kurtosis	-0.55
Skewness	0.30
Range	120.53
Minimum	24.84
Maximum	145.38
Count	549.00
Confidence Level (95.0%)	1.90

Table 3. Descriptive statistics of annual temperature within saxaul distribution area

Mean	4.084
Standard Error	0.073
Median	4.205
Standard Deviation	1.700
Sample Variance	2.889
Kurtosis	-0.830
Skewness	-0.071
Range	7.632
Minimum	0.015
Maximum	7.647
Sum	2229.716
Count	546.000
Confidence Level (95.0%)	0.143

Sample number

It's essential to correctly define required number of samples for further analysis. For that reason, we made following estimation based on Normal distribution. Within confidence level 99% and margin error 1% we required in total 16,581 samples in 41,866,073 hectare area.

In terms of the above-mentioned numbers, the sample size *n* and margin error E area given by following equation.

$$x = Z\left(\frac{c}{100}\right)^2 r(100 - r) \quad (1)$$

$$n = \frac{Nx}{(N-1)E^2 + x} \quad (2)$$

$$E = \sqrt{\frac{(N-n)x}{n(N-1)}} \quad (3)$$

where: N is population size, *r* is the fraction of responses and Z*(c/100)* is the critical value for the confidence level *c.* Setting the response distribution to 50% is the suitable to determine forest or non-forest land in our case.

Since sampling clusters must be allocated systematically at grid, it is required to determine spacing between 165,81 sample plots in potential Saxaul growth area. The distances interval calculated by following formula.

$$a = \sqrt{\frac{F}{n}} \quad (4)$$

where:
F = Potential Saxaul growth area
n = number of sampling clusters
a = distance between systematically disturbed samples. (Spacing between grid)

According to the reference area, it is required to allocate 16,581 sample plots systematically in the interest area and the distance between samples are 5,025 meters.

$$a = \sqrt{\frac{418660.7km^2}{16581}} = 5.0248\ km \quad (5)$$

The reference area of the Collect earth assessment, one sample plot represents 2,525 hectare area. It is called an expansion factor in another word.

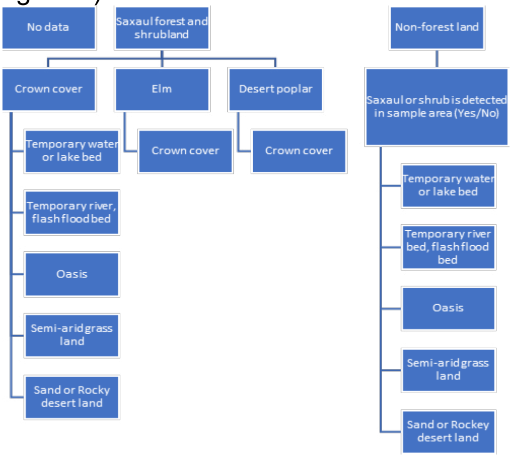
Survey design

The design of classification rule for the saxaul forests are consistent with forest management planning inventory. However, it is technically impossible to define saxaul tree (*Haloxylon ammodendron*) from other type of shrubs in semi-arid desert land. For that reason, our survey design principally covers only “forest” or “non-forest land” (See Graphic 1). Also, the survey aimed to determine other tree species distribution Elm (*Ulmus pumila*) and Desert poplar (*Populus diversifolia*).

The sample plots contain 49 elements which represent samples in sample. Single element quantifies 2% crown cover (Adia et al., 2015).

Results

Based on the climate study, we have created potential saxaul tree (*Haloxylon ammodendron*) distribution map (See figure 3).



Graphic 1. Classification rule

The Figure 3 shows approximately 41.8-million-hectare area is suitable for Saxaul tree distribution in the South of Mongolia where we implemented crown cover assessment using dot-grid method.

The area estimation can be calculated using Table 4 if we multiply expansion factor by the number of samples that contains saxaul tree elements in the sample plots.

Table 4. Saxaul and shrub crown cover counts of the plots

Crown cover percentage	Number of plots
0 < 2%	4960
2%	1247
4% ≤	1052

Saxaul and shrubs distributed in 18,256,385 ± 182,564 hectare area with crown cover of 0 < 2%, 3,136,205 ± 31,362 hectare area have 2 % crown cover and 2,645,780 ± 26,458 hectare area have more than 4 percent crown cover.

Acknowledgments

This work was made possible with technical support of the UN-REDD Mongolia National Program. We thanks to the technical staffs from the Forest Research Development Centre involved to this study to assess the samples plots.

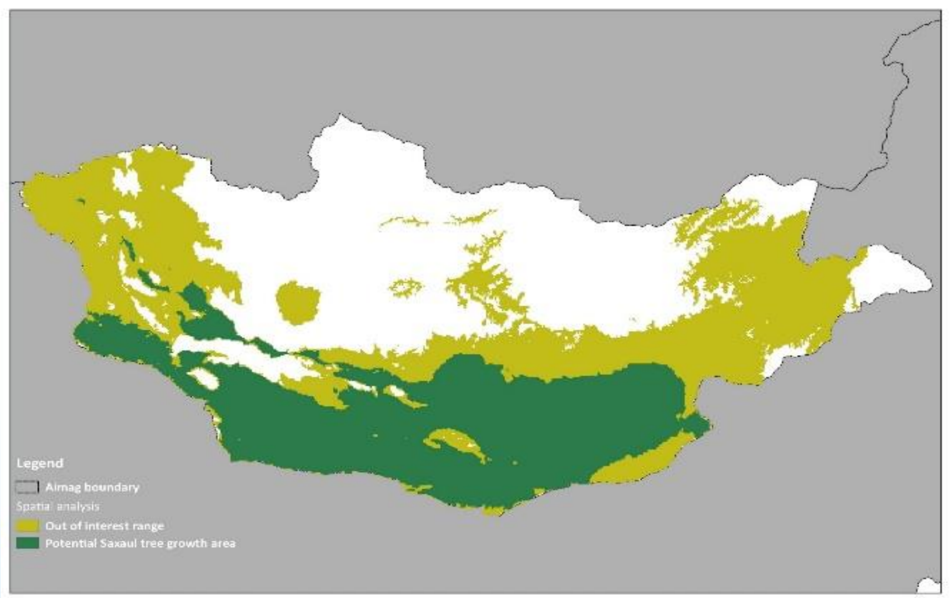


Figure 3. Potential suitable areal of Saxaul tree (*Haloxylon ammodendron*

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THE ASSESSMENT OF SOIL LOSS AND GULLY EROSION USING REMOTE SENSING, GIS IN THE KUITUNKA RIVER BASIN (WESTERN TRANSBAIKALIA, RUSSIA)

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Abstract: Multi-temporal assessment of the potential soil loss from arable land and gully erosion in Kuitunka (catchment area of 1141 km2) river basin (right tributary of the Selenga) performed. In basin widespread aeolian-collluvial loess-like sandy loam, occur actively soil and gully erosion (Reimkhe, 1986; Tarmaev, Korsunov, Kulikov, 2004). Calculations include assessment of potential soil loss, according universal soil erosion equation (USLE), and module of gully sediments in the middle of the last century using our and published data. In current estimation we used field research results, Russian modified USLE (Larionov, 1984), RUSLE (Panagos et al., 2015), remote sensing, GIS. In the middle of the last century soil loss in basin was 293 t km-2 yr-1, module of gully sediment – 190 km-2 yr-1 (Ryzhov, 2015), total potential soil loss from erosion (483 km-2 yr-1) were composed. Current potential soil erosion (117 km-2 yr-1), module of gully sediments (39 km-2 yr-1), total loss (156 km-2 yr-1) were estimated. There was a significant reduction of potential soil loss and gully erosion due to decrease of arable land area, dry conditions during twenty last years, self-development of gullies. A significant part of soil and gully erosion sediments accumulated on slopes, in gully bottoms, on fans. Part of gully sediments was composed 23-39% in total balance. On base of modified USLE and RUSLE equations, remote sensing, GIS technologies we computed soil loss in the Tarbagataika river basin. Reduction of soil and gully erosion contributes to improvement of environmental conditions in the Kuitunka river basin.

Keywords: gully erosion, Kuitunka, soil loss, Transbaikalia, USLE

Introduction

Degradation of agricultural land as a result of sheet and gully erosion is a global problem. It actual in Russia, where snowmelt, rain storm and gully erosion occur on large areas of agricultural land. Soil erosion on crop and fallow land in Russia in 2010 is estimated at 372 million tons yr-1, in the East Siberian economic region (including Krasnoyarsk and Transbaikal territory, the Republic of Tyva, Khakassia, Buryatia, Irkutsk region) 22.7 million t yr-1 (Catchment …, 2017). That corresponds, respectively, 4.1 and 7 t/ha-1 yr-1. There are 122.5 thousand permanent gullies with total length 35 500 km in the Eastern Siberia, (Ryzhov, 2015). Despite a significant decrease in soil flushing values, degradation of agricultural land continues in a number of areas and catchments in Eastern Siberia (Bazhenova et al., 1997; Ryzhov, 2015; Catchment …, 2017).

The main soil and gully erosion factors are precipitation, soil type, topography, land use and land management. To exist >80 water erosion models (Karydas et all., 2014). The most commonly used erosion model is Universal Soil Loss Equation (USLE) (Renard et all., 1997) which estimates long-term average annual soil loss by sheet and rill erosion (Panagos et al., 2015). We used modified for Russia USLE (Larionov, 1984; Catchment, 2017)

Description and study area

The Kuitunka river basin (right tributary of the Selenga) have catchment area of 1140 km2. It length is 65 km, the slope of stream – 1.26°, the depth of the erosion dissection is 110-360 m (Surface, 1976; Reimkhe, 1986). In geological composition of the study area involved Permian-Triassic granites and syenites. They are overlain by Quaternary deposits of different ages. Lower-medium-Quaternary sandy alluvial deposits are composed of 35-40 m river terraces. Upper Quaternary aeolian-colluvial loessal sandy loams and loams sediments lie in the valleys, on slopes and watersheds. The Upper Pleistocene and Holocene deposits include alluvial, alluvial-colluvial, aeolian-colluvial deposits compose slopes, I and II terraces, floodplains.

The relief of the Kuitunka river basin was formed as a result of erosion-denudation activity of permanent and temporary water flows, which contributed to the development of a large number of well-expressed erosion-accumulative forms. The climate is extra continental, the average annual temperature is -(1.1-1.5°C), the annual precipitation are289-308 mm (Climate-data.org). There is significant precipitation difference in the long-term and seasonal regime. Most of them (82-83%) fall from May to September (Climate-data.org). The water module runoff of the Kuitunka river – 1.25 l s^{-1} km^{-2}, the sediment yield - 62 t km^{-2} yr^{-1} (Surface, 1976). Tarbagataika river (left tributary of Kuitunka) have catchment area is 215 km^2 and the length is 22 km. Erosion dissection density is 2.51 km km^{-2}, including gullies and draws (1.32 km

(Wischmeier and Smith, 1978) and its revised version (RUSLE)

km^{-2}), gullies to (1.08 km km^{-2}) (Reimkhe, 1986).

Methods

USLE model was used to estimation the average annual soil loss as a combined function of rainfall-runoff erodibility, soil erodibility, slope length and steepness factor, cover and management, conservation support practice factors in the Tarbagataika river basin (left tributary of Kuitunka river). The equation is expressed as

$$A=RxKxLSxCxP \qquad (1)$$

where, A = predicted average annual soil loss (t $ha^{-1}yr^{-1}$),
R – rainfall-runoff erosivity factor (rain fall and snow melt) in (MJ mm ha^{-1} hr^{-1} yr^{-1}),
K – soil erodibility factor (t $ha^{-1}yr^{-1}$ MJ mm^{-1}),
LS–slope length and steepness factor (dimensionless),
C–cover-management factor (dimensionless),
P–support practice factor (dimensionless).

Russian modified USLE equation (Catchment…, 2017) is expressed as

$$M_w=R_{epp}xK_{se}xL_{sl}xS_{ss}xCxP \qquad (2)$$

where, M_w= predicted average annual soil loss (t $ha^{-1}yr^{-1}$),
R_{epp}–erosion precipitation potential factor (dimensionless),
K_{se}– soil erodibility factor t $ha^{-1}yr^{-1}$ R_{epp}^{-1}
L_{sl}-- slope length factor (dimensionless),
S_{ss}–slope steepness factor (dimensionless),
C–cover-management factor (dimensionless),
P–support practice factor (dimensionless).

USLE model was selected and applied in study area as it required Land Cover map that can be generated by remote sensing images, management practice, soil types and properties (Ganasri, Ramesh, 2016). Parameters of this model can be easily integrated to GIS techniques.

Module of gully sediment calculated by the formula (Geography, 2006):

$$\mu = D x V g x S \qquad (3)$$

where, μ–module of gully sediment (t km^{-2} yr^{-1}),
D–gully density (gullies km^{-2}),
Vg–middle linear rate (gully head retreat (GHR) m yr^{-1}),
S–cross sectional area (m^{2}).

Results

Historical and present dates of soil loss and gully erosion

According to (Litvin, 2002), in 1980 predicted average annual soil loss in Republic Buryatia was 1080 t ha^{-1}. Kuitunka river basin is one of the most developed under arable land in the Selenga Midland. The part of arable land in 1980 was 27% (Tarmaev et al., 2004). Therefore, crop land area composed 309.6 km, potential soil loss calculated as 334 400 t yr^{-1}, or 293 t km^{-2} from river basin. Having accepted volume weight of ploughed soil (1.3 g/cm^{-3}) (Reimkhe, 1986), we obtain that the potential soil loss was 7.3 m^{3} km^{-2} yr^{-1}. An annual decrease of humus horizon in soil thickness was 0.7 mm. During 200 years of active land use was eroded soil layer 14 cm.

Calculated module of gully sediment in 1980 included gully dissection – 0.89 km km^{-2}, the density of gully heads 3.9 units km^{-2} (Reimkhe, 1986), average gully head retreat 1.5 m yr^{-1} and cross-sectional area 18.3 m^{2} (Tarmaev et al., 2004). This value was composed – 107 m^{3}/km^{-2} (190 t km^{-2} yr^{-1}) (Ryzhov, 2015). Total sheet, rill and gully erosion was 483 t km^{-2} yr^{-1}.

At present day part of arable land in the Kuitunka basin has decreased to 17%. Average annual soil loss in Republic Buryatia in 2010 was 700 t ha^{-1} (Catchment, 2017). Potential soil loss (134 000 t yr^{-1}, or 117 t km^{-2} from river basin) is composed. Calculated present module of gully sediment included gully dissection – 0.61 km km^{-2} (Figure), the density of gully heads 2.4 units km^{-2}, average gully head retreat 0.5 m yr^{-1} and cross-sectional area 18.3 m^{2}. This value 22 m^{3} km^{-2} (39 t km^{-2} yr^{-1}) was composed. Total sheet, rill and gully erosion were 156 t km^{-2} yr^{-1}. Large differences are due to the reduction of arable land square, the decrease in the moisture content during last 20 years.

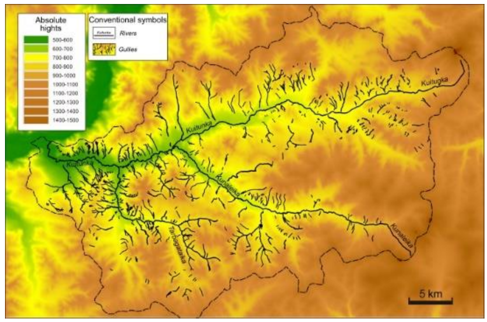

Figure 1. Map of gullies (composed D.V. Kobylkin)

A significant part of the products of soil erosion accumulated on the slopes, in the bottoms of gullies. If in last century the potential loss of soil was 483 km^{-2} yr^{-1}, now this value (156 t km^{-2} yr^{-1}) was calculated. The average sediment yield calculated for the 12-year observation period is 29 t km^{-2} yr^{-1}. It ranges from 167 (in 1968 yr) to 1.25 (in 1982 yr) t km^{-2} yr^{-1}. Based on these calculations, the coefficient of sediment reduction (the ratio of the proportion of sediment carried outside the catchment in the total volume of material moved by various denudation processes in the catchment for any unit of time) (Makkaveev, 1981) is 0.06-0.18. The part of gully deposits in total erosion is 23-39%.

Assessment of soil erosion by Russian modified USLE in the Tarbagataika river basin

Russian modified USLE parameters estimation.

The R (erosion precipitation potential) in equation 2 is the result of kinetic energy of rainfall event (E) and its maximum 30-min intensity (I_{30}) (Brawn and Forster, 1987). We used long-term data (21 years)of rainfall amounts and intensity for rains with precipitation more than 10 mm (Bazhenova et al., 1997) and published data (Litvin, 2002). For Ulan-Ude R factor was calculated 3.2 (Bazhenov et al., 1997). In the Selenginskoe Midlands it varies from 2.5 to 5 (Bazhenov et al., 1997; Litvin, 2002). In Tarbagataika basin (52-70 km from Ulan-Ude), according to long-term data, an average falls annually 289-308 mm of precipitation. By introducing the correction factor, the R equal 3.7-3.9. Correlation between the erosion precipitation potential factor (R_{epp}) with rainfall amount and the absolute heights in Eastern Siberia was no founded (Litvin, 2002). During June, July, August and September, respectively, R_{epp} account for 10, 60, 95 and 100% (Catchment…, 2017).

The surface slope runoff layer depends on the water snow supply in during snowmelt and the runoff coefficient. According to research (Tharmaev et al., 2004), the water reserves in snow in the developed regions of the Kuitunka river basin are 18-25 mm. Loss at the sublimation ere 20-22mm, and a runoff coefficient of 0.1-0.2, melt water slope runoff – 0-5 mm (Tarmaev et al., 2004). To assess soil erosion and meltwater slope runoff during snowmelt is determined by the formula:

$$H_{sl}=(H_{sn}+H_{pr})K_{sl}K_{ex} \qquad (4)$$

where, H_{sl}–meltwater slope runoff (mm),
H_{sn}–maximum of water supply in snow (mm),
H_{pr}–a layer of precipitation during snowmelt (mm), equal to the average amount of precipitation for the time from the average date of the maximum water supply in the snow to the average date final melting snow cover,
K_{sl}–slope runoff coefficient during snowmelt;
K_{ex}-slope exposure coefficient (Catchment, 2017).

Melt water soil erosion can be snowfalls in April, when snow falls on moisture thawed soil (Bazhenov et al., 1997). On the arable land in the Selenga Midlands snow often evaporates in spring and not form of runoff, especially on the southern expositions slopes. The H_{sl} value is not more 5 mm (Tarmaev et al., 2004). In spring water from the higher forest areas comes to the arable land frequently. There is a so-called water dumping effect (Reimkhe, 1986; Litvin, 2002).

There are various equals (Wischmeier and Smith, 1978; Panagos et al., 2014; Ganasri, Ramesh, 2016; Catchment, 2017), nomograms (Wischmeier and Smith, 1978; Larionov, 1984) for calculate K, taking into account data on the structure of the soil, its water permeability, organic matter content and particle size distribution.

The Tarbagataika river basin consists of 8 different soil types, unite to 4 groups with varying soil characteristics. In general, soils formed on silty loam and loessal loamy sand (Reimkhe, 1986; Tarmaev et al., 2004; Sympilova et al., 2015). In soils predominant fine sand and coarse silt fraction (respectively 30-40 and 40-50%) (Tarmaev et al., 2004). We used equation (Catchment …, 2017) and (nomogram (Larionov, 1984) for calculate K factor. Soil erodibility factor (K) varies from 1.50 to 4.4 soil parameters and depend from soil textures.

The Topographic factor represents a ratio of soil loss under given condition to that at a site with the “standard” slope steepness of 9% and slope length of 22.6 m (Ganasri, Ramesh, 2016). Topographical factor constitutes two factors which are slope length (L) and slope steepness (S). The topographic factor) was calculated on the basis of a DEM. The data of topographic factor calculation are given on fig. In the Tarbagataika river basin it ranges from 0 to 40.81, and an average dimension is 5.93. L_{sl} x S_{ss} factor has a maximum value on the steep slopes of more than 10-15^0. It reduced on the slopes and has a minimum value on the floodplain and river terraces.

The C-factors are the most important for reduction soil erosion. Since C-factors are not available for most of Buryatia Republic crops. C-factors were used to indicate the effect of cropping and management practices on soil erosion rates. Cover management factor (C) is determined by a group of factors, among which the most important are the biological abilities of crop growth, the technology of their cultivation and the nature of the distribution of the precipitation potential factor index (Catchment, 2017).

The land use cover of the Tarbagataika basin was classified with fore land cover classes: forest area, grassland, cultivated land, artificial surfaces. The seasonal variation of C-factor depends on many factors such as rainfall, snowmelt, agricultural practice, type of crops. However, the present study considered an annual variation as there is no cultivation (October-April) in the study area. The actual soil conservation capacity of the field crop may be calculated according (Catchment…, 2017). In the Tarbagataica basin crops seed in May, harvest in September. Crop management factor are calculated for winter tillage – 0.8, cultural vegetation (spring grains) - 0.59. Agricultural lands snowmelt erosion K factor in Transbaikalia were 0.71-0.8 (Litvin, 2002, p. 140).

Fallow lands have average plant projective cover 20% (Simpilova et al., 2015), C factor equal 0.2. The average K value for agricultural land is 0.5 (Table). Forest area concentrated in the upper and middle parts of the basin on watersheds, steep slopes (>8-10^0). Projective cover in forests is 20-90%. C Factor value is on average 0.003 and varies from 0.001 to 0.01.

The summation of erosion precipitation potential factor, soil erodibility factor, topographic length factor, topographic steepness factor, crop management factor and conservation practice factor, then the result were found that mean annual rainfall soil loss equal to 25.7 t ha^{-1} y^{-1} (or 2570 t km^{-2} y^{-1}). Melt water erosion does not have significant role in the total soil loss.

Table 1. Cover and practice factor

Cover/Crop/Practice	Average C factor value	P Factor value
Forest area	0.003	
Grassland	0,1	
Cultivated land	0,5	1
Artificial surfaces	0,1	

Discussion

We compared the data on the Russian modified universal equation of soil erosion with the data of the RUSLE (Panagos et al., 2015). If LS, C, P factors are the same for equals 1 and 2, for calculate R and K were used other indicators. The main difficulties arise in the calculation of R index where there are no observations of intensity of precipitation. An average annual value of rainfall erosivity factor was estimated by means of six empirical models (Koffas, Hrisanthou, 2017), using mean monthly and annual rainfall depths. H. M. J. Arnoldus (1977; 1980) modified Fournier's index to:

$$F = \sum_{i=12}^{12} \frac{P_i^2}{P} \qquad (4)$$

where F–modified index value, p_i is average monthly rainfall depth (mm); and P is the average annual rainfall depth (mm). We use date of average monthly and annual rainfall (April-October) for Tarbagatai (258 mm) and Desyatnokovo (274 mm) (Climate-data.org) and calculated F index (respectively 53.2. and

56.9). R index, according six equations, were 369-1044 for Tarbagatai, 485-1103 for Desyatnokovo. We take minimal R factor value with P index (369 and 406).

Table 2. R index value

Authors	Equation	R Factor value
Arnoldus (1977)	$R = 0.302 \times F^{1.93}$	647* 737**
Arnoldus (1980)	$R = [(4.17 \times F) - 152] \times 17.02$	1188 1451
Lo et al (1985)	$38.46 + 3.48 \times P$	936 992 1138
Renard and Friemund (1994)	$R = 0.739 \times F^{1.847}$	1289
Renard and Friemund (1994)	$R = 0.0483 \times P^{1.61}$	369 406 1037
Yu and Rosewell (1996)	$R = 3.82 \times F^{1.41}$	1140

*Tarbagatai, ** Desyatnokovo

Soil erodibility factor (K) was calculated by equation (5) (Panagos et al., 2014):
$K = [(2.1 \times 10^{-4} M^{1.14} (12\text{-}OM) + 3.25(s-2) + 2.5(p-3))/100]^{*}\ 0.1317$.
According (Wischmeier and Smith, 1978) silt fraction does not exceed 70%, organic matter content 4%. In the Kuitunka basin content silt fraction more than 70% often (Reimkhe, 1986; Tarmaev et al., 2004; Sympilova et al., 2015; Golubtsov et. all., 2017). K factor varied from 0.034-0.067 with average value 0.040. Mean annual soil loss equal to 26.2-28.9 t ha^{-1} y^{-1} (2620-2890 t km^{-2} y^{-1}).

Conclusion

Multi-temporal generalized data on soil losses in result of soil and gully erosion are obtained. Using two equations we calculated soil loss in the Tarbagataika river basin. The trend of decrease in soil and gully erosion is revealed. The results of calculations using two equations show equal values. This indicates the possibility of their joint use for the calculation of soil losses. In the future, it is necessary to clarify the value of the soil loss on steep slopes and divide on land cover classes. Studies of soil loss and gully erosion will continue.

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HUMIC PREPARATIONS TO COUNTERACTING DESERTIFICATION

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Abstract: Desertification processes currently threaten vast areas in southern Russia, in Central Asia, in particular in Mongolia. Counteraction to desertification includes a number of measures: recultivation of technologically disturbed lands, prevention of soil erosion, development of farming systems that ensure high and sustainable productivity, and improvement of the structure of agricultural land. Currently, the most important task is to develop methods and drugs for this purpose. The biological activity of humic preparations (HP) in the form of sodium and potassium humates is investigated depending on the structural group parameters: degree of aromaticity (fa), hydrophilic-hydrophobic parameter (fh/h) and parameter reflecting the ratio of aromatic and aliphatic fragments of the organic mass of HP (far/al). Evaluation of the biological activity of native and modified HP was carried out on wheat and radish seeds. Studies have shown that destructive alkylation and subsequent debituminating of initial coals changes the structural group composition of humic acids, increases the degree of aromaticity. It was established that the biological activity of HP is directly proportional to the following structural parameters: the degree of aromaticity fa, the hydrophilic-hydrophobic parameter fhh, and the parameter reflecting the ratio of aromatic and aliphatic fragments of organic mass of HP (aromaticity / aliphaticity) far / al. In general, humic acids obtained from the naturally-oxidized form of brown coal showed the greatest efficiency. In the first case, the greatest influence affected the length of the roots, in the second - on the length of the seedlings.

Keywords: desertification, humic acids, structural parameters, biological activity

Introduction

At present, desertification is threatening vast territories in the southern Russia and Central Asia, particularly Kazakhstan and Mongolia. Desertification can hinder a successful socio-economic development of these and neighboring countries and is a global environmental and socio-economic problem. In Russia, a territory of 50 mln ha, including the Black lands of Kalmykia, suffers from this process. In Kazakhstan having 182 mln ha of ranchland, 14 mln ha are completely out of use, and the total area of degradation exceeds 50 mln ha . In Mongolia, the area of non-desertified land constitutes 22% of its territory; weakly desertified, 35%; moderately desertified, 26%; strongly desertified, 7%; and extremely desertified, 10% (Mandakh et al., 2016). According to current data, 46% of all arable land is liable to erosion, which demonstrates that special attention should be paid to reclamation of degraded lands and development of the appropriate methods and agents.

Humic substances (HS) are a special class of natural compounds that are formed from the remnants of dead organisms with selection and accumulation of the structures that are resistant to biodegradation. Their annual increment on the planet (Orlov, 1997) ranges from 0.6 to 2.5•10^9 ton. HS are present in soil, water, and in peats and lignites.. Although humic substances have been studied for a long time, their structure is only hypothesized (Perminova, 2000). Particular emphasis is made on the biological activity of humic acids and related agents (Khristeva, 1973).

HS perform not only accumulative, transport and protective functions, but also regulatory and physiological ones. The regulatory function, first of all, includes the formation of the soil structure and water-physical properties and, as a consequence, the thermal regime of the soil. Potassium, sodium and ammonium humates exert a pronounced beneficial effect on the moisture-physical and physicochemical properties of soil: they increase the moisture capacity of light soils (by 30% on the average), facilitating the formation of agriculturally valuable lumpy-granular structure; improve porosity and water permeability of heavy soils, preventing the formation of cracks and crusts; regulate the ionic exchange reactions between soil and aqueous solutions; and affect the buffer capacity of soils, thus maintaining the natural pH level even in the case of excessive delivery of acid or alkaline agents. The most urgent task now is reclamation of soil fertility and prevention of desertification.

Great attention is paid to the ability of humic substances to enhance plant resistance to detrimental environmental factors: overdoses of mineral fertilizers, high or low temperatures, chemical plant protection agents, radiation, etc. It was shown that small doses of humic substances stimulate the development of plants and their ability to assimilate nitrogen from mineral fertilizers (Aleksandrova, 1972). Large doses of humates (above 0.1%) suppress the growth of plants.

The physiological function is related to the action of humic substances on various organisms. When humates are employed in farming, they raise the yield of cereal and fodder crops and vegetables by 10-30% on the average, improve the vitality and germinating ability of seeds, stimulate plant metabolism, absorption of mineral substances and formation of roots. Water-soluble forms of humic acids are involved in the cellular redox processes: they serve as a source of activated oxygen, on the one hand, and as a hydrogen acceptor, on the other hand (Dragunov, 1980).

Previous experiments (Apraksina et al., 1988) did not reveal a direct dependence of the biological activity of humic acids on the content of carboxylic and phenolic hydroxyls. However, it is stated (Kukharenko, 1976) that the biological activity of humic asids (HA) is determined by the ability to participate in redox reactions in a plant cell and by the enhancement of such reactions according to the Bach–Palladin–Szent-Gyorgyi theory. Thus, the biological activity is related to the structural parameter “degree of aromaticity” fa, which reflects the content of quinoid groups, phenolic hydroxyls and free radicals. Testing of humic agents on cereal crops – oats and wheat – demonstrated that the biological activity of HA is directly proportional not only to fa but also to other structural-group parameters, such as hydrophilic-hydrophobic parameter fhh and the ratio of aromatic and aliphatic fragments in the organic mass of HA (aromaticity/aliphaticity) far/al (Zherebtsov et al., 2015).

The biological activity was also tested on some natural and modified humic substances obtained from different sources (Dobbs et al., 2010), and estimated from changes in the root structure of tomato and maize. Various reactions were used for modification: hydrolysis, reduction, alkylation with methyl, and splitting of alkyl fragments. Most efficient were the humic substances oxidized with potassium permanganate and alkylated with methyl. The hydrophobic domain of humic substance was supposed to include the biologically active molecules that are similar to auxins. A contact with organic acids delivered from the root destroys the hydrophobic shell, which is accompanied by a release of biologically active components.

The goal of this work is to determine physicochemical characteristics of some coals and HA, select factors of the structural-group composition of HA related to biological activity, and substantiate characteristics of HA for subsequent screening of feedstocks and obtaining physiologically active precursor agents for desertification control.

Methods

The study was carried out with humic brown coals from various deposits: Baganuur and Shivee-Ovoo (Mongolia); Tisulsky deposit of the Kansk-Achinsk basin (Russia) (TS), its natural oxidized form (TSO); Tyulgansky (T) and Mayachny (M) deposits in the Southern Ural. Humic acids were obtained from sodium (HumNa) humates by precipitation from a solution upon addition of hydrochloric acid. A series of HA was obtained from coal samples that were successively alkylated with alcohols and debituminized by the methods reported in (Zherebtsov et al., 1997, 2017).

Table 1. Technical and elemental analysis of the tested samples, wt.%

Sample	W^a	A^d	C^{daf}	H^{daf}	$(O+N+S)^{daf}$ from the difference	$(HA)_t^{daf}$
Coal Baganuur, (BAG)	-	26.3	67.5	4.4	28.1	31.2
HumNa BAG	6.9	17.9	60.5	3.8	35.7	52.8
Coal Shivee-Ovoo, (ShO)	-	31.6	70.5	4.4	25.1	34.0
HumNa ShO	16.2	24.8	66.8	4.5	28.7	58.9
Coal Tisulsky, (TS)	8.3	10.3	61.4	5.0	33.5	22.1
HA HumNa TS	3.8	1.9	59.8	3.5	36.7	-
Coal Tisulsky natural oxidized (TSO)	10.0	43.5	69.3	6.0	24.7	60.9
HA HumNa TSO	10.6	10.9	59.7	6.2	34.0	-
Coal Tyulgansky, (T)	6.5	23.5	66.2	7.0	26.8	39.1
HA HumNa T	3.63	7.57	62.9	5.82	31.3	-
Coal Mayachny, (M)	5.3	20.0	58.6	6.8	34.6	73.5
HA HumNa M	-	-	57.3	7.4	35.3	-

A^d - ash content on a dry sample; C^{daf} is the content of combustible carbon for a dry ash-free sample; daf – dry ash free state of the sample; $(HA)_t^{daf}$ is the yield of free humic acids; H^{daf} is the content of combustible hydrogen for a dry ash-free sample; $(O + N + S)^{daf}$ - the content in the sample of oxygen, nitrogen and sulfur by difference (calculated) for a dry ash-free sample; V^{daf} - the release of volatile substances on a dry ash-free sample; W^a - analytical moisture.

Experimental samples of sodium were produced from brown coal and its natural oxidized form. The initial lignites and humate samples were characterized by elemental-technical and functional analyzes (Tables 1, 2), and ^{13}C NMR spectroscopy (Tables 3,4).

High resolution solid-state ^{13}C NMR spectra were recorded on a Bruker Avance III 300 WB instrument at a frequency of 75 MHz using standard cross polarization magic angle spinning (CP-MAS).

After analysis of the literature data (Kalabin et al., 2000), three parameters calculated from ^{13}C NMR data were chosen to elucidate a relation between structural-group composition of HA and their biological activity:

– the degree of aromaticity

$$fa = C_{Ar}\text{-}OH + C_{Ar} \qquad (1)$$

–the hydrophilic-hydrophobic parameter

$$fh/h = (C{=}O + COOH(R) + C_{Ar\text{-}OH} + CO_{\text{-}Alk\text{-}O} + C_{Alk\text{-}O})/(C_{Ar} + C_{Alk}) \qquad (2)$$

and the aromaticity/aliphaticity ratio

$$far/al = (C_{Ar\text{-}OH} + C_{Ar})/(C_{O\text{-}Alk\text{-}O} + C_{Alk\text{-}O} + C_{Alk}) \qquad (3)$$

The data obtained are listed in Table 3 and 4.

Table 2. Content of active oxygen-containing groups in humic acids of coals from Baganuur and Shivee-Ovoo deposits

Sample	Content of acid groups, mg-Eq/g			Quinoid groups, mg-Eq/g
	Carboxyl groups	Phenolic hydroxyls	Sum	
BAG HumNa	4.33	3.42	7.75	2.75
ShO HumNa	5.13	3.52	8.65	3.17

Table 3. Structural parameters of coal samples and humic acids according to ^{13}C NMR data, %

Sample	Structural parameters		
	f_a	$f_{h/h}$	$f_{ar/}$
Coal TS	23.3	0.3	0.3
HA HumNa	23.3	0.5	0.4
Coal TSO	40.8	0.6	0.8
HA	39.9	0.7	0.8
Coal T	28.7	0.5	0.5
HA	29.3	0.7	0.5
Coal M	32.8	0.5	0.6
HA	29.8	0.5	0.5

Results

Destructive O-alkylation of lignites with alcohols depolymerizes the organic mass of coal and increases, on the one hand, the yield of predominantly aliphatic bitumoids and, on the other hand, aromaticity of the debituminized coal residue (Zherebtsov et al., 1997, 2017). HA extracted from such an object are, accordingly, more aromatic than those extracted from the initial lignites. Thus, there are prerequisites for the enhanced biological activity of the indicated humic acids. Table 4 lists data on the structural-group composition of humic acid (HA) samples obtained from the initial coals and subjected to destructive alkylation and debituminization (HAA), which have a significant dispersion of the f_a values. Indeed, data of Table 4 show an increase in aromaticity of HAA in comparison with the corresponding HA for all the studied humic asides. Thus, for HA extracted from brown coal of Tisulsky deposit, f_a is equal to 23.3. HAA extracted from the same coal that was preliminarily alkylated with butanol and then debituminized have f_a equal to 31.9. Tests were made to estimate the biological activity of humic acids in the form of Na humates (the concentration of 0.02%), which were obtained from initial samples of coal and peat (HA) and modified by successive alkylation (HAA) and debituminization.

Table 4. Aromaticity for HA and HAA samples according to ^{13}C NMR, %

HA sample	Aromaticity f a
Coal from Tisulsky deposit	
HA	23.3
HAA	31.9
Coal from Tisulsky deposit naturally oxidized	
HA	40.9
HAA	43.1
Coal from Tyulgansky deposit	
HA	29.3
HAA	36.7
Coal from Mayachny deposit	
HA	29.8
HAA	42.2
Peat from Krapivinsky deposit	
HA	22.6
HAA	22.8

Discussion & Conclusions

To reveal the structure-property dependence, a series of experiments was carried out by the methods reported in (Zherebtsov et al., 2016) in compliance with GOST 12038-84 and GOST 54221-2010. Varietal wheat "Novosibirskaya 89" and "Iren" as well as radish "Smak" were used in the experiments. The biological activity of HA estimated from an increase in the yield was found to be directly proportional to the chosen structural parameters. Fig. 1 displays the dependences demonstrating that the yield of wheat "Novosibirskaya 89" increases with raising the HA aromaticity and hydrophilicity.

In some experiments, the biological activity of HA was found from an increase in the root length of wheat Δ_1 (a gain with respect to the control, %) and from the value of phytoactivity index (PI) taking into account the germinating energy of seeds (GE), root length (RL) and acrospire height (AH). PI is the general index, which is calculated by averaging the sum of GE, RL and AH expressed in decimal fractions (Voronina et al., 2012):

$$PI=(GE+RL+AH)/3\cdot 100 \quad (4)$$

where GE, RL and AH are the values averaged over three trays (% with respect to the control, Δ_2).

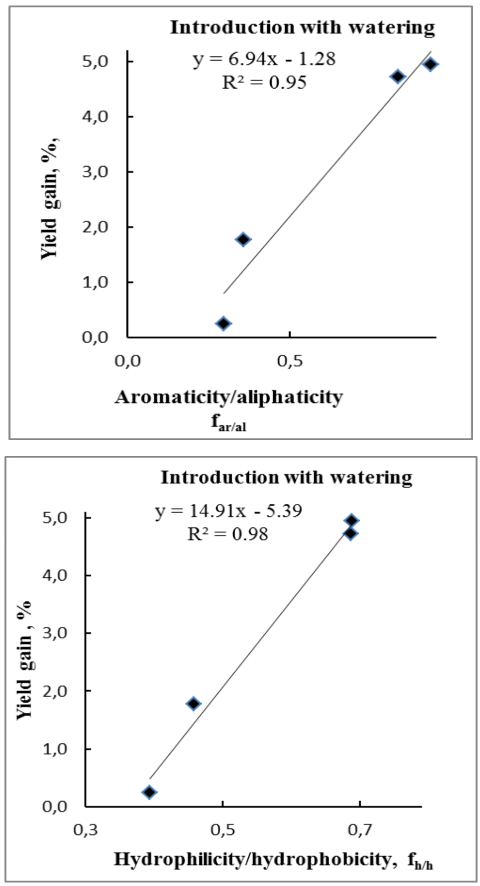

Figure 1. A relation of HA structural parameters (^{13}C NMR) and biological activity

Figures 2 and 3 illustrate results of the experiments with wheat and radish seeds, namely, the gain in the root length of wheat seeds with respect to the control experiment Δ_1 and phytoactivity index Δ_2 of radish seeds versus the degree of aromaticity f_a of the tested humic acids.

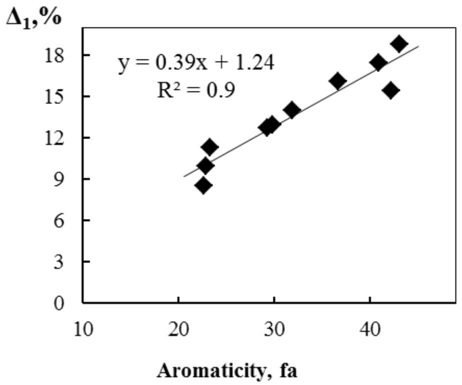

Figure 2. The root length of wheat (a gain over the control Δ1, %) versus the aromaticity degree fa of HA samples

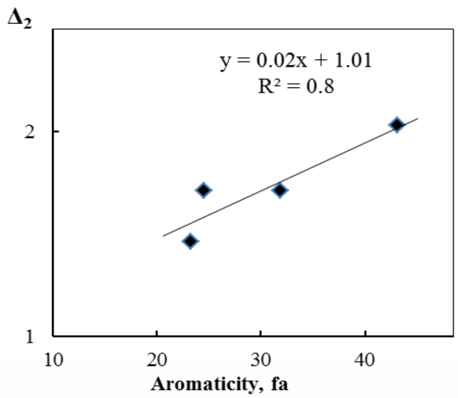

Figure 3. Phytoactivity index of radish seeds Δ_2 versus the aromaticity degree f_a of HA samples

As seen on Figs. 2 and 3, the biological activity of HA and HAA estimated from parameters Δ_1 and Δ_2 with respect to the tested cultures – wheat and radish – is also proportional to the structural parameter "aromaticity degree" f_a. The aromaticity degree of the humic acids extracted from coals that were preliminarily alkylated and debituminized is close to that of highly active natural humic substances in naturally oxidized coals (Table 4) of the brown coal maturity stage; the biological activity of such humic acids is higher as compared to HA extracted from the initial coals.

Acknowledgments

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INTEGRATED ASSESSMENT OF CLIMATE CHANGE VULNERABILITY AND RISK IN MONGOLIA

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Abstract: This study is considered integrated assessment of climate change vulnerability and risk in water and forest resource, wild animal, pasture-soil and disaster as natural and ecosystem component, as well as in livestock, arable farming, public health as main socio-economic sectors in Mongolia, based on dynamically downscaled output of regional climate modeling. As we defined that mean of standardized indicators for sectors in the present is shown vulnerability index and its future value will show risk index based on standardized method, which was used in Human Development Index of United Nation organizations. According to climate change integrated assessment, Mongolia will be shift from “vulnerable/risk” to “high vulnerable/high risk” category in near 2050 years. Relative high risk will be having in livestock, arable farming pasture-soil, permafrost, water resource sectors of Uvs, Khuvsgul, Tuv, Khovd, Gobi-Altai, Zavkhan, Bulgan, Selenge, Khentii and Umnu-gobi provinces. Therefore, the research result could answer question that where and in which sectors adaptation measures and activities are needed to take in order to reduce climate change vulnerability and risk of Mongolia.

CONTRASTING CHANGES IN VEGETATION GROWTH DUE TO DIFFERENT CLIMATE FORCINGS OVER THE LAST THREE DECADES IN THE SELENGE-BAIKAL BASIN

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Abstract: The Selenga-Baikal Basin, a transboundary river basin between Mongolia and Russia, warmed at nearly twice the global rate and experienced enhanced human activities in recent decades. To understand the vegetation response to climate change, the dynamic spatial-temporal characteristics of the vegetation and the relationships between the vegetation dynamics and climate variability in the Selenga-Baikal Basin were investigated using the Normalized Difference Vegetation Index (NDVI) and gridded temperature and precipitation data for the period of 1982 to 2015. Our results indicated that precipitation played a key role in vegetation growth across regions that presented multiyear mean annual precipitation lower than 350 mm, although its importance became less apparent over regions with precipitation exceeding 350 mm. Because of the overall temperature-limited conditions, temperature had a more substantial impact on vegetation growth than precipitation. Generally, an increasing trend was observed in the growth of forest vegetation, which is heavily dependent on temperature, whereas a decreasing trend was detected for grassland, for which the predominant growth-limiting factor is precipitation. Additionally, human activities, such as urbanization, mining, increased wildfires, illegal logging, and livestock overgrazing are important factors driving vegetation change.

MODELING SOIL HYDRO-THERMAL COUPLED RESPONSE TO WARMING AND DEGRADATION IN THE PERMAFROST REGION OF THE QINGHAI-TIBET PLATEAU

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Abstract: Climate warming and grassland degradation are primary environmental issues on the Qinghai-Tibet Plateau. However, the processes and mechanism that they impact the alpine ecosystem remain great unclear, which restricts the prediction for climate and environmental change. The soil hydrothermal variation caused by warming and degradation is the fundamental process controlling the ecosystem change. In this study, the ECOsystem (TECO) model combining the freeze-thaw cycle and degradation dynamics was used to simulate the response of soil temperature and moisture in the depth of 0-300 cm to warming (+0.3, +0.6, +1. 5, +2.5, and +4.5°C) and degradation (slight, moderate, and severe). Research shows that, after model being conditioned through data assimilation, the simulation is in high accord with the observation, but the accuracy decreases with the increase of soil depth. The simulated soil temperatures have better consistency with the observed data ($R2>0.92$, $P<0.01$) than the simulated soil moistures ($R2>0.80$, $P<0.05$). The freeze-thaw cycle in the active layer induces the hydrothermal process to exhibit substantial seasonal differences. In the warming season, heating dried the soil of the root zone (10-20 cm), which is greatly exacerbated by degradation. The influence of degradation on soil temperature is far less than that of heating, although severe degradation cooled soil to a small extent. Degradation influence soil moisture further than that on soil temperature, which mainly performs drying the shallow soil and wetting the deep soil. Our finding implicates that warming and degradation-induced loss of soil water mostly due to the plant growth and infiltration, not evaporation. Climate warming will not alleviate the impact of grassland degradation on alpine ecosystems, and the measure of improving soil structure and nutrient of degraded grassland is still essential.

Keywords: alpine ecosystem, degradation, hydrothermal process, Qinghai-Tibet Plateau, TECO model, warming

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Sub-Session:

Environmental Process and Modelling

ENVIRONMENTAL STUDIES OF MONGOLIA USING ADVANCED SPATIAL TECHNIQUES

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Abstract: The aim of this study is to apply some advanced spatial techniques based on remote sensing (RS), geographical information system (GIS) and global positioning system (GPS) for environmental studies in Mongolia. For this purpose, different case studies conducted at national, regional and local level are highlighted. The case studies at national level describe the studies related to monitoring of vegetation conditions of Mongolia using multitemporal NDVIs as well as snow cover distribution and yellow dust spread in the country. The case studies at regional level highlight monitoring of vegetation conditions in northern Mongolia using multitemporal high resolution images, and also a pastureland change study using different spatial techniques. The case study at local level describes how a very high resolution RS imagery can be used for a detailed environmental analysis. Overall, the research indicates that modern spatial techniques and technologies are reliable tools for different environmental studies in Mongolia.

Keywords: Environmental study, RS, GIS, GPS, Spatial

Introduction

The Mongolian environment has a large variety of features. About 81% of the country is higher than 1000m above sea level and the average elevation is 1580m. The lowest point is Hukh Lake (560m above sea level) located in Eastern Mongolia, and the highest point is Huiten peak in the Mongolian Altai mountain range (4,374m). The country is divided into several natural regions (Amarsaikhan, 2013).

The mountain taiga comprises about 5% of the country's territory in the Khentii and Khuvsgul mountain regions in the northernmost part of the country and experiences a relatively cold and humid climate. Due to a brief warm period, the growing season is not long enough for many plant species. The mountain forest steppe region encompasses about 25% of Mongolia's territory and extends through the Altai, Khangai, Khuvsgul massifs and borders with the taiga region. One specific feature of the mountain forest steppe is that the back of the slopes of the mountains facing the north, northeast and northwest are covered with different species of forest and woody plants, whereas their front slopes facing the east, south and southwest are densely covered by the steppe plants almost up to the sharp ridges of the mountains (Mongolia, 2019).

The steppe region with an area of approximately 20% of the country's territory comprises the entire Eastern and Central Mongolian vast flat plains extending as a tapering zone. The vegetation of the Mongolian steppe is dominated by xerophya, caragana and many forms of feather grass. The desert steppe region includes the depression of Great Lakes, the valley of lakes and the middle and Eastern Gobi lowlands. This area belongs to the semi-arid zone which has loose soil and fewer species of plants compared to the northern regions. The Gobi desert region is located in the southern and southwestern parts of Mongolia and is dominated by extremely unique physical formations of changing contrasts like hills, hillocks, rolling heaths, and sand dunes (Mongolia, 2019).

Mongolia has a severe continental climate with hot summers and cold winters. Known as the 'Land of Blue Skies', the country has over 270 sunny days each year. Although, the winter is long and cold, the blue winter sky makes it often feel warmer. There is little snowfall but it and ice can remain for several weeks at a time. The rainy season is from June to September, but the showers are often brief. The summer is a very pleasant time in most of the regions and summer evenings can be cool enough because of country's high altitude (Amarsaikhan, 2013).

At present, spatial information is used for many research, planning and management activities. For environmental studies, the spatial information plays a number of important roles. This kind of information can be collected from many different sources such as a field survey, general planning maps, topographic maps, digital cartography, thematic maps, positioning systems and RS. Of these, only RS can provide real-time information that can be used for thorough spatial analysis (Amarsaikhan *et al.,* 2011).

In recent years, huge amount of satellite information with different spatial and spectral resolutions as well as other supportive geographical data have become available free of charge and downloaded from different sources on the Internet. Although, these data sets represented mainly in a raster format occupy a greater volume in a storage device, can easily be integrated with historical GIS data sets and applied for accurate analyses.

The aim of this study is to demonstrate how advanced spatial technologies can be used for environmental studies in Mongolia. For this purpose, some case studies conducted for different applications at national, regional and local level have been highlighted. For the final analyses, optical satellite images with different spatial resolutions as well as some other spatial data sets have been used and different RS, GIS and GPS techniques were applied.

Environmental monitoring at national level

In Mongolia, moderate resolution RS data can be successfully used for monitoring of the environment, particularly pastureland and vegetation conditions as well as snow cover and dust distribution at a national scale. For vegetation monitoring, NDVIs are considered as one of the most vigorous methods. They are designed to enhance the vegetation reflectance from measured spectral responses by combining two (or more) different wavebands, often in the red (0.6-0.7 mm) and near-infrared wavelengths (0.7-1.1 mm). They provide consistent, spatial and temporal comparisons of global vegetation conditions (Erdenentuya, 2010). In the present study, red and near infrared bands of MODIS images acquired in between June and September of 2018 have been used. Figure 1 shows the changes of vegetation conditions from June until September periods. Looking at these images, one can easily observe that green vegetation boundaries shift from the north of the country to the south starting from April.

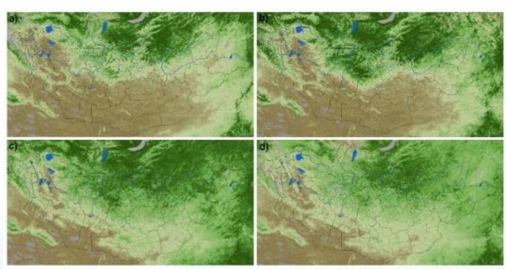

Figure 1. Monitoring of vegetation conditions: a) 2018.06.01; b) 2018.07.01; c) 2018.08.03; d) 2018.09.02.

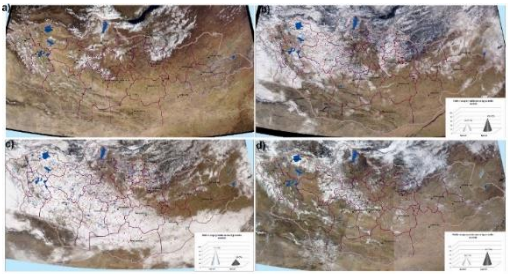

Figure 2. Snow cover distribution: a) 2018.10.10; b) 2018.12.31; c) 2019.02.20; d)2019.03.30

In case of MODIS data, received at Information and Research Institute of Meteorology, Hydrology and Environment of the Ministry for Environment and Tourism can have many more applications (Amarsaikhan *et al.,* 2008). For example, thermal infrared channels may be extensively used for temperature studies and fire monitoring. Snow cover has a strong reflectance in the visible range, but a low reflectance in the short-wave infrared region. Meanwhile, shortwave images can be successfully used for dust monitoring. Figure 2 illustrates snow cover distribution in between October 2018 and March of 2019, whereas Figure 3 shows yellow dust spread occurred during a spring period in Mongolia.

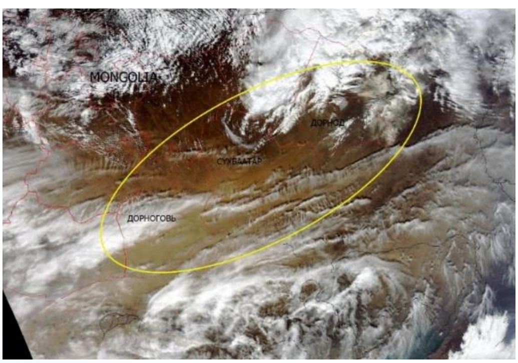

Figure 3. Yellow dust spread in Mongolia (2018.03.27)

Environmental monitoring at regional level

High resolution RS data sets such as Landsat, Spot and Sentinel provide an important source of information for determination of the environmental conditions at a regional scale. As Mongolia has an extensive area in comparison with its over 3 million people, high resolution images can significantly save time and human labor for conducting research in various geographical regions of the country. For example, a time series of Landsat images can be used for many different applications, including vegetation and pasture monitoring, forest and meadow studies, and other resources management (Enkhjargal *et al.,* 2014). Figure 4 shows monitoring of vegetation conditions in Selenge aimag, northern Mongolia from June to September periods, using multitemporal Landsat images.

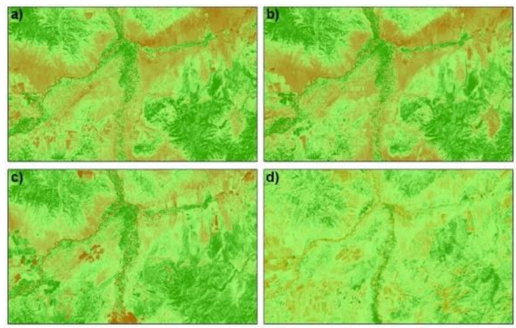

Figure 4. Monitoring of vegetation conditions using multitemporal Landsat images: a) 2017.06.23; b) 2017.07.17; c) 2018.08.13; d) 2018.09.30

As a case study of application of high resolution RS data at a regional scale, we conducted a pastureland change study using RS, GIS and GPS (Amarsaikhan *et al.,* 2016). The test area covers Jargalant, Erdene-Mandal and Tsetserleg sums of Arkhangai Province, Central Mongolia. As RS data sources, green, red and near infrared channels of Landsat 5 data of 14 September 1987, Landsat 7 data of 18 September 2001, Landsat 8 data of 23 August 2014 have been used. In addition, a topographic map of scale 1:100.000, a GIS pasture map, GPS measurements and ground validation data were available.

To define available land cover classes, a refined maximum likelihood classification (MLC) based on the spectral and spatial properties, has been used (Amarsaikhan *et al.,* 2012). Initially, all images were georeferenced to a UTM map projection using a topographic map of the study area. Then, to form the training signatures several AOIs representing the available classes have been selected using GIS and GPS data. The separability of the training signatures was evaluated using T-D distance and the samples that demonstrated the greatest separability were chosen (Richards and Jia, 2014). For the accuracy assessment, the overall performance was used (Amarsaikhan *et al.,* 2016). Classification results of the multitemporal RS images are shown in Figure 5.

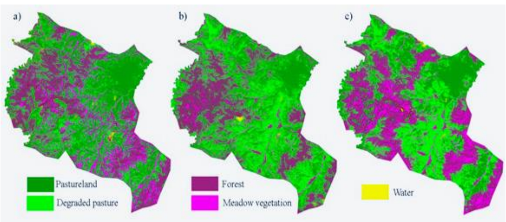

Figure 5. Classification results: a) Result of 1987; b) Result of 2001; c) Result of 2014

After the classifications, the total areas belonging to the selected classes were calculated. Although we had 5 classes, in the current study, the change analyses of only 2 classes (pastureland and degraded pasture) have been conducted. As can be seen from the classification results, in 1987, the pastureland and degraded pasture occupied 387,633 ha and 85,299 ha, respectively, whereas in 2001 these two classes covered 381,176 ha and 183,756 ha, respectively. As seen, within 14-year period pastureland was decreased by only 1.7%, whereas the degraded pasture was increased more than two-fold. Moreover, it was seen that in between 2001 and 2014, the pastureland had been decreased to 275,639 ha and degraded pasture had been increased to 190,427 ha.

Environmental monitoring at local level

Since the emergence of the very high resolution satellites such Ikonos, Quickbird and WorldView, RS has become a valuable source in providing accurate information for detailed environmental studies. Now such very high resolution data sets, in some cases, can replace aerial images and used as supporting evidential information for national and regional scale studies. For thematic information extraction from such images, advanced object-based classification techniques could be applied along with traditional supervised and unsupervised methods, or their combinations. Moreover, as the current digital image processing methods are so advancing, different knowledge-based techniques may be applied for the automatic interpretation of RS data sets. Nevertheless, at this level NDVIs and LAIs can still be used for very accurate assessment of vegetation condition as well as biomass estimation (Mather, 2004). Figure 6 illustrates NDVI image, created by the use Quickbird data acquired in July of 2018. This image could be used for evaluation of vegetation condition in Orkhon River basin, northern Mongolia and support other studies conducted at national or regional level.

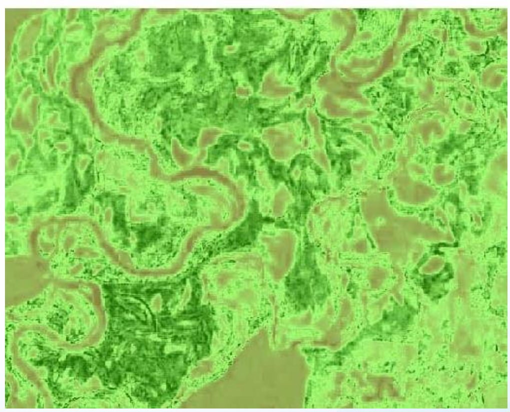
Figure 6. Quickbird NDVI image (July of 2018)

Conclusions

The main aim of this research was to demonstrate how spatial techniques and technologies based on the RS, GIS and GPS could be used for the environmental studies in Mongolia. For this purpose, different case studies conducted at national, regional and local scales were given. The case studies at a national scale highlighted the monitoring of vegetation conditions in the country using multitemporal NDVIs as well as the studies of snow cover distribution and yellow dust spread. The case study at a regional scale described monitoring of vegetation conditions in Selenge aimag using multitemporal Landsat images. In addition, a pastureland change study using different spatial techniques was highlighted. The case study at a local scale described application of a very high resolution Quickbird imagery for a detailed environmental analysis. Overall, the study indicated that modern spatial techniques and technologies could be successfully used for different environmental studies in Mongolia.

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MONITORING MARSH CHANGES IN THE SANJIANG PLAIN SINCE THE 1950s BASED ON MULTI-SOURCE DATA

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Abstract: The marshes have undergone dramatic loss in the Sanjiang Plain since the 1950s. This paper analyzed the spatiotemporal changes of the marshes using the transition probabilities index, loss rate, and landscape indices. We also used a trajectory analysis method to trace every location of marshes over multiple points in time and to quantitatively estimate the impact of human activities on the marsh changes since the 1950s. This study indicates that the marsh area declined sharply by 79.4% (approximately 2.99 million ha) from 1954 to 2015. A large area of marsh was reclaimed as cultivated land from 1954 to 2015. The changes in the related landscape indices showed the large-scale loss of the marsh area and marsh fragmentation in the study period. Human activities were the dominant factor that influenced the marsh changes in the Sanjiang Plain during the last 60 years compared with natural factors. These findings can provide valuable information for better understanding wetlands changes and implementing sustainable management strategies for wetlands (such as wetland restoration).

PLANT BIOMASS DYNAMICS IN A DESERT ECOSYSTEM, NW CHINA: PRESENT CONDITION AND CLIMATE CHANGE SCENARIOS

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Abstract: The temporal dynamics of vegetation biomass are of vital importance for evaluating the sustainability of arid and semiarid ecosystems. Field observations indicate that soil moisture and plant biomass fluctuate stochastically with the occurrence of rainfall events. Based on long-term field observations, we find that the dynamics of the vegetation biomass can be quantified by their analytically derived time-dependent probability distribution. This allows for the study of the impact of climate change scenarios on vegetation cover and plant water resource competition. It is found that in a restored desert ecosystem in northwest (NW) China, the growing season leaf biomass is expected to increase by nearly 25% compared to the present. The temporal dynamics of vegetation biomass are of key importance for evaluating the sustainability of arid and semiarid ecosystems. In these ecosystems, biomass and soil moisture are coupled stochastic variables externally driven, mainly, by the rainfall dynamics. Based on long term field observations in northwestern (NW) China, we test a recently developed analytical scheme for the description of the leaf biomass dynamics undergoing seasonal cycles with different rainfall characteristics. The probabilistic characterization of such dynamics agrees remarkably well with the field measurements, providing a tool to forecast the changes to be expected in biomass for arid and semiarid ecosystems under climate change conditions. These changes will depend - for each season - on the forecasted rate of rainy days, mean depth of rain in a rainy day, and duration of the season. For the site in NW China, the current scenario of an increase of 10% in rate of rainy days, 10% in mean rain depth in a rainy day, and no change in the season duration leads to forecasted increases in mean leaf biomass near 25% in both seasons.

Keywords: climate change impacts, ecohydrology, soil moisture, stochastic dynamics, vegetation modeling

GLOBAL NDVI PATTERNS IN RESPONSE TO ATMOSPHERIC WATER VAPOR ANOMALIES OVER THE INDO-PACIFIC WARM POOL DURING APR-MAY-JUNE

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Abstract: Vertically integrated atmospheric water vapor (VIWV) over the Indo-Pacific warm pool (IPWP) indirectly affects terrestrial vegetation growth (TVG) patterns through atmospheric water vapor transmission. However, their linkages and mechanisms are poorly understood. This study intends to understand the contributions of VIWVIPWP to TVG and the mechanisms by which VIWVIPWP impacts TVG. Combining monthly SST, VIWV, and NDVI data from 1982 to 2015, the linkage between VIWVIPWP and NDVI is investigated during April–June (AMJ). A strong correlation between VIWVIPWP and NDVI suggests that VIWVIPWP is an important factor affecting TVG.Acomposite analysis of VIWVIPWP anomalies and their relation to NDVI patterns shows that VIWVIPWP positively influences the NDVI of 68.1% of global green land during high-VIWVIPWP years but negatively influences 74.7% in low years. Corresponding to these results, during high-VIWVIPWP years, the warm and humid terrestrial climate conditions improved TVG by 9% and 2% in the Northern and Southern Hemispheres, respectively, but cold and dry conditions inhibited TVG for both hemispheres during the low years. Additionally, strong spatial correlations betweenVIWVIPWP and precipitation imply that VIWVIPWP affects the spatial–temporal pattern of precipitation. There is a stronger interaction between the Pacific north–south ridge and the two land troughs during high-VIWVIPWP years than during low-VIWVIPWP years. The zonally averaged wind at 850 hPa and VIWV results indicate that, during high-VIWVIPWP years, the enhanced wind from the ocean brings more atmospheric water vapor to land, increasing the probability of precipitation and resulting in moist climate conditions that promote AMJ vegetation growth. In brief, VIWVIPWP indirectly induces vegetation growth by affecting the distributions of terrestrial VIWV and precipitation.

REVIEW THE POSSIBILITIES OF WORLD PARK SPECIAL STATUS ON SOME REPRESENTATIVE PROTECTED AREAS OF MONGOLIA

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Abstract: In this context, the principal missions of protected areas are: protection of pristine natural territories for the- preservation and conservation of biological diversity, and for maintenance the protected natural complexes and objects in a natural state; organization and conduct of scientific research, including the keeping of the “Chronicles of Nature”; conduct of ecological monitoring and educational activity; assistance in training scientific personnel and specialists in the field of environmental protection; encouraging local residents to participate in environmental protection measures with prospects for presentation of ecological forms of nature management using the park as the base. The wider economic benefit of parks encompasses the broad range of assets that contribute to our present and future quality of life and prosperity, including the value of ecosystem services such as water, soil, climate regulation and pollination; direct economic returns from tourism and the socio-economic benefits attached to recreation, the impact on people’s physical and mental health, as well as cultural health. Some of these values are more easily quantified than others such as tourism. Based on conservative calculations and estimates outlines some of the additional potential revenue is from park entry fees. This forecast excludes potential revenue from additional state allocations from better business planning and using the economic justification for parks, tour operator fees, allowing all parks to charge entrance fees, daily vs entrance fees, the establishment of a concession system, any return from land use fees, mining and biodiversity off-sets, a return from ecosystem services, corporate sponsorships, new tourism opportunities, debt for nature swaps and it assumes that the current level of investment by donors remains the same.

Keywords: Mongol Daguur SPA, Protected areas, World park special status

Introduction

During the Rio summit in 1992, Mongolia declared that the country is aiming to designate 30 % of its territory as protected areas 9 in Parliament Resolution No-43, 1993. Based on IUCN 6 basic categories (Dudley, 2008) different countries choose and adopt their own appropriate categories with some adjustments. Mongolia has officially four different categories for protected areas such as strictly Protected Areas, National Parks, Nature Reserve and Natural monuments. Apart from that there are emerging new sites are start attracting encompassing into international level by their own unique characteristics to World heritage, Biosphere reserve, RAMSAR conventions, South East Asian rare animals and bird conservation network, North East Asian Crane Site Network and Global transboundary protection areas network.

Six trans-boundary parks with Russia and seven trans-boundary parks with China is planned to be established (Oyungerel, 2010). World Heritage-Uvs Lake depression is approved as a transboundary protected area (Kurbatskaya et al, 2013). Furthermore, there are six potential transboundary areas with Russia, seven potential transboundary areas with China are under process of developing protected area justification and proposals (Oyungerel, 2005).

Since the 1990s, the area of Mongolia designated as protected areas has expanded significantly, to the current total of 93 protected areas and total now covers 27.9 million hectares, or 17.85% of country's surface which was reported in report of the Strengthening the Protected Area Network" Project MON/10/302 by UNDP/GEF of 2012. Of them 16 or 44.4 percent are Strictly Protected Areas, 42.5 percent or 30 are National Parks, 12.6 percent or 32 are Nature Reserves, 0.5 percent or 15 are Monuments

In total by 2017, 17.85 percent or 27.9 million hectares of land was allocated to state special protected areas, totaling 1298 land areas with 27,409,003.69 hectares occupying 17.5% of the total territory. The Government of Mongolia and Ministry of Nature Environment and Tourism (MNET) has a target to protect 30% of land area Mongolia. Therefore, just recently, by the resolution of the Parliament on May 2, 2019, a total of 22 land areas covering 3.4 million hectares of 29 soums of 9 aimags were issued with state special protection. The value of the policy implementation process for the State SPA is as follows: These include:

In Mongolia, 16 national parks of 12.4 million hectares and 30 natural parks with 11.8 million hectares play a unique role in maintaining the ecological balance of the main natural zones and ecosystems. Mongolia has been heavily involved with special conservation areas with significant ecological significance. However, the government should pay special attention to the implementation of policy objectives for new levels on management of these areas. In summary, about 70 percent of the forest area, about 10 percent of the rivers and streams, over 60 percent of endangered and endangered species of 300 species of plants and animals, and 80 percent of the natural scenery and historical places have been protected under state special protection. Those special protection of the country is defined as the value, significance and importance of PA (Batjargal Z., Shiirevdamba Ts., 2016).

Method

Mongolia has 4 types national and 3 types of international protected sites whereas 13 types of national and 3 type of international protected sites in Republic of Korea. The Protected Areas which cover a total of over 26.2 million hectares, or approximately 17, 5% of the country's surface has becoming main tourism destinations in Mongolia.

Due to lack of appropriate management of natural resources usage, conservational planning and management, tourism cannot contribute well for Protected Area development. Even tough, protected areas management plan was developed to keep the balance the protection and enhancement of its sensitive natural environment, socio-historical sites and improve social and economic outcomes for local residents, the supporting plans such as tourism management plan and business plan are still not developed.

What would the categories of Special World Park Status?

I. Area that preserves evidences of world's geological and evolutionary history.

II. Special natural ecosystem and region, habitat of globally endangered species, habitat of the source population of unique species and unique scenic landscape.
III. Traditional knowledge and traditional lifestyle that is in harmony with nature is preserved by the indigenous or ethnic groups of local people. Place where people use natural & living resource sustainably and their livelihood directly depends on ecosystem services.
IV. Area that preserves world historic and cultural heritage of humanity evidences of human evolutionary history and ancient Mongolian cultural heritage.

Mongolia's protected areas represent the country's very best landscapes, ecosystems, wildlife habitats, watersheds and forests. International and domestic visitors are attracted to these protected areas because they offer the opportunity to enjoy wide open spaces, solitude, adventure, to connect to nature and the chance to experience some of the best hospitality in the world. Globally, these values are becoming increasingly rare and sought after.

Result

Introduction of Mongol Daguur

Using Mongol Daguur SPA as an example, we have made an assessment of the changes in landscapes occurring from 1992 to 2011. Determined the chief causes of them and outlined the principal management tasks regarding specially protected natural territories focusing on minimizing the level of negative effects. We examine the ecological problems faced by the SPA and the associated hazards and suggest recommendations on an optimization of management of the SPA with a view to decrease the possible occurrence of challenging ecological hazards.

This SPA divided two parts “A” and “B”. The part “A” is located in Chuluunkhoroot soum. Northern border of SPA is duplicated with the state border. The part “A” is located between north latitude of 114030’-115030’, east longitude if 49045’- 50015’ that bordering on Russian Federation along the Yanlah River Valley. Total area is 87780 ha. The part “B” of Mongol Daguur SPA is located along the Ulz River Valley between northern latitude of 114055’-115037’, eastern longitude of 49038’- 49044’ through the border of Chuluunkhoroot, Gurvanzagal, and Dashbalbar soums. Total area is 15236 ha.

The Mongol Daguur SPA occupies the northern part of the Daurian steppe eco-region that was acknowledged to be one of the most significant sites for conservation of the planet’s biodiversity within the Global 200 list on the border between two its components, the Mongolian-Manchurian steppe and the Daurian forest-steppe. The steppe sites are currently poorly represented in the World Heritage list. The Daurian steppe is one of the vastest and well-preserved examples of steppe natural complexes on Earth, which comprises intra-zonal wetlands and forest-steppe landscapes that are of great significance for conservation of the universal biodiversity. A virtually complete historical set of plants and animals that are typical of the Daurian steppes and forest-steppes is represented at this site. Almost all types of vegetation associations characteristic for the region, as well as the complex of mammalian and bird (50 and 327 species, respectively) are present here.

The species structure diversity and abundance of birds and mammals, as well as the number of rare species at this site is considerably higher compared to the same figures at the other steppe territories of Eurasia and planet in general. It is attributed to a number of factors: to biotope diversity (the entire range of landscapes and biotopes that is typical of the Daurian eco-region is located here), to location at the place where the migration flyways of the birds become narrow and at the place of junction of large bio geographical units, as well as to the variability of ecosystems caused by climate cycle.

The East Asian-Australasian flyway of waterfowl, semi-aquatic, and passerine birds becomes narrower in the Torey hollow; therefore, it is the key resting site for these birds. The Torey lakes with mouths of the Imalka and Ulz rivers, as well as a [art of the Ulz river floodplain are inscribed on the list of wetlands of international importance and the important bird's areas. Up to 3 million migrating birds stop here. Among the avian species observed at the site, more than half are vagrant birds. A total of 15 globally endangered species inscribed on the IUCN Red List (2011) have been observed in this territory: 1 – critically endangered; 3 – endangered; 11 – vulnerable; and about 40 species have been inscribed on the Red Data Books of the Russian Federation and Mongolia. The site is of is of special significance for conservation of the crane species. Six crane species inhabit the territory; up to 20% of the total world population of the *Demoiselle Crane*, up to 12% of the world population of the *Hooded Crane*, 5% of the *White-naped Crane*, and up to 1% of the *Siberian Crane* accumulate in the Torey hollow before the autumn migration. The Torey lakes are one of the four breeding sites known in the world of the Relict Gull (over 20% of the world population); the lake hollow and the adjacent regions are the habitats of approximately 13% of the total world population of the Eastern Great Bustard. It is one of the last Paleoarctic regions still inhabited by numerous herds of wild ungulates – *dzerens* (Mongolian gazelles). The territory is of key importance for conservation of natural massive transboundary migration routes of *dzeren*, which is the last grandiose phenomenon of this type in Central Asia. The total number of migrating *dzerens* annually staying for winter at this region is as high as 100,000 individuals (5–8% of the total number of the species); the number of non-migrating *dzerens* is 7–8 thousand individuals (Kiriluk, et al., 2013).

This territory is an outstanding example of evolutionary processes: the natural communities of the Torey hollow and the adjacent regions were formed under conditions of periodic climate change, which was the reason for the development of a number of adaptations to continuous deep changes in existence conditions at the level of species and communities. Under contemporary conditions, the climatic cycles during which an arid phase replaces the wet phase occur over relatively short periods of time (approximately 30 years), thus causing substantial and relatively swift rearrangement of steppe ecosystems and a drastic rearrangement of wetland ecosystems. The periodic transformation of wet biotypes into dry and back provides the optimal conditions for the existence of a number of species with different (sometimes opposite) ecological requirements within the same territory. The site is of an undoubted scientific significance as an example of adaptation of the species and ecosystems to the continuously changing climatic conditions and is an important object for monitoring these processes (Kiriluk et al., 2013).

Changes in Landscape Structure PA in Dauria

Our investigation into the dynamics of landscape cover used digital satellite images acquired by Landsat- TM and Landsat-ETM which were converted to the synthesized scan pattern referenced to the topographic map. The ERDAS IMAGINE software package was employed for a classification of land use units on satellite images. The software used included the ESR1 Inc. products: ArcMap G1S desktop package, ERDAS Imagine, I1WIS, and ENVI. The analysis also used the most significant cartographic publications (Oyungerel & Munkhdulam, 2011), and other cartographic and statistical materials. Data from analyzing the satellite images intimate that the border between two its components, the Mongolian-Manchurian steppe and the Daurian forest-steppe, forests steppe were replaced to a significant extent by steppe with meadow and bog- meadow associations, while the meadow steppes gave way to shrub birch steppe (see table 1). There is severe deflation of sands, especially near the mouths of smaller rivers along the lake's left shores, such as the Baruun Tari Lake.

Table 1. Land cover changes in 1991-2008

Landscap types	Area, km^2		Change	
	1991	2008	km^2	%
Lake	7.8	0.0	7.8	0.05
Wetland	61.8	14.4	47.4	29.8
Meadow	12.1	49.9	37.8	23.7
Steppe	26.3	34.6	-8.3	0.05
Bare land	30.3	35.5	-5.2	0.03
Grope field	4.2	0	4.2	0.02
Sand	0.3	0	0	0
Dried lake		0.44	0.44	0.003

Overall, our investigation shows that the main factors that are responsible for changes in the park's landscape cover are due to global warming (by 60%) and are determined by anthropogenic impacts, including overgrazing and the 40%-excess of the utilization of steppe resources.

For example, the water surface area of Lake Baruun Tari has increased over recent years (see figure 1). This is due to two factors, one of which is global climate change. Currently there is taking place an intensification of global processes influencing the dynamics of the largest glaciers, which leads to a water level rise in the lake. The studies show that in the transition zone between the Daurian steppe and the Central desert zone, warming is quite conspicuous. Annual average air temperature is around – 0.9…1.5^{o}C in eastern part of Mongolia. Probably an occurrence of absolute high and low temperature is once in every 20 years. The variation of many years' air average temperature shows the area warmed up to 0.6-1.9°C since the time to make an observation in that region.

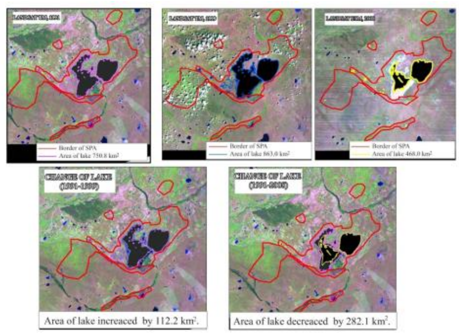

Figure 1. Water surface changes of lake Baruun Tari

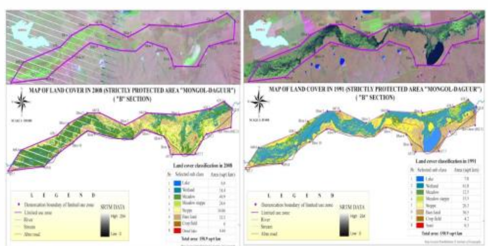

Figure 2. Land cover of Mongol Daguur PA in 1991 and 2008

The other reason is behind from severe anthropogenic impacts. The findings attest that in the Daurian steppe with pasturing. A change in the landscape area of Dauria SPA is 101.8

km^2 totally for the period from 1991 to 2011 (see figure 2).

Discussion and Conclusions

In this context, the principal missions of protected areas are: protection of pristine natural territories for the-preservation and conservation of biological diversity, and for maintenance the protected natural complexes and objects in a natural state; organization and conduct of scientific research, including the keeping of the “Chronicles of Nature”; conduct of ecological monitoring and educational activity; assistance in training scientific personnel and specialists in the field of environmental protection; encouraging local residents to participate in environmental protection measures with prospects for presentation of ecological forms of nature management using the park as the base. The scope and functions of the park listed above suggest that the park’s future management can be formulated as follows. To refine the zoning arrangement requires taking into account the representativeness of landscapes, and updating, reconciliation and approval of zoning changes, and the expansion and establishment of protected zones based on monitoring results on rare animal species and on the state of landscapes should become the immediate top-priority measures. To optimize the layout of the park’s territory, it is imperative that assessments be made of natural and anthropogenic factors affecting the natural complexes of the protected area, with the relevant investigations repeated on a regular basis, and that a data bank be created and the new management plan be worked out.

It is necessary to raise the degree of staff training as well as to improve material and technical equipment of the park. Ecological education and involvement of the local population and administrative bodies in decision-making is main concerning the park’s biodiversity conservation. Considering that illegal mining especially in current situation of minerals is underway, even within the protected areas, it is necessary to foresee the possible outcome of the existing situation and propose the optimal ways to resolve emerging conflicts.

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COMPARATIVE ANALYSIS OF DRIVING FORCES OF LAND USE/COVER CHANGE IN THE UPPER, MIDDLE AND LOWER REACHES OF THE SELENGA RIVER BASIN

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Abstract: The Selenga River Basin is an important section of the Sino-Mongolian Economic Corridor. It is an important connecting part of the Eurasian Continental Bridge and an important part of Northeast Asia. Together with the Mongolian Plateau, the basin forms an important ecological security barrier in northern China. This paper uses the upper reaches of Selenge County, the middle reaches of Sukhbaatar city and the downstream area of Ulan-Ude city as the case area; the land use/cover change pattern is developed based on 12 Landsat remote sensing image data. The comparative analysis of changes reveals the driving force using the PLSR model. The results show the following: (1) In 2005-2015, the area of construction land and cultivated land increased in Selenge County. In Sukhbaatar, the areas of urban and rural construction land, forest land, sparse forest land and grassland area were reduced and in Ulan-Ude city, urban and rural construction land, grassland area expansion. (2) Selenge County is overloaded with overgrazing. Sukhbaatar city is the best water and soil area in Mongolia. Since the disintegration of the Soviet Union in Ulan-Ude, the abandonment of farming has been severe due to the reduction of the agricultural population, resulting in a reduction in the area of cultivated land. (3) The Selenga River Basin is the core strategic area for the construction of the "Belt and Road" and the Sino-Mongolian Economic Corridor.

Keywords: Land use and land cover change, Driving mechanism, The Selenga River Basin, PLSR

Introduction

As the main upstream river and water source of Lake Baikal, the Selenga River Basin is an area that is sensitive to global change, and it is an important channel for the Sino-Mongolian-Russian economic corridor and a key area for the construction of the "Belt and Road". Land use and cover change (LUCC) in this region directly affects water resource changes in the basin and affects the ecological security of the human natural heritage of Lake Baikal.

At present, LUCC research is not limited to the construction of land use/cover patterns, and the quantitative analysis of LUCC process changes and driving mechanisms has become a global research hot spot. In the analysis process, statistical measurement models are in-

-troduced to describe the relationship between LUCC and impact factors in the time period, to rationally adjust social and economic activities, and to scientifically utilize land resources.

Although past studies have been conducted in the Selenga River Basin, the analysis of land use change and its driving force in the cross-border areas of China, Mongolia and Russia are scarce, and most wereconcentrated on a large scale. A comparative analysis of the upper, middle and lower reaches of the basin has not yet been carried out. It is a weak area for LUCC research, and there is room for further analysis and discussion. Therefore, based on remote sensing technology and local natural and socio-economic data, this paper analyses the spatial and temporal characteristics of LUCC and the construction of its driving mechanisms for typical cities in the upper, middle and lower reaches of the Selenga River Basin from 2005 to 2015. The purpose is to analyse the spatial differentiation law of LUCC in the middle and lower reaches of the basin and the differences in its driving mechanism, to provide scientific information for the protection of ecosystems in the upper, middle and lower reaches, and to provide a theoretical reference for promoting ecological protection and sustainable socio-economic development in cross-border areas.

Methods

Data pre-processing

For the Landsat remote sensing image data, we performed geometric precision correction and image registration, and we used high-resolution data for image fusion, image mosaic and cropping.

Object-oriented classification

This paper uses eCognition 8.7, an object-oriented classification method, to select a variety of classification features. In the classification process, the high-resolution images are manually interpreted, and the incorrect areas are corrected to ensure high data accuracy.

Create a classification system

Combined with the nature and characteristics of Mongolian land resources and based on the ecosystem type, the classification system was unified to contain eight types of new classification classes.

Land use/cover change measures

The spatial operation of the land use status map of remote sensing images is carried out, and the land use type transfer matrix of different time periods is obtained to quantitatively analyse the entire process of LUCC.

PLSR for selecting the LUCC driving factors

Figures and photographs must fit within one column or Using the land area of each city in 2005, 2010 and 2015 as the dependent variable, the driving land analysis of the typical cities' construction land, cultivated land, forest land and grassland was carried out, and the driving factor index system that matched the urban characteristics was established.

Results

Land Use/Cover Pattern

During the period of 2005-2015, the land use/cover type in Selenge County was dominated by forest land, followed by grassland, and the proportion of artificial surface area was small. In 2005-2010, the proportion of forest land in Selenge County increased from 49.58% to 55.74%, and the proportion of grassland area decreased from 20.30% to 14.27%. The area of woodland did not change considerably, and the proportion of construction land and cultivated land increased from 0.47% and 0.77% to 1.65% and 0.89%, respectively; in 2010-2015, the proportion of forest land decreased to 39.36%, the proportion of grassland increased to 25.07%, the area of woodland increased slightly, and the proportion of construction land and cultivated land increased to 3.59% and 3.98%, respectively.

During the period of 2005-2015, the land use/cover type of Sukhbaatar city was dominated by forest land and grassland, followed by unused land, and the area of artificial surface decreased. In 2005-2010, the proportion of forest land in Sukhbaatar city decreased from 29.37% to 17.86%, and the proportion of grassland area decreased from 16.30% to 11.76%. The area of woodland increased slightly, the proportion of construction land area decreased from 14.21% to 9.69%, and the proportion of cultivated land increased from 5.37% to 10.40%. In 2010-2015, the proportion of forest land decreased to 8.40%, the proportion of grassland increased to 15.11%, the area of woodland decreased slightly, the proportion of construction land area did not change, and the proportion of cultivated land increased to 13.11%.

During the period of 2005-2015, the land use/cover type of Ulan-Ude city was dominated by forest land, followed by grassland, and the area of artificial surface gradually increased. In 2005-2010, the proportion of forest land in Ulan-Ude city decreased slightly, the proportion of grassland increased from 11.52% to 17.74%, and the proportion of sparse forest area increased from 11.87% to 14.84%. Additionally, the proportion of construction land area increased slightly. The proportion of cultivated land decreased from 17.12% to 13.99%. In 2010-2015, the proportion of forest land increased to 17.55%, the proportion of grassland area decreased to 15.99%, the proportion of sparse forest land decreased to 5.11%, the proportion of construction land increased to 30.68%, and the proportion of cultivated land decreased to 8.78%.

Land use/cover change

The land area of Selenge County is 4905.5 km2, and the landscape substrate is forest land, accounting for approximately 50% of the total land area. At the beginning of the study period, there were 23.30 km2 of urban and rural construction land, 37.94 km2 of cultivated land, 2432.29 km2 of forest land, 995.92 km2 of grassland, 522 km2 of sparse grassland, 41.38 km2 of unused land, 21.93 km2 of water area, and 794.12 km2 of woodland. By 2015, the area of forest land was reduced to 1962.11 km2, accounting for 39% of the total land area, the urban and rural construction land expanded to 179 km2, accounting for 3.59% of the total land area, and the area of grassland increased to 1249.62 km2, accounting for 25% of the total land area.

The urban area of Sukhbaatar is 22 km2, and the landscape substrate is grassland and woodland, accounting for approximately 50% of the total land area. At the beginning of the study period, the classes in the region were ranked by area: 6.66 km2 for forest land, 3.70 km2for grassland, 3.25 km2 for woodland, 3.22 km2 for construction land, 2.73 km2 for unused land, 1.43 km2 for sparse grassland, and 1.22 km2 for cultivated land. By 2015, the increase of sparse grassland was 5.52 km2, the forest land area was reduced to 1.86 km2, the area of urban and rural construction land was reduced to 2.12 km2, and the woodland and grassland areas were slightly reduced to 2.91 km2 and 3.34 km2, respectively. Additionally, the cultivated land and unused land increased to 2.9 km2 and 3.2 km2, respectively.

The urban area of Ulan-Ude is 354 km2, and the landscape substrate is forest land and grassland, accounting for approximately 30% of the total land area. At the beginning of the study period, there were 73.55 km2 of urban and rural construction land, 64.83 km2 of forest land, 60.73 km2 of cultivated land, 42.12 km2 of sparse forest land, 40.87 km2 of grassland, 34.50 km2 of sparse grassland, 21.51 km2 of unused land, and 11.60 km2 of water surface. By 2015, the urban and rural construction land area expanded to

108.57 km2, accounting for 31% of the total land area. The forest land area was reduced to 62.10 km2, accounting for 17% of the total land area, and the grassland area increased to 56.60 km2, accounting for 16% of the total land area.

