

# Assessing Households' Adaptive Capacity to Climate Change in the Diverse Socio-Cultural and Geographical Landscape of South Asia

## Major Findings



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## 1. Introduction

This three-year research project (2022-2024) is focused on assessing climate change, its impacts on agricultural sector, and farmers' adaptive capacity, particularly in Nepal, India, and Bangladesh.

Agriculture is the major source of livelihood in South-Asian countries where about 40-60% of the population in these countries are directly engaged in this sector for their livelihood. Its contribution to the GDP is about 11% in Bangladesh, 15% in India, and 24% in Nepal.

Agriculture in this region is predominantly rain-fed and particularly vulnerable to climate change due to its location in the Himalayas, one of the most climate-sensitive regions globally (Yao et al., 2019). Over the past fifty years, the Himalayas has been warmed by approximately 1.8°C, a rate much higher than the Northern Hemisphere and globally (Bajracharya et al., 2023; Yang et al., 2014). Both seasonal and annual temperatures have been rising, particularly in higher-elevation areas across the Himalayas (Bajracharya et al., 2023; Yao et al., 2019). Projections indicate that the Hindu-Kush-Himalayan (HKH) region could experience an overall temperature increase of 1–2°C, with localized warming reaching up to 4–5°C by 2050—significantly exceeding global averages (Shrestha et al., 2015). Under this scenario, the average economic loss is estimated at 9.9% for Nepal and 9.4% for Bangladesh, with even higher losses anticipated in India (Wang, Lee, and Son, 2017). In this context, it is crucial for farmers to strengthen their adaptive capacity (AC) to effectively cope with

the impacts of climate change. AC refers to individuals' capacity to adapt to change (Cinner, 2018). It encompasses the conditions that enable them to anticipate and respond to actual or expected climate and other external changes, minimizing consequences, recovering, and seizing new opportunities (Grothmann and Patt, 2005; Aase, 2017). This research therefore aims to assess smallholder farmers' vulnerability and adaptive capacity to climate change within the region's diverse geographical, socio-cultural, and environmental contexts, thereby contributing to more effective policy formulation for climate change adaptation and sustainable development.

## 2. General Background of the Study Area

This study covers three countries: Nepal, India, and Bangladesh (Fig. 1).

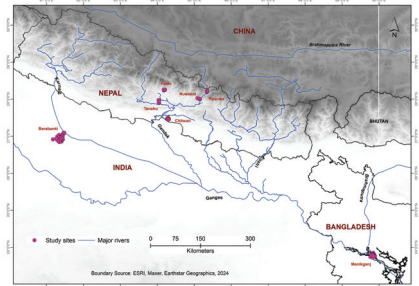


Fig. 1: Study area

In Nepal, it has covered the Mountain, Hill, and Tarai regions. There is a steep slope and limited agricultural land available around the settlements located at 2700 masl in the Mountain region. Hill region is located between Mountain and Tarai which consists of different types of land such as terraced hill slope and small valleys. The Tarai region is the low lying flat land suitable for farming. The study

sites in India has covered the settlements in Barabanki district along the Ghagra River. Study sites in Bangladesh, covers settlements of Manikganj district located at the confluence of Brahmaputra and Ganges rivers.

The study is based on household surveys, KII, FGD, and the analysis of long-term climate data. The study sites cover a complex topography, climate, and different social, economic, and cultural groups.

### **3. Major Scientific Findings**

#### **3.1 Household Assets, Access to Information and Services, and Decision Making**

##### *Households' land and socio-economic characteristics*

Household size varies by country, averaging 5.2 in Nepal, 6.8 in India, and 5.3 in Bangladesh. The literacy rate is highest in Nepal (85%), followed by India (82%) and Bangladesh (81%). However, there is a higher percentage of people in secondary and higher education levels (67%) in India in comparison to Nepal (52%) and Bangladesh (40%). Nepal has a significantly higher percentage of households with members migrating abroad (30%) compared to India (2.8%) and Bangladesh (7.1%). Limited household heads are involved in agriculture activities-related training, representing only 6% in India, 7% in Bangladesh, and 21% in Nepal.

