

HKH winter outlook 2026

NOVEMBER 2026–FEBRUARY 2027

Published by

International Centre for Integrated Mountain Development
GPO Box 3226, Kathmandu, Nepal

Authors

Sarthak Shrestha and Manish Shrestha – ICIMOD

Jing Yang, Shiyu Zhang, and Qinyao Zhou – Beijing Normal University (BNU)

Hongbo Liu and Xuechao Feng, Institute of Atmospheric Physics, Chinese Academy of Sciences (IAP–CAS)

Citation

Shrestha, S., Shrestha, M., Yang, J., Zhang, S., Zhou, Q., Liu, H., Feng, X., Sanyal, S. (2026). *HKH Winter Outlook 2026*. ICIMOD, BNU, and IAP–CAS. https://doi.org/10.53055/ICIMOD.1152

Production team

Nagraj Adve (Consultant Editor)
Mohd Abdul Fahad (Designer)

Photos

Alex Treadway: Cover, page 2, and 3
Jitendra Raj Bajracharya: Page 12

For further information, please contact:

info@icimod.org

Acknowledegments

The authors would like to thank Professor Qing Bao of IAP–CAS for generating the data and providing comments.

We also thank Birendra Bajracharya, Debabrat Sukla, Rongkun Liu, and Sravan Shrestha.

Copyright © 2026

International Centre for Integrated Mountain Development (ICIMOD)

Beijing Normal University (BNU)

Institute of Atmospheric Physics, Chinese Academy of Sciences (IAP–CAS)

This work is licensed under a Creative Commons Attribution Non-Commercial, No Derivatives 4.0 International License (https://creativecommons.org/licenses/by-nc-nd/4.0/)

Note

This publication may be reproduced in whole or in part and in any form for educational or nonprofit purposes without special permission from the copyright holder, provided acknowledgement of the source is made. ICIMOD would appreciate receiving a copy of any publication that uses this publication as a source. No use of this publication may be made for resale or for any other commercial purpose whatsoever without prior permission in writing from ICIMOD.

The views and interpretations in this publication are those of the author(s). They are not attributable to ICIMOD and do not imply the expression of any opinion concerning the legal status of any country, territory, city or area of its authorities, or concerning the delimitation of its frontiers or boundaries, or the endorsement of any product.

This publication is available in electronic form at www.icimod.org/himaldoc

Disclaimer

All information in this document is provided ‘as is’. The authors make every effort to ensure – but not to warranty, either express or implied – the accuracy, reliability, timeliness, non-infringement, merchantability, and fitness for a particular purpose of any of the materials. In no event shall the authors or ICIMOD, BNU, or IAP–CAS be liable for any loss or damage of any nature, including special, indirect, punitive, or consequential damage arising in connection with the access, use, or reliance on any of the materials. Visit our website for the complete terms of use.

Key messages

A WETTER WINTER, FORECASTED FOR MUCH OF THE HKH, WOULD HELP AGRICULTURE BUT COULD ALSO MEAN GREATER RISK OF DISASTERS.

Normal to above-normal winter precipitation is forecast across much of the Hindu Kush Himalaya (HKH), including parts of Afghanistan, Pakistan, northern India, Nepal, and the Xizang Autonomous Region (XAR), China. Whereas higher-than-normal precipitation could improve soil moisture, support winter agriculture, and contribute to the accumulation of snow in mountain catchments, heavy precipitation could increase the risk of avalanches, localised flooding, and landslides. Preparedness planning must account for these regional differences and variability in precipitation rather than rely on seasonal averages alone.

MORE SNOW IN THE WESTERN HIMALAYA, LESS IN THE EAST: QUESTIONS FOR FUTURE WATER SECURITY.

Above-normal snow depth is projected across parts of the western HKH, particularly in Afghanistan, Pakistan, northern India, and Nepal, while below-normal snow depth is expected in parts of Bhutan and eastern XAR. Winter snow acts as a natural reservoir, helps sustain river flows, and provides water for irrigation and hydropower generation in subsequent months. However, these benefits depend on how much snow accumulates, how long it persists, and when it melts. Monitoring of snow conditions is essential to assess water availability during the spring and pre-monsoon seasons.

A WARMER WINTER COULD LEAVE FARMS AND WATER SUPPLIES UNDER PRESSURE ACROSS PARTS OF SOUTH ASIA.

Above-normal temperatures are projected across much of Afghanistan, Pakistan, and Bangladesh, and parts of India and Nepal, while cooler conditions may prevail at higher elevations. Warmer conditions combined with below-normal precipitation, particularly in southern India, could increase pressure on irrigation supplies and water resources. Cooler conditions in high-altitude areas may adversely impact crop growth and yields due to frost. Agricultural and water management agencies should consider local temperature and precipitation patterns in their seasonal planning and promote frost-protection measures to reduce potential impacts on livelihoods and water security.