Analysis of driving factors of major land-type changes

Selenge County, which is in the upper reaches of the Selenga River Basin, is in the territory of Mongolia. In the past ten years, the area of urban and rural construction land, grassland, wasteland and bare land has increased, the area of forest land has declined, and desertification has intensified. On the one hand, there are better conditions for aquatic plants in the region, and the animal husbandry industry has been developed. However, due to overloading and pastoralism, desertification occurs, forest land is reduced, and grassland is degraded into wasteland. On the other hand, after the privatization of Mongolian land, the population migrated to places with convenient transportation, which led to overloading and grazing around the main railway line and aggravated the phenomenon of desertification.

The city of Sukhbaatar is in the middle reaches of the Selenga River and is located at the junction of Russia and Mongolia. It is rich in aquatic resources and has the best water and soil conditions in Mongolia. During the period of 2005-2015, the land use/cover type of Sukhbaatar city was dominated by forest land and grassland, followed by unused land, and the area of artificial surface decreased. To ensure the food security of Mongolia, there have been more openings, and the area of cultivated land is increasing.

Conclusions

Through the comparison of the upper, middle and lower reaches, the results show the following: (1) In 2005-2015, the impact of human activity intervention was more obvious. The land use/cover type of Selenge County in the upper reaches was mainly forest land, followed by grassland. The proportion of artificial surface is small, but it is expanding. The land use/cover type of Sukhbaatar city in the middle reaches is mainly forest land and grassland, followed by unused land, and the area of artificial surface has a decreasing trend. In recent years, the rate of Ulan-Ude city construction land use has increased, the area of construction land has expanded, the area of cultivated land has decreased, and the area of grassland has increased. (2) Over a relatively short period of time, the typical urban land cover pattern changes in the basin and the natural factors are not obvious. Human activities and their side effects play a leading role in small-scale urban LUCC. (3) It is recommended to advocate for the concept of greening the "Belt and Road", strengthening the land management and control, and preventing the disorderly development of regional land. The upper reaches of the region should focus on preventing overgrazing, which leads to desertification. In the middle reaches, it is necessary to prevent the over-cultivation of cultivated land. The downstream areas should prevent the urban space from expanding too quickly and causing damage to the human nature heritage Lake Baikal ecosystem.

The typical city of Ulan-Ude in the lower reaches of the Selenga River Basin is in the Republic of Buryatia, Russia. In the past ten years, the area of construction land and grassland has increased, the area of cultivated land has decreased, and the area of forest land has slightly declined.

Acknowledgments

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EST 2019

Sub-Session:

Ecology and Environmental Research Approach

SOIL EROSION STUDY USING FALLOUT RADIONUCLIDE TECHNIQUES IN SOUTHERN MONGOLIA, OROG LAKE AREA

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Abstract: The soil erosion study using 137-Cesium fallout radionuclides methods was done, in Gobi desert of southern Mongolia in case Orog lake area. Study area is grazing land, therefore estimation of soil erosion rates from radionuclide inventories used Profile Distribution Model. Totally, 67 soil samples taken by core methods and analyzed by gamma spectrometry. Average soil erosion rate of Orog lake basin desert area is 12.57±1.08 t ha-1 y-1. The maximum soil erosion -40.87 t ha-1 y 1 value is identified in the middle steep slope of Ikh Bogd mountain and highest soil sediment accumulation (7.55 t ha-1 y 1) is occur in the Solonchak soils in meadow area of south-east shoreline of Orog lake. Study areas divided by 3 groups according by geographical conditions, as a mountain, desert and meadow. The average soil erosion in mountain area is -15.00 t ha-1 y 1, desert area is -13.65 t ha-1 y 1, and meadow parts -5.70 t ha-1 y 1 defined. Climate warming have general negative impact for soil erosion in desert areas. Other hand livestock number increases 3.2 times within the 30 years (1987-2017) and overgrazing becoming one of additional factor for soil erosion.

Keywords: Cesium 137, Gobi desert, Mongolia, Soil erosion, Soil organic matter

Introduction

Arid land soil erosion process is one of serous environmental problem which cause increase of desertification and expand of unfertile barren land. Water and wind erosion are the two primary causes of land degradation; combined, they are responsible for about 84% of the global extent of degraded land, making excessive erosion one of the most significant environmental problems worldwide (Blanco & Lal, 2010).

The soil erosion in Gobi desert area of Mongolia increasing due of overgrazing and climate warming. The wind and water erosion is both existing in desert area and making difficulties to soil erosion study. Still not much data about soil erosion in Gobi deserts of Mongolia. The soil erosion study using 137Cs isotope techniques was conducted in the Sainshand typical desert area south-eastern Mongolia and result show 4.19 t ha-1 y-1 value for desert soil erosion (Jiyuan et al., 2008). For the steppe area of Mongolia have several investigation of soil erosion using isotope techniques (Norov et al.,1998, Kato et al., 2006, Batkhishig, 2013, Hirose et al., 2017). Fallout radionuclide-based techniques are powerful tools to assess soil erosion/deposition at several spatial and temporal scales in a wide range of environments, and offer potential to monitor soil quality (Dercon et al, 2012).

Study area and Methods

Study area is Orog lake basin area, representing typical Gobi desert region in south-west of Mongolia. Geographically this area belong to the "Valley of lakes", from north-west to the south-east oriented depression between Khangai and Gobi-Altai mountain ranges. In the southern parts rising Ikh_Bogd mountain massif with elevations up to 3957 meter a.s.l. and northern parts mainly plain area with few small rocky hillocks with lowest point in the shoreline of Orog lake with elevation 1221 meter a.s.l. The Orog lake level changing according by climate condition and last century it was disappeared several times. The late Quaternary period Orog lake level change was significant, up 60 meter high lake level was identified (Lehmkuhl et al., 2018).

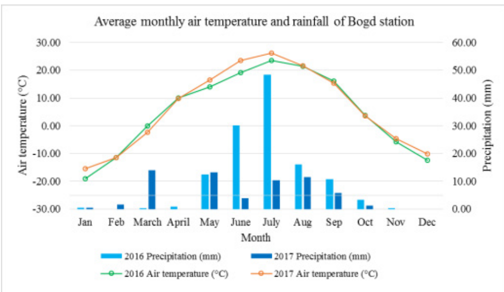

Figure 1. Average monhtly air temperature and preceptation (Bogd station)

Study area average air temperature according by Bogd station is 4.94^{O} C, January air temperature -17.28^{O} C and July air temperature is 24.9^{O} C (year 2016-2017). Annual precipitation is 92.6 mm, big difference in year 2016 and 2017 with 122.9 mm and 62.3 mm respectively.

Administratively study area belong to the Bogd soum of Bayankhongor aimag. The total number of livestock in 1987 was 71,280 head after 30 years it was increased 3.2 times up to 231,750 head. Mainly goats number is drastically increased this period about 5 times from 34.130 up to 168,660. Overgrazing becoming serious problem in this area.

Study area Orog lake basin is comparatively large, therefore for the soil samplings we used "isosectors" approach (Mabit et al., 2014). Used core sampling with 15 cm depths. Field study was conducted in 2017, totally from 67 points take a soil samples. Gamma spectrometry analysis was done in the Nuclear Center Laboratory of National University of Mongolia. In the Soil Laboratory of Institute of Geography-Geocology of Mongolian Academy of Sciences conducted soil organic matter, pH, EC, texture, gravel and bulk density analysis.

For estimation of soil erosion and deposition rates from radionuclide inventories of 137Cs in grazing lands used Profile Distribution Model. If it is assumed that the total 137 Cs fallout occurred in 1963 and that the depth distribution of the 137 Cs in the soil profile is independent of time, the erosion rate Y for an eroding point can be estimated as (Walling et al., 2014):

$$Y = \frac{10}{(t-1963)P}\ln\left(1-\frac{X}{100}\right)ho \qquad (1)$$

where: Y - is the annual soil loss (t ha-1 yr-1); t - is the year of sample collection (yr); X - is the percentage 137Cs loss in total inventory in respect to the local 137Cs reference value (defined as [(Aref - Au]/Aref]x100); A - is the measured total 137 Cs inventory at the sampling point (Bq m-2); P - is the particle size correction factor. For statistical data analysis we used SPSS-23 software.

Results

Areas strongly affected by wind erosion area difficult to find suitable places for reference sampling. Possible to adopting the reference values from studies carried in surrounding or nearby areas with similar conditions (FAO/IAEA, 2017). In central Mongolian grassland area west of Ulaanbaatar city research was determined 137Cs reference inventory (CRI). In the top of small hillocks CRI ranges 1558-1778 Bq m^{-2}, and average value is 1668 Bq m^{-2} (Batkhishig, 2013). In the several research study in Inner Mongolian grassland area determined 137Cesium reference inventory (CRI). The measured reference inventory of 137Cs was 1967 (±102) Bq m^{-2} located at a summit position of moderately grazed steppe (Funk et al., 2012). For this study we used average data of above research (1917.5 Bq m^{-2}) and for soil erosion inventory calculation used this value.

The Orog lake basin surrounding areas possible to divide 3 groups according by landscape geographical conditions. First group is, mountain area of Ikh Bogd massif with sampling area elevation ranging 2895-1295 meter a.s.l. In mountain areas mostly dominated Leptic Kastanozem soils, in the higher parts under alpine meadow-steppe vegetation's formed Mollic Umbrisols, and foot slopes dominated Leptic Calcisols. Soil organic matter ranges 8.58-3.176 % in the Mollic Umbirols, 1.84-1.09 % in Leptic Kastanozems and 0.81-0.29 % in the Calcisols. Second group is, desert plain area with domination of Calcisols. Third is, meadow-grass area surrounding of Orog lake shoreline and floodplain of Tui rivers with domination of Solonchaks and Luvisols,

Table 1. Descriptive statistics of Soil erosion, (t ha^{-1} yr^{-1})

Statistic	Mountain (n=17)	Desert (n=38)	Meadow (n=12)	Total (n=67)
Mean	-15.00	-13.65	-5.70	-12.57
Max	-40.87	-28.13	-16.44	-40.87
Min	-2.15	0.02	7.55	7.55
STD	10.84	7.11	8.09	8.86
Var	117.50	50.49	65.54	78.48
Med	-14.44	-12.38	-3.94	-11.96
SEM	2.63	1.15	2.34	1.08

The Orog lake basin area average soil erosion rate calculation from 67 data is 12.57±1.08 t ha^{-1} y^{-1} (Table 1). Maximum soil erosion rate -40.87 t ha^{-1} y^{-1} value, is marked in the middle steep slope of Ikh Bogd mountain with slope inclinations 30^{O}. Highest soil sediment accumulation (7.55 t ha^{-1} y^{-1}) is occur in the Solonchak soils in the meadow of south-east shoreline of Orog lake.

Table 2. ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	710.9	2	355.5	5.09	.009
Within Groups	4469.1	64	69.8		
Total	5179.0	66			

Soil erosion variables mean between mountain, desert, meadow areas significantly ($p<0.05$) differed (Table 2). More variables in mountain area soil erosion. The mountain area soils more eroded with average rate -15.00 t ha^{-1} yr^{-1}. Foot slope area soils less eroded with mean values -10.28 t ha^{-1} yr^{-1}. Also, in the high top part of Ikh Bogd mountain area soils comparatively less eroded with average value -11.49 t ha^{-1} yr^{-1}. Soil organic content is higher in the top part mountains. Mountain middle slope area soil erosion is highest with average soil erosion value 22.85 t ha^{-1} yr^{-1}.

Desert plain area soil erosion is high with average of 38 point data is -13.65 t ha^{-1} yr^{-1}. Within the desert plain areas depending of soil properties, topographies soil erosion is differed. West and north-west of Orog lake area desert soils more eroded with average value -14.13-15.48 t ha^{-1} yr^{-1}. East and north of Orog lake areas less eroded with average erosion rate -10.52-11.60 t ha^{-1} yr^{-1}. Clear evidence of soil particles accumulation in the east of Orog lake area is, big sand dune "Mongoliin hooloi". But in the western part of lakes few single sand dunes. The Orog lake is several times completely dried out in the last century. Last big drought occur in late 1980-s and after 2000. Orog Lake dried bottom bare land becoming one of source of soil sediments erosion.

In the surrounding of Orog lake shoreline depressions growing more grass vegetation. Mean soil erosion in the meadow depression part is -5.70 t ha^{-1} yr^{-1}. Some parts have soil accumulated with sedimentation rate 2.68 and 7.55 t ha^{-1} yr^{-1}. Meadow area soil vegetation cover is more complex, most of this area is depression with soil accumulations. But due of strong winds some of depression areas prevailing soil erosion.

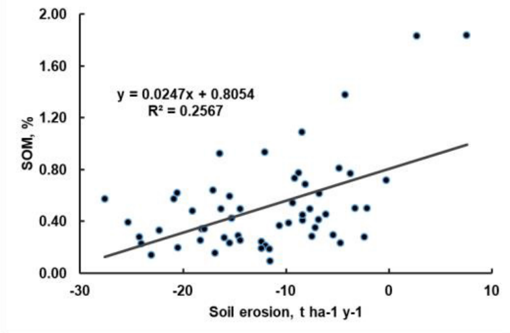

Figure 2. Soil erosion and SOM scatterplot

Soil organic matter content linearly slightly depends from soil erosion rate (Figure 2). Pearson correlation (r = 0.507) also show more direct relation. Mountain area soil organic content is higher (3.176-8.580 %) than comparing with other parts. Meadow area soil organic matter is not much high ranging 0.233-1.836 %.

Study results show, desert area soil erosion in case of Orog lake basin is 12.57±1.08 t ha^{-1} y^{-1}. Comparing with central Mongolian steppe grassland area (Batkhishig, 2013) soil erosions (5.613 t ha^{-1} yr^{-1}), desert area soil erosion is more than twice as higher. Climate warming have general negative impact for soil erosion in desert areas. Other hand livestock number increases 3.2 times within the 30 years (1987-2017). Overgrazing and livestock pressure on soil is becoming one of additional factor for increase of soil erosion.

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CRISIS OF TIGER POPULATION IN THE WORLD

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Abstract: The future earth is in our hands. But nowadays, biodiversity is very rapidly diminishing from global level due to massive anthropogenic pressure. In conservation of tigers have multiple advantages such as the promotion of cultural services, increase in carbon storage and sequestration, poverty alleviation, watershed management, natural hazard regulation, sustaining food security and agriculture services, improvement of medical services and ecotourism. We know, if tigers are protected the landscape also remains protected along with other endangered species and their habitats. In 1990, about 100,000 tigers roamed the forests of the world, but their numbers dropped steadily, hitting a low of 3,200 in 2010 when the last estimates were compiled. But a new count shows the number of tigers in the wild at 3,890, with India being home to 2,226, or more than half of them due to project tiger programme. In the study area, the Ranthambhore tiger reserve area has sixty plus tigers and about 0.3 million people directly or indirectly depend on these tiger's services. The objectives of this research are to assess crisis of tiger population, the habitat vulnerability and human wildlife conflicts. This research based on primary and secondary database and data analysis has been done through ArcGIS, Erdas, QGIS software's and MS Excel 2016, SWOT Matrix Method and other techniques. The tiger ecosystem services and habitat ranking have been analyzed through numerous methods and techniques. In Ranthambhore tiger reserve, the research reveals how the existence of tiger has proved a double-edged sword as it has catalyzed the protection of ecosystem and conflict planning and on the other hand given rise to human wildlife conflicts. The research identified the geographical, social, economic and political factors that are responsible for human wildlife conflicts as well as identifies the vulnerability in Ranthambore and subsequently suggest comprehensive management strategy for tiger conservation in the reserve which is holistic, inclusive and sustainable development of tiger habitat. That kind of conservation will be flourish in magnolia also due to the wildlife of Mongolia consists of unique flora and fauna in eight habitats dictated by the diverse and harsh climatic conditions found in the country.

Keywords: Human Wildlife conflict, Tiger conservation, Tiger corridor, Habitat vulnerability, Eco Development and Sustainable Development

USING BIODIVERSITY FOR DEGRADED RANGELAND RESTORATION IN CHINA

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Abstract: The grassland deterioration has been the main environmental problem in China, which has not only affected the quality and function of the grassland itself but also led to deterioration of the ecological environment, threatening the survival and development of humankind (Batunacun et al., 2012). The study would introduce the current status of rangeland deterioration in China, and make a comparative analysis of the changes in last decade; identify the main driving forces causing land degradation; analyze the evaluating and monitoring index for the health and multifunction of ecosystem; figure out the gaps for our research and policy efforts, propose the policy suggestion on using biodiversity for ecosystem restoration.

1. The main situation on rangeland degradation in China

The process of grassland deterioration includes grassland degradation, grassland desertification and grassland salinization (Yan &Tang, 2008). According to the China Ecological Environment Bulletin, during 1997-1998, more than 90% of the natural grasslands in China were deteriorating at different levels, and the deterioration was accelerating at a rate of 2% annually in the available grassland regions.

2. Main driving forces on rangeland degradation

Grassland degradation is the combination of natural and human factors. However, human factors, such as faulty system, overgrazing, closed household behavior, single industrial structure, are the main factors leading to the rapid degradation of grassland ecology (Qin et al., 2016; Han et al., 2014; Li et al., 2002).

3. Monitoring and evaluation index on rangeland degradation restoration

According to the GB 19377-2003, there is a series of index for monitoring and evaluation on rangeland degradation restoration. Essential monitoring index include plants community characteristics, the plants community components and structures, indicator plants, aboveground biomass, soil nutrients, subsidiary monitoring index: surface feature, soil physical and chemical properties.

4. Research focuses on degradation rangeland restoration

According to the 5th China National Desertification and Sandification Inventory Monitoring results in 2014, compared with these in 2009, the hot regions of grassland deterioration research mainly distribute in northern and western China, Inner Mongolia (Hulun Buir) and middle eastern Inner Mongolia (Xilingol, Chifeng, Wulanchabu), are significant hot regions of grassland deterioration research area (Hu et al., 2017).

Research efforts to understand the mechnisms of degradation include gazing management, optimized utilizing the rangeland resources, pasture development, degraded

-ation include gazing management, optimized utilizing the rangeland resources, pasture development, degraded ecosystem restoration methods, such as fertilizer, irrigation and reseeding of degraded rangelands. But It is argued that unless the mechanisms are understood, restoration will be more costly and likely to fail.

5. Policy support for rangeland restoration

Rangeland restoration is now emphasized by the National Green Development Plan. The first major attempt to improve the rangelands and their management occurred in 1985 with the enactment of the Rangeland Law. Since 1990 the Government and related sectors, have enacted a series of policies and regulations to protect the environment and resources of rangelands.

Promoted by the policy of grants and incentives for grassland ecological protection, the pace of implementation of various policies, such as grassland contract, basic grassland protection, balance of grass and livestock, forbidding grazing and resting grazing etc has been markedly accelerated.

Understanding the experiences and good practices of rangeland situation and restoration efforts would be quite helpful for the other countries generating the green developing strategy and future collaboration.

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EST 2019

SESSION 2:

ENVIRONMENTAL MANAGEMENT AND REGIONAL DEVELOPMENT

Session Description

The main focuses of the session are scientific results from a piecemeal to a holistic approach can be seen as an important part of a “sustainable development” approach noting that environmental quality has an impact on the performance of the economy. This session outlines a management system designed to improve both economic development and environmental management at the regional level. At this time, Mongolian government has been developing spatial development programs which is “Regional Development Concepts of Mongolia”, “State Policy on Population Settlement and Residential system of Mongolia” and “Integrated Industrial Planning and Mapping of Mongolia”. At this meeting, to support the development of these policy documents by scientific results, discussions and cooperation.

This session has included 4 sub-sessions that are Environmental Policy and Sustainability; Regional Economic Corridor and Integration; Transdisciplinary, Interdisciplinary research and Cooperation and The Efficient State, Science and Business Collaboration and Cluster Development Concept.

The Sustainable Development Goal was adopted by the UN General Assembly in September 2015 and officially launched since 1st of January 2016. These 17 Sustainable Development Goals need to be implemented in all developed and developing countries - in a global partnership. Mongolian government approved Sustainable Development Vision 2030 of Mongolia. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality and spur economic growth – all while tackling climate change and working to preserve our oceans and forests.

Economic corridor development can be instrumental in promoting the regional cooperation agenda and it is concerned with the spatial development planning and activities. We have been focusing to research on relation between International initiative, Regional Integration and National spatial development planning.

Contemporary sustainable development challenges are complex, and tackling those demands cooperation between specialists with diverse backgrounds in both the environment and social sciences. We try to develop Interdisciplinary and Transdisciplinary research and Cooperation on scientific platform.

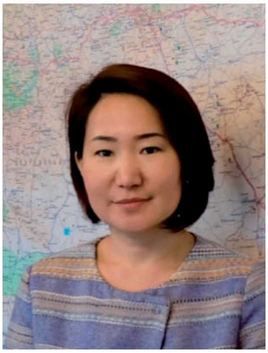
Many governments and industry organizations around the globe have turned to develop the cluster development concept in recent years as a means to stimulate urban and rural economic growth. Otherwise a cluster development is a strategy that seeks to promote economic growth by methodically structuring an urban area or region with a balance of different types of businesses and educational institutions.

EST 2019

Sub-Session:

Environmental policy and sustainability

INTEGRATED WATER RESOURCE MANAGEMENT IN MONGOLIA



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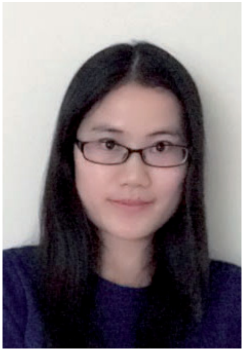
Abstract: Water stress scenarios are evident in Mongolia, a region characterized by semi-arid to arid climate with low precipitation. Significant future gaps in water supply and demand have been identified in the capital city Ulaanbaatar, home to roughly half the population, and the fast-growing mining region of the southern Gobi. To overcome such water challenges, the Mongolian government introduced the Mongolia Water Law in 2012. The law aims to promote integrated water resources management (IWRM) as a key framework for hydrological planning and implementation. The legal framework mandates each of Mongolia's 21 River Basin Authorities (RBA) for 29 river basin—which is part of the government—to be monitored by a multi-stakeholder River Basin Council (RBC) that comprises representatives from the private sector and civil society at the basin level. Although formalized by law, the RBCs were not functioning effectively.

Since the time when 2030 Water Resources Group (2030 WRG) was officially launched in 2013, 2030WRG has conducted numerous comprehensive and targeted analyses to help chart a path towards water security in the country. Based on the rigorous assessments and 2030WRG Multi-Stakeholder Platform (MSP) recommendations, the revised guidelines on reformation of existing RBC into RB MSP council was officially accepted by the government as an official administrative act on March 13, 2018. These guidelines cover critical issues such as the establishment of the River Basin MSP Council, the facilitation of stakeholder participation in the planning and implementation of basin-level IWRM plans, collaboration and engagement with basin authorities, financing of the Councils, and identification of stakeholder responsibilities.

In order to implement the new guidelines, the River Basin Management Division, Ministry of Environment and Tourism collaborated with 2030 WRG on the establishment of new RBCs, as well as the re-formation of existing RBCs into river basin MSP Councils. Before the adoption of the new guidelines for River Basin MSP Council development, a total of 14 River Basin Councils had been established in Mongolia according to the earlier (2013) RBC guidelines. As a result of collaboration, 10 new RBCs were successfully established, and 13 RBCs were reorganized according to the MSP concept by December 2018. In addition to basin-level MSP formation, 2030WRG also supported capacity building and coaching on river basin governance for a range of stakeholders, ensuring effective stakeholder participation river basin planning and implementation.

Finally, 2030 WRG gratefully acknowledge financial support received from Swiss Agency for Development and Cooperation in strengthening water governance in Mongolia.

VARIATIONS IN ECOSYSTEM SERVICES IN RESPONSE TO WETLAND LOSS IN A COLD REGION



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Abstract: In the last six decades, natural ecosystems in the Sanjiang Plain, Northeast China, have undergone significant disturbance. Our study investigated wetland loss history and revealed the ecosystem service decline caused by wetland loss in this area. Based on multi-source data, we obtained wetland loss history since the mid-1950s. Then ecosystem service value (ESV) changes in response to wetland loss were estimated quantitatively in the Sanjiang Plain. Results indicate that wetland area declined by 73.3% (about 2.77 million ha) since 1954, mainly due to the transformation of wetlands to farmland. Wetland loss has reduced the ecosystem service value by $57.46 billion over the past six decades in the Sanjiang Plain. The largest reduction in ESVs was due to agricultural expansion, especially that of dry farmland. Ecosystem services of all functions except agricultural product functions showed a decreasing trend in the past 60 years. Agricultural product functions increased at the expense of other functions. Wetland restoration and protection of existing wetlands are necessary to reduce the loss of ecosystem services as well as to promote sustainable development.

FOREST MANAGEMENT DEVELOPMENT OF PROTECTED AREA IN MONGOLIA

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Abstract: Forest study of Protected Areas (PA) was conducted in totally 5 National Parks (NP), 4 Strictly Protected Areas (SPA) which distributed forests in Eastern, Central and Western regions of Mongolia. This work was first basic research of forest sustainable management of 9 PAs with forests. The main objectives of the study was to identify forest cover area, damaged area by insects, logging and forest fire, to define natural regeneration process in damaged area, restoration activities and stand growth trend by methodologies of forest taxation and dendrochronology, and to assess forest management using SWOT analysis. For developing forest management should be taken such as increasing funding, strengthening capacity building, forest action planning, and implementing restoration activities and silvicultural activities developing cooperation and tourism. In order to ensure efficiency, need for an appropriate management information system and monitoring of management activities, is more important in protected area administration (PAA).

Keywords: national park, strictly protected area, forest cover, natural regeneration, restoration

Introduction

Mongolia was probably one of the first countries in the world to realize the importance of conservation. The International Union for Conservation of Nature (IUCN) defines a Protected Areas as "a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley 2008).

Bogd Khan Mountain was established as Mongolia's first official protected area in 1778 (Myagmarsuren and Namkhai, 2012). In 1992 the Mongolian Parliament established the goal to expand the protected area system, to protect 30% of the country by 2030 (ChimedOchir 1997).

The Law on Protected Areas of Mongolia has designated four types of protected area (i) Strictly Protected Areas, (ii) National Parks, (iii) Nature Reserves, and (iv) Natural and Historical Monuments.

In recent years, within foreign aids several large projects have been implementing in some regions of PA such as "Biodiversity and Adaptation to Climate Change" No2012/65/511 project for strengthening PA management, conservation biodiversity, supporting sustainable livelihoods of local people in the buffer zone, and in 2013-2018, "Mongolia's Network of Managed Resource Protected Areas MON13/303" project for establishing a habitat of Mongolian biodiversity endangered in the world, and ensuring multi-ecosystem integration implemented in 3 PAs, in 2016-2019, "Integrated Livelihoods Improvement and Sustainable Tourism in Khuvsgul Lake NP MON48216" project for establishing a habitat of Mongolian biodiversity endangered in the world, and ensuring multi-ecosystem integration implemented in 3 PAs, in 2016-2019, "Integrated Livelihoods Improvement and Sustainable Tourism in Khuvsgul Lake NP MON48216" project for improving livelihoods and increasing income of local people through the development tourism based on local people participation, in 2017-2018, "Sustainable Tourism Development MON50013" project for developing technical and economic feasibility study of sustainable tourism development implementation in Khuvsgul lake NP. Now the project with assistance of Investment bank of Germany is implementing for providing equipment, devices, technics, facilities and building constructions.

In 2016, within the scope of project "Biodiversity and adaptation to climate change" by Ministry of Environment and Tourism (MET), researchers of Forest Resource and Forest Protection division of Institute of Geography-Geoecology, Mongolian Academy of Sciences have done to provide expert service "Preparing baseline information and conducting research for the sustainable forest management in Special Protected Areas and their buffer zones". Forest basic study was conducted in Khangai Mountain NP, Gorkhi-Terelj NP, Onon-Balj NP, Orkhonii khundii NP, Tarvagatai Mountain NP, Khan Khentii SPA, Ulaan Taiga SPA, Otgontenger SPA and Zed, Khantai, Buteel mountains SPA.

Results

At national level, the Department of Protected Area Administration of the Ministry of Environment and Tourism is responsible for providing overall Protected Area management and Protected Area administrations (PAAs) established at local level are responsible for carrying out the actual management of Protected Areas. In 2016, within the framework of the new PAs boundary, forest survey has been revised to forest covered and non-forest covered area of each PAs using Landsat satellite data. The survey has been provided baseline information of forest state and management defining for PAs.

Forest cover, type and growth trend

In the Khangai Mountain NP which located in Arkhangai aimag, there is total 61719 ha of forest covered areas, 1155 ha of burned forest areas, 354 ha of damaged forest areas by insect. Type classification of forest covered areas can be further divided as: 52587 ha coniferous forests, 8806 ha evergreen forests, 326 ha mixed forests.

In Ulaan Taiga SPA which located in Khuvsgul aimag, there are 654401 ha of forest covered area, burned forest area is 23974 ha, and there is no damaged forest by insect. The comparing to previous forest inventory data, there has been increased of forest covered area by376203 ha and burned forest area by 12300 ha due to expansion protected area.

Total forest area of Otgontenger SPA which located in Zavkhan aimag was determined 53486 ha by using satellite data. Regardless of its low fire hazard rank, there has been large extent forest fire in 2002, and total 32991 ha areas (61.7%) were burned.

Total forest area of Gorkhi-Terelj NP in Tuv aimag (near the Ulaanbaatar city) is 136470 ha, out of which 553 ha area is damaged by insects, and 5567 ha is burned.

The forest area of Onon-Balj NP which located in Khentii aimag is 322260 ha, out of which 225442 ha is forest covered area, 96459 ha (42.8%) is burned forest area, 359 ha (0.1%) is insect damaged area.

Khan Khentii SPA which belongs 2 aimag's territory of Khentii and Selenge has 1332.8 thous.ha forest area, out of which 444.7 thous.ha area affected by forest fire, 2805 ha insect damaged. Forest area can be traced as: 634.6 thous.ha evergreen forests, 397.3

thous.ha coniferous forests, 16.6 thous.ha broadleaved forests, 284.3 thous.ha mixed forests.

The forest area of Tarvagatai Mountain Range NP which located in Zavkhan aimag is 128224.9 ha, out of which forest covered area is 46475 ha, burned forest area is 81735 ha, and insect damaged forest is 14.9 ha. Coniferous forests is 36346 ha, mixed forests is 8774 ha, evergreen forests 1355 ha.

Total forest area of Orkhonii Khundii NP which located in 2 aimags territory of Arkhangai and Uvurkhangai is 78150 ha, out of which forest covered area is 72150 ha, burned forest area is 3147 ha, and insect damaged forest is 187 ha. Evergreen forest is 24773 ha, coniferous forest is 24350 ha, and mixed forest is 23048 ha.

Totally, result of dendrochronological analysis shows that radial growth increment of forests was decreased dramatically in last 20 years lower than average increment.

Natural regeneration

In Ulaan taiga SPA, natural regeneration in the burnt larch forest was counted average12200 seedlings per ha. According to the regeneration assessment at the subalpine zone of Mongolia, this regeneration number counts as sufficient.Insect damaged forest area,burnt andforest edge areas have insufficient regeneration in Zed, Khantai, and Buteel Mountain Range SPA. Natural regeneration process wasn't gone in insect damaged area of Khangai mountain NP and Orkhonii khundii NP. In long term changed areas after clear-cutting and highly damaged area by insects of Gorkhi-Terelj NP, Tarvagatai Mountain NP, Onon-Balj NP and some area of Khan Khentii SPA weren't regenerated naturally. Large amount areas of larch forests about 60% were degraded dramatically by forest fire in 2002, but that burned areas were regenerated successfully by larch trees with high density. There is more need thinning for decreasing number of trees in young high density stands.

Restoration activities

There are no reforestation and forest restoration in Zed, Khantai, and Buteel Mountain Range PA and the Khangai Mountain Range NP. Tree breeding nursery wasn't established in Zed, Khantai, and Buteel Mountain Range PA. They don't have any experiences to propagate and to transplant seedlings. However, forestry unit in Tsenher soum initiated tree propagation site in 2015, and the activity is in its early stage of development. There are no forest community groups and contracted forest owners in Khangai Mountain NP and its surrounding areas. There is not necessary to take restoration activity that natural regeneration process is sufficient naturally in Ulaan taiga PA. Forest resource of the Khan Khentii SPA and Onon, Balj NP were affected by fire occurred in 2005-2007, the park administrations have no financial capacity to do restoration work and have no research and database.

Protected area management

We used SWOT analysis and TOWS matrix for analyzing of forest activities and managements of 9 PAs. Management of forest resources in Mongolia suffers from several weaknesses such as unregulated use, overuse, and inadequate protection. In period of 2002-2012, national level assessments were carried out concerning the legal status, human resource, financial sustainability, and management effectiveness of Protected Areas in Mongolia. Specially, new tool adapted (CAP, MIRADI) 11 of PAs has developed management plan through new guideline and biodiversity monitoring mechanism started in 2011. Recommendations derived from these assessments are being used for implementation of National Program on Protected Areas, and the Action plans. All administrations of PA are lacking in the human resources needed for efficient Protected Area management.

Insufficient budget is leading to reduce management effectiveness. Because of no budget is allocated to the public awareness and advocacy works, and public awareness is assessed lower.

The building diversified portfolios which better reflect the full range of goods and services associated with the forest sector is key to enhancing long-term sustainable financing for SFM, and increasing the effectiveness and impacts of forest funding (UNREDD report, 2013). Although the tourist business started in Mongolia about forty years ago, there was no policy for ecotourism and until recently there was only one authorized travel agent. Tourism management is the weakest in the protected areas due to the insufficient legal environment, human resource and capacity.

It is required to objectively plan the financing of Protected Areas, increase financial sources, create a sustainable financing mechanism, provide a possibility to the administration to spend its generated incomes on management activities and improve the legal environment to support these. A core to implement activity plans, work fruitfully and maintain a sustainability of human resource is a business plan, which is an inseparable part of the management plan. Therefore, PAs needs to develop business plan and implement it (WWF report, 2013).

Management effectiveness (ME) of total 6 PAs was assessed with 47 questions related to 6 main elements and 13 directions. In Central and Eastern region of Mongolia, management effectiveness was determined the average to be around 49.0%, with a high 64.6 (Zed Khantai Buteel SPA), and a low of 40.9% (Ulaan Taiga SPA). Results of the assessment show that the following difficulties hamper such as lack of legal framework and conflicts between Law and regulations on PA and other newly revised Environment related Laws, scarcity of budget, lack of equipment and infrastructure in PAA, lack of capacity of human resource of PAAs and key local stakeholders, lack of research and monitoring and data management, not adequate responsibility of the natural resource users and key stakeholders, and weak monitoring and evaluation systems for the improvement of the management and the need to reduce the threats to the biodiversity of the protected areas (Oyunchimeg et al, 2019).

Recommendations on improving forest management activities in Protected Area

Funding

- Increase internal and external sources of finance, create a sustainable financing mechanism, provide a possibility to the administration to spend its generated incomes on management activities and improve the legal environment to support these. Certain percentage of income generated from the payments for the time harvest in the PA should be spent on the activities towards forest protection and improvement of management
- Provide financial support to the establishment of tree breeding nurseries for reforestation
- Fire prevention expenditures will be financed in the local annual budget

Capacity building of human resources

- Rangers need to be trained and included in capacity building activities to improve work efficiency
- Forest specialists will be updated. Specialists should control and monitor forestry activities regarding forest insect pests, and related researches, and therefore improve forest management plan implementation.

Improving equipment, tools and techniques

- Increase number of rangers and decrease the area per ranger
- Supply all employees and rangers of PA with necessary equipment, tools for

research and monitoring, also train rangers for self-defense, communication devices and reliable transportation

- Provide enough fire extinguishing tools, establish fire lookout towers

Cooperation

- Should broaden domestic and international collaboration with organizations, forestry units, NGO, research institutes to improve forest management activities, and implement joint projects
- Develop collaborative forest management with research organizations, local administration, people and forest community group
- Exchange of experiences within the region and national level and study experience of foreign organizations

Forest protection and forest management

- Work out long-term plan for research and monitoring to define impacts of threats and integrate information, and plan of forest fire prevention and forest firefighting, implement more realistic and practical management plans
- Burned and timber cut forests are capable of regenerating naturally, and therefore should only carry out thinning to supply more light for young trees
- Awareness raising activities regarding rules and regulations of PAs should be conducted via radio and media, discussions with local people, exchange of ideas with herders and families in surrounding areas, as well as organizing awareness training periodically
- In case there is no natural regeneration in logged, insect pest damaged sites, it is recommended to carry out reforestation, and assisting natural regeneration. Take measures for prevention and determine probable forecasts of insect and disease distribution

Acknowledgement

The forest baseline study of total 9 Protected Areas with forests was carried out within the frame of project on "Biodiversity and adaptation to climate change" of Ministry of Environment and Tourism. We express our gratitude to all researchers of Forest resource and forest protection division in Institute of Geography and Geoecology, MAS.

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Sub-Session:

Economic corridor and integration

AN EVALUATION OF THE ECONOMIC, SOCIAL, AND ECOLOGICAL RISKS OF CHINA-MONGOLIA-RUSSIA HIGH-SPEED RAILWAY CONSTRUCTION AND POLICY SUGGESTIONS

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Abstract: The construction of China-Mongolia-Russia high-speed railway is a strategic move to promote transportation infrastructure inter-connectivity between these countries, which will accelerate the implementation of the China-Mongolia-Russia Economic Corridor. However, well-planned China-Mongolia-Russia high-speed railway demand accurately identifying construction risks, scientifically evaluating risk levels and mapping the spatial distribution of these risks. Therefore, this study established the integrated risk evaluation model (IREM) to scientifically evaluate the economic, social and ecological risks of China-Mongolia-Russia high-speed railway construction and and determine their magnitude and spatial distribution pattern. Based on this analysis, we propose designs for the east and west China-Mongolia-Russia high-speed railways and policy suggestions to mitigate construction risks. Suggestions include developing innovative cooperation of the "high-speed railway for resources and market", strengtherning communication and technology dissemination, and applying innovative engineering techniques and setting buffers; establishing collaborative prevention and control systems to mitigate the three major ecological risks in the China, Mongolia and Russia trans-border areas; and promoting economic integration by improving strategic coordination. In summary, this study provides scientific support for designing the China-Mongolia-Russia high-speed railway minimizing construction risks.

Keywords: China-Mongolia-Russia high-speed railway construction, risk evaluation, designs of high-speed railways, policy suggestion, IREM

THE DETERMINING CITIES AND SOUMS WITH DEVELOPMENT POTENTIAL ALONG THE ECONOMIC CENTRAL CORRIDOR

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Abstract: Mongolia has 5 economic regions, a capital city, 21 cities of aimag center and 330 soum of rural area. Of these, there is a need to analyze and determine which regions, cities and soums are relatively potential for development or relatively high development potential for socio-economic, infrastructure and natural resources in the future, for spatial location, development resources and opportunities. And also need to determine their development resources and opportunities based on which sectors of the economy and society. By doing this research, it is important to science-based policy making which are to first select and develop the region, cities and soums which have the greatest impact in regional economic independence and satisfying national sustainable economic growth, and can support for development of remoted and less developed region, cities and soums. Furthermore, it possible to increase investment based on their development resources and opportunities and involve other nearby local cities and soums of the selected region, cities and soums. For example, the result of this study will be used to policy making for spatial planning policy documents, to implement and ensure coherence between them such as program of “China-Mongolian-Russian economic corridor”, “Regional development policy of Mongolia” and “State Policy on Population Settlement and Residential system of Mongolia”. The survey covered 9 aimags, 10 cities (aimag centers, the capital city), 119 soums in impact zone of road and railway along the economic central corridor of Mongolia-Russia-China in Mongolia. In determining for potential development cities and soums, in the five main areas, population, economic resources, infrastructure, social services and environmental condition, 17 sub-criteria were identified and evaluated based on The Spatial Multi Criteria Decision Analysis (MCDA). MCDA was combined with the Analytical Hierarchy Process (AHP) method and geographical information system (GIS) programs to determine the development potential cities and soums. As a result of the survey, the capital of Ulaanbaatar, Darkhan and Choir, higher population density, well developed infrastructure and processing industry and passed through by the road and railway route, are higher development potential. However, Mandal, Zamyn-Uud, Altanbulag and Airag soums have more development resource than other soums, whereas Shiveegobi, Orkhon, Saikhan, Khushaat, Tsagaannuur, Jargalan, and Bornuur soums are based on agriculture and mining.

Keyword: cities and soums with development potential, development resource, regional development

AN APPROACH TO ECONOMIC GROWTH AND ENVIRONMENT EFFECTS IN NORTHEAST ASIA AND CHINA-MONGOLIA ECONOMIC CORRIDOR

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Abstract: Global achievement of urbanization and food security in recent decades has resulted in serious damage to the environment upstream and downstream of the related industry sectors, including Northeast Asia and China-Mongolia Economic Corridor. The livestock wastes could be either important anaerobic fermentation materials of biogas energy or, if discharged into the environment without appropriate processing, serious pollution sources to soil and water systems. And, the quantity and quality of farmland are both decreasing gradually in some developing countries. At the same time, rural energy poverty is currently a major threat to sustainable development and livelihoods. The availability of clean, affordable and reliable energy is of significant concern in both policy and scholarly circles. Moreover, pollutants related with agriculture and animal husbandry have been identified as one of the dominant contributors to contamination of water systems, such as surface water eutrophication and groundwater nitrate enrichment. The environmental degradation-energy shortage-farmland reduction-food security nexus is being urgently sought to focus and advance the policy debate, as the main contents of rural revitalization policies. Consequently, assessing agricultural emissions, livestock waste and the associated biogas systems is of critical essence in rural energy and environmental decision-making. The present study concentrates on a Northeast Asia context and attempts to explicitly investigate environment-economy nexus applying heterogeneous panel cointegration methods, combining with distribution and characteristics of agricultural emissions and livestock waste for Northeast Asia national economies from 1992 to 2016, and explore an open and international farming perspective for agriculture. It is indicated a long-run inverted U-shaped co-integrated EKC relationship between the environmental and economic index. With economic growth and consumptive change, problems arising from farming and animal husbandry mode can be increasingly great. There will be many major challenges to address these special environmental issues in rural area. Biogas production by animal excreta could be one of the most important rural energies and waste treatment patterns.

Keywords: Economic Growth, Environmental Discharge, Agriculture, Rural Energy

Introduction

Global achievement of urbanization and food security in recent decades has resulted in serious damage to the environment upstream and downstream of the related industry sectors, including Northeast Asia and China-Mongolia Economic Corridor. The usage of agrochemicals has become the symbol of modern agricultural civilization. Agriculture-related pollutants, however, have been identified as the dominant contributor to contamination of water systems globally (Norse & Ju, 2015; Thorburn et al., 2003), such as surface water eutrophication and groundwater nitrate enrichment at both the catchment scale (EEA, 2005; USEPA,

, 2009) and the national or regional scale (DE-FRA, 2007; Chen et al., 2010; Li et al., 2016). Environmental degradation and social transition issues from agriculture and rural areas have influenced sustainable development around the world, especially in developing countries. The increase in pollutants driven by agriculture, especially animal husbandry, has cascading consequences for the environment and human health, including degradation of air and water quality and also increases in the pressures of disease and pest (MacDonald et al., 2011; Schipanski and Bennett, 2012). Over the past decades, annual global meat consumption per capita has nearly doubled. Wastes from livestock and poultry breeding are largely either spread on fields as dry litter or pumped into waste lagoons and sprayed as liquid onto fields (Schipanski and Bennett, 2012). The world is thus being confronted with the challenge of addressing special agricultural pollution while in the throes of economic transition.

In addition, the growth is fuelling rapid increases in energy demand across all sectors in some Northeast Asia countries. In the context of rural energy, this demand brings the associated environmental challenges such as air quality, forest conservation and GHG issues (Christiaensen and Heltberg, 2012). Rural energy is not a traditional concept in most energy catalogues. It mainly refers to energy problems of rural areas in developing countries, as many farmers have to rely on local crude energy due to shortage of commercial energy and backward economies. In many developing countries, a huge portion of the population are relying primarily on traditional biomass, over 80% of who are living in rural areas and negatively affected as the lack of access to clean, affordable and reliable energy. Providing sustainable energy services has been acknowledged as a key component to reduce poverty and improve their livelihoods. The various socio-economic conditions make energy issues much more complicated than in urban areas. Moreover, the rural household is the basic and main pattern of agricultural activities of developing countries. With insufficient energy consumption per capita, they have been using traditional and non-commercial energy for a long history (Fan et al., 2011), such like firewood and straw as their main energy sources for non-production purposes on a large scale, although many rural households were provided with access to commercial coal and electricity by extension of power grids and the small hydropower exploitation. Despite recent research progress and policy developments in the field of rural energy (Li et al., 2016), most of them are still only some universal ideas of the rural energy presented. Exploration of specific and effective approaches to rural energy based on the energy materials estimation, and analytics of energy and emission reduction options to these rural communities, is still a major study point of criticism and key policy issue in many developing countries.

Over the last decades, global livestock and poultry industry is growing continuously, with large amounts of excreta produced. Significantly, these wastes could be either important materials of biogas energy or, if discharged into the environment without appropriate processing, a serious pollution source to soil and water systems, which has received increased attention among environmentalists, economists and policymakers. Identifying quantitative information is critically essential to focus and advance the decision-making debate, especially in the context of developing countries. Hence, it might have promising implications for sustainability to assess the impact of agriculture and animal husbandry on the environment and biogas energy potential stemming from the excreta in rural areas. Several studies provided evidences of the management effectiveness in reducing sediments and nutrients contained in runoff (Rodriguez et al., 2011; Li et al., 2016). However, the general substantial explorations and effective options are not as put forward as could be in developing countries, although recently case study progress has emerged in controlling water pollution or promoting biogas, especially in some nutrient-surplus areas around the world (Dai et al., 2015). Several recent studies involved carbon emission of rural energy (Li et al., 2016), but overlooking the biogas energy related with livestock and poultry breeding.

Hence, combining with the distribution and characteristics of rural discharge and waste, approach to the Environmental Kuznets Curve (EKC) is performed using heterogeneous panel cointegration methods. To the best of the authors' knowledge, none of prior studies tested the EKC with regard to this particular rural environmental issue on such a scale of countries, although there are an abundance of studies on air or water pollution and deforestation (Li et al., 2016). Besides, the present study assesses the potentiality of biogas energy, before finally offering a policy discussion on some rural environmental and energy options.

Method

We first discuss nitrogen demand for agriculture production based on nutrient balance in agro-ecosystem, and then analyze nitrogen surplus from agricultural synthetic fertilizers. The model specification is given as

$$NS = \left[\sum F_j NF_j - \left(\sum Q_k NU_k - B\right)\right] / CL \qquad (1)$$

where NS is the nitrogen surplus from synthetic fertilizer per hectare cultivated area for different region, F and NF denote fertilizer consumption and its nitrogen content for fertilizer type *j*, Q and NU stand for output of farm product and its nitrogen uptake for crop type *k*. B stands the soil basic fertility, involving natural nitrogen supply with no fertilizer use, CL is the area of cultivated land. The biologic nitrogen fixation and nitrogen consumption of crops are calculated according to the web of fertilization formula by soil testing. The phosphorus surplus per hectare cultivated area is estimated similarly. The use of organic fertilizer is not included in these data, the amount of which is much smaller than synthetic fertilizer and can be even ignored, so the surplus in agricultural sector may be underestimated a little.

We studied the impacts of livestock and poultry breeding within the framework of environment and development initiatives. Over the recent decades, literatures of human impacts on global biogeochemical cycles largely focused upon nitrogen (Schipanski and Bennett, 2012). The amount of excreta and the nitrogen masses are chosen as main environmental indicators on the basis of spatial livestock and poultry number and estimated excretion values. The current waste estimation methods are in line with daily emission and annual emission as follows:

$$P = \sum_{i=1}^{n} Q_i \times W_i \times Pd_i \times T_i \qquad (2)$$

$$P = \sum_{i=1}^{n} Q_i \times Pa_i \qquad (3)$$

where *P* denotes the annual pollutant emissions from livestock and poultry breeding. Q_i is the amount of livestock and poultry and W_i is the daily waste production for animal type *i*. Pd_i stands for the pollutant coefficient of waste and T_i is the growth period for animal type *i*. Pa_i stands for the annual emissions of pollutants for animal type *i*. Livestock and poultry mainly involve cattle, hogs, sheep, rabbits, chicken, ducks and other main animal types.

The Environmental Kuznets Curve, as the classic theory on the relationship between environmental pollution and economic growth, has been studied by many researchers using various methodologies for different periods since becoming a key topic, following the pioneering work of Grossman and Krueger (1991) and Panayotou (1993), where the inverted U-shaped curve was found. This relationship has become the focus of a large number of theoretical explorations and empirical investigations in many countries, based mainly on the empirical estimation of time series and the dynamic panel data approach (Brock and Taylor, 2005; Li et al., 2016). The studies of some provide extensive review surveys of the literature which tested the economic growth-environmental pollution nexus and the EKC hypothesis. There is an increasing progress of researches on air or water pollution, deforestation, diversity and indicators of environmental amenities up until for some recent findings around the world (Bergh et al., 2019). However, researches on the relationship between agriculture-related pollution and economic growth are relatively scanty (Shortle and Abler, 2001), few of which were related to Environmental Kuznets Curve. To our knowledge, few other prior studies have tested the EKC in the case of these environmental issues arising from agriculture. This issue is significant considering the importance of environmental and ecological safety issues (Shortle and Abler, 2001), and should be taken more attention. No sole environment-economy relationship exists that fits all types of pollutants, regions scales and time periods.

Results

For the EKC results, in general, an economy is associated with smaller levels of pollution after some threshold income point. The agricultural environment-economy nexus also show the inverted U-shaped EKC relationship, indicating that pollution increase at first, then may decline with economic growth. Moreover, the turning points of these inverted U-shaped curves vary between different indicators. Obviously, there is much more pressure of pollution abatement for current development mode. Furthermore, compared with EKC results, across indicators and studies, these turning points for agricultural environmental indices are much higher than those for pollutants such as NOx and SO_2 generally. The EKC takes various shapes depending on the type of pollutants and is more likely to hold for short-term and local impact pollutants than for those with more global, indirect, and long-term impacts. It is emphasized that agricultural pollution reduction is much more difficult than those such as urban-related NOx and SO_2, to a certain sense, and should be paid more attention in the future. It should be also noticed the new problems caused by agricultural pollutants whose direct sources are untraceable, in contrast to the traditional problems derived from the traceable pollutants. The environmental policies need to be formulated concerning each substance, such as its origin, manageability, and the like, rather to be standardized, especially with little effective agriculture-related environmental management.

Biogas production efficiency by animal excreta is of critical essence for waste treatment, as one of the most important available energies in rural region. It is dependent on many various determinants, such as anaerobic environment, organic matter, temperature, and pH, related to different excreta types of livestock and poultry, and other institutional and socioeconomic constraints. This potential of biogas production can be estimated based on amount of COD or TS by animal excreta:

$$PE = Q_{COD} \times D \times Cb \qquad (4)$$

where *PE* denotes the biogas potential by wastes from livestock and poultry breeding. Q_{COD} is the amount of COD produced, and *D* is the available percentage of COD disposed, taken as 80%. *Cb* is the coefficient of biogas production, taken as 0.269, 0.538 and

0.807 m^3/kg, in the region (<15°C), region (15-25°C) and region (>25°C), respectively, according to various climate areas.

This type of biogas project can contribute to ecological restoration, avoiding excessive deforestation and desertification resulting from lack of rural energy. In addition, biogas development could be helpful for curbing air pollution, and also controlling GHG emissions. Livestock excreta-related biogas treatment can reduce CH_4 emissions, and can be used to replace coal, further reducing CO_2 emissions. Hence, development of biogas projects related with animal husbandry has a great potential in rural developing countries. What's more, the gas discharged from burning biogas is of carbon neutrality and no toxic components, such as NO_x or SO_2. The thermal efficiency of 50% burning biogas for a biogas digester of 8 m^3 can provide more than 80% of a household's daily energy requirements, even under normal rural conditions. It is of profound importance for large scale biogas digester application, in response to native rural environment and applied energy, and global climate change.

Based on the perspective of environment-economy nexus, agricultural pollution can be regarded as a contradiction between economic growth and agriculture-related environment and resources, which is essentially the discrepancy between the infinite demand from economic growth on agro-environmental resources and the limited supply capacity of the environment. Agricultural pollution is a negative externality of agricultural production in nature. The positive and negative external effects of agro-environment goods are the underlying causes of the agricultural pollution, and its public goods properties enable no producer-payment. In addition, there is an unfairness issue of comparative profit and adverse selection risk of the farmer's production, since their short-term risk aversion behaviors will aggravate the agricultural pollution trend, and the information asymmetry of agricultural pollution makes the environmental policies less effective. In addition, as a result of urban-rural dual structure, property rights, and other institutional factors, there is an agriculture-related environmental regulation failure. Economic growth has thus a double impact on the quality of the environment and agriculture-related environmental issues will significantly influence economic growth.

With increased urbanization and industrialization, rapid economic growth can exert considerable influence on agrochemical use and the agriculture-related environmental issues as to some economic effects. There are some main theoretical explanations supporting the empirical evidence that an EKC exists. Each of the following explanations could interact with the explanations (Cochard et al., 2005; Galeotti et al., 2009).

(1) Sources of economic growth, where increasing output requires more inputs, which implies more emissions as a byproduct. Thus, economic growth exhibits a scale effect that has a negative impact on the environment in the early stages of development (Copeland & Taylor, 2004). With rising economic growth and urbanization, the urban population is growing and the agriculture-related industry sector is developing rapidly, the demand for agricultural products is increasing largely, while the farmland area and rural labor are sharply decreasing, marginal farmland use pressure increase, and man-earth conflict keeps intensifying. The above conditions induce overuse and misuse of agrochemicals and the environmental issues consequently. Economic growth, however, also has positive impacts on the environment via a composition effect. As income grows in the later stages of development, there is an increase in cleaner activities that produce less pollution. Whether policies are socially efficient or inefficient, EKC can exist

because of increasing returns to scale. In the case of agriculture-related environmental issues, which is the focus of this study, environmental degradation tends to increase with the use of toxic chemical loadings as the economy grows, and starts to fall as the some sort of scale economy.

(2) Income effects, where the shape of the EKC reflects changes in the demand for environmental quality, or agri-risk in this study, as income rises. Economic development can transform agriculture-related environmental quality into a consumer utility function, and the market demand constraints induce progressive agricultural producers and government more attention to the environmental concerns. Moreover, economic growth will improve the national education level and environmental awareness of farmers significantly. The relationship between pollution and income should vary across pollutants according to their perceived damage.

(3) Threshold effects. An environmental measure is implemented after some threshold has been reached. These effects can arise in either the abatement opportunities, or in the political process. The first type of threshold effect is the technology constraint explanation. An economy needs to pass certain threshold levels of development before obtaining access to cleaner production technologies. A strong economic base should provide for the application of environmentally friendly technologies and the skill mastering of farmers, such as soil testing and fertilizer recommendation issues.

The second type of threshold effect is an institutional and policy constraint explanation. It assumes that some obstacle prevents developing countries from establishing the social institutions necessary to regulate pollution. The political or economic barriers are considered to be fixed costs, so that the appointment costs of institutions stick up for the environment. The rural development, the land property rights system, and other institutional issues result in the serious overuse and abandonment of farm land. Agriculture is characterized at present by the traditional and original production mode with the single farmer household unit. Rural environmental protection is consequently neglected, and the supply of environmental policies, environmental agencies, and environmental infrastructure is highly insufficient. Agricultural pollution issues can be regarded as a byproduct of the special urban-rural dualistic structure and accordingly becomes a both extension and aggravation of the social structure and equity issues.

Conclusions

The present study provide a general picture of the environment-economy nexus in China and Northeast Asia countries, for a panel data set for the period from 1992 to 2016, using the panel cointegration techniques, which might be helpful to focus and advance the debate on environment and farmland and livestock policies in the developing countries, especially rural emerging and developing economies.

External cooperation in agriculture is an important domain of the “Belt and Road Initiative”, especially in China-Mongolia-Russia Economic Corridor (Dong et al., 2016). China-Mongolia agricultural cooperation is a mutually beneficial move. Mongolia can also take advantage of China’s economic development to achieve agricultural revitalization. China’s overseas investment and cooperation of arable land and livestock breeding should receive more efforts. While foreign investment in agriculture has increasingly become the focus of western scholars, it has not fully and sufficiently attracted the attention of China domestic scholars. At present, the investment in arable land and livestock breeding in Mongolia and Russia would become an important mode for

China to ensure environment and food cooperation, which can also serve as a key direction for China-Mongolia-Russia comprehensive cooperation. It is significant to actively carry out the construction of cross border agricultural production belts and agricultural innovation cooperation zones in the adjacent region, and explore the establishment of a China-Mongolia-Russia food reserve base, which might play a key role in safeguarding region food security. Of course, agricultural international cooperation is a systematic project involving various aspects such as geo-politics, geo-economics, and resources and environment, including land selection, market research, investment entities, and product logistics sales.

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HUMAN SETTLEMENT PLAN OF MONGOLIA BASED ON MIGRATION FACTORS AND SUSTAINABLE LAND USE

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Abstract: An appropriate ratio of human settlement systems of Mongolia has been lost because of rapid rural-urban migration after transition period to market economy from socialist period. Its main evidence is that almost a half (1,5 million) of total human population live in the one largest city which is located total 0.04% out of territorial land area. Environmental (air, soil, water and noise) and social-economic (traffic congestion, urban health and urban redevelopment cost) problems have been increased year by year due to migration induced human overconcentration in Ulaanbaatar city. So, one of the development main challenges for Mongolia becomes now to decrease human population overconcentration in Ulaanbaatar city. According to migration theories, migration pull factors and urban some functions need to replace to satellite cities or secondary cities from Ulaanbaatar. To conclude, administration and high education pull factors of migration or urban multi-functions need to replace to satellite and secondary cities from Ulaanbaatar based on the migration studies. Moreover, administrative and territorial division should be enlarged in order to support local market size and to adapt to land use and climate change.

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Sub-Session:

Transdisciplinary and Interdisciplinary Research Cooperation

TRANSFORMATIVE ADAPTATION OF NOMAD'S LAND SYSTEMS IN DIFFERENT ECOLOGICAL ZONES OF MONGOLIA

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Abstract: Pastoral systems in Mongolia have been sustainable for centuries, surviving recent changes. However, additional pressure from climate change is intersecting with social and economic changes since the transition to democracy and market economy in early 1990s. Dryland ecosystem services are diminishing due to climate change, overgrazing and decreased mobility of herders. A study of adaptation, mitigation and sustainable development of pastoral social-ecological systems in Mongolia contributed for a number of outcomes from local to regional and national scales. A summary of combined scientific and traditional knowledge led to transformation of nomadic civilization towards to green civilization concept, using green technologies such renewable energy and IT. As a result, the Green Development Policy of Mongolia was developed and adopted by the Parliament of Mongolia in 2014. An adaptation to increasing climate extreme events by local herder like predicting coming zud (severe for livestock winter condition), and slaughtering 40% of livestock and storing it in his winter house, gave an idea for scientific improved zud prediction system and renewable energy driven meat storage system development for transformative adaptation of pastoral social-ecological systems "Win-Win" outcomes ecologically and socio-economically.

The Government of Mongolia is currently working on a general plan of regional settlement and development – territorial governance of land social-ecological systems. A new regional settlement planning requires land system transformation. Our proposal on transformation of land systems is to give traditional cultural landscapes in traditional community ownership, opening opportunities for sustainable development and holistic management of all natural resources such as rangelands, water, forest, wildlife etc. However, a land ownership policy has to be ecosystem specific. We need to envision possible adaptation pathways in different social-ecological zones and analyze how decision contexts should be reframed to allow new options for adaptation and sustainability of nomadic lands in Mongolia.

Keywords: Transformation, adaptation, pastoral social-ecological systems

PERMAFROST STUDY IN RELATION TO SPATIAL DEVELOPMENT PLANNING OF MONGOLIA

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Abstract: Permafrost is perennially frozen ground that underlies a huge area of land at high latitudes and altitudes in the northern hemispheres. The latest study reminds that more than 22% of the exposed land surface in the northern hemisphere is underlain by permafrost (Obu et al., 2019). Permafrost distribution in Mongolia, which encompasses about 29% of the total land area of the territory (Jambaljav et al., 2016), is mosaic-like because Mongolia is located at the southern boundary of the Siberian permafrost region (Dashtseren et al., 2014). The air temperature has increased by 2.07°C/70yr in Mongolia, and this increase has occurred more intensively in the mountain regions than in the Gobi and steppe regions (MARCC. 2014). Therefore, due to the location and climate conditions, permafrost temperatures in Mongolia are mostly close to 0oC, making the environment vulnerable to climate warming and human impacts.

Permafrost research has been systematically conducted in Mongolia since the begin of 60s and it is continuing until now. During the past time, the scientists have done permafrost studies in the whole country. As results of these studies, the thermal state of permafrost, general distribution of permafrost, seasonally frozen ground, cryogenic processes and features in Mongolia are well known. Nevertheless, there is a study gap concerning the interaction between permafrost and social-economic conditions in Mongolia.

Population density and agriculture activities are higher in permafrost regions than in permafrost free regions in Mongolia. Furthermore, many sum centers are located in permafrost areas, and there are several hundreds of kilometer-paved road in a permafrost environment. Permafrost of Mongolia is not only thawing but also disappearing in some area. Thawing and disappearing of permafrost can negatively affect to social-economic conditions of regional and local societies in Mongolia. For example, the study results show that 31 sum centers are located on cold and warm permafrost patches. The permafrost temperature ranged from -3.1oC to -0.6oC and the active layer thickness varied between below 2 m to more than 5 m in the sum centres. Permafrost in the sum centers is a big challenge for construction of infrastructures like buildings and roads. Many broken buildings in the sum centers have been noted within the last few decades. These permafrost degradations will increase future costs to maintain, repair and replace damaged infrastructure, and it have negative effect on the economic source in Mongolia. In addition, many frozen wells are observed in the rural areas with permafrost region (Dashtseren et al., 2017).

Of course, we have had the spatial development planning at the regional and local scales.

However, most of these spatial development plans did not completely base on environmental studies such as permafrost studies. This is also one of the reasons why infrastructures are severely damaged by permafrost impacts. Nowadays, Mongolian government is intending to produce the spatial development plans such as “Regional Development Concepts of Mongolia”, “State Policy on Population Settlement and Residential system of Mongolia” and “Integrated Industrial Planning and Mapping of Mongolia”. In addition, it is evident that international trans-boundary programs (e.g. economic corridor of “Mongolia-Russia-China and Belt-Road initiative) are crossing Mongolia. Therefore, we have to consider permafrost issues into the spatial development plans and economic corridor programs as well as human settlements, urban planning and regional planning in order to reduce negative permafrost risk. This study attempts to describe the current condition of permafrost and necessity of permafrost study to spatial development planning of Mongolia.

ECONOMIC EFFECTS OF THE USA-CHINA TRADE WAR: CGE ANALYSIS WITH THE GTAP 9.0A DATA BASE

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Abstract: An analysis of the economic effects of the ongoing USA-China trade war using the standard CGE Model and GTAP Data Base 9.0a revealed that both parties will be worse-off from this trade friction, having welfare losses and real GDP contractions regardless of international capital mobility status—i.e. whether the capital is internationally mobile or not. Moreover, the results indicated that the negative economic and trade impacts on China would be larger compared to those of the USA. Although, other countries and regions would be better-off having positive changes in their welfare and real GDP, their magnitudes were much lower than losses of the USA and China. Therefore, as a whole, the global economy will be worse-off as a result of this trade war between the world's two largest economies, the USA and China. Also, the results indicated that despite some welfare gains, more industries in Mongolia will have output declines as an impact of this trade war when capital is internationally mobile. This is an indication that Mongolia's industries and investment environment are not yet competitive internationally.

Keywords: Trade policy, CGE models

EVALUATION OF THE CONTRIBUTION OF THE TOURISM INDUSTRY TO THE ECONOMY OF THE REGIONS OF THE GREAT TEA ROAD (ON THE EXAMPLE OF THE BORDER TERRITORIES OF ASIAN RUSSIA)

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Abstract: The article considers the current state of tourism development in the border regions of Asian Russia, including the Republic of Buryatia, the Trans-Baikal Territory and the Amur Region. The considered model territories have a common border with China and Mongolia. A comparative analysis of the main indicators of the development of tourism in the regions. Revealed similarities and differences in the dynamics of the number of collective accommodation facilities (CAF). The analysis shows positive growth trends in the number of CAFs in model areas. In terms of the number of people accommodated in the CAF in Buryatia and the Amur Region, there is a positive trend, in Transbaikalia – negative. There is an increase in the number of tourist firms in the Amur Region. In other regions, there is a reduction in their number. Therefore, the volume of tour packages sold to the population is also decreasing. In the regions, there is an increase in the number of tourists leaving, which indicates a stabilization of the situation in tourism. However, there are regional differences. The most popular countries for outbound tourism in model areas are China, Thailand and Vietnam. The analysis made it possible to show not only the general trends for the regions in the development of tourism, but also to reveal its regional features. The border position of the regions brings not only benefits, but also a strong dependence on foreign policy processes. In general, there is a stable development of the tourism industry in the regions of Asian Russia. It is necessary to modernize the existing and build new CAFs, equipment of objects of display and sights, expand the range of tourist services and other activities.

Keywords: tourism, border region, collective accommodation facilities (CAF), tourist firm, tour package.

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Sub-Session:

The Efficient State, Science and Business Collaboration and Cluster Development Concept

THE PUBLIC-PRIVATE PARTNERSHIP POLICY ISSUES FOR SUSTAINABLE DEVELOPMENT

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Abstract: The purpose of the World Sustainable Development that was adopted by General Assembly of the United Nations forum in September 2015 presented the development documents with 17 targets and 169 goals that covered a wide range of issues, including the elimination of poverty, protecting the environment and ensuring human rights and peace.

The Parliament of Mongolia approved the Law on Development Policy Planning of Mongolia on November 26, 2015. The law clarifies the policy of the documents, timelines, processing phases, and monitoring implementation and evaluation. Under the Development Policy Planning Law, the "Sustainable Development Concept of Mongolia-2030" with four chapters, 44 targets and 20 indicators developed based on the World Sustainable Development Framework, which will be implemented during 2016-2030 with three stages that approved by Parliament's resolution #19 on February 2016.

At the Third International Conference on Financing for Development held in Addis Ababa in July 2015, a discussion on how to mobilize the ever-expanding financial resources needed to meet the Sustainable Development Goals. As a result of the conference, a consensus has been agreed upon by Addis Ababa's action plan, with a series of bold measures to reform international financial activities and to direct investment in addressing economic, social, and environmental challenges.

Governments are committed to implementing policies and institutional reforms aimed at building comprehensive financial management to ensure the implementation of the Sustainable Development Goals, which are the priorities of the country's development. At the meeting, the private sector should take into account the environmental, social and governance impacts of sustainable business development in the business community, and the Government directs the banking and financial sector policies to promote and encourage private sector investment in sustainable development, improve coordination of public-private partnership and achieve sustainable development goals and to encourage access. It has been approximately 30 years since the establishment of a democratic system and market economy. The contribution of our private sector to our achievements in the past is high. At present, the private sector constitutes about 70 percent of the country's economy.

Presently, 175 thousand enterprises and organizations are registered in Mongolia, yet only 87,7 thousand of them are operating. Due to lack of inaction, 47 thousand enterprises have not started their operations, and another 35 thousand of them have been suspended, indicating numbers show that there is an urgency to boost the business environment in

Mongolia. 86.4 percent of the daily operating entities have only 1-9 employees, while the share of organizations with more than 50 employees is only 2.8 percent which is 2500 of them. However, our country in the last 28 years, since we shifted into a free market economy, we have been running the country with inaccurate policy and lack of responsibility. As a result, we face socioeconomic difficulties and social deprivation, but in the future, the issue of how the public and private sectors can work together in harmony with their rules of engagement is crucial for the further development of the country. Both the state and the private sectors can be responsible for the citizens and create social well-being.

In conclusion, we need to let the private sectors handle development projects. However, the concession law, which is being enforced today, can not meet this need. It is imperative to create a regulatory environment that will ensure the mutual benefit of public and private responsibilities based on other developed foreign countries partnership experiment, in order to ensure that the project funds are paid out in partnership. This will enable the public and private partnership to move into a new stage of major projects.

COMPARATIVE ANALYSIS OF THE LAND FUND STRUCTURE OF THE BORDER AREAS OF RUSSIA AND MONGOLIA: RISKS OF DESERTIFICATION DEVELOPMENT

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Abstract: Desertification is one of the major problems of our time. In connection with the intensification of the development of border areas, the risks of desertification processes increase. Under these conditions, conducting comparative studies of desertification processes in Russia and Mongolia will be particularly relevant. In the course of the research, the structure of the land fund of the border territories of Russia and Mongolia was analyzed in dynamics. These areas are characterized by the development of agriculture, mining and residential environmental management, which carry the risk of developing the processes of desertification. The tendencies of development of the territory are revealed. The similarities and differences in the dynamics of land resources of Russia and Mongolia are revealed. The similarity is noted in the trend of reducing the area of agricultural land, increasing the land area of settlements, industry, transport, communications, etc. Differences are noted in the change in other categories of land. Changes in the land fund structure of the border areas of Russia and Mongolia with increasing pressure on the land used in the economy carries with it the risks of desertification development. The identified trends require further research.

MONGOLIAN BUSINESS IN ADJACENT REGIONS OF RUSSIA

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Abstract: The participation of investors from Mongolia in Siberian regions of Russia is analyzed. The main part of the enterprises of Mongolian investors is located in Buryatia and is registered by individuals, not organizations. The prevailing activities of these enterprises are wholesale and retail trade and business consulting with fast capital turnover. Mongolian business has to compete with Chinese entrepreneurs in the Trans-Baikal Territory. Investment of individuals reflects the development of business at the local level without the help of a state.

Keywords: business consulting; investment; foreign enterprise; joint venture; wholesale and retail.

Introduction

Mongolia is bordered by the two largest nations of Asia - Russia and China. The idea of developing the economic corridor through Mongolia offers new opportunities for the prospects of territories involved. Inter-country economic cooperation is expressed by cross-border investments. But cooperation is important not only for economic growth, but also for the development of social connections, that help citizens and organizations of neighboring countries to form a common economic and cultural space to improve the well-being of the population (Sadykova et al., 2018; Zhan, 2016).

The expansion of national business abroad shows its potential in relation to expansion into global markets, and also reflects the situation inside the country, growth opportunities for its citizens and capital.

Relations with Russia formed the economic landscape of Mongolia for a long time, and up to date close ties in some areas remain. For Mongolian economic agents, the possibilities of going abroad are most easily realized in the border zone of the Russian Federation, both due to the previously established relationships and to ethnic and linguistic factors.

Method

In most cases foreign investment is analyzed in macroeconomic terms – its volume and structure by countries and regions. Mongolia is regarded as a country that accepts investment rather than exporting capital (Dugar et al., 2018; Chuluuntsetseg, 2018).

We investigated a movement of Mongolian business abroad and its presence in the regions of Siberia, the scope of their activities and level of development. The analysis was carried out at the microeconomic level, i.e. the enterprises organized by Mongolian citizens and organizations in the regions of Siberia were the subject of investigation. Data on the enterprises with foreign capital were provided by the Russian national agency of economic information “Prime”.

These enterprises included two categories - foreign enterprises, i.e. fully owned by foreign investors, and joint ventures where foreign companies and citizens own a part of assets.

Foreign enterprises are formed by legal entities or individuals, and this is important for assessing their development prospects, since a significant part of the enterprises formed by individuals is a form of transfer of labor more than of capital. Despite the fact that amount of enterprises owned by legal entities is significantly smaller, the effect for the economy and its export potential is expected just from the enterprises registered by companies and corporations.

Results

According to the Prime Agency 61 Mongolian enterprises operated in Siberia in 2016. Currently, four regions of the Russian Federation border Mongolia: the Altai Republic, Tyva, Buryatia and the Trans-Baikal Territory, but most of these enterprises (56 units) were located in Buryatia. Two enterprises were registered in the Irkutsk region, the rest three enterprises were in the Trans-Baikal Territory, Tuva and the Novosibirsk Region. All the Mongolian enterprises are formed by citizens, with one exception - the tailoring company in Buryatia is registered by the company "Darkhan Nehiy".

In Buryatia, the presence of the Mongolian business can be compared with the expansion of Chinese capital. There are registered 132 foreign enterprises, and there is no owerwhelming domination of Chinese investors like in the Trans-Baikal Territory. Mongolia is on the second place among foreign investors in Buryatia (Table 1).

As the table shows the market niches occupied by the investments of Mongolia and China in Buryatia also differ. Chinese enterprises control foreign agriculture, mining, sawing wood in Buryatia, but the number of foreign enterprises in these industries is negligible. Chinese enterprises also predominate in logging, construction, wholesale, catering, property management, travel agency activities. But most foreign retail businesses are formed by citizens of Mongolia (6 out of 11 units). The complete dominance of the activity of Mongolian citizens is manifested in another area – in economic intermediation and business services. Foreign sector in activity, named by the Russian national classifier as “consultation on issues of commercial activity and management” is represented only by enterprises registered by Mongolian citizens – 28 of them. Another kind of activity, related to previous one and named as support services for business also includes only 9 enterprises of Mongolian citizens. In advertising three out of four foreign enterprises are also Mongolian ones. These three positions together provide almost three-quarters of Mongolian enterprises in Buryatia.

Table 1. Foreign enterprises (FE) in Buryatia by principal activities

	Total number	FE from	Mongolia	FE from China	
		Total	individuals	Total	individuals
Construction	19	1	1	17	13
Wholesale	30	7	7	18	18
Retail trade	11	6	6	2	2
Catering	15	1	1	11	11
Business consulting	28	28	28	0	0
Support for business					
All	9	9	9	0	0
	154	56	55	74	68

The complete dominance of the activity of Mongolian citizens is manifested in another area – in economic intermediation and business services. Foreign sector in activity, named by the Russian national classifier as "consultation on issues of commercial activity and management" is represented only by enterprises registered by Mongolian citizens – 28 of them. Another kind of activity, related to previous one and named as support services for business also includes only 9 enterprises of Mongolian citizens. In advertising three out of four foreign enterprises are also Mongolian ones. These three positions together provide almost three-quarters of Mongolian enterprises in Buryatia.

The rest 5 Mongolian enterprises in other regions of Siberia are registered as wholesale traders, and one of them in the Irkutsk region deals with motorcars and their repair parts.

An important area of cooperation is formed by joint ventures, although their number is much less than foreign ones in each region, including Buryatia. There are 12 joint ventures with the Mongolian side in Buryatia, while there are 38 with Chinese partners (Table 2).

In contrast to foreign enterprises, joint ventures with Mongolian citizens are engaged in wholesale trade. The citizens of Mongolia and China are also more active in business cooperation with local residents than their companies.

Table 2. Joint ventures (JV) in Buryatia by principal activities

	JV with Mongolia		JV with China	
	Total.	With ind.	Total.	With ind.
Logging	2	0	4	2
Construction	1	1	4	3
Wholesale	4	4	6	5
Retail trade	0	0	3	3
Catering	1	1	5	5

Discussion and conclusions

The conclusions from the facts presented are as follows. In Buryatia, the functioning of foreign and joint enterprises is more active than in the Trans-Baikal Territory due to the significant presence of Mongolian businessmen, which prefer just Buryatia outside the borders of their country. This is caused primarily by the ethnic commonality and the ease of language communication, which is the important factor for further expansion of economic interaction. But a significant proportion of the Buryat population, including the autonomous region, also lives in the Trans-Baikal Territory. The more massive presence of Chinese business there does not allow Mongolian citizens to compete in the market of activities with fast capital turnover. And their funds are not enough for capital construction abroad. It can be said that the Mongolian business within the country does not have sufficient capital surpluses for its export.

High proportion of enterprises formed by individuals indicates a broad expansion of foreign investment at the local level without the help or intervention of a state. The ventures of individuals occupied a niche in the field of intermediation and services, accessible to their level of investment and recruitment. The legal entities prefer to attract labor from their country which is typical for Chinese enterprises, and this is even more characteristic of individual enterprises, in most of them the owners work themselves.

This region is of interest for large capital in relation to natural resources only, like in Mongolia itself (Nandin-Erdene, 2017), while individual entrepreneurs try to occupy activities that do not require large investments, with a rapid turnover of capital. We tend to view this process as a form of survival to a greater extent than development due to unemployment in the motherland. Survival refers not only to coming individual investors, but also to the host population. In this respect, Chinese entrepreneurs are more organized and occupy rather strong positions in comparison with others. The case with the predominance of Mongolian individuals in the field of business counseling reflects the difficulties in establishing their field of activity and employment. Almost all of them declare no any revenue or income. Perhaps in this case, a more significant role is played by officially registered additional activities of these ventures, which include trade, processing of telephone calls, warehousing services, public relations and others.

J. Dunning singled out 4 goals for investing abroad, which include the search for raw materials (natural resources), for new markets, for increasing efficiency and for acquiring assets (Dunning, 1994). The first incentive connected with the need to obtain raw materials is prevailing for most Siberian regions and its role is gradually increasing in the border regions, but it is more characteristic of legal entities.

The acquisition of assets in the regions analyzed, including real estate, is more relevant for citizens of Mongolia as well as from the Central Asia. The sales market is also important for investors, what is reflected by the abundance of investments in trade and intermediary activities.

The development of transit infrastructure probably will not change the specialization of this territory, and foreign corporations will continue to invest primarily in resource projects. But attracting foreign investment in infrastructure will allow developing on-site service for maintaining future flows where new forms and scales of intermediation, the sophistication of technologies in communications, transport and other spheres will be required. Regional economies should focus on increasing exports of infrastructure services. And the target for successful development in the corridor zone is to increase the degree of involvement of residents of this zone in international investment projects through stimulation of joint venture creation. Local residents from both sides of the border need the help of the state for such a joint participation.

Acknowledgments

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EST 2019

SESSION 3:

ENVIRONMENTAL INNOVATION AND TECHNOLOGY

Session Description

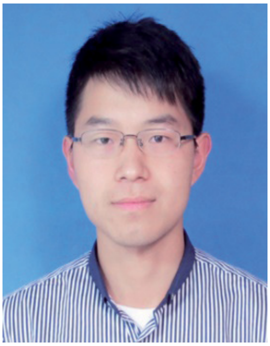
Environmental Sciences is a knowledge plattform for the future sustainable environmental technologies and innovation. It bridges the scientific knowledge and the technical know-how for best practice solutions in different concepts of green technology. Central Asia is dramatically affected by recent climate change requesting environmental sustainable solutions as the biggest challenge of the livelihood of regional and local societies for the next half of the century. This session brings together stakeholders from government, industry, NGOs and private companies as well as scientists of different disciplines in order to share their knowledge and exchange their experience in renewable green energy, bioenergy, sustainable energy policies, green chemistry, green economy, green nanotechnology, recycling, air purification, and environmental remediation. IWRM, water scientific issues and wastewater management including sanitation are more and more pressing issues especially in the growing urban areas of Mongolia. The overall subjects of this session include environmental education in a multi-level approach and measures of ecological stability and low carbon technologies.

EST 2019

Sub-Session:

Remediation and Control Technologies

DESERTIFICATION MITIGATION BY TRANSGENIC PLANTS WITH DROUGHT RESISTANCE GENES FROM ENDOCARPON PUSILLUM



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Abstract: Endocarpon pussilum is a dominant lichen species grown in desert areas. The laboratory uses Endocarpon pussilum as experimental materials and it has been evidenced that the symbiotic fungi of Endocarpon pussilum can survive for 8 months under starvation and drought stress conditions in our lab. Due to its slow growth rate and the lack of a genetic transformation system, functional confirmation of the predicted stress-related genes in E. pusillum relies on using surrogate, heterologous hosts-Saccharomyces cerevisiae. Overexpression of Epgst, Epmbf1 and Epann genes can significantly improve the resistance of Saccharomyces cerevisiae to sodium chloride, heavy metals and high temperature, respectively. Among all of them, Epann gene appeared the best ability of stress resistance. Further study of Epann found that hydrogen peroxide, sodium chloride and PEG stress could induce the up-regulation of Epann in Endocarpon pusillum. The coding product of Epann is an annexin-EpANN.Furthermore, the resistance mechanism of Epann gene has been studied. A peroxidase activity was found of EpANN, which could repress the accumulation of ROS and reduce the oxidative damage to cells under stress conditions. Significantly, we report here for the first time the chaperone activity of annexins in fungi and show that this activity is primarily mechanism for EpANN-mediated stress tolerance. In addition, expression of Epann in Arabidopsis thaliana, the germination rate and growth of Arabidopsis thaliana under hydrogen peroxide stress were better than those of wild types, and it was more tolerant to drought stress. Inspired by this revelation, the stress-resistant genes Epann, of the Endocarpon pussilum was transferred to the which can be used to alleviate desertification in arid and semi-arid regions with an average annual precipitation of less than 200 mm.

Keywords: Lichenized fungus, Abiotic stress tolerance, Heterologous expression, Agrostis stolonifera, Desertification

ADAPTATION AND MITIGATION TECHNOLOGY TO CLIMATE CHANGE: INFRASTRUCTURE IN PERMAFROST REGION, MONGOLIA

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Abstract: Contemporary construction methods of infrastructure in permafrost regions of Mongolia are ineffective in warm and ice-rich permafrost areas. Today it is request to use additional cooling to sustain the infrastructure on the permafrost, especially for Mongolian permafrost with temperature close to 0°C. There are several adaptation and mitigation techniques for construction of infrastructure in other countries with permafrost. Local and site-specific factors play an important role in occurrence and disappearance of permafrost. Choose of exact techniques depends on these specific factors. Here we present the examples in other countries and current conditions of some infrastructure in Mongolia.

Keywords: crushed rock, warm and ice-rich permafrost, thermosiphon, shading board, ventilation duct

Introduction

The global mean annual air temperature has increased by 0.85°C within the last hundred years in worldwide scale, while it was increased by 2.07°C in Mongolia for 73 years (IPCC, 2014, MARCC, 2014). Many impacts of climate change have already been observed, including sea level rise, glacier retreat, changes in the timing of seasonal events and changes in climate extremes.

As noted in the definition of permafrost, it is defined firstly by temperature and secondly by time (French, 2007). On another word, permafrost is the product of cold climate. Climate warming is more intensive in Mongolia than global average in worldwide. Warming is more pronounced in the high mountainous areas and their valleys, where the permafrost occurs more extensive, and less in the Gobi desert (Batima, 2005). Changes of climate and vegetation affect the processes of surface heat and water balances, and feedback appears as a change of underground processes. These complex changes lead to change of permafrost. Changes in permafrost are associated with changes in the hydrological and hydrogeological conditions at local landscapes (Iijima et al., 2012, Saruulzaya, et al., 2016). Permafrost changes have been observed everywhere in Mongolia with different rates and reported in several international journals and conference proceedings (Sharkhuu, 2001, Anarmaa, et al., 2008, Ishikawa, et al., 2008, Jambaljav, et al., 2013, Ishikawa et al., 2018). Overall, the average rate of incease in mean annual permafrost temperatures is 0.2-0.4C per decade and the thickness of active layer increases by 5-20cm (Sharkhuu, et al., 2012, Lin Zhao et al., 2010). Permafrost has been degrading more intensively during the last 15 years (since 1990s) than during the previous 15-20 years (1970s and 1980s). The permafrost is not only degrading also is disappearing in low or southern limits of country (Jambaljav et al., 2013). Some buildings, as well as roads, are under threat due to the permafrost retreat in many soum centers of the permafrost region, Mongolia.

Due to climate warming the permafrost retreats deeper and the thickness of active layer increases downward. As ground ice melts, soils shift and collapse making the ground unstable thus jeopardizing infrastructure at the ground surface. Factors that contribute to permafrost thaw include thermal disruption (i.e. increase in heat) caused by both the construction of infrastructure itself as well as by a warming climate. Improved engineering methods and standards are needed to alleviate these effects.

This article summarizes the current state of the infrastructure on permafrost in Mongolia and thematic adaptation methods and mitigating technologies in other countries. Here, it summarizes the results of the current ongoing project “Permafrost Study along some road” and the result of an ERT survey conducted under a school building that was damaged due to thawing permafrost.

Methods

Electrical resistivity tomography

Electric resistivity tomography (ERT) transects were completed in conjunction with the drilling of boreholes in the investigation sites. The ERT surveys were acquired using a Syscal R1 plus with switch pro box and 96 electrodes from IRIS Instruments. The spacing of the electrodes and total length of the survey varied by transect, and are mostly 1 m and 18 m depth. A Wenner and Wenner-Schlumberger array were used to clarify the heterogeneities of underground layers. Wenner-Schlumberger array is new hybrid between the Wenner and Schlumberger arrays. For the Wenner array each deeper data level has 3 data points less than the previous data level, while for Wenner-Schlumberger array there is a loss of 2 data points with each deeper data level (Figure 1). The main goal of a geophysical survey as part of a geotechnical investigation is evaluation of the homogeneity of an investigated body and the uncovering of heterogeneities in it. In general, geophysical methods are indirect. Direct evaluation of soil properties by geophysical methods id limited. To make a direct conclusion, geophysical data should be calibrated by using information on soil obtained by direct methods, such as trenching and drilling. Geophysical methods can theoretically greatly reduce the number of boreholes.