The average landholding size of the study area ranges from 0.6 ha in Bangladesh, 0.7 ha in Nepal to about 1.0 ha in India. About 81% of households

have land in two or more location in Bangladesh, followed by 71% in Nepal and 69% in India. There is a limited canal irrigation facility in Nepal. About 87% of households in India and 93% in Bangladesh depend on shallow and deep tube wells for irrigation.

##### *Major crops and seed varieties*

In Bangladesh, rice and maize are the major crops. However, wheat cultivation is gradually declining. Iri rice is grown on less fertile but well irrigated land, while Aman rice, a deep-water variety, is cultivated in areas prone to high flooding. In addition, potato and green vegetables are grown in the winter. Fishing is the major occupation of 13% of households of the study area in Bangladesh. More than 20 varieties of fish are commonly found in the Padhma River. Fish availability in rivers is declining due to several factors, including reduced water volume in winter, decreasing river depth caused by increased siltation and sedimentation, and frequent changes in water flow patterns along with the emergence of sandbars.

In India, farmers used to cultivate paddy, maize, wheat, sugarcane, oilseeds, lentil, horse-gram, and peas 20 years ago. At present, they cultivate rice, wheat, sugarcane, oilseeds, peppermint, potato and a few households cultivate vegetables in winter. In the case of Nepal, barley, wheat and potato are major crops in Mountain. Maize, millet, rice and winter vegetables are cultivated in Hill. Similarly, farmers in the Tarai primarily cultivate rice and maize. Besides, they also cultivate oilseeds and vegetables in

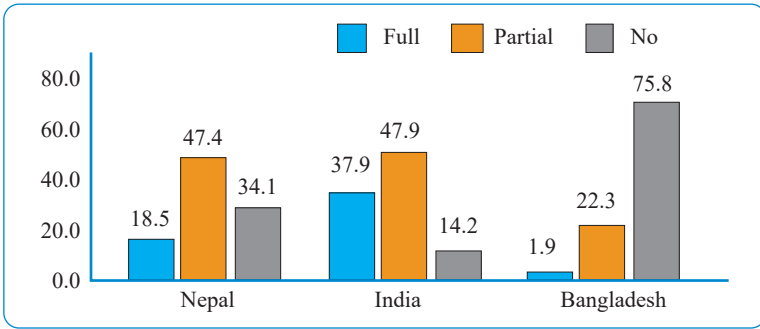


Fig. 2: Knowledge on modern seed varieties (HH%)

Farmers have limited knowledge of modern seed varieties. In Nepal, most farmers in the Mountain region rely on traditional varieties, while modern seed varieties have been used for only a few years in the Hill region. Farmers in Tarai region of Nepal, India and Bangladesh frequently change seed varieties. Only 18% households in Nepal, 38% in India and 2% in Bangladesh have knowledge about the modern seed varieties (Fig. 2). Farmers contact private local agro-vets shops for modern seeds and information related to fertilizer and pesticides requirements, disease controlling methods. About 55% households have

food sufficiency in Nepal, followed by 63% in India, and 75% in Bangladesh.

#### Access to nearest service

Health, market, road, agriculture and livestock extension services are important for farmers. About 10% households in all the three countries require more than 30 minutes to access these services. In the case of Nepal, 42% households need more than 30 minutes to reach to market. Access to agriculture and livestock extension service is poor in Bangladesh where 87% household take more than 30 minutes followed by 26% households in Nepal, and about 6 percent households in India.

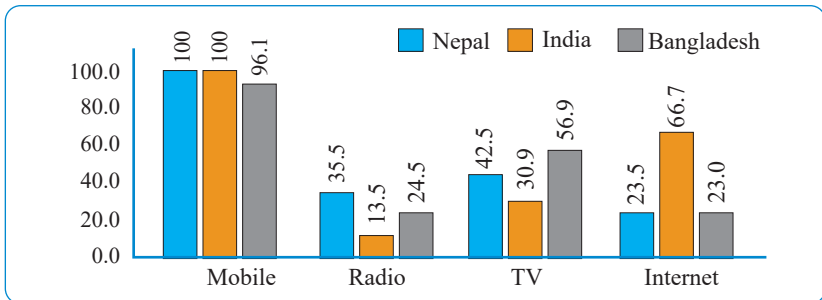


Fig. 3: Access to means of communication (HH%)

Mobile phone, radio, TV and internet are the major means of information to farmers. All of the households have mobile phone. Households with radio ranges from 13% in India to 35% in Nepal. Similarly, 31% households in

India and 57% in Bangladesh have television. The households with internet connection is equal (23%) in Nepal and Bangladesh while it is higher in India (with 67%) (Fig. 3).