WETTER WINTER FORECASTS OFFER NO GUARANTEE AGAINST WILDFIRES IN THE HKH.

Despite projections of wetter conditions across much of the HKH, moderate to high levels of forest and grassland fire hazard have been forecast across Bhutan, parts of Pakistan, and other areas, with particularly elevated levels of danger in parts of southeastern XAR, Myanmar, and India. These variations demonstrate that seasonal precipitation patterns alone cannot determine local hazard conditions. This Outlook provides an early indication of potential risks but cannot predict the magnitude, timing, or location of individual events. National authorities should combine seasonal predictions with updated weather forecasts, snow-cover observations, and local monitoring to guide preparedness and timely action.



About the HKH-S2S prediction system

The Hindu Kush Himalaya Sub-seasonal to Seasonal (HKH-S2S) prediction system is supported by the Institute of Atmospheric Physics, Chinese Academy of Sciences (IAP–CAS), one of the WMO's meteorological originating centres for S2S data. At its core is the FGOALS-f2, a fully coupled climate system model that integrates varied components – the atmosphere, ocean, land, and sea ice.

The system is downscaled using the FGOALS-UFS, enabling a higher spatial resolution of approximately 20 km × 20 km. Fire hazard was assessed by comparing forecast Fire Weather Index (FWI) values, calculated using temperature, relative humidity, wind speed 10 metres above ground, and precipitation, with grid-specific quintile thresholds derived from historical FWI data. The model hindcast spans 2010–2024 and includes eight ensemble members while the Outlook includes 49 ensemble members, allowing for improved representation of forecast uncertainty and variability. The current prediction covers November–December–January–February (NDJF) 2026–2027, and is based on initialised outputs for October.

The findings of this Outlook should be interpreted cautiously as seasonal forecasts indicate the probability of conditions occurring relative to 15-year climatological averages. They do not predict the exact magnitude, timing, or location of specific events. The Outlook should therefore be interpreted alongside national meteorological forecasts, observed river flows, snow cover monitoring data, reservoir levels, and agricultural water-demand assessments to support adaptive planning and timely decision-making across the Hindu Kush Himalaya (HKH).



Overview of winter monsoon conditions in South Asia

The climate of the HKH is generally cold and dry from November to February, with freezing temperatures and snow at higher altitudes. The region transitions entirely away from the summer monsoon and is dominated primarily by two winter systems: western disturbances (WDs) – extra-tropical weather systems that bring rain and snow to northwestern and northern India, Pakistan, Afghanistan, and parts of Nepal – and the northeast (winter) monsoon.

During July 2026, sea surface temperature anomalies in the central-eastern equatorial Pacific had strengthened to 2°C above normal. By mid-August, temperatures increased to 2.6°C above normal, indicating a continued intensification of the ongoing El Niño (WMO, 2026). With exceptionally warm ocean conditions, the El Niño is expected to strengthen further during the coming months before peaking towards the end of 2026. These elevated temperatures are expected to continue having impacts into February 2027.

The HKH Winter Outlook 2026 (hereafter, Outlook) analyses projected precipitation, temperatures, snowfall patterns, and forest and grassland fire hazards across South Asia, in particular in the HKH. It draws on outlooks and information from global and regional institutions such as the Hindu Kush Himalaya Sub-seasonal to Seasonal (HKH-S2S) prediction system, the WMO, and the El Niño–Southern Oscillation (ENSO)[1] bulletin by the India Meteorological Department

[1]ENSO is a climate pattern that develops in the Pacific Ocean due to changes in ocean temperatures and winds. It can influence rainfall, temperature, droughts, floods, and monsoon conditions in many parts of the world, including South Asia.

(IMD). Various seasonal predictions indicate an "exceptionally high likelihood of nearly 100%" for El Niño conditions to persist from now until February 2027. The IMD's October outlook indicated neutral Indian Ocean Dipole (IOD)[2] conditions, meaning that the sea surface temperature difference between the western and eastern tropical Indian Ocean was close to its normal range; however, the Australian Bureau of Meteorology reports that the IOD index has exceeded the positive threshold (+0.4°C) for seven consecutive weeks, reaching +0.69°C in the week ending 25 October, with positive conditions expected to persist into December 2026.

The seasonal prediction from the HKH-S2S model for the period November 2026–February 2027 indicates normal to above-normal precipitation (as measured against the baseline period 2010–2024) across the HKH. In contrast, central and southern India are expected to receive normal and below-normal precipitation respectively.