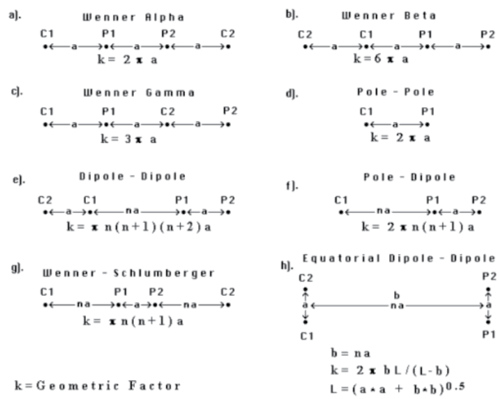

Figure 1. Common arrays used in resistivity surveys and their geometric factors

Boreholes:

Twelve boreholes were drilled using the Tanaka hand drilling machine and XYX-3 rotary drilling machine along the roads at investigation sites. Most of boreholes are located at ERT transects near the road embankment. During the drilling we determined the thickness of active layer and took several samples for ice, water content and did core description. After drilling the PVC pipe was installed in the borehole, and it is ready to measure the temperature at different ground levels. We also installed an i-bottom data logger on the asphalt surface and on both sides of the embankment.

Examples in other countries

As in Mongolia and in other countries with permafrost the construction of infrastructure on permafrost can be accomplished in two ways, 1) protect the permafrost from thawing, and/or 2) design for flexibility with the infrastructure as the permafrost destabilizes (Mongolian standard). The main guiding principle has been to prevent permafrost thaw and settlement by keeping the ground frozen with different methods. Currently, construction principles in Mongolia and other countries do not take into account the effects of climate warming. However, permafrost is most vulnerable to climate warming, especially in the low or southern limits of permafrost, such as Mongolia.

Engineers and scientists have developed a range of adaptations to meet the challenges of building infrastructure on permafrost including insulation, excavation of the ice rich ground, refrigeration with thermosyphons (passive heat exchangers), as well as designing structure (e.g. pilings) that can be adjusted as the ground surface elevation changes over time from subsidence or heave.

The biggest challenge to planning infrastructure for permafrost is creating design criteria (depicted in the engineering futures schematic), including identifying where ground ice is currently located, and how temperature and water will interact with ice and the infrastructure over time in a changing environment.

Thermosyphons are a two-phase passive refrigeration devices charged with a working fluid that transfers heat from the ground to the air when appropriate temperature differentials prevail. It has been widely applied in Alaska, northern Canada, Russia and China to preserve and cool permafrost. Thermosyphons have been applied to help stabilize permafrost-dependent infrastructure ranging from rail lines and mining tailing facilities, to pipelines, tank farms, roadways, and buildings. There are three thermosiphon designs, such as thermopile, sloping thermosiphon and flat looped thermosiphon, all of which use in north America and in Canada (Figure 2).

Figure 2. Thermosiphon types

Series of proactive roadbed-cooling methods can be used to lower the temperature of permafrost beneath the embankment and to stabilize the roadbed. These methods include solar radiation control using shading board, heat convection control using ventilation ducts, thermosyphons, air-cooled embankments, and heat conduction control using “thermal semi-conductor” materials, as well as combinations of above mentioned.

There are 6 types of embankment designs that are tested in different permafrost regions of Alaska, Canada, Russia and China. The first one is embankment with insulating materials. This type of embankment was used in cold permafrost. The second is an embankment with a thermosyphon. This type of embankment is used in areas with warm and ice-rich permafrost. Third, embankment with ventilation ducts, which reduces the temperature of the ground as much as the ventilation duct is buried close to the original surface of the ground. Fourth - crushed rock embankment. There are several types of crushed rock embankments. The fifth is a dry bridge that can shade the ground from the sun and air can freely flow through it. It is effective way of ensuring the stability of roadbeds in ice rich and sensitive permafrost. Sixth - embankment with shading boards. These types of embankments provide not only a solution for engineering construction in sensitive permafrost areas but also a countermeasure against possible global warming.

Test of thermosyphon in Mongolia

We have tested 3 types of thermosyphons in Mongolia in recent years within domestic projects and obtained significant results from their tests. The freezing radius of sloped thermosyphon with a diameter of 50mm and a length of 6m was approximately 1.0m. A thermopile with a length of 3m was frozen at a radius of 0.8m. With 50 mm diameter of condenser part and 20 mm diameter evaporator part, flat loop thermosiphon lowered the ground temperature by 5C on the evaporator.

Results

School building

Most of buildings were constructed using a concrete pile foundations as a first principle, protect the permafrost from thawing. However these buildings are under the damage after 2-10 years of construction (Figure 3).

Figure 3. School building in Tsahir soum.

Due to geographical location of Mongolia this method of construction is unsuitable at present climate condition, because the permafrost is degrading with different rates. Additional heat from buildings quickly increases the ground temperature, accelerating the degradation of permafrost and forming a thawing bowl. (Figure 4).

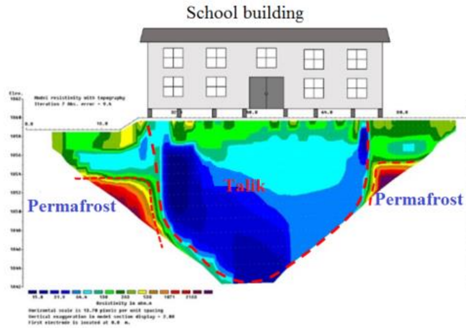

Figure 4. School building in Numrug soum.

Paved roads

As mentioned above, there are 6 types of embankment used in permafrost region. These types of embankments were tested in other countries, but our road engineers did not know about these types of embankments, and they build embankments like in a region without permafrost. After 2-5 years of road construction, deformation with a different size is formed on the road surface due to the deepening of the permafrost table. (Figure 5).

We have done several ERT surveys across road and found that under the embankment permafrost deepens more rapidly and road surface set down with different rate, why the formed waved surface. We did some ERT cross-transect examination of the road and found that the permafrost deepens faster under the embankment and the road surface sits down with different sizes, why the undulating surfaces form.

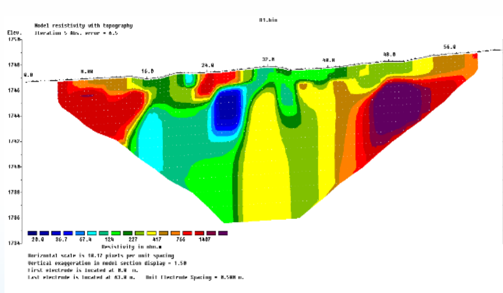

Figure 5. Geophysical measurement near in Chuluut valley.

Conclusions

1. Permafrost degrades rapidly with different rates by region and some shallow permafrost completely disappeared in lower or southern limits of permafrost distribution in Mongolia.
2. Infrastructure on the permafrost accelerates the degradation of permafrost and the degradation of permafrost reduces the life of the infrastructure. It loads on the country's economy.
3. Request to update standards and norms of construction, especially recommend to update them for permafrost regions in Mongolia.

Acknowledgments

Project “Permafrost study along the some roads” with number of ШУСС2017/42 was financially supported by the Ministry of Education, Culture, Science and Sport, Mongolia. The authors deeply thank colleagues from drilling company for help to drill boreholes and colleagues from Road Authorities at countryside especially in Arkhangai and Bayan-Ulgii aimag.

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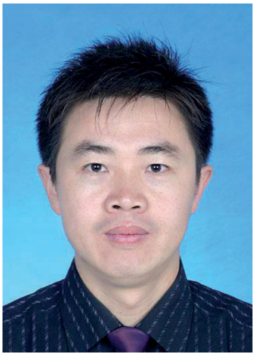
KEY TECHNIQUES OF FAST ARTIFICIAL RESTORATION OF BIOCRUSTS AND ITS APPLICATION IN THE FIELD



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Abstract: As a new ecological restoration method, artificially constructed biocrusts with obvious advantages over traditional plant measures in terms of construction efficiency, maintenance cost and protective effect and so on. In order to promote the establishment of technical system for biocrusts engineering, considering the growth regulators, functional microorganisms, algae and herbaceous plants as the key experimental factors of indoor expansion and field inoculation, discussed through researches designed by complete experimental method. The results show that: (1) In indoor propagation, functional microorganisms could significantly increase the coverage, plant density and plant height of biocrusts ($P < 0.05$). Bacillus mucilaginosus showed the best performance, and the coverage, plant density and height reached 34%, 17 plants/m^2 and 6.3 mm after 60 days of cultivation; (2) Under field conditions, the coverage and thickness of biocrusts increased significantly ($P < 0.05$) by 12.66% and 21.57%, compared with those without algal addition respectively. Added 1g algae with Bacillus megaterium was the best treatment, and its coverage and thickness of biocrusts were 90.67% and 3.08mm. (3) In slope restoration, biocrusts could significantly increase the coverage, plant height and aboveground biomass of herbs by 47.55%, 31.81% and 163.84% significantly ($P < 0.05$). Grass promoted the coverage and thickness of biocrusts significantly ($P < 0.05$), which increased by 121.57% and 21.28%. In general, the application of algae, functional microorganisms and herbaceous plants has played a key role in promoting the recovery efficiency of artificially restored biocrusts, and can be fully used in future engineering recovery practices.

Keywords: algae, biocrusts, functional microorganisms, growth regulators, herbaceous plants

FEATURES OF SPATIAL AND TEMPORAL DYNAMICS OF LAKE BAIKAL BASIN VEGETATION COVER

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Abstract: The purpose of this work is to create and analyze a map of NDVI trends in the Lake Baikal basin based on long-term satellite observations. The Lake Baikal basin is characterized by an exceptional diversity of ecosystems, due to natural conditions of the region, located on the border of the boreal and arid regions of Eurasia. The relevance of the topic is confirmed by the need to preserve Lake Baikal – UNESCO World Heritage Site. The initial data was the MODIS NDVI time series of the thematic product MOD13Q1 from 2000 to 2018. An NDVI linear trend map was created as a result of per pixel processing of more than 10 million regression equations. For the study area, positive NDVI trends are observed for 76 % of the basin area, and negative for 24 %. Statistically significant trends ($p < 0.05$) are observed for 82% of the Lake Baikal basin area of which 65 % for positive trends, 17 % for negative trends. In the Russian part of the basin, negative NDVI trends are typical for steppe vegetation and positive for forest ecosystems. In the Mongolian part of the basin, there are mainly positive NDVI trends for steppe vegetation. Strong negative and positive NDVI trends are typical for forests prone to logging, fires and reforestation. For spatial comparison of NDVI trends with climatic variability in the Lake Baikal basin, the trends of temperature and precipitation were calculated from monthly data of 20 meteorological stations from 2000 to 2018. It was found that in the Mongolian part of the basin precipitation trends are positive and for the Russian part are negative which agrees with the dynamics of the vegetation of the steppe zones. Almost for all meteorological stations there are non significant positive temperature trends. The reported study was funded by Russian Foundation for Basic Research according to the research project No. 19-55-53026.

Keywords: NDVI, MODIS, Lake Baikal, basin, vegetation cover, trend, precipitation, temperature

ECOLOGICAL RESTORATION IN DEGRADED LAND RESTORATION—USING MICROBIAL ORGANIC COMPOUND

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Abstract: We are facing tremendous land degradation across the whole world, especially in the vulnerable arid and semi-arid areas. There are about 42 million km2 of land under human-induced desertification. Numerous methods have been applied to combat desertification and many of them received a satisfactory restoration. However, some of the methods are time consuming, some are expensive and some may cause environmental problems. We developed a fast way to restore degraded sandy land by using microbial organic compound (MOC). Organic waste from straw and livestock dung were smashed into small pieces and mixed as raw organic compound. Effective cellulose decomposers were inoculated to accelerate the organic compound decomposition. The MOC could be used for degraded land restoration when the fermentation were done in two months. The optimized MOC was significantly efficient in rehabilitating bare sand dunes, accelerating biological soil crust formation, and cropland amendment. The MOC had a potential advantage for increasing water holding capacity, wind erosion resistibility and soil fertility. It is also a potential option to replace the use of chemical fertilizer in cropland. This technique provides an effective and ecological method that aims to accelerate successful restoration from degraded sandy land in the arid and semiarid areas.

Keywords: degraded land, restoration technique, microbial organic compound, arid and semi-arid area

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"WASTE MANAGEMENT AND WATER TECHNOLOGY" ADB PROJECT: THE DETERMINATION OF BACTERIAL SOIL POLLUTION NEAR THE LATRINES OF SOME GER AREA, BAYANZURKH DISTRICT, ULAANBAATAR

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Abstract: The recent studies of environmental pollution mainly focus on the content of toxic chemicals in the environment. However, air, water, and soil become the source of transmission of pathogenic microorganisms. Therefore, it is necessary to determine the environmental pollution caused by microorganisms. Therefore, this study conducted that the determination for bacterial pollution of soil near the latrines of ger area in Bayanzurkh and Songinokhairkhan district. Soil samples were collected from selected households of ger area 27th khoroo, Bayanzurkh district. Sampling was performed that the 1 meter of distance from latrines and 0-20 cm depth (below the ground level), were used as a shovel and a spatula. Soil samples were transported by using sterile bags and containers under the sterile condition and reached to the laboratory within 4 hours. High, moderate, low level of bacterial pollution and non-polluted soil were observed 27%, 8%, 52% and 13% of soil samples among the 60 selected points. 5 samples of 20 samples collected from 6th khoroo, Songinokhairkhan district were fecal coliform positive. In addition, the pathogenic bacteria, enterococci were detected in 5 samples. 2 samples of 7th khoroo, Songinokhairkhan district were fecal coliform positive. In addition, the pathogenic bacteria, enterococci were detected in 4 samples. But salmonella was not found in those khoroos. 8 samples and 4 samples of 27th khoroo, Bayanzurkh district were positive with fecal coliform and enterococci, respectively. It was observed that the soil pollution was high during the spring of 2018, however, the bacterial pollution of soil was decreased in these three khoroos during the spring of 2019.

AIR POLLUTION IN ULAANBAATAR, MONGOLIA AND RESULTING IMPLICATIONS FOR PUBLIC HEALTH: A REVIEW

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Abstract: The recent growth of Mongolia's capital Ulaanbaatar coincided with a massive increase in air, water and soil pollution levels. Air pollution is considered to be the single largest problem from a public health perspective, with the key problem being particulate matter emissions from the stoves used for heating gers. These aerosols are problematic for human health not only because of their small size, but they also contain traces of heavy metals such as As or Pb. Since aerosols are eventually removed from the atmosphere by dry or wet deposition, they also influence soil and surface water quality. Due to air, soil and water pollution, the population is thus exposed to the same pollutants via different pathways. This review aims at synthesizing the current state of knowledge and pointing out future research needs.

Keywords: Ulaanbaatar, air pollution, particulate matter, heavy metals, deposition, soil pollution

Introduction

Mongolia, which has been an overwhelmingly nomadic society until the communist revolution of 1921, still has about 80% of its territory covered by common rangeland (Upton, 2010). In 1639, Ulaanbaatar's present location was first mentioned as the location of a mobile, yurt-based Buddhist Monastery; in 1778, the settlement became permanent (Diener and Hagen, 2013). In 1855, present-day Ulaanbaatar became Mongolia's capital (Ishii, 2016). The city remained a small settlement, until the communist era coincided with the propagation of a modern, urban lifestyle. In 1924, Ulaanbaatar received its present name, but a planned urban development began only in the late 1950s, when new amenities like electricity or piped water supply were seen as an important step towards a modern socialistic state (Janzen 2012; Karthe et al. 2016). Housing the majority of Ulaanbaatar's population in Soviet-style apartment building was considered a key element "socialist progress" (Diener and Hagen, 2013:633). In the early 1960s, Mongolia's historically very low urbanization rate therefore increased massively (Figure 1).

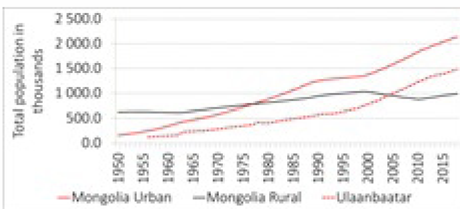

Figure 1: Urbanization in Mongolia and growth of Ulaanbaatar City. Source: United Nations Population Division 2018

Air pollution in Ulaanbaatar and its Relevance for Public Health

Direct effects of air pollution

Ulaanbaatar is one of the worst affected cities worldwide in terms of air pollution, with aerosol concentrations and compositions comparable to those in major cities in China (Zhamsueva et al., 2018). Air pollution with particulate matter (PM) is worst during the winter season due to a massive increase in fuel consumption for heating purposes. PM10 (and sometimes even PM2.5) concentrations often reach several hundred µg/m^3. In highly polluted localities, even 1000 µg/m^3 are exceeded (Cavanaugh, 2017; Davy et al., 2011; Hasenkopf et al., 2016). Further problems include the enrichment of the particles with toxic elements such as As, Cu, Pb and Zn (Nishikawa et al., 2011) and relatively high SO_2 concentrations which may exceed 40 µg/m^3 during the winter (Luvsan et al., 2012).

Air pollution in Ulaanbaatar has been linked to various health impacts. Both respiratory disorders and cardiovascular diseases occur more frequently in highly polluted areas and during the winter heating season, when PM concentrations reach their peak (Dashdemberel et al., 2012; Enkhjargal & Burmaajav, 2015). Allen et al. (2013) estimated that at least 29% of cardiopulmonary deaths and 40% of lung cancer deaths are caused by outdoor air pollution, causing about 10% of the city's total mortality. In particular, air pollution affects pregnant mothers and children living in the city's ger districts, leading to pregnancy losses, premature birth, low birth weights and increased levels of childhood asthma (Dorj et al., 2016; Enkhmaa et al., 2014; Yoshihara et al., 2016).

A few studies have focused on biomarkers of environmental pollution rather than direct health outcomes. Most notably, it was shown that some of the ger area residents have blood lead concentrations that exceed the U.S. Center for Disease Control's safety reference level of 5 µg/dl (Enkhbat et al., 2016; Praamsma et al., 2016). Mean levels of urinary1-hydroxypyrene (1-OHP), which result from exposure to carcinogenic polycyclic aromatic hydrocarbons (PAHs) were double to more than four times higher for children in ger areas as compared to apartment areas (Chen et al., 2015).

Indirect effects of air pollution

Most of the solid and gaseous substances contained in polluted air are eventually deposited on soil and water surfaces, for which they act as diffuse pollution sources (Wu et al. 2018, Zanetti et al. 1990).

As and Pb have been detected at levels exceeding the Mongolian soil standards in several recent studies (see table 1).

Table 1. Heavy metals in Ulaanbaatar's soils according to recent studies (Study 1: Batjargal et al., 2010; Study 2: Kasimov et al., 2011a; Study 3: Tserenpil et al., 2016)

	Study 1	Study 2	Study 3
Number of samples (n)	22	90	10
Samples exceeding MPC			
… for Pb (100 mg/kg)	13.6 %	16%	0%
… for As (6 mg/kg)	100%	100%	100%
Maximum concentrations			
… for Pb (mg/kg)	143		55
… for As (mg/kg)	64.1		21.7

Additionally, soils were found to exceed 34% and 20% respectively exceeded the MPCs for Zn and Mo (Kasimov et al., 2011a). Despite some enrichment, Hg concentrations in Ulaanbaatar's soils are relatively moderate, which may be due to the fact that Hg concentrations of Mongolian coal are about one half to two thirds below the world average (Chung & Chon, 2014).

Elevated levels of heavy metals which are likely to originate at least partly from air pollution have been documented in several other environmental compartments, too. Sorokina et al. (2013) showed that the snow cover in Ulaanbaatar contains unusually high concentrations of heavy metals, especially in the ger areas. Kasimov et al. (2011b) observed an accumulation of Zn and Cd in poplar leaves (*Populus laurifolia*), whereas Mo and V were found in elevated concentrations in larch needles (*Larix sibirica*). However, it should be noted that the authors did not observe a direct correlation between metal concentration in soils and biomass could be established (Kasimov et al., 2011b).

Discussion

Ulaanbaatar experiences some of the world's highest airborne PM concentrations during the winter season. Fine PM particles are problematic because they can deeply penetrate the respiratory system. This becomes even more problematic when they contain toxic substances such as As or Pb, which is the case in Ulaanbaatar. Because most aerosols are eventually deposited, they also contribute to soil (and water) pollution. Since small scale agriculture is common in ger areas, the high levels of heavy metal accumulation observed in soils and trees are highly problematic and point to multiple exposure pathways (by respiration and by consuming locally grown vegetables).

In the future, integrated research is necessary to account for the pollution of different environmental compartments and the resulting health effects.

Acknowledgments

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Consistency of style is very important in citations in the text and in the list of references.

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EGIIN GOL HYDROPOWER PLANT: PROSPECT OF DEVELOPMENT AND FUTURE CHALLENGES

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Abstract: Hydrological impact studies of the "Egiin Gol" Hydro Power Plant to the Selenge River and Baikal Lake executed by the French and Russian experts. Consequently, the Mongolian state owned "Egiin Gol" Hydro Power Plant Company implemented the studies in order to preserve the Selenge Rivers flow change in its natural variation. The first stage includes the construction of the downstream buffer dam to control high flows during EGHPP pick hours, accumulating and releasing it gradually throughout day. The second stage comprises building of the artificial lake in the northern floodplain of the Selenge River and the remained part of excess flow from the pick powers will be regulated by this lake. These technical applications demonstrated in the HEC Ressim Reservoir simulation model developed by USA Army Corps of Engineers, considering the period of reservoir filling and operation. The downstream flow change of the Selenge River assessed in the varieties of high, medium and low flow periods. Result of the study approves possibility of preserving Selenge Rivers flow in natural deviation which means the flow regime will kept in natural system and the daily runoffs are close to natural. The EGHPP state owned company intends to undertake an additional study on the impacts of the EGHPP on the biodiversity of the Selenge River and Lake Baikal.

Keywords: artificial lake; buffer dam; runoff; HPP; hydrological impact.

Introduction

The proposed Egiin Gol Hydro Power Plant (EGHPP) is located on the Eg River in northern Mongolia, at 2.5 km upstream Eg and Selenge Rivers confluence. The Eg River takes its origin from the Lake Khuvsgul, which contains 75 percent of the fresh water resources Mongolia. Hydrological impact studies of EGHPP to Selenge River and Baikal Lake executed by the Tractebel Engineering S.A. France in 2015. The flow changes of Selenge River downstream of the EGHPP revealed at Hyalganat, Zuunburen, Nausk, Novoselenginsk and Mostovoy stations in monthly time steps. The results show that there is no total annual flow change, however flows in winter (November to March) will increase and in spring and autumn, it will decrease.

In the Russian report "The impact assessment from the planned hydro technical structures in Mongolia to the trans boundary Selenge River basin" (2018), the impact of EGHPP assessed in 10 day time step by "Flow-ecology" model and concluded that there is no regulation version, which is appropriate to ecological demand.

Consequently, EGHPP state owned company implemented the studies in order to preserve the Selenge River flow change in its natural variation. These include construction of downstream buffer dam to control high flows during EGHPP pick hours, accumulating and releas-

-ing it gradually through days and the remained part of excess flow would resolve by regulation of artificial lake in floodplain of the Selenge River. Result of study approves possibility preserving flow in natural deviation.

It includes the following studies with the purpose to preserve Selenge River flow change in its natural variation during the filling and operation of the EGHPP.

1) Water resources and flow characteristics of the Selenge River
2) Development of the HEC ResSim model for EGHPP during its filling period and downstream flow changes of the Selenge River
3) Development of the HEC ResSim model for EGHPP during its operation and downstream flow changes of the Selenge River
4) Mitigating impact of the EGHPP during its operation on Selenge River flow by regulating the artificial lake
5) Flood modelling of the Selenge River during high occurrence flood (HEC RAS)
6) Comparative results from Russian and Mongolian studies on "The Selenge River flow changes during the EGHPP regulation"

Method

In this study were used the HEC ResSim Reservoir simulation model developed by the USA Army Corps of Engineers and in intentions considered the period of reservoir filling and operations. The downstream flow change of the Selenge River under the impact of the EGHPP estimated in the varieties of high, medium and low flow periods. The distinction of this technical study is that inclusion of the downstream buffer dam and artificial lake to reduce the EGHPP impact on downstream flows.

The HEC-ResSim represents a river-reservoir system as a georeferenced network of reservoir, routing reach, stream junction, and diversion elements. The model includes data that represents both physical and operational aspects of the system. Physical data includes reservoir elevation-capacity tables, complex outlet works, power-plant specifications, and river-reach routing parameters. Operational data is represented as rule stacks, which allow users to identify and prioritize multiple reservoir operation rules. The model supports both local rules for at-site operations and system operation rules for downstream control, system hydropower generation, and tandem/parallel system storage balancing (RMA, 2013).

HEC-ResSim is comprised of a geographical user interface (GUI), a computational program to simulate reservoir operation, data storage and management capabilities, and graphic and reporting facilities.

HEC-ResSim has three separate sets of function called Modules that provides access to specific type of data within a watershed. These modules are Watershed setup, Reservoir network and Simulation. Each module has a unique purpose and an associated set of functions accessible through menus, toolbars and schematic elements (HEC, 2013).

The Watershed setup module provides framework to create watershed and definition among different modeling applications. The Reservoir network is to isolate the development of reservoir model from the output analysis. In this module can develop network schematic and describe the physical and operational elements of the reservoir model. The Simulation model has a purpose to isolate output analysis from the model development process.

First studied the objectives of (or constraints on) the EGHPP operation of a reservoir then affiliation HEC-ResSim rule specifies an operational goal or constraint as a desired limit on the range of allowable releases.

The reliability of the developed model evaluated by the methods which are used commonly in international hydrological studies such as Nash–Sutcliffe efficiency (NSE), Percent bias (PBIAS), RMSE-observations standard deviation ration (RSR) and the result was acceptable. Based on the model the downstream flow change of the Selenge River estimated at Hyalganat, Zuunburen and Naushk stations.

Results

In this study were used long-term flow records from the Eg River- Khantai (1959-2015), Selenge River- Khutag (1972-2015), Hyalganat (1982-2014) and Zuunburen (1974-2015) stations and were built the differential integral and probability curves of the annual and monthly average flows in order to determine high, medium and low water periods.

The reservoir-filling period of EGHPP estimated by the HEC ResSim (Figure 1) model as following:

- In the high water years, filling time is 1 year and 2 months, starting from April 1993 to June 1994;
- In the medium water years, filling time is 2 years and 9 months, starting from March 1998 to December 2000;
- In the low water years, filling time is 4 years and 9 months, starting from March 1978 to December 1982;

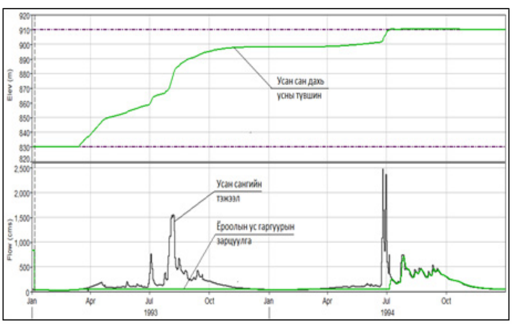

Figure 1. Reservoir filling in high water years (1993-1994) at Eg River-Khantai station

Using the curve determined high, medium and low water periods to simulate the different variation. As well, using the long-term flow records from the Selenge River- Zuunburen station, Orkhon River-Sukhbaatar stations were built probability curves of the yearly, monthly and seasonal flows to determine its extent (Figure 2).

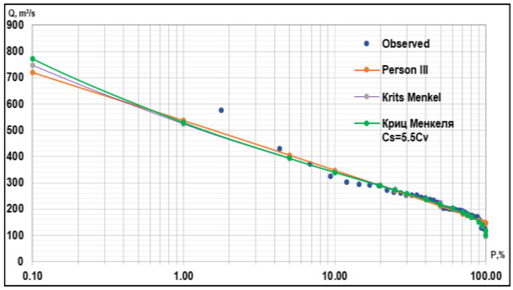

Figure 2. Mean annual runoff probability curve (Selenge River-Zuunburen station)

Resent years Russian and international researchers consider on long lasting low water period in the Lake Baikal basin and noted that the low water cycle has started since 1996 and reached its disaster level in 2014-2015 which observed the extreme low water years with the probability of 99 percent.

As stated in the long time flows records of the Selenge River basin, the extreme low flow observed at the Eg River Khantai station observed in 1981, 2015 (49.8; 52.9 m^3/c). The extreme low water period observed the Khutag and Zuunburen station of the Selenge River in 2002 (47.1, 125 m^3/c) and at the Sukhbaatar station of Orkhon River in 1980 and 2005 (54.2, 55.1 m^3/c).

As can be seen from the long-term variability graph, in the recent years the annual flow of the Selenge River (Figure 3) observed significantly below the long term average, on the both of territory of Mongolia and Russia. These low water periods of the Selenge River and other tributaries contributed to recompose low water period of the Lake Baikal.

The Selenge, Eg and Orkhon River's characteristics of mean flow, its quantities with different probability of occurrence has presented in the Table1.

Table 1. Characteristics of mean annual flow

River/ Station	Long term mean, km^3	Annual flow volume, км^3 by probability, %					
		0,1	1	5	50	95	99
Eg Khantai	3.1	7.9	6.0	4.9	3.0	1.9	1.6
Selenge Khutag	3.9	15.3	10.1	7.2	3.9	1.9	1.5
Selenge Zuunb	7.4	24.3	16.7	12.4	6.87	4.35	3.72
OrkhonSukhb	3.7	11.2	9.0	7.1	3.5	1.4	0.9

Table 2. Total deviation Selenge River runoff from its natural fluctuation range at Hyalganat

Prob, %	I	II	III-VIII	IX	X-XI	XII
99	15-25	10		5-45		5
95	20-25	10				5-10
50	20-30	5-15				5-10

(m^3/s)

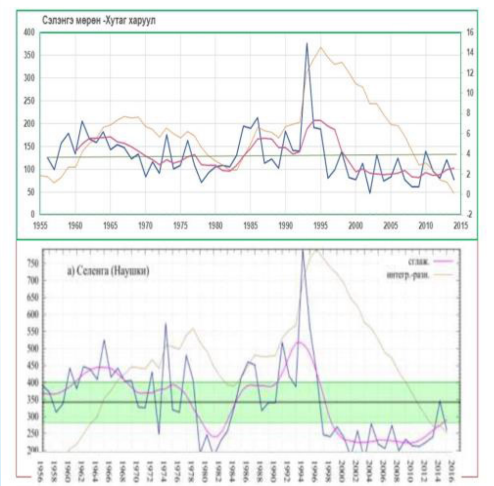

Figure 3. Mean annual runoff and integral curve 1.Selenge Khutag; 2.Selenge Naushk

The impact of the EGHPP with the buffer dam during its operation on the Selenge Rivers flow estimated by the years of 50 percent probability (2001-2002), 95 percent (2007-2008) and 99 percent (2002-2003).

In medium water years, under the impact of EGHPP, the Selenge River's daily flow stay within its natural flow fluctuation range in all seasons. However, in low water periods under impact of EGHPP in some months, the daily flow of Selenge River excess the bottom (red) and upper (blue) edge of natural variability ranges as indicated in the Table 2-4.

Table 3. Total deviation Selenge River runoff from its natural fluctuation range at Zuunburen (m^3/s)

Prob, %	I	II	III-VI	VII	VIII	IX	X-XII
99	35-45	50		15	30-55	150	
95	40-50	40-50					
50	40-50	50-55					

Table 4. Total deviation Selenge River runoff from its natural fluctuation range at Nausk (m^3/s)

Prob, %	II	III-IV	V	VI	VII	VIII	IX
99	15-25		45	15-20	15-20	130	25-8
95	15-25	10	20		30		
50	15-30						

Therefore, to mitigate this affect was concerned version to build artificial lake with volume of 250-280 million cubic meters in the northern flood plain of the Selenge River to accumulate the excess of the flows. During the months from December to February, the 30-40 m^3/s

River will accumulated in the lake and during the dry period, from April to September, this water will used to enhance the Selenge Rivers low flow.

The outcome of this study was compared to Russian studies (2018) to verify the results. Example, in medium water years the Russian study notes that in winter season the flow will increase significantly comparative to natural (3.5 times at Nausk), and it will exceed (in blue color) the natural flow maximum range by 21 percent in November and 100 percent in February at Naushk station (Figure 4).

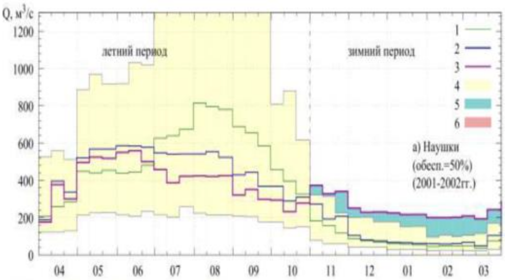

Figure 4. Natural and regulated flow changes of Selenge River at Naushk station (2001-2002)

The result of Mongolian study shows that the flow exceeded natural flow range will disappear when flow regulated doubly with the buffer dam and artificial lake (Figure 5).

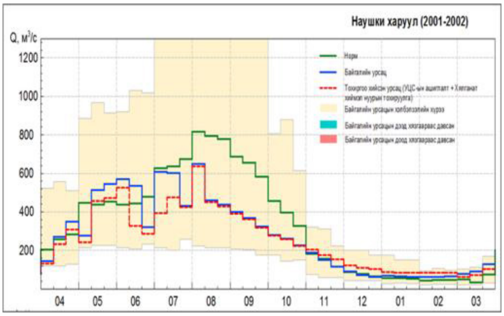

Figure 5. Natural and regulated flow changes of Selenge River at Naushk (2001-2002)

In Russian report stated that when observes the flow of 99% probability the regulated flow affect will increase and exceeds the natural flow maximum range from July to November reaching 30% at Naushk.

The result of this study show that the flows exceeding the natural flow range at Nausk will disappear completely after that double regulation of buffer dam and artificial lake.

Discussion & Conclusions

Hydrological impact studies of the EGHPP to the Selenge River and Baikal Lake executed by the Tractebel Engineering S.A. France in 2015. The flow changes of Selenge River downstream of the EGHPP revealed at Hyalganat, Zuunburen, Nausk, Novoselenginsk and Mostovoy stations in monthly time steps. The results show that there is no total annual flow change in the Selenge River, however the flows in winter (November to March) will increase and in spring and autumn, it will decrease. The findings of the Tractebel engineering company show that water accumulation during the reservoir filling period is equal to 0.002-0.023 percent comparative to Lake Baikal volume which means the impacts are negligible.

In the Russian report “The impact assessment from the planned hydro technical structures in Mongolia to the transboundary Selenge River basin” (2018), the impact of the EGHPP assessed in 10 day time step by the “Flow-ecology” model and concluded that there is no regulation version, which is appropriate to ecological demand. However, in the Russian first stage report concluded that “... in general the impact of the EGHPP to Russian territory in the terms of flow deviation from natural and during summer and winter period is less and mellow comparative to the Shuren HPP. ...”.

The state owned EGHPP LLC implemented the studies in order to preserve the Selenge River flow changes in its natural variation. These include construction of the downstream buffer dam to control high flows during the

EGHPP pick hours, accumulating and releasing it gradually through days and the remained part of excess flow will resolve by regulation of artificial lake in the floodplain of the Selenge River.

The downstream flow change of the Selenge River assessed in the varieties of high, medium and low flow phases. Result of the study approves possibility of preserving Selenge River flow in natural deviation which means the flow regime will kept in its natural system and the daily runoffs are close to natural.

The EGHPP the state owned company intends to undertake an additional study on the impacts of the EGHPP on the biodiversity of the Selenge River and Lake Baikal.

Acknowledgments

We thank EGHPP state owned company for giving possibility to present.

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DEVELOPMENT OF IMMERSED BOUNDARY LATTICE BOLTZMANN METHOD FOR OPEN CHANNEL SEEPAGE FLOWS

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Abstract: The immersed boundary-Lattice Boltzmann method directly coupled with a free surface flow treatment is introduced as an alternative numerical model for porous media flows at the representative elementary volume scale. The liquid fraction values representing the presence of void in porous media are used as the model parameter which explicitly relates to the permeability. The exact relation of the liquid fraction and permeability is examined by the analytical and numerical computations of flows through a U-tube with a porous zone. The model with the permeability relation obtained provides good agreement with the analytical results convincing the extended applicability to porous media flows. The model retains the inherent advantages for parallelization and the smooth treatment of a moving boundary.

Keywords: Porous-media flow, Immersed boundary method, Free surface flow, Lattice Boltzmann method

Introduction

Generally, a flow through any type of solid scattered structure is considered as a porous-media flow (Scheidegger, 1958) and its flow definition can be classified into pre-Darcy, Darcy and Forchheimer zones, depending on the magnitude of flow velocity through the porous medium. In hydraulics, porous-media flow is often described by Darcy's law (Darcy, 1856), in which the velocity is proportional to the pressure gradient of the flow. Using Darcy's law and its extended version with Brinkman and Forchheimer, the numbers of analytical and numerical solutions have been applied for various problems to address static and time dependent dynamic behavior of the flow through porous media.

In the last two decades, the lattice Boltzmann method (LBM) has been extensively applied to fluid flows including porous media flows (Chen and Doolen, 1998) and free surface flows (Kцrner et al., 2005). The LBM has been dealing with porous media flows at the pore-scale and the representative elementary volume scale (REV) (Guo and Zhao, 2002). It can directly be applied to the pore-scale porous media flow, where detailed interactions between fluid flow and solid are attained. While there are two types of LBM at REV scale, one based on the generalized NSEs (Guo and Zhao, 2002) and the other taking advantages of partial bounce-back rules in the LBM (Dardis and McCloskey, 1998), have been developed. Inspired by the simple nature of the immersed boundary-LBM (IB-LBM) proposed by Noble and Torczynski (1998), we introduce a novel REV scale IB-LBM to model porous media flows. The proposed model allows, with the free surface formulations of LBM (Kцrner et al., 2005), to be applied to free surface flows through unconfined porous media.

Free surface-immersed boundary-lattice Boltzmann method

Without losing generality, an additional collision term formulated from mass and momentum conservation perspectives and accounting for the interactions with each solid obstacle representing the porous media is introduced by Noble and Torczynski (1998) to the lattice Boltzmann equation. The evolution equation in the immersed boundary-lattice Boltzmann method is:

$$f_i(\mathbf{x}+\mathbf{c}_i\delta t, t+\delta t) - f_i(\mathbf{x},t) = -\frac{\delta t(1-\beta)}{\tau}\left(f_i(\mathbf{x},t) - f_i{}^{eq}(\mathbf{x},t)\right) + \beta f_i{}^{m}(\mathbf{x},t) + \delta t(1-\beta)A_i, \qquad (1)$$

where $f_i(\mathbf{x},t)$–density distribution function (DF) at time t (as shown in Fig. 1a) in a two dimensional space, $\mathbf{x} = (x,z)$–position vector (m), $\mathbf{c}_i = (cx_i, cz_i)$–discrete lattice velocity, δt–lattice time step, τ–dimensionless relaxation time, which can be the total relaxation time, if a turbulent model is employed, $\beta = (1 - l_f(\mathbf{x},t))$–immersed boundary weighting function, $l_f(\mathbf{x},t)$–lattice liquid fraction value, $f_i{}^{eq}(\mathbf{x},t)$–equilibrium distribution function, $f_i{}^{m}(\mathbf{x},t)$–additional collision term, and A_i–force term. At each lattice time step, the evolution equation is solved by two steps, namely collision and streaming, on fluid and interface cells, as shown in Fig. 1b. After the streaming step, the boundary conditions realized in forms of distribution functions should be applied. The macroscopic physical variables, pressure, p, and velocity vector, $\mathbf{u}$, can be defined by the evaluated distribution functions as

$$p = \frac{\rho}{3} = \frac{1}{3}\sum_{i=0}^{8} f_i \text{ and}$$

$$\frac{\rho\mathbf{u}}{l_f(\mathbf{x},t)} = \sum_{i=0}^{8}\mathbf{c}_i f_i + \frac{\mathbf{F}\delta t}{2}, \qquad (2)$$

where $\mathrm{F}(=\rho g_L)$–force due to the gravitational acceleration, $g_L(= g_R\,\Delta t^2/\Delta x)$, L and R subscript stands for lattice and real physical values and, Δt and Δx are physical time step (s) and grid spacing (m), respectively.

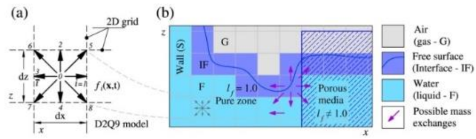

Figure 1. Schematic description of a numerical model: a D2Q9 lattice arrangement on a cell, b free surface representation and zones for porous media and pure fluid according to the liquid fraction.

In the present model, the equilibrium distribution for the fluid flow can be calculated by the second order of the expansion of the Maxwell distribution function (Chen and Doolen, 1998) and the force term by Guo et al. (2002) is used. Among the several forms (Noble and Torczynski, 1998), the additional collision term in Eq. (1) can be expressed as

$$\mathrm{f_i^m(x,t) = f_i^{eq}(\rho, u_s) - f_i(x,t)} + \left(1 - \frac{\delta t}{\tau}\right)\left[\mathrm{f_i(x,t) - f_i^{eq}(\rho,u)}\right], \qquad (3)$$

where $\mathrm{u_s}$–velocity of the moving solid at new time on the cell. The liquid fraction value of the cell takes a value between 0 for a fully solid cell and 1 for a fully fluid cell. It should be noted that the porous medium is stationary, the velocity, $\mathrm{u_s}$, will be zero. The additional collision term with the weighting function allows some degree of momentum and mass transmission through the partially filled solid cells depending on the liquid fraction value. The liquid fraction value can be used solely instead of the weighting function in the governing equation to reduce unnecessary memory consumption, only if the relationship between the liquid fraction and weighting function is linear and a problem is just a flow through porous media.

From Darcy's law, the permeability of a porous medium can be defined as

$$K_p = \mathrm{u}\nu\Delta L/g\Delta H\,, \qquad (4)$$

where u–seepage flow velocity (m s^{-1}), ν–kinematic viscosity of fluid (m^2 s^{-1}), g–magnitude of the gravitational acceleration (m s-2), $\Delta\mathrm{H}/\Delta\mathrm{L}$–hydraulic gradient. By defining the variables in Eq. (4) in terms of the lattice Boltzmann method, the several types of permeability relation derived by different authors, such as Dardis and McCloskey (1998) and Walsh et al. (2009). Therefore the relation by Walsh et al. (2009).

$$\mathrm{k} = \frac{\mathrm{l_f}\nu_\mathrm{L}}{2(1-\mathrm{l_f})}\,, \qquad (5)$$

is chosen to be used for the simulation of porous media flows with the IB-LBM. In the relation, $k(\sim K_{pL})$ can be called the model permeability, not necessarily the same as lattice permeability, K_{pL}, which is scaled from the real permeability, ν_L–lattice fluid viscosity and $l_f(\mathbf{x},t)$ is considered here instead of the solid fractions. The relation in Eq. (5) not only enables the IB-LBM to simulate heterogeneous porous media, but also helps to define correct connections for lattice parameters to their physical parameters.

Numerical experiments: Flows in U-tube porous media

To define the connections between parameters in the FS-IB-LBM to their physical counterparts, we have conducted the numerical experiments with different cases. The procedure for this is done by accurately matching the results obtained by the analytical and numerical simulations. Simple gravity driven seepage flow through porous media packed in a U-tube was solved as a benchmark problem for numerical experiments.

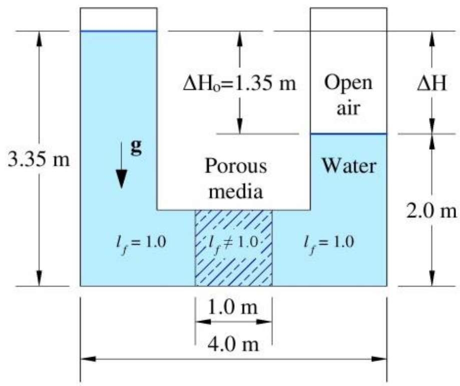

Figure 2. The geometry and initial condition of the flow through U-tube

The analytical solution of the head difference and seepage velocity in terms of elapsed time, t, can be computed as respectively. In the formulae, the permeability, $\mathrm{K_p}$ ($\mathrm{m^2}$), can be inserted instead of the hydraulic conductivity using the relation $\mathrm{K_h} = \mathrm{K_p}\,\mathrm{g}/\mathrm{v_k}$.

$$\Delta H = \Delta H_o \exp(-2K_h t/L) \text{ and}$$
$$u = \Delta H_o K_h \exp(-2K_h t/L)/L\,, \qquad (6)$$

The problem geometry is discretized into 400×340 grids spacing as $\Delta\mathrm{x} = \Delta\mathrm{z} = 0.01$ m for the simulation cases with the FS-IB-LBM. For all cases, the following parameters except the liquid fraction values were used: lattice gravity $\mathrm{g_L} = 1.28 \times 10^{-4}$, which gives the relaxation time $\tau = 0.5315$ and the physical time step $\Delta\mathrm{t} = 3.61 \times 10^{-4}$ s. The initial condition is given by hydrostatic condition in the fluid region (Badarch and Tokuzo, 2018).

The simulated results of the cases agree well with those of analytical solutions, as shown in Fig. 3. The corresponding case parameters for the analytical and numerical simulations are given in table 1.

Table 1. Parameters for experimental cases.

	1	2	3	4	5
Analytical solution K_{pR}, m^2	1.07 E-9	2.09E-10	1.39 E-10	6.96 E-11	2.14 E-11
l_f in FS-IB-LBM	0.9	0.7	0.5	0.3	0.1

The FS-IB-LBM properly predicts the flow and pressure gradients, which agree with Darcy's law.

However, with the very low permeability, the model shows some degree of discrepancies in head differences and seepage flow velocities, as seen in Fig. 3, due to the low liquid fraction values. It is seen that the model under/overestimate the head difference and repeatedly overestimate the seepage flow for lower permeability. In the simulations, the seepage velocity was measured as average on the horizontal axis of the porous zone.

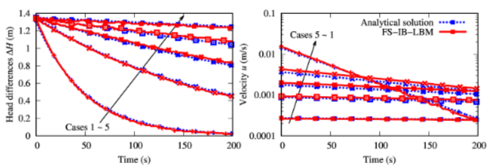

Figure 3. Comparisons of the head differences and seepage flow velocities for experimental cases

The experiments show that with the correct relation of the permeability the original formulation of the IB-LBM with an appropriate additional collision term can be applied to the porous media flow directly. It can be seen that if l_f becomes lower approaching its limit, unlimited model permeability will be provided. In turn the additional operator for the IB-LBM correctly reflects the distribution functions from the impermeable solid. In other case of $l_f = 1$, the additional operator is vanished and the standard LBM for fluid flow will recover.

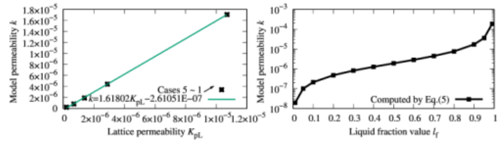

Figure 4. Relations of the model permeability to the lattice permeability and liquid fractions

From the numerical experiments, we derived the scaling of the model permeability to the lattice permeability, as shown in Fig.4a. The correct scaling of the lattice permeability to the model permeability or vice versa is essential for the accuracy of the model. The computed relations (Fig.4b) between the model permeability and the liquid fraction values were similar to the Kozeny-Carman equation

Conclusions

The free surface-immersed boundary-lattice Boltzmann method (FS-IB-LBM is introduced in first time for flows through porous media. In this regards, the relation of permeability and scaling of the permeability are purposed as $k \cong 1.618\, K_p/\Delta x^2$.

The model is rather simple than any other alternative models because the resistance term is included in the governing equations and it possesses advantages of immersed/moving boundary condition.

Nevertheless, the model is at representative elementary volume scale, it is applicable for pore scale porous media.

The FS-IB-LBM retains the inherent advantages for parallelization and smooth treatment of hydrodynamic force estimation.

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Sub-Session:

Ecological Stability and Low Zero Carbon Technologies

GOSAT CO2 AND CH4 EMISSIONS FROM THAWING PERMAFROST REGIONS IN CENTRAL ASIA

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Abstract: Permafrost of high latitude ecosystems contains an estimated 1700 Gt of carbon dioxide (CO2) and methane (CH4), which is almost twice as much greenhouse gas (GHG) as is currently contained in the atmosphere. GHG emissions from permafrost play an important role in driving global warming and put a negative effect on terrestrial ecosystems. This feedback can accelerate climate change, but the magnitude and timing of GHG emissions thawing permafrost regions in central Asia and their impact on climate change remain uncertain. The main objective of the research is to estimate the actual magnitude of the CO2 and CH4 emissions from thawing permafrost in central Asia such as Mongolia, Yakutsk in Russia, and Tibetan Plateau based on high-resolution remote sensing approaches and observation datasets. The Greenhouse Gases Observing Satellite (GOSAT) affords and ability to assess and monitor CO2 and CH4 near-surface atmospheric concentrations globally a monthly scales pertaining. The GOSAT TANSO-FTS datasets used in the study to estimate the temporal and spatial distributions of CO2 and CH4 emissions from 2009 to 2018. During the June 2009 through December 2018 validation campaigns were performed using three Total Carbon Column Network (TCCN) sites that use ground based FTS. The results show that the annual CO2 emissions increased gradually between 383 ppm and 407 ppm from thawing permafrost regions in central Asia during the last 10 years, with the highest value being in spring and the lowest in summer and autumn. The annual CH4 emissions raised significantly from 1780 ppb to 1834 ppb which are high in Tibetan Platea in China and low in Mongolia between 2009 and 2018, while seasonal variations of CH4 emissions similar results with CO2 trend. The CO2 and CH4 emissions from thawing permafrost in central Asia have an annual increasing trend both. The annual mean rate of increase is CO2 (2.417 ppm/a) and CH4 (6.904 ppb/a). The CO2 and CH4 concentrations of each season increase compared with the preceding years. The CO2 and CH4 of each month are higher than those of the corresponding months of the previous year in central Asia. This research have addressed gap in our understanding of the efforts of GHG emissions from thawing permafrost regions in these key areas, and it is very important to improve datasets for regional and national GHG inventories. Furthermore, this newly generated datasets will be contributed to support capacity development of policy makers, governments, and regional professionals.

Keywords: Greenhouse gas, CO2, CH4, thawing permafrost, GOSAT, and central Asia.

EXPLORING THE APPLICATION OF LICHEN RESOURCE IN ARID AND SEMI-ARID DESERTS OF CHINA

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Abstract: Desertification is one of the important ecological environmental problems in the world. Microbiotic crusts is carpet-like encrustation covered on the surface of desert, among which lichen is one of the main components. In our study, we chose the Southeastern margin of Tengger Desert, and analyzed the lichen species succession in four different-age crust areas. It showed lichen coverage is increasing with the age of recovery, and correlates in some degree to the vascular plants and microbiotic crust, thickness of crust and concentration of soil nutrients, supporting the ecological function of lichen should be paid more attention. Then we expanded the scope of research to Hunshandake sand land and Badain Jaran Desert besides Tengger Desert in Inner Mongolia according to rainfall. It showed lichen species composition, dominant species and coverage are different among different deserts, indicating the potential of lichen species being applied to deserts most possibly related to local conditions. Based on the above results, we particularly studied the species diversity of Lichinales, which are dominant groups in Tengger Desert and Badain Jaran Desert. Several new records and new species have been found, some of which showed great potential to be used in the desert restoration in the near future. Endocarpon pusillum, as a dominant species in Southeastern margin of Tengger Desert, has been used in our artificial sand control. It can form fungi-algae complex crust on the sand surface within one month in the lab condition, and the transfer to the field of desert is now under studied.

Keywords: Desert, lichen, microbiotic crust, sand control, symbiont

STRATEGIES FOR SOIL PHYTOREMEDIATION: LESSONS FROM METAL HYPERACCUMULATION

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Abstract: Using zinc/cadmium hyperaccumulating plant Arabidopsis halleri along with approaches in biochemistry and mass spectrometry, we have identified that metal hyperaccumulating plants could specifically regulate the bioavailability of the metal elements in their surrounding soil rhizosphere. A. halleri roots release the metal-binding metabolic compounds into rhizosphere those could increase the uptake of essential elements such as iron, while decreasing (slowing down) the uptake of toxic heavy metals such as zinc and cadmium into its roots. In a such way, the efficient acquisition of essential nutrients and the slowed entry of toxic metals facilitate the metal hypertolerance and further metal hyperaccumulation in A. halleri. Recently, using biochemical and genetics approaches, we have shown that in a unicellular green algae Chlamydomonas reinhardtii, the acidic vacuolar compartment, acidocalcisome, is required for metal hyperaccumulation ability of different metal elements such as manganese.

Keywords: heavy metal, soil pollution, phytoremediation, metal hyperaccumulation, root secretion

Introduction

Because of the numbers of contaminating sources including rapidly expanding industrial areas, mine tailings, disposal of high metal wastes and coal combustion residues, an environmental pollution has become a global problem due to its direct effect on ecosystems and human health. Phytoremediation is a cost-effective, eco-friendly and plant-based approach for removing the contaminated heavy metals from soils. However, not every plant species can be used for this approach. Specific plant traits, called metal hyperaccumulators, grow endemically on metal-polluted and metal-enriched soil environments and accumulate more heavy metals than non-hyperaccumulating normal plants (Kramer, 2010). Understanding of the underlying molecular mechanisms in metal hyperaccumulating plants is therefore critically required for efficient clean-up strategies for phytoremediation and the genetic engineering of the suitable plant species for this approach.

With this purpose, we have studied zinc (Zn) /cadmium (Cd) hyperaccumulating plant Arabadopsis halleri and showed that metal-binding root released metabolic compounds have involved in Zn hyperaccumulation and hypertolerance ability of this trait. We also report that the acidic vacuolar compartment is required for metal hyperaccumulation of green algae Chlamydomonas.

Method

Experiments on root secretion analysis were done using our developed mass spectrometry approaches (Tsednee etal., 2012). Detailed metal speciation was performed with LC-ESI-MS/MS as described previously (Tsednee approaches such as XRF, TEM-EDX, nano-SIMS along with ICP-MS and biochemistry approaches. (Tsednee et al., unpubl.).

Results and Discussion

Metal hyperaccumualation vs. root secretion

Using a comparative untargeted metabolite profiling approach with LC-ESI-TOF-MS (1) in root secretions of two plants, Zn/Cd hyperaccumulating plant and normal plant, we have identified that the metal-binding metabolic compound, nicotianamine (NA), was secreted in a high amount from hyperaacumulating plant. We further showed that exogenous supply of NA into non-hyperaccumulating plant results tolerance to excess Zn (Figure 1).

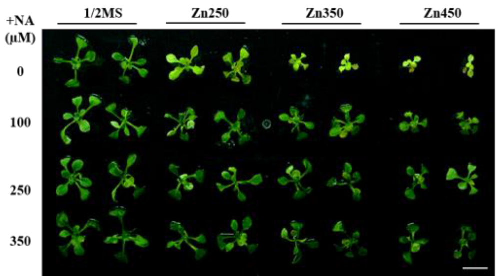

Figure 1. Exogenous NA application increases tolerance to excess Zn in non-hyperaccumulating plant (reprint from Tsednee et al., 2014).

Metal-speciation analysis revealed that the reason for Zn tolerant phenotype in Figure 1 is due to the Zn-NA complexation on the surface of the plant roots that leads to decreased Zn entry into roots (Tsednee et al., 2014). Interestingly, such complex formation also allows the increased uptake of essential nutrient, iron, in plants.

Metal hyperaccumulation vs. vacuolar compartment

Previously, unicellular green algae *Chlamydomonas reinhardtii* is known to hyperaccumulate copper (Cu) in an electron dense acidic compartment (Hong-Hermesdorf et al., 2015). In our study, we showed that *Chlamydomonas* cells could also hyperaccumulate manganese (Mn) in the acidic compartment called as acidocalcisome. Mutant strain defected in a biogenesis of acidocalcisome was not able to hyperaccumulate Mn compared with that of wild-type strain (Figure 2).

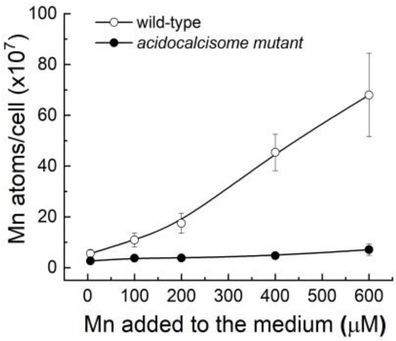

Figure 2. Mutant defected in acidocalcisome biogenesis (*acidocalcisome mutant)* lost the ability to hyperaccumulate Mn. (Tsednee et al., unpubl.)

Our data therefore suggest that the acidic compartment serves as the metal storage site and thus required for metal hyperaccumulation of green algae under excess metal presences (Tsednee et al., unpubl.).

Altogether, the knowledge and lessons learned from metal hyperaacumulation mechanisms revealed via biochemical and molecular biology approaches in specific organisms could fundamentally be cooperated with further biotechnological engineering of the suitable plants for a large scale of cleaning of the environmental heavy metal pollution.

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HYDROPEAKING STRUCTURAL MITIGATION MEASURE: A CASE STUDY OF THE EG HYDROPOWER PLANT, MONGOLIA

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Abstract: Hydropower plant's (HPP) operation regime can cause artificial rapid fluctuations in downstream river flow and corresponding water levels, so-called hydropeaking. Hydropeaking can have many negative effects on aquatic habitats, organisms, and riverine ecosystem. About 40.1 km long reach of the Selenge River, located immediately downstream of the confluence the Eg and Selenge rivers was selected for the study reach. The HPP releases the water with discharge of 442.7-454.7 m3/sec by the turbine during the peak-load hours and about 56.2-57.7 m3/sec (21:00-17:00) for the base-load hours. Considering the result, the strongest degree of hydropeaking occurs in winter season. In order to mitigate the above-mentioned hydropeaking caused by the HPP operations, we intended to construct the buffer dam in downstream of the HPP. The hydropeaking is completely eliminated by the buffer dam in the winter and summer seasons.

Keywords: buffer dam, dam, hydropeaking, hydropower plant, mitigation measures.

Introduction

Hydropower plant's (HPP) operation regime can cause an artificial rapid fluctuations in downstream river flow and corresponding water levels, so-called hydropeaking (Moog, 1993). Riverine physical habitats caused by hydropeaking can have many negative effects on aquatic habitats, organisms, and riverine ecosystem. Effects of hydropeaking on fish are fish stranding, downstream displacement, reducing in spawning and rearing survival, nest site dewatering and fish migrations (Young et al. 2011).

Adverse impacts on aquatic habitats, organisms, and riverine ecosystem induced by the hydropeaking can be mitigated by direct and indirect measures. Direct measures commonly apply to reduce hydrological impacts with operational and/or structural measures, whereas indirect measures can apply to mitigate the ecological impacts by adapting river morphology (Greimel et al. 2018).

However, there is still great deal of interests in the hydropeaking mitigation measures to improve effectiveness and mitigation measures in research (Young et al. 2011; Greimel et al. 2018).

The objectives of this research is to evaluate a possible mitigation measure to predict impacts of hydropeaking on river habitats. We have selected a reach of the Selenge River as a study reach, which is located in boreal climate zone characterized by long and cold winter. The selected reach is expected to strongly suffer caused by hydropeaking that induced by the Eg HPP. The HPP intended to be built on the Eg River, which is one of the largest tributaries of the Selenge River.

Study area

About 40.1 km long reach of the Selenge River, located immediately downstream of the confluence the Eg and Selenge rivers was selected for the study reach. Elevation of the reach is about 823 m and 794 m above sea level with an average slope of 0.0007 m m-1.

Methods

Data
The Eg riverine Khantai and the Selenge riverine Khutag hydrological station's daily flow have been used for this study.

Reservoir model
The reservoir model HEC-ResSim (HEC, 2013) in this study is to simulate the temporal variation of downstream flow caused by the Eg HHP operation regimes. Daily flow data of the Eg Khantai and Selenge Khutag stations, the electricity generation schedule, characteristics of the reservoir storage (i.e., water elevation versus to storage and water surface area) and physical features of the Eg dam (e.g., spillway, outlets, dam dimensions and power plant characteristic) are used as inputs for the HEC-ResSim.

Mitigation measure
A structural mitigation measure (i.e., buffer dam) was conducted in this study. Purpose of the buffer dam is to take up hydropeaking and release the water smoothly to the downstream.

Results

As the result of HEC-ResSim Model, Eg Hydro Power Plant is capable of producing the electricity in the winter as well as summer according to the intended schedule.

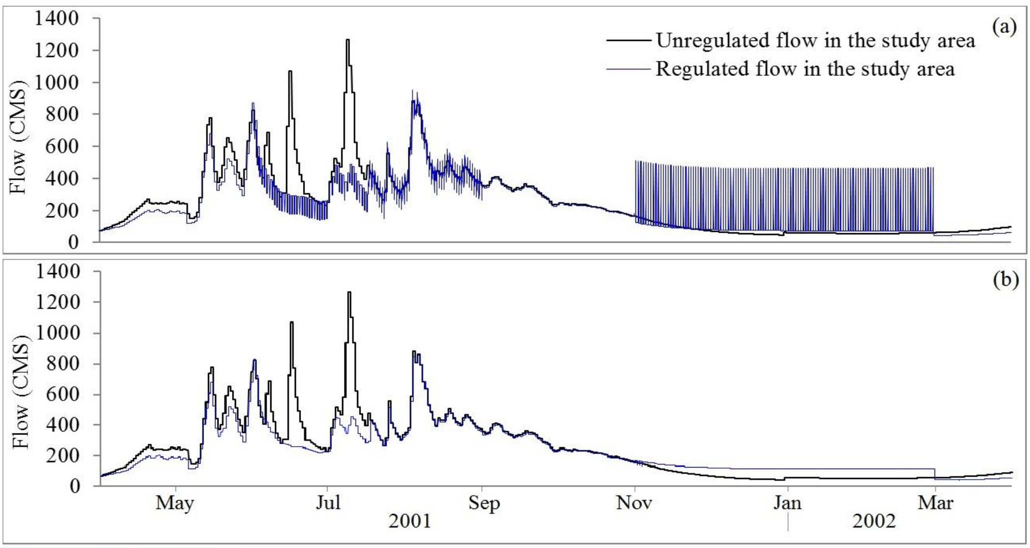

Figure 1. Above results based on the hydrological data of Apr., 2001-Mar., 2002: (a) and (b) shown the hydrographs without and with buffer dam in the study reach (i.e., reach of the Selenge River).

Winter regime

The HPP releases the water with discharge of 442.7-454.7 m^3/sec (18:00-20:00) by the turbine during the peak-load hours and about 56.2-57.7 m^3/sec (21:00-17:00) for the base-load hours in order to generate the electricity in accordance with the intended schedule. Considering the result, the strongest degree of hydropeaking occurs in the season. In order to mitigate the above-mentioned hydropeaking caused by the HPP operations, we intended to construct the buffer dam in downstream of the HPP. The hydropeaking is completely eliminated by the buffer dam. Outflow of the buffer dam is around 103-105 m^3/sec during winter. Since the Selenge riverine flow is merged to the outflow of the buffer dam, the river flow in the study reach becomes about 144 m^3/sec on November, 122 m^3/sec on December and 118-119 m^3/sec on January and February. The above-mentioned regulated flow is 1.3-2.2 from November to February, comparing to the unregulated flow (Q_{reg}. buffer/Q_{unreg} at Selenge River).

Spring and Autumn regime

The HPP is operated at the base-load (20 MW) in the spring (Mar.-May) and in the autumn (Sep.-Oct.) in order to accumulate water in the reservoir to ensure the summer and winter operations of the HPP, respectively. The buffer dam is operated in the spring and autumn regime.

Summer regime

The HPP is intended to be operated at the summer regime between June and August. Operation of the summer regime is 100 MW (7:00-24:00) and 20 MW (24:00-7:00). Flow of the Eg River from the HPP to the confluence of Eg and Selenge is fluctuated between 143.9 m^3/sec (7:00-24:00) and 28.8 m^3/sec (24:00-7:00). Such hydropeaking occurs until the spillway overflow occurs in the mid of July. Once the spillway overflow occurs, the regulated flow (i.e., turbine discharge + spillway overflow) is nearly similar with the unregulated flow in flow quantity until the confluence. However, hydropeaking is occurred caused by the summer operation in the study reach in case of without buffer dam. With buffer dam, the hydropeaking is completely eliminated.

Acknowledgments

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SUCCESSFUL RESULTS OF THE KOREA-MONGOLIA GREENBELT PROJECT AND AFFORESTATION EXPANSION METHODS IN MONGOLIA

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Abstract: Mongolia is hit hard by desertification(78% of its territory is desertifified)- Dust and sandstorms(DSS) from the desert adversely affect the Northeast Asian region
to turn the desert green, the Korea Forest Service(KFS) made a bold move to join Mongoloa's Green Belt National Program. Since 2007, KFS has dispatched plantation experts to Mongolia, undertaken the Korea-Mongolia Greenbelt Plantatuion Project, and planted tree with Mongolia experts, based on its successful reforestation experience in once-desolate land of South Korea

This project has achieved the following results.

First, Increase of forest area for the prevention of desertification
second, Standardization of afforestation technology and training system for survival of planting tree
third, Improvement of Mongolian's consciousness about afforestation project

Based on these results, we plan to proceed as follows

First, Establishment of sustainable management system(Afforestation plan for sustainable forestation management, Development of management model based on local communities)
second, Expand cooperation and technical information for expansion afforestation(Expansion of research cooperation for sustainable planting and management, Expansion of planted land by sharing and cooperating plantation technology with the research results)

AEOLIAN DESERTIFICATION AND ITS DRIVING MECHANISM OF THE MIDDLE INNER MONGOLIA, NORTHERN CHINA

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Abstract: Aeolian desertification is very severe in the middle Inner Mongolia, northern China. Based on Landsat images, time series MODIS data, SPOT-VGT data, field investigation, comprehensive analysis of climate factors and human activities, Aeolian desertification and its driving mechanism in the study area was explored. The results showed that huge vegetation variation, strong soil wind erosion, frequent dust storms and severe Aeolian desertification was occurring during the last decades in the study area. Huge variation of vegetation in the growing season (NDVI_gs) mainly occurred in those grasslands close to the precipitation isoline of 200 mm, but also variation of NDVI_gs greatly was attributed to the summer vegetation growth features (NDVI_su). Severe drought events and its spatial difference were detected at the initial period of 21th century based on the standardized precipitation evapotranspiration index (SPEI) and the temperature/vegetation dryness index (TVDI). Strong and frequent dust storms further deteriorated local degraded grassland and severe Aeolian desertification. Declining wind speed and wind erosion climatic index of spring since 1970s are helpful for reducing local Aeolian processes. However, improper human activities combining with drought events accelerated Aeolian desertification processes, mainly through changing local temporal and spatial vegetation patterns, as well as top soil features, and further inducing soil wind erosion. Overgrazing was the key cause of local Aeolian desertification, due to quick increasing livestock, lack of diversity of vegetation, and inflexible market regulation under adverse climatic conditions. Local Aeolian desertification processes are still going on under present fence grazing and landscape patterns are also changing. Combating desertification has a long way to go in the study area.

Keywords: Aeolian desertification, Vegetation variation, dust storms, drought, overgrazing

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Sub-Session:

Environmental Education

ENVIRONMENTAL EDUCATION PRACTICE IN MONGOLIA: MONGOLIA BETWEEN TRADITION AND CIVILIZATION

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Abstract: We, the Mongols traditionally lived nature-oriented and auspicious to Mother Earth for thousands of years. However, as the century of technology is progressing drastically, we tend to forget our traditional nature closeness and lovely handling with them more and more. As humankind is on the verge of creating the sixth mass extensions and altering their environment more than ever before, environmental education is as global as well national of more importance. Not only we, but also other nations should learn from nomadic traditional lifestyle as a good example of minimalist lifestyle. We should attempt to bring our children and youth of today close to nature and give them chance to understand impacts of human daily activities on environment and to restore public environmental awareness. With an experience of more than 60 years in environmental education and as the only state organization in this field, the Environmental Education Center of the National University of Mongolia consider him selves as a major player in the implementation of education for sustainable development in Mongolia. We are concerning to spread knowledge on education for sustainable development in an intelligible and interesting form. We developed interactive learning programs for our gusts and remodeled our garden, greenhouse and zoological museum to a place for nature experience for children.

Keywords: Environmental education in Mongolia and education for sustainable development, Environmental Education Center of the National University of Mongolia, Minimalist traditional lifestyle of the nomadic Mongols

HOW ARE GENDER AND ENVIRONMENT CONNECTED

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Abstract: How do you think gender and environmental issues are linked? Why should a researcher or anyone in the environment sector know about gender? Addressing gender issues in environmental areas, like water use, climate change, and forestry, benefits our society and our ecosystems. Women and men have different roles and responsibilities in society and these gender dynamics are recreated in the human-environment relationship, meaning that women and men relate to the environment in different ways, have differing access, control, goals and uses of environmental resources and processes. As a result of these dynamics, environmental changes have different impacts on their lives. Gender not only determines women's and men's ability to cope and adapt to environmental changes but existing inequalities also mean that changes have a disproportionate impact on women, especially in rural areas. This presentation will discuss how gender dimensions of the human-environment relationship create different environmental knowledges amongst women and men and will discuss the value of these different knowledges for environmental researchers and policy-makers. Applying a gender lens or perspective to environmental research will help us achieve important goals on gender equality and on sustainable development, such as the Sustainable Development Goals.

IMPACT OF PASTORAL ECOLOGY VULNERABILITY ON GRAZING LIVESTOCK: CASE OF GOVI-ALTAI AIMAG

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Abstract: The nomadic pastoral system is one of the important sector in the Mongolian social economy which is covering over 50% of gross domestic product of 14 provinces, 30% of working force and 26% of total householders at national level. The nomadic grazing pastoralism have been used the grazing land within pasture capacity through traditional nomadic management to keep an ecosystem resources. Unfortunately, rapid increase in livestock numbers, and changes of climate condition affected the pasture degradation and extending insufficient pasture for grazing that adversely reducing the further sustainability of nomadic grazing societies. This study was identified the relevance of pastoral ecological vulnerability on miscarriage of grazing livestock and its grazing managements in the Govi-Altai province at western Mongolia. The pastoral ecological vulnerability assessed the exposing degree of key factors in drought, pasture use and vegetation cover and analyzed the relevance of factors on the livestock miscarriage. The research analyses used the remote sensing techniques and geostatistical analysis with observation data of temperature and precipitation from weather stations, satellite data of eMODIS and SPOT, and statistical data of livestock number, pasture area, prepared hay and number of miscarried livestock from 1999 to 2017. As a result of study, that pasture ecological vulnerability effected to increase a number of miscarried livestock (especially goat) in high correlation value (0.5-0.8). The most affecting factor were vegetation cover and drought. The impact of pastoral ecological vulnerability on miscarry of grazing livestock was different in type of livestock, there was the highest relationship in small animals of goat and sheep. The soums of Bugat, Tonkhil and Khaliun at desert ecosystem in Gobi-Altai province were evaluated as the highest (0.7-0.8) statistic relation during last 20 years. The Delger, Taishir and Tugrug soums in desert steppe ecosystem of Gobi-Altai province had less statistic relation which were well prepared the hay and forage for their livestock. As a conclusion, if herders have good management of grazing such as reducing the pressure on grazing field of livestock, increasing movement of grazing field, to reduce the number of livestock, increase a prepared hay and forage and increase a water source for livestock can be keep the nomadic grazing system in future.

Keywords: pastoral ecological vulnerability; grazing livestock; miscarried livestock.

Introduction

Nomadic pastoralism is a complex human-environmental system in which livestock, pasture and herder interdepend each other (Bazargur, 2005; (Chuluun, 2014). It has been developing as an adaptive mechanism, switching pastureland in accordance with pasture recovery capacity, for fluctuations of arid-terrestrial ecosystems (Chuluun.T, 2006, Maria, E. F.-G 1999, 2006). The nomadic pastoral system is one of the important sectors in the Mongolian social economy covering over 50% of gross domestic product of 14 provinces, 30% of work force and 26% of total households at national level.

In recent years, over-population growth and climate change have adversely affected recovery capacity of the pasture, which has resulted in the pasture land degradation and increasing lack of vegetation cover. (Tserendash.S, Bilegt.Ts, 2017) (Tserendash.S, Bilegt.Ts, 2017), (Bolortsetseg, B., Erdenetsetseg, B., Bat-Oyun, Ts., 2002.), (MET, 2009). There are warning that pasture land suitable for livestock grazing will decrease in the future (JICA & Almac.corp, 2016)

The ecological vulnerability is defined as a combination of the degree of exposure or sensitivity (Adger, 2006) of ecosystems due to climate and human impacts to adapt by perceiving, mitigating and taking advantage of new opportunities created by change (Ainong.Li, 2006), (Turner. B.L, Roger. E.Kasperson, Pamela. A.Matsone, James. J.McCarthyf, Robert. W.Corellg, Lindsey. Christensene, Noelle. Eckleyg, Jeanne. X.Kasperson, Amy. Luerse, Marybeth. L.Martellog, Colin. Polskya, Alexander. Pulsiphera, and Andrew, 2003)

The Mongolian pastoral systems are very sensitive to climate variability and extreme events, such as drought, fires, pests, and dzud (Chuluun, Ojima, & Altanbagana, 2011).

Pasture degradation remains a problem of herders although the government is implementing many policies and programs on livestock. Thus, investigation and assessment of pasture ecological vulnerability is the most important factor to formulate local adaptation strategies.

The main aim of this research is to identify the relevance of pastoral ecological vulnerability on miscarriage of grazing livestock and its grazing managements in Gobi-Altai province, western Mongolia.

Method and data analysis

The study area

The study has been carried out for Gobi-Altai province (aimag) located in the Gobi desert, desert and mountain steppe ecosystem region of western Mongolia. It covers 141400 sq.km and the elevation ranges from 1000-3802 m above sea level within wide valley of Shal, Biger, Khaliun, Sharga, Huis, Alag nuur, zahui and Zarman, and high mountains of Altai, Khasagt Khairkhan, Khantaishir and Idren. The study area is situated in the semi-arid and dry climatic region with four seasons followed by cold winter, windy spring, dry summer and golden autumn. The annual average precipitation is 80-135mm, the most of the rain fall is during summer season.

Gobi-Altai province consists of 18 sub provinces (soums), sheltering 58471 population, and 3513370 livestock while 21% of total population are herders, totally 16711 householders and its 66.6% are living in rural area to take a nomadic herding.

Data collection and used data

For this study, we used the satellite (eModis and SPOT)[1] image data from 1998-2017 by using Arcgis software. Our research is based on time series analysis using statistical data on total livestock number, types of livestock number types, number of miscarriage for female animals (NSO, 2017), and meteorological observation data on annual temperature and precipitation (NAMEM, 2017) during 1998-2017 and secondary data extracted from the map of national atlas on pastoral area size and pasture carrying capacity at all soums of Gobi-Altai province.

Calculation of pasture vulnerability index

This research assessed the pastoral ecological vulnerability at case research area using 3 proxy variables (Moss 2001) of climatic and human activity related factors (Natsagdorj & Sarantuya, 2004), (Yanqiang.Weia, 2017) natural disasters of drought (Altanbagana, Suvdantsetseg, Nominbolor, Kherlenbayar, & Chuluun, 2015) grassland degradation/ vegetation index (Zhou, Gang, & Jianlong, 2014), (Miyasaka, Okura, Zhao, & Takeuchi, 2016) and pasture use index.

The main method of the research used multivariate statistical analysis and the weighted summation analysis for rescaling different index values. The model structure is partly based on spatially explicit ecological model (Robert. Pastorok, 2003) one of the most advanced ecological and landscape analysis models.

Determining the thresholds for vulnerability assessment is important (Chuluun.T, et al 2017, Adger 2006, Reynolds et al 2007) and to assess integrated vulnerability using vulnerability thresholds for each key variable.

After calculating separate component indices we combine them to calculate an integrated ecological vulnerability assessment. Because component indexes have different measurement units and numerical values, we need to convert the indexes into same numerical range from 0.0 to 1.0 by rescaling the weighted summation of same numerical values for long term data (Chuluun, Altanbagana, Tserenchunt, & Davaanyam, 2012).

To calculate the integrated ecological vulnerability assessment, it is necessary to integrate the variables as the geometric mean after distributing the variables value between 0.01 and 1 (Chuluun, Altanbagana, Tserenchunt, & Davaanyam, 2012); (Chuluun, Ojima, & Altanbagana, , 2011).

$$V_{t,i}^{eco} = (S_{t,i}^{norm} + N_{t,i}^{norm} + Vg_{t,i}^{norm})/ \quad (1)$$

Where, $V_{t,i}^{eco}$ pasture vulnerability index; $S_{t,i}^{norm}$ normalized drought index; $N_{t,i}^{norm}$ normalized pasture use index; $Vg_{t,i}^{norm}$ normalized vegetation degradation index

Drought

Vulnerability mainly defines drought risk rather that the frequency and severity of weather anomalies (Downing TE, Bakker K, 2000). Drought estimates are calculated using the Ped index, which represents long-lasting atmospheric degradation. The Ped index value greater than S > 3 is intensity drought (Natsagdorj.L, 2009), the S = 3 value is chosen as the threshold value of pasture vulnerability.

Ped's index:

$$S = \sum_{t=1}^{n}\left(\frac{T_j-\bar{T}_j}{\sigma_T}\right) - \sum_{t=1}^{n}\left(\frac{R_j-\bar{R}_j}{\sigma_R}\right) \quad (2)$$

Here, Tj, Rj– mean temperature, and total precipitation (mm) of summer at a given weather station in j[th] month; $\bar{T}_j$, $\bar{R}_j$– average temperature and total precipitation; $\sigma_{T,}$ σ_R - standard deviation of temperature and precipitation. The 5-8 monthly average temperature and precipitation data are used in calculation.

After calculating the drought index for the meteorological station, a vulnerability index was calculated by using the Inverse Distance Weighting (IDW) model to show the percentage of the total area of the soum due to drought. Here:

$$\Delta Si = Sti/Si \quad (3)$$

Where $\Delta S_{i,t}$ – the percentage area, occurred by drought, in total area of *i*-th soum, of year *t*; S_{ti} - The area that occurred by drought in *i*-th soum of year *t*; S_i – total area of soum

Pasture use

In 1990, the number of animals that were suitable for grazing 1 hectare in the soum was determined (National Atlas of Mongolia, 1990). These values were selected as the threshold value of vulnerability of pasture use and pasture use was calculated using the methodology of Tserendash.S (2006) using the following expressions.

$$\Delta N = \frac{N}{N_0} \qquad (4)$$

Here, ΔN - Pasture use index

N- livestock number per unit of a given soum's rangeland, [sheep unit/ha]; N_0– rangeland capacity depends on the ecological zone of the soum (National Atlas of Mongolia, 1990), [sheep unit/ha].

Changes in vegetation cover

Vegetation yields of pasture of Mongolian territory reach peak levels in August of every year and was for vary spatial depending on drought, climate change variability and pasture use (Sanjid, 2002) (Bazargur, 2005). The annual vegetation biomass important role for grazing of winter and spring. If there is the more the change in vegetation cover, it will affect to pasture vulnerability by pasture land degradation and reduction of suitable area for livestock grazing.

The value of the vulnerability of the vegetation cover is determined by the following expression:

$$\Delta V_i = (\bar{V} - \bar{\sigma}) \qquad (5)$$

ΔVi – The threshold value of vulnerability of the pixel; $\bar{V}$ – average value of NDVI of the pixel; $\bar{\sigma}$ – standard deviation of NDVI at province level

The extent of vegetation cover in the soum is high, which indicates that the soum is vulnerable.

$$\Delta V = \frac{Vt,i}{Vi} \qquad (6)$$

ΔV – the percentage of the area exceeding the threshold value. Vt,i – the area of the area exceeding the threshold value; Vi – total area of the soums.

Impact of pastoral vulnerability on livestock miscarriage

If the pasture is vulnerable, it will adversely affect grazing livestock, this is compared to the following spring miscarriage rate of breeding stock. Miscarriage rate of breeding stock is calculated using Eq.(7).

$$Mc_{i+1} = N_{i+1}/(A_i - M_{i+1}) \qquad (7)$$

where, Mc_{i+1} represents percentage of miscarried female livestock in i+1 year; N_{i+1} and $M_{i+1}$are number of survivals of young animal and barren female animals in i+1 year; A_i is number of breeding stock in i year.

The Pearson Product-Moment Correlation Coefficient, commonly termed as correlation coefficient (r), is a measure of collinearity between two arrays and most widely used in test statistics. Correlation Coefficient is computed pair wise between pastoral vulnerability and miscarriage rate of breeding stock. It is calculated using Eq. (8).

$$\boldsymbol{r} = \frac{1}{n} * \sum_i^n (\frac{x_i - \bar{x}}{Sx}) * (\frac{y_i - \bar{y}}{Sy}) \qquad (8)$$

where, xi and yi represent the values of arrays with 'n' number of elements being compared and *x* and *y* are the mean values of two arrays and Sx and Sy are the standard deviation of xi and yi respectively. The r measures the degree of similarity in variation about the means of two values.

Results

As seen from the result, Chandmani, Darvi, Esunbulag, Jargalan and Khaliun sub provinces have degraded the vegetation cover; Chandmani, Jargalan, Delger, Sharga and Taishir soums have occurred the drought and pasture use were high in Esunbulag, Chandmani, Tugrug, Jargalan and Khaliun soums. Darvi, Jargalan, Tugrug, Chandmani and Khaliun sub provinces from Gobi-Altai province were evaluated as having the highest ecological vulnerability under climate and human activity related impacts during the last two decades (Figure 1).

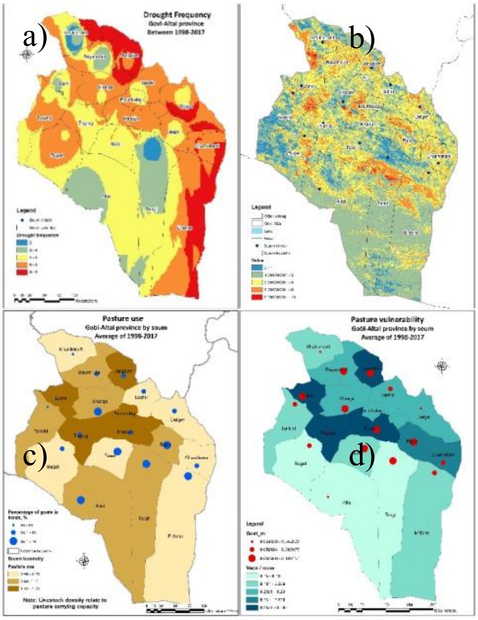

Figure 1. a). Drought frequency; b). Frequency of Vegetation cover degradation; c). average of pasture use and percentage of goats in herds d). Integrated pasture vulnerability and goat miscarriage, average of 1998-2017

The most effective variables are drought indexes and vegetation cover degradation increased during 1999-2003, 2006-2009, 2017 which is climate change related impacts. The pasture use increased during 2006-2009 and 2012-2017, with respect to human activity related increase in number of livestock.

Therefore, increase in both climate and human activity related pressure in this province will add to the pasture vulnerability. The research concludes that a human activity specially increased number of livestock, and pasture managements related adaptation strategies needed to be implemented in this province to reduce ecological vulnerability (Figure 2). Tugrug sub province had higher pasture vulnerability (0.27) but miscarriage rate of breeding stock is lower as compared to Darvi sub province which is higher pasture vulnerability (0.30) had higher miscarriage rate of breeding.

Table 1. Correlation coefficients of each livestock type and pasture vulnerability.

Soum	*Horse*	*Cattle*	*Sheep*	*Goat*
Altai	0.32	0.61	0.63	*0.64*
Bayan-Uul	0.13	0.30	0.39	*0.65*
Biger	0.32	0.26	0.25	*0.49*
Bugat	0.18	0.53	0.68	*0.85*
Dariv	0.33	0.46	0.28	*0.54*
Delger	0.34	0.49	0.41	*0.27*
Esunbulage	0.50	0.19	0.63	*0.53*
Jargalan	0.17	0.43	0.47	*0.55*
Taishir	0.14	0.32	0.17	*0.40*
Tonkhil	0.34	0.17	0.54	*0.69*
Tugrug	0.15	0.38	0.16	*0.29*
Khaliun	0.04	0.36	0.52	*0.65*
Khukhmorit	0.37	0.19	0.39	*0.45*
Tsogt	0.56	0.35	0.55	*0.54*
Tseel	0.33	0.33	0.28	*0.70*
Chandmani	0.46	0.22	0.46	*0.46*
Sharga	-0.08	0.28	0.55	*0.63*
Erdene	*0.43*	*0.41*	*0.52*	*0.52*

During the past decades, the impact of climate change rather than human activities was the major factor for the ecological vulnerability. Due to the dzud occurred in 2000-2002 and 2009-2010 (Altanbagana & Kherlenbayar, 2016), livestock number had been dramatically reduced. However in recent years human impact is increasing trough rapid growth in number of livestock.

The pasture ecological vulnerability affected to increase number of miscarriage livestock especially in small animals of goat and sheep with high correlation value 0.5-0.8 (table 1). Herders are mostly interested in raising goats (JICA & Almac.corp, 2016) and 46-76% of total livestock in the 18 soums are goats.

The most affecting factor were vegetation cover and drought. The soums of Bugat, Tonkhil and Tseel at desert steppe ecosystem in Gobi-Altai province were evaluated as the highest (0.7-0.8) correlation during the last 20 years. Delger, Taishir and Tugrug soums in mountain steppe ecosystem of Gobi-Altai province had less correlation.

The pasture vulnerability did not only affect livestock loss, but it also limits the growth of livestock. Miscarriage rate of breeding stock increased when pasture vulnerability was high in 1999-2002, 2006-2009 and 2017.

Conclusion

This study assessed pasture vulnerability by using key factors that negatively impact on pasture productivity and determined how the pasture vulnerability affected miscarriage of livestock in the last 20 years in the case area of Gobi-Altai province.

The most affecting factors for pasture ecological vulnerability were vegetation cover and drought but not pasture use. When the pasture vulnerability is increased it affects the increased miscarriage in female goats, the main herd of total livestock. It also limits the growth of livestock. On the other hand, it affects herder income.

However, the miscarriage rate in Tugrug and Chandmani soums, with higher pasture vulnerability were less as compared to Darvi and Jargalan soums. The importance of pasture management and maintenance of livestock is clearly shown from the facts that the soums with lower pasture vulnerability had well prepared hay and forage for their livestock, while those with high vulnerability were not well prepared.

If herders apply good pasture and grazing management practices such as reducing the pressure on grazing field, increasing movement of livestock, reducing the number of livestock, increasing prepared hay and forage and water source for their livestock can keep the nomadic grazing system in future.