### Weather information sources and level of trust

Farmers receive weather information from different sources. Local FM and community organizations are major sources in Nepal. Community organizations and public media, and relatives are such sources in India and Bangladesh. Only 17% households in Nepal, 48% in India and 49% in Bangladesh fully transfer the available weather information into adaptation action. This information together with the traditional knowledge are considered while taking decision particularly for sowing and harvesting of major crops in all the countries.

### Decision making on agricultural activities

Household decision making on crops and vegetable selection differs by country. In the case of cereal crops, mostly male take decision in India and Bangladesh while male and female jointly take such decision in Nepal. In the case of vegetables cultivation, decision is taken either jointly or by female in Nepal but it is taken by male in India and mostly by 'others' (the community, agro-vet, and lead farmers) and male in Bangladesh (Fig. 4).

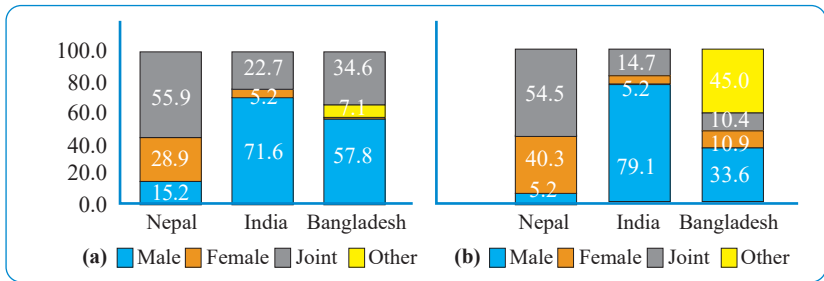


Fig. 4: Gender role in decision making on crops (a) and vegetable cultivation (b) (HH%)

## 3.2 Climate Change and Its Impacts

### Climate change situation

The analysis of observed climate data from the study sites shows increasing temperature and decreasing rainfall. The observed data (1990-2020) from Nepal shows the highest temperature increase (0.0921°C/a) in Hill region compared to Mountain (0.0254°C/a) and Tarai region (0.0042 C/a). The rainfall trend is the highest in Mountain (-13.126 mm/yr) (Paudel, et al., 2022). In the case of India, temperature has remained relatively stable during the 1981-2000 but rainfall has decreased by -8.945 mm/yr. Similarly, temperature has increased by 0.0139 °C

per year during 1981 to 2021 and rainfall has decreased by -10.909 mm/yr in Bangladesh.

The household survey data also shows that more than 90% farmers in Bangladesh, India and about 78% in Nepal have experienced increases in temperature. Except in Nepal, more than 50% farmers in Bangladesh and India have experienced decreasing rainfall. Rainfall variability has been increasing and experienced by more than 75% households in all the three countries. Importantly, draught has increased in all countries and especially became longer in Bangladesh (Fig 5).

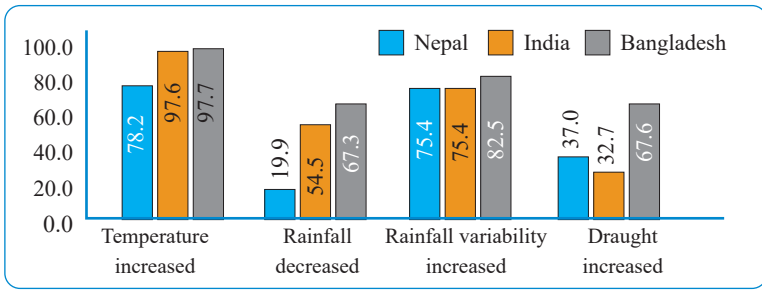


Fig. 5: CC experienced by farmers in study countries (% HH)

### Climate change impacts on crops

Climate change has a major impact on crops. Household survey data shows that about 60% households in Nepal

and Bangladesh, and 76% in India have experienced adverse impacts of climate change on crops (Fig. 6).

