

**Course Objectives**

This course provides an in-depth exploration and understanding of the Himalayan environment, focusing on its geography, environmental conditions, and cultural, livelihood and societal significance. It examines the impacts of climate change on local and regional scales, including changes in precipitation, extreme weather events, and glacial melting. The role of glaciers in water resources and regional hydrology is discussed, alongside the use of remote sensing technologies to monitor Himalayan cryosphere. The course also addresses sustainable agricultural practices, the cultural and social impacts of climate change, and various climate disasters including landslides and flash floods. Students will learn about various disaster risk reduction, adaptation, and mitigation strategies, including community-based approaches and national and international policy frameworks and interventions, aiming to foster disaster risk resilience and sustainability in the Himalayas.

**1. Course Outcome**

**CO1:** Comprehend the principles and processes related to cryosphere changes driven by climate change in the Himalaya.

**CO2:** Identify vulnerable areas in the Himalaya and assess the historical and future impacts of climate change on these regions.

**CO3:** Conduct laboratory exercises to map and analyse cryosphere features such as glaciers, glacial lakes, and associated landforms in the Himalaya using remote sensing and GIS tools.

**CO4:** Identify and recognize the impact and consequences of mountain disasters on people and the environment, discuss mitigation strategies, and propose suitable solutions to address these hazards.

**2. Course Delivery**

1. PowerPoint-based lectures (instructor and guest presentations)
2. Hands-on training in remote sensing and GIS
3. Peer-to-peer student and instructor interactions and collaborative learning

**3. Syllabus****Unit 1 (6 hours)**

**Overview of the Himalaya:** Geography, evolution of Himalaya and its significance, environmental conditions, ecosystem and biodiversity, local- and regional-scale weather and climate, water resources and livelihood.

**Climate Change in the Himalaya:** Observed and historical climate changes, changes in precipitation, extreme weather events, future projections, fluctuating monsoon patterns including cloud bursts, future glacial melting.

#### **Unit 2 (6 hours)**

**Water Resources:** Glacier as a source of water resource, Role of glaciers in regional hydrology and water supply, and climate change, basic principles of glacier formation and movement, Influence of climate variables (temperature, precipitation) on glacier dynamics, glacier mass balance and extent, seasonal shifts in water availability.

#### **Unit 3 (6 hours theory) and Laboratory Course (8 hours)**

**Remote Sensing of Mountain Cryosphere:** Introduction to remote sensing systems, Active and Passive methods to map and monitor Himalayan glaciers, snow and ice, glacial landforms, dynamics, mass balance and volume, glacial hazards, permafrost.

#### **Unit 4 (6 hours)**

**Agriculture and Livelihoods:** Types of farming and crops, sustainable agricultural practices and water management, agricultural productivity, shift in crop patterns, suitability and yield, agriculture, and ecotourism.

**Cultural and Social Impacts:** Cultural Heritage, language, Indigenous Traditional Knowledge, Archaeology and mythology, social structures and challenges, Role of community-based adaptation strategies, climate communication.

#### **Unit 5 (6 hours)**

**Climate Disasters in the Himalaya:** Glacial Lake Outburst Floods, landslides, avalanches, flash floods (cloud bursts) formation, causes and impact on communities, mapping and monitoring techniques, recent examples and their consequences, extreme weather events, anthropogenic activities contributing to vulnerability (deforestation, forest fire, construction, mining).

#### **Unit 6 (6 hours)**

**Disaster Risk Reduction, Adaptation and Mitigation Strategies:** Mitigation and early warning systems, community-based adaptation and examples, technological and policy interventions, weather and climate forecasting, and early warning systems Policy frameworks supporting resilience and adaptation, Community-based disaster risk management (CBDRM), geopolitics and transboundary issues, policy frameworks and institutional mechanisms, role of Non-Governmental Organisations, national, international and industrial agencies.

#### 4. Evaluation Plan

Continuous Evaluation based on

a) **Continuous Assessment :20**

(Assignment and class participation)

b) **Mid Semester exam : 30**

c) **End Semester exam : 50**

1. Mini project (Group) : 20

2. Exam : 30

#### Books and References

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- Dimri, A. P., Bookhagen, B., Stoffel, M., & Yasunari, T. (Eds.). (2020). *Himalayan Weather and Climate and their Impact on the Environment*. Cham: Springer, <https://link.springer.com/book/10.1007/978-3-030-29684-1>
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- Sabin, T. P., Krishnan, R., Vellore, R., Priya, P., Borgaonkar, H. P., Singh, B. B., & Sagar, A. (2020). Climate change over the Himalayas. *Assessment of climate change over the Indian region: A report of the Ministry of Earth Sciences (MoES), Government of India*, 207-222, [https://doi.org/10.1007/978-981-15-4327-2\\_11](https://doi.org/10.1007/978-981-15-4327-2_11)
- Negi, V. S., Tiwari, D. C., Singh, L., Thakur, S., & Bhatt, I. D. (2022). Review and synthesis of climate change studies in the Himalayan region. *Environment, Development and Sustainability*, 24(9), 10471-10502, <https://doi.org/10.1007/s10668-021-01880-5>

- Dhimal, M., Bhandari, D., Dhimal, M. L., Kafle, N., Pyakurel, P., Mahotra, N., ... & Müller, R. (2021). Impact of climate change on health and well-being of people in Hindu Kush Himalayan region: A narrative review. *Frontiers in Physiology*, *12*, 651189, <https://doi.org/10.3389/fphys.2021.651189>
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- Shekhar, M. S., Chand, H., Kumar, S., Srinivasan, K., & Ganju, A. (2010). Climate-change studies in the western Himalaya. *Annals of Glaciology*, *51*(54), 105-112, <https://doi.org/10.3189/172756410791386508>