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Secondly we would also like to thank our project collaborators who helped us a lot in finalizing this project within the limited time frame.

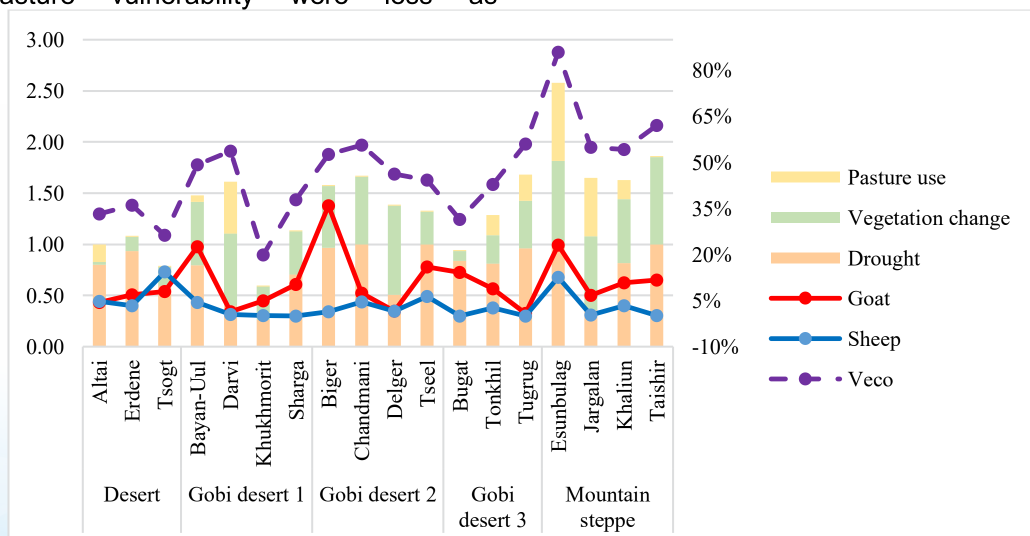

Figure 1 Pasture vulnerability of 2007 & miscarriage rate of livestock of 2008

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POSTER SESSION

CHANGE IN CHARACTERISTICS OF SOIL CARBON AND NITROGEN DURING THE SUCCESSION OF *NITRARIA TANGUTORUM* IN AN ARID DESERT AREA

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Abstract: The shrub *Nitraria tangutorum* is distributed widely in arid desert areas, and plays a critical role in the desert–oasis ecosystem. At soil layer depths between 0–100 cm in the *N. tangutorum nebkha* dune ecosystem, organic C and total N storage was 1195.84 g/m2 and 115.01 g/m2 during the SDS, respectively, with an increase of 11.13% and 12.59% from the IS. The changes and accumulation of C and N were greater in the deeper (40–100 cm) layer than in the surface layer of soil (0–40 cm). Changes in soil organic carbon (SOC) as well as in the total nitrogen (TN) were strongly related to the coverage degree, water content in soil, and the ratio of fine soil particles (silt and clay). To sum up, the intensive development of water resources has vastly reduced the ability of *N. tangutorum* vegetation to sequester C and N in the Minqin desert. Efforts to perform ecological restoration and reverse desertification in the Minqin Desert should focus on preventing the unreasonable exploitation of water resources in order to maintain stable *N. tangutorum* communities.

Keywords: carbon sequestration, nebkhas, soil organic carbon, total nitrogen, vegetation succession

Introduction

Understanding the cycles of carbon (C) and nitrogen (N) in soil in ecosystems is essential for estimating their influence on global climate change and determining the ecological strategy (i.e. conservation) of particular land ecosystems (Lal, 2004; Foster et al., 2003). Deserts and dry shrub lands have great potential to sequester C because of their large extents, and because soil organic carbon (SOC) contents are relatively low as a result of extensive and prolonged land degradation (Li et al., 2015). In addition, accurate estimates of C change in arid desert areas can inform climate change mitigation efforts on global scales. Nebkhas are the most common landforms in arid desert areas, and their origination and development are considered the indicators for the change in the local climate and environment (Lang et al., 2013). Consequently, research related to nebkhas has increased in recent years. The presence of nebkhas has been considered a distinctive indicator of land degradation and the intensification of wind erosion, of a significant decrease in land production, and also of the degradation of an ecological environment (Wang et al., 2006). Thus, most studies focusing on the formation and development of nebkhas are related to vegetation, climate change, anthropogenic influence, geological and hydrogeological conditions, wind strength, and sand source. However, nutrient cycling in nebkhas, which determines changes in C and N in arid systems through vegetation–soil feedback, has not been sufficiently studied (Dougill et al., 2002; Yan et al., 2005; Wang et al., 2006; Li et al., 2016).

Xerophyte *N. tangutorum* is a dominant shrub in the deserts in China, and is best known for its great tolerance to salt and drought, as well as its highly opportunistic water-use strategy (Wu et al., 2013). In the study, a space-for-time method was used, and the hypothesis was that the different stages of succession would impact C and N content and the storage of nutrients differently, and that the relationship between C, N, and succession develops in a linear manner in the steppe ecosystem of the desert. The objectives of the study are as follows: (1) to determine the variations in the content of SOC and TN between 0–100 cm depth in soil during the four successional stages of *N. tangutorum* vegetation in an arid desert area; (2) to examine the total as well as average increases of C and N storage during the four successional stages of *N. tangutorum* nebkhas; and (3) to look into the interrelationship between the storage of C and N and plant diversity in the *N. tangutorum* ecosystem.

Methods

The present study was carried out in an enclosed area to prevent grazing in Liangucheng National Nature Reserve from May to October 2010. According to the successional stage classification standards, which mainly comprised the extent of shrub vegetation, the morphological characteristics of the nebkhas, and the status of soil crust of *N. tangutorum* nebkhas in this region, the selected experimental nebkhas were divided into four successional stages: an initial stage (IS), stable stage (SS), degraded stage (DS), and severely degraded stage (SDS). Six 30 m Ч 30 m plots were chosen in each successional stage at each experimental nebkha, for a total of 24 shrub plots for shrub vegetation surveys. Within each of these plots, five small quadrats (1 m Ч 1 m) were chosen, one in the center and four at the corners of the plots, demarcating a total of 120 shrub quadrats for herbaceous plant surveys.

At each shrub plot, the long axis, short axis, height, coverage, and crust status of the nebkha was determined, and the biomass, length of branch, height, shrub vegetation composition, and numerical characteristics of the subsequent *N. tangutorum* community was measured as well. In each small quadrat for herbaceous plant surveys, the species composition, coverage, density, and frequency of the herbaceous plants were recorded.

In each plot of shrub *N. tangutorum*, three sampling ditches were dug for soil samples collected at six depths, with three replicates. Soil samples were put in sealed plastic bags for transfer to the laboratory. Simultaneously, the bulk density of soil at the six layers in all of the quadrats was measured using a soil corer, a steel cylinder with a volume of 100 cm^3, with three replicates. On an oven-dry mass basis, after drying samples at 105˚C for 24 hours, the soil water was determined gravimetrically. Each sample was thoroughly sieved in the laboratory at 2 mm to get rid of roots and debris, and measure particle size, SOC, active organic carbon and TN.

SPSS was used to analyze all the data. One-way ANOVA was adopted for determining the differences among the successional stages. Significant differences between successional stages were identified by taking $\alpha \leq 0.05$ as significant.

Results

Changes in Topsoil Texture During Succession

The succession of *N. tangutorum* vegetation had a significant effect on the distribution of particle size and soil water content in nebkha topsoil (0–5 cm) (P <

0.05) (Table 1). As *N. tangutorum* vegetative succession progressed, the clay and silt content increased sharply between the IS and the DS, but surprisingly decreased in the SDS. The clay and silt contents were 4.5 and 3.8 times greater during DS than IS, while they were reduced by 35% and 60% during the SDS stage, respectively (Table 2). In general, the contents of clay and silt increased by 259.5% and 94.5% throughout the entire succession process, respectively (Table 1). Compared with IS, the soil water content increased by 2.7% during SS, and was reduced by 17.3% from SS to DS, and by 41.9% from DS to SDS (Table 1). The differences of sand content, bulk density, and soil water content among different successional stages were not significant. The changes in bulk density were not noticeable.

Changes in the Storage of C and N in the Soil

The storage of SOC and TN at 0–100 cm in depth fluctuated considerably throughout succession, but overall, there was a slight increase. SOC and TN storage increased by 11.13% and 12.59% from IS to SDS ($P < 0.05$) (Table 2). The storages of SOC and TN were the highest during the SS, with values of 8465.97 g/m^2 and 749.29 g/m^2, respectively. The amounts of C and N were the lowest during the SDS, with values of 1076.12 g/m^2 and 102.15 g/m^2, respectively (Table 2). Compared with the degree of change and the rate of SOC and TN storage in the surface soil layer (0–40 cm), those in the middle soil layer (40–100 cm) were much higher. The total values of SOC and TN storage were 6.87 and 6.33 times greater during the SS than the IS.

Changes in the storage of soil C and N in relation to vegetative succession

To confirm how vegetative succession affects the storage of soil C and N, the distribution of soil particle size, soil texture, and all of the biomass were correlated with the storage of C and N of *N. tangutorum* nebkhas. Through the correlation analysis, it was found that the storage of soil SOC and TN correlated positively significantly ($P < 0.01$), for which the correlation coefficient was 0.997. The results showed that bulk density and SOC and TN storage correlated negatively and significantly ($P < 0.01$), for which correlation coefficients were −0.695 and −0.688, respectively. The correlation analysis also showed there were no significant correlations among the storage of soil SOC and TN with vegetation coverage, aboveground biomass, belowground biomass, clay biomass, total biomass, soil water content, clay content, and silt content ($P > 0.05$). There were significant negative correlations among soil water content, sand content, and slit content ($P < 0.05$), with correlation coefficients of −0.879 and −0.718, respectively, while no correlations were found with other soil properties and vegetative characteristics. Moreover, a correlation analysis showed that there was a significant negative correlation between sand content and TN storage, with a correlation coefficient of −0.997 ($P < 0.01$); while the correlation between the sand content and SOC was not significant ($P > 0.05$), with a correlation coefficient of −0.444 (Table 3).

Discussion & Conclusions

In arid desert ecosystems, vegetation restoration results in C and N sequestration, while vegetation decline or desertification results in C emission (Zhao et al., 2009). The two opposing processes each appeared throughout the successional gradient of vegetation in the present study, and greatly impacted the SOC and TN content and storage in desert regions. Although the C and N pools are comprised of both plants and soil, the soil C pool is considered the main pool, occupying more than 90% of the C in arid and cold ecosystems (Yang et al., 2015). Hence, only C and N in soil were investigated in this study.

The variation trends in the average content and storage of the SOC and TN at depths from 0–100 cm were the same as the dynamic changes of the vegetation at each successional stage. This strongly supports related studies where SOC changed with the variety of sand-binding vegetation in desert ecosystems (Jia et al.,2007; Li et al., 2017). However, different soil depths affect the C and N sequestration at significantly different degrees with the expansion of vegetation. During the IS, the shallow layer had much higher contents of SOC and TN than the deeper layer. In fact, the nutrient contents of the deeper layer (40–100 cm) were quite low, and decreased with the layer gradient, which agrees with other studies (Jia et al.,2007) . This can be explained by the higher inputs of organic materials in the shallow soil. Throughout succession, the greatest number of species appeared in this stage. Most of the species were herbaceous, with roots distributed at depths between 0–40 cm, which were mostly in the soil layer between 5–20 cm. In addition, the shrub communities were primarily composed of seedlings, with the roots distributed between 0–40 cm (Sun and Xu, 1992).

The succession of *N. tangutorum* nekbhas in the shrub-dominated desert ecosystems was effective at C and N sequestering in this study. However, the C and N sequestration effect is limited, because there was a huge C and N loss at the end of succession due to desertification. The C and N offset during the succession of *N. tangutorum* nekbhas indicates that the arid desert ecosystem can easily become an emitter if no action is taken to restrain the deterioration of nekbha vegetation. Therefore, in order to continue to sequester C and N in arid deserts, ecological restoration efforts to reverse desertification should be given priority, including reducing human activities that unreasonably exploit and excessively utilize water resources. Restoration should focus on maintaining the stable stage of vegetative succession, as defined here.

Acknowledgments

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Table 1. Changes in topsoil texture of *N. tangutorum* nebkhas at the different successional stages.

Items	Stages of succession			
	IS	SS	DS	SDS
Clay content (%)	0.79 ± 0.10^{c}	2.91 ± 0.67^{b}	4.37 ± 0.82^{a}	2.84 ± 0.13^{b}
Silt content (%)	3.67 ± 0.32^{c}	8.31 ± 1.82^{b}	17.81 ± 4.45^{a}	7.14 ± 0.37^{b}
Sand content (%)	95.54 ± 0.41^{a}	88.78 ± 2.49^{a}	77.81 ± 5.22^{b}	90.02 ± 0.48^{a}
Bulk density (g/cm^3)	1.47 ± 0.06^{a}	1.42 ± 0.05^{a}	1.35 ± 0.06^{a}	1.41 ± 0.07^{a}
Soil water content (%)	0.73 ± 0.29^{a}	0.70 ± 0.09^{a}	0.62 ± 0.09^{a}	0.36 ± 0.03^{a}

Values represent means ± SD (n = 3). Values with the same letters within a row do not show significant difference at P < 0.05.

Table 2. Changes in the storage of SOC and TN in the soil at 0–100 cm during the different successional stages.

Depths	Stages of succession			
	IS	SS	DS	SDS
SOC storage (g/m^2)				
0−5	60.08 ± 17.31^{b}	224.07 ± 144.01^{a}	255.28 ± 91.63^{a}	102.00 ± 31.84^{b}
5−20	254.99 ± 14.31^{b}	793.20 ± 629.22^{a}	1280.67 ± 8.84^{a}	182.24 ± 9.56^{b}
20−40	294.89 ± 18.41^{b}	967.84 ± 750.25^{a}	1142.70 ± 47.97^{a}	242.37 ± 19.39^{b}
40−60	195.66 ± 48.81^{b}	2309.50 ± 948.00^{a}	1207.55 ± 523.14^{a}	196.81 ± 1.32^{b}
60−80	173.69 ± 37.82^{b}	2237.37 ± 859.42^{a}	1235.00 ± 78.95^{ab}	226.97 ± 19.54^{b}
80−100	96.81 ± 31.80^{c}	1933.99 ± 392.43^{a}	972.60 ± 80.89^{b}	245.44 ± 23.73^{bc}
Total	1076.12 ± 168.46^{b}	8465.97 ± 3723.34^{a}	6093.81 ± 831.42^{a}	1195.84 ± 105.38^{b}
TN storage (g/m^2)				
0−5	5.38 ± 1.31^{b}	20.41 ± 11.95^{a}	24.52 ± 10.28^{a}	9.32 ± 3.19^{b}
5−20	24.72 ± 2.26^{b}	72.86 ± 55.33^{a}	120.36 ± 13.56^{a}	17.03 ± 0.19^{b}
20−40	28.57 ± 0.52^{b}	85.73 ± 64.80^{a}	102.51 ± 0.14^{a}	24.82 ± 1.03^{b}
40−60	20.06 ± 6.74^{b}	200.67 ± 55.83^{a}	98.78 ± 35.01^{a}	19.30 ± 1.02^{b}
60−80	14.81 ± 3.20^{b}	192.60 ± 56.83^{a}	116.27 ± 1.75^{ab}	22.19 ± 0.24^{b}
80−100	8.61 ± 2.87^{b}	177.01 ± 40.30^{a}	90.82 ± 9.04^{b}	22.36 ± 1.60^{b}
Total	102.15 ± 16.91^{b}	749.29 ± 285.03^{a}	553.25 ± 69.78^{a}	115.01 ± 7.28^{b}

Values are means ± SD (n = 3). Values with the same letters within a row do not differ significantly at $P < 0.05$.

Table 3. Relationship between the SOC and TN storage, soil properties, and vegetative characteristics during the different successional stages.

Correlation	SSOC	STN	BD	VC	AB	BB	CB	TB	SWC	CC	SC
STN	0.997**										
BD	−0.695**	−0.688**									
VC	0.753	0.744	−0.635								
AB	0.708	0.701	−0.860	0.719							
BB	0.628	0.621	−0.816	0.654	0.994**						
CB	0.891	0.890	−0.938	0.836	0.946	0.904					
TB	0.623	0.620	−0.822	0.622	0.990**	0.999**	0.896				
SWC	0.501	0.496	0.300	0.756	0.098	0.003	0.346	−0.038			
CC	0.594	0.604	−0.697	−0.067	0.325	0.299	0.407	0.333	−0.276		
SC	0.543	0.555	0.692*	0.668*	0.626	0.647*	0.442	0.687*	−0.718*	0.959**	
SAC	−0.444	−0.997**	0.979**	0.890**	0.774**	0.828**	0.395	0.865**	−0.879**	0.659*	0.710*

*$P < 0.05$, **$P < 0.01$. SSOC: storage of soil organic carbon; STN: storage of total nitrogen; BD: bulk density; VC: vegetation coverage; AB: aboveground biomass; BB: belowground biomass; CB: clay biomass; TB: total biomass; SWC: soil water content; CC: clay content; SC: silt content; SAC: sand content.

BACKFILLING AND SECURING OF ABANDONED SMALL SCALE COAL MINES WITH COAL COMBUSTION BY-PRODUCTS (CCBS) GENERATED AT POWER PLANT SITES AND WITH DOMESTIC CCB'S GENERATED AT GER DISTRICT SITES

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Abstract: Recently GMIT finished the BASMIC project to improve both, the sustainable usage of Coal Combustion by-Products (CCB's) and the stability of abandoned small scale mines. Many CCB samples generated at power plants, other furnace processes and in ger districts have been investigated regarding their suitability as backfill material for abandoned mining sites. BASMIC research has been taken place with a motivation to reason out how CCB's produced at thermal power plants and ger districts can be used as a binder material for backfilling material for holes that are left open from small scale, more specifically hand mines, or any other considerable big holes. The conventional practice often recommends to use fly ash as a binder material because of its technical, economical, and environmental merits. Yet, the research raised a challenge to investigate if bottom ash, which often can be found admixed with fly ash, can be used as a binder material for reclamation purposes. To do that, several bottom ashes and one fly ash are collected from various sources and are examined for various tests to judge their compatibility for uses as a binder material. Some tests are carried out at external laboratories, and at mechanical-processing laboratory of German-Mongolian Institute for Resource, and Technology. The results showed that the collected bottom ashes, when admixed with fly ash whose CaO content is considerably high, cannot pass the requirements. Indeed, the mixtures failed during preparation even before the planned tests. But when the ashes are admixed with cement, they exhibited outstanding performance in terms of mechanical strength. Also, the fly ash alone is found to be an eligible backfilling material in terms of mechanical strength. All the materials collected under the research are investigated being not dangerous to the environments in any manner.

Keywords: Coal Combustion by-Products, Ash, Small Scale Mining, Backfilling, Pozzolanic

Introduction

In Mongolia more than 800.000 t of "coal combustion by-products" (CCB's: Fly Ash, Bottom Ash, Boiler Slag) are generated by thermal power plants and by coal combustion in ger districts. Most of these CCB's are usually disposed to special designed ponds without any environmental or social benefits. Particularly the pozzolanic material behaviors qualify CCB's as stable construction material, e.g. for backfilling operations in underground mines.

In Nalaikh – 30 km southeast of Ulaanbaatar - hundreds of small scale miners are digging for coal, leaving behind a multitude of unsecured surface openings and unclear branches towards the subsurface. During peak seasons in winters of the last years up to 2.000 small scale miners worked in around 200 mine shafts. Nalaikh's coal counts to about 70% of the 1 Mio. t coal burned every year in UB's ger district. The abandoned small scale mines, over time, often pose a permanent threat to humans in the neighbourhood.

Stabilization of these mine sites is a crucial part of a rehabilitation concept that has been developed at GMIT for the Nalaikh mining area.

Method

For the experiment, 9 different types of CCBs that can represent Mongolian CCB's and an electric arc furnace slag are collected then examined. This CCB's and electric-arc furnace slag mentioned above were used as filler material in the experiment. Based on the chemical content analysis portland cement, electric-arc furnace slag and fly ash were nominated to be candidates as binder materials. The candidates were chosen based on their calcium content. Portland cement was used to compare the filler materials and binders.

Analyses and test were conducted on the samples like sieve analysis, SEM analysis, radioactivity detection, moisture content analysis, XRF chemical content analysis. With cubic blocks that were produced from mixing different ashes, slags and binders uniaxial compression test have been conducted. FTIR samples were taken from the components of mix and the broken blocks. Elution test samples were drawn from the curing water for the cubes.

Result

All backfill mixes that was produced are proven that they would neither harm the environment nor human health because there was neither radiation nor the leached toxins that exceeded the safety standards. Most of the mix designs that used Portland cement as a binder satisfied the requirements. But some CCB's should be avoided as a filler material due to the blocks that had been produced from these materials disintegrated in the curing water even though 10% Portland cement was used as a binder.

On the other hand, some mix designs with CCB's as binder materials did not satisfy the requirement. Some CCB's have excellent amount of CaO and SiO2. FTIR analysis showed that pozzolanic reaction took place in balanced mixes. In short Portland cement must be used when utilizing bottom ashes.

Fly ash that is produced at the 4th power plant of Mongolia by means of electrostatic separators can be potentially used as backfilling material for reclamation of abandoned small scale mine holes. Strength of the ash is more than required. Therefore some other ashes, bottom ashes particularly can be used to deteriorate its strength down to the minimal accepted value. In that way, fly ash is saved and other industrial waste are properly dumped.

Discussion

The research expectation was that fly ash can be used as binder material on bottom ashes. But after mixing with other ashes those blocks where disintegrated during the curing process. As a consequence not every block could be compressed. It can be stated that the compressive strength of the samples is almost not depending on ashes size.

During the assessment of metallurgical slag, it is expected that CaO that is needed to carry the pozzolanic reaction is not tending to be released from the slag just by water. Besides, CaO locked inside the slag's particles are essentially isolated from SiO_2 resulting in an insufficient yield. Finally, the research concludes metallurgical slag to be a good aggregate also to reclaim abandoned small scale mine holes.

According to a literature, bottom ash was stated to be toxic. Therefore, the research was initially assuming the ashes are toxic. But elution test and radiation test denies the statement. It was reasonable if a careful look is given to chemical contents of the components.

Acknowledgments

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REGIONAL-SCALE DIFFERENTIATION AND PHYLOGEOGRAPHY OF A DESERT PLANT ALLIUM MONGOLICUM (LILIACEAE) INFERRED FROM CHLOROPLAST DNA SEQUENCE VARIATION

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Abstract: Past geological and climatic changes have promoted regional-scale intraspecific differentiation and range contraction/expansion in many temperate plants. However, little is known about how the desert species in central Asia responded to past geological and climatic changes, especially for a few widespread desert plants. In the present study, we aimed to survey the population structure and phylogeographical history of Allium mongolicum, which is widely distributed in the deserts of northwestern China. We sequenced two chloroplast DNA fragments (accD-psaI and psbA-trnH) for 418 individuals from 38 populations across the whole range of the species. Fourteen chlorotypes were identified and three out of them were dominant. All populations were divided into three larger distinct groups by SAMOVA, which was largely congruent with the geographical division based on the Monmonier's maximum-difference algorithm. Each of the groups occupied a distinct geographical region with a specific dominant chlorotype. Analysis of molecular variance showed that a high proportion of the total genetic variation (70.05%) existed among the three regions. The demographic dynamic tests indicated that the desert species had experienced a sudden regional-scale range expansion/recolonization in the Quaternary glaciers, which was further identified by the ecological niche modeling (ENM). These results suggest that the species has a distinct regional-scale differentiation as well as multiple geographically isolated refugia. Our results further enforce the idea that the environmental changes since the late Miocene greatly promoted differentiation of desert plants in northwestern China, and the Quaternary climatic oscillations played an important role in structuring the current populations of these species.

Keywords: Population structure, Genetic differentiation, Chloroplast DNA, Desert plant, *Allium mongolicum*

Introduction

The Quaternary climate oscillations caused repeated range contraction and expansion of most organisms in the Northern Hemisphere (Hewitt 2000), and such historical changes undoubtedly left genetic imprints in their extant populations (Hewitt 1996; Abbott et al. 2000; Avise 2000; Hewitt 2004; Schonswetter et al. 2006). Numerous studies have identified glacial refugia for temperate plant species and have traced their postglacial recolonization routes (e.g. Petit et al. 2003). The historical changes of most trees inferred from their population genetic variations are largely congruent with those inferred from fossil evidence (Petit and Grivet 2002; Burban and Petit 2003; Hamper et al. 2003; Kropf et al. 2003; Jaramillo-Correa et al. 2004; Marquardt and Epperson 2004; Godbaut et al. 2005). However, genetic evidence has become the only information for elucidating the phylogeographic history of some species because of the lack of fossil records (Anderson et al. 2006; Afzal-Rafii and Dodd 2007).

The Quaternary climatic oscillations and the associated regional-scale geological events probably had profound effects on intraspecific divergence and genetic structure of species due to the survival of populations in different glacial refugia and the subsequent barriers to dispersal (e.g. Avise 2004). Although there was no unified glacial sheet in Asia, such as in northern China, the current studies suggested that the Quaternary climatic oscillations also has a similar impact on the historical changes and genetic structure of species in this area (e. g. Zhang et al. 2005; Meng and Zhang 2011; Qiu et al. 2011). A case study by Chen et al. (2008) confirmed that *Pinus tabulaeformis* Carr., a major and widespread component tree of coniferous forests in northern China, had changed its distribution ranges in response to the Quaternary climatic shifts, and retained multiple refugia during the Last Glacial Maximum (LGM). However, a general conclusion has not been drawn on how plants in northern China responded to the Quaternary climatic oscillations (Tian et al. 2009; Guo et al. 2010). In addition, a few geographical barriers led by geological processes, such as uplifts of mountains, formation and development of deserts, and oasis expansion, also probably had a dramatic effects on the population genetic structure and geographical history of many desert species (e. g. Riddle et al. 2000; Nason et al. 2002; Riddle and Hafner 2006; Garrick et al. 2009; Fehlberg and Ranker 2009; Rebering et al. 2010). The uplift of the Qinghai-Tibet Plateau (QTP) led the climatic changes and accelerated the formation of deserts in central Asia, especially in northwestern China (Guo et al. 2002). Eight large deserts had formed in northern-northwestern China before or at the beginning of the Quaternary (Sun et al. 1998; Yang et al. 2006). These deserts seemed to have promoted the allopatric divergences of the studied species and these diverged populations should have survived in the different refugia during the LGM (e.g., Guo et al. 2010; Wang et al. 2011; Li et al. 2012; Zhang and Zhang 2012). However, little is known about how desert species in central Asia responded to past geological and climatic changes. Especially, for a few widespread plant species with disjunct distributions in the desert regions of northern-northwestern China, it is desirable to know whether their populations were derived from a common refugium or from different refugia during the Quaternary glaciations.

Allium mongolicum Regel (Liliaceae) is a kind of typical xerophytes in central Asia and mainly occurs in a few desert regions of northwestern China. Owing to its wide distribution, this species provides an ideal material for examining whether the desert plants changed their distribution in response to past climatic changes in this region. In this study, we used two cpDNA fragments (*acc*D-*psa*I and *psb*A-*trn*H) to examine genetic structure and phylogeographic pattern of the plant species. We mainly aimed to address the following questions: (1) is there any inter-regional genetic differentiation in the wide geographic distribution of this perennial herb？(2) Were regional populations derived from a common refugium or from independent refugia that occurred within each region during the Quaternary glaciations? And (3) did the more recent climatic fluctuations result in the species range contraction and expansion within geographical regions?

Results

1.Chloroplast DNA variation and distribution

The total alignment of *acc*D-*psa*I sequence obtained for 418 individuals in 38 populations was 714 bp in length. Nucleotide substitutions occurred at eight sites (230, A/C; 249, C/A; 439, A/G; 528, A/C; 539, T/C, 618, G/C; 667, A/C; 694, G/A), and 7 indels of different length (4-31 bp) were present between sites 425 and 641. However, there were only two indels detected in the *psb*A-*trn*H cp DNA fragment with a total alignment length of 613 bp (Table 2). The thirteen *acc*D-*psa*I sequences and three *psb*A-*trn*H sequences recorded in *A. mongolicum*, together with the *acc*D-*psa*I and *psb*A-*trn*H sequences obtained from one individual of *A. anisopodium*, were deposited in the EMBL GenBank under accession numbers KU204857, KU253459-KU253475. The combined alignment of the two cpDNA fragments with a total length of 1327 bp, identified fourteen different chlorotypes (H1-H14) among all individuals sampled. The phylogenic analysis did not resolve the relationships among these chlorotypes (Online resource 3). Twenty-one populations were fixed for a single chlorotype, while the remaining 17 were polymorphic (Fig.1: a). The most common chlorotypes were H2, H4 and H6 (Fig.1: a, b). H2 mainly occurred at high frequency in the populations of the east-central range (1-15, 35) of the species and a few populations in the western range (23 and 25). H6 was fixed as a single chlorotype or occurred at high frequency in most populations of the west-central range (13-22, 28-33, and 36-38), and H4 was fixed or occurred commonly in western populations of the species' range (23-27). The other haplotypes were distributed in several populations in different parts of the species' range normally at low frequency, although occasionally at high frequency in a few populations (e.g. population 34 which was fixed for chlorotype H1). Four rare chlorotypes, H3, H8, H11, and H13, were present only in populations 8, 3, 18, and 1 at low frequencies, respectively. Especially, two populations (8 and 13) had a markedly different chlorotype composition compared to the rest, which comprised most of the chlorotypes identified in this study. Population 8, which contained the greatest gene diversity (H_E = 0.737), was polymorphic for chlorotypes H2, H3, H7, and H12, occurring at different frequencies, while population 13 was polymorphic (H_E = 0.726) for six chlorotypes (H1, H2, H5, H6, H10 and H14) that occurred at high frequencies (H2 and H6) and low frequencies (H1, H5, H10 and H14), respectively. Both of these populations appeared to mix most dominant and rare chlorotypes (H1, H2, H3, H5, H6, H7, H10, H12, H14) from most populations apart from the populations in Xinjiang (western range). Notably, the most common chlorotype H2 in the east-central populations was also detected in the two populations (23, 25) of the western range (Xinjiang) which was geographically far from the east-central populations and occupied a separated distribution.

2.Regional-scale differentiation and population structure

The analysis of spatial genetic structure based on the cpDNA variations showed that the differentiation among groups (F_{CT}) reached a plateau when the number of groups (K) equaled 4. All the sampled populations were divided into three larger regional groups and a small one by SAMOVA corresponding to K = 4: the east-central group (ECG) consisting of populations 1-12, 25, and 35; the west-central group (WCG) consisting of populations 13-22, 28-33, and 36-38; the western group (WG) containing populations 23, 24, 26, and 27; and Qinghai group (QHG) containing only one population (34) (Fig.1: a). The differentiation among these four groups (F_{CT}) estimated using SAMOVA was 0.732. Each of the three larger groups didn't have distinct overlapping geographical ranges: the ECG was distributed in the east-central range of the species, while the WCG mainly occurred in the west-central range, and the WG was in the western range of the species (Xinjiang). Especially, each of the three larger regional groups had its own dominant chlorotype, i.e. H2 for the ECG, H6 for the WCG, and H4 for the WG (Fig.1: a, b). Particularly, the dominant chlorotype H2 in the ECG, together with the dominant chlorotype H4 in the WG, was also present in population 25 at high frequency. Consequently, this population was assigned to the ECG in the analysis of spatial genetic structure using SAMOVA. Actually, this population lies in Xinjiang and geographically belongs to the western group. In addition, the small group of Qinghai comprised only one population (34) that was fixed for a single chlorotype H1 which otherwise occurred in only two other populations (13 and 33). Furthermore, three populations (13, 14 and 15) in WCG contained the two dominant chlorotypes (H2 and H6) respectively.

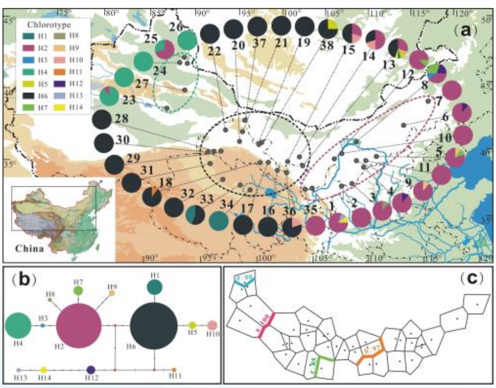

Fig. 1 Map of the sampling sites, geographic distribution of the chlorotypes, the phylogenetic network, and genetic barriers among populations of *A. mongolicum*.

(A) Sampling sites and chlorotype frequencies in surveyed populations. Pink dashed line circle represents the east-central group (ECG, consisting of 14 populations); black dashed line cycle indicates the west-central group (WCG, consisting of 19 populations); and green dashed circle represents the western group (WG, consisting of 4 populations). (B) Phylogenetic network of the fourteen chlorotypes. Circle size is proportional to the frequency of a chlorotype over all populations, with the largest circle representing the most abundant chlorotype. The small red dots indicate median vectors (i.e. unsampled or extinct chlorotypes). (C) Genetic barriers to chlorotypes between different sampling areas.

The result based on the Monmonier's maximum-difference algorithm in BARRIER was largely congruent with the regional-scale differentiation in SAMOVA. Two strong genetic barriers were also detected among the ECG, WCG, and WG areas (Fig.1: c), and these two barriers received high bootstrap values (a: 100%, b: 97%). Although two genetic barriers were detected within the WCG and WG areas, their support values were relatively low (c: 85%, d: 80%).

The PERMUT analysis revealed that the average gene diversity within populations of the species was low, H_S = 0.180, while the total gene diversity across all populations was high, H_T = 0.693. The level of differentiation among all the populations surveyed was relatively high (G_{ST} = 0.740, N_{ST} = 0.759), suggesting lower levels of recurrent gene flow among populations. A permutation test showed that N_{ST} was not significantly higher than G_{ST} ($P > 0.05$), indicating that no clear phylogeographic structure existed among populations across the whole distributional range of the species. By contrast, the values of H_T and G_{ST} for the three larger groups distinguished by SAMOVA were lower (East-central group: H_T = 0.250, G_{ST} = 0.124; West-central group: H_T = 0.267, G_{ST} = 0.294; Western group: H_T = 0.050, G_{ST} = 0.000). Analyses using AMOVA revealed that approximately 70% of the total cpDNA variation occurred among groups whereas only about 10% occurred among populations within groups, indicating very strong regional-scale differentiation between the three larger groups identified by SAMOVA. However, within-population variation (20.76%) of the whole distribution was about two times greater than that of among populations within groups (10.29%). For the three larger groups distinguished by SAMOVA, variation within populations was obviously higher than that of among populations.

3. Range expansion/recolonization of A. mongolicum under climate scenarios

The geographic distribution of the fourteen cpDNA haplotypes showed that only two chlorotypes (H2 and H4) occurred in the west population group of the species distribution range. Therefore, we did not use Arlequin to carry out any further statistical tests on the demographic expansion in this group. The mismatch distribution analysis showed that the distribution of pairwise differences for the whole populations and the two population groups (ECG and WCG) were unimodal curves. The higher *P*-values of Harpending's raggedness index (*RAG*) and the sum of squared deviation (*SSD*) for the ECG and WCG suggested that the curves for these two population groups were not significantly different from the expected distribution model of sudden population expansion, which indicated that the ECG and WCG populations had experienced a rapid regional-scale range expansion. Furthermore, the significantly negative values of Tajima's *D* and the negative values of Fu's *F*s in these groups similarly supported sudden demographic expansion hypotheses. The demographic expansion time was estimated to be between 20 and 190 Kya, based on the highest and lowest cpDNA mutation rates of angiosperms (Wolfe et al. 1987; Richardson et al. 2001), the whole chlorotype sequence length of 1327bp, and an estimated generation time of 3 years on the basis of field investigation and cultivation experiments.

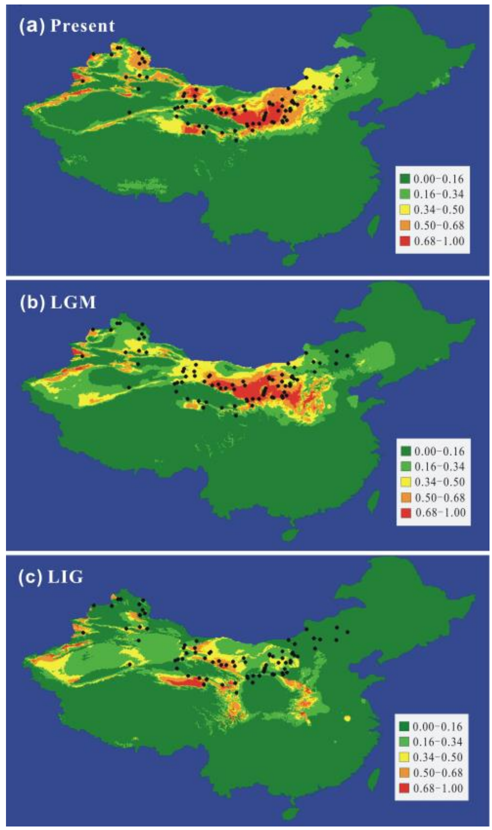

Fig. 2 Predicted distributions of *A. mongolicum* during the present day, the LGM, and the LIG based on ecological niche modeling using MAXENT.

Predicted species distributions are shown for (A) the present-day model, (B) the LGM-MIROC model, and (C) the LIG model. The black plots represent the 85 sites, including 38 our own field sampling sites and 47 specimen records from the Chinese Virtual Herbarium. LGM, Last Glacial Maximum; LIG, Last Interglacial.

According to the 40 replicates of the MAXENT runs, the goodness of the species distribution models was supported by the high average AUC scores (0.922±0.029) of ENM. Estimates of relative contributions of the environmental variables on the basis of jackknife test showed that Temperature Annual Range (27.0%), Precipitation of Warmest Quarter (20.8%), Annual Mean Temperature (14.7%), Mean Temperature of Wettest Quarter (11.5%), Mean Diurnal Range (5.4%), and Precipitation of Driest Quarter (5.3%) mainly affected the distribution ranges of *A. mongolicum* (Online resource 5). Based on the six environmental variables and the 85 sites dataset, the potential distribution ranges were modeled for the present day, the LGM, and the LIG, respectively (Fig. 2). Based on a high habitat suitability index (more than 0.34), the LIG model revealed a narrow potential distribution range, while the distribution ranges in the present-day and the LGM periods had a significant expansion or recolonization in the geographical range of the species. Although the LIG had a narrower predicted distribution, we also observed that the potential niche map of LIG based on high habitat suitability (> 0.34) had four distinct fragmented distributions in our sampled area, which were nearly corresponding to the four regional groups by SAMOVA (Figs.1: a; 3: c). In addition, the distribution ranges of the species might have experienced northeastward and westward expansion, and further extended to the northeast of the ECG (Fig.2: a, b).

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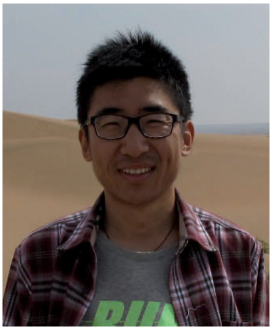
THROUGHFALL AND ITS SPATIAL VARIABILITY BENEATH XEROPHYTIC SHRUB CANOPIES WITHIN WATER-LIMITED ARID DESERT ECOSYSTEM



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Abstract: Throughfall is known to be a critical component of the hydrological and biogeochemical cycles of forested ecosystems with inherently temporal and spatial variability. Yet little is understood concerning the throughfall variability of shrubs and the associated controlling factors in arid desert ecosystems. Here we systematically investigated the variability of throughfall of two morphological distinct xerophytic shrubs (*Caragana korshinskii* and *Artemisia ordosica*) within a re-vegetated arid desert ecosystem, and evaluated the effects of shrub structure and rainfall characteristics on throughfall based on heavily gauged throughfall measurements at the event scale. We found that morphological differences were not sufficient to generate significant difference ($P < 0.05$) in throughfall between two studied shrub species under the same rainfall and meteorological conditions in our study area, with a throughfall percentage of 69.7% for *C. korshinskii* and 64.3% for *A. ordosica*. We also observed a highly variable patchy pattern of throughfall beneath individual shrub canopies, but the spatial patterns appeared to be stable among rainfall events based on time stability analysis. Throughfall linearly increased with the increasing distance from the shrub base for both shrubs, and radial direction beneath shrub canopies had a pronounced impact on throughfall. Throughfall variability, expressed as the coefficient of variation (CV) of throughfall, tended to decline with the increase in rainfall amount, intensity and duration, and stabilized passing a certain threshold. Our findings highlight the great variability of throughfall beneath the canopies of xerophytic shrubs and the time stability of throughfall pattern among rainfall events. The spatially heterogeneous and temporally stable throughfall is expected to generate a dynamic patchy distribution of soil moisture beneath shrub canopies within arid desert ecosystems.

Keywords: Canopy structure, Rainfall characteristics, Spatial variability, Throughfall, Time stability, Xerophytic shrubs

WATER QUALITY RESEARCH OF ANTHROPOGENIC IMPACT IN HIGH RISK RIVER /CASE STUDY OF RIVER SHAR/

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Abstract: The territories of Mongolia belong to three large Basins of the watersheds, including the Arctic Ocean, the Pacific and the Euro-Asia, which are no outflow Basin. The most of the largest rivers of Mongolia are included in the Arctic Ocean Basin. We will discuss the water quality of River Shar, which is one of the tributaries in right sides of the River Orkhon, which is also included in Arctic Ocean Basin. This river is one of the small river impacted by human activities, upstream part depends on the gold mining operations, and downstream on coal mines, and the downstream of the middle is depends on agriculture. According to the study, chemical composition of River Shar is included a hydro carbonate class, calcium group 1, and the water quality is fresh and soft. But the river water is severely polluted and turbidity level is 8.0-12.5 times higher than “clean” normalization, also concentration of aluminum and iron of the river in mining operation are particularly large (Al 3-18.7 times and Fe: 3.9-21.7 times higher than MNS 6148: 2010: standard), and it decreased along to the riverbed and accumulates in the river floor. Aluminum and iron levels in the floor sediments are more concentrated than basic elements, such as calcium, magnesium, sodium, potassium and cations, but there is no standard to compare these parameters. In addition, there are high detected feces bacteria / total coliform, thermo tolerant coliform, Escherichia coli/ it may exceed the standard limit at almost all points along to length of the river.

Keywords: water turbidity, micro elements, coliform

Introduction

Most cities of Mongolia are located along the river basins, to become center in river valleys following water, and gold mining are operated mainly along to the riverbeds, and herders live along to the rivers in summer. It creates the risk of natural disasters, and the rivers on high risk for human activity are increasing year by year. One of these rivers is River Shar, it flows through the Kharaa and Yuroo river basins, also flow into the Orkhon River, and it incur to all kinds of human activities. The floor of the river, which is pure, clear and fresh, also it has sand-gravel sediments, but the clay proceed by goldfields have increased extra in recent years.

The River Shar is effluented by river Suuj and Serkhen from the eastside River Shar, and is from the right side effluented by rivers Asgat, Hagalbar bulag, Urd ekh, Hoid ekh, Ar Gakhait, Uvur Gakhait, Monost, Shivert, Khurgad, Khavchuu, Shaazgait and Khuiten. Most of these tributaries are impacted on mining operations, and it is created pits, piles of mud and deep ponds along to the riverbeds, also it becomes risk of falling animals and livestock, not only streams the natural view.

In this article, we discussed about the research results of the water pollution level of this river, due to River Shar and the tributaries are pol-

-luted to impact from gold mine. The samples were analyzed according to standards approved by the modern method of water analysis stationary laboratory.

Research Method and Materials

We have measured in River Shar and some tributaries, and analyzed volatile parameters such as physical parameters, temperature, water environment (pH), conductivity, dissolved oxygen, turbidity by field research, and determined the basic characteristics in field laboratory.

Detailed analysis of water micro element was analyzed by the ICP 80T tool, in laboratory of SGS IMME Mongolia LLC. The results of the water quality study are compared with "Environment, Health Protecting. Safety. Drinking water. Hygienically requirements, assessment of the quality and safety: MNS 0900: 2018”, "Quality parameters of aquatic environment: MNS 4586-98” standard, "Classification norm of surface water ", and some parameters of sediments are compared with "The tolerance level of groundwater pollutants and elements MNS 6148: 2010” standard. Water microbiological measurements have been used by DelAgua portable incubators. MLSB environment / membrane lauryl sulfate broth/ have used to prepare the environment. The incubator has two types of separated cameras as a 37°C temperature of the total coliform and 44°C incubation of the thermotolerant coliform for 16-18 hours and to count colony number in 100 ml of water [6]

Table 1. Drinking water. Hygienically requirements, assessment of the quality and safety: MNS 0900: 2018

Total coliforms in 100 ml	Thermotolerant coliforms in 100 ml
0	0

We sampled and measured at 19 points in August 2018, such as 11 samples were along to the length of the River Shar, and 9 samples were at the tributaries and the others.

Results

The water of River Shar is included hydrocarbonate class, calcium group type 1 about chemically composition, and the quality is fresh and soft water, but now it is very high turbidities.

During August field research, rainfall events had significant impact on the water quality of the river.

The main chemical elements of the river are shown following diagram. The following diagram shows that rivers of the beginning side of River Shar have very fresh and very soft water. River Shar is more mineralized (mineralization 180-330mg/l and hardness 2.0-3.1 mg-eqv/l), it is decreased after mineral water confluenced the river Khuiten.

The upperstream of the river Khuiten was fresh water like as River Shar, although the downstream of gold mining area was also polluted and mineralized. The mineralization of the right side tributaries river Khurgad, Khavchuu, Shaazgait are relatively higher than other rivers (mineralization is 334-480 mg/l and hardness is 3.70-4.80 mg-eqv/l) [3,5].

Table 2. Surface water hygiene Kirschner classification et al. (2009) [11]

	Little	Moderate	Critical	Strong	Excessive
Total coliform	≤500	> 500 - 10'000	> 10'000 - 100'000	> 100'000 - 1'000'000	> 1'000'000
Thermotolerant coliform	≤100	> 100 - 1000	> 1000 - 10'000	> 10'000 - 100'000	> 100'000

According to the study, the turbidity level increased at whole area down from gold mining area at the upper stream of the River Shar, which is 8.0-12.5 times higher than the "Clean" parameter of "Classification norm of surface water".

The analysis of 53 micro elements in River Shar shows that some heavy and toxic elements have detected significantly. Particularly most of the micro elements have relative more detected in the water from the water head of River Shar, which is in downstream of the River Uvur Gakhait gold mine. The following table shows the analysis of the most detected six elements from the total micro elements. Other elements are not included in this table, because they are detected low.

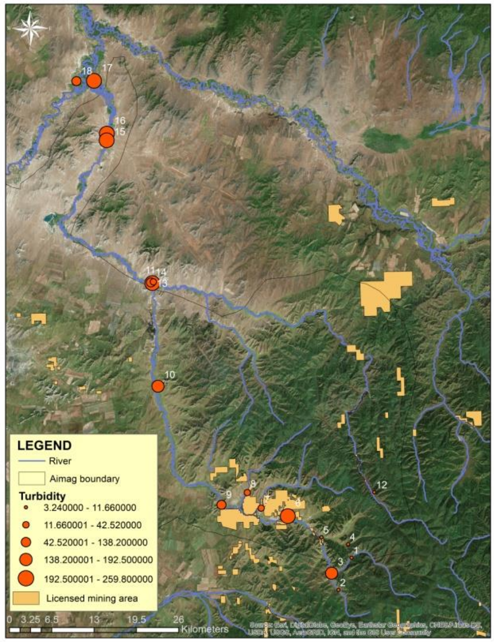

Figure 1. The turbidity amounts along to the length of the River Shar, NTU

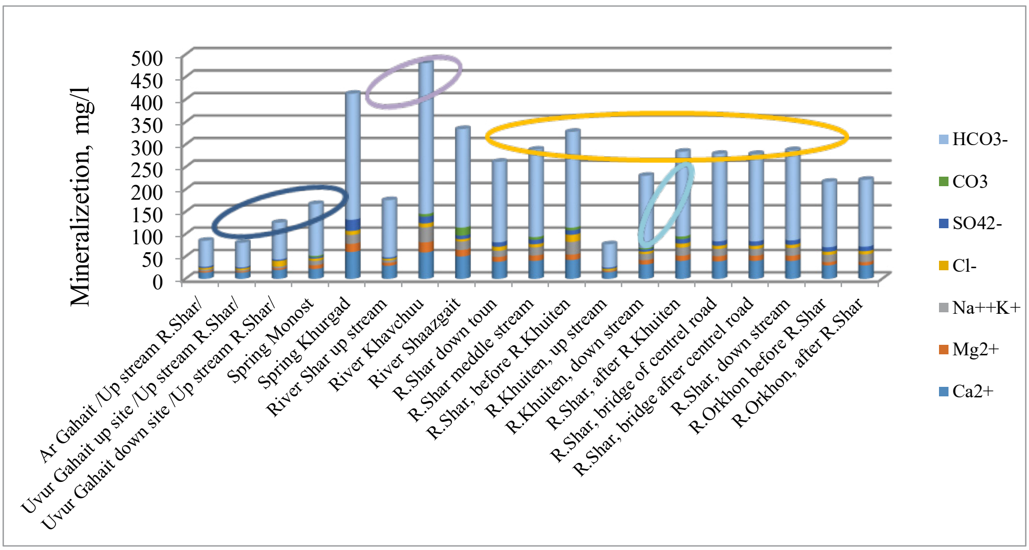

Diagram 1. Water quality change of River Shar by length

Table 3. The concentration of some micro elements in River Shar and other water points, mg/l

Sampling sites	Arsenic (As)	Aluminum (Al)	iron (Fe)	Molybdenum (Mo)	Phosphorus (P)	Uranium (U)
MNS 4586:1998	<0.01	-	-	<0.25	<0.1	-
Classification of surface water	<0.01	-	<0.5	<0.1	<0.1	
MNS 6148:2010	<0.01	<0.5	<0.3	<0.04		0.02
SG upstream, Ar gahait	<0.0000	<0.010	<0.05	0.0023	<0.050	0.0016

	3		0			
SG upstream, Uvur gahait upper	0.00022	2.003	1.178	0.0012	<0.050	0.0007
SG upstream, Uvur gahait lower	0.00179	9.359	6.506	0.0033	0.150	0.0004
Hurgad estuary	0.00014	<0.010	<0.050	0.0033	<0.050	0.0202
SG upper	0.00077	1.516	1.109	0.0069	0.068	0.0117
Havchuu, lower	0.00034	<0.010	<0.050	0.0054	<0.050	0.0115
Shaazgait, lower	0.00125	<0.010	<0.050	0.0034	0.068	0.0043
SG, down the town	0.00101	1.147	0.940	0.0066	0.090	0.0188
SG, middle	0.00151	0.548	0.467	0.0077	0.090	0.0180
SG, up before Huiten river	0.0013	0.382	0.346	0.0048	0.093	0.0099
Huiten river upstream	<0.00003	<0.010	0.206	0.0018	<0.050	0.0003
Huiten river downstream	0.00073	0.100	0.091	0.0027	<0.050	0.0033
SG, down after Huiten river	0.0019	0.332	0.314	0.0074	0.119	0.0173
SG, main road bridge	0.00135	0.195	0.146	0.0056	0.124	0.0072
SG, after main road bridge	0.00149	0.175	0.235	0.0056	0.123	0.0080
SG, downstream	0.00156	0.182	0.231	0.0056	0.123	0.0071
Orkhon river, before SG river	0.00181	0.080	0.069	0.0035	0.075	0.0024

According to the results of micro element analysis, contentration of aluminum and iron in the river with mining operation are particularly high detected, and from this table, Aluminum and iron levels in the floor sediments are more concentrated than basic elements, such as calcium, magnesium, sodium, potassium and cations, but there is no standards to compare this parameters /Table 3/

The following table is shown by the amounts of total coliform and thermotolerant coliform in 100 ml water, which we determined in field research. It decreased along to the riverbed and accumulate in the river floor.

Table 4. Contentration of sedimentary elements of River Shar,%

River name	Ca	Mg	Na	K	Al	Fe	P	S	Ti
SG upstream, Ar gahait	0.81	0.22	2.03	3.31	2.89	1.30	0.02	0.02	0.12
SG upstream, Uvur gahait /mining/	2.21	1.12	1.56	1.97	5.94	3.62	0.07	0.12	0.39
SG upstream /mining/	2.21	0.65	2.41	2.01	4.90	2.15	0.05	0.04	0.31
SG, down the town	3.43	0.91	2.68	1.95	6.36	2.79	0.07	0.07	0.38
SG, middle	2.51	0.76	2.59	1.99	5.45	2.24	0.04	0.02	0.35
SG, down after Huiten river	1.76	0.43	2.55	2.07	3.83	2.25	0.03	0.01	0.41
SG, main road bridge	1.91	0.47	2.82	2.24	4.30	1.88	0.04	0.02	0.30
SG, after main road bridge	2.01	0.47	2.90	2.17	4.75	1.97	0.03	0.01	0.34
SG, downstream	2.66	0.93	2.69	2.29	6.17	4.66	0.07	0.05	0.37
Orkhon river, before SG river	1.76	0.75	2.64	2.33	4.73	2.69	0.05	0.06	0.32
Shaazgait river, downstream	2.98	0.88	2.48	1.70	5.89	2.82	0.05	0.04	0.44
Huiten river downstream	1.87	0.51	2.73	1.97	4.24	1.81	0.04	0.02	0.26

	3		0			
SG upstream, Uvur gahait upper	0.00022	2.003	1.178	0.0012	<0.050	0.0007
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Table 5. The amounts of total coliform and thermotolerant coliform in 100 ml water

№	Sites	Coordinate	Total	Thermotolerant
Classification of surface water hygiene based on Kirschner et al. (2009) moderate			> 500 - 10'000	>100 - 1000
Environment. health Protecting. Safety. Drinking water. Hygienically requirements, assessment of the quality and safety: MNS 0900: 2018			0	0
1	Orkhon river, before SG river	49°50'26.5" 106°06'15.9"	803	300
2	Orkhon river, before SG after	49°53'10.0" 106°08'46.8"	778	400
3	SG, downstream	49°50'26.5" 106°08'30.8"	4020	1690
4	SG, main road bridge	49°45'25.9" 106°10'0.6"	315	83
5	SG, after main road bridge	49°45'59.1" 106°10'3.3"	3370	1310
6	SG, down the town	49°14'36.4" 106°23'48.6"	970	960
7	SG upstream, Ar gahait	49°09'56.4" 106°40'7.3"	61	81
8	SG upstream, Uvur gahait upper	49°07'14.9" 106°38'22.4"	91	91
9	SG upstream, Uvur gahait lower	49°08'40.3" 106°37'33.3"	2200	1760
10	Hurgad estuary	49°11'42.8" 106°36'22.1"	443	246
11	Shaazgait, lower	49°15'35.3" 106°27'6.4"	6150	4680
12	Шарын гол эх /алтны уурхай/	49°13'32.6" 106°32'10.1"	1280	740
13	Monostoi spring	49°11'4.9" 106°39'43.7"	93	60
14	Havchuu, lower	49°14'16.0" 106°28'49.9"	300	239
15	SG, middle	49°24'40.7" 106°16'15.0"	6030	3300
16	Huiten river downstream	49°33'27.9" 106°15'40.4"	1510	106
17	SG, down after Huiten river	49°33'24.9" 106°15'21.7"	590	350
18	SG, up before Huiten river	49°33'21.5" 106°15'32.9"	1460	1150
19	Huiten river upstream	49°15'13.1" 106°42'49.4"	4	0

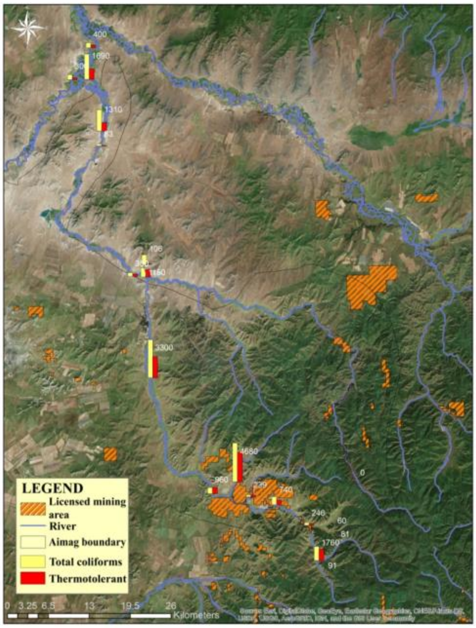

Figure 2. The coliform amounts along to the length of the River Shar

According to microbiological analysis, all the monitoring points along to the length of the River Shar are polluted by total coliform. But it is low detected in the water head of the river, which is not impacted by mining.

Conclussion

- The previous research on water quality in River Shar determined the main water chemical parameters, nutrients and turbidities. But we have described at this time more advantages, that the concentration of micro elements was determined by 53 parameters and microbiological analysis.
- The River Shar valley is affected by mining impacts at the upper stream, agriculture impacts at middle stream to downstream of the river. There is insufficient implementation of law, and the river's water is very high turbidity than the standard.
- The concentration of micro elements is relatively high in the gold mines area; particularly the concentration of aluminum and iron from heavy metals was high and decreased along to the riverbed and accumulate in the river floor.
- The total coliform is high detected in water of River Shar, due to this river water cannot be used directly for drinking.

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LAKE ENVIRONMENTAL QUALITY AND RIVERINE POLLUTANTS: CASE OF CHAOHU

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Abstract: Social and economic developments in recent decades of years have led to large amounts of pollutants being transported to the lakes wroldwide, causing heavy pollution of the waters, posing significantly harmful effects on the human environment health around the region. Hereinto, taking one of the three most eutrophic lakes of China as example, riverine pollutants influenced greatly the quality of Lake Chaohu, although it still plays an important role in potable water supply and environmental regulation. The water environmental capacities for CODMn, TP, and NH3-N in Lake Chao were estimated with a zero-dimensional model using Class III water quality of China as the target. The effects of river pollutants transported by the eight major tributaries on the lake's water quality were then analyzed. To prevent further deterioration of the lake's water quality, it is critical to strengthen pollution control in the rivers around the lake and to reduce the sources of river pollution. Research on water environmental capacities for pollutants in Lake Chao and the effects of riverine pollutants transported by tributaries on lake water quality might provide information to improve environmental health and pollution control measures for the similar lakes globally.

Keywords: Riverine pollutants, Lake, Environmental capacity, Water quality

Introduction

Background Social and economic developments in recent decades years have led to large amounts of pollutants being transported to the lakes, causing heavy pollution of the waters, posing significantly harmful effects on the human environment health around the region. Around 90% of the lakes of China are in the state of medium to high eutrophication. Hereinto, riverine pollutants influenced greatly the quality of Lake Chaohu, one of the three most eutrophic lakes of China, although it still plays an important role in potable water supply and environmental health regulation. In the long term, the treatment of lakes will continue to be a difficult issue that the official authorities will have to tackle. The main task in the national management of lakes is to further research on the water environmental capacities. Research on water environmental capacities for pollutants in Lake Chao and the effects of riverine pollutants transported by tributaries on lake water quality might provide information to improve environmental health and pollution control measures for the similar lakes. There are few studies that reports this issue for the region.

Although some progress has been achieved, the water quality remains questionable since it is difficult to control the total amount of pollutants being transported to the lakes (Yin and Zhang, 2003). In addition, the water environmental capacity of the lakes under varying conditions has not been clearly identified. In the country's eleventh 5-Year Plan, measures for the management of water environments were revised from total target to total capacity controls (Zhang et al., 2010; Liu and Cui, 2004). Hence, the main task in the national management of lakes is to further research on the water environmental capacities. Pollutants in surface runoffs and point-source discharges are direct sources of lake pollutants (Chu and Xia, 2009; Yan et al., 2003). These enter the water of rivers and tributaries and are eventually transported to the receiving water bodies, including the lakes. Although river pollutants have direct and significant impacts on the water environmental capacities of lakes, quantitative research on the relationship between the two is lacking.

In this study, the lake's water environmental capacities for COD_{Mn}, TP, and NH_3-N for 2011–2017 were estimated, using the target of Class III water quality. The impacts of river pollutants transported by the tributaries to the lake on its water environmental capacity were also quantitatively analyzed. These provided scientific data to support future pollution control measures for the lake water environmental protection globally.

Method

Lake Chaohu is one of the five largest fresh lakes in China. Now it is one of the three most eutrophic lakes of China attracting more and more attention in the world-wide-concern. There are thirty three tributaries entering Lake Chaohu. The Nanfei (NFR), Hangbu (HBR), Fengle (FLR), Shiwuli (SR), Pai (PR), Dianbu (DBR), Ershibu (ER), and Zhao (ZR) Rivers are the major tributaries that contribute most of the total water discharge into the lake (about 90%). In this study, six sampling sites were selected throughout the lake, and one sampling site was selected in each of the eight tributaries. The concentrations of CODMn, TP, and NH3-N in the sampling stations were monitored monthly during 2001 through 2017.

The water environmental capacity for CODMn in Lake Chaohu was calculated using the Vollenweider model.

$$\frac{Vdc}{dt}=Q_iC_i-Q_eC-kCV \quad (1)$$

Where, V is the water volume of the lake (m^3); Q_i is the total water input to the lake (m^3/yr), and Q_e is the total water output the lake (m^3/yr); C_i and C is the concentration of COD_{Mn} in water input to the lake and lake water(mg/L), respectively; k is the biochemical degradation coefficient (1/d).

The water environmental capacity for TP and NH3-N in Lake Chaohu were calculated using the Dillon and Hetianjian models, respectively. The calculation equation of Dillon model (Wang et al., 2005; Fang et al., 1988).

The total water discharge of the eight studied tributaries was estimated using rainfall data and the runoff coefficient within the watershed. The monthly rainfall ranged between 3.5 and 304.2 mm. The many-years' mean runoff coefficient was about 0.46 within the watershed (Yang and Zhang,2005; Gao et al., 2009). Then we calculated that the total water discharge to the lake would range from 41.2Ч108—56.2Ч108 m3 during 2011--2017. This result is very close to the monitored value in other reports (40Ч108 m3, Mi and Zhou, 2009). Considering the water discharge of the eight tributaries to Lake Chaohu (about 90%), it is estimated that about 36.6Ч108--51.1Ч108 m3 water was discharged to the lake during the study period.

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Results

Considering the water discharge of the tributaries to Lake Chaohu (about 90%), it is estimated that about 35.3Ч10^8-49.7Ч10^8 m^3 water was discharged to the lake during the study period. Water environmental capacity for COD_{Mn}, TP, and NH_3-N in the lake ranged 5.12-5.85Ч10^4, 0.05-0.06Ч10^4, and 1.06-1.34 Ч10^4 ton/yr from 2011 to 2017, with a mean value of 5.39±0.16 (SD)Ч10^4, 0.05 Ч10^4, and 1.09Ч10^4 ton/yr, different with other Chinese lakes under the same water quality target. Different types of lakes and pollution conditions may result in different water environmental capacities in various lakes. In addition, the interactions and relationships between pollutants, such as the improvement of the environmental capacity for one pollutant may lead to the reduction of other pollutants, may also result in the difference of water environmental capacity for nutrients in the lake.

Concentrations of three pollutants ranged 3.98-12.09, 0.06-0.43 and 0.08-3.66 mg/L, with a mean value of 5.98±1.29, 0.17±0.06 and 0.69±0.58 (SD) mg/L, respectively, indicating higher concentration values in autumn and winter, with COD_{Mn} and TP being the major pollutants. Annual reserves of three pollutants was estimated to be 0.87-1.19, 0.02-0.05, and 0.08-0.17 Ч10^4 ton/yr, which accounted for 14-19%, 57-75%, and 5-16% of the lake's total water environmental capacity, respectively, indicating that the water environment has remaining assimilative capacity for all three pollutants. For the target of Class III water quality, the safety margins for three pollutants in the lake was 6.13-6.77, 0.02-0.04, and 0.84-1.09 Ч10^4 ton/yr, respectively.

Monthly changes in the concentration levels of three pollutants in the major tributaries was 1.9-69.2, 0.02-4.51 and 0.02-159.00 mg/L, with mean value of 8.32±6.21, 0.47±0.56, and 7.01±15.47 (SD) mg/L, respectively.

Among the tributaries, the pollution level of the Hangbu and Fengle Rivers was relatively low, with the water quality maintained at Class III perennially. However, the pollution level of the other tributaries was more serious, with the water quality at Class IV–V (inferior). Total annual amounts of three pollutants transported by the tributaries into the lake was 3.86-4.33, 0.16-0.22, and 3.69-4.57 Ч10^4 ton/yr, respectively. The total annual amount of COD_{Mn} transported was below the lake's water environmental health standard and safety margin, at the proportion of 52–63% and 68–79% respectively. However, the total annual amount of TP transported was 2.98–3.95 times the lake's water environmental health standard and 6.87–12.32 times its safety margin. For NH_3-N, the total annual amount transported was 3.15–3.88 times the lake's water environmental health standard and 4.02–4.54 times its safety margin. Total annual amount of TP and NH_3-N transported was severely affecting the lake water environmental health issues.

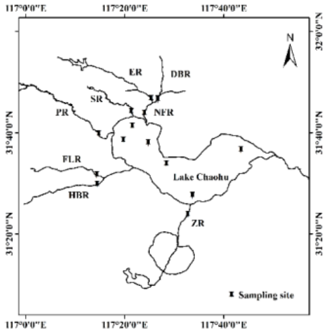

Figure 1 Location of sampling site

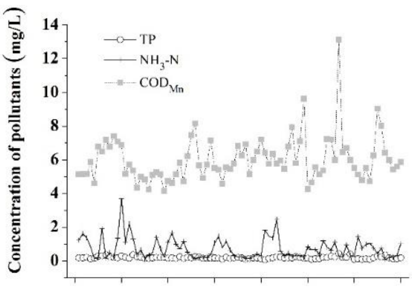

Figure 2 Monthly concentrations of COD_{Mn}, TP and NH_3-N

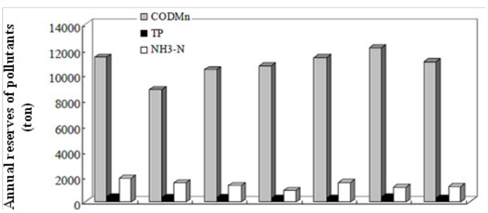

Figure 3 Annual reserves of COD_{Mn}, TP, NH_3-N

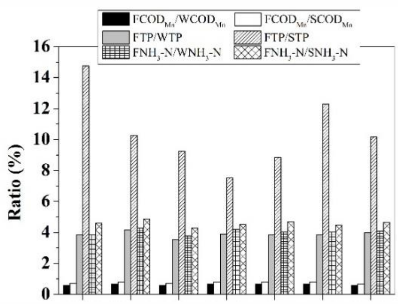

Figure 4 Impact of riverine pollutants fluxes on water environment capacity of Lake Chaohu ($FCOD_{Mn}$, FTP, and FNH_3-N indicate the fluxes of COD_{Mn},TP, and NH_3-N exported by the eight tributaries to the lake; $WCOD_{Mn}$, WTP, and WNH_3-N indicate the water environmental capacity of COD_{Mn},TP, and NH_3-N in the lake; $SCOD_{Mn}$,STP, and SNH_3-N indicate the safety margins of COD_{Mn},TP, and NH_3-N in the lake)

Conclusions

It is important to estimate the water environmental capacity and the riverine fluxes of pollutants, for resolving river pollutants transports and lake environmental issues. Water quality of Lake Chao maintained at Class IV-V during 2011-2017 period, with COD_{Mn} and TP being the major pollutants. The total annual amounts of TP and NH_3-N transported by the tributaries exceeded lake water environmental capacity. It is critical to reduce the yields of pollutants in the watershed and improve environment issues in the rivers around the region for the restoration of the lake.

Acknowledgments

The study was funded by the Science & Technology Basic Resources Investigation Program of China (2017FY101300), the National Natural Science Foundation of China (No. 41301642).

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BIRCH FOREST INSECTS IN THE HUSTAI NATIONAL PARK

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Abstract: Methodologies such as shaking the wood, checking fallen and cut wood, sweeping, and using traps were applied in this study to collect short-term prognostic data, such as the composition of the predominant insect species, the insect development stage, the damage caused by the insect, the size of the leaves and the size of the dried tree field. These findings led to specific recommendations to prevent and protect from further degradation from insect infestations. As claimed by our survey in 2018, a total of 3417 individual insects of 37 species, belonging to 4 groups and 31 genres were collected. According to the details, 29 species from Coleoptera, 4 different moth species were collected. Results of the ACE estimation showed that species richness value is highest in the 9th field, and then the 1st and 2nd sites are very widespread. But the 10th and 3rd plots have the least amount of species richness compared to other sites. The difference between these areas is considered significant, according to a single-factor analysis (p=0.002). In addition, the Necydalis major L beetle in the birch forests has also occurred in many pots. For example, 220 pcs of eggs from Ocneria dispar L, were counted in one pack, and the number of egg is like to rise in 2017).

Introduction

Hustai National Park is located at the border of Altanbulag, Argalant and Bayankhongor soums of Tuv province, approximately 115 km from Ulaanbaatar. Hustai National Park's forest is composed of 1138 ha from Bayankhongor soum, 211 ha from Argalant soum and 485 ha from Altanbulag soum. The total amount of forested area in Hustai mountain is 1834 ha. In the Hustai mountain range, the forest area is located only near the mountaintop due to the effect of steppe which surrounds forest area and most of the steppes are covered by steppe flora. Due to many factors, such as weather, dryness, mechanical damage and forest pests, the forest condition has dramatically changed and natural forest area has been reduced by 983 hectares, or 57.2 percent. Therefore, the purpose of the research work is focused on studying biological and ecological characteristics of dominant insects in forest ecosystem infestations, as well as their ecological grouping, distribution, outbreaks and impacts. This study will produce a scientifically based assessment and make conclusions to prevent and protect from further infestation and degradation.

Methods

Methodologies such as shaking the wood, checking fallen and cut wood, sweeping, and using traps were applied in this study to collect short-term prognostic data, such as the composition of the predominant insect species, the insect development stage, the damage caused by the insect, the size of the leaves and the size of the dried tree field. These findings led to specific recommendations to prevent and protect from further degradation from insect infestations.

Study areas

Birch forest and birch-European aspen forest populations in Hustai National Park were selected for the field study areas. Monitoring research was carried out 3 times during the vegetation period (May to September). We placed 13 traps in trees for a species inventory and collected 10 trap samples from July 20th, 2018 to August 20th, 2018.

Results

According to the research by N.Tsagaantsooj (2002) and Ch.Gantigmaa (2009), 384 species were recorded in forests in Mongolia; of which most were plants-eating insects. Tsagaantsoj and Gantigmaa's findings predict that the density of the *Epicauta dubia* F., *Deporaus betulae ,Orthoptera and Scarabaeidae* L. species are likely to increase over time. Researchers have not yet precisely defined the total forest insect population in

Mongolia and it is said that further study will be necessary to do so. As claimed by our survey in 2018, a total of 3417 individual insects of 37 species, belonging to 4 groups and 31 genres were collected. According to the details, 29 species from *Coleoptera*, 4 different moth species were collected.

Population diversity and Population richness

We used ACE index to estimate analysis of population structure and composition of the total insects trapped in birch forests and the Shannon index's "Estimate" program to evaluate population richness. The results showed the highest richness value in the 1st and 4th sites; with values between H=0.9 and 1.1. It can be seen that population diversity in the 10th, 3rd, and 5th sites were poorer than other sites. These differences were analyzed using a Variance analysis, which showed that the variations were statistically insignificant (p=0.0001). This illustrates that habitatsare independent of forest mensuration and characteristics.

Results of the ACE estimation showed that species richness value is highest in the 9th field, and then the 1st and 2nd sites are very widespread. But the 10th and 3rd plots have the least amount of species richness compared to other sites. The difference between these areas is considered significant, according to a single-factor analysis (p=0.002). In addition, the *Necydalis major* L beetle in the birch forests has also occurred in many pots. For example, 220 pcs of eggs from *Ocneria dispar* L, were counted in one pack, and the number of egg is like to rise in 2017).

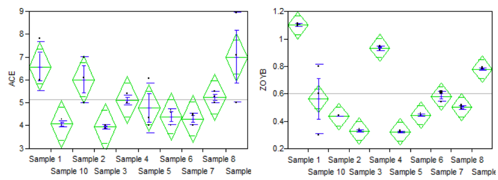

Figure.1 Population diversity and population richness

After comparing the insect population in the forest using cluster analysis between sample plots, it was clear that the 9th and 10th sites were closely related. In this area, dead organisms such as *Formicidae*, *Loxostege sticticalis*, *Thanasimus femoralis* Zelt, *Nicrophorus investigator* L and egg-eating insects have the same value of spread.

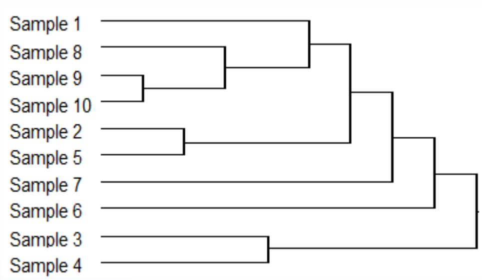

Figure 2. Population diversity of beetle

Table.2 *Number of eggs of Lymantria Dispar L in a packet*

Year	Samples	Average	Standard deviation	Standard error	Plausible values		P
					Max	Min	
2018	40	220.6	87.9	14.1	249.3	191.9	0.7

According to the table 1, the number of *Lymantria Dispar* L in a packet is likely to rise. The eggs of *Lymantria Dispar* L were raised in laboratory conditions and survival rate of the larva from each egg is clearly defined.

Of total 5 packets, or 1935 live eggs, 797 pieces, or 41.1%, of them are larvae and 1138 pieces or 58.8% of eggs have not been developed. In Hustai National Park, the larvae of butterflies are expected to be harmful for 3-4 years, so it is necessary to carry out detailed research on insects and carry out conservation measures.

Conclusions

- The tree-eating insects, such as *Cerambycidae, Buprestidae* and *Scolytidae,* have the advantage to survive in the habitat condition of a degraded forest.
- Around 40 species were found from our study in 2017 in Hustai National Park.
- The number of *Lymintria Dispar* L population is not declining and damaged areas are increasing; therefore it is necessary to increase studies on forest insects in 2018 and 2019.
- It is necessary to do sanitation and salvage cutting to provide ecosystem balance, and implement research works on increasing the number of insect-eating birds
- To establish monitoring and control station points to improve activities on forest protection determining insects' outbreaks.
- Furthermore, research and protection measures must be scientifically implemented to ensure whether the number of insects has increased, the magnitude and duration of the infestation, the reduction of the number of infestations, and determining number of insects that indicate outbreaks.

Acknowledgments

I would like to thank Dr. Gerelbaatar S. asst Professor, NUM and Dr. Battulga P. Researcher, IGG, MAS for their participation in the study who supported helped me get results of better quality. I am also grateful to Misha Goforth for English editing of this paper.

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Table1. Taxonomic rank of forest insects in Hustai National Park

Order	Family	Genus	Species	Individuals' number
Coleoptera	*Silphidae*	2	2	53
	Carabidae	2	4	12
	Cerambycidae	3	4	63
	Elateridae	4	5	6
	Cleiridae	2	2	5
	Curculionidae	2	2	2
	Scolytidae	1	1	2
	Buprestidae	2	2	11
	Tenebroiniidae	1	1	1
	Chrysomelidae	2	2	20
	Scarabaedae	2	2	7
	Meloidae	1	1	300
	Anobiidae	1	1	1
	Aradidae	1	1	7
Hemiptera	*Pentatomidae*	1	1	1420
Lepidoptera	*Lymantriidae*	1	1	230
	Noctuidae	2	2	6
	Erebidae	1	1	21
Hymenoptera	*Formicidae*	2	2	1250
Total		31	37	3417

Table.3 *Survival rate of Lymantria Dispar L*

No.	Number of eggs	Number of eggs without larvaes	Number of eggs without larvaes	**Survival rate (%)**
1	310	181	129	42%
2	560	204	356	64%
3	275	203	72	26%
4	140	135	5	4%
5	650	415	235	36%
	1935	1138	797	41%

SOME RESULTS OF THE STUDY ON GROUND WATER QUALITY IN GER DISTRICT AREA OF ULAANBAATAR CITY

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Abstract: Within the scope of the grant to the "Project of developing the recommendations for protecting the human health from the water pollutions, conducting the survey on the quality and the composition of water used for the drinking purposes in Ulaanbaatar city", we conducted such survey in 2016 and since that time, many boreholes that do not meet the quality requirements are closed and built the wells of Water Supply and Sewerage Authority. The wells connected to the WSSA, boreholes of the remote territories with the less population's centralization and 129 watery points of the areas other than the apartment housing districts were covered by this research. The chemical composition of the groundwater wells in the ger district included mostly subject to hydrocarbonate class, Ca group, water type 1-2. But type 3 is 32.15 % of the total well water samples, it was found that some of these wells have relatively high hardness. Results show that 7.2% have water with large mineralization and salty level which do not satisfy the quality requirements. For hardness, 22.6% or some 28 water points have hard and very hard level that exceeded the related standard. Regarding to bacteriological analysis, water is contaminated with total coliforms and thermotolerant coliforms. From this point, one-fourth of the wells in ger districts of Ulaanbaatar are inadequate for any indicator. The concentrations of metals and other toxic elements were below the standard level. Fifty four parameters have been selected for assessing the groundwater quality. In addition, total coliform and thermotolerant coliform bacteria the most common microbiological contaminant detected of tested wells.

Keywords: water quality, hardness, total coliform and thermotolerant coliform

Introduction

One of the main factors which influence a countries development is availability and access to clean and fresh water. Vital concerns worldwide are the issues of increasing fresh water resources, and protecting them from pollution, shortage, and aquatic ecosystem deterioration. Loss of environmental equilibrium is increasing in Mongolia due to unbalanced development of settlements, the inconsistent situation of investment policy, and over centralization in the capital city of Ulaanbaatar. Today 60% of the total population of Mongolia work and live in Ulaanbaatar city. Extensive migration into the city is increasing the size of Ger districts and the number of inhabitants. Of the total population of Ulaanbaatar, 62 percent live in the Ger districts, and 38 percent live in the apartment districts. The influence of anthropogenic impacts following this trend of urbanization is resulting in risks to groundwater quality. Particularly, primary groundwater features such as irrigation, movement, regime and water level is changing due to human impacts, especially due to build-

-ing construction. Furthermore, drinking water quality and natural groundwater composition is changing. This pollution of water may have adverse effects to human health. In the MDGs accepted by the Mongolian Government, the Government is obliged to double the population with sustainable access to an improved water source in both urban and rural areas. In order to fulfill this goal the National Action Plan on Water has started to be implemented. In the Ger districts, grey water discharge boreholes, pit latrines and solid waste previously haven't been under any regulation, resulting in soil and water quality not satisfying hygienic requirements. One of the main factors contributing to this is that people in the Ger districts have no experience or knowledge about protection of the environment, especially from contamination sources.

We have determined the qualities and pollutions of the groundwater that are used by ger district population in households not connected to the central network of the capital using the parameters of pollution by the chemicals, contamination of the micro-elements and microbiological analysis with the scientific basis and completed this work within the scope of the grant project for working out the instructions and recommendations on how to improve the watery points that do not meet the human health requirements.

Location of the study area

Figure 1. Location of study area and sites of groundwater samples collected for analytical analysis in 6 central districts, Ulaanbaatar city.

Methods and Materials

Groundwater samples for 129 locations were collected from wells from different parts of Ulaanbaatar district. Some of the more easily measured parameters were determined in-situ, due to the fact that some of those gases dissolve rapidly in water or organic substances. Field measurements were made for pH, TDS (total dissolved solids), EC (electrical conductivity), temperature, and Turbidity. Water quality parameters were determined by the following methods and analyzed in the water analysis laboratory of the Institute of Geography-Geoecology. Calcium (Ca^{2+}), magnesium (Mg^{2+}), total hardness (TH), hydrocarbonate (HCO_3^-) and chloride (Cl^-) were analyzed by volumetric titration method. Nitrate (NO_3^-), nitrite (NO_2^-), ammonia (NH_4^+) and sulphate (SO_4^{2-}) were analyzed by T60 U spectrophotometer and DR2800 spectrophotometer. The piper diagram were plotted based on the hydrochemical results to assess the quality controlling mechanism and dominated hydro-geochemical facies of the study area. ArcGIS software were used to represent the spatial distribution maps of physio-chemical parameters. The physio-chemical parameters analysed for groundwater were compared with water quality in the drinking water standard MNS 900:2018.

Photo 1. Field Research (March-April, 2019)

Water physico-chemical parameters (temperature, pH, conductivity and turbidity) were taken in situ at access points (Photo 1). When assessing the water quality, it's been compared to the Mongolian national drinking water standard "MNS 900:2018".

Table 1. Classification of natural water by its mineralization and hardness [Javzan Ch, 2011].

Mineralization		Hardness	
Level	g/l	Level	mg-eqv/l
Very fresh	< 0.20	Very soft	<1.50
Fresh	0.21-0.50	Soft	1.51-3.00
Fresh or relatively high mineralization	0.51-1.00	Slightly soft	3.01-5.00
Salty or high mineralization	1.01-3.00	Slightly hard	5.01-7.00
Salty or little bit bitter	3.01-7.00	Hard	7.01-9.00
Very salty or bitter	>7.01	Very hard	>9.01

The samples were analyzed according to standards approved by the modern method of water analysis stationary laboratory. Detailed analysis of water micro element was analyzed by the ICP 80T tool, in laboratory of SGS IMME Mongolia LLC. The results of the water quality study are compared with "Environment. health Protecting. Safety. Drinking water. Hygienically requirements, assessment of the quality and safety MNS 0900:2018" standard. Water microbiological measurements have been used by DelAgua portable incubators. MLSB environment / membrane lauryl sulfate broth/ have used to prepare the environment. The incubator has two types of separated cameras as a 37°C temperature of the total coliform and 44°C incubation of the thermos tolerant coliform for 16-18 hours and to describe the number in 100 ml of water [Karthe et al, 2017]. Total coliforms and thermotolerant coliforms must not be detectable in any 100 ml sample in Standard of Micro-organisms in other sources of drinking water MNS 900:2018. The drinking water standard requires that no coliform bacteria be present in drinking water (Table 2).

Table 2. Surface water hygiene Kirschner classification et al. (2009) [Karthe et al, 2017].

	Little	Moderate	Critical	Strong	Excessive
Total coliform	≤500	> 500 - 10'000	> 10'000 - 100'000	> 100'000 - 1'000'000	> 1'000'000
Thermo-tolerant coliform	≤100	> 100 - 1000	> 1000 - 10'000	> 10'000 - 100'000	> 100'000

Results

In the survey, 6 districts of the capital city with the high level of population's centralization were covered and the most of the khoroos are connected to the centralized network or wells of the WSSA and had the portable water reservoir. 31 groundwater wells of Songinokhairkhan district, 7 from the Bayangol district, 11 from the Chingeltei district, 11 from the Sukhbaatar district, 26 from the Bayanzurkh district and 43 groundwater wells in Khan-Uul district were covered by the survey and analysis. According to research, it represents that when going away far distance from the alluvial aquifers of river Tuul, the chemical composition change and occur the hard water layers and as for the chemical contents. It can be observed from our study that 40 groundwater wells in study area subject to hydrocarbonate Ca class and water type 3 shows that the hardness is high. Water can be classified based on the hardness and mineralization as follows (Table 3).

Table 3. Classification of mineralization and hardness of 129 groundwater wells participated in the survey.

			Hardness, mg-eqv/l		
Classification	Number of wells	Percentage %	Classification	Number of wells	Percentage %
Very fresh	14	10.85	Very soft	8	6.2
Fresh	70	54.26	Soft	16	12.4
Quasi-fresh	36	27.9	Slightly soft	54	41.86
Quasi-solty	8	6.2	Slightly hard	23	17.82
Salty	1	0.77	Hard	8	6.2
Very salty	-	-	Very hard	20	15.50
Total 129 wells		100.0	Total 129 wells		100.0

Figure 2 shows the iso-concentration for physio-chemical parameters analysed using inverse distance weight (IDW) interpolation in a GIS environment. The highest concentrations are noticed at the Khan-Uul and Songinokhairkhay district. Total hardness (TH) is found highest for the all three districts (Figure 3).

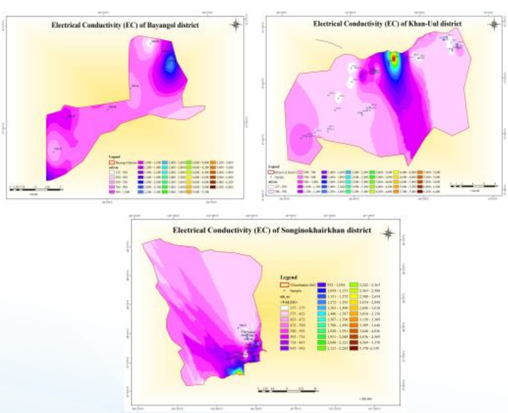

Figure 2. Spatial distribution map of EC (μS/cm) in the groundwater of districts.

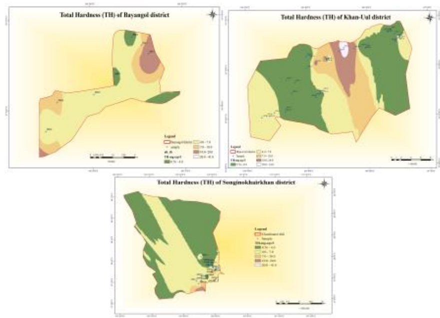

Figure 3. Spatial distribution map of TH (in mg-eqv/l) in the groundwater of districts.