Similarly, the model projects a mixed temperature pattern in the HKH for the upcoming winter season. Above-normal temperatures are likely across Afghanistan, Pakistan, northwestern India, Bangladesh, and the hills of Nepal and southern Bhutan. The higher altitudes in Nepal may be cooler than normal. Near-normal temperatures are likely over Myanmar and eastern parts of the Xizang Autonomous Region (XAR), China, with below-normal temperatures in southwestern XAR.

Consistent with the predicted precipitation and temperature anomalies, the model projects a spatially variable snow-depth outlook for the upcoming winter season. Above-normal snow depth is expected across the western HKH, with the probability of this occurring exceeding 70% in some areas, whereas below-normal snow depth is projected across parts of the eastern Himalaya, including Bhutan and eastern XAR.

The probability of fire hazards across the region's forests and grasslands is expected to be high to very high, including in southeastern XAR, eastern and southern Myanmar, and parts of southern and northeastern India, and low to very low across Nepal and much of central and eastern India. A low probability of fire hazards is forecast for Bangladesh, while a moderate probability is forecast for most of Bhutan.

[2]IOD is a climate pattern that develops in the Indian Ocean due to differences in sea surface temperatures between its western and eastern parts. It affects rainfall, monsoon strength, droughts, and flood conditions across regions surrounding the Indian Ocean, including South Asia.

Forecasts

The following maps (Figures 1A–1D) show the seasonal mean precipitation, temperature, and snow depth anomalies, and fire hazard respectively, as indicated by the HKH-S2S prediction system for the 2026–27 winter season.