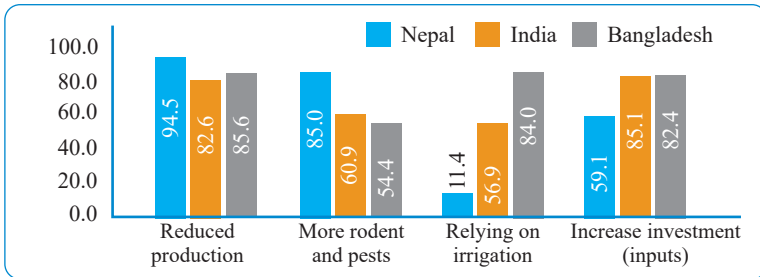


Fig. 6: Climate change impacts on crops (HH%)

More than 80% of farmers confirm that crop production has decreased. In the case of High Mountain of Nepal, it has decreased up to 40%. The other major impacts include increasing cost for farming due to the increasing price of fertilizer, seeds, and other inputs, increasing quantity of fertilizer used, followed by increasing pests and diseases on crops. Many horticulture crops, which

were best suited to the local environment, are not bearing fruits now or have dried. Likewise, rainfall variability affected pasture production in highlands. Farmers in the low land are compelled to rely more on groundwater extraction using deep tube-wells for irrigation, resulting an increase in the production cost (Fig. 6 and 7).



Hailstorm in Pokhara on October 17, 2023: Damage paddy

Heavy rainfall in mid-September damage vegetable, India, Sept. 2023

No rainfall in winter damage winter crops in Bangladesh, March 2023

Pests and disease in maize, Mountain region, Nepal, May-June 2022

Fig. 7: Observed climate change effects on crops in different countries

Annual crop loss and damage due to climate change-induced phenomena is estimated between 1500-2000 USD in Nepal and Bangladesh, while it is more than 2000 USD in India. The loss is far higher for those farmers who primarily focus on cash crops.

Climate change impacts on crops challenge food security that may result in massive migration and relocation of population at different scales. It has challenged the sustainability of natural resources, particularly water, agricultural and grazing land, and fisheries on which the livelihood of the majority of the people of these countries is dependent.

**Climate change-induced livelihood vulnerability**

Climate change-induced livelihood vulnerability of these countries, including China is varied and shaped by a complex interplay of exposure, sensitivity, and adaptive capacity (Fig. 8).

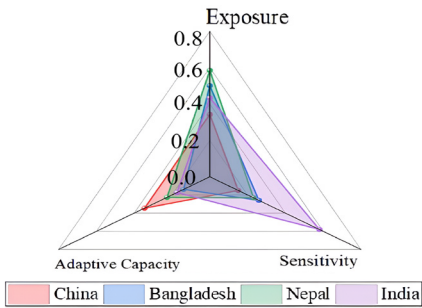


Fig. 8: Situation of exposure, sensitivity and adaptive capacity

India has the highest vulnerability (0.84), followed by Bangladesh (0.62), Nepal (0.59), and China (0.15). The high vulnerability of India is due to its high sensitivity, with an over-reliance on natural water sources and agricultural production as the main contributing

factors. Bangladesh has the second-highest vulnerability, with the lowest adaptive capacity and minimal natural, financial, and social capital, along with significant vulnerability to policy impacts. The lack of subsidies and labour exchange were found as the primary factors increasing the vulnerability of this country.

Despite the climate change exposure at the highest level, Nepal ranks third in terms of overall vulnerability which is largely due to its strong social capital that helps people adapt to climate shocks by sharing resources and information and providing mutual aid whenever it is needed. Changes in precipitation and housing structures are the major critical factors affecting Nepal's vulnerability. Finally, China is ranked the least vulnerable, with the lowest level of exposure and sensitivity. It has higher physical, financial, and natural capital, along with favorable policy impacts, resulting in the highest adaptive capacity, although it lacks sufficient human capital. The primary factors contributing to its vulnerability are drought variability and social organization.

**3.3 Farmers' Adaptation Strategies to Climate Change**

**Factors affecting farmers' adaptive capacity**

Different livelihood capitals together with knowledge and information, livelihood diversity, and institutions and agency have affected adaptive capacity (AC) of farmers. The relative importance of different indicators varied depending on geographic and climatic conditions of these countries. These factors operate together to enable or derange farmers to make informed decisions, adapt to

changing environmental conditions, and build resilience to climate change impacts.