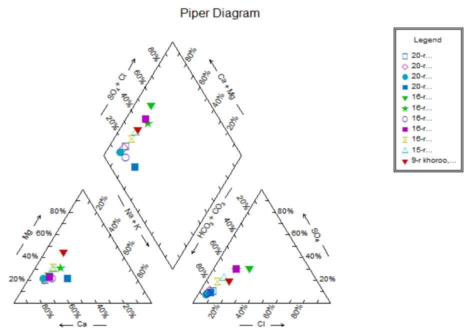

Figure 4. Piper diagram of the groundwater samples of Chingeltei district.

The groundwater samples were plotted in Piper diagram using Rock Ware Aq.QA software. The pie diagram of the average values of major ions (Fig 7) shows that the abundance of the major ions in groundwater is found in the following order: $Ca^{2+}>Mg^{2+}>Na^{+}+K^{+}$ and $HCO_3^{-}>Cl^{-}>SO_4^{2-}$. It is noticed that Ca^{2+} and HCO_3^{-} are the dominant cation and anion (Figure 4).

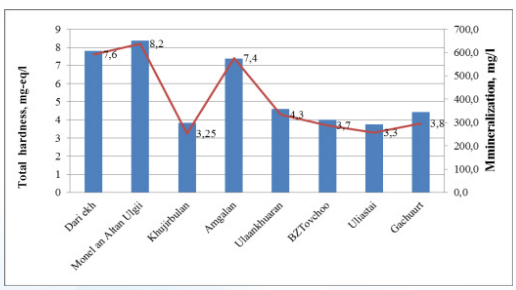

Figure 5. The water mineralization and hardness of Bayanzurkh district.

From the results of the eastern part of the district, mineralization of well water sampled near the Khujirbulan, Uliastai, Bayanzurkhiin tovchoo and Gachuurt area have relatively fresh (292.2-442.4mg/l), Monel, Altan-Ulgii sample site had relatively high mineralization (500.8-852.0 mg/l). Generally, the mineralization of the Ulaanhuaran, Dari-Ekh and Amgalan water is fresh to relatively high mineralization (249.5 -875.0 mg/l).

The amount of hardness of groundwater in area Amgalan, Monel, Altan-Ulgii, and Dari-Ekh were higher than drinking water standard (7.1-12.7mg-eq/l), the hardness of well water sampled near the Ulaanhuaran was hard (6.4mg-eq/l), and other parts of the well water is soft to softish (2.1-3.8 мг-экв/л) (Figure 5).

Figure 6 shows the average data of the bacteria counts for each well sample after analyses. Of the 129 wells sampled, 16 samples of groundwater examined contain bacteria especially, total coliform and thermotolerant coliforms. The count for total coliform ranges from 1 to 11 in wells. From the above results it is obvious that the groundwater at studied area contains microbiological organisms that can be very injurious to human beings and endanger general public health if consumed or used for domestic purposes without scientific treatment.

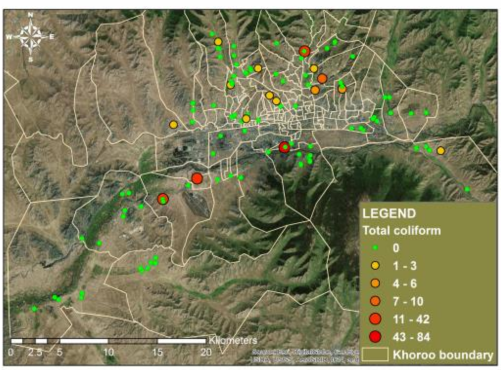

Figure 6. Microbiological data for ground well water from 6 central districts.

Conclusion

By the survey conducted in 2013, it was revealed that the most of the watery points that haven't met the applicable water quality standards were closed and had the wells of WSSA and this situation has created the possibility to permanently control and inspect the water quality and resulted to improve the conditions.

According to the survey of 2019, it is concluded that many groundwater wells are newly created in ger districts of Ulaanbaatar city and 18% of the total samples covered by the survey have slightly hard, 6% of them have hard and 16% of them have very hard and this situation shows that it can negatively influence the population's health.

All analyzed samples show certain level of pollution parameters and at the result of the bacteriological analysis, water is contaminated with total coliforms in the 16 groundwater at the certain level has the basis to have relations with the soil pollutions and pit latrine in ger districts. The owners of the boreholes are required to pay attention to the sanitations of surrounding areas and set the hygiene zone.

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THE IMPACT OF THE CLIMATE CHANGE OF THE SEED RESOURCES

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Abstract: Mongolia is located at the central part of Eurasia, landlocked, located far from oceans, surrounded by high mountain ranges with average altitude is 1500 m a.s.l. and due to these specific conditions, Mongolia has extreme terrestrial, harsh climate. Main peculiarities of Mongolian climate is the large seasonal and diurnal fluctuations, especially of the air temperature, less precipitation and strong effects of altitude and latitude. Dry and short summer continues June-August, cold winter continues November-April, and the duration of fall and spring season fluctuates year to year.

Total amount of the precipitation is less and the amount of precipitation differs by regions and are not same due to location of mountains and altitude. For instance, regions of Khangai, Khuvsgul, and Khentii has biggest rivers along these mountain ranges amount of annual precipitation varies between 250-390 mm, in Altai mountain range varies 90-130 mm and steppe and plain areas accounts as180-280 mm.The amount of precipitation decreases as southward and the smallest amount of precipitation (70-150 mm) accounts for Gobi desert region (Division of Climate change and resource of Institute of Meteorology, Environment and Hydrology, 2017). This extreme climate condition of Mongolia shows large impacts on the flowering, seed ripening, and seed yields of woody plants.

Keywords: seed stands, larch, pine, seed, germination, weight of 1000 seeds

Introduction

A total forest resource in Mongolia is estimated to 1245.4 million.m3 and which includes larch (78.5%), Scotch pine (4.9%), pine Siberian cedar (9.4%), spruce (0.23%), fir (0.02%), birch (6.17%), aspen (0.18%), poplar (0.05%), elm (0.007%), willow (0.27%), populous diversifolia (0.002%) and Saxaul (0.14%) forests (MNE, 2017).

Forest resources in Mongolia have been continuously degraded over the past few years due to improper exploitation for timber and fuel wood, forest and step fires (Tsogtbaatar, 2004), insects/pests and diseases, mining, uncontrolled grazing, and inadequate management. During last decades, Mongolia lost approximately 4 million ha of forests, averaging to 40 000 ha annually. But between 1990 and 2000, the rate of deforestation has increased to 60,000 ha/year. As a result of ongoing loss and degradation, only 13 million ha of closed canopy forests remained in relatively remote area. Much of the other 5.3 million ha of forests are fragmented and degraded (World Bank, 2002) Reforestation activity in Mongolia has been started since 1968. During 1980 to 2000, reforestation was carried out in 72.132 ha areas, 50% of which was replanted by seedlings. Although some positive results have been shown, fires, disease infection and grazing by the livestock have caused damage to some of the planted areas. Up to year 2002, an area of about 98,000 ha has been reforested (MNE, 2000, 2002, 2006). Reforestation success was very low, and survival rate of planted seedlings ranged from 30 to 60% (seldom reaching 50%). Consequently, the total area that has been successfully replanted represented only 5% of the total forest lost, mostly due to low survival rates of the seedlings (World Bank, 2002).

Success of plantation and reforestation depends on many factors, including seed and seedling quality, site-species compatibility, and appropriate silvicultural practices (Udval., Batkhuu, 2013). Seed quality plays a major role in the production of high quality plants. Many factors, climate, both biological and environmental, influence the quality of seed produced by a given tree under natural conditions.

The main objectives of this study are 1) to determine seed quality of diverse seed stands, 2) to study climate impact on seed yield and seed quality.

Study area and data sources

The locations of fourteen different populations of *P. sylvestris* in the three northern provinces namely, Khentii, Khuvsgul, and Selenge, Mongolia listed in Table 1. Four popuations from Khentii, 8 populations from Selenge, one population from Khuvsgul provinces were selected for this study.

Methodology

Methodology developed by N. P. Anuchin (2004) is used for the establishment of sample plots and measurements of tree growth parameters.

Collection of cones was carried out at the of March, 2018. Thirty (30) representative trees of the approximately with same age from the natural populations of *P. sylvestris* were subjected to cone collection and selected trees were located minimum 50 m apart and thirty cones with three replications were collected per individual tree (in total 900 cones). The variation in cone, seed and seed quality characteristics were measured.

Laboratory tests of seed quality were conducted by the International Rules for seed Testing (ISTA, 1999). Seeds were examined for their qualities by purity, weight of 1000 seeds, germination test. Laboratory tests of seed traits were conducted by the Seed Testing Laboratory of the Ministry of Nature and Environment of Mongolia.

The parameters were analyzed by One-way analysis of variance (ANOVA) followed by Duncan's multiple range test.

Results and discussion

Results of studies conducted in Khuvsgul, Khentii and Selenge aimags where we are evaluated of seed yield and forecasting using classification by A.A.Korchagin. The results showed that the Siberian larch forests scored 0, which means they didn't have seed yield for 2017 growing season. Multiple factors affect seed yield, including, climatatic condition during flowering, pollination, seed ripening, moisture condition of the vegetation period, soil fertility, age of the trees, and growth condition of the stand etc.

Table 2. Evaluation of seed yield for the Scots pine (Pinus sylvestris L) seed stand

№	Province	Tree species	Seed yield score
1	Selenge province	*Pinus sylvesris* L.	3/medium
2	Khentii province	*Pinus sylvesris* L.	2/low
3	Khovsgol province	*Pinus sylvesris* L.	2/low

Evaluation results of seed yields for Scotch pine seed stands shows seed yield score between 2 and 3, which means expecting medium amount of seed yield for 2017. In the Scotch pine plantations, trees have lagged growth, high loss of biomass in the crown, and loss of needles due to lack of silvicultural treatment activities. Also trees have reached the age to produce flowers, pollinate and produce seeds, however no seed production is observed. One-way-factoral analysis of variance (ANOVA) was carried out to test seed yield in the

Table 1. Description of populations used in this study

№	Provinces	Soum name	Population name	Latitude	Longitude	Altitude, m
1	Khentii	Binder	Uvur-huurt	N48^{0}38’18.0”	E110^0 25’ 33,7”	1198
2	Khentii	Binder	Yangiin Ar	N48^{0}38’41.5”	E110^0 28’ 38,0”	1084
3	Khentii	Dadal	Shanagan tolgoi	N48^{0}57'14.6"	E111^0 37' 04,0"	1064
4	Khentii	Norovlin	Dev nars	N48^{0}44’09.9”	E111^0 30’ 08,6”	957
5	Selenge	Selenge	Gun nuur	N50^{0}15'36.5"	N106^{0}38'11"	671
6	Selenge	Selenge	Togos uul	N50^{0}03'12.6"	E106^{0}35'06.5"	773
7	Selenge	Javhkhlant	Yargait	N49.41	106.41	706
8	Selenge	Bugant	Ikh ulunt	N49^{0}25'17.0"	E107^{0}20'44.7"	882
9	Selenge	Altanbulag	Tsaram	N50^{0}05'69.5"	E106^{0}05'69.5"	761
10	Selenge	Selenge	Khuder	N49^{0}46'28.3"	E107^{0}13'57.9"	893
11	Selenge	Shariin gol	Monostoi			
12	Selenge	Khond	Mukhar Dukhum	N50^{0}11'17.2"	E106^{0}37'30.2"	701
13	Khuvsgul	Khuvsgul	Tsagaan nuur			

Table 3. ANOVA for seed morphological characteristics of studied provinces of *P. sylvestris* (n=900)

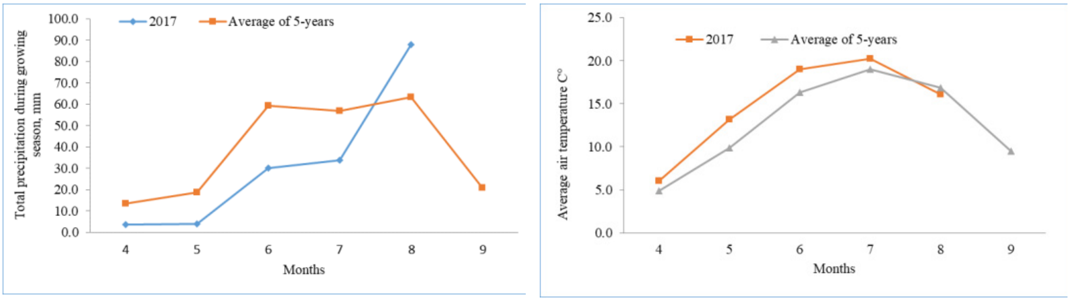
Source	DF	*SL*, mm	*SW*, mm	*SWL*, mm	*SWW*, mm	*SWA*,
Province	2	5.86**	0.72ns	18.22***	87.38***	44.24***
Seed stands	12	3.16***	1.15ns	22.22***	23.94***	27.42***

Table 4. ANOVA for seed morphological characteristics of studied populations of *P. sylvestris* (n=900)

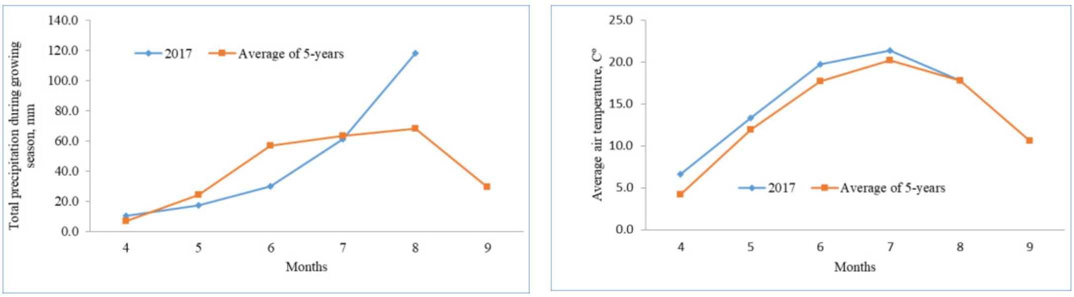
Province	SL, мм	SW, мм	SWL, мм	SWW, мм	SWA,	Rank
Khentii	4.57a	2.58b	14.56a	5.38b	79.06a	II
Selenge	4.61a	2.76a	14.57a	5.64a	82.51a	I
Khovsgol	3.98b	2.34c	11.96b	4.62c	55.97b	III

Table 5. Seed quality

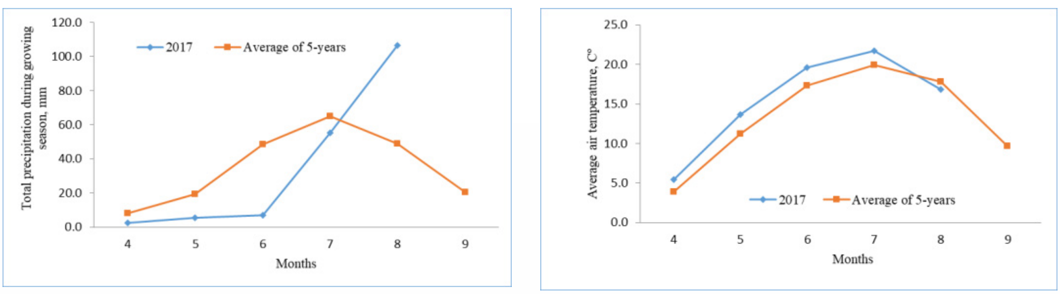
No	Provinces	Population	Seed germination energy, %	Seed germination capacity, %	1000-seed weight, gr	Seed quality category
1	Khentii, Binder	Ovor khuurt	74.0	74.8	5.2	III
2	Khentii, Binder	Yangiin ar	80.8	81.0	5.4	II
3	Khentii, Dadal	Shanagan tolgoi	50.5	51.0	5.3	NS
6	Khentii, Norovlin	Dev nars	66.3	69.0	6.2	III
4	Selenge, Altanbulag	Gun nuur	78.5	79.8	6.9	III
5	Selenge, Altanbulag	Togos uul	76.3	76.5	7.1	III
8	Selenge, Altanbulag	Yrgait	-	-	-	-
9	Selenge Bugant	Ikh Olont	70.5	71.5	5.6	III
11	Selenge, Altanbulag	Tsaram	69.0	70.0	6.1	III
12	Selenge, Khuder	Dohom	57.8	59.5	4.6	NS
13	Selenge, Shariin gol	Monostoi	74.8	78.3	6.6	III
14	Selenge, Khond	Mukhar tohom	54.0	55.5	5.7	NS
15	Khovosgol, Tsagaan Uur	Ongonii nars	-	-	-	
Average			**68.41**	**69.65**	**5.88**	



Graphic 1. According to data of 2017 provided by Murun meteorological station in Khuvsgul aimag, total precipitation during vegetation period has reduced by 15mm in May, and29.3 mm in June, and average air temperature increased by3.3^{0}in May, and 2.7^0 in June.



Graphic 2. According to data for 2017 provided by Sukhbaatar meteorological station in Selenge aimag, total precipitation during vegetation period has reduced by 7.3mm in May, and26.9 mm in June, and average air temperature increased by1.4^{0}in May, and 2.0^0 in June.



Graphic 3. According to data for 2017 provided by Undurhaan meteorological station in Khentii aimag, total precipitation during vegetation period has reduced by 13.7 mm in May, and 41.6 mm in June, and average air temperature increased by 2.4^{0}in May, and 2.3^0 in June.

*Source: Agency of meteorology and environmental monitorin

stands, and it showed statistically significant (*p=0.001*) different seed yield amongst the stands.

Seed morphological characteristics

Seed morphological traits such as seed length (*SL*), seed width (*SW*), seed wing length (*SWL*), seed wing width (*SWW*), and seed wing area (*SWA*) among provinces and populations.

The average seed length and seed width were 4.54±0.04 mm, 2.86±0.19 mm, longer seeds (4.61±0.02 mm) was observed in from Khentii province, while shorter seeds (3.98±0.04 mm) were originated from Khuvsgul province. In case of variation at the population level, Dadal-Shanagan population had longer seeds (5.01±0.51 mm) and population of Javhglant-Yargait had wider seeds (2.91±0.04 mm), while shorter and narrow cones (3.98±0.04 mm and 2.34±0.02 mm) were originated from Tagaan-Uul population, Khuvsgul province.

Seed germination characteristics

Seed quality testing, including germination energy (*GE*, %), germination capacity (GC, %), and 1000-seed weight was examined by the State Forest Seed Testing Laboratory, Ministry of Environment and Tourism, Mongolia and Laboratory of Forest Genetics and Ecophysiology, National University of Mongolia.

The overall mean germination capacity (*GE*) and germination energy (*GC*) were 68% (varied from 20% to 81%) and 69% (varied from 51% to 81%), respectively. Highest germination value was shown by population Yangiin Ar, Khentii province (*GE*=80.8% and GC=81%). Whereas lowest germination value (*GE*=50.5% and GC=51%0) was revealed by population Dadal-Shanagan tolgoi. The mean weight of 1,000 seeds was 5.88 g (Figure 14). The heaviest seed (7.1 g) was found in population Togos Uul, Selenge prvince and the lightest one (4.6 g) was in population Khuder, same from Selenge province.

Total precipitation and air temperature during of 2017 vegetation period of three provinces were compared to 5-year annual average values and comparative results showed that air temperature was higher and precipitation was lower and occurred drought in springs season in 2017 compared to multi-year average (Graphics 1-3). During late May and early June when Siberian larch produces flowers, the precipitation was low and air temperature was high, therefore, due to dry condition Siberian larch trees did not yield seeds for 2017 in all provinces.

Research results on flowering and production of seeds Scotch pine shows that maximum production of flowering occurs in 30 days starting from late May through early June, and seeds ripen after 18 months starting in late February and early March of the following year (Bazarsad, 1996; Udval, 2014). Evaluation of seed yield forecasting and evaluation of seed crop was conducted in each provinces and shown in the following Table 5.

Conclusion

1. There is a strong correlation between weather condition at given year and flowering, germinating process of pine seed. According to the study findings, high altitude temperature and lower annual precipitation than the long-term average in the study field have had negative influence on seed yield.
2. We observed slow decreasing tendency of seed quality indicators, growth process and the mean weight of 1000 seeds due to climate change and other environmental factors.

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THE TERRITORIAL ORGANIZATION OF ECOLOGICAL TOURISM SERVICES: AN EXAMPLE OF HUSTAIN NURUU NATIONAL PARK

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Abstract: The article considers ecological tourism as a combination of complementary models of recreational resource use, such as tourism in specially protected natural territories, cultural and rural tourism. The aim of the work was to study the territorial organization of ecological tourism services using the example of the National Park Hustay Nuruu (Mongolia). The main types of ecological tourism services were identified, and we reflect on the problem of balancing the environmental, tourist and economic functions of the territory.

Keywords: ecological tourism; ecological tourism services; Mongolia; specially protected natural territories; territorial organization of tourism

Introduction

The active involvement of specially protected natural areas (SPNA) in tourism is associated with the solution to a wide range of problems. The search for a balance of environmental, economic and social priorities determines the need for new management technologies and the introduction of eco-tourism models to SPNA, which allow them to implement their environmental and recreational functions. The Hustain-Nuruu National Park in Mongolia is considered as one of successful example of this approach.

The aim of this work was to study the territorial organization of ecological tourism services on the example of a specially protected natural area located in the adjacent regions of Russia and Mongolia (Evstropyeva, 2008). The formation of a cross-border tourist and recreational space between Mongolia and the Baikal region became the basis for analyzing the development of ecological tourism (Enkhtaivan & Evstropyeva, 2015). For this purpose, the identification of the main types of ecological tourism services offered to visitors of the national park has been carried out, and a list has been compiled. Also, a general description of the proposed services of ecotourism is given, which includes their territorial confinement, availability of infrastructure base, volumes by the number of persons served, and cost (Sarancha, 2011).

The primary task of the study was to record the interactions between the territories where the services are implemented and where they are directly provided, taking into account their environmental and tourist functions. For this, the main participants were identified who provide certain services at different stages of the journey from Ulaanbaatar to the national park, and an analysis of the interactions between them was carried out.

The most important part of this kind of research should be an assessment of the position of ecotourism services in the budget structure of the model area, as well as the relationship between the environmental effect and the economic benefits obtained (Perelet, 2015). However, information of a commercial nature, as a rule, remains fully or partially closed and does not allow us to draw reliable conclusions about the effectiveness of market mechanisms implemented in the protected areas.

Brief description of the study area

Hustain Nuruu National Park (Birch Mountains) is located 93 km west of the capital of Mongolia, UlaanBaatar. It occupies 506 km ², covered with forest-steppe landscapes. More than 450 species of vascular plants and 46 species of mammals live here. The Park was founded in 1993, and in 2002 was included in the network of UNESCO biosphere reserves (Namhai & Adiya, 2010). In 2003, the Mongolian Government delegated the management of the national park to a non-governmental organization (Hustai National Park Trust). The main task of the park is to recreate the Przhevalsky horse population, as well as to protect forest-steppe landscapes and historical and archaeological sites. In addition, Hustain Nuruu National Park is active in environmental education and research. One of the most important activities is the development of ecological tourism (Myagmarsuren, 2000).

The territory of the national park includes the following functional areas: central, limited use and tourist. A buffer zone is also adjacent to the park's boundary, the main function of which is the preservation and development of traditional forms of farming (nomadic cattle breeding). In the immediate vicinity of the park is a unique, natural tourist attraction, the sand dunes of Moltsog Els, where an environmental monitoring platform functions. Hustain Nuruu National Park gained its fame thanks to the international project on the reintroduction of Przhevalsky's horse (Mong. Tachi). This unique animal has become the main object of attracting tourists and a symbol of the park. In addition, there are archaeological objects on the territory, including a deer stone, a cult-memorial complex of ancient Turks and the ruins of a Buddhist temple.

Results

The number of tourists annually visiting the Hustay Nuruu NP, currently reaches 15,000people. Of these, 2/3 are foreigners. Tourist center gear-camp, located at the entrance to the park, can simultaneously accommodate up to 100 people in the summer and up to 40 in the winter. In addition, 25 places are available in the Moilt Camp located in the depths of the park (several wooden houses for summer accommodation of students and researchers, as well as local holidaymakers).

The national park actively involves the local population living in the buffer zone in the development of tourism. The families of herders provide accommodation for tourists. Visitors get acquainted with national traditions, cuisine, and lifestyle of modern nomads. In addition, households are suppliers of local food, souvenirs, and leather and wool products, which are sold to visitors in the national park. For example, according to information provided in the park's information and visiting center, in 2013 ten such families were involved in tourist services. They provided tourists with accommodation in yurts and food with traditional products of their own household. One of these families received 325 tourists over the summer.

During the research, it was revealed that each of the functional zones of the park is characterized by different intensity of tourist use. Thus, the greatest recreational load falls on the tourist zone, where the main infrastructure facilities are concentrated (yurt camp, restaurant, museum, business information center, etc.). Visitors are here around the clock and can get a full range of tourist services. Regular tourist load also falls on the buffer zone, where horseback excursions and walks are carried out, as well as interaction with the local nomadic population (10 families) participating in the service. The daily migration of the Przhevalsky horses pass through the central zone. Tourist groups visit it sporadically as part of small excursion groups. For this purpose, equestrian and hiking routes have been developed, passing mainly along the border between the tourist and the central zone and including visits to animal observation sites. Ring route through the park can be done in an SUV. Two sections of the restricted use zone (located in the north and south of the park) are difficult to access, thus economic and tourist activities are limited here (Sobolev & Evstropyeva, 2016). Table 1 presents a list of basic ecological tourism services and tourist facilities of the national park, taking into account its functional zoning and travel stages.

The table shows that most of the tourist infrastructure facilities are located in the tourist zone of the park, as well as at the starting point of the route - the city of Ulaanbaatar. The tourist zone of the national park has several functions: accommodation and meals, information and education. The buffer zone functions as a zone of close walks and excursions, partly - accommodation and food, which ensures tourist flow outside the park. The central zone combines the main environmental protection function with the tourist and scientific-educational. The predominant function of the restricted-use zone is the preservation of intact landscapes and habitats of wild animals. The city, being at a considerable distance from the national park, is mainly an informational function. It is connected to the national park transit zone - a 90-kilometer corridor with points of intermediate stops, including trade, catering, as well as attractions.

The most important condition for the successful functioning of the system of ecological tourism services is the interaction between all its participants. The cycle of tourist services associated with visiting the National Park Hustayn-Nuruu, is based on the interaction of consumers (foreign tourists and urban population going on vacation), suppliers (tourist information centers and tourist companies), responsible users of the territory and resources (national park and local population) (Aleksandrova, 2014).

Primary information about the park, which is necessary for tourists, is available at the office of the tourist information center of Ulan Bator. Services for organizing tours (interaction between service providers and their consumers) occurs both in the urbanized zone and in the park in the tourism zone: a tour ticket can be purchased in the commercial information center of the city and several travel companies offer accommodation, catering, and sightseeing A tour of the park is offered directly on-site. In turn, the information center of the national park provides all the necessary information about the environment, history and sights of the territory. The local population provides accommodation and food services and does so with active interaction with the national park, and the national park, in turn, offers visitors information about the possibility of taking advantage of accommodation in family yurts. Thus, the national park and the local population combine the functions of users responsible for the preservation of the ecological and recreational properties of the territory and the suppliers that receive economic benefits from tourist activities.

The study identified possible and real problems (conflict situations) related to the need to combine the main functions of the protected natural area — environmental, tourist and economic (Sobolev & Evstropyeva, 2016). The most important of them are presented in table 2.

Conclusion

The results of the study allow us to identify the following patterns of the territorial organization of ecological tourism services in the National Park of Khustay Nuruu:

1 - The functions of the territories, both recreational and related to their economic use and the established nature protection regime, determine the set of infrastructure elements and services of ecological tourism;

Table 1. The relationship of tourist facilities and services, taking into account the functions of territories.

Services and objects	City	Transit territory	NP Tourist area	NP Central zone (strict conservation)	NP Restricted area	NP Buffer zone	Moltsog Els Sand Dunes
			Informational, organizational				
Tourist Information Centers	+	-	+	-	-	-	-
Travel companies and excursion bureaus	+	-	-	-	-	-	-
			Accommodation				
Family gears	-	-	-	-	-	+	-
Gear-camps	-	+	+	-	-	+	-
Recreation and accommodation researchers	-	-	-	+	-	+	-
Hotels	+	-	-	-	-	-	-
			Cognitive,environmental education, scientific				
Przhevalsky Horse Research Center	-	-	-	+	-	-	-
Monitoring area	-	-	-	+	-	-	+
Park Museum	-	-	+	-	-	-	-
Conference hall	-	-	+	-	-	-	-
			Transport				
Ecological trails (foot and horse)	-	-	+	+	+	+	-
Roads	+	+	+	-	+	+	-
Information signs (street navigation)	-	+	+	+	+	+	+
Public transport	+	-	-	-	-	-	-
Hiring motor and horse transport	+	-	+	-	-	+	-
			Guided Tours				
Przewalski's horse	-	-	-	+	+	-	
Forest-steppe landscapes and wildlife	-	+	+	+	+	+	+
Historical and archaeological monuments	-	-	+	-	-	+	-
Other attractions	+	+	+	+	+	+	+
			Trade and public catering				
Souvenir shops	+	+	+	-	-	-	-
Restaurants and cafes	+	+	+	-	-	-	-
			Maintain the park's ecosystem				
Park office	-	-	+	-	-	-	-

Table 2. Contradictions of combining the functions of the territory Hustay Nuruu National Park

	Problems	Decisions	Difficulties
1.	Hybridization of Przhevalsky's horses with a Mongolian horse	The ban on grazing local herds in the park, moving the camps of local pastoralists for a geographical barrier (river)	- the interest of local pastoralists in improving the livestock of domestic horses - intervention in the lifestyle of the local population
2.	Destruction of vegetation cover and soil erosion at archaeological sites	Creation of artificial obstacles, reclamation	- good transport accessibility of archaeological sites - uncontrollable behavior of amateur visitors
3.	Noise impact of vehicles on the animal population of the national park	Creation of a car route equipped with information signs	- free movement of autotourists in places that do not have natural obstacles

2 - The success of the functioning of the system of ecological tourism services depends on a set of interrelationships between the territories carrying specific tourist functions and between all participants of the tourist market, including tour organizers (tour operators), providers of individual services, responsible land and resource users, local people and by consumers;

3 - Violation of the relationship between any of the listed elements leads to functional disruptions, including conflicts between the local population, tourists and tour organizers, excessive recreational loads and degradation of natural systems, low economic efficiency of the system.

National Park Hustain-Nuruu has a full cycle of tourist services, to some extent combined with the main environmental functions. It should be noted that the park was one of the first in Mongolia to develop the goal of ecological tourism in cooperation with a public organization specializing in the field of nature and the environment. Hustain Nuruu is located in the basin of Lake Baikal. In this regard, the positive experience of forming systems of services for eco-tourism can be applied to the conditions of the Baikal natural territory.

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THE STUDY ON FOREST INSECTS OF PLANTED TREES IN THE STEPPE ZONE

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Abstract: The insects live on the ground surface of dry, arid Gobi and desert were collected by using the *pitfall* method. When we collected the samplings of insects from the greenhouse and reforestation sites in Lun soum, Central province and Dalanzadgad soum, South Gobi province, we walked 100 steps along the transect holding hand net with diameter of 30sm and collected the insects in sets of three 100-sweep samples. In total 67 species of 7 orders and 25 families were identified/discovered from the greenhouse, tree nursery site and reforestation site located in Lun soum, Central Province. In terms of statistics, from the Year 2010 to 2016, the number of individuals of the species was F=15.1, P=0.0001 in Lun soum, Central province; and the total number of each year was different. We detected species *Cherysomelpopuli L* (*Coleoptera*),from the replanted aspen, species *Epicauta sibirica Pall*, *Mylabris specioso Pall*(*Coleoptera*), from the caragana, *Lytta caragana Pall*(*Coleoptera*) from the *Caragana arborescens*, and *Lymantri dispar*, *Cerura felina Bulter*,1877, *Paranthere tabaniformis Rottemburg*, 1775 (*Lepidoptera*) from the aspen in the reforestation site of Lun soum, Central Province for causing damage. The insects of greenhouse and tree nursery site create the same group in terms of similarities while the insects of reforestation site and greenhouse create the different group in terms of similarities in Lun soum, Central province.

Keywords: Greenhouse, reforestation site, tree nursery site, number of species, number of individuals

Introduction

The insects which have spread in arid desert and steppe zone dominate in terms of role and significance of industry for the biocoenosis. In particular, beetles, a group of insects that form the order Coleoptera, have naturally adapted to dry steppe, Gobi desert more than other places. The indicators, for instance, composition of insect species, species abundance, distribution and other indexes that are common in biotopes with various types of soils and vegetation can be used as indicators (Tsendsuren and others, 1980). Among all the animals, the insects damage the plants most by eating their roots of pasture plants and other plants, decrease the amount of annual harvest significantly. Particularly, it has been proven that insects damage more because the insects feed on the juicy roots in dry and arid zone (Giliarov, 1959). The insects live very actively, for example, make a friction with the hard part of the soil, dig the outside layer of the soil and scuffle when they dwell and chase after their prey on account of most hard-winged insects and their larvae which live in the soil are bigger than the gap and hole created between piece of soil.

These factors influence the air content of soil, humidity of soil and natural production of compost to some extent and number of insects directly relies on the mechanical structure of the soil and physical properties as well (Dorj, 1997). Adequate number of in-depth researches on arid desert and steppe zone where have been degraded environmentally were not carried out yet, in particular, ecological features and playing roles of insects belong to the order Coleoptera are required to be studied in detail. Therefore, we are conducting our research which aims to conduct a research on widely spread insects in planted trees and shrubs in “Green Belt” project area, arid desert and steppe zone; and develop insect species composition, distribution, insect species abundance, species diversity; and plan preventive measures aimed at avoiding from the harm of insects and conduct bio-ecological research of specific species of pest insects.

Research methodology and used material

Field research. The insects live on the ground surface of dry, arid Gobi and desert were collected by using the ***pitfall*** method. The traps were put in every 5metres along the transects covering a total of 60m square. The trap is considered as the simplest way to catch some insect species which live on the ground surface.

When we collected the samplings of insects from the greenhouse and reforestation sites in Lun soum, Central province and Dalanzadgad soum, South Gobi province, we walked 100 steps along the transect holding hand net with diameter of 30sm and collected the insects in sets of three 100-sweep samples.

Material processing

We have used ESTIMATE S 7.52 program developed by Colwell and JUMP in 5.1, MYSTAT 12 programs when we determined the insect species diversity, ratio between dominant species, species abundance, habitat or similarities of biotopes and so forth. Moreover, other statistical methods were adopted (Ch. Awdai, D.Enkhtuya, 2000).

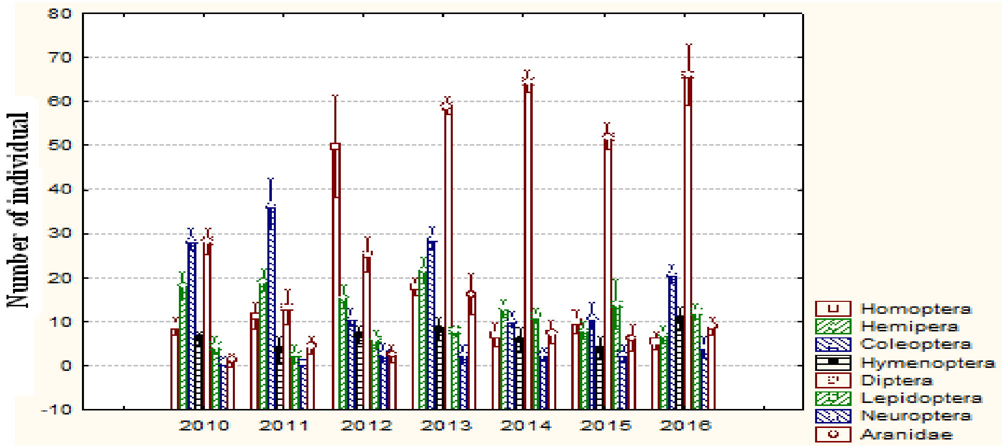
Results

Of the 7 orders, 25 families, with 67 species of insects were identified and registered from the reforestation site in Lun soum, Central province during the 6-year period from 2010 to 2016. The number of individuals of the species, distribution and methods were shown respectively in Graphic 1.

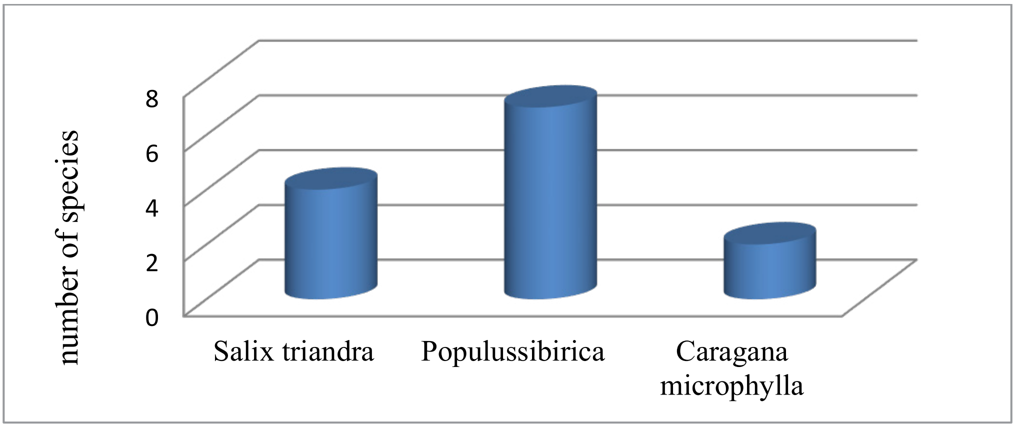
In terms of statistics, from the Year 2010 to 2016, the number of individuals of the species was F=15.1, P=0.0001 and the total number of each year was different based on the Graphic 1. The abundance of insects in reforestation site was high in 2010-2011 and 2014-2015 while the total number was constant in greenhouse and tree nursery site.

From the list of insect species discovered in the reforestation site we have recorded 1 species from the order *(Hemiptera),* 4 species from the order *(Coleoptera),* 5 species from the order *(Lepidoptera)* for harming.

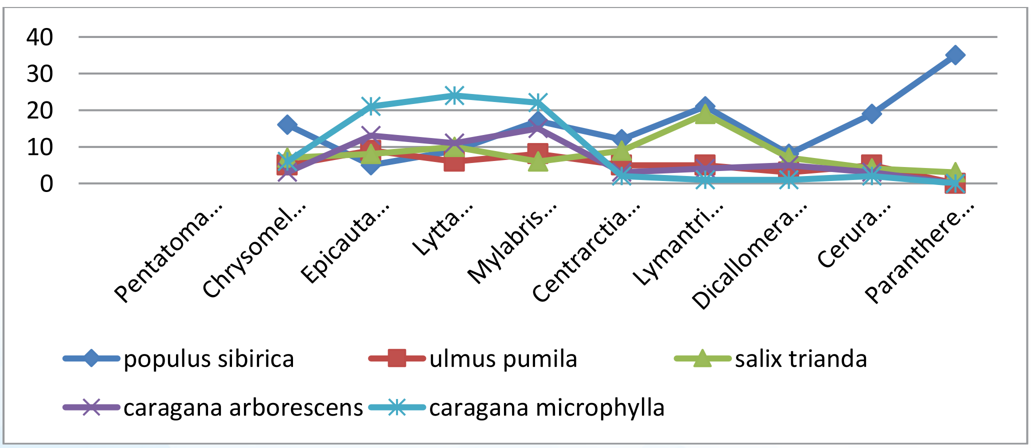
Number of species after counting the replanted trees of the reforestation site was shown in Graphic 2. During the research, we detected 7 species of harmful insects from the replanted aspen (*Populussibirca*), 4 species from willow (*Salix triandra*) and 2 species from garagana (*Caraganamicrophylla*) by geminate number. The number and activation of those insects for each replanted tree in the reforestation site were recorded in Graphic 3. The both activation and number of the harmful insects were high in replanted aspen. During the research, we detected species *Cherysomelpopuli L* (*Coleoptera)from the replanted aspen, species Epicauta sibirica Pall, Mylabris specioso Pall*(*Coleoptera)*



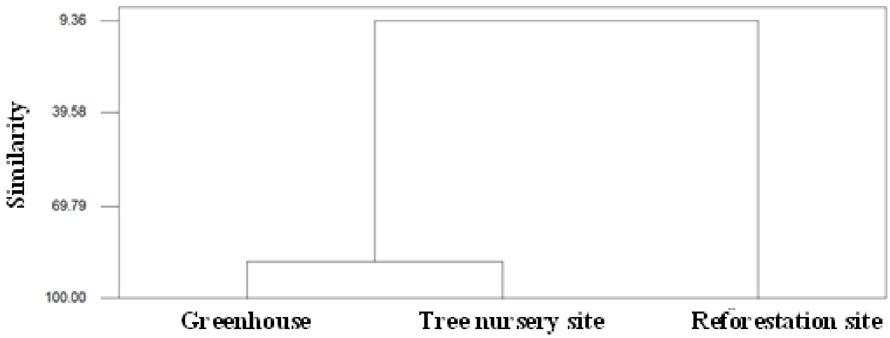
Graphic 1. The number of individuals of the species (From the Year 2010-2016)



Graphic 2. Species of harmful insects found in the replanted trees of the reforestation site



Graphic 3. Number and activation of insects for each trees of reforestation site.



Graphic 4. Similarities of insects in 3 different places, Central province

from the caragana, Lytta caragana Pall(*Coleoptera) from thethe Caragana arborescens, and Lymantri dispar, Cerura felina Bulter,1877,Paranthere tabaniformis Rottemburg, 1775 (Lepidoptera)* from the aspen for causing damage. Graphic 4 illustrates the similarities of insects for each 4 places. According to the similarities of the insect, we have identified that the insects of the greenhouse, located in Lun soum, Central province and insects in the tree nursery site created the same group/order in terms of similarities; and insects of reforestation site and greenhouse created the different group/order. In other words, total similarities of insects in greenhouse and tree nursery site was 70 percent while similarities between reforestation site, greenhouse, and tree nursery site was 9.36 per cent.

Conclusion

1. In total 67 species of 7 orders and 25 families were identified/discovered from the greenhouse, tree nursery site and reforestation site located in Lun soum, Central Province.
2. In terms of statistics, from the Year 2010 to 2016, the number of individuals of the species was F=15.1, P=0.0001 in Lun soum, Central province; and the total number of each year was different.
3. We detected species *Cherysomelpopuli L (Coleoptera),from the replanted aspen, species Epicauta sibirica Pall, Mylabris specioso Pall*(*Coleoptera), from the caragana,* Lytta caragana Pall(*Coleoptera) from the Caragana arborescens , and Lymantri dispar, Cerura felina Bulter,1877,Paranthere tabaniformis Rottemburg, 1775 (Lepidoptera)* from the aspen in the reforestation site of Lun soum, Central Province for causing damage.
4. The insects of greenhouse and tree nursery site create the same group in terms of similarities while the insects of reforestation site and greenhouse create the different group in terms of similarities in Lun soum, Central province.

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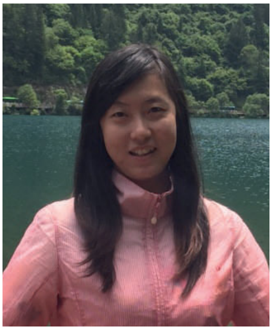
THE MECHANISM OF SOIL NITROGEN TRANSFORMATION UNDER DIFFERENT BIOLOGICAL SOIL CRUSTS TO SHORT WARMING: FROM MICROBIAL COMMUNITY FUNCTIONAL GENE STRUCTURE TO ENZYME ACTIVITY



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Abstract: The soil nitrogen (N) mineralization process is a crucial biogeochemical process mediated by microbial communities and influenced by climate change drivers. However, little information is available on the mechanisms of N turnover, especially the response of the taxonomic and functional genes of soil microorganisms involved in N transformation as well as the extracellular enzymes in biological soil crusts (BSCs)-dominated soil to the prolonged warming with reduced precipitation that is predicted to occur with climate change. Thus, we used a short-time (3 years) open top chamber (OTC) experiment to simulate warming and reduced precipitation. A shotgun metagenome sequencing approach was employed to address the following: (i) how warming with lower precipitation will affect the N transformation rate (ammonification, nitrification and mineralization) under different BSCs (moss and cyanobacteria); (ii) how soil enzymes and taxonomic and functional genes of soil microorganisms will change with warming and consequently affect N transformation. It was found that warming with reduced precipitation decreased the N transformation rate and extracellular enzyme activity. Bacteria exhibited the highest abundances among the three types of soils (moss-dominated soil, cyanobacteria-dominated soil and bare soil), but their abundance decreased after warming. At the phylum level, warming decreased the abundance of Actinobacteria, Acidobacteria and Proteobacteria but increased the abundance of Actinobacteria in cyanobacteria-dominated soil. Furthermore, a higher abundance of cyanobacteria was observed in BSCs-dominated soil. At the gene level, the ammonification-related gene abundance was lower with warming, while the genes involved in nitrification in cyanobacteria-dominated soil increased with warming. These results indicate that the belowground microbial communities that mediate N transformation responded to warming and reduced precipitation by suppressing the abundances of the gene families related to ammonification and mineralization and stimulating the abundances of the gene families involved in nitrification of cyanobacteria-dominated soil. This study provides a genetic basis for identifying the microorganisms involved in key processes in the N cycle in temperate desert ecosystems, and shows that short-term warming selectively affects the N transformation process instead of regulating every process in arid and semiarid regions due to the mediation of BSCs in the microenvironment.

Keywords: Warming, N transformation, Biological soil crust, Microbial community composition, Microbial functional structure, enzyme activity

REDUCING POLLUTION USING EM TECHNOLOGY

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Abstract: In the recent years, the survey and research results of the inspection and research organizations have been showing that the sources of soil and groundwater pollution of the settled areas and cities of Mongolia are the human wastes, ger areas which produce the household wastewater and earth closets of the summer camp and this is proven by the examples, statistics and facts. On the one hand, it is a common condition, but on the other hand, it is required to consider that the environment is capable of the self-purification and elimination of pollution and the scientific findings and technologies for the reduction and elimination of pollution have been already used in the practice.

A scientist of Buryatia, the Russian Federation, P.A.Shablin invented "EM" technology (Effective Microorganisms) biopreparation firstly, conducted different tests, researches and experiments for the reduction of pollution and reached to the satisfactory results and EM technology has been used in the practice for long years. EM technology is used in more than 90 countries worldwide and the technology is considered as significant. EM technology is intended to make the environment and human healthy using the beneficial microorganisms and bacteria. In 2011, the biopreparation of EM technology was used to over 180000 earth closets and sewage plants of ger areas and camp all over Ulaanbaatar and the central treatment plants of local cities and settles areas and the result was significant. This is important to decompose the organic substances, accelerate the natural process and restrict the odors of earth closets, such as uric odor and sulfur and growth of insects and flies.

Keywords: wastewater, treatment plant, photosynthesis, lactic acid, fermenting microorganisms, fertilizer, remediation, ecology

Introduction

The average family membership per household of the ger area is 4 and daily average water consumption per person is 7L and daily waste per household is several times lower than a household who lives at apartment. First of all, I want to say that 20% of the households of ger area moved to city center in cold times and live at their apartment for 8 months of the cold seasons. But the waste of earth closet accumulated for long years is stored for long times. The waste of earth closet is penetrated into the depth of soil permanently and the waste is the main reason of adverse impacts. I think that EM technology is significant and the biopreparation should be regularly used for decomposing wastes of city, settled areas, industries, plants and business entities, disinfecting sewage and reducing the soil pollution, air pollution, environmental deterioration, desertification and land degradation, especially soil and environmental pollution. The biopreparation is important because the biopreparation is no adverse impacts to human health, flora, fauna and environment. In this article, I considered the importance, results, studies and experiments of several products made of EM technology.

Material and methods

I have considered the importance and results of the researches, tests and experiments of the scientists and researchers who applied EM technology in the activities, such as seed plantation, wheat fructification process and root growth, preparation of compost bio fertilizer, greenhouse plantation, reduction of soil pollution and disinfection of earth closets and manholes. I analyzed the test result of EM biopreparation which was applied in sewerage and manhole of Ar Janchivlan nursing resort and compared to my experiments which applied the biopreparation I bought to the earth closet of tourist camp, located near to Bulgan province, the earth closet, located in Chingeltei district and the manhole of comfortable winter house, located in Sukhbaatar district and my experiment results are high as same as other experiment results.

A scientist of the Russian Federation and Doctor of Medical Science Shablin contacted with the biggest businessmen of Mongolia in the end of 1990 and expressed his request to use EM technology in Mongolia. At that time, IrvesIntertrade Co.,Ltd started to work with Doctor Shablin. After that, the company obtained the product patent officially, constructed its production industry and had the capacity to produce 3 ton biopreparation per week in 2010.

Elimination and reduction of the adverse impacts of earth closets in ger areas

The economic development focusing to ecology is considered importantly worldwide. As forecasted by the scientists, the world population will be grown twice, the consumption of products will be grown three times and the scope of business of the enterprises will be grown 5-10 times in the next half century. If the wastewater is treated, disinfected, sterilized and recycled at the highest quality level using high technology, it is the significant action of the humans to protect the environment. In the developed countries, the government destroyed the earth closets and connected all of households to central sewerage network.

The soil and water pollution impacts to the equivalence of the ecosystem adversely and poisons the human, plants and animals and this is related to incapacity to efficiently treat the household or industrial solid, liquid and gas wastes and human wastes in compliance with the ecological requirements.

As above conditions, there is the requirement to apply EM technology biopreparation which is applied by over 80 world countries efficiently in order to eliminate and reduce the pollutions permanently. “Tamir Em” preparation created using EM technology in compliance with MNS6445:2014 is the compound of the fermented microorganisms, such as Lactobacillus casei-21, Streptococcus Lactis-47, Photo pseudomonas palistris-108 and Saccharomyces cererisial-76. In addition, it is the biological preparation, comprised of the most beneficial microorganisms of more than 100 families, such as photosynthetic microorganisms, lactic acids and enzymatic fungi.

“Baigali-Em” biopreparation created using EM technology in compliance with MNS 6446:2014 is the biological preparation, comprised of the most beneficial microorganisms of more than 100 families, such as photosynthetic microorganisms, fermenters and enzymatic fungi. EM technology is significant to grow the beneficial microbes, stabilize the ecosystem of microorganisms and restrict an opportunity of the growth of pathogenic microbes. Therefore, the technology is the most useful to restore the fertility of the soil, improve the benefits and natural medicinal capacity of fruits, vegetables and garden plants and harvest the natural agricultural products, which keep the natural properties. This technology is used in the foreign countries as well as Mongolia widely and resulted to resolve the matters of plant diseases, soil degradation, pollution and water pollution and restore the soil fertility.

"Baigali-Em" is the liquid which cultured more than 80 active microorganisms which live in the soil in form of symbiosis. In addition, "Baigali-Em" makes the long-term interaction between the aerobic and anaerobic microorganisms. One of these microorganisms is fed by the products which are produced by other ones, not depending on the different living conditions, and they can make the positive accumulation of the compounds of microorganisms by living together in the term of active exchange of feed sources.

The application of EM technology is significant because the technology can accelerate the natural process of organic wastes according to the ecology procedure. EM technology restricts the pathogenic microbes, decomposes organic wastes and makes the environment healthy and clean. The biopreparation is the living microorganisms and the direct supply for use is important and efficient.

In the beginning of the warm seasons, we start to feel the odor and other adverse impacts of earth closets. Although soil is polluted, the soil is capable of purifying itself. The soil purification process is at 0.2-0.25 meter depth because of the impacts of organic matters, bacteria and chemicals. The soil purification process depends on level of pollution, type of pollutants, weather and soil structure. Because of it, the earth closet has been used for long centuries.

The disadvantage of the earth closets is to accumulate and store the waste for long years and have different adverse impacts. The waste of earth closet is penetrated into the depth of soil permanently and the waste is the main reason of adverse impacts. In 2011, the sterilization and disinfection were provided to more than 180000 earth closets and sewage plants of ger areas of 9 districts in Ulaanbaatar using "Tamir-Em" biopreparation for resolving the problem. It was initiated by "IrvesIntertrade" Co.,Ltd, funded by "Fresh Air" Foundation, organized by the Governor's Office of Ulaanbaatar, implemented by the sterilization and disinfection companies and inspected by the Specialized Inspection Agency of Capital City and other departments.

The activity has been observed by the laboratory periodically for long times. In the result of the activity, the odor of earth closet was reduced, the human waste was decomposed, the absorption level was accelerated, the flies were decreased importantly and the growth of worms and flies in the autumn was restricted. The odor was importantly decreased within 5-10 days of using Tamir-Em preparation in the earth closet and the Hepatitis A in the human waste was reduced in the result of Virology Test. The main object of the activity was to sterilize and disinfect the earth closets and manholes of ger areas near Gandan, which has been the settled area for long years (Fig-1).

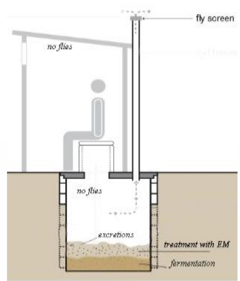

Figure 1. Toilet with-EM biopreparation

Figure 2. Some EM technology biopreparations

When the analysis of situation was conducted by the Specialized Inspection Agency of Capital City at the soil and air samples and the earth closets of the household after applying EM products, the nitrate of the polluted soil was reduced by 87,2%, nitrite was reduced by 74,5% and ammonia was decreased by 87,2%. As the result of air bacteriology analysis, the count of bacteria in air was decreased 3.4 times.

As the comment of some households, they were satisfied for the result and expressed their desire to buy and apply the preparation again. In the result of such activity, it was significant to make the living environment of the humans healthy by purifying the uric gas in the air and soil and water pollution and reducing the pollution importantly.

Wastewater treatment & garbage

The treatment plants of the cities, settled areas and province centers in Mongolia can't be operated at full capacity. Also, soums do not have the water supply and sanitary facility and lack of the household culture. The schools, kindergartens and hospitals equipped with partial water supply and sewerage system have been constructed in the biggest soums with high density in the recent years.

The organizations should dispose the wastewater from these facilities and use EM biopreparation and technology for the treatment plant widely. Today, several organizations, such as Ar Janchivlan and Central Treatment Plant of Erdenet have been using EM biopreparation.

As the survey results, the permanent application of the technology is efficient to reduce the content of sludge from the wastewater and decompose the organic waste. Therefore, it is possible to process the sludge of the treatment plant at the sludge field and produce the composite fertilizers and soils, consisted of the mixtures of soil, plant, leaf, fir-needle and other natural organic waste and the fertilizers may be used for the street and garden cultivation, tree plantation, forest remediation, mining degraded land, stockpiling and biological remediation. Also, there is an opportunity to replace other similar import fertilizers and soils with such products and export these fertilizers and soils to abroad.

Applied to polluted and putrefactive water, EM holds a dominant position in the layer of microorganisms and help ecosystems revive and reduce sludge and foul odors. The purpose of EM application is not to create apparently-clear water by chemical means but to revive the native function of aquatic ecosystem. In this sense, Depending on the overload of drainage and the volume of water, the amount and the frequency of Application of EM should be various.

Highy developed foreign countries

The highly developed European and Asian countries have been using EM technology widely to produce the fertilizers using the organic waste, reduce the soil and air pollution, improve the process of the Treatment Plants and reduce the river water pollution and resolving their ecological problems.

Figure 3. Technology to fertilize organic waste by EM biopreparations *(sours: cooperation with EMPO)*

EM-1 in Malaysia: The EM-1 in Malaysia is produced by Virgin Greens Sdn Bhd under license from EM Research Organization (EMRO), at its facility in Batu Caves, Selangor. The microbes are extracted from the local soil and environment. Each batch of EM-1 is produced under strict supervision of EMRO's Technical Officer to ensure that the quality produced in Malaysia is similar to those produced in other licensed countries. Virgin Greens specializes in Waste Management, and the Manufacturing of various high-quality organic fertilizers, using EM-1 . Antrade Services is the official appointed distributor, and experienced to train in the application of EM Technology.

Discussion

It is seemed that EM product is not widely used in Mongolia, but some poultry farms, fruit and vegetable farmers, cities, resorts and nursing centers applied EM technology and reached to high results. Therefore, the product and information of EM technology were provided to some districts and khoroos, but they could not apply the technology because of their financial situations. I have published my articles and works at journals and magazines of some institutes with purpose of providing the findings and advantages of the product to the people widely.

Conclusion

Tamir-Em biopreparation could be applied at 90,5% of the earth closets and manholes of the households who live in ger areas. 78% of the citizens felt that the odor of disinfected sewage points was reduced, the flies were destroyed and level of waste and sludge was reduced importantly in the result of the activity and they supported and encouraged the product.

I think that the correct concept about EM technology, such as broad application of EM biopreparation, which is environment-friendly, harmless to human health, free from the chemicals and capable of improving soil absorptionrate of the waste,should be provided to the people and citizensand it is required to use in Mongolia widely, provide the knowledge and determine the funds in the budget on the regular basis.

Microorganisms have much to do with the process of water purification in nature. Even in the latest water purification technology such as the activated sludge process, microorganisms play a major role. Self-purification power of water works well under the indigenous ecosystems functioning properly with a rich aquatic ecosystem pyramid .In polluted water with sludge accumulating at the bottom and foul odors, self-purification power decrease as the result of the dominance by putrefactive microorganisms. This leads to decrease of nutrition necessary for ecosystems to function and keep their purification.

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WATER SOURCES VARIABILITY CHARACTERISTICS FOR SAND-FIXED VEGETATION IN SUCCESSIONAL STAGES OF DESERT ARTIFICIAL REVEGETATION, NORTHWEST CHINA

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Abstract: The water resources management of arid desert area, which is increasing stressed by climate change and anthropogenic activity, is difficult, particularly because of variations in water uptake patterns associated with the artificial revegetation establishment stage and vegetation type. In shapotou area of northwest China, artificial revegetation were planted from 1956 year begin and informed different stage sand-fixed landscape, where was a ideal area for researching water uptake source variability characteristics during artificial sand fixation process. The stable isotopes δ18O and δ2H were employed to investigate the water uptake patterns of typical artificial revegetation Artemisia ordosica and Caragana korshinskii which were planted in different year. Based on the soil water content vertical distribution, soil layer were divided into five groups (5-10 cm, 10-40 cm, 40-80 cm, 80-150 cm, and 150-300 cm). We compared stable isotope ratios of shrub stem water to soil water pools at various depths and groundwater, and examined the contribution patterns of different water sources for revegetation desert shrubs. The results indicated that Artemisia ordosica derived the majority of their water from 20-150 cm soil layer, Caragana korshinskii obtained water source from 40-150 cm soil layer, and the main water sources of Artemisia ordosica and Caragana korshinskii plants changed with the sand fixed year from deeper to shallow soil. This study provides insights into revegetation water uptake and desert area water management.

THE STUDY OF THE MOUNTAIN KASTANOZEM STRUCTURE AND ITS STABILITY IN THE NATIONAL PARK OF MONGOLIA

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Abstract: Due to rapid development of tourism, families with a large number of livestock settling in Gorkhi-Terelj National Park (GTNP), and recreational facilities and camps are being built in large numbers in some Mongolian protected areas, we are facing problems of overgrazing, land degradation, and lack of vegetation cover, and ultimately, these are leading to pasture degradation. Currently, soil erosion is detected severely and plant cover is depleting at national park areas due to nature and climate change, increasing number of tourism and animal numbers; and those are impacting to the environment negatively. Therefore, we have chosen this land and scientifically justified the impact on the condition of the park and its impact on the stability of the soil structure.

Keywords: soil aggregate, stability of the soil structure, soil degradation, pasture degradation, fenced area, national park

Introduction

In Mongolia, soil erosion, degradation and desertification are widespread because of the fragile ecosystem and the landscape of land. Particularly, due to climate change, recreation, tourism and livestock numbers, soil erosion and degradation in protected areas, including natural parks, have been detrimental to vegetation cover and have a negative impact on nature and ecology. There has been a strong deterioration in Gorkhi-Terelj National Park, the number of domestic tourists and tourists is the most visited and the number of foreign tourists visiting the park is increasing year by year.

In recent years, at this national park area's soil, soil cover and plant species are depleting intensively due to environmentally unfriendly various activities such as irregular movement of people and vehicle, rangeland degradation and uncoordinated crossroads.

The purpose of our research is to investigate changes in the nature of the soil structure depending on the utilization conditions of the protected areas.The soil we defined is mountain kastanozem.

In order to achieve our goal, the following objectives were proposed. These include:

1. Determine the soil aggregate of the surveyed area and estimate its structure
2. Identify and value the stability of the soil structure of the surveyed area

Methods

The object of the study:10 000 hectares of fenced area, used as a tourism and pasture land of Uvur-Gorkhi which borders to Gorkhi-Terelj National Park.

Experimental study version:

A- Fenced area

B- An area with camping, tourism and pasture

To determinate the soil structure: Aggregate size determination, N. I. Savinov dry method and method of determining the stability of soil structure using a cellular box to determine the stability of the soil structure that has not been used in Mongolia previously, it has been tested in field conditions by linear point method and assessed by 6 points. The most stable texture is the 6-point scale.

Methodology for the research material: Methods of mathematical modeling, summarizing data analysis, statistical generalizations, methods of testing, intervals etc. SPSS statistics 22 have used for processing.

Results

The study was conducted by sampling samples from 0-8 cm and 10-16 cm layers of soil in two scenarios of fenced area and recreation and pasture areas (Table 1). As a result, the percentage of mountain kastanozem 0.25-10 mm 59 %-78 % and 31 % less than 0.25 mm.

According to the result, the structure of the 0.25-10 mm mountain kastanozem stabilized in the protected area is 68.5 % of the structural value, which is a good grade, which is resistant to erosion, degredatian, soil, water, it is assumed that the structure is suitable for heat regime and plant growth. On the other hand, recreational structures, tourism and pasture areas of 0.25-10 mm in the mountain kastanozem on average 34.1 %, which is inadequate as a result of the structural assessment, indicating that the structure of the soil is affected by erosion and degradation.

We conducted this survey and assessed the sustainability of the structure of the mountain kastanozem in the fenced area and resorts, tourism, pasture areas (Table 3).

As a result, the average sample size is 4.6 in the 0-3 cm layer and 4.1 in the 3-5 cm layer. The indicator of land erosion is below average. And the above table shows that the average of all soil samples is 2.2 in the soil at 0-3 cm and 2.0 in 3-5 cm. The indicator is considered to be a strong degradation of the degree of degradation.

Discussion

G. Solongo, L. Davaa (2016) Researchers from study the effects of crop technology on the soil structure of the soil. According to the researchers, the soil structure of potatoes, forage and wheat cultivation area is 1-10 mm in size, 5-20%, while 50-80% in size is less than 0.25 mm.

In our study, the proportion of 0.25-10 mm in the mountain kastanozem of 0-8 cm is 20-45% and the structure of less than 0.25 mm is 75%.

D.Avaadorj,D.Adyamunkh, D.Tsognamsrai (2014). Researchers have improved the structure of the soil by pastureland and desert steppe zones of Bayandelger and Uul-Bayan soums of Sukhbaatar aimag, which have been used to improve pasture degradation is defined.

According to these researchers, the stability of the soil structure at the 1-2 cm of soil on the vegetation point of the normal use area is 2 points and on the without vegetation is 1 point.

According to our study, the stability of the soil structure of the fenced area is 0-3 cm when the 5.5 points of the vegetation and 4.5 without the vegetation, while the soil is 0-3 cm in the area of tourism and pasture areas 2.5-3.5 points.

Conclusions

1. According to the results of soil structural analysis, the structure of 0.25-10 mm in the mountain kastanozem of 0-8 cm is 59-78% and structure is less than 0.25 mm by 31%, while recreational and tourism areas the share of 0.25-10 mm in the mountain kastanozem 0-8 cm is 20-45% and the structure is less than 0.25 mm in 75%, which is used for recreational, tourism and pasture places are being affected by degradation.
2. Assessment of the stability of the soil structure of the park as a result of the soil structural stability survey 4.1-4.6 while the value of the structural stability

of the tourism, tourism and pasture areas is between 2-2.2. This indicates that soil erosion, degradation and degradation caused by the use of the park.

Table 1. Results of the mountain kastanozem aggregate structural analysis

Sample depth	10	10-7	7-5	5-3	3-2	2-1	1-0.5	0.5-0.25	<0.25
	Aggregate structure (mm), its share (%)								
Fenced area									
0-8	78±61	77±62	76±61	71±56	76±62	61±52	56±42	59±45	31±23
10-16	79±63	75±66	76±62	72±53	72±60	62±53	55±40	66±51	39±20
Recreation, tourism and pastureland									
0-8	20±10	25±15	28±16	36±22	40±30	35±31	42±30	45±31	75±40
10-16	25±13	30±20	35±21	38±23	39±32	38±33	44±35	46±35	60±41

Table 2.Results of the mountain kastanozem aggregate structural analysis

Version	Percentage of aggregates of 0.25-10 mm	Structural evaluation
Fenced area	68.5	Sufficient
Recreation, tourism and pasture	34.1	Non sufficient

Table 3. Sustainability of the mountain kastanozem structure (the point)

Sample depth (cm)	n	Structural stability Vegetated	Non vegetated	General average
Fenced area				
0-3	24	5.3	4.0	4.6
3-5		5.0	3.3	4.1
Recreation, tourism and pasture				
0-3	24	2.5	2	2.2
3-5		2.3	1.8	2.0

Acknowledgement

We are deeply grateful to the Soil Agrochemical Laboratory of the Mongolian University of Life Sciences and the Administration of the Gorkhi-Terelj National Park and State inspectors of Gorkhi-Terelj National Park, residents of the complex.

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THE DIVERSITY OF SAPROXYLIC BEETLE IN THE BOREAL FOREST OF THE TUUL BARKH CIRCLE

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Abstract: Dead wood and its characteristics are recognized as being one of the most important factors for forest biodiversity (Moretti & Barbalat, 2004, Siitonen, 2001). The boreal forests in this area have been influenced by anthropogenic factors such as fire, human recreation and have been damaged by Lymantria dispar L and Dendrolimus sibiricus superans Tschet, which are primary pest insects. In this research, diversity, and habitat of the saproxylic beetle were studied at 45 plots in the boreal forest of Tuul-Barkh circle. We compared in three burnt larch forest, three burnt mixed forest, three unburnt larch forest, three unburnt mixed forest, and three damaged by insect. We highlighted that the diversity in saproxylic beetle communities reflects the different tree communities by analyzing alpha diversity value at the different forest type. Data presented here supports the strategy to conserve the diversity and include species composition, habitat selection of saproxylic fauna. We collected a total of 1472 individuals, belonging to 112 species and 29 families of saproxylic beetles. Although the majority (62%) of individuals was collected in burnt mixed forest, the number of families collected was higher in the burnt larch forest than in the others.

Keywords: Saproxylic beetle, alpha diversity, degraded forest, different forest habitats

Introduction

Saproxylic beetles are common components of forest insect communities and play diverse roles in ecosystem function (Kevin et al., 2008; Puntsagdulam et al., 2004) and most often associated with woody plant tissue of dead or decaying trees. In some areas of boreal mixed wood forest with species such as Pinus sylvestris L, Betula platyphylla Suk, Populus tremula L, canopy composition can be related to succession (Muhlenberg et al., 2012; Tsedendash et al., 2009). A characteristic of most boreal forests is the common occurrence of stand-replacing disturbances, such as fire, windfalls, or insect's outbreak (Muhlenberg et al., 2012). Recently, in other countries, the role of fire was reinterpreted from the viewpoint of disturbance ecology and biodiversity conservation (Moretti et al., 2002, Wikars, 1997). From the forest ecology point of view, it is thus important to investigate the response of saproxylic invertebrates to fire as an important functional group in the food chain of living and dead wood. Our study main objectives were 1) to estimate the diversity of saproxylic and tree communities; 2) to define saproxylic beetle species collected in the boreal forest of Tuul barkh circle.

Material and Methods

Characterization of the study area

In total, 15 sites were sampled in the Bogd Khan Mountain Strictly Protected Area and the camping area. Eleven of these sites were located the Bogd Khan Mountain (47°43' - 47°54' N; and 106°46' - 107°10' E), where the forested area is remarkably isolated from surrounding conifer forests at 1450-1600 ma.s.l.

The study design included fifteen forest study sites, each including five forest habitats representing different forest types, and degradation: three burnt larch forest, three burnt mixed forest, three unburnt larch forest, three unburnt mixed forest, and three damaged by insect.

1.*Unburnt mixed forest habitat* **(**Khandgait I, Oinbulag, and Nukht I**):** This forest is a mixed dark taiga forest of *Picea obovata* Ledeb with varying amounts of *Pinus sibirica* Du Tour*, Larix sibirica* Led*, Pinus sylvestris* L *and Betula platyphylla* Suk that occur in the lower montane belt of Khandgait I, Oinbulag, and Nukht I.

2.*Burnt mixed forest habitat* (Khandgait II, Artsat, Nukht II**):** These forest habitats have been subject to extensive human disturbance (fire, cutting) in the past. This boreal forest is mostly comprised of old growth stands dominated by birch (*Betula platyphylla* Suk) and cedar (*Pinus sibirica* Du Tour).

3.*Damaged by insects forest habitat* **(**Bumbat, Chuluut and Khureltogoot): The most common tree species in these forest is *Larix sibirica* Led*,* commonly known as Siberian larch. The sites of the mouth of Bumbat, Chuluut and Khureltogoot are completely defoliated and died after a gypsy moth invasion in 2005 and 2006.

4.*Unburned larch forest habitat* **(**Shadivlan, Zalaat, and Chuluut-I)**:** This forest habitat was studied in three forest sites, namely Shadivlan, Zalaat, and Chuluut-I. These forests are not influenced by insect and fire.

5.*Burnt larch forest habitat* **(**Shajin khurkh I, II, and Turkhurkh): In the past, the Shajinkhurkh, and Turkhurkh have been impacted by fire. Fire occurred in 2006. Forest sites are located in mountainous larch (*L. sibirica* Led) dominated forest-steppe landscapes.

Beetle sampling

Saproxylic beetles were captured using window traps and a sweep net. Samplings were conducted from July to September 2016 and 2017. The traps were placed in the trees in the middle of July, and were emptied 2 times in August and September. Eight pitfall traps in each site were spaced at least 20 m intervals. A total of 120 traps were hung from a tree stem, 1.50 m above ground. Collected insects were transferred to bottles to be killed containing cotton soaked with ethyl acetate and covered with paper.

Data analysis

The diversity of beetle assemblages was estimated with alpha-diversity values (Shannon-Wiener, Simpson and Evenness index) and rarefaction. Alpha-diversity values were also measured for the tree diversity at each study plot. Species rarefaction curves were constructed using the Mao Tau richness estimator, which estimates the number of species expected based on the total sampled assemblage (Colwell, 2013). Shannon and Simpson indices are both based on proportional species abundance; however, the Simpson's index, a dominance measure, is more influenced by common species (Magurran, 1988).

Mean diversity and abundance for the traps were compared with habitats from the first year. To estimate evenness, Shannon's evenness index was calculated. Evenness, which measures the equitability of species abundance, is complimentary to the diversity index concept and it indicates how the individuals of various species are distributed in the community.

Results

We collected a total of 1472 individuals, belonging to 112 species and 29 families of saproxylic beetles first year study. Although the majorities (62%) of individuals were collected in burnt mixed forest, the number of families collected was higher in the burnt larch forest than in the others.

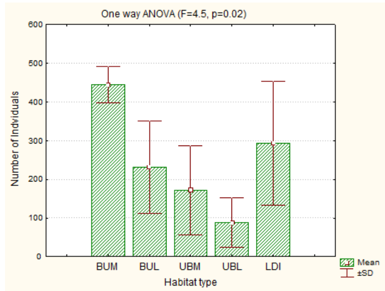
Alpha diversity indices of tree communities at the five forest habitats revealed remarkable differences between study sites, reflecting the actual difference in tree species composition and abundance: burnt larch forest, unburnt larch forest and damaged by insect forest scored a Simpson and Shannon Index equal to 0, with only one tree species present at each site. The burnt mixed forest had a Simpson Index=2.53 and a Shannon Index=1.06, while unburnt mixed forest had higher values (Simpson Index=1.6, Shannon Index = 0.57) (table 1). However, the values of the Shannon indices for beetle diversity were particularly high in the burnt mixed forest, whereas the five habitats for Simpson indices differed (table 1).

Table 1. Alpha diversity indices (Shannon, Simpson and Evenness) of beetle communities, and tree communities and correlation indices at each study habitat (tree and beetle)

Habitat	Ind	Shan non	Simp son	Shan non	Simp son
		tree	beetle	tree	Beet le
Burnt larch forest	356	0	2.5±0	0	4.5±0.2
Burnt Mixed forest	**474**	**0.6**	**2.9±0.1**	1.6	7.3±0.4
Unburnt larch forest	112.8	0	2.7±0.03	1	**9.1±0.3**
Unburnt mixed forest	340	1.1	2.3±0.03	**2.5**	4.1±0.2
Dama ged by insect	368	0	2.5±0.06	1	6.9±0.4

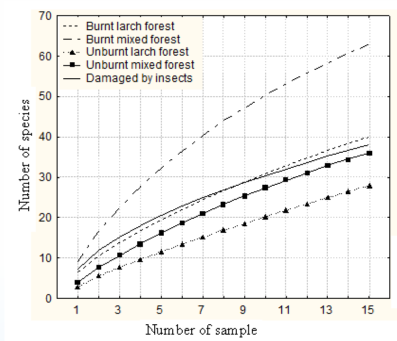
Measures of evenness of beetle assemblages were very similar in the burnt mixed forest and the damaged by insect forest, but differed slightly between burnt larch forest, unburnt larch forests and unburnt mixed forest. The evenness index obtained for the unburnt larch forest was 0.57 and 0.59 for the unburnt larch forest.

The variability in habitat-level species abundance was markedly higher in the burnt mixed forest than in the others for beetles. According to the one way ANOVA, the burnt mixed forest habitat differed significantly (Graph 1).



Graph 1. Number of individuals at the five forest habitat (BUM-burnt mixed forest, BUL-Burnt larch forest, UBM-Unburnt mixed forest, UBL-Unburnt larch forest, LDI-Larch forest damaged by insect)

We used sample-based rarefaction curves because the saproxylic individuals were recorded from each sample rather than sampled randomly (Gotelli and Colwell 2001). Therefore, we constructed these curves by calculating the expected richness function (Mao Tau) and the 95% confidence interval for each sample (Colwell, 2000). Observed sample-based rarefaction curves showed a positive slope at the maximum number of samples (Graph 2).



Graph 2. Comparison of sample based rarefaction curves of beetle assemblages at five different forest habitats.

Four forest habitats, namely, unburnt larch forest, unburnt mixed forest, burned larch forest, and damaged by insect forest curves exhibited similar trends, with fewer species added with greater sampling effort; while the curve for burnt mixed forest confirmed a higher species density that rose steeply. Outputs of species richness estimators for all four sites differed based on the algorithm used, but they all listed a similar site ranking, with the highest species richness at burnt mixed forest and the lowest at unburnt larch forest, confirming the trends shown by rarefaction curves.

Regarding concerns for species conservation, the window traps captured 2 threatened species; one of them (*Stephanopachys substriatus* Payk., 1800) was exclusively found in the burnt mixed forest, the other (*Boros schneideri* Panz., 1795,) was found in the damaged by insect forest and the burnt mixed forest. These two species (The *Boros schneideri* Panz., 1795, *Stephanopachys substriatus* Payk., 1800) are listed in Annex II of the EC/92/43 Directive.

Discussion and Conclusion

This article have provides the findings of diversity of saproxylic beetles and tree communities as well as habitat selection for beetles in boreal forests the Tuul barkh circle. In this study we compared beetle assemblages in five boreal various forest habitats in the Tuul barkh circle: burnt mixed forest, burnt larch forest, unburnt mixed forest, unburnt larch forest, and damaged by insect forest. Regarding concerns for species conservation, the window traps captured 2 threatened species; one of them (*Stephanopachys substriatus* Payk., 1800) was exclusively found in the burnt mixed forest, the other (*Boros schneideri* Panz., 1795) was found in the damaged by insect forest and the burnt mixed forest. These two species (The *Boros schneideri* Panz., 1795, *Stephanopachys substriatus* Payk., 1800) are listed in Annex II of the EC/92/43 Directive. According to the available literature *Boros schneideri* Panz, 1795 is recognized as a relict of primeval forests (Gutowski et al., 2014), and is found in a limited number of locations and with limited density in many European countries, e.g., Germany, Finland and Romania.

Analyzing each study habitat separately, *Cerambycidae* was the richest family by species richness across the ecosystems, while *Buprestidae* was the richest family by species abundance (49.4%) at all habitats. In the unburnt mixed forest, *Lymexylidae (Elateroides dermestoides L)* was the richest family by abundance. The *Erotylidae, Staphylinidae, Cryptophagidae, and Bostrichidae* families were registered only in the burnt larch forest, while the *Boridae* family occurred only in the burnt larch forest and larch forest damaged by insects. The *Anaspis genus* (*Scraptiidae*) occured only in burnt larch and unburnt larch forest. The most abundant species was *Antaxia quadrifoveolata* Solsky, 1871 in *Buprestidae.* The beetle assemblages we found were well adapted to fire and dry open forest damaged by insect forest.

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AVAILABLE PHOSPHORUS, ACTIVITY OF ACID AND ALKALINE PHOSPHATASES IN PASTURE SOILS

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Abstract: The grazing is traditional for nomads in our country. The increase of livestock may play a significant role in sustainability of soil ecosystems. According to National report on Mongolia's Pastureland Situation grazing livestock exert one of the primary effects on pasture. In this study we estimated the available phosphorus, activity of acid and alkaline phosphatase in pasture soils taken from the Bayanchandman sum, Tuv aimag in 2017. Soil samples were taken from the different distance from winter camp and directly from the winter camp. The results of the study show that the pH of the studied soils changes to the alkaline side and soil fertility decreases in areas with intense livestock grazing.

Keywords: pasture soil, available phosphorus, phosphatase activity

Introduction

Global change is bringing new environmental conditions to our planet, which affects the condition of the soil. Increasing levels of carbon dioxide, the variability in precipitation and temperature, and the impact of pollutants and land management are expected to induce important changes in the stoichiometry of carbon (C) nitrogen (N)and phosphorus (P) in natural systems (Margalef, 2017). The grazing of pasture by livestock is common in our country. Winter camp is a wintering place for nomads and depending on weather conditions nomads graze livestock at different distance. The increase of livestock may play a significant role in sustainability and quality of soil. Based on these arguments we estimated the available phosphorus, soil titrative acidity, activity of acid and alkaline phosphatases in pasture soil depending on the distance from the winter camp.

Soil sampling. Soil samples were taken from the winter camp (N48012'56.5" E106028'17.5", 1344 m a.s.l.), short distance pasture (N48013'00.0" E106028'07.2", 1333 m a.s.l.), middle distance pasture (N48012'06.7" E106028'05.4", 1311 m a.s.l.) and long distance pasture (N48010'25.1" E106026'32.4", 1360 m a.s.l.) in 2017, Bayanchandman sum, Tuv aimag. The soil subsamples were taken from the four places and sampled from three horizons: 0-7, 7-15, 15-25 cm from the soil surface, mixed, sieved (2 mm), stored and kept in freezer until laboratory analysis.

Methods For estimation of acidity of the soil samples were shaken with 0.9% NaCl for 30 minutes after what was filtered and titrated by 0.001 N NaOH; available phosphorus was estimated by colorimetric assay with hydroquinone, which based on the bicarbonate method developed by Olsen et al. (1954). After adding 2 ml of Na2CO3 and Na2SO3 into soil filtrate, mixture of 1% hydroquinone was added and the absorbance was measured at 750 nm (Jones, 2001). Calculations were made according to the phosphate calibration curve (0.05 mg/ml). Amount of available phosphorus was expressed in µg/g of soil sample. Activity of acid (EC 3.1.3.2) and alkaline phosphatases (EC 3.1.3.1) were estimated by Tabatabai-Bremner assay with para-nitrophen-

-ylphosphate (PNPP) as a substrate (Khaziev, 2005). Enzymatic activities were expressed in units (U): 1U of phosphatases activity were defined as the amount of enzyme protein in 1 g of soil, which forms 1 mg of paranitrophenol in one hour.

Data analysis. All experiments were carried out with 3-5 repetitions and mean values were taken. Pearson correlation coefficient (r) was calculated among available phosphorus and enzymes activities.

Results

Soil samples were taken directly from the winter camp and pastures at different distance from it. The results show that the available phosphorus content in the soil is the same in winter camp and short distance pasture (5.76±0.21μg/g) whereas phosphorus content decreases with distance (3.71±0.17μg/g in middle distance pasture soil and 3.90±0.19μg/g in long distance pasture soil) from the camp (Figure 1).

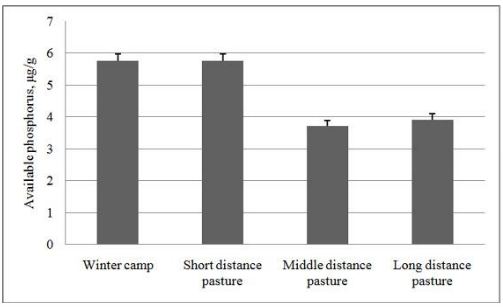

Figure 1. Soil available phosphorus

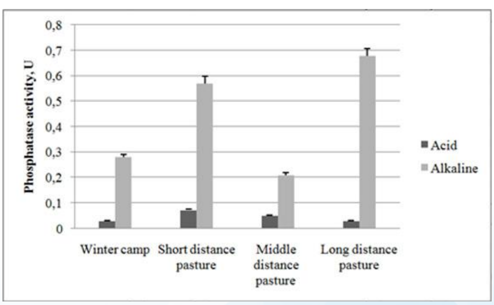

Figure 2. Soil phosphatases activity

Alkaline phosphatase activity was almost ten times higher than acid phosphatase activity in all samples (Figure2).

This may indicate that the pH of the soil tends to alkalize.

Soil titrative acidity decreases winter camp>short distance > long distance > middle distance pasture (0.056>0.054>0.05>0.048mg/g) and showed similar trend with available phosphorus.

Soil acid phosphatase activity was in winter camp - 0.029U, short distance pasture - 0.072 U, middle distance pasture - 0.05 U and long distance – 0.029 U. Alkaline phosphatase activity was in winter camp - 0.28 U, short distance pasture - 0.57 U, middle distance pasture - 0.21 U and long distance – 0.68 U accordingly.

Table 1. Correlation coefficients (r values) for relationships among available phosphorus and soil phosphatase's activities

			Phosphatase activity	
	Soil sample		Acid	Alkaline
	Winter camp	Available phosphorus	0.944	0.363
Pasture	Short distance		0.065	0.873
	Middle distance		0	-0.581
	Long distance		-0.929	0.268

Activity of alkaline phosphatase has no correlation on the available phosphorus, while acid phosphatase activity correlated on available phosphorus content and this dependence changes with distance from the winter camp (Table 1).

Discussion

Phosphatase production depends on a combination of phosphorus demand from plants and microbes, available organic phosphorus substrate and phosphorus limitation of the soil. Results of some work show the dependence of phosphatases activities on different factors. For example, Turner & Haygarth (2005) estimated the phosphodiesterase and phosphomonoesterase activities in pasture soils. Their results show that enzyme activities were strongly correlated with soil pH and labile organic phosphorus. Acidic soils contained high phosphomonoesterase, low phosphodiesterase activity and high concentration of labile organic phosphorus.

Results of Lemanowicz *et al.* (2016) show that acid phosphatase activity was found predominantly in acid soils and alkaline phosphatase activityin alkaline soils. Our results show that the activity of alkaline phosphatase was higher than acid phosphatase in all soil samples. This may indicate that the pH of the studied soils changes to the alkaline side.

Speir & Cowling (1991) estimated the phosphatase activities of herbage roots and low- and high-fertility soils over 12 months. They indicated that at the low-fertility site herbage and root phosphatase activities were correlated significantly ($P<0.05$) with available organic phosphorus. The results of our work are similar to these results and showed that the correlation among available phosphorus and soil acid phosphatase activities decreases with increasing distance from the winter camp.

Conclusions

The results of the study show that pH of the studied soils changes to the alkaline side and soil fertility decreases in areas with intense livestock grazing. It is necessary to continue research on biochemical and enzymatic properties of the soils affected by grazing livestock.

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THE MUTAGENIC ACTIVITY OF THE MINING SOIL, MONGOLIA

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Abstract: In the area of Tsogttsetsii sum, Umnugobi, have mining of the coal through open and centralizing population and vehicles, which made polluting of the environment local area. As the environmental pollution are causing of diseases for the living organisms. Through our previous investigation, we were collected the soil samples from 8 sites of the Tsogttsetsii sum, Umnugobi. The environmental pollution not only causes of disease for the living organisms but also change their genes, which clear by investigation of researchers and current studies of soil and water towards for determine the mutagenic activity. Never study the genotoxicological investigation of soil and water of Tsogttsetsii sum, Umnugobi.

Keywords: bacteria, genotoxic activity, soil

Introduction

The environmental pollution causes the diseases in the alive organism but also it makes change in its gene have become clear according to the researchers researches and in this modern time the soil and water researches have been directed to determine their mutagenic reactions (Alan Wild., 1995). The natural object mutagenic reaction revealing researches, mostly or especially the auxotroph mutant microorganisms (Salmonella typhimurium, E.coli) are used as the amino acid by any substrate by making them the test system (Ames B.N.,1971). According to our researches, the soil genotoxic reactions surrounding the natural resources open mining which are located in the Tsogttsetsii soum, Umnugobi province territories have been investigated at the first time.

The main aim of this study is to investigate genotoxicological study of soil Tsogttsetsii sum, Umnugobi.

Method

Sampling: We were collected the soil samples from 8 sampling sites of the Tsogttsetsii sum, Umnugobi province, by “Envelope” method (Table 1).

