E-COURSE:

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| Institution | Khovd University of Mongolia |
| Course name | **Glaciology and Climatology** |
| Credits | 2 ECTS |
| Course type | Specific course (optional course)  |
| Lecturers | Demberel Otgonbayar |
| Level | MSc and PhD courses |
| Course duration | 16 weeks |
| Type | General skill |

**Summary**

This course examines This course examines Glaciation, factors of glaciation, origin, and development, classification of glaciers. Climate, the relationship between glacier and climate, climate change affects the degradation of glaciers and the methodology for estimating changes of glaciers. The course is more relevant to the master's and doctoral programs in science, policy planning, management, and the environment's basic natural science concepts, including water resource and climate change reduction management. In addition, it introduces students to environmental changes and integrated climate and glacier degradation reduction management. The course includes data collection, data analysis, individual and group exercises, fieldwork, seminar presentation, and report writing.

**Target student audiences**

MSc and PhD students in environmental science, geography, hydrology and climatology

**Prerequisites**

Required courses (or equivalents):

- Environmental science

- Ecology

- Physical geography

**Aims and objectives**

The purpose of this course is to provide students with knowledge on the causes of the glaciation and glacier process, calcification of the glacier, glacier dynamics; the weather, the climate, the climate change, and the methods of calculating the change of the glacier. The course consists of the following three parts.

1. provide students with knowledge the concept of Glaciation and glacial process

2. provide students with knowledge the concepts of climate and climate change

3. provide students with knowledge on methods for climate and glacier change, how to calculating

**General learning outcomes:**

By the end of the course, successful students will:

- understanding the glaciation

- history of glaciation of the Geologic time scale of the World

- Glacier and climate

- impact of climate change

- Climate elements

- glacier as a product of climate

- Climate change and glacier dynamics

**Applicable learning outcomes:**

- understand the interrelationships between climate and glacier

- conduct climate and glacier change impact analysis

- assess of risk and natural hazards of mountain region from climate and glacier change

- writing reports, group discussions, and interviews

**Overview of sessions and teaching methods**

The teaching methodology will be based on class lectures and practical work classes. The lectures will consist of an expository session, which will serve to introduce the fundamental concepts associated with the syllabus. These classes will be followed by lectures and presentation lessons (8 lessons of 3 hours), aiming the preparation for lab classes, in which students will carry out the resolution of exercises using concepts covered in lectures, they will be explained the methodologies used in field

work and practical classes, they will practice how to use remote sensing data, how to calculate change of area of the glaciers. Case studies will be studied. Practical classes (6 classes of 3 hours, interspersed in the other classes), are mainly targeting the implementation of practical classes for climate data analyses and glacier area changes and climate change how is connected, and correlation analyses. Experimental and practical results will be analyzed and discussed.

The aim of these practical classes is mainly to provide a more practical view of theoretical concepts as well as instigating the initiative and participation of students. The learning gained in classes will be measured by the elaboration of Reports, one for each practice work. This methodology allows the evaluation of learning objectives throughout the process, requires greater interaction between students and teacher, allowing constant assessment by the teacher of the knowledge acquired by the student, allowing you to make the necessary adjustments.

**Course workload**

The table below summarizes course workload distribution:

Lectures

Activities Learning outcomes Assessment Workload

(hours)

In-class activities

Understanding theories, concepts, methodology

and tools Class participation 10

Moderated

in-class discussions

In-class assignments

Paper review and discussion

Understanding the glaciological and climatological theory and common problems in climate warming situation how to change (degrading) glaciers, and what will be in the future.

Understanding glacio-climatological problems and situation in the changing world environments

Independent work Familiarity with and ability to critically and creatively discuss key concepts, tools and

Class participation

and preparedness 10 for discussions

Class participation

and preparedness 10 for assignments

Class participation

creative and active 30

methods as presented in the literature contribution to discussion

- Climate and climate elements

- to understand the climate and their elements. This will include a collection of data, calculations, report writing, and make presentation.

- Ablation period - to understand Ablation period,

pollution components

- Accumulation period

 Field work

6-8 months of summer ablation period This will include a collection of data, calculations, report writing, and make a presentation.

- to understand Accumulation period of the year 9-5 mounts. This will include a collection of data, calculations, report writing, and make a presentation.