FIGURE 1A: **SEASONAL MEAN PRECIPITATION ANOMALY FOR THE 2026–2027 WINTER SEASON IN SOUTH ASIA**

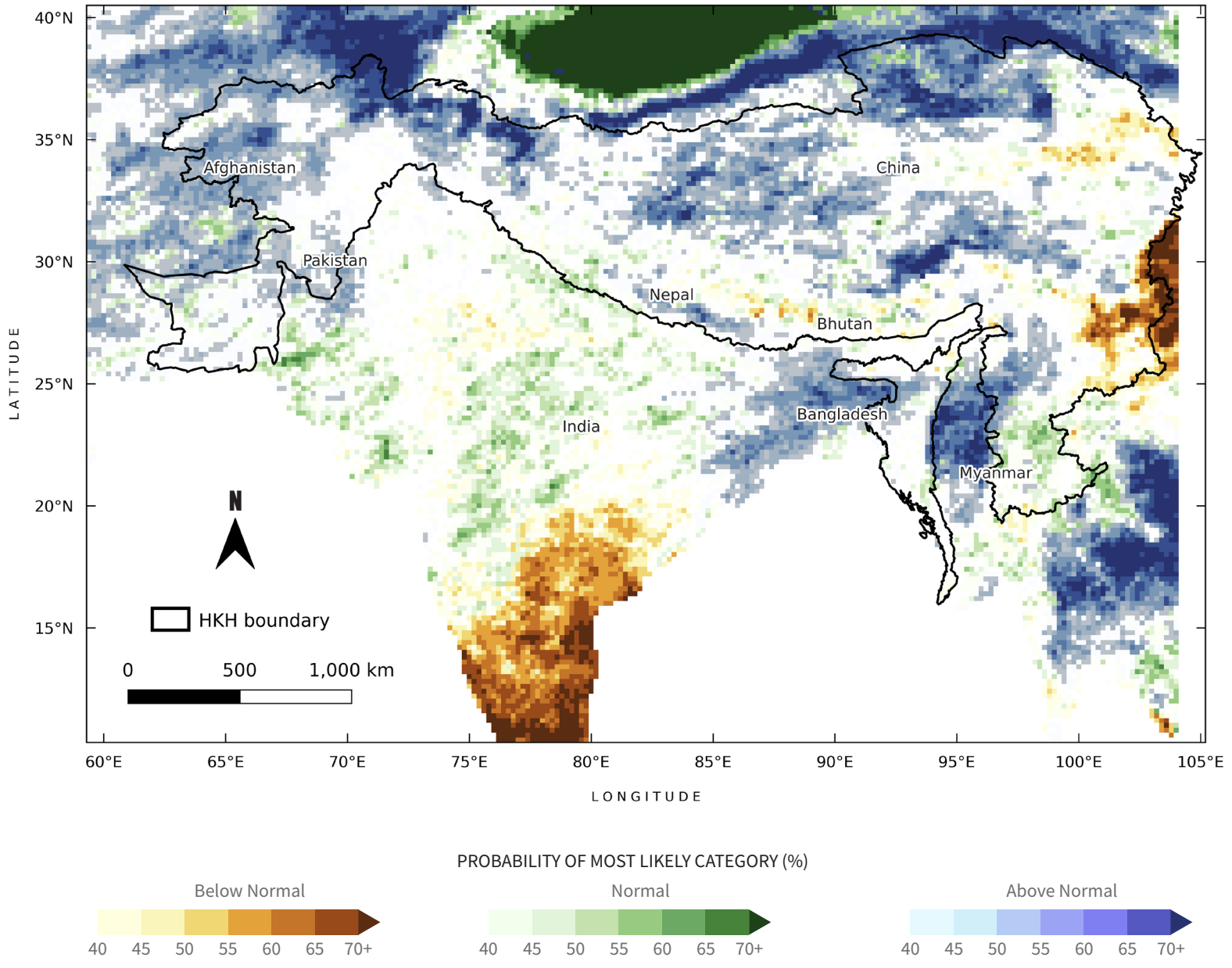


FIGURE 1B: **SEASONAL MEAN 2 m TEMPERATURE ANOMALY FOR THE 2026–2027 WINTER SEASON IN SOUTH ASIA**