Table 1. Location and GPS points of sampling sites

№	Location	GPS point	Comment
1	Enrichment Industry	N43°39'54.4" E105°32'22.0"	East side of the Enrichment Industry
2	MCS International LLC	N43°40'31.1" E105°32'42.3"	East-north side of the MCS International LLC
3	Ger district	N43°42'55.5" E105°33'45.4"	Southern side of the Ger district
4	Waste Water Treatment Plant	N43°43'03.4" E105°33'53.7"	Southern part of the waste water treatment plant of the Mine
5	Well of the sum	N43°43'57.2" E105°34'26.8"	Bayanbulag well, which located in the northern part of the center of sum
6	Liquid waste's point	N43°42'56.2" E105°34'57.5"	East side of the integrated waste point of the sum and mine
7	Solid waste's point	N43°43'03.6" E105°34'53.3"	East-southern part of the integrated waste point sum and mine, which is located south of sum.
8	New point of waste	N43°42'55.6" E105°35'06.6"	South side of the older waste point, around 2 km from the sum.

Bacterial test strain

We used the bacterial test strain, which genotype as shown in table 2, for the genotoxicolical investigation.

Table 2. Genotype of the bacterial test strain

Test strain	Genotype	Resource
Salmonella typhimurium TA100	his G46 rfa uvrB bio$^-$ pKm 101	Microorganisms collection of the Kazan University, Russia
Escherichia coli wp^2 rec$^-$ pol$^-$ uvr$^-$	*trp$^-$ E* *trp$^-$ 65 rec A* *trp$^-$ 65 sul mal B* *pol A* *trp$^-$ 65 sul uvr$^-$*A 155	

We use following methods for the Laboratory analysis.

- Method collects the soil sample (MNS3298-90)
- Method of the preparation soil extraction (MNS 5367:2004)
- Determined the soil capability damage to DNA of the test microorganisms (Methodological manual, 1995)
- Determined the soil samples activity cause of mutation for the test microorganisms (Ames and McCann 1981)

Results

Determinant result of the sample exhibit toxic property to the test-microorganism

We were investigated the genotoxic activity of the soil of Tsogttsetsii sum, Umnugobi province. There to: determined that water and organic extraction of the soil exhibit toxic property to the mutant strain *Salmonella typhimurium* TA100, mutagenic activity, and test strain damage ability to *E.coli's* DNA.

The experiment of mutagenic activity incorrect result prevention that determines the present sample exhibit toxic property to the test strain. Bacterial toxic property exhibit to the test strain determines through survival ability and survival ability less than 3% that the present sample is not use for the investigation of mutagenic activity. We were investigated water and organic extraction of the soil exhibit toxic property to the mutant strain *Salmonella typhimurium* TA100, which exhausted as following result.

Table 3. The results of survival ability of the *S.typhimurium* TA100 strain in the soil sample

№	Sampling site	Survival ability of test strain, %	
		Water extraction	Organic extraction (DMSO)
1	Enrichment industry	82.4	77.0
2	MCS International LLC	92.7	73.0
3	Ger district	95.2	52.0
4	Waste Water Treatment Plant	67.7	79.1
5	Well of the sum	-	71.4
6	Liquid waste point	-	92.9
7	Solid waste point	69.6	91.3
8	New waste point	93.1	65.3

-Non growth

As seen table 3, were determined water extraction of ger district (95.2%) and organic extraction of liquid waste point, that survival ability of the strain *S.typhimurium* TA100 rather than others in the soil sample.

The toxic property revealed from the water extraction and organic extraction, which attesting the sample contain organic and non organic compounds. The toxic property of organic extraction was rather than water extraction.

The determinant result the test strain damage ability to E.coli's DNA of investigated sample

As shown in Tables 4-5, the determinant result the water and organic extraction of soil damage ability to the test bacterial DNA, which collected from Tsogttsetsii sum, Umnugobi province.

Table 4. Determinant result the damage ability of water extraction of soil to the E.coli DNA

№	Sampling site	Inhibition zone growth of test bacteria (mm)			
		wp	*rec⁻*	*uvr⁻*	*pol⁻*
1	Enrichment industry	1	1	(+)	(-)
2	MCS International LLC	(-)	(+)	(+)	(+)
3	Ger district	(-)	(+)	1	1
4	Waste Water Treatment Plant	1	(+)	(+)	(+)
5	Well of the sum	1	(+)	1	1
6	Liquid waste point	1	1	(+)	1
7	Solid waste point	1	(+)	1	(+)
8	New waste point	(-)	(+)	(+)	(+)

comment: (+) less than 1mm, (-) no zone

For the result investigation of water extraction of soil damage ability to bacterial DNA that determined water extraction of soil around ger district, well of the sum were inhibited *E.coli uvr⁻* and *pol⁻* strain (Table 4). Whereas, the organic extraction of soil around MCS International LLC, Enrichment industry and solid waste point inhibited growth to *E.coli pol⁻* , well of sum to *E.coli uvr⁻,* and new new waste point to *E.coli uvr⁻* and *pol⁻* inhibited respectively (Table 5).

Table 5. The organic extraction of soil sample damage ability to *E.coli* DNA

№	Sampling site	Inhibition zone growth of test bacteria (mm)			
		wp	*rec⁻*	*uvr⁻*	*pol⁻*
1	Enrichment industry	2	(-)	(-)	1
2	MCS International LLC	(-)	(-)	(+)	1
3	Ger district	(-)	(-)	(-)	(-)
4	Waste Water Treatment Plant	1	(-)	(-)	(+)
5	Well of the sum	(-)	(-)	1	(-)
6	Liquid waste point	(+)	(-)	(+)	(+)

7	Solid waste point	1	(+)	(+)	1
8	New waste point	(-)	(+)	1	1

comment: (+) less than 1mm, (-) no zone

The result activity generates mutation of investigation sample to the test bacteria. As shown in table 6, the result mutagenic activity of water and organic extraction of soil, which used *S.typhimurium* TA100 strain, we were studied currently. The water extraction of soil around enrichment industry, ger district, and solid waste point were "slightly" mutagenic activity to *S.typhimurium* TA 100 strains (numerical comparison of revertant 5.2-5.8), and MCS International LLC, well of sum, new waste point were "moderately" mutagenic activity (10.4-50). Therewith, the organic extraction of soil around enrichment industry, MCS International LLC, well of sum and new waste point were determined "slightly" mutagenic activity (3-3.3) to the test bacteria (Table 6).

Table 6. The soil sample indicated mutagenic activity to *S.typhimurium*TA100

№	Sampling site	Mutagenic activity	
		Water extraction	Oragnic extraction (DMSO)
1	Enrichment industry	5.2	3.3
2	MCS International LLC	12.8	3.3
3	Ger district	5.8	2.0
4	Waste Water Treatment Plant	-	3.3
5	Well of the sum	10.4	2.3
6	Liquid waste point	0.8	3.0
7	Solid waste point	5.6	2.3
8	New waste point	50	1.7

(-) non growth

We were determined the mutagenic activity of the soil samples from 8 sites of Tsogttsetsii, Umnugobi province, by Ames test (*Ames, 1981*). We used the auxotroph mutant bacteria for the histidine (Salmonella typhimurium TA-100 /his G46, rfaB, bio pKm 101/). The researchers have determined that the surface sample organic extraction damages the DNA more than the water potion and it has the active mutagene (Nishimura T., 1984; Arashidani,. 1992, Edenharder R et al., 2000). As a result of our research, also the same sample organic solution has more mutagenic active.

The soil mutagenic activity has been relatively higher researched in the countries such as USA, Germany, Japan, Russia, Brazil, Canada, Italy and Netherlands where the industries have developed. The USA researchers have determined that it was increased in the city industrial zones. The Canadian researchers (Marvin et al., 1993) researched the Hamilton Harbour (Ontario's right region) state soil sample mutagenic reactions, Watanabe researched the mutagenic reaction of the Osaka city, Japan by the Ames test and the mutagenic type was revealed. But for our country, since 2002, the soil genotoxic reactions of Ulaanbaatar, Darkhan, Erdenet , Arvaikheer and Zuunmod cities have been researched. But seeing from the soil sample research result which was made for the Umnugovi province, Tavan tolgoin mining soil by the Mongolian University researchers about the mining zone lands soil genotoxic reactions, there was not shown any mutagenic reactions for the *Salmonella typhimurum* TA 100 strain. By our research, in the Sergelen soum mining area all the soil samples, the mutagenic was determined to be inactive for the *Salmonella typhimurum* TA100 strain but in the Zaamar soum, the soil 2 samples weak mutagenic were active. Also the research soil sample water and organic extraction, *E.coli pol⁻, uvr⁻*; mutant have the damaging ability for the test strain DNA.

Conclusion

From data found in these experiments it can be concluded that:

1. The water and organic extraction of soil around enrichment industry, waste water treatment plant and new waste point more toxic property rather than other sampling sites.
2. The samples were involved for the investigation generates mutation activity to the *Salmonella typhimurium* TA100 strain by Ames test. Consequently, water extraction of soil around enrichment industry, ger district and solid waste water were "slightly" mutagenic activity, MCS International LLC, well of sum and new waste point belonged to "moderately" category. Therefore, the organic extraction of soil around enrichment industry, MCS International LLC, liquid waste point and waste water treatment plant belonged to "slightly" category.
3. Therewith, the water extraction of soil around ger district, well of sum, solid waste point, and the organic extraction of soil around MCS International LLC, well of sum, waste water treatment plant and new waste point were with damaging ability DNA of *E.coli.*

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HYGIENIC MICROBIOLOGICAL STUDY OF THE MINING SOIL, ON THE INSTANCE ZAAMAR AND SERGELEN, TUV PROVINCE

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Abstract: The main aim of this study was determinant of some indication of the hygienic microbiology openly mining area located at Zaamar and Sergelen sums, Tuv province. According to microbiological study, 1 g soil in Zaamar soum contains an average of 1.01 Ч 106 cells and 82.5% bacteria, 14.6% actinomycin and 2.9% mold. Gram positive and endangered rods with did not endospore dominated in the soil. As a result of hygienic microbiological investigation, soil samples were subject to different levels of contamination by total bacterial number and coliforms contents contained in soil per 1 g. 8 samples were not contaminated with anerobic bacteria and bacterial pathogens in the study soil were not detected.

Keywords: bacteria, mining industry, pollution, soil

Introduction

The natural resources have been open pit mined in the territories of the Zaamar and Sergelen sums, Tuv province and those circumstances have caused the pollution for the local environment because of the crowded population and machine techniques centralization.

Mining is impacting of decline in soil fertility (degradation, sedimentation), loss of surface vegetation cover, toxic substances, wastes, and deterioration of water quality (drainage, mine dewatering and environmental pollution), air quality degradation (hazardous earth and gas emissions, increased smoke, wind blown waste and hazardous waste) (Gonchigsumlaa, 2008).

The soil is contaminated with solid, liquid waste, plant residues, and domestic and industrial sewage. With these contaminants, large amounts of microorganisms are deposited in the soil for a long time (Lubashenko, 1980). As the pathogens do not multiply or grow in the environment, and due to saprophytic organisms inhibiting them for made directly detected from the external environment, therefore, the main indicator of the contamination of the external environment is a microorganism that lives on the respiratory and digestive pathways of humans and animals. Detection of the hygienic microorganisms from the external environment implies that the object may be contaminated by man and animal contamination and it's prove possibility live the pathogenic microorganisms (Battsetseg, 2011).

The main aim of this study was determinant of some indication of the hygienic microbiology openly mining area located at Zaamar and Sergelen soums, Tuv province.

Method

Sampling: We were collected soil samples from 8 sampling sites of the Zaamar sum and 4 sampling sites of the Sergelen sum, Tuv province in august, 2018 by "Envelope" method (Table 1). 25 m2 square is chosen from the main pointed place where the soil has been polluted from every 1000 m2 square field for the research area and the sample is taken from the square's four corners and central parts or totally 5 points of places, 15-20 cm deep place.

When the sample is taken, the little spade is cleaned well and it is cleansed well with the spirit absorbed cotton by the cotton fire flame and the place to take the sample is dug, the spade is cleansed again, take about 3-5 cm thick part is taken from the hole by the cleansed spade, 150-200 g soil dust is taken from the soil and put it in the clean bottle and cover the bottle mouth with the parchment paper. One sample quantity is not more than 1 kg (MNS 3298-90).

Table 1. Location of sampling sites

№	Elevation	GPS	Location name
1	943m	N 48 18 255', E104 24 638'	Khailaast valley, Zaamar, Tuv province
2	943m	N 48 18 255', E104 24 638'	Khailaast valley, Zaamar, Tuv province
3*	950м	N48 18 462', E 104 24 962'	Red hill, Zaamar, Tuv province
4	945м	N 48 21 245', E 104 30 133'	Bayasgalant mountain, Zaamar, Tuv province
5	914м	N 48 22 001', E 104 29 887'	Bayan river, Zaamar, Tuv province
6	916м	N 48 22 000', E 104 29 886'	The end of Khailaast valley, Zaamar, Tuv province
7	916м	N 48 22 000', E 104 29 886'	Nuruugui hillock, Zaamar, Tuv province
8	984м	N 48 18 978', E 104 26 017'	Well of Khailaast village, Zaaamar, Tuv province
9	1536 м	N 47^{0}27.949', E 107^{0}33.446'	Airag downhill, Sergelen, Tuv province
10	1556 м	N 47^{0}28.131', E 107^{0}33.064'	Airag downhill, Sergelen, Tuv province
11	1555 м	N 47^{0}29.721', E107^{0}32.701'	Airag downhill, Sergelen, Tuv province
12	1619 м	N 47^{0}29.762', E107^{0}25.866'	Airag downhill, Sergelen, Tuv province

*water sample

Laboratory analysis

Conducted a hygienic microbiological investigation of soil samples to 1: 10^1 till 1: 10^6 dilution (MNS 5367:2004).

<u>Total number of bacteria</u>

From the dilution of soil sample inoculated into a sterile Petri dishes with Plate Count Agar plates and incubated at 37 ° C, calculate the number of colonies.

The total number of bacteria contained in soil per 1 g is calculated from the following equation:

$$x = a \times b$$

a- Total number of bacteria

b- Dilution grade

x- Total number of bacteria in 1g soil (Lubashenko, 1980).

<u>Determine of the coliforms – enrichment broth medium and oxidize disc</u>

Using oxidizing methods, from each dilution of soil samples 1 ml inoculated into tubes with Lactose Peptone Broth, *E.coli* Broth liquid medium and incubated. After 24 hours, on the plates with Endo agar, Eosin Methylene Blue Agar inoculated conformance from acid and gaseous forming cultures. Picked up with a sterile loop sparkling metal blushful (Endo) and black (EMB) colonies and oxidase tests using Oxidase disc. The content of coliforms were determined by some morphological indicators (MNS ISO 5367:2004).

Detection of the anaerobic bacteria

In determining the anaerobe bacteria, each diluted soil sample is placed into a sterile tube and heated to a temperature of 80 degrees for 15 minutes. After heating, from last dilution of the soil suspension took 1ml by sterile pipet into a sterile Petri dish and then add until temperature of 45 ° C cooled *Clostridium* Agar and *Perfringens* Agar Base. In the anaerobic atmosphere, for 24 hours at 37 ° C, prepared a preparations from black colonies grown in solid medium and determined *Cl.perfringens* by microscopic examination (MNS 6341 : 2012).

Results and Discussion

On average, 1 g of soil in Zaamar and Sergelen sums contains 1.01x10^6 cells, 82.5% of which are bacteria, 14.6% are actinomycins and 2.9% are mold. (Figure 3)

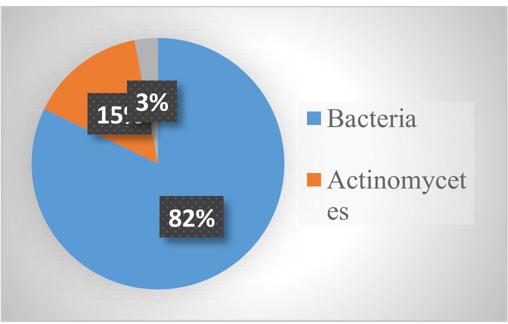

Figure 3. Composition of microorganisms

Result of total number of bacteria

According to the hygienic microbiological study were determined of pollution category of the mining soil bacterium, these include: total number of bacteria contained in soil 1 g, titer of coliforms, titer of anaerobe and content of intestinal pathogenic bacteria.

S.Y.Lubashenko was evaluated by the total number of bacteria, which divided into four pollutants in 1 g of soil, and the number of bacteria is 1-1.5 million is clean, 2 million is slightly polluted, 2.5-3 million is moderately contaminated, and 3-5 million times more polluted.

Table 2. Evaluation of mining soil pollution estimated by the total number bacteria.

Pollution category	Bacterial number (mln cell\g)	Soil sample
Clear	1-1,5	1, 2, 4, 5, 6, 7, 8, 10
Low	2	9, 12
Moderate	2,5-3	-
High	3 and greater	11

As a result of our survey, soil samples belong to different levels of contamination by the total number of bacteria contained in soil per 1 g. Particularly, 1st sample 0,9x10^6 cells / g, 2nd sample 0,63x10^6 cells / g, 4th sample 0.58x10^6 cells / g, 5th sample 0,51x10^6 cells / g, 6th sample 1x10^6 cell / g, 7th sample 1,2 Ч 10^6 cells / g, 8th samples 0,96x10^6 cells / g, 9th sample 1.8x10^6, 10th sample 0.8x10^6 cells / g, 11th sample 3.2x10^6 cell / g, 12th sample 2.3x10^6 cells / g (Table 4).

The results of the study that determined the titer of coliforms

The coliforms content were determined by the titer. Titer is the smallest volume of the studied substrate which detected that microorganism, and the presence of coliforms in the soil testifies to the contamination by the excrement.

Table 3. Results of mining soil pollution were determined by the coliforms

Pollution category	Titer of coliforms	Soil samples
Clear	1 and greater	4, 9, 10, 11, 12
Low	0.1-0.01	2, 5, 7
Moderate	0.01-0.001	1, 6, 8
High	0.001 and less	-

As shown in Table 4, samples 4, 9, 10, 11, and 12 were not contaminated with coliforms, 2, 5, and 7 samples were mildly contaminated, 1, 6 and 8 samples were moderately contaminated.

The findings of the anaerob bacteria

As a result of the survey of soil pollution by aerobic bacteria, samples 1, 2, 4, 5, 6 and 7 were not contaminated with anaerobic bacteria, 8 sample was slightly contaminated (Table 5).

Table 4. Soil pollution was determined by the concentration of anaerobic bacteria

Pollution category	Titer of the anaerobic bacteria	Soil samples
Clear	0,1 and greater	1, 2, 4, 5, 6, 7, 9, 10, 11, 12
Low	0.1-0.01	8
Moderate	0.01-0.0001	-
High	0.0001 and less	-

The study found that bacterial pathogens did not occur in the mining soil of Zaamar and Sergelen soums, Tuv province.

Results of hygienic microbiological studies on mining soil of Zaamar and Sergelen sums were compared with the results of other studies (Gerelmaa, 2009, Oyun-Erdene 2009). The total number of bacteria contained in soil of Zuunmod 1 g is $0.8x10^6$ cells / g, Arvaikheer soil was $3.2x10^6$ the soil of Khongor sum was $4.06x10^6$ cells / g and the soil of Zaamar sum was $0.7x10^6$ cells / g, soil of Sergelen soum was 2,025 $x10^6$ cells / g. Zaamar soil was less than the total number of bacteria from other soums, and Sergelen soils were greater than the soils of Zuunmod, less than the Arvaikheer and Khongor soils.

Conclusion

- According to microbiological study, 1 g soil in Zaamar sum contains an average of 1.01 Ч 10^6 cells and 82.5% bacteria, 14.6% actinomycin and 2.9% mold. Gram positive and endangered rods with did not endospore dominanted in the soil.
- As a result of hygienic microbiological investigation, soil samples were subject to different levels of contamination by total bacterial number and coliforms contents contained in soil per 1 g. 8 samples were not contaminated with anaerobic bacteria and bacterial pathogens in the study soil were not detected.

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ULAANBAATAR SOIL TRACE ELEMENTS POLLUTION AND SPATIAL DISTRIBUTION

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Abstract: Environmental pollution is a worldwide problem that humanity is facing today. It is well known that the soil pollution can affect human health. Soil is considered as a dynamic ecosystem, able to accumulate and transport many components (including trace elements). Some of those trace elements are natural components of the environment, being healthy for humans, animals and plants. However, if the concentrations of these elements are significantly elevated in ecosystems, they are recognized as harmful. Different anthropogenic (wastes from different industries and transportation) and natural (soil-forming processes) sources influence the soil composition and the ability of soil for self-restoration (Kabata-Pendias 2011). The urban soils are much more vulnerable to pollution due to a low capacity of natural self-purification processes. Like in other big industrial cities, the surface soils of Ulaanbaatar city (Mongolia) are exposed to a strong anthropogenic influence due to the growth of the urban population and number of industries, industrial and domestic wastes, and thus have to be subject of continuous environmental monitoring. Pollution and spatial distriburion of Ag, As, B, Ba, Bi, Co, Cd, Cr, Cu, F, Ge, Mo, Mn, Li, Ni, Pb, Sb, Sn, Sr, Tl, V and Zn in the surface soil were identified by factor analysis and geostatistical modeling, respectively. The samples characterized the different areas of the city and had different degree of anthropogenic load: near thermal power plants; roads; residential areas; urban park zones. The statistical procedures were calculated and generalized via Microsoft Office Excel 2013 and STATISTICA 13; the geostatistical modeling was done with ArgGIS 10.1.

An exploration statistical analysis of the data showed that there was one (or more) pollution source. Factor analysis identified five principal components to explain 69.1 % of the total data variance. Ordinary kriging was used to interpolate and map of soil properties. The distributions of the selected factors indicate a high probability of environmental problems for the areas of Ulaanbaatar where thermal power plants and yurt buildings are located, and also point that dust aerosols from coal combustion is the main reason the enrichment of urban soils with trace elements. The specific wind rose contaminates the Central area of Ulaanbaatar by coal combustion products in the Northern areas of the yurt building and TPP-3, located in the West of the city. It is shown that a complete description of the sources of the type of contamination of surface soils of Ulaanbaatar, as well as the development of the most appropriate methodology of corrective actions, require the expansion of the statistical model data of the trace element compositions of the studied soils.

Keywords: soils of Ulaanbaatar, sources of trace elements, exploration statistical analysis, factor analysis, ordinary kriging

PLANT LIFE FORM, GROWTH FORM, AND CLONALITY IN BULGAN RIVER BASIN

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Abstract: Studying plant functional trait is a promising way to tackling important ecological questions such as vegetation responses to environmental variation or change, notably in climate, land use and natural disturbance regimes. Empirical studies on plant functional types and traits have flourished recently and are rapidly progressing towards an understanding of plant traits relevant to local vegetation and ecosystem dynamics. In 2014, we sampled 840 individual plant life from, growth form, and clonality followed international methodological protocol (The handbook for protocols for standardized and easy measurement of plant functional traits worldwide, 2003) instructions to understand how those plant functional traits changes due to altitudinal gradients with different climatic conditions. Sample sites were deliberately chosen to represent relevant vegetation types, ranging from higher mountains to the oases. Based on our result we found plant life form, growth form, and clonality are widely varied in the Bulgan river basin under climate and altitudinal gradients. There are more functional types in lower altitude than the higher altitude. The main reason for this is environmental conditions, vegetation communities are more stable in above 2100m a.s.l comparing the lower zones. High mountain forest steppe occurs in above 2100 m a.s.l whereas steppe, desert steppe, desert and oasis vegetation types are below 1500m a.s.l. Number of hemicryptophytes increases in higher altitudes due to climatic "harsh" condition. Clonality trait vastly founds in lowland and upper mountain areas. This being associated with high grazing pressure by livestock during the winter and summer season.

Keywords: Plant functional trait, altitudinal gradient, vegetation, ecosystem dynamics

APPLICATIONS OF MULTITEMPORAL RS IMAGES FOR LAND COVER CHANGE STUDIES IN BATSUMBER SOUM, TUV AIMAG, CENTRAL MONGOLIA

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Abstract: The aim of this study is to conduct a study on land cover changes in Central part of Mongolian territory using multitemporal optical remote sensing (RS) data sets. As the data sources, Landsat 8 images acquired in 1990, 2000 and 2017 are selected. To define the available land cover classes, the satellite images are classified using supervised (minimum distance, maximum likelihood and support vector machine) and unsupervised (isodata) classification methods and the results are compared. Of these methods, the better results are obtained through the use of the minimum distance and support vector machine methods. Overall, the research indicates that in recent years, the land cover classes in the selected test site have been significantly changed.

Keywords: Multitemporal images, Land cover, Land use, Change studies, RS

Introduction

Land cover is an obviously changing feature of the Earth's landscape and the changes occur due to periodic natural and human modifications. There have been drastic changes in land cover over recent decades (Houghton 2003). Efforts have been made to quantify the nature and extent of anthropogenic changes in land cover on national and local scales. The primary mode of human modified land use has been the conversion and modification of natural ecosystems for agriculture (Ramankutty and Foley 1999). The impact of humans on the environment is not a recent issue. In ancient times, there were many instances of harmful human activities affecting the Earth's landscape (Marsh 1864), and recent decades have provided valuable ideas, methods, tools and techniques to minimize impacts caused by land cover changes. Some researchers have conducted excellent work, documenting these historical changes globally (Ramankutty and Foley 1999; Pongratz et al. 2008) and nationally (LRMP 1986; Uddin et al. 2015). The process of land cover change is very complex and takes different forms, with differences in magnitude and rate. Its dynamics vary according to its scale (Keyser and Kaiser 2010).

Mongolian territory covers northeast and central Asia and has an area of 1.565,000 sq.km. The population of the country is about 3.2 million. The country is surrounded by dense forest in the north, Gobi desert in the south, plane steppe in the east and High Rocky Mountains in the west. Although, the country has different mineral deposits such as copper, coal, gold, molybdenum, fluorspar, uranium, tin, and tungsten, they have not been properly exploited until recently. On the contrary, the main type of land use is pastureland for semi-nomadic livestock husbandry and it covers about 81% of total land of the country. Due to availability of large pastureland the economic activity in Mongolia has been mainly based on herding and agriculture. The actual availability of pasture is determined by rainfall, and access to fodder is determined by the availability of water during summer and of snow during winter. Compared to the pastureland, the use of agricultural land accounts for a very low percentage, because the presence of the Gobi desert and mountains in the west and northwest provide natural limits for its extended use (Amarsaikhan 2013).

The country has harsh continental climate. The winter low temperatures result in heavy snowfalls and the summer high temperatures often result in drought. Moreover, there are frequent forest and steppe fires during spring periods. These adverse climatic conditions often influence the country's fragile economy, specifically, agricultural crop production and animal husbandry. The drought and dzud also affect the productive capacity of the land. When there is drought, the fodder production is too low to feed all animals. As a result, extensive overgrazing occurs, because the increasing livestock numbers have degraded much of Mongolia's grasslands, especially those around major settlements. The drought and high temperatures decrease the cohesion of the exposed fertile topsoil and strong winds blow away the topsoil particles, resulting in dust storms, including yellow dust. Such sustained damage over a longer period of time will result in irreversible changes. With continued pressure of drought and overgrazing, the land degrades and may finally turn into desert (Amarsaikhan et al.2008).

The drought, high temperature and high radiation decrease the cohesion of the exposed fertile topsoil and strong winds blow away the topsoil particles, resulting in dust storms, including yellow dust. Such sustained damage over a longer period of time will result in irreversible changes. With continued pressure of drought and overgrazing, the land degrades and may finally turn into desert, because even improved weather conditions might not immediately restore the old vegetation cover. Currently, in Mongolia the process of desertification is being strongly observed everywhere. For example, compared to 1960, a number of days with dust storms have been increased by a factor of more than four, while grasslands' productivity has been decreased by a factor of five. Many rivers and lakes are drying out. Soils are becoming more and more saline and loose their regenerative capacity. Meanwhile, the mobility of sand has been increased. A recent study has shown that, about 78% of Mongolian total territory has been degraded. Thus, there are many problems related to the environment and natural resources in Mongolia which in turn influence the socio-economic sustainable development of the country (Jetten 2009, Amarsaikhan 2011).

In the present research, we wanted to conduct a study on land cover changes in Central Mongolia using multitemporal optical RS images. To define the available land cover classes, the RS images have been classified using supervised and unsupervised classification methods and the results were compared. In the study, water and farmland classes were digitized from a topographic map of the test site, because, these classes were difficult to classify by the use of supervised classification. The analysis was carried out using ENVI system installed in a PC environment.

Test area and data sources

As a test site, Batsumber soum located in Tuv aimag (province) has been selected. The area of the Tuv aimag is considered as part of the Khentii-Khangai Mountain Range and Eastern Mongolian plains and most of its territory is elevated in between 1200m and 1500m above sea level. Large mountains and valleys lie in the north (as for the selected test area) and a steppe with small hills and mound sit in the south of the aimag. The Batsumber soum is bordered with the Selenge aimag to the north and with other soums of the aimag in all other directions. Steppe chestnut and light chestnut soil is dominated in most of the test site. The area has a harsh climate and the annual average temperature usually drops below 0 degree.

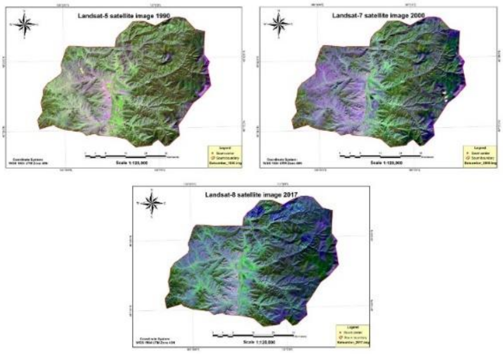

Figure 1. Multitemporal Landsat images of the Batsumber soum, Tuv aimag.

The data used consisted of series Landsat data sets acquired during summer period of 1994, 2000 and 2014. The Landsat images have seven multispectral bands and the spatial resolution is 30 m for the reflective bands, while it is 120 m for the thermal band of the TM and 60m for the band 6 of the ETM+. In the present study, channels 2,3,4,5 and 7 have been used. In addition, a topographic map of 1986, scale 1:50,000 and a general land use map of 1985, scale 1:100,000 were available, accordingly. Figure 1 shows the study area in multitemporal Landsat images.

Georeferencing of the Landsat data sets

In the beginning, the Landsat series images were georeferenced to a UTM map projection using more regularly distributed ground control points (GCP)s defined from different sites on the topographic and general land use maps of the test area. Generally, the GCPs have been selected on clearly delineated sites such as river valleys, morphological structures and roads. For the transformation, a second-order transformation and nearest-neighbour resampling approach (ERDAS 2010) were applied and the related root mean square (RMS) errors were in between 0.63 pixel and 0.96 pixel.

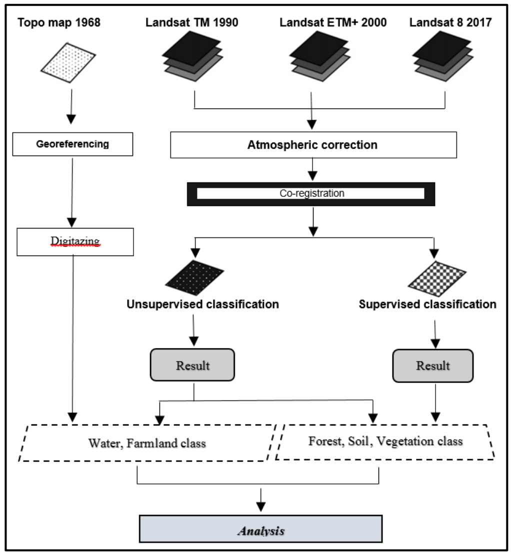

Figure 2. Methodological scheme.

Classification of the images and land cover change studies

After the georeferencing, the images have been classified using such supervised and unsupervised classification techniques as the minimum distance, maximum likelihood, support vector machine and isodata clustering. The minimum distance rule calculates the spectral distance between the measurement vector for the candidate pixel and the mean vector for each signature(ENVI 2004). The maximum likelihood classification is the most widely used supervised classification technique, because a pixel classified by this method has the maximum probability of correct assignment, while the objective of the support vector machine algorithm is to find a hyperplane in an N-dimensional space(N—the number of features) that distinctly classifies the data points.(Cortes, Corinna; Vapnik, Vladimir N.1995). Unlike these methods, the isodata is iterative process that repeatedly performs the entire classification and recalculates statistics. It uses minimum spectral distance to assign cluster for each candidate pixel (Mather 1999). The process begins with a specified number of arbitrary cluster means or the means of existing signatures, and then it processes repetitively, so that those means shift to the means of the clusters in the data (ERDAS 2011).

In the present study, as the features for the classification, for all data sets green, red, near infrared and two middle infrared bands have been selected. To define the sites for the training signature selection, from the images of different years, several areas of interest (AOI) have been selected for the available classes such as soil, water, forest, green vegetation and pastureland using the local knowledge and land use map. Then, the separabilities of the selected training signatures were evaluated using Jeffries–Matusita distance (Richards1999) and the samples which demonstrated the best possible separabilities were chosen to form thesignatures. The final signatures included about 95-484 pixels.

In the case of 1990 data, after the visual inspection, it was seen that the best result has been obtained by the use of the minimum distance decision rule. As could be seen from the results, the worst classification result has been obtained by the use of the unsupervised classification method, because there were very high mixtures among the classes: green vegetation, soil and farmland. In addition there were many areas classified as water. Unlike other methods, the second better result has been obtained by the use of the maximum likelihood classifier, although, the result had some mixtures between the vegetation and forest classes. The results of the classifications of 1990 data are shown in Figure 3.

As could be seen from the results of the classification of 2000 images, the best result has been obtained by the use of the support vector machine classifier. Moreover, it is seen that the worst classification result has been obtained by the use of the isodata clustering method as in the previous case, because there were high mixtures among the classes as green vegetation, soil and forest.

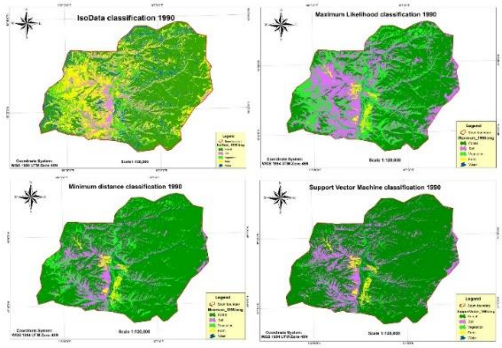

Figure 3. The results of the classifications of the Batsumber soum, Tuv aimag (1990).

Again there were many areas misclassified as water and farmland. In the case of this classification, the second better result has been obtained by the use of the minimum distance classification, although, the result had different mixtures between the forest and soil classes. The results of the classifications of the 2000 data are shown in Figure 4.

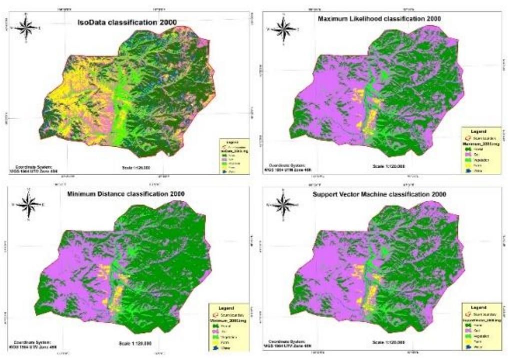

Figure 4. The results of the classifications of the Batsumber soum, Tuv aimag (2000).

As seen from the results of the classification of 2017 image, the best result has been obtained by the use of the minimum distance classifier, because there were very little mixtures among the statistically overlapping classes such as green vegetation and farmland. Moreover, it is seen that the worst classification result has been obtained again by the use of the isodata clustering method, because there were high mixtures among all classes. For the 2017 image, the second better result has been obtained by the use of the maximum likelihood and support vector machine classification methods, because these results looked very similar to the result of the minimum distance method. The results of the classifications of the 2014 data are shown in Figure 5.

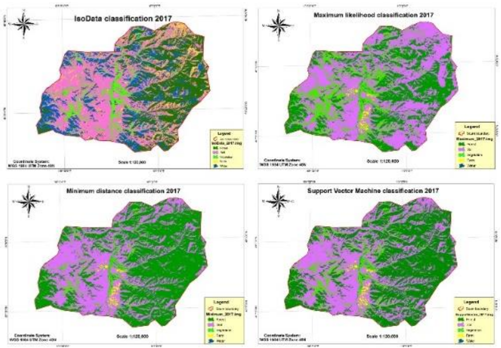

Figure 5. The results of the classifications of the Batsumber soum, Tuv aimag (2017).

The areas related to the selected classes evaluated from RS images obtained at different years are shown in table 1. As could be seen from Table 1, in recent decades the test site has faced many changes and the areas of the classes have been significantly changed since 1990. In order to define the areas related to land cover changes, the total areas related to each class were defined by calculating statistical parameters of the classified multitemporal RS images.

Conclusion

The aim of this research was to carry out a study on land cover changes in Central Mongolia using multitemporal staellite data sets. As the data sources, Landsat images from 1990, 2000 and 2017 were selected. To classify the available land cover classes such as soil, water, forest, green vegetation and farmland minimum distance, maximum likelihood, support vector machine and isodata classification methods were used and the results were compared. Among the applied techniques, the better results were obtained by the use of the minimum distance decision rule and support vector machine classifier. Overall, the study indicated that over recent years, the land cover classes in the selected test site have been significantly changed.

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Table 1. The total areas for the available classes in different years, evaluated from multitemporal Landsat data sets

№	**Year**	**Water (Ha)**	**Forest (Ha)**	**Farmland (Ha)**	**Soil (Ha)**	**Vegetation (Ha)**
1	1990 (minimum distance)	1172	180842	3998	31958	24738
2	2000 (support vector machine)	1235	125096	3450	96795	16132
3	2017 (minimum distance)	876	122860	1527	101337	16109

PIXEL-BASED CLASSIFICATION OF FOREST AREA USING MULTI-SOURCE SATELLITE IMAGES IN CENTRAL MONGOLIA

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Abstract: The aim of this research is to conduct a forest resources study in central Mongolia using the integrated optical and SAR data sets. As data sources, microwave Sentinel-1B C-band dual-polarization data and optical Sentinel-2B images are available. After creation of a pseudo color image using a principal component analysis (PCA), a supervised classification is conducted. For the classification of forest types, a support vector machine (SVM) classification method is used. The result has been evaluated using an accuracy assessment technique. Overall, the research demonstrated that the combined optical and SAR features can be successfully used for forest resources study in Mongolia.

Keywords: Remote sensing (RS), PCA, SVM classification, forest

Introduction

Forest is one of the most important natural resources in our planet and plays a fundamental role in the economic, social, cultural and sustainable development of the nations (Wang et al. 2012). Actual management of forest resources requires consistent and updated information about the status and trends of forest resources. Generally, all levels of the government, private entities and research institutions have conducted a wide range of forest inventory and monitoring efforts. In order to successfully manage the forest resources, the forest and land managers should require a much greater volume of information with different spectral characteristics and larger spatial and temporal scale (Peterson et al. 2000).

As the present RS techniques and methods are so advanced, it is possible to produce a reliable forest map and use it for planning and management (Amarsaikhan et al. 2011, Enkhjargal et al. 2015).

The study site is a forest located between the Siberian taiga and the Mongolian plateau of grassland, a region that plays a vital role in preventing soil erosion, regulating the water regime, and providing suitable conditions for wildlife and Biodiversity conservation (Tsogtbaatar, 2000). However, forests in Mongolia grow in harsh climatic conditions here low precipitation and high radiation rates prevail throughout the year (FAO 2011); hence, they have a low capability to restore naturally and a heightened sensitive to forest wildfires, plagues, and degradation by human influence (Mьhlenberg et al. 2012). For these reasons, a detailed description of the Mongolian forests is relevant for sustainable management purposes.

The purpose of this study is to conduct a forest resources study in central Mongolia using the integrated optical and SAR data sets. Overall, the research demonstrated that the combined optical and SAR features can be successfully used for forest resources study in Mongolia.

Study area and data sources

As a test site, Bulgan soum located in Arkhangai aimag (province) has been selected. Arkhangai aimag is situated in the central part of the Khangai mountain range and its territory comprises mountains, steppe and plains. Over 70 percent of the territory of the aimag is pasture land, almost 2 percent with hay fields, about 1 percent with sown area, and 15 percent of the territory is covered with deciduous and coniferous forest.

The study area has an area of 3220 km^2 with a forested area of 410 km^2, approximately 12.7% of the total area. The topography is relatively mountainous area. The elevation range is between 1620 and 3464 m above sea level.

In the current study, the satellite data used consisted of geocoded Sentinel-2B multispectral images acquired on 18 August of 2018 and Sentinel-1B C-band dual polarization radar image acquired on 3 August of 2017 and topographic maps of the area. The ground truth information was acquired through a forest inventory, which by law has to be conducted for specific forest areas in Mongolia. In the study area, the forest inventory started in 2012 and ended in 2013. The data analysis and processing was completed by the Forest Division in the Ministry of Nature and Environment (MNE).

Methodology

The main goal of this study was to map the change of forest area using satellite image data and the ground truth data. According to the field surveying, the study area has four main tree species: larch (Larix Sibirica), cedar (Pinus Sibirica), poplar (Populus) and willow (Salix sp.). The larch is a dominating forest and it covers approximately 93.3% of the forested area in the study site. However, 11.8% of the larch forest was burned by wildfire. All datasets acquired for this study are shown in Figure 2.

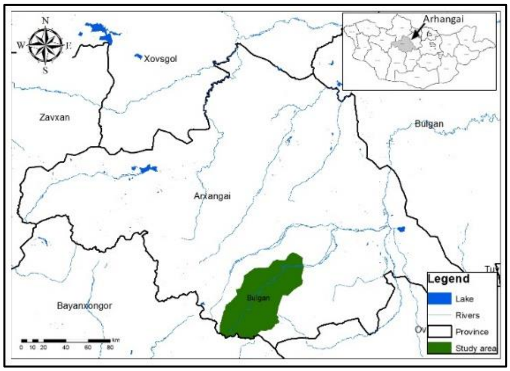

Figure 1. Location of the study area

In some areas of the forest classes represented on the optical images, the boundary between fuzzy classes: grass-herb and young forest could not be distinguished due to their similar spectral characteristics. However, these two classes might be distinguished on the SAR images because they have different structures that can cause different backscatter return. These two fuzzy classes have the following backscattering properties (Amarsaikhan, 2004). From forest canopy, at different radar wavelengths, volume scattering derived from multiple-path reflections from leaves, twigs, branches and trunks can be expected. However, in case of the C-band SAR data sets only volume scattering from the top layer of the forest (Amarsaikhan, 2013).

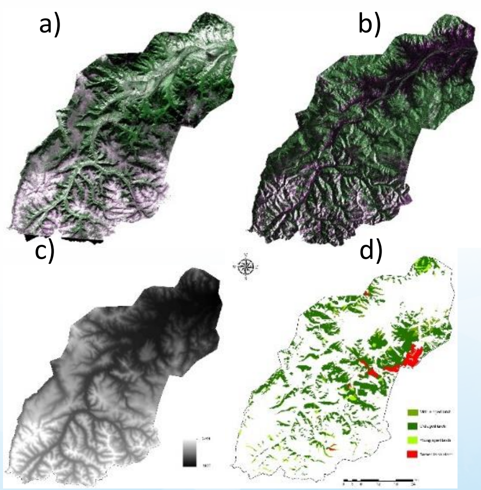

Figure 2. a) Sentinel 2B image, natural color b) Sentinel 1B, VH, VV polarization c) SRTM digital elevation model d) Forest reference map

In this study, PCA has been performed for the image fusion of the multisource datasets. The image fusion a technique used to combine image of different spatial and spectral resolutions. In other words the image fusion is the integration of different digital images in order to create a new image and obtain more information that can be separately derived from any of them (Amarsaikhan *et al*. 2012).

The PCA is a statistical technique that transforms a multivariate data set of intercorrelated variables into a set of new uncorrelated linear combinations of the original variables, thus generating a new set of orthogonal axes. It is also a data compression technique used to reduce the dimensionality of the multidimensional datasets and helpful for image encoding, enhancement and multitemporal dimensionality (Richards and Xia, 1999).

For the actual classification a SVM method has been used. In RS applications, SVM was primarily used for the hyperspectral image classification and object detection, although researchers have recently expanding its application for multispectral remote sensing data provided a detailed introduction of SVM to the RS community (Melgani and Bruzzone, 2004).

Results and discussion

In order to carry out forest analysis, the Sentinel images were thoroughly analyzed in terms of brightness and geometric distortion. The images were of a good quality and did not include distortions or noise. Then, the Sentinel images were successively geometrically corrected to a UTM projection using a topographic map of the study area, scale 1:100.000. The ground control points were selected on clearly delineated sites and in total 16 regularly distributed points were chosen. For the actual transformation, a second order transformation and nearest neighbor resampling approach (Mather and Koh, 2011) have been applied and the related root mean square errors were 0.57 pixel and 0.63 pixel. Then, image fusion has been applied to the optical and SAR images. The image fusion a technique used to combine image of different spatial and spectral resolutions. In other words the image fusion is the integration of different digital images in order to create a new image and obtain more information that can be separately derived from any of them (Amarsaikhan *et al.* 2012).

PCA has been performed using all available bands and the result showed that the first three PCs (principal components) contained 93.4% of the overall variance. The visual inspection of PC4 and others indicated that they contained noise. A color image created by the use of the first three PCs is shown in Figure 3.

After the image fusion, the image has been classified using SVM supervised classification technique. Initially, to define the sites for the training signature selection, area of interest representing the available four classes (old, middle, young aged larch and non-forest).

For the accuracy assessment of the classification results, the overall performance has been used. This approach creates a confusion matrix in which reference pixels are compared with the classified pixels and as a result an accuracy report is generated indicating the percentages of the overall accuracy (Amarsaikhan *et al.* 2011). As ground truth information, different AOIs containing 2,585 purest pixels have been selected. AOIs were selected on a principle that more pixels to be selected. The overall classification accuracy for the selected classes were 80.29 % using PC bands. Figure 4 shows a forest map created by the SVM classification method. Table 1 shows the area size of the forest.

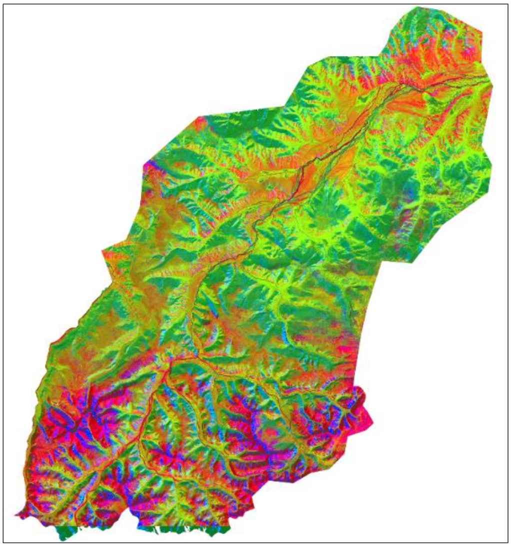

Figure 3. Image created by the PCA method (Red-PC1, Blue-PC2, Red-PC3)

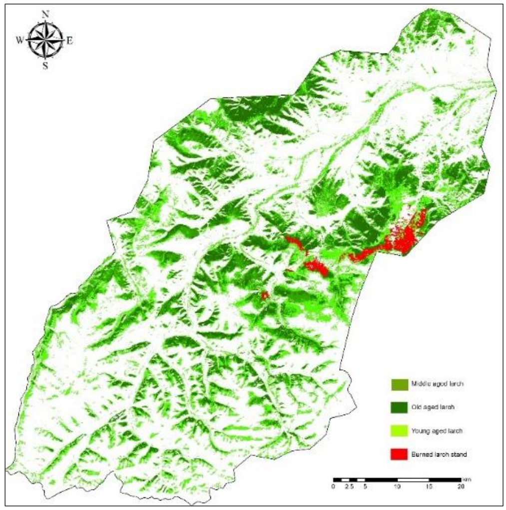

Figure 4. Classification result

Table 1. Area of larch forest

1	Forest types	2013 (км^2)	2018 (км^2)
	Old aged	330.664741	382.722264
	Middle aged	36.23877	29.1547
	Young aged	12.752183	68.06399
	Larch	379.655694	479.940954
3	*Burned larch*	44.797094	14.836667

To compare the final result with the existing information, a GIS layer was created using a ground truth of 2013 and ArcGIS system.

As seen from Table 1, in recent five years the middle aged larch forest has been decreased, but old aged and young aged larch forest have been increased, respectively. However, the burned larch area has been reduced due to recovery. It seen that the most significant increase occurred in young aged larch class. As could be seen from the final result, the class of burned trees was transformed into the class of young forests.

Conclusion

The main goal of this study was to conduct a forest resources study in central Mongolia using multisource satellite datasets. As data sources, multispectral optical images, C-band dual polarization microwave images and ground truth data were used. Overall, the research indicated that in recent years, the forested area in the selected site have been significantly changed and multisource information could improve the interpretation and analysis of forest classes.

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OBJECT-BASED CLASSIFICATION OF NORTHERN BOREAL FOREST IN MONGOLIA

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Abstract: An accurate classification of tree species is essential for sustainably managing forest resources and effectively monitoring species diversity. The aim of this study is to conduct classification of boreal forest using optical images. For this purpose, a boreal forest-dominated site near the Lake Khuvsgul located in northern Mongolia is selected. Sentinel-2 images acquired on 17 August and 18 October of 2018 are used. To produce a reliable boreal forest map from the Sentinel-2 images, an object-based classification technique is applied. For the classification, initially, the multiresolution segmentation is performed. The selected parameters: scale, shape, compactness were set as 120, 0.3 and 0.5, respectively. Then, the image objects were assigned to the corresponding classes using a rule-base. Overall, the research demonstrated that advanced classification technique based on object- segmentation is a reliable tool for forest studies.

Keywords: Boreal forest, Mongolia, Object-based image analysis (OBIA), Sentinel-2 images

Introduction

Tree species diversity is a relevant parameter to describe forest ecosystems. Traditional forest inventories and other field-based data acquisition methods are not possible to acquire detailed tree species information over large areas purely on the basis of field assessments. Therefore, remote sensing (RS) is particularly useful for this task (Rautiainen and Lukes, 2015).

Over the past few years, object-based classifications have been increasingly used for different mapping applications. These methods have been developed in order to improve the traditional pixel-based classification techniques. Unlike the pixel-based classifications that are based on the information of each pixel in the data, the object-based classifications are based on the information from a set of similar pixels called image objects. The image objects are groups of pixels that are similar to one another based on the spectral properties, size, shape, and texture, as well as context from a neighborhood surrounding the pixels. The object-based method uses a segmentation process and iterative learning algorithm to achieve a semi-automatic classification procedure that demonstrates more accurate results than traditional pixel-based methods (Grenzdцrffer, 2005, Hay and Castilla, 2006, Liu and Xia, 2010, Weih and Riggan, 2012).

The Mongolian forests are mainly located in the northern parts of the country along the Russian border forming a transition zone between the Siberian taiga forest and the Central Asian steppe zones (Tsogtbaatar, 2002). In the past, total forest related area of Mongolia constituted about 17.5 million ha or 11.2% of the total land area. The area of potentially exploitable forest was estimated to be between 5 and 6 million ha. However, recently, forest land degradation has become the main concern in the country.

It has been found that much of the existing forests have been destroyed, mainly by timber preparation, legal and illegal logging, forest fires and careless human activities. To account all of these changes, forest specialists need to have an updated forest map. As the present RS techniques and methods are so advanced, it is possible to produce a reliable forest map and use it for planning and management (Amarsaikhan *et al.* 2011, Enkhjargal *et al.* 2015).

The aim of the study was to classify different tree species within northern boreal forest in Mongolia. For this purpose, an object-based classification technique based on a multi-resolution segmentation and constructed rule-base have been applied.

Materials and Methods

Study area

Forests in Mongolia comprise 140 species, 84% of which is coniferous and deciduous forests of the Forest Steppe, Boreal Forest, and Montane zones (FAO, 2011). The study area is boreal forest site located in the Northern part of Mongolia, particularly within Khankh soum, Chandmani-Undur soum, Tsagaan-Uur soum and characterized by such main classes as coniferous forest, deciduous forest, grassland, light soil, dark soil and water. The annual precipitation in the region is about 350-400 mm and it makes the area as the most humid region in the country (Amarsaikhan *et al.,* 2012). The height above sea level varies between 750 and 2500 meter. Figure 1 illustrates the study area.

Figure 1. The location of the study area

Dataset

In the present study, we used two Sentinel-2 images acquired on 17 Aug and 16 Oct, 2018 with low cloud covers (Figure 2). The satellite carries single multi-spectral instrument with 13 spectral channels. The visible and near-infrared (NIR) band have 10m, the vegetation red edge bands and shortwave infrared (SWIR) bands have 20m and the rest of the bands have 60m resolution (Agancy, 2015).

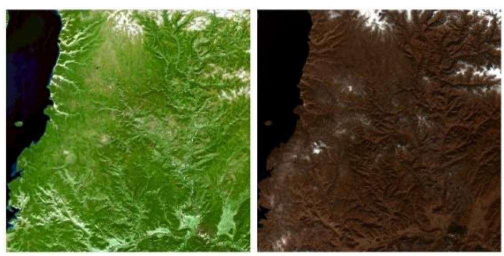

Figure 2. Sentinel 2 images acquired on Aug 17 (left) and on Oct 16 (right), 2018.

Object-based classification

The OBIA method employs spectral and spatial information simultaneously (Zhou, 2013). This method can increase the amount of information regarding the object in the classification, such as color, texture and compactness. This method can also reduce the number of units to be classified (Youjing & Hengtong, 2007).

Object-based boreal forest classification with Sentinel-2 data mainly consists of 2 steps, including (1) extraction of image objects using a multiresolution segmentation algorithm and (2) rule-based classification based on segmented objects. eCognition Developer 8.64 software (formerly Definiens) of Trimble Germany GmbH (Mьnchen, Germany), which was specifically created as a powerful instrument for object-oriented image analysis (Benz et al., 2004), was chosen for the purpose of this study.

Segmentation is one of the critical aspects of object-based classification. In the segmentation process, size, and shape of desired objects are defined by the calculation of heterogeneity between adjacent pixel, where scale is the main input parameter and have a significant effect on classification accuracy (Hajek *et.al.,* 2014). Although several tools have been developed to automate some of the parameter selection (Zhang *et al.,* 2010 and Dragut, *et al.,* 2010), human interpretation of the results and subsequent adjustments to the parameters is still a common practice that yields acceptable results. Hence, suitable segmentation is achieved by adjusting the parameters such that we minimize the number of image objects that comprise a physical item in the image while avoiding objects that span to areas outside of said physical object. The selected parameters: scale, shape, compactness were set as 120, 0.3 and 0.5, respectively.

Rule-based classification is based on the rules that have been defined by object attributes. Rule set development is based on the varying knowledge of analysist regarding the spatial, spectral, and textural characteristics of each feature (Shojanoori *et al.,* 2016). For this study, three types of indices, two types of band ratios, mean spectral reflectance values of several bands of has been estimated for the summer and fall images. The classes vegetation and non-vegetation were distinguished first, using a normalized difference vegetation index (NDVI). Non-vegetated areas were classified into two further classes: water and clear-cuts using automated water extraction index (AWEI). The single broad class of vegetation was re-classified into forest and non-forest using ratio of green and red bands. Separating forests into species, including cedar, larch and birch was reasonably accomplished through the threshold value of green leaf algorithm (GLA), ratio of near-infrared and red bands and mean spectral reflectance of red edge, near-infrared bands. The purposed class hierarchy in eCognition Developer is presented in Figure 3.

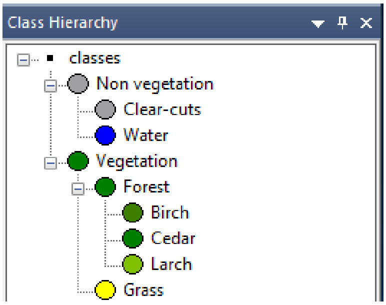

Figure 3. Class hierarchy of rule-based classification

Results

As seen from Figure 4, the image objects have been created by combining similar pixels based on their properties, and a total of 14618 image objects were detected.

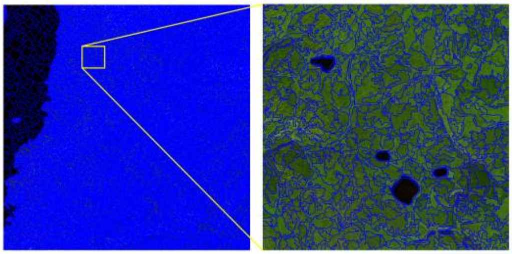

Figure 4. Multiresolution segmentation results.

Figure 5 shows the result of vegetated and non-vegetated area separation. Figure 6 presents classification of surface water and clear-cuts, respectively.

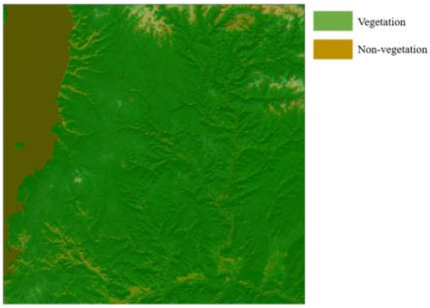

Figure 5. Classification result of vegetated and non-vegetated areas

The result of the classification of forest and grassland is shown in Figure 7. As could be seen from this figure, most of the vegetated area is covered by forests. Finally, the classified individual species of the boreal forest is shown in Figure 8. These results indicate that developed rule-based technique based on optical RS data is reliable tool for tree species classification of boreal forests.

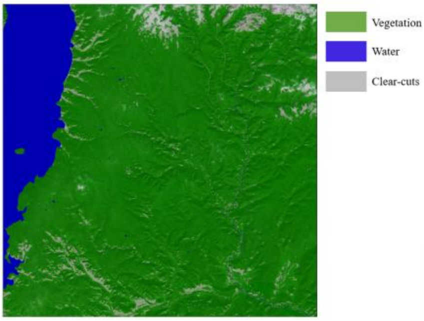

Figure 6. Classification result of water and clear-cuts

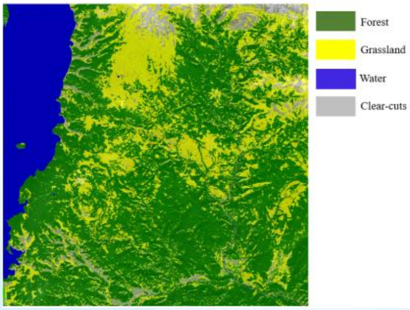

Figure 7. Classification result of forest and grassland

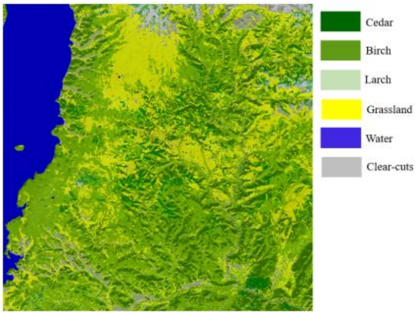

Figure 8. Classification result of forest types

Discussion and Conclusions

The aim of the research was to produce a reliable boreal forest map using multitemporal optical Sentinel-2A images. As a test site, northern area of Mongolia with highly mixed forest types was selected. For the extraction of the forest class information, the object-based classification technique was applied. To derive the thematic information, initially, to the selected remotely sensed images, multi-resolution segmentation was applied. Then, the obtained image objects were classified into different forest classes using the developed rule-base. The rule-base contained a hierarchy of rules, describing different conditions under which the actual classification should to be accomplished. The results of the study indicate that the object-based classification technique based on the well-constructed rule-base is a reliable tool for forest studies.

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SOURCE AND ASSESSMENT OF SOIL HEAVY METALS POLLUTION OF ERDENET AND ULAANBAATAR CITIES, MONGOLIA

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Abstract: The purpose of this study was to calculate the source and assessment soil heavy metals pollution in Ulaanbaatar and Erdenet cities where more than half of Mongolia's population lives. The pollutions of heavy metals in urban soils are affected by multiple factors including land uses, air pollution, household solid wastes, and automobiles. A total fifty-two soil pollution samples were collected in a depth of 0-20 cm of soil surface from different parts of the cities and analyzed for their As, Cr, Cu, Mo, Co, V, Fe, Ni, Zn, Pb and Cd. The concentration of Arsenic (As) was exceeded the permissible limit (6mg/kg) stipulated by the Mongolian soil standart at all the sampling sites of Ulaanbaatar city. However, the mean concentrations of elements such as Cr, Cu, Pb, Cd, and Zn in the urban soils were above the background values. The assessment of soil metal pollution was calculated using the contamination factor (CF). The CF values for As, Cd and Pb were significantly high at all the samling sites. The concentration of Cr, Cu and Zn assumed to be moderate contaminated at all the sampling sites. To calculate the pollution load index (PLI) all the soil samples had a PLI greater than 1, indicating metals contamination. Calculating the contamination degree (Cd) of soil metals pollution, four points had high, fifteen points had moderate, three points had low degree of contamination. The extent of soil metal contamination was assessed using the crustal enrichment factor (EFc). Arsenic (As) had the most high and lead (Pb) had the second highest EF values among metals studied. The source of As pollution in soil appears to be the coal combustion in power plants and stoves in Ger district and geological minerals of urban. For Pb enrichment may be related to the remarkable increase in the number of used vehicles and the increase in the use of leaded fuel in recent years. Also Cu, Zn, Cd, V exhibited moderate and Cr, Ni, Sr, Co miner enchrichment. The concentration of Cu, Mo and As were higher than the permissible limit according to the Mongolian soil standard at more than 50 percent of the all the sampling sites of Erdenet city. Calculating the contamination factor(CF), Cu and Mo were highest, As was considerable and Co, Cr, Ni, Pb, V, Zn were moderate contaminated. PLI was higher than 1 at all the samples. The enrichment factor of these elements is relatively high, or is influenced by anthropogenic. At the urban location, there was highly contaminated with Cu and Mo, which are major elements of ore minerals. But concentration of Cu and Mo are high in ore minerals composition in soil geological formation of Erdenet city and related with content of metals in white dust formed by proccess of copper–molybdenum (Cu–Mo) mines. As is accompanied by rare elements like gold and copper. For that reason content of As in the soil was high.

Keywords: Soil pollution, heavy metals, contamination factor, pollution load index, contamination degree, enrichment factor

Introduction

The soil cover is accumulation of chemical elements circulating in biosphere and obtainer of their compositions. Heavy metals are one of the main sources of environmental pollution, they are dangerous for human health, life of animals, quality of the atmosphere and surrounding environmental quality. They can affect biogeochemical cycles and accumulate within living organisms because they are not degraded by physical processes, therefore, they have the ability to persist for a long time. Heavy metals in urban soils are very useful tracers of environmental pollution. They may result from many different sources such as industrial discharge and energy production, chemicals used in agricultural production, construction, vehicular exhaust and particulate emission, vehicle wear, airborne dust and coal and fossil fuel combustion. Generally, heavy-metal pollution is the most abundant and persistent problem in urban areas. Toxic metals accumulate in urban environment due to their non-biodegradability and long residence time. In urban areas, these heavy metals have become a potential threat to human health and have severely disturbed the natural geochemical cycling of the ecosystem. Furthermore, metals have a direct influence on public health as they can easily enter human bodies by dust ingestion, dermal contact, or breathing.

Ulaanbaatar is the capital and also the largest city of Mongolia. The surface water of Ulaanbaatar is included in the Tuul River Basin. It is located in the north-central part of the country at an elevation of about 1300-1400m in the Tuul river valley, which is surrounded by mountains, resulting in adverse environmental impacts in urban areas such as air pollution and accumulation of soil and water pollution in the center of the city. Ulaanbaatar, a capital city of Mongolia, a home of almost 1.4 million people. Past several decades the mobility to city from rural areas increased drastically resulting in high demand for consumption and production of waste and other unwanted products which stresses the environment. The soil erosion and contamination spread all over Ulaanbaatar due to expanding ger district, illegal land applications. There are almost no soil-reclamation activities, such as covering soil with green plants or trees in Ulaanbaatar. There are almost no soil-reclamation activities, such as covering soil with green plants or trees in Ulaanbaatar.Therefore, this research is focused to study the heavy metal pollution in urban soil and identify the enrichment factor for each elements in order to prevent future pollution and to reclaim.

This study has chosen the urban and local areas near Erdenet factory which has been operating for more than 30 years and has a good capacity as my research object. The soil of the areas near the industrial zone, especially near the big, and long-lasting factories, are contaminated due to the factory operation. Moreover, there is no research dedicated wholly to the origin and process of the contamination from the mining sector. Therefore it is better to determine the origin of the contamination by comparing clean, healthy soil collected around the industrial zone with the contaminated soil collected within the industrial zone. The macro and microelements in the soil of the industrial zone differ due to the mining field's soil's general characteristics and features of the element in the ore. However, it cannot be assumed that the content of heavy elements is only related to minerals. This is because the content of heavy elements in the soil contaminated by mining activities is high.

Materials and methods
Contamination factor (CF)

To calculation of contamination factor is concentration of metal in present point compared to background and for value of contamination factor, soil contamination is classified as follows (Hakanson.L, 1980).

CF<1	**Low contamination**
1<CF<3	Moderate contamination
3<CF<6	Considerable contamination
6<CF	Very high contamination

Pollution load index (PLI) The pollution load index (PLI) is generally assessed for the presence of heavy metals in present points, and is calculated using the formula CF using each formula (Tomlinson DL,, 1980).

$$PLI = (CF_1 \times CF_2 \times CF_3 \times \ldots CF_n)^{1/n}$$

This empirical index provides a simple, comparative means for assessing the level of heavy metal pollution. In present point PLI>1, pollution is considered to be present, whereas if PLI<1, no pollution is assumed.

Contamination degree (Cd)

In addition, using the summation of CF values, the degree of contamination (Cd) can be determined (Loska.K, 1997).

(Cd = Cd 1+ Cd 2+ .... Cd n)

C_d < 10	low degree of contamination
10< C_d <20	moderate degree of contamination
20< C_d <40	considerable degree of contamination
40< C_d	very high degree of contamination

Enrichment factor (EF)

EF can be used to determine the source of soil pollution. EF is a good tool to differentiate the metal source between anthropogenic and naturally occurring.

$$EF = \frac{(M_x/Fe_x)_{sample}}{(M_c/Fe_c)_{crust}}$$

This study is used result of metals average concentration in earth crust (Wedepohl.K, 1995).

EF<1	Indicates no enrichment
1<EF<3	Minor enrichment
3<EF<5	Moderate enrichment
5<EF<10	Moderately severe enrichment
10<EF<25	Severe enrichment
25<EF<50	Very severe enrichment
EF<50	Extremely severe enrichment

Result and discussion

Total twenty-two soil samples were collected from Ulaanbaatar city and calculated the CFs, Cd, and PLI of heavy metals in urban soil. For the CF value, Concentration of Ni in most points, Cr, Cu, Zn in total points is concerned classification of low and moderate degree contamination. Also concentration of Cd, Pb in 2, 3, 5, 6, 7, 8, 9, 10, 12, 13, 14, 17, 18, 19, 21, 22nd points is concerned classification of considerable, very high degree of contamination. PLI in the all soil samples had greater than 1, indicating metals contamination problems. Cd in each point is calculated by total content of metals Cr, Cd, Pb, Cu, Zn, Ni, are presented in Figure 3. From the result, in 21st point is very high contaminated, 2, 8, 22nd points are considerable contaminated, 1, 4, 16th points are low contaminated, other 15 points are moderate contaminated.

Figure 1. Results of the spot distribution showed by contamination degree of heavy metals in the total points of Ulaanbaatar

Calculated enrichment factor to determine the natural and human activity resource of heavy metals pollution in soil are presented in figure 2. As shown in the picture, to calculate the heavy metal enrichment factor, most metals are contaminated by anthropogenic sources. Arsenic (As) EF 1.9-11.1 pollution caused by human activities. This observation is related to the high content of As in some coals, which are the main energy source. The As content in the coal samples from ten large mines of Mongolia was determined. Results showed the highest As concentration for the coal samples sourced from Baganuur (183 mg/kg) and Nalaikh (121 mg/kg), which are the main coal suppliers for power plants in Ulaanbaatar city. Ger-dwelling residents and the three power plants in Ulaanbaatar mainly use coal from these two fields as fuel. The Baganuur coal deposit is the main fuel supplier of Ulaanbaatar city. Thus, the residual-ash-containing toxic chemical elements resulting from the combustion of coal may have spread in the city. This is responsible for the high content of As in the soil samples. Lead (Pb) had the second highest EF values among metals studied (1.0–13.4). This result indicated that Pb pollution is related to vehicle emission resulting from the use of leaded gasoline. Recently, the number of used cars in Ulaanbaatar has increased sharply. Unfortunately, leaded gasoline is still being used in Mongolia, and used cars release a considerable amount of smoke containing Pb and other toxic chemicals. Another main source of Pb contamination is the utilization of coal in the city. After the combustion of the coal, the residual-ash-containing Pb probably spread to the rest of the city by wind. EF of Zn was 1.3-6.6 which is moderate enriched in urban soil, Cr (0.6-2.6), Cd (1.0-19), Cu (0.8-6.1), Sr (0.9-2.1) is classified as miner enrichment. The other elements (Co, Ni) displayed relatively lower EF values (EF<1 or close to 1) indicating that these metals in soil are originated from natural sources dominantly.

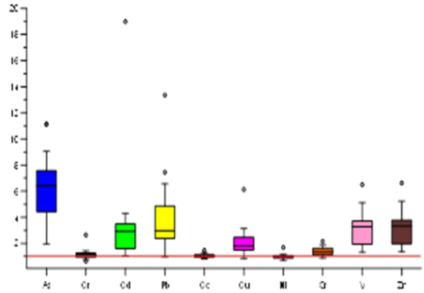

Figure 2. Heavy metal enrichment factor in soil of Ulaanbaatar

Total thirty soil samples were collected from Erdenet city and calculated the contamination factor in all the sampling sites. The CF values for Cu, Mo were very high contaminate (e.g., 1.3–79.0) at all the sampling sites, indicates that high degree of Cu contamination from anthropogenic sources. PLI calculated that there were more than 1 in the total points indicated heavy metals contamination. Calculating the Cd of the soil as heavy metals in all the sampling sites, the concentrations of nine metals (As, Cr, Pb, Co, Cu, Ni, Pb, V, Zn) were found to be very high contaminated at 6 points, moderate contaminated at 11 points, considerable contaminated at 12 points and low contaminated at 1 point. Cu and Mo were metals that has been very severely enriched in urban. From the EF values, soils was heavily contaminated with Cu and Mo, the main components of the ore materials from the Erdenet mining activities. The second sources of Cu, Mo in surface soil was white dust formed by Erdenet mining activities. EF of Zn (0.7-24.7), As (2.3-14.9), it is considered as a higher contaminated. As is accompanied by rare elements like gold and copper. For that reason content of As in the soil was high. In total samples, EF of Pb (0.3-4.5), Cr (0.7-6.5), Ni (0.6-3.0), Sr (0.8-2.3) and Co (0.6-3.8) are indicated that there is low contaminated.

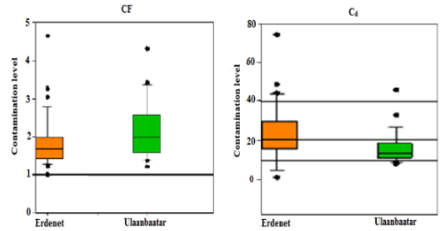

Figure 3. Soil pollution load index of Ulaanbaatar and Erdenet cities and Comparison of contamination degree.

As a result of the pollution load index of heavy metals in Ulaanbaatar and Erdenet cities, the total amount (n=52) in the samples was PLI> 1 or certain amount of contaminant. Of these, Ulaanbaatar is heavily contaminated by heavy metals in total samples. In addition, comparing the results classified by contamination degree of heavy metals in cities soil, contamination degree in Erdenet is higher than in Ulaanbaatar. It was the metals Cu, Mo, Zn, As, Pb in the soil of Erdenet are highly caused by extraction of natural mineral rocks and the Erdenet mining industry. But the heavy metals contained in the soils of Ulaanbaatar are contaminated by pollution sources caused by urbanization, therefore, they are slightly lower in heavy metals than in Erdenet.

Conclusion

The following conclusions were reached on the source and assessment of heavy metals in Ulaanbaatar and Erdenet cities.

1. In Ulaanbaatar, the arsenic content in soil was 86% of the all sampling sites exceeding the permissible level (Mongolian soil standart (5850: 2008)).

Concentration of Lead (95%), Copper (77%), Zinc (91%), Cadmium (77%), Nickel (22%) in all samples were higher than background concentration.

2. Contamination of As, Pb and Cd were high when calculated soil contamination factor (CF) in Ulaanbaatar. Also pollution load index (PLI) were higher than 1 or certain amount contaminated at all sampling sites. Also according to the contamination degree (Cd) , 68% of the all points are low , 27% are non-contaminated, one point are very high contamined. From the result of the heavy metals enrichment factor in the soil of Ulaanbaatar, Ni was indicates no enrichment and had natural sources, Cd, Cu, Zn were miner enriched due to human activity, while As and Pb were moderately severe enriched due to city ger districts and Baganuur power plant, Nalaikh coal consumption, fuel consumption, and accumulation of urban geological minerals.

3. When determining the heavy metals pollution in the Erdenet soil by the pollution load index, all the sampling sites contaminated heavy metals at a certain amount. And by the pollution factor, all samples contaminated with Cu, Mo's high pollution and As's pollution. According to the contamination degree, heavy metals contamination of total samples 23% was very high contaminated, 37% was considerable contaminated, 37% was moderate contaminated and at one point was low contaminate.

4. In heavy metal enrichment factor in the soil of Erdenet, Pb was indicates no enrichment and had natural sources, Cr, Co, Ni, Sr, V, Zn were miner enriched due to human activity, while As, Cu, Mo were significantly high enriched. Cu and Mo accumulations are related to high content of copper sulfide minerals in the soil of Erdenet. It also shows that accumulation of As is associated with rare elements such as Au and Cu.

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THE EFFECT OF SHELTERBELTS ON LIVING WINDBREAKS AND WIND DATA USED LONG-TERM MONITORING IN ARID AREAS

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Abstract: This study aimed to identify the wind effects of shelterbelts on the tree yearly growth of several tree species intended for reforestation. 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 district of Bulgan province, central Mongolia. The trees studied were 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 windbreak sub-model of the Wind Erosion Prediction System (WEPS). Windbreak shelter is modeled 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. Windbreak characteristics (windbreak type, height, width, porosity, and location) were recorded. The effect of windbreaks was found to give good shelterbelt effect to the wind vector distribution on study years.

Keyword: Tree yearly growth, Windbreak, Wind speed, Windroses, Wind speed reduction

Introduction

One of the most traditional methods of controlling wind erosion is the establishment of windbreaks. Windbreaks are strips of trees, shrubs or tall grass species planted around agricultural fields, houses, and animal farms to reduce the wind velocity and erosion. Windbreaks are also referred to as wind barriers and shelterbelts. The windbreaks protect soil from strong winds, divert the wind direction, and reduce wind velocity, thereby reducing soil erosion. A small decline in wind velocity by adoption of control practices results in a large decrease in wind erosion. By intercepting the erosive energy of the winds, windbreaks help to improve soil properties by reducing evaporation, promoting soil water storage, and reducing losses of nutrient-rich fine soil. Vegetation cover becoming sparser is common cause for the process of top soil being carried away by wind. This study aimed to identify the wind effects of shelterbelts on the tree yearly growth of several tree species intended for reforestation.

Materials and Methods

Profiles of Windbreaks and Data Collection

The study area is located surrounding the boundary between forest-steppe and dry steppe zones, based on the plant geographical classification in Mongolian (Gunin et al., 2013). Each species is compared of twenty different trees with a total of 120 trees per replicate. Trees were planted with a spacing of 2 x 1.5 m. During the study year trees were measured each year during the last week of September and data were collected at four replications. The weather data collected by the U30 Weath-

-er Station data loggers were downloaded using Onset HOBOware® Lite Software Version 2.2.1. The wind speed and wind direction, were measured using a sampled every 3 seconds (s) by the data logger using S-WSB-M003 and S-WDA-M003 sensor, located 2 m above the surface.

Reduction in Wind Erosion effect of Windbreaks

The driving variable for transport is the wind friction velocity μ^* (m/s), which is related to average wind speed $U_{(z)}$ (m/s) at height *z* (m) by the logarithmic law (Panofsky and Dutton, 1984):

$$U_{(z)} = \frac{\mu^*}{k} \ln\left[\frac{z-d}{z_0}\right] \quad (1)$$

Where $U_{(z)}$ is the wind velocity at height *z*, μ^* is the friction velocity, *k* is the von Karman constant equal to 0.4, *d* is the aerodynamic displacement height equal to 0.7 x height of roughness element, and z_0 is the aerodynamic roughness parameter assumed to be equal to 0.15 x height of roughness element (Bohner et al., 2003). In the friction velocity is calculated in two steps (Hagen, 1996). First, the friction velocity at the weather station (u_*^{WS}) was computed by applying the logarithmic law (Eq. 1), then the friction velocity at the subregion level u_*^R was calculated with Lettau's equation (Panofsky and Dutton, 1984):

$$u_*^R = u_*^{WS}\left(\frac{z_0^R}{z_0^{WS}}\right)^{0.067} \quad (2)$$

Where z_0^R is the roughness height of the subregion and z_0^{WS} is the roughness height at the weather station (Hagen, 1996). The friction velocity reduction (f_{xh}) of wind in m/s^{-1} by windbreaks was calculated as follows (Vigiak et al., 2003):

$$f_{xh} = 1 - \exp[-a\,xh^2] + b\exp[-0.003(xh + c)^b] \quad (3)$$

$$a = 0.008 - 0.17\theta + 0.17\theta + 0.17\theta^{1.05} \quad (4)$$

$$b = 1.35 \exp(-0.5\,\theta^{0.2}) \quad (5)$$

$$c = 10\,(1 - 0.5\theta) \quad (6)$$

$$d = 3 - \theta \quad (7)$$

$$\theta = op + 0.02\frac{w}{h} \quad (8)$$

where *xh* is the distance to the windbreak parallel to the wind direction in barrier heights, θ is the barrier porosity, *op* is the optical porosity, w is the barrier width, and *h* is the barrier height (Vigiak et al., 2003). The influence of windbreaks on soil erodibility of the sheltered fields can be estimated by (Woodruff and Zingg, 1952).

$$d = 17h\left(\frac{V_m}{V}\right)\cos\theta \quad (9)$$

where *d* is distance of full protection by the barrier in the lee (m), *h* is height of the barrier (m), V_m is minimum wind velociy at 15 m height needed to move the most erodible soil fraction, V is actual windvelocity (m/s^{-1}). And cos θ is angle of the prevailing wind direction.

Statistical Analysis

The comparision procedures were statistically analyzed by one-way analysis of variance (ANOVA) followed by the homogeneity of variance which was verified using Levene's test. Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) Version 21 (IBM Corp., New York, NY, USA). Statistical significance was accepted at $p < 0.05$.

Results

The Wind Speed and Wind Direction in Elsentasarkhai Station

The results show that the wind speed recorded from Elsentasarkhai at an hourly resolution (2013-2017). Statistical data summarized provisional wind speed (m/s) data at daily variability resolution average, minimum, maximum, average, and gust speed of data available (Figure 1). The figure 1 showed the full record, while figure 2 showed the study years and the each seasonal data. The threshold for calculating climate statistics for the wind variables was, 95 % of data availability. The study area had a semi-arid continental climate that was characterized by average wind speed of 2.55 with maximum 16.87 m/s, respectively; whereas the gust speed was with 5.41, and maximum 23.67 m/s. Seasonal patterns were evident with the strongest wind events occurring during spring and the most consistent wind speeds occurring during summer. High wind speed was usually observed during the spring season (Figure 2).

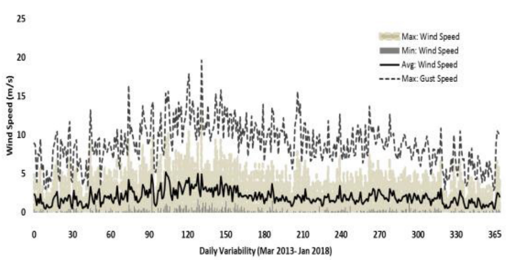

Figure 1. Elsentasarkhai: Mean daily variability wind speeds fall within this range 95% of the time (365 days).

The frequency of wind direction in each season was displayed in Figure 3 by the wind rose. Wind direction was mainly found in the WNW-NNE and ESE–SE sectors, as a result of the orientation of the Khugnu-Tarna sand dune. The mountains to the north (Khugnu-Khaan mountain) and south (Bat-Khaan mountain) of the Khugnu Tarna sand dune significantly inhibited winds in these directions, especially those with a wind speed above 2 m/s^{-1}. The strongest wind direction, was about NW and NNE at this site. However, during the winter season characterized by windroses mainly from the WNW and NW. The frequency of northerly winds was comparable with that of easterly or westerly winds, the wind speed of easterly winds was exclusively under 2 m/s^{-1}.

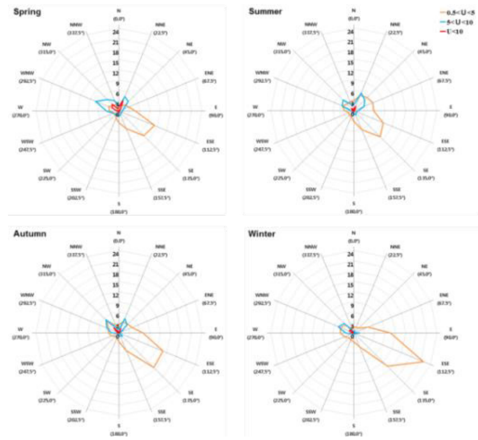

Figure 2. Elsentasarkhai; Seasonal windroses. The wind direction and speed data were divided into 16 wind direction categories (22.5° each) and 3 wind speed classes: (1) less than 5 m/s-1, (2) between 5 m/s-1 and 10 m/s-1, and (3) greater than 10 m/s-1.

Height Growth of Tree Species

The trees species studied showed different height growths, even though all individuals were measured under the same ecological conditions found in tree and shrubs. This tree growth monitoring research was carried out between 2010-2017. Overall, the results showed that *P. sibirica* showed the tallest tree heigtht, after *A. tataricum*, *S. ledebouriana, U. pumila, C. arborescens*, but *M. pallasiana* species has the shortest height in autumn 2017. The height growth of *P. sibirica*, *U. pumila, C. arborescens and S. ledebouriana* significantly increased (7.02 %, 13.30 %, 30.35% and 9.14 %, respectively) during the study years. But *A. tataricum* (-1.56 %) and *M. pallasiana* (-3.70 %) species showed a decrease in height. The value of trees height showed significant differences between speices ($F = 41.43$ to 79.08; $p = < 0.001$).

Estimated Distance of Full Protection by the Wind Break in the Leeward Side

Results showed the distance of full protection by the barrier on the leeward side at Elsentasarkhai research station during 2010–2017. The moderate linear relationship of *P. sibirica, S. ledebouriana, U. pumila, C. arborescens* was manifested at the weak linear relationship of *A. tataricum* and *M. pallasiana* (R^2 = 0.61, 0.41, 0.31, 0.43, 0.05 and 0.03, respectly).

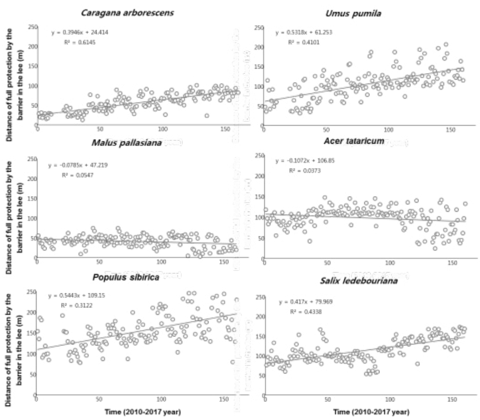

Figure 3. Windbreak effect of deciduous trees and shrubs in Elsentasarkhai station during 2010–2017.

During the monitoring period, the impacts varied, but all species were reduced by the wind speed to a certain distance (24.58 to 193.35 m lee).Compared to tree species, *P. sibirica* (6.93 %), *S. ledebouriana* (9.07 %), *U. pumila* (13.26 %), and *C. arborescens* (29.93 %) showed significant height growth and continuously full protection by the study period. However, then *A. tataricum* (-1.48 %) and *M. pallasiana* (-3.64 %) showed significantly decreased hight growth pattern, they exhibited significant windbreak effects (12.03 to 26.63 and 11.61 to 78.51 m lee) Fig 3. As a result, the annual growth rate of tree species shows the importance of wind protection .

Estimate the Friction Velocity Reduction at a Distance Relative to Tree Species

The following table 1 showed the results of estimated friction velocity reduction at a distance relative to tree species, feild measured data has been used in Elsen Tasarkhai station (2010-2017). The study showed that windbreak significantly reduced the wind velocity to a distance of 5-30 times in the windbreak height leeward side (F = 59.11 to 106.20; p = < 0.001).

When comparing the amount of friction velocity reduction, *P. sibirica*, *U. pumila,* and *S. ledebouriana* trees had significantly precedence effect on wind speed reductions in 15-20H of leeward side, while *A. tataricum*, *M. pallasiana* and *C. arborescens* showed better effect on 25-30H leeward.

The table 2 showed the results of windbreak porosity class effect in reducing wind on mixed tree species. The measured values significantly reduced the wind velocity for a distance of 15-30H the windbreak height in the leeward side (F = 3.70 to 25.06; p = < 0.05).

The effect of wind friction velocity in the porosity class order of 20, 40, 60, and 80 % have reduced. According to the comparative study, the significantly more friction velocity reduced to 15-20H of leeward side with porosity of 20-80 % on mixed trees.

Discussion

The findings from this study suggested that it was characterized by average wind speed of 2.55 with maximum 16.87 m/s, respectively; whereas the gust speed was 5.41, with maximum 23.67 m/s (Figure 1). The wind velocity must be near 8 m/s^{-1} at 2 m above the soil surface for the soil particles to be displaced by wind (Blanko and Lal, 2008). Sandy loam and sandy soils with low organic matter content develop aggregates with weak bonds and were thus the most erodible. Dry loose soil material <0.84 mm in diameter occurring on the soil surface, known as loose erodible material, was the fraction that was readily transported by wind (Zobeck, 1991[b]). The way that wind speed and turbulent flow were modified by the windbreak will determine its shelter efficiency (Wang and Takle, 1997).