In the case of Nepal, land-holding size, knowledge of modern seed varieties, agricultural-related skill development training, and trust in weather information have primarily affected AC.

In the case of India, access to agricultural inputs, knowledge of modern seed varieties, trust in weather information, and income source diversity are the major determinants of AC.

In the case of Bangladesh, access to financial institutions, community cooperation in farming, availability of weather information sources and trust in the information, and distance to agriculture livestock extension services are the major determinants of AC. The major factors and their effects are discussed in the published paper (<https://doi.org/10.1007/s11442-025-2326-3>).

Damage of crops by wild animal in Nepal, flood and strayed cattle in India, and flood and river bank cutting in Bangladesh are the major constraints to farmers.

### *Farmers' adaptation strategies to climate change*

Farmers have taken various adaptation strategies to climate change effects. These strategies are almost common among these countries but have a different priority. For instance, installation of shallow and deep tube-well for irrigation, increase in amount of fertilizer and pesticides use, and new seeds varieties are adopted at various extent in Bangladesh. Fishermen are gradually switching to modern fishing equipment while women have started involving in income generating activities.

In the case of Nepal, farmers have started applying more fertilizers and pesticides, using modern agricultural tools and new seeds varieties, water harvesting using different irrigation methods, and abandoning cropland as the ultimate option. In addition, sowing time has also been switched earlier or later depending on weather situation. In the case of India, farmers have focused to increase the amount of fertilizers and pesticides, changed seeds varieties, and also switched the sowing and harvesting time of crops (Fig. 9).

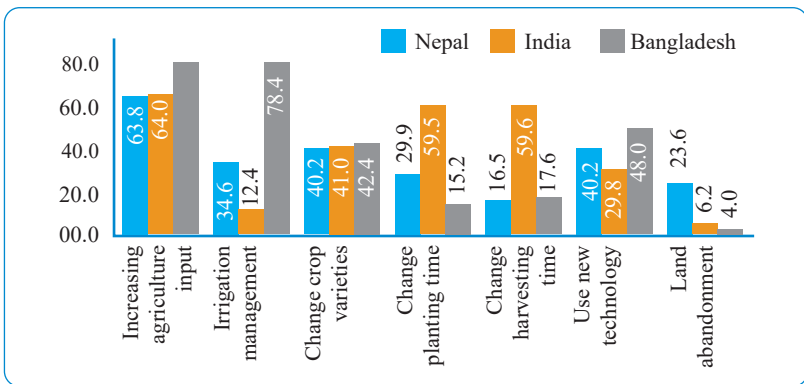


Fig. 9: Climate change adaptation strategies of farmers (HH%)

### 3.4 Knowledge and Policy on Climate Change

Climate change adaptation (CCA) policy pathway of all the three countries followed a climate-resilient development approach. However, significant differences in CCA policy priorities, knowledge, and understanding are evident among these countries. Most of the farmers in Bangladesh (96%), Nepal (87%), and India (76%) are not aware of the existing climate change policy and related interventions in the agriculture sector. They are either unaware of agro-climatic information or have low trust in it. Fifty-two percent of farmers in India, 8% in Nepal, and 3% in Bangladesh are aware of crop insurance programs. This evinces that linking available information to decisions and converting it to adaptive actions remains a significant challenge.

Lack of sectoral integration, alignment on CCA targets, and financing at the local levels are major gaps in the policy front. A lack of understanding and awareness of CCA in a local sociocultural context among implementation authorities and weak institutional mechanisms are gaps at the institutional front. Nepal has a high level of participation and inclusion compared to India and Bangladesh, particularly in activities related to gender-responsive capacity development, interventions, and collective agriculture and resource management. The main policy issue in Bangladesh is the lack of knowledge and awareness about CCA among local authorities and the limited effectiveness of institutions with undefined roles and responsibilities.

Local-level CCA interventions are mostly stand-alone, short-term, and project-oriented, centered on climate-induced

disaster risks. India offers various financial tools for CCA, yet smallholder farmers struggle to access them and have limited climate financing opportunities. In contrast, farmers in Bangladesh have higher access to institutions, but their willingness to participate is lower, and the government's delivery mechanism is relatively poor. Farmers in Nepal have limited financial instruments and poor accessibility to the agriculture market and services. Reactive adaptation like increased use of chemical fertilizers and changing crop varieties without proper understanding are common adaptive actions of farmers in all three countries inclining towards maladaptation.