Familiarity with real situation, communicate with field experts, photo taken, collect relevant data and information

Self-work

Individual report 30 and presentations

Class participation

and preparedness 30 for discussions

Class participation

Report and Presenting

Calculating year and multiyear climate data analyses, average temperature and precipitation of the ablation and accumulation period, and glacier changes , report writing, and make a presentation.

and preparedness 30 for discussions

Total 150

Grading

The students’ performance will be based on the following:

 Level of preparedness for participation in class discussions and seminars (30% from 100% for active participation and demonstrated familiarity with the course readings to 0% for completely ignoring in-class discussions);

 Contribution to group assignments and demonstration of individual work (30% from 100% for clearly demonstrated input to 0% for non-participation);

 Quality of the approach application and reporting and presenting (40% from 100% for clearly shown the report and presentation to 0% for non-participation);

o correct application of the approach +20%

o write report +10%

o make presentation +10%

**Course schedule**

Class In-class hours

Topic Type

1 4  Introduction the climate and climate elements Lecture

Seminar

2 4  Climate change Lecture

Seminar

3 4  Air temperature and precipitation Lecture

Seminar

Lecture

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4 4  Glaciology Seminar

5 4 Glaciation and glacier Lecture

Seminar

6 4  the types of glacier Lecture

Seminar

7 4  Ablation and accumulation Lecture

Seminar

8 4  Precipitation Lecture

Seminar

9 4  Morphometric characteristics of glaciers Lecture

Seminar

10 4  Dynamics of the glacier Lecture

Seminar

11 4  Mountain glacier Lecture

Seminar

Lecture

12 4  Icesheets

Seminar

13 4  Climate and glacier change Lecture

Seminar

14 4  Glacier is a resource fresh water Lecture

Seminar

15 4  Mountain hazards form glacier changes Lecture

Seminar

 16 4  Glacioclimatology as interdisciplinary Lecture

Seminar

**Course assignments**

Course assignments will constitute a multi-part project:

 Assignment #1 – Glaciology and glacier: Short report in class 12

 Assignment #2 – Climate and climate elements: Short report in class 3

 Assignment #3 – Climate and glacier change: Short report in class 16

**Assignment #1** will require a greater level of self-organized work from students. It will help students to understand Glaciology, and glacier, glacier types. This will include translation and reading understanding, report writing and make presentation. Maximum 5 pages of the Glaciology, glaciers how to develop glaciers to prepare as a report and must submit their report prior to class 11, and the result will be discussed during class 12.

**Assignment #2** will require a greater level of self-organized work from students. It will help students to understand the Climate and climate main elements as an air temperature and precipitation. This will include a collection of data, calculations, report writing, and make presentation. Maximum 5 pages of the air temperature and precipitation specially of ablation period (June-August) of a year and multiyear to prepare as a report and must submit their report prior to class 3, and the result will be discussed during class 4.

**Assignment #3** will require a greater level of self-organized or group work from students. It will help students to understand climate change's influence on glacier dynamics. This will include remote sensing, collection of data, report writing, and make a presentation. Maximum 5 pages of the climate and glacier change and correlation their changes to prepare as a report and must submit their report prior to class 16, and the result will be discussed during class 15.

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**Literature**

Compulsory:

1. Batchuluun.E, World science, 2012
2. Гляциологический словарь, Л., 1984
3. <https://www.igsoc.org/>
4. <https://www.nationalgeographic.org/encyclopedia/climatology/>
5. <http://www.izdatgeo.ru/index.php?action=journal&id=2>
6. <https://www.rgo.ru/ru/obshchestvo/periodicheskie-izdaniya-rgo/zhurnal-lyod-i-sneg>
7. <https://www.swisseduc.ch/glaciers/index-en.html>

Recommended:

1. Borodavko, P. S., Volkova, E. S., Melnik, M. A., Litvinov, A. S., & Demberel, O. (2018). Climate change impact on high-altitude geomorphological systems. IOP Conference Series: Earth and Environmental Science, 211, 012004. doi:10.1088/1755-1315/211/1/012004
2. Malygina, N. S., Eirich, A. N., Barlyeva, T. V., & Papina, T. S. (2018). Isotope composition of macrocirculation processes responsible for precipitation in the Altai mountains. IOP Conference Series: Earth and Environmental Science, 211, 012008. doi:10.1088/1755-1315/211/1/012008
3. Algae-pollen monitoring in Altai Biosphere Reserve (Altai Republic, Russia) [E.Yu. Mitrofanova**+**](http://journal.asu.ru/biol/article/view/5932#author-1)[N.A. Kuriatnikova**+**](http://journal.asu.ru/biol/article/view/5932#author-2)[N.S. Malygina**+**](http://journal.asu.ru/biol/article/view/5932#author-3)[О. Demberel**+**](http://journal.asu.ru/biol/article/view/5932#author-4) [Vol 5 No 2 (2019)](http://journal.asu.ru/biol/issue/view/366) Published June 23, 2019 <https://doi.org/10.14258/abs.v5.i2.5932>
4. High-resolution late Holocene record from lake Bayan Nuur (Uvs Aimag, Mongolia): the multu-proxy study Publication: 20th EGU General Assembly, EGU2018, Proceedings from the conference held 4-13 April, 2018 in Vienna, Austria, p.16170
5. Present Glaciers of Tavan Bogd Massif in the Altai Mountains, Central Asia, and Their Changes since the Little Ice Age[D.A. Ganyushkin](https://pureportal.spbu.ru/en/persons/%D0%B4%D0%BC%D0%B8%D1%82%D1%80%D0%B8%D0%B9-%D0%B0%D0%BD%D0%B0%D1%82%D0%BE%D0%BB%D1%8C%D0%B5%D0%B2%D0%B8%D1%87-%D0%B3%D0%B0%D0%BD%D1%8E%D1%88%D0%BA%D0%B8%D0%BD), K.V. Chistyakov, [I.V. Volkov](https://pureportal.spbu.ru/en/persons/%D0%B8%D0%BB%D1%8C%D1%8F-%D0%B2%D0%BB%D0%B0%D0%B4%D0%B8%D0%BC%D0%B8%D1%80%D0%BE%D0%B2%D0%B8%D1%87-%D0%B2%D0%BE%D0%BB%D0%BA%D0%BE%D0%B2), [D.V. Bantcev](https://pureportal.spbu.ru/en/persons/%D0%B4%D0%BC%D0%B8%D1%82%D1%80%D0%B8%D0%B9-%D0%B2%D0%B0%D0%B4%D0%B8%D0%BC%D0%BE%D0%B2%D0%B8%D1%87-%D0%B1%D0%B0%D0%BD%D1%86%D0%B5%D0%B2), [E.P. Kunaeva](https://pureportal.spbu.ru/en/persons/%D0%B5%D0%BB%D0%B5%D0%BD%D0%B0-%D0%BF%D0%B5%D1%82%D1%80%D0%BE%D0%B2%D0%BD%D0%B0-%D0%BA%D1%83%D0%BD%D0%B0%D0%B5%D0%B2%D0%B0), [Tatyana A. Andreeva](https://pureportal.spbu.ru/en/persons/%D1%82%D0%B0%D1%82%D1%8C%D1%8F%D0%BD%D0%B0-%D0%B0%D0%BB%D0%B5%D0%BA%D1%81%D0%B0%D0%BD%D0%B4%D1%80%D0%BE%D0%B2%D0%BD%D0%B0-%D0%B0%D0%BD%D0%B4%D1%80%D0%B5%D0%B5%D0%B2%D0%B0-2), Anton V. Terekhov, Demberel Otgonbayar Geosciences **2018**, 8(11), 414; [**https://doi.org/10.3390/geosciences8110414**](https://doi.org/10.3390/geosciences8110414)
6. Glacier monitoring tracks progress in limiting climate change M. Zemp.. ., Otgonbayar D et all., December 2019, Nature 576(7785):39-39
7. Агатова А.Р., Непоп Р.К., Отгонбаяр Дэмбэрэл , Ганюшкин Д.А. Влияние сейсмического процесса на современное оледенение массива Цамбагарав(Западная Монголия) ТЕЗИСЫ ДОКЛАДОВ XVII гляциологического симпозиума "Роль криосферы в прошлом, настоящем и будущем Земли" г. Санкт - Петербург 17 - 20 ноября 2020 г. ISBN 978-5-89658-065-2 стр. 15-16