According to these findings, there was a high risk of wind erosion in the study area. This study presented to identify the wind effects of shelterbelts on the tree yearly growth of several tree species intended for reforestation. Windbreak studies have been particularly useful for determining relationships between height, width, porosity and species type of elements (Grant and Nickling, 1998; Wu et al., 2015). The full protection by the barrier on the leeward side to moderate linear relationship of *P. sibirica, S. ledebouriana, U. pumila, C. arborescens* was manifested at the weak linear relationship of *A. tataricum and M. pallasiana* species. But then *A. tataricum* and *M. pallasiana* have significantly decreased hight growth pattern, but have been shown to have significant windbreak effects.

The following friction velocity reduction at a distance relative to tree species, where windbreak significantly reduced the wind velocity for a distance of 5-30H of the windbreak height in the leeward side. This study shows the amount of friction velocity reduction, *P. sibirica*, *U. pumila,* and *S. ledebouriana* trees had the significantly precedence effect on wind speed reductions in 15-20H of leeward side, while *A. tataricum*, *M. pallasiana* and *C. arborescens* better effect on 25-30H leeward. In a related study, the short tree windbreak tended to produce a more intense slow down than the tall trees, due to their lower porosity in general, which supported previous findings that low-porosity elements induced the greatest slowdown. It was appropriate to evaluate the shelter effect of the windbreak according to whether the leeward wind speed exceeded the critical value or not (Ozawa et al., 2007). These and other confounding factors, mean that past interpretations of Naegeli's results overstate the link between porosity and sheltered area (Heisler and De Walle 1988). Close inspection of results from other field measurements failed to reveal any large differences in the sheltered area for low and high porosity windbreaks (Caborn, 1957). In other related studies, wind tunnel studies do not find large reductions in low porosity windbreaks (Raine and Stevenson, 1977).

In the present study, was windbreak porosity class effect of significantly reduced the wind velocity for a distance of 15-30H the windbreak height in the leeward side. In comparision, theres friction velocity reduced significantly 15-20H of leeward side which porosity of 20-80 % on mixed trees. Other related experimental studies showed that wind speed was reduced to 62% in open wind speed, but the estimated erosive force of the wind was reduced to 24 % of open values (Bird et al., 1992). Multiple row-windbreaks reduce wind erosion more than single rows (Blanko and Lal, 2008). The results of this study were demonstrated that even a small reduction ratio of wind speed could effectively reduce the erosive force of the wind and therefore help control wind erosion particularly if windward protection is considered (Rouse and Hodges, 2004). In our experiment, the impacts have been varied, but all species have reduced the wind speed to a certain distance. As a result, the annual growth of tree species showed the importance of wind protection. But, once windreak is established, it has have a sustained and long lasting positive impact on the environment. Further studies and experiments will be needed to be undertaken based on the results of this study in different ecological zones in order to reduce land degradation.

Conclusions

This study presented to identify the wind effects of shelterbelts on the tree yearly growth of several tree species intended for reforestation. The full protection by the barrier in the leeward on the leeward side to moderate linear relationship of *P. sibirica, S. ledebouriana, U. pumila* and *C. arborescens* was manifested at the weak linear relationship of *A. tataricum and M. pallasiana* species. But then *A. tataricum* and *M. pallasiana* have significantly decreased height growth patterns, and have been shown to have significant windbreak effects.

The following friction velocity reduction at a distance relative to mixed tree species, was windbreak significantly reduced the wind velocity for a distance of 5-30 times the windbreak height in the leeward side. This study showed amount of friction velocity reduction, *P. sibirica*, *U. pumila,* and *S. ledebouriana* trees had the significantly precedence effect on wind speed reductions in 15-20 times of leeward side, while *A. tataricum*, *M. pallasiana* and *C. arborescens* had better effect on 25-30 times leeward. The short shrubs tended to produce a more intense slow down than the tall trees, due to their lower porosity in general, which supported previous findings that low-porosity elements induced the greatest slow down. 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 importance of wind protection.

Acknowledgments

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Table 1. Relationship between distance and tree species in friction velocity reduction

Species class	**Distance from the windbreak**							
	0H	**5H**	**10H**	**15H**	**20H**	**25H**	**30H**	**35H**
Effect of reduce wind on tree species (%)								
P. sibirica	0.88	1.46^{a}	1.77^{a}	1.80^{a}	1.79^{a}	1.77^{a}	1.75^{a}	1.74
A. tataricum	0.88	1.01^{c}	1.30^{c}	1.50^{c}	1.63^{b}	1.70^{b}	1.75^{a}	1.74
M. pallasiana	0.86	0.88^{d}	0.94^{d}	1.02^{d}	1.11^{c}	1.21^{c}	1.30^{b}	1.70
U. pumila	0.87	1.22^{b}	1.64^{b}	1.78^{a}	1.80^{a}	1.79^{a}	1.78^{a}	1.74
C. arborescens	0.89	1.03^{c}	1.36^{c}	1.63^{b}	1.76^{a}	1.81^{a}	1.81^{a}	1.74
S. ledebouriana	0.86	1.28^{c}	1.71^{ab}	1.80^{a}	1.79^{a}	1.78^{a}	1.77^{a}	1.74
F	1.40	70.66	106.20	105.67	99.63	80.98	59.11	0.76
Sig.	ns	***	***	***	***	***	***	ns

Data followed by the same case letter across column are not significantly different at 0.05 level. 5H, 10H, 15H - distance from the windbreak to the stand position in 5, 10, 15 times the height of the windbreak.

Table 2. Relationship between distance and porosity class in friction velocity reduction

Porosity class	**Distance from the windbreak**							
	0H	**5H**	**10H**	**15H**	**20H**	**25H**	**30H**	**35H**
Porosity class effect of reduce wind on mixed tree species								
20%	0.94	1.48	1.78	1.81^{a}	1.80^{a}	1.78^{a}	1.76^{a}	1.74
40%	0.90	1.44	1.75	1.78^{b}	1.78^{b}	1.76^{ab}	1.75^{ab}	1.73
60%	0.87	1.45	1.74	1.77^{b}	1.76^{c}	1.75^{bc}	1.74^{bc}	1.72
80%	0.82	1.50	1.74	1.76^{b}	1.75^{d}	1.74^{c}	1.73^{d}	1.72
F	2.49	0.39	0.69	6.44	25.06	9.55	3.70	1.33
Sig.	ns	ns	ns	**	***	***	**	ns

Data followed by the same case letter across column are not significantly different at 0.05 level. 5H, 10H, 15H – distance from the windbreak to the stand position in 5, 10, 15 times the height of the windbreak

ICING DYNAMIC CHANGES IN BAYANZURKH DISTRICT, ULAANBAATAR, MONGOLIA

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Abstract: The icing conditions in northern central Mongolia were assessed using satellite images, Electrical Resistivity Tomography and metrological data. The study result show that the area of icing is decreasing but it depends on its formation. The area of river icing more decreased than that spring icing, and however these decrease on icily likely due to increase in air temperature both in summer and winter rather than precipitation. As icing forms in the settlement, it has negative effects on the infrastructures.

Keywords: TTOP, modelling, permafrost, FDD, TDD

Introduction

Icing is a sheet-like mass of layered ice which is formed on the ground surface or on top of river or lake ice in winter where water seep from the ground in springs, rivers and lakes (Van Everdingen et al. 1998).

In the northern hemisphere icing is regarded as a hydrological phenomenon which is linked to a seasonal periglacial process and can be observed in different regions with permafrost and without permafrost as reported by several sources (e.g., Van Everdingen et al. 1998, Pollard 2005, Yde et al 2005, Morse et al. 2014, Morse et al. 2015, Morse et al. 2017, Makarieva et al. 2018).

The study area is located 10 till 50 km east and northeast of Ulaanbaatar City in lower reaches of the Uliastai valley and in the Baruun Bayan Gol valley, both are small north-bounded tributaries of Tuul river. However icing can be observed at different other places in the upper Tuul valley and its tributaries. This region belongs to the extreme continental climate of Mongolia with seasonal annual air temperature amplitudes of around 60° C, a mean annual average temperature (MAAT) of 0.4° C (and lower) and an annual total precipitation of 271 mm at the Ulaanbaatar Meteorological station. The distribution of the precipitation pattern is very various and there is observed strong increasing tendencies of annual precipitation recently. Seasonal genesis of icing features in Mongolia. Icing is not strictly linked with permafrost and appear regularly in non-permafrost areas of the periglacial environment in Mongolia. In general it is bounded on river valley bottoms and the foot zone of the direct neighbouring slopes.

- Summer: Springs with gravitation outlet during summer in the valley bottoms or the edge of the valleys against higher niveaus (like river terraces, tectonic faults or alluvial fans)
- Autumn: increasing hydrostatic pressure by diminishing the outlet channels by freezing; thermal energy of the water temperature is slower decreasing than air temperature.
- Winter: hydrostatic water outlet (icing mound); at the begin of January cold water can reach the surface and freeze immediately at the surface of the outlet due to cold surface air temperatures. Due to the winter temperatures the spring water can block the outlet by freezing and the spring water find a different outlet.
- Spring: The icing dome thaw at the ice surface and at its outline in the contact with the warmer soil and vegetation. Increasing water

temperatures accelerate the thawing process in March and April and artesic water is pressed on the surface, preferably at the sides of the icing plate.

Distribution of icing in the study area

Study area is located at the north eastern border of Ulaanbaatar city in the lower part of the Uliastai river sub basin in the north Central Mongolia. The Uliastai River has a catchment area of 705.9 km^2 and includes several springs in the study area (Figure 1). The elevation of the river basin ranges from 1225 m a.s.l in the lower part of the catchment to 2773 m a.s.l in the uppermost part with the mountain summits.

In study area 1 three locations of icing (U1, U2 and U3) observations with different conditions were selected in the lower part of catchment of Uliastai valley. U1 and U2 represented icing under natural condition, while U3 represented an icing feature, which impact human infrastructure. Springs and river channels exist in U1 and U2 area, while U3 is located inside a settlement area, which is quite far away from the river channel. The ice hummock is wide distributed cryogenic landform in icing areas, and cracks usually form along the Uliastai river valley. The soil of the study area is unusually characterized by fine sediment in the valley, with abundant soil moisture, and predominantly stones and boulders on the slopes. According to geological study, there are several small faults in the study area, especially in the lower part of the basin (Figure 1).

Method

We used Landsat and Sentinel-2 satellite images in order to evaluate the area of icing and its special dynamics. The satellite images obtained from https://eos.com/, with resolutions of 30 m for Landsat and 15 m for Sentinel-2. Several researches successfully have used the satellite images and normalized difference snow index (NDSI) for mapping the icing area [e.g., 2; 4; 5; 6; 7], permitting to use this index for our study.

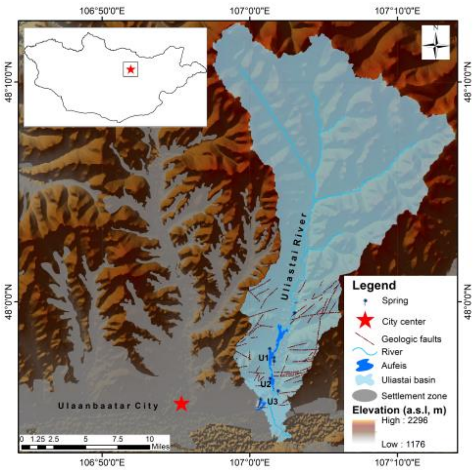

Figure 1. Location of study area Uliastai valley. The area of icing based on Landsat image with the scene id of LT05_L1TP_131027_19940329_20170114_01_T1 and, springs, river and faults are based on topographic and geological maps with scales 1:100,000.

$$NDSI = (Green-SWIR1) / (Green+SWIR1) \quad (1)$$

However, NDSI maps both snow and ice, making difficult to separate ice from snow. In order to avoid from this problem, we selected the satellite images for U1 and U2, which have the date with after snow melt in springs. Snow quickly melts in the settlement area compared with countryside, even in the middle winter. This is probably due to the heat from settlement and city dust. This idea can provide that we can determine the seasonal dynamics of icing in the settlement area such as U3.

We also used air temperature and precipitation data from the Ulaanbaatar metrological station in Ulaanbaatar city.

Form the air temperature data, we calculated freezing degree days (FDD)—the daily degrees below freezing summed over the total number of days the temperature was below freezing; and thawing degree days (TDD)—the daily degrees above freezing summed over the total number of days the temperature was above freezing.

Additionally, the vegetation index was calculated to investigate the vegetation differences between icing areas and non-icing areas.

$$NDVI = (NIR — Red) / (NIR + Red) \quad (2)$$

Result

Climate condition

The long term air temperature data from 1969 to 2018 at the Ulaanbaatar station indicates that the daily air temperature ranges from -35.9° C to 30.6° C, with an average of -0.4° C. During the observation period, mean annual air temperature (MAAT) increased by 2.6° C, and increase rate was 0.51° C/10year (Figure 2a). The air temperature turns to positive values at the 10th of April and negative values at the 20th of October, respectively. The precipitation ranged from 166 mm to 395 mm between 1980 and 2018, with an average of 271 mm. From 1995 to 2006, precipitation sharply decreased, but after it increased continuously (Figure 2a). During the observation period, ratios of FDD and TDD significantly changed, and the former ranged from -3039.5 to -1866.4 and the later ranged from 1952.5 to 2699.3 (Figure 2b). The increase ratio of FDD was lower with an average of 52.6/10year than that the increase ratio of TDD with an average of 122.6/10year. No significant changes are observed on precipitation, and approximately 90 percent of precipitation occurs between April and September (DASHTSEREN et al. 2014).

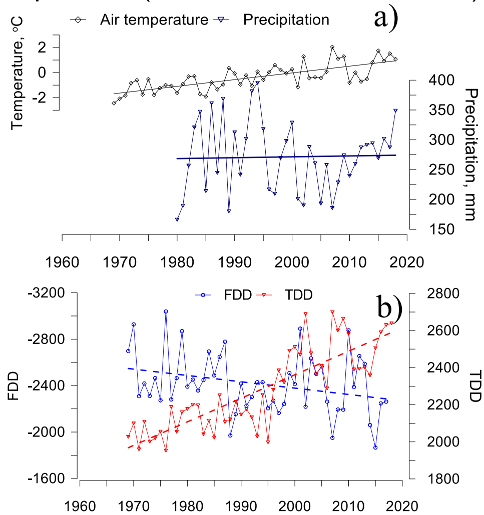

Figure 2. a) Changes of air temperature and precipitation and b) FDD, TDD at the Ulaanbaatar meteorological station.

The dynamics of icing

Figure 3 shows the long term icing area changes at U1, U2 and U3. According to this result, the area of icing at the sites gradually decreased, and most significant was accounted at U1. During the mapping period between 1992 and 2018, the icing area contracted from 110.0 ha to 6.4 ha at U1, from 38.0 ha to 6.0 ha at U2 and from 55.8 ha to 22.7 ha at U3, respectively. After 1995s, icing was not developed at the head of U1, but only formed down at the foot of U18 by leaving spring water. In 2018, the icing was formed 1.2 km long and 0.36 km wide at U1, 1.30 km long and 0.34 km wide at U2 and 0.68 km long and 0.82 km wide at U3, respectively. Based on satellite images of 1997-1998, 2001-2002, 2008-2009 and 2013-2014, icing at U3 begins to developed in the beginning of October and continues until the mid of February when icing has the largest extension, then it gradually degrades and completely disappears by the beginning of May.

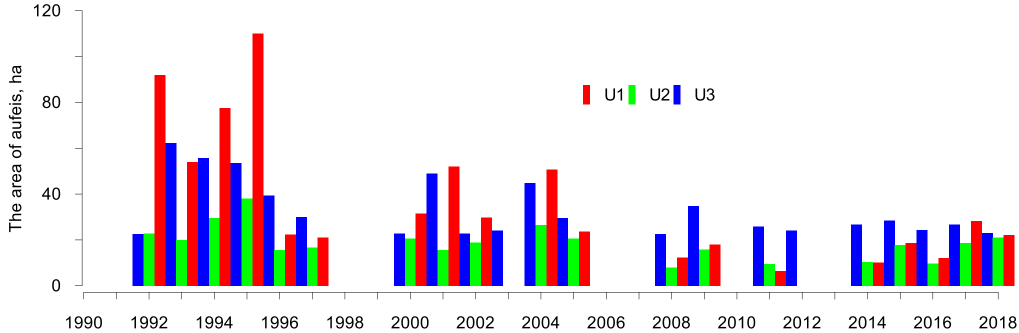

Figure 3. The long term icing area changes at U1, U2 and U3

Conclusions

The result of this study show that the formations of icingess belong to spring and river. The meteorological data from 1969 to 2018 within the study area indicate that MAAT increased by 2.6ºC, while no significant changes are observed on precipitation. The areas of icing significantly decreased at all sites and it is likely related to the air temperature regime. Icing features are influencing human infrastructure negatively and can contribute to environmental pollution. To avoid these negative effects a careful urban planning can be useful and an adapted technology for disadvantaged environmental location must be implemented.

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SIMULATION OF DISCHARGE AND POLLUTANT'S CONTENT IN TUUL RIVER BASIN WITH THE HYDROLOGICAL MODEL ArcSWAT

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Abstract: Urban area waste water treatment, unmanaged mining activities, land cover degradation and forest area changes are the key processes that negatively affect the water resources of the Tuul river basin. Due to the climatic and man-made impact conditions, discharge decline and growth of concentration of pollutants are being observed in that basin. For that reason, there is a need to identify runoff, discharge and critical pollutants, its loss and transport potential. The aim of this study was to test the performance of the ArcSWAT model and the feasibility of using this model as a simulator of discharge and nitrogen and phosphorus yields over the Tuul river basin. Spatial data layers of land slope, soil type and land use were combined with GIS to aid in creating HRUs. And daily weather data obtained from CFSR, digital elevation model were also used as model input data. Calibration and validation were conducted using the SWAT-CUP program. The observed discharge and pollutant's concentration data at Tuul-Ulaanbaatar, Tuul-Altanbulag gauging station were used to calibrate and validate the model with SUFI-2 algorithm. Time series plots and statistical measures were used to verify model predictions. The correlation between the simulated and the observed flow is measured by r2 was 0.75 in Tuul-Altanbulag gauging station and r2 was 0.67 at the Tuul-Ulaanbaatar gauging station. Based on the simulated flows value, phosphorus and nitrate concentrations in streamflow have been identified. Nitrate and phosphorus content was positively correlated with range between 0.5-0.7 with gauge stations measurements.

Keywords: ArcSWAT model, Discharge, Hydrologic modeling, Nitrogen and Phosphorus, Tuul river basin

Introduction

The Tuul river basin is located in the central part of Mongolia crossing the economic regions of Ulaanbaatar, Tuw, and Khangai. As for administrative units, it covers the territories of 7 districts of Ulaanbaatar city and 37 soums of 5 aimags includes Arkhangai, Bulgan, Uwurkhangai, Selenge and Tuw aimag (Ministry of environment and green development, 2012). The Tuul river basin occupies only 3.2 percent of Mongolia's territory, but as of 2016, about 47.6 percent of total population lives in there (Ministry of environment and green development, 2012). In that year, Ulaanbaatar value produced was MNT 16274.9 billion and in Tuw aimag was MNT 508.3 billion, which was some 67.9% of Mongolian gross domestic product. Based on these testimonies, that basin is an economically viable and highly productive region in terms of society and economy. Also due to population growth in this area, significance of Tuul river basin will be more expanding in the future. On other hand global warming is taking place in research area. The apparent indication of this is that the temperature increased by 0.043^{0}C by year between 1940 and 2008.

Since 2000, this increase has been even higher and it was 0.14^{0}C by year between 1991 and 2008 (Ministry of environment and green development, 2012).

The thermal resources accumulating during the plant growing period are increasing due to climate warning. Therefore the water that evaporates form the land and water surface is increasing. Some researchers believed that this increase has been influence the water losses of rivers, lakes and reservoirs. Between 1961 and 2008, surface evaporation increased by 153 mm, whereas the summer rainfall decreased by 51 mm. The research works which are oriented to determine water quality index based on field survey, define chemical and physical properties of surface water using laboratory analysis, and simulating surface runoff with TOPLATS, HEC-HMS, HBV, DeFLOW and other hydrologic models are mainly carried out in tributaries of Tuul river basin (Byambakhuu, 2011). The study works to estimate surface runoff and concentration of pollutants in given case, inseparably using simulation methods had rarely done previously.

Method

Description of Swat model

The SWAT model, developed by the Agricultural Research Service (Arnold et al., 1998, Neitsch et al., 2005), is a river basin scale or watershed scale model, which simulates hydrological cycle, cycles of plant growth, transportation of sediment, and agricultural chemical yields in a daily basis time step (Yipung Wu & Ji Chen, 2009).

It was developed to predict the impact of land management practices on water, sediment, agricultural chemical yields in large complex watersheds with varying soils, land use and management conditions over long periods of time (Neitsch et al., 2005). The benefits of this model are watersheds with no monitoring data (such as discharge gauges) can be modeled and the relative impact of alternative input data on water quality can be examined (Benedikt, 2016). Input information for each sub basin is grouped or organized into the following categories: climate, hydrologic response unit, ponds and wetlands, groundwater and the main channel, or reach, draining the sub basin. Hydrologic response units are lumped land areas within sub basin that are comprised for unique land cover, soil and management combinations (Neitsch et al., 2005)

Input data collection and analysis

The model requires sets of spatial datasets including topography, land use, soil and the temporal dataset of the weather (precipitation, minimum and maximum air temperature, relative humidity, wind speed, and solar radiation). The DEM data were required to delineate the watersheds in the ArcSWAT interface. The soil and land cover data were important to define the HRUs. Supervised classification method was used for land use classification from satellite imagery of the June in 2018. General 18 types of land use in the ArcSWAT database are used as input data types to preparing land use data.

The model structure of SWAT requires continuous data for the whole watershed as well as information about depth-related soil properties. Due to the lack of adequate, affordable national soil data in Mongolia, the global soil dataset of FAO/UNESCO and global soil access database of MWSWAT were applied. Soil cover data is used from the International Soil FAO classification database. The FAO soil classification system distinguishes the 106 soil types of the world, and the 6 types of soil are dominant in study area.

Weather datasets are used to simulate the hydrological processes in SWAT. We applied two types of weather data, one for SWAT simulation and another for weather datasets validation process. The two weather datasets sources used were observed weather data from Ulaanbaatar, Terelj meteorological stations in Tuul river basin and weather datasets from the NCEP's CFSR (Climate Forecast System Reanalysis). The conventional weather has daily rainfall and average temperature from 2 climatic stations. It spans the period 2000-2014 with monthly. CFSR weather datasets includes rainfall, maximum and minimum temperature, wind speed, relative humidity, and solar radiation (Chinzorig, 2017) for 10 stations by day period. The CFSR weather is produced using cutting-edge data-assimilation techniques (both conventional meteorological gauge observations and satellite irradiances) as well highly advanced atmospheric, oceanic, and surface-modeling components at 38 km resolution (Saha et al., 2010).

Equations

In SWAT model, surface runoff volume was calculated by using a SCS curve number method initially developed by the Natural resource conservation service (USDA Soil conservation, 1972).

$$Q_{surf} = \frac{(R_{day} - I_a)^2}{(R_{day} - I_a + S)} = \frac{(R_{day} - 0.2S)^2}{(R_{day} + 0.8S)} \quad (1)$$

I_a is the initial amount of water that includes surface storage, canopy interception, and infiltration before runoff. S is the maximum soil moisture retention after runoff begins. I_a and S are determined with the runoff curve number CN.

CN had a range between 30 and 100 where values increase with runoff potential. CN is determined empirically and based on NRCS soil groupings, surface characteristics such as vegetation cover or impervious surface area, and antecedent soil moisture conditions (Lance Olot Le, 2015).

Potential and actual evapotranspiration were determined by the Penman-Monteith equation (Monteith, 1965).

$$\lambda E_t = \frac{\Delta(H_{net} - G) + \gamma * K_1 * (0.622 * \lambda * p_{air}/P) * (e_z^0 - e_z)/r_a}{\Delta + \gamma * (1 + \frac{r_c}{r_a})} \quad (2)$$

r_c, r_a are plant canopy and diffusion resistance, γ is the psychrometric constant, e_z^0, e_z are the saturation and water vapor pressure, p_{air} is the air density, K_1 is dimension coefficient, P is atmospheric pressure, λ is latent heat of vaporization, H_{net} is net radiation, G is the heat flux density to the ground (Jensen et al., 1990).

The SWAT in-stream water quality algorithms incorporate constituent interactions and relationships used in the QUAL2E model (Brown & Barnwell, 1987). The equations were used to determine the concentration of organic phosphorus, nitrogen, nitrate, and nitrite is given below.

$$\Delta orgP_{str} = \left(\alpha_2 * \rho_a - \beta_{p,4} * orgP_{str} - \sigma_5 * orgP_{str}\right) * TT \quad (3)$$

$$\Delta orgN_{str} = \left(\alpha_1 * \rho_a - \beta_{N,3} - \sigma_4 * orgN_{str}\right) * TT \quad (4)$$

$$NO_2 = \left(\beta_{N,1} * NH_{4str} - \beta_{N,2} * NO_{2str}\right) * TT \quad (5)$$

$$NO_3 = \left(\beta_{N,2} * NO_{2str} - (1 - fr_{NH4}) ** \alpha_1 * \mu_a\right) * TT \quad (6)$$

Statistical parameters for evaluation of model

R^2 is used to evaluate how accurately the model tracks the variation of the observed values. The difference between the NSE and the R^2 is that the NSE can interpret model performance by replicating individually observed values while the R^2 cannot (Green and van Griensven, 2008).

$$R^2 = \frac{\left(\sum_{i=1}^{n}(Y_{i,obs}-\overline{Y_{obs}})(Y_{i,sim}-\overline{Y_{sim}})\right)^2}{\sum_{i=1}^{n}(Y_{i,obs}-\overline{Y_{obs}})^2\sum_{i=1}^{n}(Y_{i,sim}-\overline{Y_{sim}})^2} \quad (7)$$

Calibration of model performance
Model calibration is the adjustment of model parameters, within recommended ranges, to optimize the agreement between observed data and model simulation results (Tolson & Shoemaker, 2007). Furthermore, the SWAT mode, version 2005, has an embedded auto-calibration procedure that is used to obtain an optimal fit of process. This procedure is based on multi-objective calibration and incorporates the Shuffled Complex Evolution Method algorithms (Green & Van Griensven, 2008). SWAT-CUP stands for Calibration and Uncertainty Programs and is an automated model calibration tool for the SWAT model. This tool was developed by the aquatic research institute Eawag located in Switzerland (Abbaspour, 2015). SWAT-CUP is a public domain program and uses a generic interface. Different sensitivity analysis, calibration, validation and uncertainty analysis are possible within SWAT-CUP. Five different uncertainty algorithms (SUFI-2, PSO, MCMC, ParaSol and GLUE) are implemented in SWAT-CUP.

Results

Watershed delineation.
This watershed delineation resulted in the definition of 6 sub basins from above the outlet point. Outlet points had chosen coordination of Tuul-Altanbulag and Tuul-Ulaanbaatar gauging station.

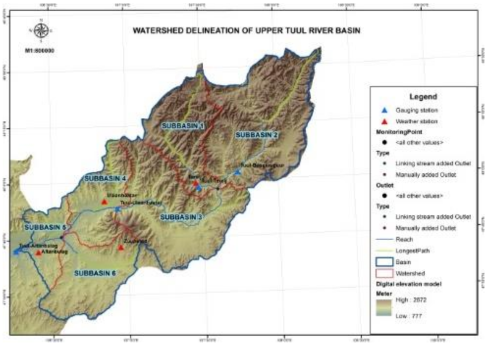


Figure 1. Watershed delineation of study area

Surface average elevation in the study area was 1694 meter, the highest point is 2672 m, and the lowest is 1165 meters. Total area of study is 8678.59 km^2.

HRU analysis result.
Land use reclassification. Figure 2 gives an overview about the spatial distribution of the 5 SWAT land use classes in study area. In the north east part of the catchment, the land use characteristic is clearly dominated by forest (almost 28% of area). As shown in table 1, also 28.3% of the watershed area is covered by range grass land, 16.5% in the urban areas, 16.0% in the agricultural land and 11.3% occupied by water bodies.

Table 1. Land use type by area

Land use type	Area, km^2	Area, %
Residential-URBN	1433.92	16.52
Water-WATR	981.53	11.31
Forest-Mixed-FRST	2414.69	27.82
Range grasses-RNGE	2459.72	28.34
Agricultural land-Generic-AGRL	1388.95	16.00

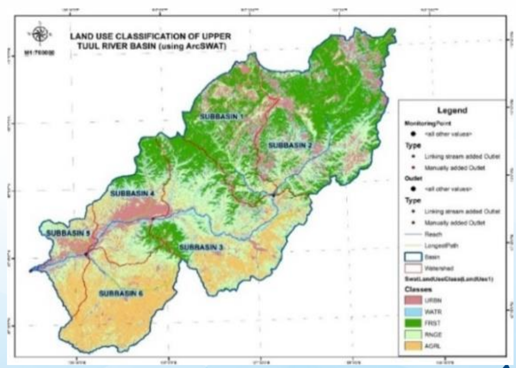


Figure 2. Classification of land use classes in Tuul river basin using SWAT model, percentage distribution of land use

Soil reclassification. The FAO soil classification system distinguishes the 106 soil types of the world, and the 6 types of soil are dominant in study area.

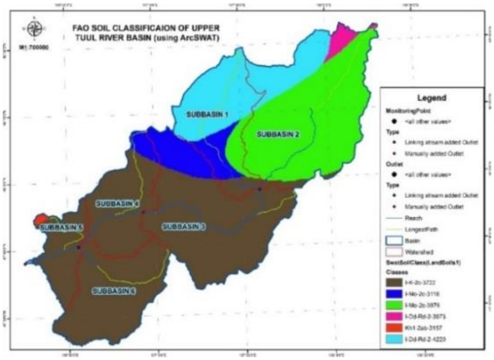


Figure 3. Soil classification of study area

Table 2. Dominant soil type by area

Surface flow estimation, calibration and validation.

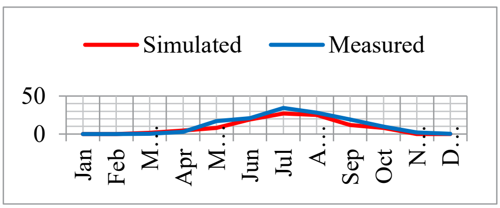
Soil type by FAO classification	Area, km^2	Area, %
I-Dd-Rd-2-3973	104.01	1.20
I-Dd-Rd-2-4220	1294.27	14.91
I-K-2c-3722	4435.05	51.10
I-Mo-2c-3116	642.35	7.40
I-Mo-2c-3976	2202.90	25.38

The average flows in the Tuul river basin is given with 127.5 mm/year (Ministry of environment and green development, 2012), which shows a good correlation with the simulated flow (169.4-211.2) mm/year. The actual base flow factor is 0.25 (Davaa & Erdenetuya, 2004) at Tuul river basin which correlates well with the simulated base flow of 0.28 in the SWAT model. The reference ratio of streamflow and precipitation is 0.69 (Davaa & Erdenetuya, 2004) which shows good accordance with the simulated ratio of 0.8.

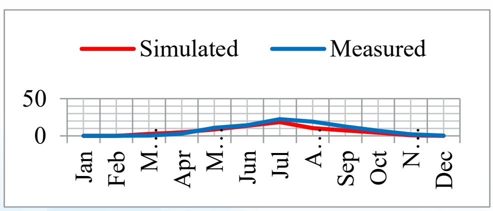
Table 3. Simulated hydrological water balance in SWAT model, with values of evapotranspiration, surface runoff and several hydrological ratios

Constituent	Unit	Simulated by SWAT
Water balance ratios		
Base flow/Total flow	-	0.28
Surface runoff/Total flow	-	0.72
Streamflow/Precipitation	-	0.8

Graph 1. Correlation between measured and simulated values of discharge (Tuul-Ulaanbaatar gauging station)



Graph 2. Correlation between measured and simulated values of discharge (Tuul-Altanbulag gauging station)



Discussion and conclusion

Using the Penman Monteith method for calculating evaporation of each sub basin, and also SCS curve number method is used for estimating surface runoff for each sub basin. In this study, calibration effort focused on improving model predictions of daily streamflow at the main watershed flow gauging station at Tuul-Ulaanbaatar and Tuul-Altanbulag. Daily streamflow observations at these stations for the period from January 1, 2005 to December 31, 2014 are available. And 3 year warm up period was used for minimizing the impacts of uncertain initial conditions in the model simulation. The correlation between the simulated and the measured flow rate is measured by r^2 was 0.75 in Tuul-Altanbulag hydrological station and r^2 was 0.67 at the Tuul-Ulaanbaatar gauging station. Based on the simulated flows value, phosphorus and nitrate concentrations in streamflow have been identified. Nitrate content was positively correlated with range between 0.5-0.7 with gauge station measurements. Phosphorus concentration is 0.16 non-dependents on the Tuul-Altanbulag station, which is related to the need to increase the number of source data and repeat the calibration. It is believed that this model can be used to calculate the surface flow and nitrate rate effectively.

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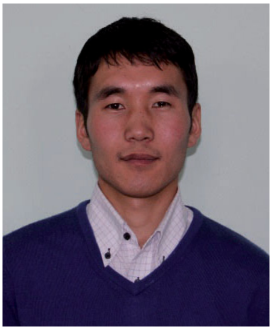
SOIL ORGANIC CARBON CHANGES OF URBAN AND SUBURBAN AREAS IN STEPPE AND DRY STEPPE ZONES IN MONGOLIA



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Abstract: The urban population and urbanized land in Mongolia have same increased last 80 years. Urban developments have grown at unpresented rates with unknown consequences for ecosystem functions. In Mongolia, the effect of urbanization on the stock of soil organic carbon never been studied before. In this study we compared the soil organic carbon (SOC) pools in several land use types with native soil. We collected from urban and non-impacted (near the soum) places (several middle scale city-Aimag, soum) in steppe and dry steppe eastern Mongolia. Which include 3 aimag center and 4 soum center. The result showed significant difference in the sampling and land use types. Especially, Urban soils had lower Soil organic content than Native soil and conversely SIC content higher. SOC stocks decreased due to land use. In Choibalsan city's average SOC stock had altered -56% at top 30 cm layers, Chinggis khaan city's SOC stocks decreased -42%, Baruun urt city's SOC stocks decreased -17%. SOC stocks changing rate between 3.85%-75.15% and relatively high. The mean SOC stock changes of Urban soil in eastern Mongolia is higher than central Mongolia (Native-pasture).

Keywords: Soil organic carbon, in organic carbon, urban soil, land use, changes.

Introduction

Urban areas cover less than 1% of the earth's surface, more than 50% of world's population lives in cities and town (Schneider, 2010). Urban growth is understood as the expansion of built-up areas that implies changes in Land Use/Land Cover (LULC). The recently projection by the United nations press revealed more people live in in rural areas, with 55 % of the world's population residing in urban areas in 2018. In 1950, 30 % of the world's population was urban, and by 2050, 68 % of the world's population is projected to be urban (United nation, 2018). Each year, global coverage of urban land has reached approximately 0.63% in 2010 (Liu, 2018) but population number will be increase faster (Angel et al., 2011). The impact of urban area increases on the global environment more direct effect in the future (Grimm et al.,2008).

Soil carbon stock, including that Soil organic carbon and Soil inorganic carbon is largest carbon in the terrestrial ecosystem. Soil organic carbon is that very sensitive for any land use and activity. But, Effect of urbanization on soil remain poorly characterized (Lehman & Stahr., 2008) compared with native soils in the World, especially in Mongolia. Some Russian scientist observed Urban soils are generally higher pH values, coarser texture, and higher Bulk density; mineral composition totally disturbed and changed, and they are enriched in carbonate and iron oxides (Gerasimova, 2003).

In this study, we report SOC stocks for the urban sites in the Eastern Mongolia which 4 provinces and 4 soums. The objective of this study were quantity of SOC stock in different land use types (Street-unpaved road, ger dis-

-trict, black market-supermarket, building areas) and estimate to the changes of SOC concentrations (in depth 30 cm) compared with same soil classification types.

Materials and Methods

Study area and sampling

The study was conducted in the south and eastern Mongolia, Especially in Dornod, Sukhbaatar, Khentii and Dundgobi provinces (45°40´-48°04´N, 106°50´-114°27´) (Figure 1). Including several soums (1-Gurvansaikha, 2-Bayanjargalan, 3-Baruunurt, 4-Dashbalbar, 5-Choibalsan, 6-Khulunbuir, 7-Chinggis khaan) in the above mentioned provinces. We used a Manual soil sampling methods (used for spoon) from 25 sampling sites. Soil samples were collected from 5x5 m plots of different land uses were randomly designed in each plots. The top 30 cm surface of the two replicated in each plots. Soil organic carbon in the top 30 cm of the mineral soil according to IPCC recommendations which state that it is good practice to measure soil carbon to a depth of at least 30cm (Penman et al., 2003).

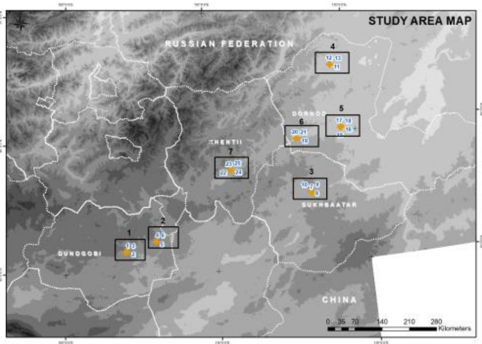

Figure 1. Soil sampling area

All study sites divided into several groups based on land use types.

Laboratory analysis

Soil samples were air dried and sieved to analyze the chemical properties (<2 mm for analysis). Using Thermal pH meter, Soil pH was determined in distilled water at soil-to-solution ratio. The SOC was analyzed using potassium dichromatic oxidation method (Tyurin method) and Soil Inorganic Carbon (Calcium carbonate) analyses using volumetric analyses. Texture was determined using the percentage of sand, silt and clay as determined by the hydrometer method. Also, Soil bulk density was determined using for the Gravimetric method.

For all data, the density of carbon (Batjes, 1996) in a unit area (1 m^2) was calculated as follows:

$$T_d = \sum_{i=1}^{k} pi\ Pi\ Di\ (1 - Si)$$

where T_d is the total amount of organic carbon over depth, d, (in Kg m^{-2}), i is the bulk density of layer i (Mg m^{-3}), P_i is the proportion of organic carbon in layer i (g C Kg^{-1}), D_i is the thickness of this layer (m), and S_i is the volume of the fraction of fragments >2 mm.

Results

Soil organic carbon concentration

Highest soil organic carbon concentration was located in the non-eroded soils close to the town compared with urban soils in eastern Mongolia (Figure 3). Also, the content and stocks of non-eroded (native soil) soils higher than urban soil carbon. Several studies assumed that urban soil organic carbon higher than native soil organic carbon (Brown, 2012; Luo,2014). I this study shows that contrast result with previous study. It's directly depend on soil reclamation and gardening in soil after civilization time.

Soil bulk density

For road and building construction, heavy machinery used, which destroys soil aggregates, compacts the package of particles, decrease porosity (Jo, 1995). Due to human activity soil bulk density clearly higher than non-impacted soils. The average density was significantly higher in urban soils 1.668 gm/cm^3. Whereas it is equal on average to 1.432 gm/cm^3 in non-impacted soil (Table 1). Urban soil restores its structure with time and it approaches the native value.

Soil properties

Large variations were observed within urban land, natural, and throughout the study area as a whole for SOC, SIC, Gravel content, and Bulk density (Table 1). The coefficient of variations (CV) of soil properties ranged from 6% for urban soil pH to 304% for urban soil salinity. In contrast, Natural soil properties had relatively low CV compared with Urban soils.

The comparison of soil properties between urban and natural soils revealed significant differences, except for SOC.

A simple subdivision of urban soils by the evolution stages was suggested in USA (Park et al., 2010). This classification distinguishes two soil groups depending on the urban development stages, for instance first step under construction activity when soil degraded and after construction activity soil condition will recover.

Effect of the land use

There were statistically significant differences in soil organic carbon stock among urban and non-eroded soils (Figure 2, 3). For all urban sites (excluding Gurvansaikhan soum) had lowest SOC stock, while non eroded soils had highest. SOC stocks decreased due to land use for last several decades. In Choibalsan city's average SOC stock had altered -56% at top 30 cm layers, Chinggis khaan city's SOC stocks decreased -42%, Baruun urt city's SOC stocks decreased -17%.

In Dornod provinces soum's SOC stock decreasing level higher than aimag center. For instance, Dashbalbar and Hulunbuir soums SOC stock decreased -64-70%.

In contrast, Gurvan saikhan soum center's SOC stock had increased 5.6% (Figure 3f). It's due to infrastructure activity and gardening. Soum governors pay attention to constructing new paved road and making shelter, reforestation. Unpaved road and bare ground one of the high risk surface for Soil organic carbon by any activity.

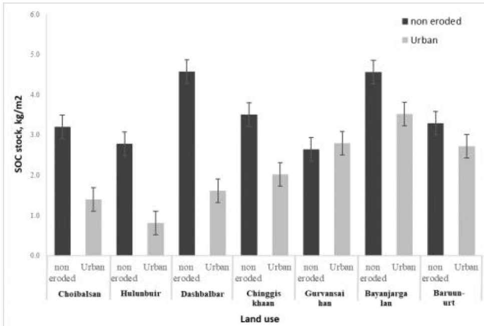

Figure 2. Mean Soil organic carbon Stocks (0-30 cm) of main land use types in study.

In the arid zone, where watering of urban soils improves the greenery state as compared to the poor native vegetation. American scientist observed at first stage of Urban development, SOC of arable land soils as compared with native soils in the temperate climate and at the second stage SOC stock rises upon urbanization in all soils (Pickett et al., 2001).

Comparing province center and soum center sites of same land use type, soum center's ger district areas had significantly lower SOC stocks than the same types located in aimag center areas (Figure 3-abc). Aimag center infrastructure well developed compared with small soum centers in Dornod province.

Soil organic carbon changes of Urban soils

In Mongolia, Previous studies assumed that Dark Kastanozem soils Soil organic matter content decreased for 10% during last three decades in central Mongolia (Batkhishig, 2017).

More recent studies concluded that Dark Kastanozem soil soils SOC stock

Table 1. Descriptive statistics of soil properties sampled from urban and native soils in study area

.	Urban land use				Native soil			
	Mean	Min	Max	CV	Mean	Min	Max	CV
Density	1.7	1.4	1.9	8.4	1.4	1.2	1.7	37
pH	7.9	7.2	9.3	5.7	7.3	6.4	7.7	35
SOC	0.6	0.2	1.7	67	1.1	0.6	1.5	47
SOC stock	2.0	0.4	5.0	62	3.5	2.6	4.6	22
CaCO	1.3	0.0	7.6	162	0.0	0.0	0.0	0
Stone	31	5.1	57	48	20	0.1	35	70
Salinity	1.6	0.0	21	304	0.1	0.1	0.2	41

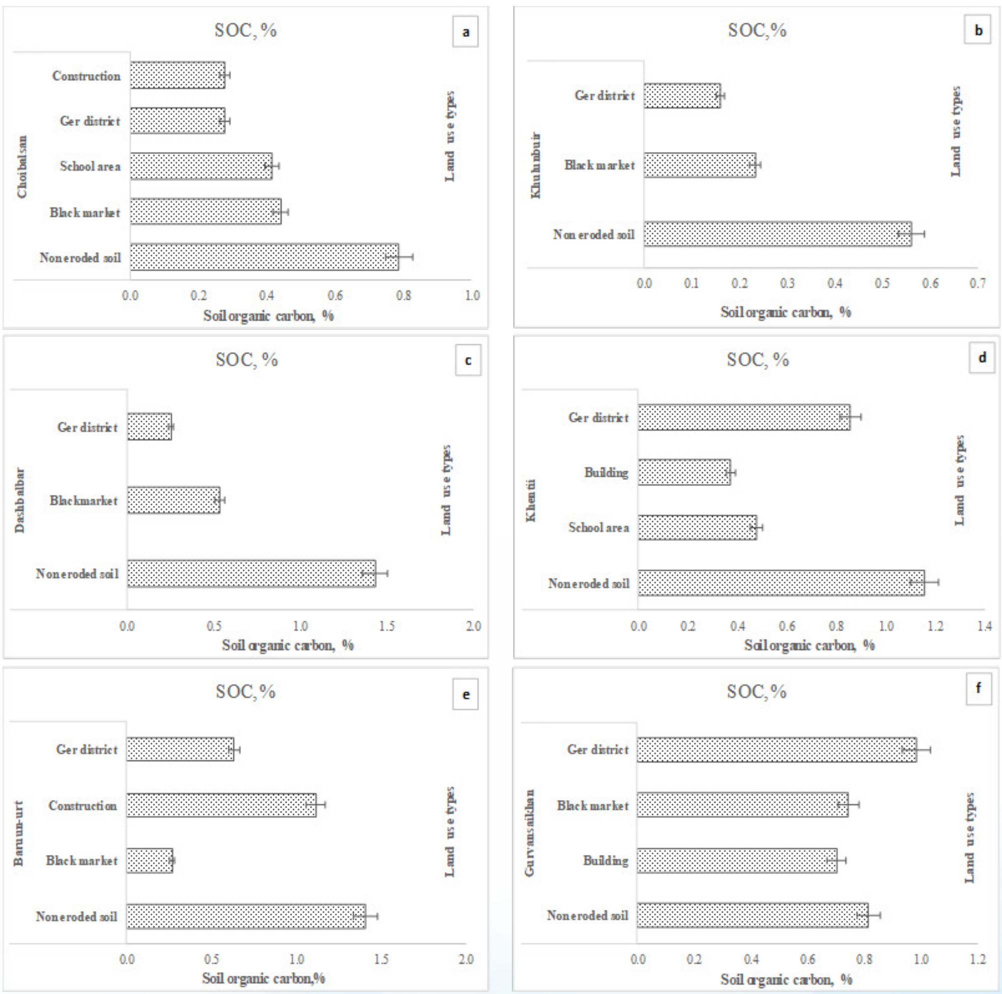

Figure 3. Mean Soil organic carbon Stocks (0-30 cm) of each land use types in Eastern Mongolia.

decreased 16.5% (14.5 t/he) in central Mongolia (Batkhishig & Ganzorig, 2018). One of the main impact is overgrazing and wrong pasture management.

The result of our study showed that SOC stock changes different in the land use types and more important things is SOC stock hugely altered from the Urban soils. A greater than tenfold difference in SOC stock observed in Black market (supermarket), Ger district zones in Dashbalbar (changes rate-75.1%), Hulunbuir (changes rate-70.4%, Dornod) and Baruun-Urt (changes rate-73.6%, Suhbaatar). SOC stocks changing rate between 3.85%-75.15%. The mean SOC stock changes of Urban soil in eastern Mongolia is higher than central Mongolia (Native-pasture).

One the other hand, Native soils SOC stocks changes not muoch higher than impacted Urban soil. Kastanozem soils SOC stock 27.8-45.7 t/he and Light Kastanozem soils SOC stock 26.5-45.6 t/he in study area (Table 2).

Urban soils SOC stock 8.2-36.3 t/he. Lowest soil carbon stock observed in Hulunbuir soum, especially in Ger district land use area and highest carbon stock in Bayanjargalan soum.

Table 2. SOC stocks rate and changes in Eastern Mongolia.

Province, soum	Native	Urban		SOC stock changes, %
	SOC stock, t-C/ha			
Dornod, Choibalsan	32.3	14.2	School	-56.0
		17.9	Black market	-44.5
		13.2	Ger district	-59.1
		10.6	Construction	-67.1
Dornod, Khulunbuir	27.8	9.9	Black market	-64.3
		8.2	Ger district	-70.5
Dornod, Dashbalbar	45.7	11.4	Ger district	-75.1
		16.1	Black market	-64.6
Khentii, Chinggis	35.1	12.6	School	-64.0
		10.2	Building	-71.0
		30.1	Ger district	-14.1
Dundgobi, Gurvansaikhan	26.5	20.0	Building	-24.3
		25.5	Black market	-3.8
		30.3	Ger district	14.3
Dundgobi, Bayanjargalan	45.6	36.3	Ger district	-20.3
		34.2	Black market	-24.8
Suhbaatar, Baruun-urt	32.9	8.7	Black market	-73.6
		31.1	Building	-5.46
		28.4	Ger district	-13.7

Our study revealed that Mongolian medium and small sized town soil's not sequestering carbon, conversely altering huge amount of organic carbon. In developed countries urban soils contain higher SOC stock than native soils, it is direct effect for the park, gardening and infrastructure in the urban. Our result requires to be emphasized that developing urbanization and rising expenses for greenery in cities, towns contribute to the growth of the soil carbon pool.

Conclusion

The study of urban soils becomes acute due to growing urbanization in Mongolia, as compared to the background, ecological situation is radically different in a city. The comparison of soil carbon storage in the different land use of urban areas with that of non-impacted areas reveals a certain decrease in carbon storage. This study reveals that the topsoil carbon stocks in the eastern Mongolian cities have a high spatial variability, and that SOC have a low range compared with native soils.

The significant differences in soil organic carbon stocks among different land use types indicate the decisive role of the human effect on the nature of urban soils.

Acknowledgments

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HYDROLOGIC SENSITIVITY OF THE KHARAA RIVER DISCHARGE IN MONGOLIA

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Abstract: The purpose of this study is to investigate long term runoff trends of the Kharaa river discharge in Mongolia. In the estimation of river runoff, we have applied two different hydrological models (RRI and HBV models). These models have been applied using a 10-years data set, which was split into two durations for calibration and validation. We used three statistical variables including Nash-Sutcliffe efficiency (NSE), coefficient of determination (r2) and relative volume error (VE) to evaluate the model performance. The evaluated statistics of RRI model were NSE = 0.80, r2 =0.89, VE = 0.04 in the calibration period and NSE = 0.89, r2 = 0.89, VE = 0.01 in the validation period. On the contrary, NSE was 0.5–0.8 for the HBV model. To quantify the hydrologic sensitivity, this study succeeded to simulate long-term rainfall-runoff for the entire river basin (14,530 km2) using RRI and HBV model.

Keywords: Long term runoff trends Rainfall, Runoff, RRI model, HBV model

Introduction

Near surface air temperature has increased by 2.07 □ during the last 70 years in Mongolia. This quite large warming has occurred more intensively in the mountainous regions than in the Gobi and steppe regions of Mongolia (MARCC, 2014). The interannual variations in summer precipitation and atmospheric circulation patterns showed a significant increasing trend in geopotential height in the lower-level of the troposphere since the mid-1980s over Mongolia (Hiyama et al., 2016). Thus, we need to assess impacts of climate change on river discharge in Mongolia. In this study we used a model-based approach and compared the simulated results in the Kharaa river basin, which is one of the most important agricultural regions in Mongolia. One of the advantages of the model-based approach is the ability to evaluate monthly or daily runoff variations. Previously, Rainfall-Runoff-Inundation (RRI) model (Sayama et al., 2015) has been applied mainly in the rivers of South-East Asia. On the contrary, Hydrological Bureau Water balance-section (HBV) model has been applied in more than 40 countries all over the world.

In this study, we applied the RRI model to the Kharaa river basin. The RRI model simulates rainfall-runoff and flood inundation processes on a 2-D basis at a river basin scale. Since these two processes interact with each other, the concept of the RRI model with forced rainfall is regarded to be suitable to estimate the elasticity of runoff and flood inundation (Sayama et al., 2015).

This study especially focuses on investigating long term runoff trends of Kharaa river discharge using the RRI and HBV models. The application of RRI model to the rivers in Mongolia is the first case. Based on the simulation results, we compared statistical results obtained from the two hydrological models, and analyzed the relationship among rainfall and runoff for the entire Kharaa river basin.

Study area

The Kharaa river basin locates in north-central parts of Mongolia. Its drainage area covers 14,530 km^2, and the river length is 291 km. The Kharaa basin is one of the tributaries of the Orkhon river. Upstream sites are located in the sporadic-isolated permafrost zone.

Methods

RRI model Structure Overview

Structure of the RRI model is a two-dimensional (2-D) model capable of simulating rainfall-runoff and inundation simultaneously (Sayama et al., 2012: Figure.1). For better representations of rainfall-runoff-inundation processes, the RRI model simulates also lateral subsurface flow, vertical infiltration flow and surface flow. The lateral subsurface flow, which is typically more important in mountainous regions, is treated in terms of the discharge-hydraulic gradient relationship, which takes into account both saturated subsurface and surface flows. On the other hands, the vertical infiltration flow is estimated by using the Green-Ampt (G-A) model. The flow interaction between the river channel and slope is estimated based on different overflowing formulae, depending on water-level and levee-height conditions.

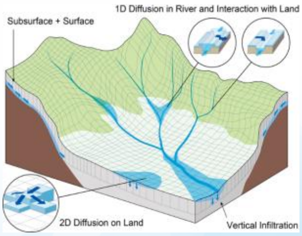

Figure 1. Schematic diagram of the rainfall-runoff-inundation (RRI) model (Sayama et al., 2012).

All the land grid cells can receive rainfall and contribute to rainfall-runoff flowing through other land grid cells and river channels. Meanwhile, they are subject to inundation due to multiple causes: overtopping from river channels, expansion of inundation water from surrounding land grid cells, accumulation of local rainwater of any combination of the three. Hence, the RRI model does not structurally distinguish between rainfall-runoff and flood inundation processes; instead, it solves water flow hydrodynamically. In terms of its application to an entire river basin with rainfall input, the model is similar to grid cell-based distributed rainfall-runoff models. While typical rainfall-runoff models fix flow directions at each grid cell based on surface topography, the RRI model changes flow directions dynamically (Sayama et al., 2015).

It is applicable to an entire river basin. It simulates flow interactions between land and river channels with considerations of levees, so that the RRI model does not require a specification an overflowing point and its overtopping discharge, which are typically required as boundary conditions when using inundation models. Another feature of the RRI model is the acceptance of rainfall and potential evapotranspiration as model input.

It estimates actual evapotranspiration based on the soil moisture conditions and simulates surface and subsurface flows, numerically solved by an adaptive time step Runge-Kutta algorithm (Cash and Karp, 1990; Priess et al., 1992), enables the RRI model to run fast and stable calculations, even for a large river basin with mountainous and plain areas.

Governing Equations of RRI model

A method to calculate lateral flows on slope grid-cells is characterized as "a storage cell-based inundation model" (e.g. Hunter et al. 2007). The model equations are derived-based on the following mass balance equation (1) and momentum equation (2) for gradually varied unsteady flow.

$$\frac{\partial h}{\partial h}+\frac{\partial q_x}{\partial x}+\frac{\partial q_y}{\partial y}=r-f \qquad (1)$$

$$\frac{\partial q_x}{\partial t}+\frac{\partial u q_x}{\partial x}+\frac{\partial v q_x}{\partial y}=-gh\frac{\partial H}{\partial x}-\frac{\tau_x}{P_w} \qquad (2)$$

$$\frac{\partial q_y}{\partial t}+\frac{\partial u q_y}{\partial x}+\frac{\partial v q_y}{\partial y}=-gh\frac{\partial H}{\partial y}-\frac{\tau_y}{P_w} \qquad (3)$$

where, "*h*" is the height of water from the local surface, "q_x and q_y" are the unit width discharges in x and y directions, "*u*" and "v" are the flow velocities in x and y directions, "*r*" is the rainfall intensity, "*f*" is the infiltration rate, "*H*" is the height of water from the datum, "p_w" is the density of water, "*g*" is the gravitational acceleration, and "τ_x" and "τ_y" are the shear stresses in x and y directions.

The RRI model spatially discretizes mass balance equation (4) as follows:

$$\frac{dh^{i,j}}{dt}+\frac{q_x^{i,j-1}-q_x^{i,j}}{\Delta x}+\frac{q_y^{i,j-1}-q_y^{i,j}}{\Delta y}=r^{i,j}-f^{i,j} \qquad (4)$$

where "$q_x^{i,j}, q_y^{i,j}$" are x and y direction discharges from a grid cell at (i, j).

Water depths and discharges are calculated by combining the equations of (4) at each grid cell of each time step. One important difference between the RRI model and other models is that the former uses different forms of the discharge-hydraulic gradient relationship, so that it can simulate both surface and subsurface flows with the same algorithm. The RRI model replaces the equations following equations of (5) and (6), which were originally conceptualized by Ishihara and Takasao (1962) and formulated with a single variable by Takasao and Shiiba (1976, 1988) based on kinematic wave approximations. The first equations in (5) and (6) ($h \le d_a$) describe the saturated subsurface flow based on the Darcy law, while the second equations ($d_a \le h$) describe the combination of the saturated subsurface flow and the surface flow. The hydraulic gradient is assumed to be equal to the topographic slope, for the kinematic wave model, whereas the RRI model assumes the water surface slope as the hydraulic gradient.

$$q_x=\begin{cases}-k_a h\frac{\partial H}{\partial_x},\ (h\le d_a)\\ -\frac{1}{n}(h-d_a)^{5/3}\sqrt{\left|\frac{\partial H}{\partial x}\right|}\,sgn\left(\frac{\partial H}{\partial x}\right)-k_a h\frac{\partial H}{\partial x},\end{cases} \qquad (5)$$

$$q_y=\begin{cases}-k_a h\frac{\partial H}{\partial_y},\ (h\le d_a)\\ -\frac{1}{n}(h-d_a)^{5/3}\sqrt{\left|\frac{\partial H}{\partial y}\right|}\,sgn\left(\frac{\partial H}{\partial y}\right)-k_a h\frac{\partial H}{\partial y},\end{cases} \qquad (6)$$

where "k_a" is the lateral saturated hydraulic conductivity and "d_a" is the soil depth times the effective porosity.

Here we calculate infiltration loss "f" with the Green-Ampt infiltration model (Raws et al., 1992).

$$f=k_v\left[1+\frac{(\phi-\phi_i)s_f}{F}\right] \qquad (7)$$

where "k_v" is the vertical saturated hydraulic conductivity, "$\emptyset$" is the soil porosity, "ϑ_i" is the initial water volume content, "S_f" is the suction at the vertical wetting front and "F" is the cumulative infiltration depth.

Interactions of water between slope and river

Water exchange between a slope grid cell and an overlying river grid cell was estimated as a function of the relationships between the slope water level, river water level and levee height and ground. River and slope water exchange, the following four different conditions. For each condition, different overtopping formulae are applied to calculate the unit length discharge from slope to river (q_{sr}) or from river to slope (q_{rs}), which are then multiplied by the length of the river vector at each grid cell to calculate the total exchange flow rate (Iwasa and Inoue, 1982).

(a) When the river water level is lower than the ground level, q_{sr} is calculated by the following step fall formula.

$$q_{sr} = \mu_1 h_s \sqrt{g h_s} \tag{8}$$

where "μ_1" is the constant coefficient (= (2/3)), and "h_s" is the water depth on a slope cell. As far as the river water level is lower than the ground level, the same equation is used even for the case with levees so that the slope water can flow into the river.

(b) When the river water level is higher than the ground level and both the river and slope water levels are lower than the levee height, no water exchange is assumed between the slope and river.

(c) When the river water level is higher than the levee crown and the slope water level, the following formula is used to calculate overtopping flow q_{sr} from river to slope.

$$q_{rs} = \begin{cases} \mu_2 h_1 \sqrt{2 g h_1} & h_2/h_1 \le 2/3 \\ \mu_3 h_2 \sqrt{2g(h_1 - h_2)} & h\_2/h\_1 > 2/3 \end{cases} \tag{9}$$

where "μ_2 and μ_3" are the constant coefficient (=0.35, 0.91), and h_1 is the difference between the river water level and the levee crown. "μ_2 and μ_3" are the constant coefficient (=0.35), and "h_1" is the difference between the river water level and the levee crown.

(d) When the slope water level is higher than the levee height and the river water level, the same formula as (2) is used to calculate overtopping flow q_{sr} from slop to river. In this case, "h_1" is the elevation difference between the slope and the river, and "h_2" is the elevation difference between the river and the levee crown.

RRI model application

The RRI model is applied to the entire Kharaa river basin. It was set up using the DEM (digital elevation model). Flow direction and flow accumulation were delineated from Hydro SHEDS 30 s (Lehner et al., 2008) and upscaled to a 60 s (approximately 2 km) resolution (Masutani et al., 2006). The RRI model uses flow direction and accumulation only to determine river channel locations but not for flood routing, since the flow direction varies depending on hydraulic gradients. Local river depths *D* (m) and widths *W* (m) were decided, based on cross-section information at the stations and measured site, while for tributaries with no cross-section information, we approximated widths and depths using the following (14) and (15) (Coe et al., 2008).

$$W = C_w A^{S_W} \tag{10}$$

$$D = C_D A^{S_D} \quad (11)$$

where "A" is the upstream contributing area (km^2) and "C_W", "S_W", "C_D," and "S_D" are regression parameters, whose values were estimated from river cross-section data.

The obtained parameters were C_W = 20.0, S_W = 3.50, C_D = 2.0, and S_D =0.18. These equations are capturing the general characteristics of the river's cross sections becoming wider and deeper downstream. To set model parameters, the area was first classified into two areas: mountains and plains. At this time, we have evaluated runoff of hydrograph and long-term changes variables depending on rainfall.

Model simulation results

We split the duration between 1995 and 2013 into a calibration period (1995-2005) and validation period (2005-2013). Figure 2 compares observed daily discharge with simulated discharge using RRI and HBV models. Both models could reproduce daily river discharge well for both calibration and validation periods.

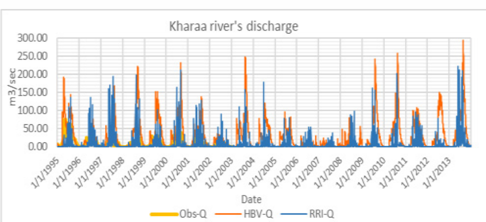

Figure 2. Observed and simulated discharge using RRI and HBV model.

Model parameters were manually calibrated by focusing on the Kharaa river's daily discharge.

We used three metrics including Nash-Sutcliffe efficiency (NSE), coefficient of determination (r^2) and relative volume error (VE) to evaluate the model performance (see Appendix). The evaluated statistics of the RRI model were NSE = 0.80, r^2 =0.89, VE = 0.04 in the calibration period and NSE = 0.89, r^2 = 0.89, VE = 0.01 in the validation period. In the HBV model, NSE was 0.5-0.7 during the calibration period (1995-2005) (Munkhtsetseg, 2008). When runoff was evaluated using HBV model in the validation period (2005-2013), NSE was 0.5-0.8 (Amarbayasgalan et al., 2015).

Table 1 shows the calibrated parameters for mountain and plain areas. The sensitivity analysis covers the period of 2005-2013. However, due to the reliability of observed discharges, we focus here on the entire period 1995-2013 for the model evaluation.

The entire river basin was subdivided into two regions: mountain and plain areas. A type S-S (surface + subsurface) model is applied to the mountain area with parameters related to soil depth d_a and d_m, lateral saturated hydraulic conductivity k_a and an exponent parameter β related to unsaturated hydraulic conductivity. A type S-I (surface + infiltration) model is applied to the plain area with the G-A model. Their parameters include vertical saturated hydraulic conductivity k_v, porosity φ and wetting front soil suction head S_f, whose values are referred to by Raws et al. (1992). The parameters n and n_{river} are Manning's roughness coefficients for land surface and river channels. Details of the parameters used in the RRI model were shown in Table 1.

Table 1. The RRI model parameter setting.

	Parameters	Mountains	Plains
n	($m^{-1/3}s$)	0.35	0.35
d_a	(m)	3.0	-
d_m	(m)	1.0	
K_a	(ms^{-1})	1.6	-

β	(-)	4.0	-
k_v	(cmh^{-1})	0.0	0.06
φ		3.8	0.471
S_f		3.1	0.273
F_{limit}	(m)	-	0.4
n_{river}	($m^{-1/3}s$)	0.03	0.03

Summary and Conclusions

In this study, we have estimated runoff of Kharaa river using RRI model. We have split the entire period (1995–2013) into a calibration period (1995–2005) and validation period (2005–2013). We have used three statistics including Nash-Sutcliffe efficiency (NSE), coefficient of determination (r^2) and relative volume error (VE) to evaluate the model performance (see Appendix). The evaluation statistics results of RRI model were NSE = 0.80, r^2 =0.89, VE = 0.04 in the calibration period and NSE = 0.89, r^2 = 0.89, VE = 0.01 in the validation period. For the HBV model, NSE was 0.5–0.8. In order to quantify the hydrologic sensitivity, this study simulated long term rainfall-runoff trends for the entire river basin. (14,530 km^2) using RRI and HBV models. We could compare runoff estimated from RRI and HBV models. Our analysis also suggested that estimated runoff of from RRI model in this basin had the highest correlation with the observed runoff.

Acknowledgments

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SOIL ORGANIC CARBON CHANGES DUE TO UNPAVED-DIRT TRACKS: A CASE STUDY IN KHENTII PROVINCE

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Abstract: Unpaved-dirt roads have several negative impacts on the environment; one of them is increased wind and water erosion. Soil erosion has four stages (detachment, breakdown, transport/redistribution and deposition of sediments), and the soil organic carbon (SOC) is influenced during all stages. Erosion process removes the light organic fraction of a low density of < 1.8 mg/m3. The main objective of this study was to determine how much organic carbon lost from soil when it's changed to a dirt road in different natural zones in the case of Khentii province. Also, the changes in soils main physical and chemical properties were examined. To do this, we took 2 samples (one from the road, and another one from adjacent to the road in order to compare) from 6 sites. A total of 12 soil bulk samples were taken from 10 cm and analyzed. According to laboratory results, the average SOC loss was 18.4% at the unpaved-dirt road in Khentii province. However, in forest road, SOC was 45.3% higher than the control sample.

Keywords: Soil organic carbon, soil erosion, unpaved-dirt track.

Introduction

Mongolia is a sparsely populated, landlocked country which has seen an economic growth spurt since the 1990s. This rapid growth in the economy has led to a growth in the number of vehicles, which far exceeded the growth of the capacity for road construction. According to Mongolian Statistical Information Service, vehicle number increased about 15 times, from 36.674 to 536.399 between 1987 and 2017 in Mongolia. It is available to see the improved auto road (paved, gravel and improved soil road) information from statistic database, but unpaved-dirt road length and area data are still rare. In 2010, The Mongolian road network has about 45 000 km of dirt roads and about 2000 km of gravel roads in its approximately 49 500 km network (Onon, 2010). Besides the scarcity of paved roads, there is practically no restriction to either vehicular movement or vehicle speeds. Also, repeated usage of tracks makes old track unsuitable for driving due to the formation of potholes and corrugations in the soil. This process is facilitated by snowmelt, rainfall, and sub-soil permafrost-thawing. Consequently, a parallel track is generated (Keshkamat et al., 2011).

The impacts of off-road vehicles have been well documented (Webb & Wilshire 1983) and one of them is increased wind and water erosion. The degree of erosion experienced in an area exposed to off-road vehicles use is affected by two main factors. First, increased water erosion is partially attributable to decreased infiltration rates due to compaction. Second, off-road vehicles destroy surface stabilizers, making soils more susceptible to erosion (Hinkley et al., 1983). The soil organic carbon (SOC) pool is influenced during all four stages (detachment, breakdown, transport/redistribution and deposition of sediments) of soil erosion. Being a selective process, erosion preferentially removes the light organic fraction of a low density of < 1.8 Mg/m^3 (Lal, 2003).Soil organic matter in eroded sediments is easily mineralized and 20–30% of the displaced SOC may be emitted into the atmosphere (Jacinthe & Lal, 2001). Therefore, the total ecosystem carbon pool is lower in eroded than in uneroded landscapes, and the rate of mineralization of soil organic matter is more in sediments than in original soil (Lal, 2003).

Over 360 small settlements which are connected by unpaved-dirt tracks in Mongolia and these tracks become much wider near settlements. In other words, multiple roads within a small location create an overlapping influence-zone larger than a single large road (Sanderson et al., 2002). For instance, road density is 4.61 km per 1 km^2 near the center of Tsogttsetsii soum which is located near the mining areas (Batkhishig et al., 2017).

In Mongolia, several types of researches about the impacts of unpaved-dirt roads have been conducted, such as vegetation recovery and soil erosion. For example, Byambaa & Muryama (2012) examined changes in vegetation cover, soil physical and chemical properties, and morphology shape in 4 different dirt roads (1-in use, 2-restored, 3-in restoration, 4- unused for a road). Their results indicated that soil chemical properties (organic content, pH) need a longer time than physical properties (bulk density, moisture, and infiltration) to restore. Vegetation recovery in the tracks of an abandoned dirt road can affect the surrounding vegetation through colonization be an expansion of low-palatability clonal species (Toshihiko et al.,2013; Shen et al., 2006). Another interesting study was conducted in Southern Mongolia; Davaadorj (2017) used field experiment simulating off-road track driving to measure soil quality changes and to compare them to conditions before the experiment. After 50 operations, 300 t/ha soil was eroded from the surface (0-10 cm) soil.

Dirt roads are a source of emission of wind-eroded dust because of their low vegetation cover (Gillette and Adams 1983; Goossens and Buck 2009a, b) and the Mongolian steppe is assumed a major source of dust emission in Asia (Zhang et al., 2008; Shinoda et al., 2011). Wind-blown dust is sometimes transported long distances and causes human disease in downwind countries such as Korea, Taiwan, and Japan (Kwon et al., 2002; Yang et al., 2005; Hashizume et al., 2010).

Therefore, unpaved-dirt road and its impacts need to be assessed objectively and quantitatively from many aspects. Importance of soil degradation in general and that of soil erosion in particular on C dynamics and possible emissions of GHGs cannot be overemphasized. In this study, we will determine how much organic carbon lost from soil when it's changed to a dirt road in different natural zones in case of Khentii province.

Method

Sampling location

The study was conducted on the Khentii province, one of the 21 provinces of Mongolia, located in the east of the country, and has 18 soums and 5 villages. The study site covered an area of 80 thousand square kilometers and is conterminous with the southern border of Russia. The Khentii province has a variety of topography, with elevation ranging from 1680-2800 meters above sea level. The northwest of the province is covered by the eastern part of the Khentii Mountains, towards the southeast the landscape changes into the eastern Mongolian steppe plains and is located between Eurasian coniferous forest taiga and Central Asian arid steppe. According to natural zones classification by Dash (2005), forest steppe, meadow steppe, steppe, dry steppes, and taiga are dominant natural zones in Khentii (Figure 1).

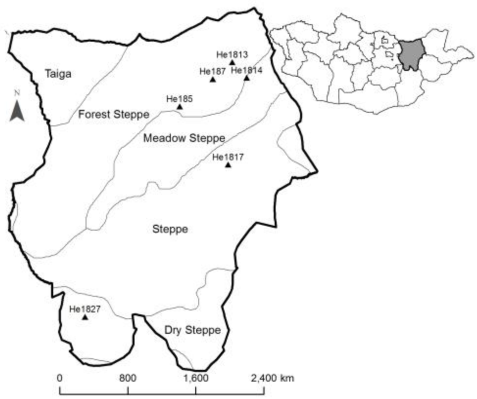

Figure 1. Map of Khentii province showing the natural zones (Dash, 2005), sampling location and ID of samples

The soils within the province are mainly Kastanozem and Chernozem. The climate is humid-cold in summer, and extremely cold in winter, with a mean annual rainfall of 200-500 mm (National Atlas, 2009).

In 2018, a total of 3758 vehicles were passed the technical inspection in this province.

Sampling method

Six sampling sites were selected from dominant natural zones in the province (Meadow steppe-He1814, Steppe-He1817, Dry steppe-He 1827, Forest steppe- He185, He187, and He1813), and fieldwork was conducted in 2018. One site is selected from every natural zone except the Forest steppe, because we also want to find out that is there any impact of land use difference on organic carbon changes due to unpaved-dirt track. Therefore, we sampled in 3 different land use type (He185-Pasture, regular track, He187-Near soum center, He1813-Forest track) in Forest steppe zone.

We took 2 samples from every sampling site, one from the road, and another one from adjacent to the road in order to compare. A total of 12 soil bulk samples were taken from 10 cm. A steel core with a known diameter and length used to collect soil samples. All samples were returned to the soil laboratory of Institute of Geography and Geoecology, air dried, gently disaggregated, and passed through the 2 mm sieve.

$$SOC = SOM(\%) \div 1.724 \quad (1)$$

The Walkley-Black method was used to measure organic content (SOM) and Van Bemmelen factor of 1.724 used to calculate soil organic carbon (SOC).

Results

Figure 2 shows PCA (Principal Component analysis) biplot of all samples main physical and chemical properties, analyzed on correlation matrix with the first two principal components explain 70.5% of the variance. In this circumstance, we will use this plot to see changes in samples main properties at every site.

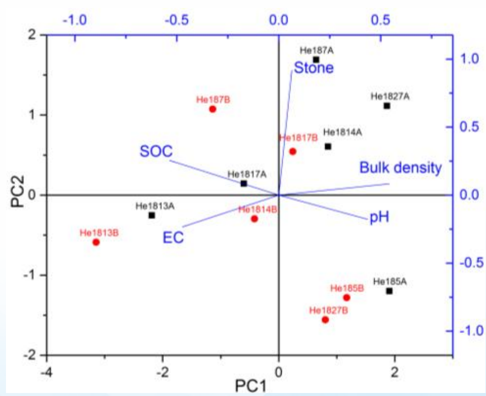

Figure 2. PCA biplot of soils main physical/chemical properties. • Pasture (control site) ■ Unpaved road

Bulk density of unpaved roads was higher than control samples at every site. Also, SOC had higher content in every control samples except He1813. EC (electrical conductivity) – salinity of soil had an increase at unpaved road samples from He1814 and He1817 sites. pH values did not show a significant difference.

Bulk density

According to PCA Biplot (Figure 2) of main soil physical/chemical properties, only bulk density had an increase at every site. Therefore, bulk density results consider separately (Figure 3).

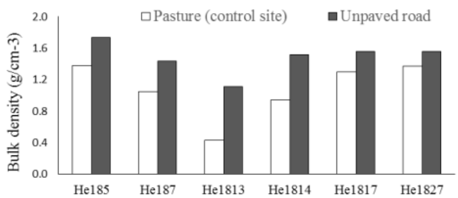

Figure 3. Changes in bulk density

At the unpaved road, bulk density was ranging from 1.11-1.74 g/cm3. In forest road, bulk density was the lowest in both road (0.43 g/cm³) and control site (1.11 g/cm³).

It can be seen that bulk density changes in He185 (forest steppe) and He187 (forest steppe) were relatively close, increased by 0.36 g/cm³ and 0.39g/cm³, respectively. Changes in He1817 (steppe) and He1827 (dry steppe) were exactly same at 1.56 g/cm³. The largest variance occurred in forest road (He1813), increased approximately 2.5 times (Figure 4).

Soil Organic Carbon

Figure 4 compares all road samples with adjacent pastures (control site) SOC content and its changes estimated by percentages.

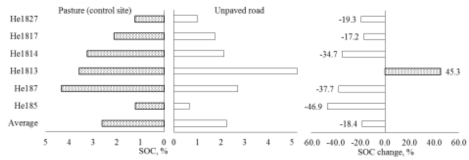

Figure 4. Soil organic carbon and its changes due to an unpaved road

Average SOC was 2.2% in the unpaved road, and 2.6% in the control site. In other words, 18.4% of SOC was lost from the upper 10 cm soil when it was changed to the unpaved-dirt road in all sites.

In Steppe (He1817) and Dry-steppe (He1827) zones, control soil samples had lower OC (2.11% and 1.24%, respectively) compare to other zones in Khentii province. Also, samples from the unpaved road in these zones had lower SOC content.

Samples from Forest steppe zone (He185, He187, and He1813) showed interesting results. Most significant SOC loss occurred at He185 (-46.9%). Also, He185 had the lowest SOC content (1.22%) in the pasture (control site). On the contrary, He187 had the highest SOC at 4.33%, however, it did not have the highest SOC content in the road. Samples from forest road (He1813) showed phenomenon result. In this site, SOC of the road was higher (45.3%) than the control site (Figure 4).

Discussion & Conclusion

From the results of 6 sites 12 samples, the average SOC loss was 18.4% at the unpaved-dirt road in Khentii province. A decrease of the soil organic carbon in the present study shows that soil erosions accelerated at unpaved roads and this is in agreement with previous studies (Davaadorj, 2017; Byambaa & Muryama, 2012). However, soil organic carbon of unpaved road had 45.3% higher than the control sample in forest site (He1813). This increase may have been caused by an enhancement of soil water retention potential and/or reduction in evapotranspiration in compacted soil. Compacting the soil compresses its macropores, thereby creating more micropores and increasing the soil's potential for water retention (Richard et al., 2001; Sillon et al., 2003). In addition, there is less wind to blow soil fine/light organic fractions and less sunlight to evaporate soil moisture in the forest.

Moreover, from the results of this study, we can assume that SOC loss is different in natural zones and land use types. Forest-steppe and Meadow steppe has high SOC. Therefore, the difference of SOC between unpaved road and control sample was also higher than dry-steppe and steppe zones. But, it needs to analyze more samples to get accurate information.

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DROUGHT SPATIAL AND TEMPORAL CHANGES DURING THE GROWING SEASON IN MONGOLIAN PLATEAU, ITS EFFECTS ON SOCIETY AND ECONOMY

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Abstract: Drought is a climate hazard, which can be influenced on pastoralism and rangeland vegetation. Recent years, drought intensity and frequency are increasing and influencing on ecosystem and economy in Mongolian plateau.

There are several ways to define the drought. One of them is PDSI - Palmer Drought Severity Index. Therefore, drought distribution, intensity and frequency were estimated with PDSI in Mongolian Plateau.

In this research, climatological growing (May to September) season data used from 108 monitoring stations between 34 years 1980-2013.

Data from Mongolian losses of adult animals in 1980-2014, Data from Inner Mongolia losses of adult animals between 2000 and 2014, monthly sum of precipitation and monthly average temperature have used this research from 108 meteorological stations of Mongolia and Inner Mongolia.

From the results of the correlation in this research site, drought frequency and intensity increased significantly than long-term average recent 34 years from North West to South East, and North East to Central part of this research site.

Mongolian Plateau covers many natural zones and widespread area from north to south according to the longitude. Drought duration and frequency are different, because of surface and landscape features.

Key Words: Mongolian Plateau, drought, PDSI, temporal, spatial distirbution, drought frequency

Introduction

Drought is defined natural and climate disaster which affects social and economic. Drought formed that evaporation is increasing because of the long period of dry hot climate, its influence on soil moisture lose and vegetation yields, lack of the surface water [1].

During the global climate change, overheating trend is increased on the bigger continents cause of the tropical air mass came from anti-cyclone [2].

Drought can be defined in several ways, though, generally, it considered three types: atmospheric, agricultural and water, and these are evaluated by various indices. Standardized Precipitation Index (SPI) is mostly used in the arid area [3]. PDSI is a widely used an index for assessment of rangeland drought. Drought frequency and danger increase since the 1970s [4]. World drought intensity index assessed by

PDSI from 1950 to 2008, the result showed that drought has increased every decade by 1.74 per cent [5]. Recent years, on a broad scale drought has more happened all around the [6], and drought happened in East Asia for 3 years between 1999-2001 [7,8].

We selected the Mongolian Plateau as a research site. This area has dry and sensitive ecosystems, and drought has changed soil and vegetation, which is determines the rangeland ecosystem. Then it became the main driver, which affects pastoral livelihoods and the livelihoods of the people. Therefore, we assessed the drought spatial and temporal distribution, changes, frequency, intensity and trending based the PDSI, even analysed the correlation between data about losses of the adult animal.

Methods and materials

Research site. This research is covered the Mongolian Plateau, which is consider totally 2.74 million.sq.km, northern part of North-East Asia, including Mongolia and Inner Mongolia. Western, North-Western and North-Eastern parts are mountainous, land locked and has continental harsh climate. Its cover many natural zones and has amplitude of temperature and precipitation, vulnerable to climate change, and most of the area is Gobi deserts. The location of research site and meteorological stations described on Fig 1.

Data and material

Data from Mongolian losses of adult animals in 1980-2014, Data from Inner Mongolia losses of adult animals between 2000-2014 Mongolian monthly sum of precipitation and monthly average temperature have used this research from 60 meteorological stations of Mongolia, 48 meteorological stations of Inner Mongolia.

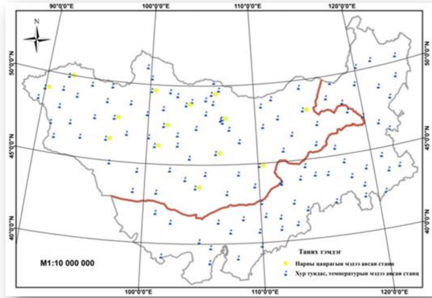

Figure 1. The location of research site and meteorological stations

Methods

Palmer Drought Severity Index (PDSI) was used in this research, which is used widely in many countries for assessment of drought.

Palmer Drought Severity Index (Palmer 1963, 1973) calculated by formula (1) [9].

$$\boldsymbol{PDSI} = \sum_{i=1}^{t} \frac{(\boldsymbol{P}-\boldsymbol{P})*\boldsymbol{K}}{(0.309t+2.69)} \qquad (1)$$

Positive value of PDSI is express humidity and negative value express drought years.

According to Palmer's classification dry and drought years (PDSI<-1) were selected and spatial distirbution map analyzed. Although, consider the correlation between PDSI and losses of adult animal from 1980 to 2014.

PDSI negative value (-2) is selected from every 108 meteorological stations in Mongolian Plateau drought frequency in growing seasons in 1980-2013 years.

Result

1. Drought temporal variation

Mongolian Plateau drought assessed by PDSI value and its dynamics from May to September for recent 34 years in research site is described on Fig2. Variation of PDSI value is high for 34 year of the dynamics. During the research period, the value of PDSI negative 1 to 2.5 that drought happened in 1982, 1997, 1999, 2000, 2001, 2002, 2004, 2005, 2006, 2007, 2008 and 2009. The value of PDSI was positive 1 to 2.5 that meant more humid in 1980, 1990, 1991, 1993, 1994, 2003 and 2013.

Drought is more harmful that other climate disasters due to its impact area of influences, duration and driving factors. From the average of the drought trends between 1980 and 2013 (Fig 2), beginning of the 1980s was dry and continued until summer of 1996, from 1999 drought frequency become closer and intense.

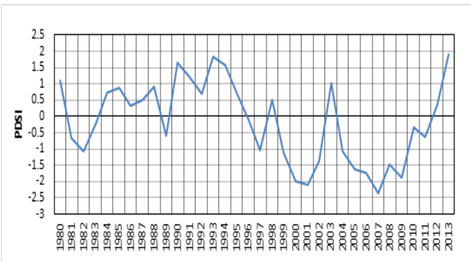

Figure 2. PDSI dynamics from 1980 to 2013 in Mongolian Plateau

2. *Drought spatial variation:*

Drought can be defined in two ways. One is defined by the amount of the disaster and the other being the duration of the disaster. Drought (PDSI<-1) year maps (1982, 1989, 2000, 2001, 2002, 2005, 2006, 2007, 2008 and 2009) were selected according to PDSI value classification and described the spatial distribution on Fig 3.

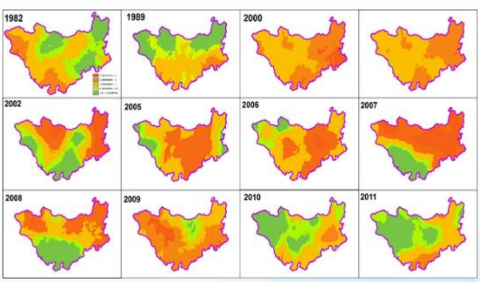

Figure 3. PDSI spatial distribution in Mongolian Plateau

From this figure we can see that drought happened in western and south west part of Mongolian Plateau in 1982, southern and south east in 1989, almost all area in 2000 and 2001, western and north east in 2002, central and east part of Gobi area in 2005, central and east part in 2006 and 2007, east and north west in 2008, and drought was intense in all area despite from Khentii and Khuvsgul Mountain in Mongolian and Southern part of Inner Mongolia in 2009.

South east and eastern part of research site was dry and drought in 2010, 2011.

From this figure we can see that in recent years from 2000 to 2009, the intensity of drought and amouth of drought area has increased.

3. *Correlation between drought and losses of adult animal*

The dynamics of losses of adult animal and PDSI dynamics for each year between 1980 and 2014 are shown in Figure 4.

During the research period, losses of adult animal rates tend to increase, drought intensity tend to increase and PDSI values decreased. The losses of adult animal was high in 1980, 1983, 1993, 2000, 2001, 2002, 2003, 2008, 2009 and 2010.

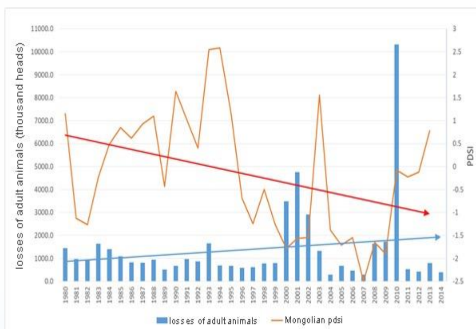

Figure 4. Correlation between PDSI and losses of adult animal in Mongolia

In those year PDSI value was 1.12 to negative 2.35 that years were dry and drought happened. In Mongolia, 22407.8 thousands of livestock lost in 1980-2000 and 26586.1 thousands of livestock lost in 2001-2014. In addition, two consecutive droughts directly impact on losses of adult animal.

Drought happened in from 2000 to 2002, from 2005 to 2009, were reason for about 10 million losses of adult animal in 2010.

However, In Inner Mongolia, losses of adult animal was higher in the early 2000s than in other years, but in the rest of the period were stable (Fig 5).