It is suggested that understanding the adaptation response on policy updates and the implementation process offers insights into future anticipation and responses for successful CCA policy implementation. Besides, direct attention to policy considerations not only for distribution but also for orienting and educating farmers toward technology adaptation, alongside capacity building is suggested for effective CCA implementation. Sectoral integration and alignment on CCA targets and financing at the sub-national and local levels must be prioritized. Since many climate impacts are local, devolving planning and financial responsibility to those most affected, smallholder farmers, is critical. In the areas where government efforts on CCA awareness, information, and interventions have not penetrated, the good practices and tested traditional knowledge of autonomous adaptations should be acknowledged and replicated. At the same time, policy-based planned CCA adaptation should be promoted to

accelerate urgent adaptation needs, to rectify maladaptation, and narrow down the adaptation gaps.

#### 4. Publication

A key achievement of the project has been its scientific publications in high-ranked international journals, as well as a country-level policy paper in national journals.

##### **Published/Submitted to International Journal**

1. Poudel et al. (2022). Perception and understanding of climate change and its impact in Gandaki River Basin, Central Himalaya, Nepal. *Atmosphere*. <https://doi.org/10.3390/atmos13122069>
2. Chapagain, et al. (2025). Factors affecting smallholder farmers' adaptive capacity to climate change: A comparative study of Nepal, India, and Bangladesh. *Journal of Geographical Sciences*. <https://doi.org/10.1007/s11442-025-2326-3>
3. Chapagain, et al. (2025). Studies on adaptive capacity to climate change: A synthesis of changing concepts, dimensions, and indicators. *Humanities and Social Sciences Communications*. <https://doi.org/10.1057/s41599-025-04453-3>
4. Chapagain et al., Weather information sources, sharing platform and its trustworthiness for climate change adaptation in Bangladesh, India and Nepal.
5. Shrestha et al., Climate change adaptation: policy, practice and adaptation gaps in the agriculture sector in Bangladesh, India, and Nepal.

6. Gou et al., Understanding the farmers' livelihood vulnerability under climate change: A comparative study of four Trans-Himalayan countries.
7. Rai et al., Climate anomalies and crop production in South Asia

##### **Published in National Journal**

1. Rai et al., (2024). Climate change adaptation policies and institutional arrangement: Agriculture and fishery sector in India. *Advances in Modern Agriculture*. <https://doi.org/10.54517/ama.v5i2.2521>
2. Shrestha et al., (2024). Climate change policy instruments in agriculture sector: From policy to adaptation practice at local level in Nepal. *The Geographical Journal of Nepal*. <https://doi.org/10.3126/gjn.v17i01.63932>
3. Islam et al., (2024). Climate change adaptation policies and institutional arrangement: Agriculture and fishery sector in Bangladesh. *The Journal of the Bangladesh National Geographical Association*.
4. Shrestha et al. (2025). Increasing Agricultural Inputs: Autonomous Adaptive Response to Climate Change and Variability Effects in Selected South Asian Countries. *The Geographical Journal of Nepal*. <https://doi.org/10.3126/gjn.v18i1.77052>

##### **Published Booklet**

1. नेपालमा जलवायु परिवर्तनले कृषिमा पारेको प्रभाव अनुकूलनका चुनौती र उपाय तथा नीतिगत सवाल (Climate change impact on agriculture, adaptation strategies & constraints, and policy implication in Nepal) 2024.

2. Research Progress Bulletin, 2023.
3. Assessing Households' Adaptive Capacity to Climate Change in the Diverse Socio-Cultural and Geographical Landscape of South Asia: Major Findings.

In addition, many reports of the project activities have been produced. The project activities have been well covered by the media and the ANSO website. More than 50 news articles have been published, covering the project activities in these countries, including websites and university bulletins.

## **5. Research Capacity Building**

This research has enhanced capacity in different ways. It has enhanced the research competency and fostered a collaborative research culture. A total of 27 young faculty from three universities in Nepal have directly benefited from the seven-day capacity-building training program organized in 2023.