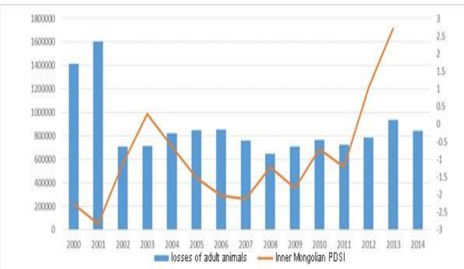

Figure 5. Correlation between PDSI and losses of adult animal in Inner Mongolia

According to the figure, 13142.3 thousand adult animal lost in 13 years between 2000 and 2014. This is less than 1 times compared to Mongolia. In some years, Inner Mongolia is heavily comparable with drought intensity in Mongolia, but losses of adult animal is low.

It can be concluded that Inner Mongolia is a no pastoral animal husbandry and fenced animal husbandry.

4. *Drought frequency in Mongolian Plateau*

PDSI negative value (-2) is selected from every 108 meteorological stations in Mongolian Plateau drought frequency figure shown in Fig 6 in growing seasons in 1980-2013 years. The figure 6 shows that drought repetition minimum is 27 times and maximum is 64 times in one station during 34 years and 170 months.

During the 34-year period during the period of May to September, a total of 508 estimates of droughts were analyzed at a total of 3468 calculated PDS estimates at 108 meteorological stations.

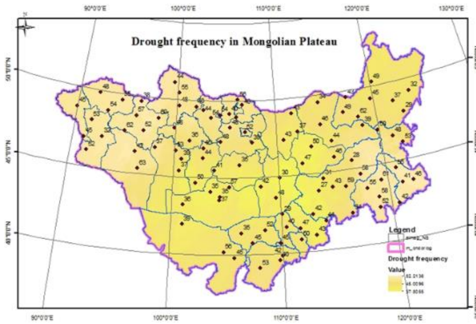

Figure 6. Long term drought frequency map in Mongolian Plateau

PDSI value less than negative 2 and drought intensity was high in 20 stations in 1981, 22 statins in 1989, 34 station in 1999, 55 station in 2000, 53 station in 2001, 47 stations in 2002, 36 stations in 2004, 41 stations in 2005, 44 stations in 2006, 64 stations in 2007, 45 station in 2008, 55 stations in 2009.

Drought happened in western part of Mongolian Plateau which is Uvs, Khovd, Zavkhan, Govi-Altai, Omnogovi and Alshaa, Bayannuur Ordos, Bugat in 1980-1990. Drought expand in central part of Mongolian Plateau, Gobi and east part of area in 1997-2013.

In other word, drought intensity increased in Uvs, Khovd, Bayankhongor, Dundgovi, Bulgan, Selenge, Tov, Sukhbaatar, Shiliin Gol, Khyangan, Ulaankhad since 1996 for 18 years. Since 2000, drought intensity and frequency increased, even the more spread.

Conclusion

- When analyzing the PDSI classification and analysis of the research area, it could be possible to express the drought in connection with the distribution of the drought intensity and socio-economic dynamics in the 1980-2013 in Mongolia.
- The intensity and frequency of drought in Mongolia is increasing year by year, and the area extends beyond eastern Mongolia and Inner Mongolia. Before 2000, drought has been repeated every 10-11 years, but since 2000 drought has been repeated over 3-5 years since 2000.
- In this research spring time losses of adult animal was high after the 12 times of drought during 1980-2013. The losses of adult animal were high in Mongolia after drought, but in Inner Mongolia losses of adult animal were stable after drought. This is because the two countries have different types of livestock herding – fenced (intensive livestock) and pastoral livestock.

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MULCHING IMPACT ON SOIL MOISTURE CONSERVATION IN URBAN SOIL

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Abstract: Applying mulch to soil has several benefits including soil moisture conservation, fertility and health improvement of the soil, reducing weed growth and enhancing the visual appeal of the area. In this study, four mulch (organic mulch - straw, leaf; inorganic mulch - sand, gravel) treatments were tested for their ability to control moisture on Technosol. We have measured soil moisture at 5cm, 10cm, 20cm and 25cm depths for 3 months. Soil moisture content determined by the gravimetric method in the laboratory. Soil moisture was significantly higher in soil with organic mulch than those with inorganic mulch for the same positions. The most significant soil moisture loss occurred in the soil with sand mulch. On the contrary, leaf mulch has the highest soil moisture storage capacity compare to other 3 mulches. Under the leaf mulch, average soil moisture was 8.9%, 8.1%, and 12.7% at 5 cm, 10 cm, and 20 cm, respectively during experiment time.

Keywords: Mulch, soil moisture, conservation moisture, organic mulch, inorganic mulch,

Introduction

Soil moisture is an important component of the Earth system (Koster et al., 2004) and strongly impacts water, carbon and energy exchange between the atmosphere and land surface (Gallego-Elvira et al., 2016). The main source of water for ecosystem evapotranspiration, and compared with precipitation, it is more closely associated with vegetation growth and ecosystem carbon dynamics (Chen et al., 2014). Soil moisture is biologically important and greatly influences biogeochemical cycles (Seneviratne et al., 2010). Moisture in soils is a key factor in decomposing soil organic carbon by soil microorganisms (Christ and David, 1996), and carbon sequestration is moisture dependent (Lamparter et al., 2009). The availability of soil water is one of the main factors affecting plant growth and development. Conversely, plant cover influences soil water conditions by affecting the evapotranspiration component of the soil water balance (Baumgartner, 1967).

Reasons for applying mulch include conservation of soil moisture, improving fertility and health of the soil, reducing weed growth and enhancing the visual appeal of the area. In horticulture plantation, both organic mulch and inorganic mulch have been into common use (George Hochmuth et al, 2002). Use of gravel-sand mulch changes the hydrological process and improves soil productivity, which is effective in reducing evaporation and runoff, improving infiltration and soil temperature, checking wind and water erosion as well as enhancing biological activity and soil fertility (Xiao Yang Li, 2003) Specifically, in this unstable climate and global warming condition, mulch is utilized to help plants adapt to climate change by modifying microclimate around the growing plants (Dvořбk et al, 2001). Some previous studies have found that mulch usage increases plant productivity (Siwek et al, 2007). According to the Colorado State University, using mulch reduces evaporation of water from the soil, and can reduce irrigation needs by up to 50% (Neibauer & Waskom, 2004). The application of mulch can be classified as an ef-

-fective soil conservation practice (Smets et al., 2007).

Many materials are used as mulches, which are used to retain soil moisture, regulate soil temperature, suppress weed growth, and for aesthetics. They are applied at various times of the year depending on the purpose. Mulch forms a layer between the soil and the atmosphere preventing sunlight from reaching the soil surface, thus reducing evaporation. However, mulch can also prevent water from reaching the soil by absorbing or blocking water from light rains. The main aim of this research was to investigate the effectiveness of various mulch types in conserving soil moisture.

Method

We used inorganic mulch (sand and stone), organic mulch (straw and leaf) cover for the soil. This study was established in gravelly, sandy urban soil (*Technosol*) in Ulaanbaatar Mongolia. The study was conducted in to choose 1m^2 area in different land cover types and to covered by sand, straw, gravel, and leaf. Also, uncovered area was chosen as control site. We used gravimetric method to determine soil moisture.

Gravimetric method: One of the most common methods of soil water content determination is a gravimetric method with oven drying (Black, 1965). This method covers the laboratory of the moisture content of the soil as a percentage of its oven-dried weight in Equation 1.

$$Swater = \frac{Swet - Sdry}{Sdry} * 100 \qquad (1)$$

S water - Soil water content (%), S wet - Weight of wet soil (g), S dry - Weight of dry soil (g)

The criterion for a dry soil sample is the difference that has been dried to constant weight in the oven at a temperature between 105^{o}C.

The measurement was installed at different depth of each study site at 5cm, 10cm, 20cm and 25cm in every 10 days for 3 months.

Result

Results from this research show that the moisture infiltration was higher at leaf mulched soil, compared to other mulch and uncovered field. In addition, organic mulches, specifically dry leaf was the most effective type of mulch for soil moisture conservation in hot summer conditions. The maximum soil moisture was 18.4-22.0% at 0-25 cm of mulched soil in July, when had the highest precipitation. The maximum soil moisture was 25.8% at 0-25 cm at the control site (Figure 1).

Control site

Soil moisture dynamic is a lot of dependent on precipitation. After precipitation, soil moisture of control site was higher than mulched soil. However, soil moisture evaporated quickly for short term. After many days rain, moisture infiltrates to 25 cm depth. But, in short term rain, moisture could not infiltrate to the depth because it was evaporated quickly. The average content of soil moisture ranges of from 7.6 to 8.9% at 0-25cm of soil in July. The maximum soil moisture content of control site soil was 25.8% in the depth of 5 cm, in the depth of 10 cm was 21.5% and in the depth of 25 cm was 17.6%. But minimum soil moisture content was 0.1-4.1% in August.

Leaf mulch

Tree leaf conserves moisture, modifies temperatures and prevents soil erosion and crusting. In time bacteria, fungi and other naturally occurring organisms decompose or compost the leaf and other organic material, supplying the existing plants with a natural, slow-release form of nutrients. Conservation of soil moisture of leaf mulching was 23.1% higher in the depth of 5cm, in the depth of 10cm was 22.2 % higher, and in the depth of 20 cm was 60.6 % higher than compared with the control site.

Straw mulch

Straw mulch is typically made from the stems of grains. The mulch helps to hold in moisture and it composts into nutrient and amendments for the soil. Soil moisture infiltrated deep into the soil and evaporate slowly influence of straw mulch. For example, it did not rain and during 14 sunny days (from 19th August to 3rd September). Straw mulch keeps soil moisture more than inorganic soil mulches. Soil mulched by straw was 2-4% moisture in 5 cm, but control site soil was 2%. Also, soil mulched by straw was 8% moisture in 10 cm, but control site soil was 4%.

Sand mulch

The arid climate of some country use of the traditional farming practices for soil and water conservation, including the use of sand mulch. The soil moisture content ranges from 3.4 to 20.1% at 0-25 cm of soil. Conservation of soil moisture of sand mulching was 10.7 % higher in the depth of 5cm, in the depth of 10cm was 13.1 % higher, and in the depth of 20 cm was 27.7 % higher than compared with the control site.

Gravel mulch

It helps to reduce erosion and prevents water loss also provide a more balanced soil temperature. The soil covered with gravel mulch is able to adsorb the rainwater into the deep of the soil. Gravel mulch soil was conserved 14.1-32.5% more than the control site.

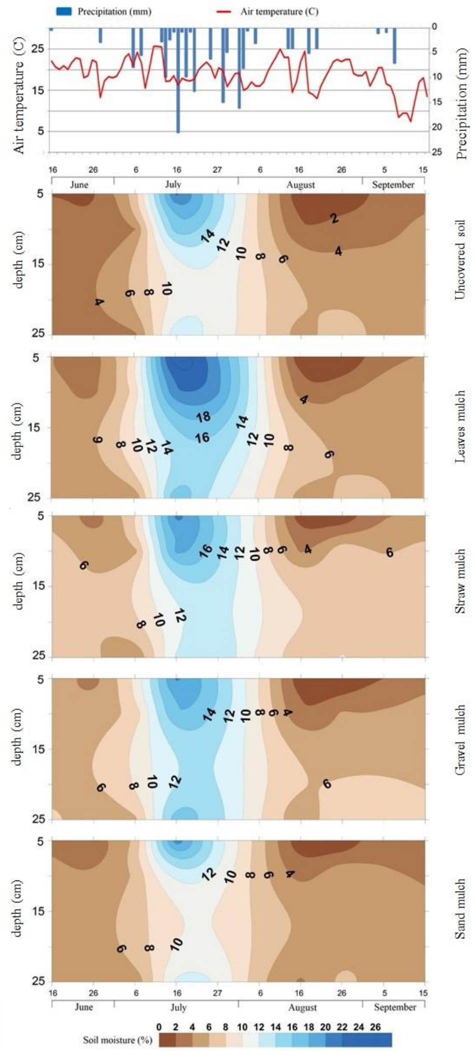

Figure 1. Each mulch moisture dynamic during summer time

Average soil moisture was 7.9%, 9.9%, 6.3%, 8.1% and 8.2% at every depth under straw mulch, leaf mulch, sand mulch, gravel mulch and control site, respectively between June and September. Soil moisture fluctuated greatly (SD= 6.5%) at every site, also the greatest soil moisture was measured in July because of high precipitation.

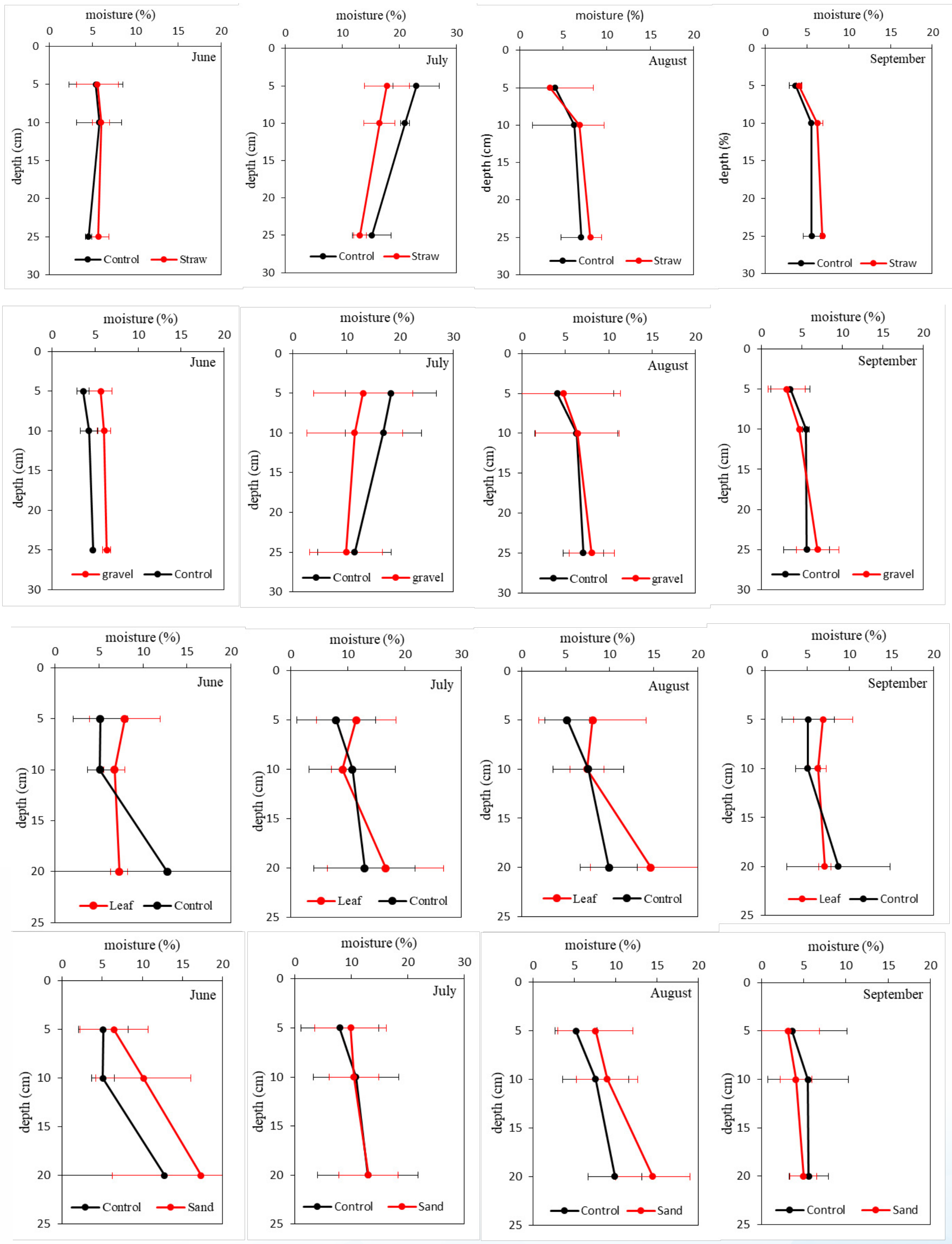
moisture (%)
depth (cm)
June
Control
Straw
July
August
September
depth (%)
gravel
Leaf
Sand

Figure 2. The average soil moisture content and standard deviation each months in summer time. b). comparison of straw mulch and control site-uncovered b). Comparison of leaf mulch and control site-uncovered c). Comparison of gravel and control site-uncovered d). Comparison of sand mulch and control site-uncoveredThe highest moisture of both 5 cm and 10 cm occurred at control site (8.1 and 8.9%, respectively), but at 25 cm depth, the highest moisture measured under leaf much (12.7%) in July. This shows that moisture can penetrate deeper under leaf mulch than other types of mulches. Whereas, in September, all sites had the least soil moisture ranging from 3.2-7.5% at every depth (Figure 2).

Discussion

These 4 different mulches are strongly affected soil moisture dynamic and leaf mulch and straw mulch can be saved moisture in the long term. Also soil protection cover can be reducing soil redistribution rate. Soil protection cover have been affecting soil temperature and soil temperature dynamics was stable under the residual and other cover types (Brady & Weil, 2000).

There are methods has been developed to improve the soil moisture content and to use sand to make mulch is more used in the field. Our previous result has shown the sand mulch impact has lower than other mulch on moisture in the soil profile. But sand mulch has useful in rehabilitation and gardening in the city has been reduced the weeds by 50% in a field experiment (Bolormaa & Byambaa, 2016). It's also to affect the soil temperature and soil temperature in 10 cm depth has warmer than control soil and its suitable condition to seeding.

Our result has been suggested that do not remove the leaf in street and in other hands to use the cover of soil until the spring with snowing. This cover has more affected soil quality and environment and such us to increase soil moisture content, to reduce soil particle removed by wind and decrease the air pollution in the dry period of spring.

Conclusion

Our experiment has shown to use organic and inorganic mulch for soil, which is more useful to reduce soil erosion, land degradation, and reclamation. The soil protections mulch has directly affected to decrease runoff for soil erosion and it was directly connected with vegetation cover. This research confirmed the effectiveness of the organic and inorganic mulch as a conservation practice.

Results from field studies and laboratory experiments showed that conservation of soil moisture in mulched soils was higher (sand mulch was 1.2 times higher, gravel mulch was 1.5 times higher, straw mulch was 2 times higher, leaf mulch was 3 times higher) when compared to uncovered soils. According to the research, this organic mulch sheet is cheaper in price more practical and effective in usage, using simpler technology, environmentally friendly, and in long-term increases soil fertility and soil moisture.

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POSSIBILITY AND LIMITATION OF FLOOD AND STORM WATER HARVESTING AND INCREASE IN GROUNDWATER

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Abstract: I have considered the hydraulic structure estimation and budget cost estimation based on the hydrography research results and estimations to provide a research on possibility and limitation of flood and storm water harvesting and increase in groundwater. As the research result and hydrographical estimation, the surface watershed, where Shavartain Bulag dam is constructed, is 386.1km2, steam bed level is 12.2 promille, steam bed length is 28.67km and flow of 1% exceedance is 56.66 m3/sec. In the result of hydro-technical estimation, I made the water recharge and discharge estimation of the reservoir and calculated the evaporation. Also, I estimated the dam construction budget. As the evaluation of the research and estimation, there is a low possibility to accumulate and use large amount of water at gobi and desert regions where the precipitation is low. Therefore, there is a risk that the accumulated water is evaporated during the wait time of the water accumulation after the biggest hydro-technical structure is constructed. But it is possible to construct 1 hectare and 1-2 m deep reservoir to use for the animal water supply and agricultural irrigation.

Keywords: усны барилга, их урсац, усан сан

Introduction

An important factor of water policy of Mongolia is to efficiently accumulate and use the flows of the rivers running out to abroad, especially the flow of storm water. It is doubtful that there is a possibility of flood and storm water harvesting and increase in groundwater at desert regions. As the geographical location, Mongolia is located in the extreme and harsh climate region. Average world precipitation level is 860 mm and average Mongolian precipitation level is 250mm. It is approximately 300-350mm in Khangai and Khentii Mountains and 50-100mm in Gobi and desert regions.

There is a method to accumulate flood and storm water by constructing the biggest dams, but this method is not efficient in gobi and desert regions because of low precipitation level and high evaporation.

Over 68% of total territories of Mongolia are located in dry and extremely dry regions / grassland and desert regions/ according to the natural moisture ability level, are lack of permanent streams and provide the water demands from groundwater sources.

There is a method to accumulate flood and storm water by constructing the biggest dams, but this method is not efficient in gobi and desert regions because of low precipitation level and high evaporation. In 1977, the dam was constructed at Shavartai Bulag, Khankhongor soum, Umnugovi province and the water system was constructed at 70 hectare field.

Research method: Maximum flow estimation methodology: Research index of long years is not enough and the potential maximum flow is estimated as the followings:

$$Qmax = 3.2 * A * F0.52$$

Where: A is 0,1-1,0 depending on physical and geographical conditions;

Hydraulic calculation method for water spillway: Hydraulic calculations for hydrological water spillway determine their basic dimensions. In real life, lined and lined channels are based on natural soils and dirt.

Determine the calculated flowrate (Q), slope (m), and the permissible velocity (v) of the trapezoid section, its bottom width (c), depth of water (h) and general slope (i). The amount of the channel will be determined from the condition of the maximum spending of the flood. Channel hydraulic calculations И. The agrochemical method is determined by the method of selecting the basic equilibrium of the water cycle. The basic equilibrium of the smooth flow of water in the trench

$$Q_T = \omega * C * \sqrt{R * j} \quad ;$$

Where: Q_T - Maximum flood control, м^3/c

ω - area of live channel, м^2

C - speed coefficient

R- hydraulic radius, m

i- declivity of channel

Research result: As the estimation of dam and hydrography and calculation of budget costs /approximately/:

Hydrographical estimation result: The storm water of 2 biggest swashes is accumulated in Shavartai Bulag dam. The oral survey was conducted among the local citizens according to the field research and this shows that the water is accumulated in the dam and water level is increased lowly in the rainy year, but the mud and sediment is increased. It was rainy on July 2018 and the mud and sediment level is increased, flood is occurred and dam is broken by the flood. Precipitation level on July 2018 was 136.1 mm and total precipitation level of this year is the highest in the last 22 years (1997-2018) and total yearly precipitation level is 224.4mm as shown in the information until August 2018.

Graphic index of the swash is determined at the topography map (scale: 1:100000) and the watershed at Shavartai Bulag is 386.1 km^2 and steam bed length is 28.67km and the steam bed level is 12.2 promille.

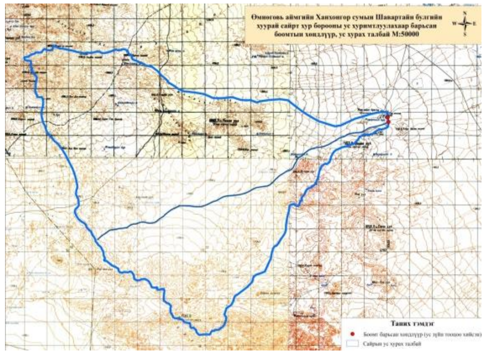


Figure 1. The crossing made of dam

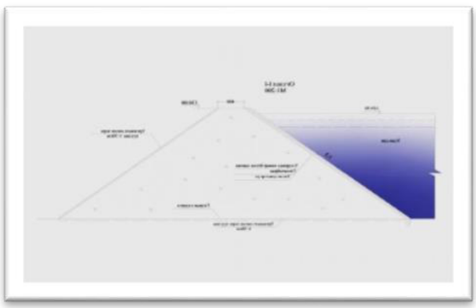


Figure 2. Cross section of the dam

Flood flow. I calculated the flow which may be occurred once per century by way of the maximum flood flow estimation when the watershed of the small stream and dry swash is more than 200km^2.

Maximum discharge with various discharge, m^3 /c

Table-3.

№	Cross-section	Various discharge, %				
		0.1 %	1 %	2 %	5%	10 %

1	Design cross bar – Shavartai bulag	89.52	56.66	49.86	31.73	21.53

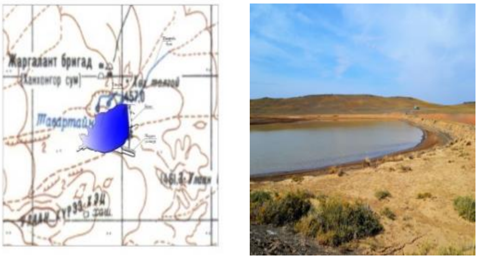


Figure 3. Shavartai Bulag dam /2018.10.19/

Geological and hydrogeological condition: There are the estimations of 5 holes along 2 horizontal profiles for the reservoir field. Bed 1 is the 0.4-2.4m deep sand bed consisted of 15-20% gravel and stone particles and Bed 2 is 1.5-3.7m deep muddy sand, stone particle and gravel bed. Filtration coefficient is 1.45 m/day.

Filtration coefficient of Bed 2 is 4.7 m/day and filtration coefficient of muddy bed is 0.06 m/day. There are diluvium - proluvium sediments and eluvium – proluvium sediments in the reservoir and soil water is found at depth 0.8-4.2 m.

Dam lengh – 170-180м
Dam heigth – 6.5-7.0 м
Dam water volume – 70.75 мян. м^3

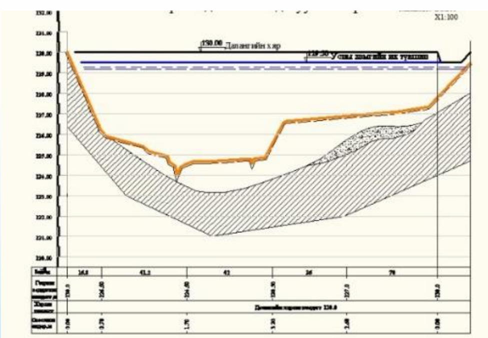


Figure 4. Longitudinal section of the dam

Reservoir volume estimation and result

The useful reservoir volume is the water volume which is used in compliance with flow between the dead volume and normal volume.

The reservoir water balance is the sum of reservoir recharge, reservoir discharge and water consumption discharge calculations.

Reservoir recharges:

- Stream water flowing in reservoir – 100626.8 m^3
- Flood and storm water flowing in reservoir through steam bed – 2876936.0 m^3
- Precipitation to reservoir - 11300.0 m^3

Reservoir discharges:

- Evaporation of reservoir water - 46574 m^3
- Filtration loss - /not applicable/

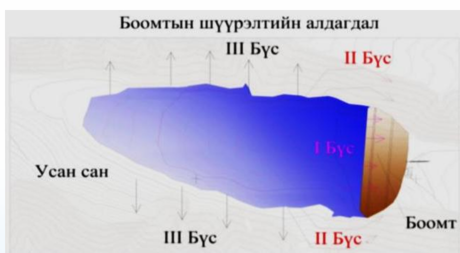
Evaporation: Water evaporation is 1160 mm per year. The hydrosphere is 40150,0 м^2 when the reservoir water level is normal. I estimated the water evaporation when the reservoir water level is normal.

$\Sigma E = F * E_0$=40150*1,16=46574 м^3

Filtration loss estimation

Filtration of the earth dam is occurred at:

- core of dam;
- bottom of dam;
- bottom and sides of reservoir;



Note: Filtration at core of earth dam is stopped by geomembrane. But I think that other filtrations are not required to close.

Reservoir estimation result

Total accumulated water in dam /stream water+precipitation/ 100626.8+11300= 111926.8 m^3; Evaporation of the accumulated water in dam 46574 m^3; Residual water in dame is 65352.8 m^3.

In the event of flood occurred once per 100 years, total 2876936.0 m^3 water is accumulated. But this is a probability.

If only stream water and precipitation water is accumulated, the water 25.0 times lower than Q_1% supply will be accumulated. /Q=111926.8 $м^3$/. When I estimated the dam size, I calculated the activity scope without considering Q_1% supply. If the dam is estimated at Q_1%, the dam size will be increased and also, the budget costs will be increased.

Above-mention estimation includes only costs /average/ of dam construction. This is an estimation of water filtration and accumulation reservoir and this does not include the water discharger and development costs. The water discharger must be considered in order to provide the dam safety.

In the event of flood occurred once per 100 years, total 2876936.0 m^3 water is accumulated. But this is a probability.

If only stream water and precipitation water is accumulated, the water 25.0 times lower than Q_1% supply will be accumulated. /Q=111926.8 $м^3$/. When I estimated the dam size, I calculated the activity scope without considering Q_1% supply. If the dam is estimated at Q_1%, the dam size will be increased and also, the budget costs will be increased. The big dam construction requires 5-6 billion MNT budget in the condition of low water recharge. This is an activity which has low economic significance.

Conclusion

There is a low possibility to accumulate and use large amount of water in gobi and desert regions where the precipitation is low. Because there is high evaporation and low flood and storm water. There is a risk that the accumulated water is evaporated during the wait time of the water accumulation after the biggest hydro-technical structure is constructed.

But it is possible to construct 1 hectare and 1-2 m deep reservoir to use for the animal water supply and agricultural irrigation.

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WATER USE IN THE TAATS RIVER BASIN, MONGOLIA

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Abstract: The study was conducted in the framework of to develop the "Integrated Water Resources Management Plan in the Taats River Basin". The purpose of the study is to estimate the total water use of basin by sector and to estimate future water demand. The research on water use in the basin consists of seven sectors: water consumption, livestock water use, water use in agriculture, industrial water use, water use in mining, water use in green areas, and water use in public utilities based on field surveys and statistical data and water consumption norms.

Keywords: Taats River Basin, Water use, Water demand

Introduction

Within the framework of the cooperation between the Governments of Mongolia and the Kingdom of the Netherlands, implementation of the "Strengthening Integrated Water Resource Management in Mongolia" project commenced on November 17, 2006 by the Water Authority (the former Government Implementing Agency for water) on the basis of the cooperation agreement signed by the former Minister of Nature and Environment of Mongolia and the ambassador of the Kingdom of the Netherlands in Beijing. The renewed "Law on Water" approved by the Parliament in 2012 makes several references to river basins including:'… develop integrated water resources management plan for Mongolia and each water basin; the plan needs to be approved and implemented by the competent authority. The study was conducted in the framework of to develop the "Integrated Water Resources Management Plan in the Taats River Basin". The purpose of the study is to estimate the total water use in the basin by sector and to estimate future water demand.

The Taats River Basin watershed area is 25404 square kilometer and is originally from the Khangai Mountains. The Taats River Basin is one of the largest basin, and south watershed boundary is Gobi-Altai mountain range, and east and west side bordered the Ongi river-Ulaan Lake Baisn and the Orog-Tui River Basin.

The basin is unique in its geographical setting, which passes through Khangai Mountain, Steppe and Gobi zones. The Taats River originates from Khojoo ridge of Jargalant bag of Uyanga soum, and the river flows 200 km passes Nariinteel soum and discharged to Taatsiin Tsagaan Lake in Baruunbayan-Ulaan soum.

Photo 1. Location of Taats River Basin

Methodology

The Taats River Basin water use is calculated for 6 soums in the basin. Water use is calcu-

-lated based on the number of population, livestock, production and service by "Water norm for production, production and service of a unit" approved by order A/301 of the Minister of Nature, Environment and Tourism of Mongolia. Estimates are based on statistical bulletin of Uvurkhangai aimag, goals set forth soum development programs, and trends in sector growth. Water use is estimated by sectors such as population, livestock, agriculture, industry, mining, green water and utilities. The water demand perspectives for the population are estimated to be 15 liters per day in 2020 and 20 liters in 2030. Water consumption of livestock in the basin is based on the average "norms for livestock water consumption". Camels, cattle and horses once a day, sheep and goats can be watered twice a day. The prospects of livestock growth in the basin are calculated based on the annual average growth rate of livestock, indiscriminate loss of livestock, and the number of breeding stocks. Plants consist of 1.7 hectares of grain, seabuckthorn in 6.13 hectare, tomatoes in 1 hectare and potatoes and vegetables in 86.67 hectares (from fieldwork in 2017). Information on physical quantities of manufactured products was taken from aimag statistical compilations. The field survey of cafeteria and hairdressers was conducted using verbal surveys from cafeteria and hairdressers.

Results

End of 2016, there are 19411 inhabitants in the Basin. Soum center population uses drinking water from 2-4 water supply wells in soum center. The population growth rate is expected to increase by 1.2% in 2020 and by 4% in 2030. Total livestock population is expected to reach 1973.1 thousand in 2020 and 2808.6 thousand in 2030. The value of livestock growth is included. In the basin, grain, potatoes, vegetables and tomatoes are cultivated in small quantities in households and cooperatives. 961 seabuckthorn trees were planted in 1 hectare area. The total water use of the basin in 2016 is shown below.

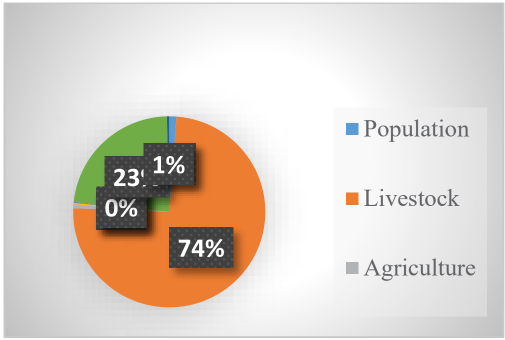

Figure 1. Percentage of sectors in total water use in 2016

Considering the future water demand for agriculture, it is estimated that 50% of the abandoned areas will be cultivated in 2020 and 50% by 2030 will be used for planting potatoes and vegetables. In the case of the basin, the industry is not well developed and every soum has a small industries. In the soum centers, small and medium-sized enterprises, such as bakery shops, cafeteria and hairdressers, operate in the basin. Estimating the water use prospects for industrial water consumption is expected to increase by 3% in the low scenarios, with the water use norm unchanged. In the Taats River Basin, there is no large mining industry, therefore mining water consumption is estimated as the representative of Bayanteeg coal mining. The mine has no coal processing, so water will not only be used for technological needs but also for water supply, water, green area and heating. Water use of green areas in the basin is based on field study and water norms. The prospects for consideration are to be considered in the context of local policies to increase green facilities. By 2020, total green plants will grow by 20% and by 2030, by 30%. Public utilities include such as schools, kindergartens, cultural centers and public baths. The water use norms for public land use have not changed in terms of water consumption norms, as well as growth rates of population and sectors. The total water use and water demand in the basin is shown in the table below.

Conclusion

The highest water user is livestock and lowest water user is mining. Water use in 2016 is 5985 million cubic per year and water demand increases 10969 million cubic per year in 2030. Only way to calculate water use is using Water Consumption Norms by basin level due to rare installation of water flow meter and nomadic habits. Cause nomadic people not settled and moving. Also installation of water flow meter is sufficient.

Table 1. The total water use and water demand in the basin

№	Sectors	Water use in 2016	Water use in 2020	Water use in 2030
1	Population	70.4	107.5	149.1
2	livestock	4481.1	6300.1	9117.4
3	Agriculture	47.13	138.43	229.73
4	Industry	1358.3	1399.0	1441.0
5	Mines	0.22	0.46	1.23
6	Green areas	4.80	5.76	6.24
7	Public utilities	23.50	24.30	25.10
	Total	5985.4	7975.5	10969.8

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GREENHOUSE GASES (GHGs) EMISSIONS FROM NATURE IN MONGOLIA

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Abstract: Mongolia is a developing country, is not obligated to reduce its GHGs emissions under the regulations of Kyoto Protocol, but under the Paris Agreement, Mongolia has set its targets to reduce GHGs emissions compared to business as usual scenario until 2030. Since 1992, GHGs sampling has been conducting by USA jointly with Institute of Meteorology Hydrology at Undur Ulaan site in Dornogobi province of Mongolia. The site is located in the dessert-steppe region of east south side of Mongolia far from the Hangai, Hentii, Huvsgul and Hentii mountain ranges underline by permafrost. The sampling data of that site is could not cover the GHGs emissions from nature in the country. On the other hand, Mongolia has done its GHGs inventories four times since 1996, and estimated from four sectors which are including 1) energy, 2) industrial process and product use, 3) agriculture, forestry and other land use, and 4) waste (MIBU Report, 2017). However, GHG inventory in Mongolia has been compiled without a natural sector. GHG emissions have not been investigated by natural sector of Mongolian region so far. Therefore, emission of GHGs has become a matter of great concern because of the future projections of global warming and related effects on nature in Mongolian region. The main objective of this upcoming research is to assess the GHG emission from nature in Mongolian region. In this study, we used the Greenhouse Gases Observing Satellite (GOSAT) data to assess and monitor CO_2 and CH_4 emissions (2009-2018) from nature. As shown the results, the annual CO_2 and CH_4 emissions from nature in Mongolia raised by 2.401 ppm/a (392 ppm – 396 ppm) and 6.904 ppb/a (1773 ppb – 1827 ppb) from 2009 to 2018, respectively. Furthermore, CO_2 and CH_4 emissions in four seasons have different with the highest value being in spring and the lowest in summer and autumn.

DETERMINATION OF ORGANIC CARBON FRACTIONS IN SOIL SAMPLES

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Abstract: A study of soil samples was done to determine the concentration of particulate organic carbon, permanganate oxidizable organic carbon. The active pool of SOC forms a relatively small portion of total SOC but it plays important roles in maintaining and monitoring soil quality. Soil samples were collected from two depths with two replications in June, 2018. The collected soil samples were subjected to analyses for soil organic fractions such as total organic carbon, particulate organic carbon, mineral associated organic carbon and permanganate oxidizable organic carbon. We measured POXC by spectrophotometer using 0.02 M $KMnO_4$ at 550 nm light and POC by sieving. Total and particulate organic C were analyzed with Walkley and Black's dichromate oxidation method. POXC was from 0.7 to 7.7 % of SOC in our study. POC was 39% of SOC in this study of agricultural soil. POXC is a good indicator of soil organic fraction in environmental monitoring programs for arid environments. Soil particulate organic carbon is closely related to soil water-stable aggregates, especially macroaggregates, and rapidly responds to agricultural managements. Soil mineral-incorporated organic carbon is closely related to soil organic matter accumulation and sequestration. SOC was major determinant of the labile carbon fractions present. Likewise, depletion in labile carbon pools could also give an early indication of the decline of SOC.

Keywords: labile fraction; particulate organic carbon; permanganate oxidizable organic carbon; mineral associated organic carbon

Introduction

Soil organic matter is an important indicator of soil fertility and productivity because of its crucial role in soil chemical, physical and biological properties (Gregorich et al., 1994). The active pool of SOM forms a relatively small portion of total SOM but it plays important roles in maintaining and monitoring soil quality (Gregorich et al., 1994; Janzen et al., 1997). Research over recent years has focused on the labile fraction (LF) or active carbon, as it is considered a quickly reactive indicator of soil productivity and health, and important as a supply of energy for soil micro-organisms. Various parameters related to the active pool of SOM have been used in soil quality assessments. Soil particulate organic carbon is closely related to soil water-stable aggregates, especially macroaggregates, and rapidly responds to agricultural managements. Soil mineral-incorporated organic carbon is closely related to soil organic matter accumulation and sequestration (Zhang et al. 2007). POXC would be closely associated with the other measured soil C fractions and that POXC would be a sensitive and consistent indicator of changes due to management or environmental variation. Our objectives were to study the changes in SOC, POC, MaOC and POXC in agricultural and pastoral Kastanozem soils, as well as the relationships among them.

Methods

Study site

Soil samples were collected from the Kastanozem soil zone in Central province. This study was conducted on agricultural and pasture soil at Central province, Sumber, Buren and Erdenesant soums (105.818026^0-106.027645E, 48.771600^0 – 48.827808^0 N).

Soil sampling and analysis
In June 2018, 38 pairs of Kastanozem soil samples were collected from agricultural and pastoral land sites. Soil samples were taken to a depth of 40 cm including 0-20 and 20-40 cm The collected soil samples were subjected to analyses for carbon fractions such as Permanganate oxidizable organic carbon, particulate organic carbon and total soil organic carbon. POXC was measured as described by Weil et al. (2003). 2.5 g of air-dried soil were reached with 0.2M $KMnO_4$ by shaking 2 minutes and allowed to settle for exactly 10 minutes. The absorbance was measured with a spectrometer at 550 nm of light and compared to an absorbance reading on a standard curve.

A previously published protocol (Cambardella & Elliott, 1992) was used to obtain particulate organic carbon. Thirty grams of air-dried soil were shaken for 2 h in 60 ml of 0.5 % hexametaphosphate solution to disperse the soil. The dispersed soil was wet-sieved through a 0.05-mm sieve, and the fractions of the sand and sand-sized organic materials (particulate fractions) retained on the sieve were oven-dried at 60^0C and weighed. Total and particulate organic C were analyzed with the Walkley and Black's dichromate oxidation method (Nelson & Sommers, 1982). Mineral-associated (<0.05mm) C was estimated as the C difference between the total and particulate fractions (Conant et al., 2003).

Statistics
The statistical analyses were conducted with SPSS 23. A one-way analysis of variance (ANOVA) was used to test the effects of soil types (agricultural and pastoral) and soil depth on total SOC, POC, and MaOC and POXC. Pearson's correlation analysis was used to determine whether there were significant interrelationships among the measured soil organic fractions of the soils.

Results

POC and MaOC contents in depths of agricultural and pastoral soils
Particulate organic carbon was found stratified along the soil depth. A higher POC was found in surface soil decreasing with depth. A higher MaOC was found in sub-surface soil. (Figure1).

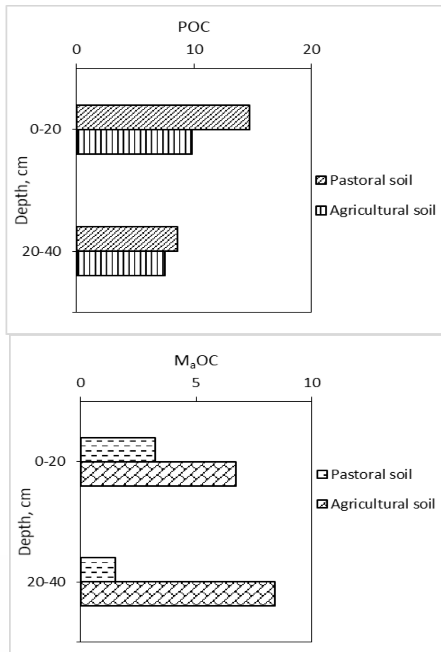

Figure 1. Mean POC and MaOC concentration in agricultural and pastoral soils of two depths

POC and POXC contents in pastoral soil were higher than in agricultural soil (Table 1).

At the 0-20 cm, POC average content in agricultural soil is 9.8 g kg^{-1} and pastoral soil is 14.7 g kg^{-1} respectively. At the 20-40 cm, POC average content in agricultural soil is 7.5 g kg^{-1} and pastoral soil is 8.6 g kg^{-1} respectively. Reference to pasture soil, cultivation decreased POC of agricultural soil by 50% and 15% at 0-20 cm and 20-40 cm respectively.

At the 0-20 cm, MaOC average content in agricultural soil is 6.7 g kg^{-1} and pastoral soil is 3.2 g kg^{-1} respectively. At the 20-40 cm, MaOC average content in agricultural soil is 3.2 g kg^{-1} and pastoral soil is 8.6 g kg^{-1} respectively.

POXC contents in agricultural and pastoral soils

At the 0-20 cm, POXC average content in agricultural soil is 296.7 mg kg-1 and pastoral soil is 627.4 mg kg-1 respectively. At the 20-40 cm, POXC average content in agricultural soil is 230.1 mg kg-1 and pastoral soil is 387.9 mg kg-1 respectively. Reference to pastoral soil, cultivation decreased POXC by 53% and 41% at 0-20 cm and 20-40 cm respectively.

Table 1. Summary statistics of SOC and SOC fractions.

SOC fractions	Soils	n	Max	Min	Mean	SD
SOC g kg-1	Agricultural	22	52.6	5.17	16.26	10.97
	pastoral	16	27.5	6.0	14.1	5.99
POC g kg-1	Agricultural	22	22.89	3.5	9.44	5.58
	pastoral	16	24.52	4.33	11.68	6.55
MaOC g kg-1	Agricultural	22	30.76	0.24	7.48	6.63
	pastoral	16	2.37	0.17	2.37	1.78
POXC mg kg-1	Agricultural	22	428.9	66.1	266.4	85
	pastoral	16	884.3	178	459	187.7

Correlations among POXC, POC, MaOC and total SOC in agricultural and pastoral soil

Soil organic carbon were significantly related to POC and MOC, not strong related to POXC in agricultural soils. Significant and positive correlation was found between SOC and MaOC (r^2=0.74) in agricultural soil.

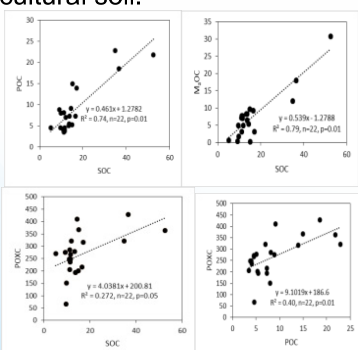

Figure 2. Relationship between SOC and POC, MOC and POXC, POC and POXC in agricultural soil.

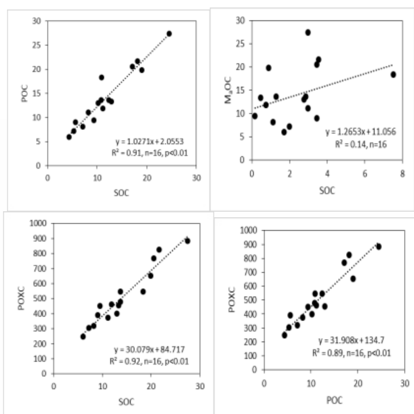

Figure 3. Relationship between SOC and POC, MaOC and POXC, POC and POXC in pastoral soil.

Soil organic carbon were significantly related to POC and POXC, not related to MaOC in pastoral soils. Significant and positive correlation was found between POXC and POC (r^2=0.89) in pastoral soil. Opposite, SOC and MaOC had the weak

(r^2=0.14) relationship in pastoral soil. Pearson correlation showed that the relation among the four variables ranged from 0.304 to 0.892 value (Table 2) in agricultural soil and from 0.267 to 0.96 (Table 3) in pastoral soil. It had shown the existence of strong relationship between SOC and POXC in pastoral soil. This suggested that the contribution of organic carbon was significantly high for POXC improvement.

Table 2. Pearson correlation coefficients between soil organic fractions in agricultural soil.

Parameters	SOC	POC	MaOC	POXC
SOC	1.00			
POC	0.860**	1.00		
MaOC	0.892**	0.537*	1.00	
POXC	0.522*	0.630**	0.304	1.00

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3. Pearson correlation coefficients between soil organic fractions in pastoral soil.

Parameters	SOC	POC	MaOC	POXC
SOC	1.00			
POC	0.955**	1.00		
MaOC	0.376	0.085	1.00	
POXC	0.960**	0.946**	0.267	1.00

**. Correlation is significant at the 0.01 level (2-tailed).

Discussion

The POC fraction has been defined as a labile SOC pool mainly consisting of plant residues partially decomposed and not associated with soil minerals. Wendling et al. (2008) also found positive correlations between the POC and POXC fractions. SOC was highly correlated with labile carbon POC and POXC.POC and POXC were significantly and positively correlated with SOC. Such correlations suggested that SOC was major determinant of the labile carbon fractions present. Likewise, depletion in labile carbon pools could also give an early indication of the decline of SOC. POC comprised roughly 39% of the total organic carbon in agricultural soil. POXC was from 0.7 to 7.7 % of SOC in our study. The correlation coefficient was highest between POXC and SOC (R^2=0.92), followed POC and SOC (R^2=0.91) in pastoral soil. Such high correlations have also been reported Rudrappa et al. and it is not surprising that the two measures of labile organic matter were closely correlated since they are closely interrelated properties. The correlation coefficient was highest between MaOC and SOC (R^2=0.79), followed POC and SOC (R^2=0.74) in agricultural soil. This result confirms the value of these fractions as sensitive indicators for the detecting changes in SOM in the short term, before they are readily measurable in total C. Likewise, these correlations also indicated that SOC also indicated that SOC was a major determinant of the labile C fractions present.

Conclusions

Permanganate oxidizable C was significantly related to all C fractions examined in this analysis, including POC, MaOC and SOC. Soil organic carbon were significantly related to POC and POXC, not strong related to MaOC in pastoral soils. POC and POXC showed significant and positive correlation in pastoral soils. Soil organic carbon were significantly related to POC and MaOC, not strong related to POXC in agricultural soil. POC and POXC had not strong relationship in agricultural soil. SOC was major determinant of the labile carbon fractions.Likewise, depletion in labile carbon pools could also give an early indication of the decline of SOC.

Acknowledgements

We are grateful for support and assistance from colleagues at Institute of Geography and Geoecology, Mongolian Academy of Sciences.

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LIVESTOCK PASTURE USE MOBILITY GPS TRACKING

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Abstract: The land policy for allocation of pastureland into possession right and private land use of grassland has severe negative impact on environment. The pasture enclosure process is diminishing the size of grazing land available for nomad's livestock, furthermore results an overgrazing and increases vulnerability of pastures to desertification process. Using Global Positioning System (GPS) technology, movements of semi-nomadic livestock in the Inner Mongolia and nomadic livestock in Mongolia had been tracked. Moreover, a remote sensing and field survey data are collected from the same tracking area to investigate which degree of mobility and land use patterns are influencing on pasture vulnerability. The climate parameters are similar since pilot areas are bordering and allow counting an equal weather impact to vulnerability. For GPS tracking of livestock, 5 households (each has around 1000 sheep) are selected and GPS receivers attached to 4 sheep of each household which automatically recorded once in 10 days. According to GPS tracking record, average path length of sheep grazing is 10.5 km and it covers 179.3-hectare areas per day in Mongolia and its 7.3 km and 62.8 hectare in the Inner Mongolia relatively. GPS observation shows the fenced yards in the Inner Mongolia are decreasing nomad's grazing area and mobility which is becoming main factor of grassland degradation. The field survey and photo monitoring are approved the GPS tracking research hypothesis that grazing land in the Inner Mongolia is more vulnerable to degradation than in Mongolia.

Introduction

With climate change, Mongolians are increasingly experiencing the consequences of natural hazards. The livelihoods of (semi-) nomadic herders are particularly affected by natural hazards, due to the nature of their income-earning activities as well as their geographic location (World Bank, 2009; 2011). In the rangeland, herders are subject to livestock food shortages in winter and droughts in summer, caused by shrinking glaciers and global warming (World Bank, 2011). Extreme weather events, landslides, avalanches as well as broken infra-

-structure are continually reducing the available rangeland for livestock tending, and result in the overgrazing and degradation of pastures around settlements (Nasritdinov, *et al*., 2010). The country is frequently hit by dzud catastrophes (severe cold and snow catastrophes) that result in escalating livestock losses. Approximately 30 percent of the nation's livestock died in three consecutive dzuds during the winters 1999-2002 (NSO, 2003), and about 20 percent died due to the 2009/10 winter dzud (United Nations, 2010). After the occurrence of dzud, a large number of impoverished herders moved permanently to urban centers (Kraehnert *et al.*, 2015a).

The paper is the result of the scientific project work ongoing in Naran soum (district), Sukhbaatar aimag (province), Mongolia and Narenbulag soum (district), Xiliin gol League, Inner Mongolia, China. The paper addresses questions that are important for policy-making for the pasture land use right impact in the North East Asian region. As a consequence of climate change and global warming, it is very likely that land use rights – such as common use in Mongolia or land use rights in Inner Mongolia – will impact on land degradation and with a higher intensity in future (IPCC, 2007). Developing countries will be most affected by this trend, both due to their geographic location and because they have limited resources that can be invested in mitigation and adaptation measures (Stern, 2007). Therefore, households in developing countries will bear the brunt of the impact of natural hazards. This burden can trigger further, damaging socio-economic and environmental consequences, inducing a vicious circle of underdevelopment. In the Inner Mongolia (China) and Mongolia, the pasture enclosure process is diminishing the size of grazing land available for nomad's livestock, furthermore results in overgrazing and vulnerability of pastures. Using Global Positioning System (GPS) technology, movements of semi-nomadic livestock in the Inner Mongolia and nomadic livestock in Mongolia had been tracked.

Method

For GPS tracking of livestock, 5 households (each has around 1000 sheep) are selected and GPS receivers attached to 4 sheep from each household which automatically recorded once in 10 days. Moreover, a remote sensing and field survey data are collected from the same tracking area to investigate which degree of mobility and land use patterns are influencing on pasture vulnerability.

The belt- transect and quadrat methods were used to set up 3 sample belts that were perpendicular to the border (belt length of 40 km, passing through Mongolia and Inner Mongolia) and 7 sample belts that were parallel to the border (belt length of 20 km, 4 in Mongolia and 3 in Inner Mongolia). Sampling points were set up in triplicates with 150 m intervals at the intersection between perpendicular and parallel sample belts. The dynamic variation data of vegetation at the survey points were obtained after Soil Adjusted Vegetation Index (SAVI). SAVI is as follows, which can minimize the soil impact when retrieve the vegetation coverage.

Result

The climate, soil, terrain, vegetation type, economy (mainly grazing livestock) and stocking rate of the two regions were generally identical. The study site has a flat terrain, with zonally distributed pale chestnut soil, surface desertification, humus layer depth of 5–10 cm, annual mean precipitation of 220 mm. More than half of precipitation is concentrated in warm season every year, which is the peak period for forage growth (Na et.al. 2018). The climate parameters are similar since pilot areas are bordering and allow counting an equal weather impact to vulnerability.

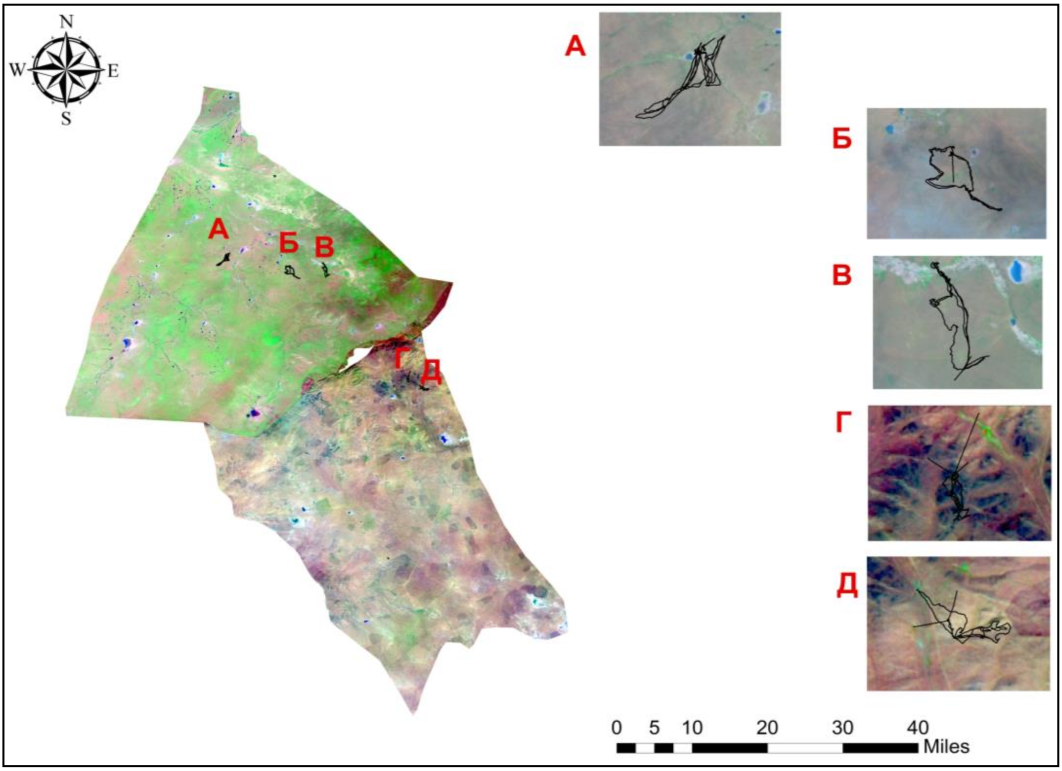

Figure 4. GPS records of 5 survey sites in 10 days, July 2016

For historical reasons, Mongolia and Inner Mongolia were divided between two countries during the early 19th century. Subsequently, the two countries adopted different grazing systems for land use management. Mongolia basically reserved common pastureland use. In Inner Mongolia, common pastureland was replaced with possession right grazing. The Grassland Contracting System Policy was implemented in 1990 in which herders used fences to surround their own pastures and implemented private grazing land. During delineation of pasture area for contracting the collective pasture was contracted to herder households with a lease period of usually 50 years. In Mongolia, nomadic grazing is carried out by the herders in the form of 4-, 3-, or 2-seasonal rotational grazing without any fee and charges (Na *et.al*., 2018).

Research hypotheses we have been proving in our case is: Livestock regular movements (mobility) of nomads for grazing across longer distances and wide areas will protect grassland from overgrazing and prevent vulnerability to desertification.

According to GPS tracking record, average path length of sheep grazing is 10.5 km and it covers 179.3 hectare areas per day in Mongolia and its 7.3 km and 62.8 hectare in the Inner Mongolia relatively.

Table 1. GPS records of 5 survey sites in 10 days, July 2016

Sites	Average path length (km) per day	Average grazing area (ha) per day
A site Naran, Mongolia	10.5	139
Б site Naran, Mongolia	11.3	260
B site Naran, Mongolia	10	139.1
Г site Naranbulag, Inner Mongolia	7.3	44.5
Д site Naranbulag, Inner Mongolia	7.3	81.1
Mean of A, Б, B site Mongolia	10,5	179,3
Mean of Г, Д site Inner Mongolia	7,3	62,8

Among the 61 quadrats in the study area, 45 quadrats were randomly selected to measure the aboveground biomass, of which 20, 20 and 5 quadrats were in Mongolia, Inner Mongolia and grazing prohibited areas in the cross-border of Mongolia and Inner Mongolia, China respectively, and then the optimal regression model was established between the measured aboveground biomass and the corresponding SAVI values.

SAVI of Landsat time series between 1989 and 2016 of nomadic grazing were significantly greater than those of continuous grazing in 1989, 2005, 2011, and 2016; and the difference was not significant in 1993 ($p > 0.05$). The aboveground biomass of communities in different grazing systems: prohibiting grazing (455.9 g) > rotational grazing (268.4 g) > continuous grazing (122.2 g), and these 3 sites showed significant differences ($p < 0.05$) (Na *et al.*, 2018). The aboveground biomass was better correlated with SAVI, and the regression relationship formula between them was $y=5600x^2+260x+110$ ($R^2=0.67$, $p < 0.05$).

Conclusion

GPS observation shows the fenced yards in the Inner Mongolia are decreasing nomad's grazing area and mobility which is becoming main factor of grassland degradation. The field survey and remote sensing SAVI index study had been approved the GPS tracking result that grazing land in the Inner Mongolia is more vulnerable to land degradation than in Mongolia.

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LAND DEGRADATION ASSESSMENT IN AN AGRICULTURAL AREA OF MONGOLIA: CASE STUDY IN ORKHON SOUM, DARKHAN UUL PROVINCE

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Abstract: This study presents detection of vegetation change in Orkhon soum, Mongolia using Landsat-8 Operational Land Imager and Landsat-5 Thematic Mapper images from 2010 and 2015. Normalized Difference Vegetation Index (NDVI) image classification techniques and change detection processes were applied. The aim of this study was therefore to assess the land degradation based reduction in the amount of green plant material of vegetation cover. And to find if there is correlation between vegetation cover change with land use, type and soil texture. Vegetation value was divided into six classes from Highly Dense vegetation to No Vegetation. The results show that the Less Vegetation class has increased by 11.7% and less moderate and moderate vegetation classes decreased by 13.8 and 27.8% respectively. Highly Dense Vegetation decreased by 11.3%. The settlement and forest area's vegetation NDVI value changed negatively. The loamy soils NDVI has increased by 10 pixel values. It means that some meadow area's vegetation cover changed positive. NDVI Values in sandy clay loamy and loamy sand soil area decreased more than 20 pixel values, indicating vegetation cover loss.

Key words: Land degradation, NDVI, change detection, assessment

Introduction

Mongolia is an extensive of 1,565 million km2. The landscape features high and low mountains, hills and plateaus. The northern and western part of the country have high mountains but the south and southeast parts are steppes and arid areas (Tsegmid 1979). Mongolia is characterized by a harsh climate and sparse plant cover, which contribute to low fertility of the soil (Avaadorj 1998). Since the 1990s when the political system changed, the animal population increased 4.5-5.6 times, especially the goat population which increased from less than 5.0 million to 20.0 million (Wang et al. 2017). The traditional method of land use for pasture was suited to protect the soil from erosion. But in the past 50 years, large area has been converted to cropland and cultivation as part of agricultural development (Avaadorj & Baasandorj 2007). Mongolia has 126.0 million hectares of pasture, including 6.2 million hectares of bluffs and gullies that are not suitable for pasture, 3.0 million hectares of sand covered areas, and 20.5 million hectares of saline soil areas in use arid desert. According to this estimation (Avaadorj & Badrakh 2007), only 76.5% or 96.8 million hectares of total pastureland area are currently used for pasture. Land degradation following the increase of livestock population and overgrazing is a serious problem. My research focused on estimating land degradation based on satellite images, which is influenced and degraded by overgrazing and various land uses in an agricultural area in Mongolia.

Materials and methods

Description of study area. The research site is located the northern part of Mongolia (Fig.1), which is situated in steppe zone as a plant geographical zones (National Atlas of the Mongolian People 1990). The soum center is located at the northern part of its territory which is located between the Shariin Gol River and Orkhon River. The elevations are between 800-1200 meters above the sea level (IGG 2010). The climate conditions are very harsh and have four seasons. The average temperature in January, which is the coldest season, is -19.9˚C (Fig.2). The average temperature in July, which is the warmest season, is 22.3˚C. The average annual precipitation is 310-320 millimetres (National Meteorological Agency 2016).

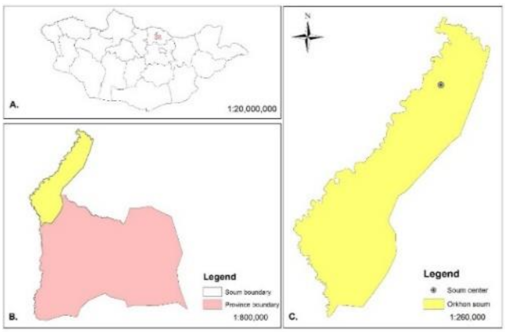

Figure 1. Map of Mongolia (A) highlighting the Darkhan-Uul province (B) where the research site in Orkhon soum (C) is located

Methods and material

In this research we used 2 types of data, vector and raster. Those described following paragraphs.

Vector data

Soil map: In this area, most of the soil type distribution is different between a north and south side of the mountain. Chestnut soils are most common. Soil textures in the research area are classified as sandy loam, loamy and sandy clay loam.

Land use map: Land utilization type is divided into 6 main classifications in Mongolia. Annual land inventory is reported to the government based on this classification. In this report, the total territory is 44221 ha, 87.1% of the total territory with used for agricultural lands in Orkhon soum (Annual Report, 2015).

Pasture map: Pasture type is divided 3 ecological type in this area. We used these type classes for analysis.

The assessment of the land degradation and vegetation cover change in Orkhon soum was done using the software ArcGIS (10.3) for data analysis.

Raster data

Raster data came from Landsat images (USGS). Dataset described on table 1.

a. Vegetation map based on normalized difference vegetation index. Estimating the vegetation cover on two satellite images (Table 1) by using Normalized Difference Vegetation Index (NDVI). This method was initially proposed by Rouse et al. (1974). NDVI is derived from the ratio Red (R) and Near Infrared (NIR). The Red band is Band3 for Landsat 5, Band4 for Landsat 8. NIR is Band4 for Landsat5 and Band5 for Landsat 8.

Table 1. Description of datasets used for NDVI calculations

Data type	Date	Path/ Row	Bands& resolution
Landsat TM	23.Aug. 2010	132/025	Band 3&4, 30 m
Landsat OLI	21.Aug. 2015	132/025	Band 4&5, 30 m

The NDVI is the most commonly used index and has measurement scale ranging from -1 to +1. Negative values represent non-vegetated surfaces, whereas values close to 1 have very dense vegetation (Ioan et al. 2013). ArcGIS different formulas can be used to calculate and display NDVI. Using the formula below, NDVI values range from 0 to 200 (rather than -1 to 1). The NDVI formula (Keranen et al. 2014) is:

$$NDVI=(NIR-R)/(NIR+R)*100+100$$

Where: NIR – Near infrared
R – Red

b.Change detection. Change detection involves the use of multi-temporal data sets to distinguish areas of land cover change between dates of images (Lillesand et al. 2008). Change detection map was created by the *Image Analysis tool* in ArcGIS from NDVI values between 2010 and 2015.

C. Correlation with soil texture and land class. The *Tabulate Area tool* in ArcGIS was used to find correlation between change detection, soil texture and land class. The tool calculated cross-tabulated areas between two datasets and outputs a table.

Results

The two years (2010 and 2017) NDVI values are summarized in Table 2. Minimum value increased by 18.2 and maximum value decreased 17.6.

Table 2. The NDVI values and the changes between 2010 and 2015.

NDVI value	2010 NDVI	2015 NDVI	Changes
Minimum	58.8	77.0	18.2
Maximum	172.6	155.0	-17.6
Mean	132.2	117.9	-14.3
Standard deviation	10.8	8.0	

In Fig.2 we can see NDVI pixel values changed between two years. In 2010, most pixel values were 121-133. And 2015 most pixel values belong 109-121.

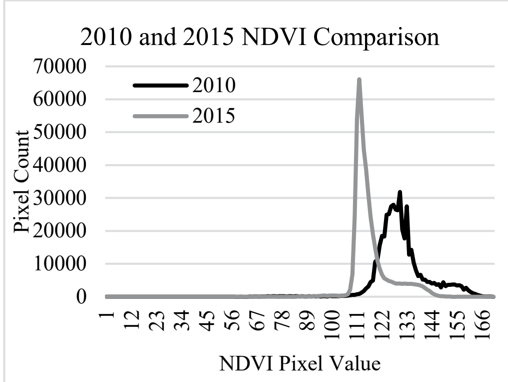

Figure 2. Graph for NDVI Pixel values 2010 and 2015.

In Fig.3 we can see the Less Vegetation pixel values were 11.7% in 2010, but 2015 this percent became 64.8%. The Less moderate and moderate vegetation decreased by 13.8-27.8%. It means most area convert from less moderate and moderate to less vegetation. Even Highly Dense Vegetation decreased by 11.3%.

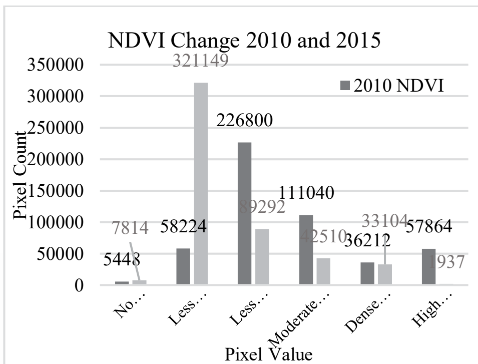

Figure 3. Graph for NDVI Pixel values in 2010 and 2015.

Vegetation cover change detection

Change detection of the differences in NDVI values from 2010 to 2015 was made and it's shown in Fig.4 and Fig.5. To investigate the correlation between change detection results and soil texture in a graph that is inserted in the map Fig 4.

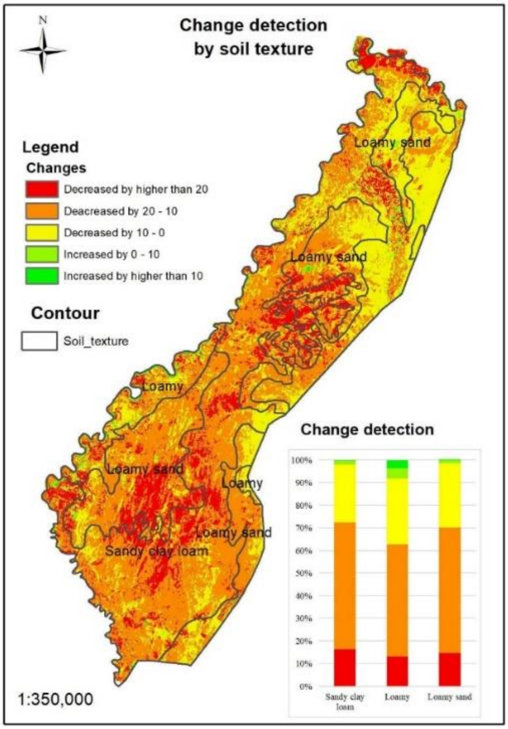

Figure 4. Change detection between 2015 and 2010, a graph showing the change in correlation to soil texture

The NDVI for the loamy soils increased by 10 pixel values. It means that in some of the meadow area the vegetation cover has increased. Sandy clay loamy and loamy sand soil area decreased more than 20 pixel values which indicates vegetation cover loss.

This map (Fig 5) shows change detection between two years by land use and pasture type. This shows that forest and settlement area's NDVI values were decreased by more than 20 pixel values, which indicated vegetation cover loss. Lake and meadow area's NDVI increased, and cultivated land's pixel value increased probably because of different type of planted vegetables.

Conclusion

Through this study, the results show that multi-temporal Landsat time series has immense potential for analysing vegetation changes in Orkhon soum, in the northern part of the steppe zone.

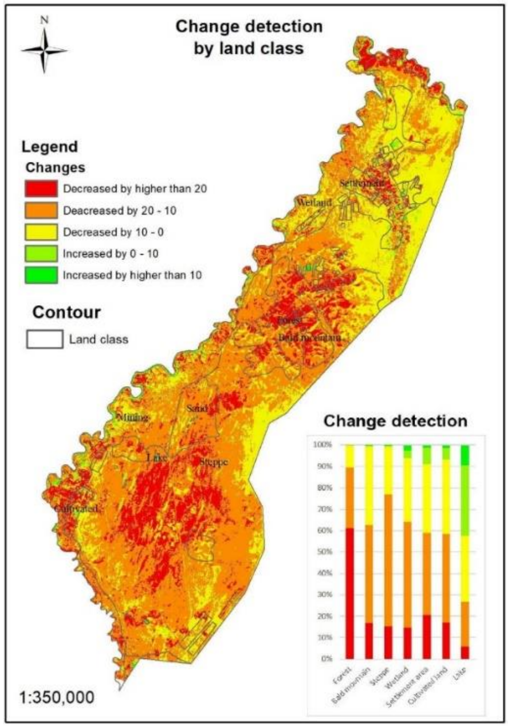

Figure 5. Change detection between 2015 to 2010 and a graph showing the change in correlation to land class, pasture type

To assess and quantify vegetation cover changes, the post classification change detection has proved to be very efficient in identifying vegetation changes during the period of 2010-2015. It has shown that, the greatest change is the Less Vegetation class has increased that by 23460 hectares (11.7%). The Less moderate and moderate vegetation classes have decreased about 6114.9 – 12269.8 hectares respectively (13.8-27.8%). It means that the biggest areas have converted from less moderate and moderate to less vegetation. Highly Dense Vegetation decreased by 4990 hectares (11.3%).

In conclusion, it can be said that the spatial analysis presented can be used in the assessment of areas with vegetation cover changes depending on factors. The accuracy of the assessment can be higher if we use images from same satellites.

There needs to be done some restoration activities or combating sand distribution, where are covered by sand. And it is important to control overgrazing through decreasing livestock population or using intensive livestock grazing management.

Acknowledgement

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THE GEOGRAPHICAL STUDY OF THE RURAL POPULATION'S SETTLEMENT

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Abstract: In the forms of population migration in Mongolia, nomadic herders move to urban and other settlements as the most common forms of migration. Population settlement is sedentary lifestyle and the basic way of improving people's living conditions, including many socio-economic and environmental aspects. The survey was conducted in 9 provinces of Central and Eastern regions of Mongolia. Analysis of herders shows that the number of herders increased during the period of 1990-2000, decline in period of 2001-2010 and the observed period of 2010-2017 has risen in the cycle. Herder households who migrated into the soum center are the factors leading to migration, such as the age of the head of household, education level, and the number of school-age children. When rural herders migrate to the province center and Ulaanbaatar, their herders move to these urban areas and settled through soums in bordering these cities. These householders managed livestock husbandry as a daily necessity, earning income and livelihoods from other sectors. In addition, the soum is intensifying the process of reducing migration from the local administration and transferring land for family purposes to the herders in the soum. Ownership of this land to rural herders is accelerating the movement of these nomadic herders into a sedentary lifestyle.

Keywords: herder household; migration; mobility; population settlement; rural population

Introduction

The Government of Mongolia is paying particular attention to the establishment of a system of interconnected settlements between urban and rural populations in order to create a balanced regional development. The agriculture sector accounts for about 14-15% of Mongolia's gross domestic product, indicating a low level of agricultural productivity. Livestock numbers have increased, traditional pasture use schedules have fallen, and following wells, roads, and settlements migrate to one place in during the four-year season, so it is repeated use of pastures does not allow for replenishment of vegetation cover (Chinbat, 1990). In recent years, due to shortage of jobs and natural disasters in rural areas, herders have lost their livestock and life is gone (Batsuuri, 2002). Therefore, herders move from rural to urban areas to "large migration" continuously, rural population is moving into a sedentary lifestyle (Bazargur & Batbuyan, 2007). Due to these factors, herders move from nomadic lifestyle to settled lifestyles, so it is necessary to study the types of settlements in the rural areas and the geographical factors that affect them and to make distinction between the settlements.

Method

The research was used on the "Geographical survey of rural settlement processes" project conducted by the Institute of Geography and Geoecology of the Mongolian Academy of Sciences and the sample survey was carried out in a mixed sampling method. The survey did not take into consideration the administrative unit and 428 herder households questionnaire was selected using a random sample of the Forest steppe, Steppe, and Gobi zone. The questionnaire such as total number of livestock, number and distance of mobility and otor was inserted into the SPSS 23.0 program and re-encoded the variables and after grouping the number of livestock, distance and number of mobility, initial counts multiple response and tables were created. It also uses the simple linear regression model and the correlation coefficient of Pearson, calculated the number of livestock and the number of mobility. At this time, dependent variable is number of mobility; independent variable is number of livestock.

The settlement of herders living in urban areas was carried out in 11 soums chosen by purposive sampling method. The questionnaire was carried out by randomly selected sample of 289 herder households, which were selected by soums involved in the central axis (Dalanjargalan soum of Dornogobi province, Bayanjargalan and Tsagaandelger soums of Dundgobi province), province center (Sergelen, Tsagaan-Ovoo and Khulunbuir soums of Dornod province) and paved roads (Tsenkhermandal, Jargaltkhaan soums of Khentii province, Lun, Undurshireet and Buren soums of Tuv province). The answers to the owned land for herder households, ger, house and apartment in residential area and household split such as questionnaire were coded at the Excel program and each of these responses was expressed in percentages.

Result

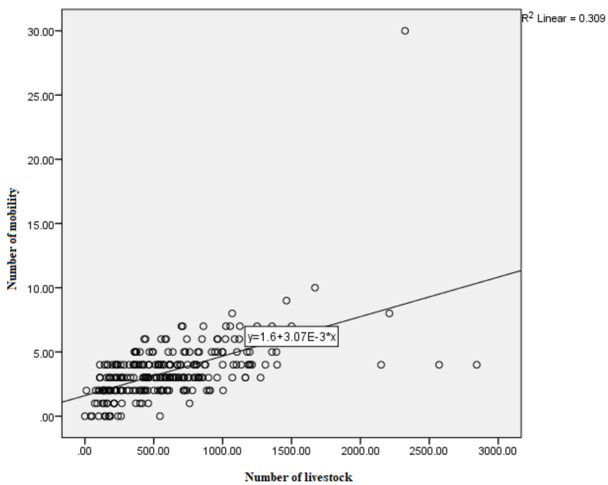
The number and distance of herders mobility is decreasing, settlement is settle on one place: Depending on the number of livestock, the herders' settlements differ. As the number of livestock decreases, the number of mobility is decreasing during the year (Table 1). 17.6% of households with up to 200 livestock don't move, rather 47.7% of households with 1001 livestock move more than 4 times a year.

Table 1. Mobility frequency of household covered by the survey, by livestock groups

Grouping number of livestock	Number of mobility								
	Never move		1-2		3-4		More than 4		Total
	Number of house holds	Percentage	Number of house holds	Percentage	Number of house holds	Percentage	Number of house holds	Percentage	
>200	13	**17.6**	16	21.6	35	47.3	10	13.5	74
201-500	4	3.1	30	**23.6**	55	43.3	38	29.9	127
501-1000	5	3.5	23	16.3	73	**51.8**	40	28.4	141
1001+	3	3.5	8	9.3	34	39.5	41	**47.7**	86
Total	**25**	**5.8**	**77**	**18**	**197**	**46**	**129**	**30.1**	**428**

Source: "Geographical Study of Rural Settlement Processes" baseline research project, Institute of Geography and Geoecology

Disaggregated by natural zones, the pattern is repeated, and affluent households with multiple livestock have moved many times and households with less number of livestock moved few times to pasture (Tseyenkhand at al., 2018).

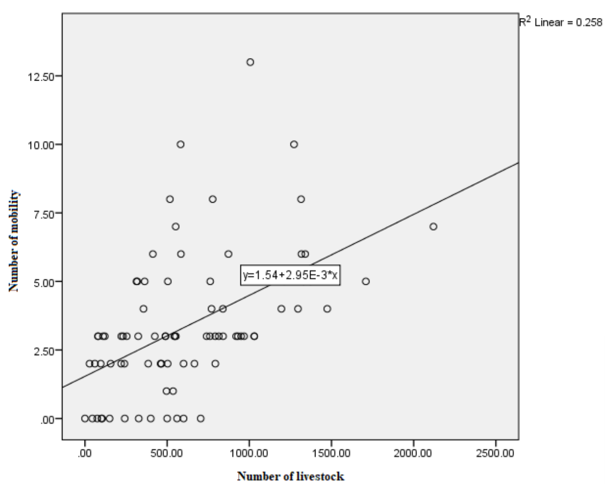


Steppe zone
Correlations

		Number of mobility	Number of livestock
Number of mobility	Pearson Correlation	1	.556**
	Sig. (2-tailed)		.000
	N	256	256
Number of livestock	Pearson Correlation	.556**	1
	Sig. (2-tailed)	.000	
	N	256	256

**. Correlation is significant at the 0.01 level (2-tailed).

Gobi zone



Correlations

		Number of mobility	Number of livestock
Number of mobility	Pearson Correlation	1	.508**
	Sig. (2-tailed)		.00
	N	81	81
Number of livestock	Pearson Correlation	.508**	1
	Sig. (2-tailed)	.000	
	N	81	81

**. Correlation is significant at the 0.01 level (2-tailed).

Table 2. Changes in number of mobility depending on the number of livestock
Source: "Geographical Study of Rural Settlement Processes" baseline research project, Institute of Geography and Geoecology

The correlation between the number of livestock and the number of mobility in the Steppe and Gobi zone was middle, with little relevance to the Forest steppe zone. For example, the correlation coefficient 0.508 in the Gobi zone and 0.556 in the Steppe zone indicates a positive [0.5-0.7] and middle correlation between the number of livestock and the number of mobility (Table 2). For linear regression, the coefficient determination R2 0.258 in the Gobi zone, 0,309 in the Steppe zone, selected variable is the number of livestock describe 30.9 and 25.8 percent of the changes in number of mobility. In other words, the number of livestock in the

Steppe zone depends on the 30.9 percent of the changes in number of mobility and the remaining 69.1 percent is influenced by other factors not elected. In the Forest steppe zone, the correlation coefficient is 0.208, indicating that there is a positive and weak [0.1-0.5] between the number of livestock and the number of mobility.

As the number of livestock increases, the proportion of a herder household who has moved many times over the distance is increasing. For instance, 35.1 percent of households with up to 200 livestock move up to 10 km, while 50 percent of households with more than 100 livestock migrate more than 50 kilometers.

On the contrary, as the number of livestock decrease, the number of distance and number of herder migration decreases, thus increasing seasonal settlement for long time on one place.

Settlement of rural populations living in urban areas

Property on place of residence is important by detecting herder's settlement (Batbuyan, 2016). For instance, 38.1 percent of herder households surveyed own land for family purposes and 41.2 percent have their own fence, ger, house and apartment, and 40.8 percent live household split (table 3).

Table 3. Selected indicators of herder households, by soums covered in the survey

№	Soums covered in the survey	Herder household	Household in own land for family purposes		A herder household who own fence, ger and house in a residential area		A herder household who lives split in a residential area	
			Number of house holds	Percen tage	Number of house holds	Percen tage	Number of house holds	Percen tage
1	Bayanjargalan	25	12	48.0	10	40.0	4	16.0
2	Tsagaabdelger	26	14	53.9	16	61.5	11	42.3
3	Dalanjargalan	25	8	32.0	8	32.0	5	20.0
4	Sergelen	23	10	43.5	10	43.5	5	21.7
5	Tsagaan-Ovoo	18	8	44.4	8	44.4	7	38.9
6	Khulunbuir	25	10	40.0	9	36.0	2	8.0
7	Tsenkhermandal	30	3	10.0	11	36.7	15	50.0
8	Jargaltkhaan	30	13	43.3	16	53.3	23	76.7
9	Lun	30	12	40.0	6	20.0	13	43.3
10	Undurshireet	30	6	20.0	9	30.0	15	50.0
11	Buren	27	14	51.9	16	59.3	18	66.7
Total		**289**	**110**	**38.1**	**119**	**41.2**	**118**	**40.8**

Source: "Geographical Study of Rural Settlement Processes" baseline research project, Institute of Geography and Geoecology

The settlement of herder households living in urban areas can be divided into two forms:

- Take in Nomadic livestock husbandry, however, has its own property in settlement, educate their children, and work, for that reason households live in split
- Take in nomadic livestock husbandry, however families in the winter live in split due to educate their children (don't own property)

In addition, clusters in herder's urban areas vary depending on the location of the settlement.

Aimag center is important for herders living nearby in the aimag center and herders of Tsagaan-Ovoo, Sergelen and Hulunbuir soums of Dornod aimag are attracted to Choibalsan city. Herders of Tsenkhermandal and Jargaltkhaan soums of Khentii province along the paved road, have land ownership and fences, gers, houses in Baganuur and Undurkhaan, which are located on paved roads. And herders of Lun, Undurshireet, Buren soums of Tuv province along the paved road, have land ownership and fences, gers, houses in Ulaanbaatar and households split to tend.

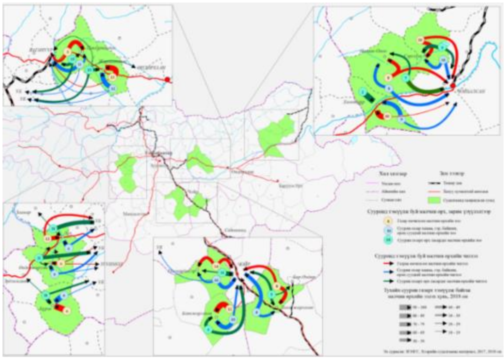


Figure 1. Selected indicators of herder household who are moving toward settlements

Discussion & conclusions

Households with up to 200 livestock are often unemployed (hidden unemployment), unable to leave their livestock, live in nearby settlement (Tserendash et al., 2003), and only provide their own domestic needs (Status of herder household, 2002). Also, our survey shows that the numbers and distance of mobility herder households up to 200 animals are low and settled on one place, the non-migrant settlements in the four seasons are the most likely to have the potential for full settlement. In 2003, the Law on Allocation of Land to Mongolian Citizens for Ownership was approved, so herders also started owning land in settlements. It is one approach to shifting to direct settlement for household of small livestock. In addition, one of the factors contributing to the settlement of herder households is school age and it affects herder's life by household split.

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INFORMATION OF FIELD TRIP

Two days field trip will be organized directly after the ETS2019 conference. Ther field trip route leads to the natural zones of steppe and forest-steppe and passes through the Tuul River, Elsen Tasarkhai, Ogii Lake, vaste range land and the first capital of Mongolia, Kharkhorin. The field trip will focus on water quality, desertification, pasture restoration and environmental monitoring activities in Mongolia.

Day 1 (15 June 2019)

Time	Visiting sites	Key words	Speakers
07:30 – 08:00	Holiday Inn hotel	Departure (registration/settling in bus)	IGG Team
08:00 – 11:00	Driving to the first stop		
11:00 – 11:30 (Stop 1)	Green belt	Explanation and discussion: Introduction of the desertification about Mongolia.	Dr. A.Khaulenbek
11:30 – 12:00 (Stop 2)	Lun bridge	Explanation and discussion: Water quality and pollution in the Tuul River	Dr. S.Chinzorig
12:00 – 14:00	Driving to the second stop		
14:00 – 15:30 (Stop 3)	Elsen tasarkhai, sanded area	Explanation and discussion: Desertification Station Lunch	IGG Team, Dr. A.Khaulenbek
15:30 – 17:00	Driving to the final stop		
17:00 – 17:30	Dream land camp	Accommodation	IGG Team
18:00 – 22:00	Dream land camp	Dinner	IGG Team

Weather forecast: Average temperature in June ranges from 10°C to 20°C and is rarely below 4°C or above 28°C. You may also, expect rain and strong wind during the field trip as well. Thus, we are kindly informing you to bring your warm,comfortable, wind and rain proof clothing and shoes along if you will participate for the field trip.

Day 2 (16 June 2019)

Time	Visiting sites	Key words	Speakers
08:00 – 09:00	Dream land camp	Breakfast	IGG Team
09:00 - 09:30	Driving to the first stop		
09:30 – 10:30	Kharkhorum	Introduction of the first capital of Mongolia “Erdene Zuu”	Ts.Bolormaa
10:30 – 12:00	Driving to the second stop		
12:00 – 13:00	Ugii lake	Lunch	IGG Team
13:00 – 13:30	Ugii lake	Poster presentation on ecosystem of the Ugii Lake	Dr. M.Walther
13:30 – 14:30	Driving to the third stop		
14:30 – 15:00	Station of pasture restoration in Gurvanbulag soum	Explanation and discussion: Station of pasture restoration	Dr. M.Urtnasan
15:00 – 16:00	Driving to the fourth stop		
16:00-16:30	Visiting Mongolian nomadic family	Short introduction about Mongolian nomads/herders	Dr. A.Dashtseren
16:30 – 19:30	Back to Ulaanbaatar	Accommodation	IGG Team

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