Additionally, the research assistants were trained in the use of online survey tools, extending its reach to participants across three countries. Three PhD students from Nepal and India played an active role and contributed to various research activities. In total, 15 Master's level students were trained on field strategies, respondent engagement, and hands-on experience in data collection.

Importantly, this project stands out as an exemplary model of close and active collaboration, with both senior and junior researchers involved in fieldwork, data analysis, and scientific paper writing, and seminar/workshop presentations.

## **6. Networking and Dissemination**

The project was successful in fostering networking, collaboration, and dissemination of its findings. It has established strong partnerships with collaborating universities, institutes, and departments. Notably, a Memorandum of Understanding (MoU) was signed between the Central Department of Geography, Tribhuvan University, Nepal, and the Department of Land Change Science and Biogeography, IGSNRR-CAS, China. This MoU will help to formalize the partnership and strengthen collaborative research efforts in the future.

During the research period, the findings were presented at over 18 national and international conferences/ workshops, and seminars across China, Nepal, India, and Bangladesh. Notable events include the 45th Indian Geography Congress 2023 in India, the Symposium of the Third Pole Environment, 2023 in China, and the International Geographical Congress 2024 in Ireland. These presentations provided an opportunity to share the research outcomes with a global audience, fostering discussions and collaborations among scholars and experts from various countries and disciplines. A final dissemination workshop was organized in Kathmandu in December, 2024, which was addressed by former president of Nepal Rt. Hon'ble Vidya Devi Bhandari, Vice-Chairman of National Planning Commission of Nepal, high level government officials, and authorities from different universities from different countries.

## Research Team and Research Support

The eight researchers from five universities/institutes of China, Nepal, India and Bangladesh have been involved in this research. Prof. Prem S. Chapagain from Central Department of Geography led the team as Principal Investigator. This research is supported by Alliance of International Science Organizations (ANSO). ANSO is a non-profit, non-governmental international scientific organization founded in 2018 by the Chinese Academy of Sciences, China. It aims to investigate and address the most urgent regional and global scientific challenges. Tribhuvan University is one of the founding members of ANSO.



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## References

- Aase, TH. (2017). Two kinds of flexibility. In: Aase TH (Ed.) *Climate change and the future of Himalayan farming*, 1<sup>st</sup> Edn. Oxford University Press, New Delhi, pp. 15–32. <https://doi.org/10.1093/oso/9780199475476.001.0001>
- Bajracharya, S. R., Pradhananga, S., Shrestha, A.B., and Thapa, R. (2023). Future climate and its potential impact on the spatial and temporal hydrological regime in the Koshi Basin, Nepal. *Journal of Hydrology: Regional Studies*, 45, 101316. <https://doi.org/10.1016/j.ejrh.2023.101316>
- Cinner, J.E., et. al. (2018). Building adaptive capacity to climate change in tropical coastal communities. *Nature Climate Change*, 8, 117-123. <https://doi.org/10.1038/s41558-017-0065-x>
- Grothmann, T., and Patt, A. (2005). Adaptive capacity and human cognition: The process of individual adaptation to climate change. *Global Environmental Change*, 15, 199-213. <https://doi.org/10.1016/j.gloenvcha.2005.01.002>
- Shrestha, A., Agrawal, N., Alifhan, B., Bajracharya, S., Maréchal, J., Oort, B.V. (2015). *The Himalayan climate and water atlas: Impact of climate change on water resources in five of Asia's major river basins*. Kathmandu, International Centre for Integrated Mountain Development (ICIMOD).
- Wang, SW., Lee, WK., and Son, Y. (2017) An assessment of climate change impacts and adaptation in South Asian agriculture. *Int J Clim Change Strateg Manag*, 9(4),517–534
- Yang, K., Wu, H., Qin, J., Lin, C., Tang, W., and Chen, Y. (2014). Recent climate changes over the Tibetan Plateau and their impacts on energy and water cycle: A review. *Global and Planetary Change*, 112, 79-91. <https://doi.org/10.1016/j.gloplacha.2013.12.001>
- Yao, T. et.al. (2019). Recent Third Pole's rapid warming accompanies cryospheric melt and water cycle intensification and interactions between monsoon and environment: Multidisciplinary approach with observations, modeling, and analysis. *Bulletin of the American Meteorological Society*, 100, 423-444. <https://doi.org/10.1175/BAMS-D-17-0057.1>