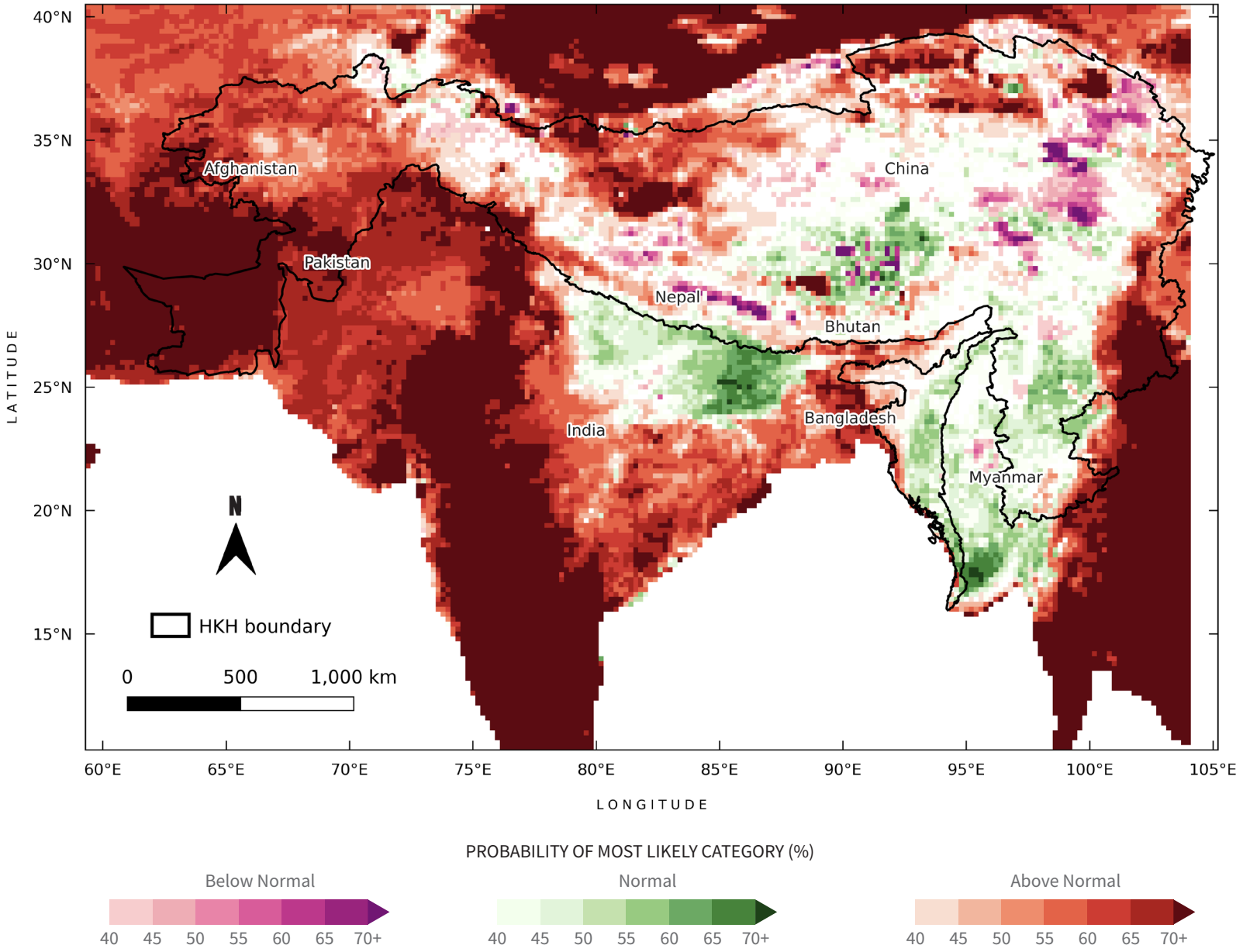


FIGURE 1C: **SEASONAL MEAN SNOW DEPTH ANOMALY FOR THE 2026–2027 WINTER SEASON IN SOUTH ASIA**

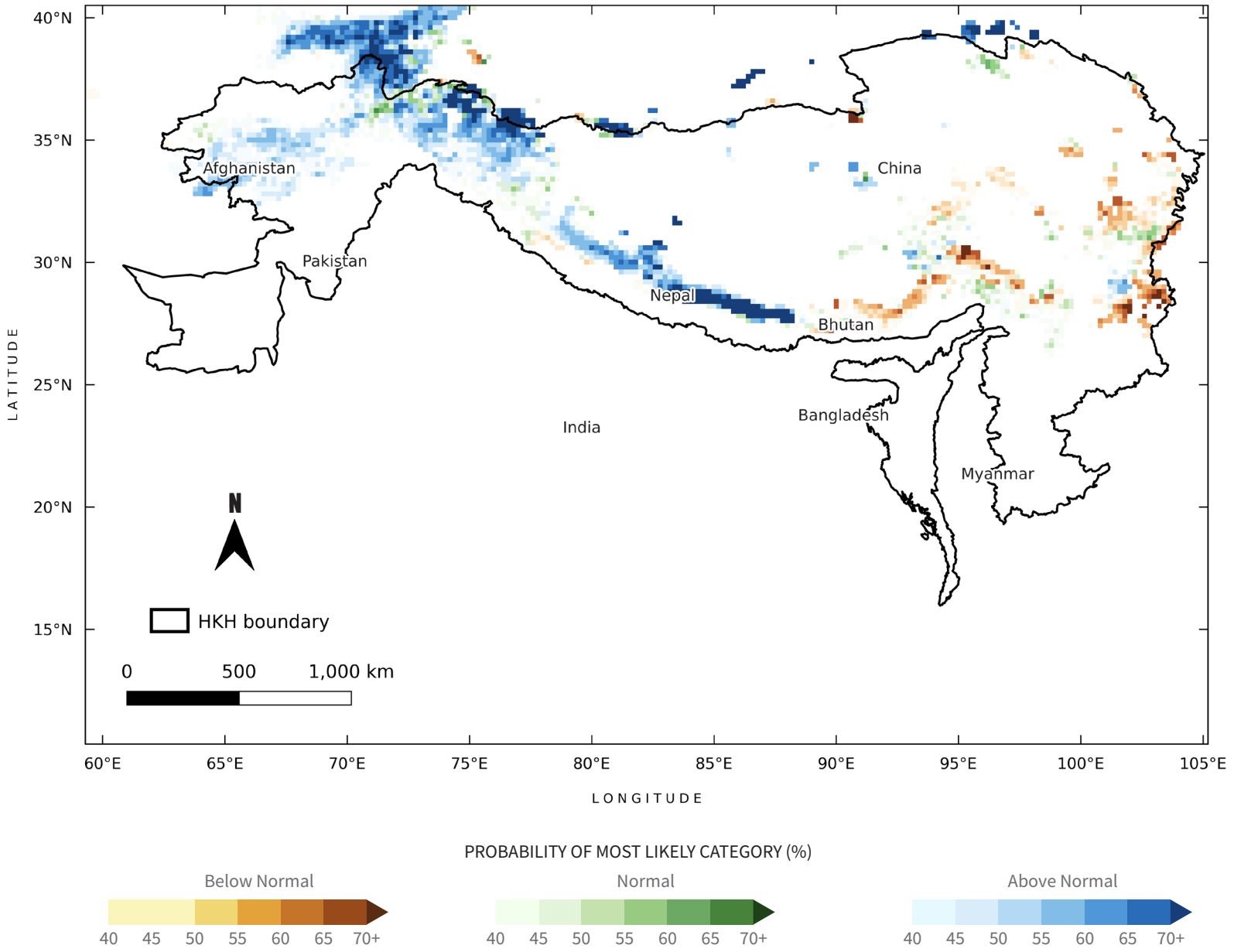


FIGURE 1D: **FOREST AND GRASSLAND FIRE HAZARD OUTLOOK FOR THE 2026–2027 WINTER SEASON IN SOUTH ASIA**

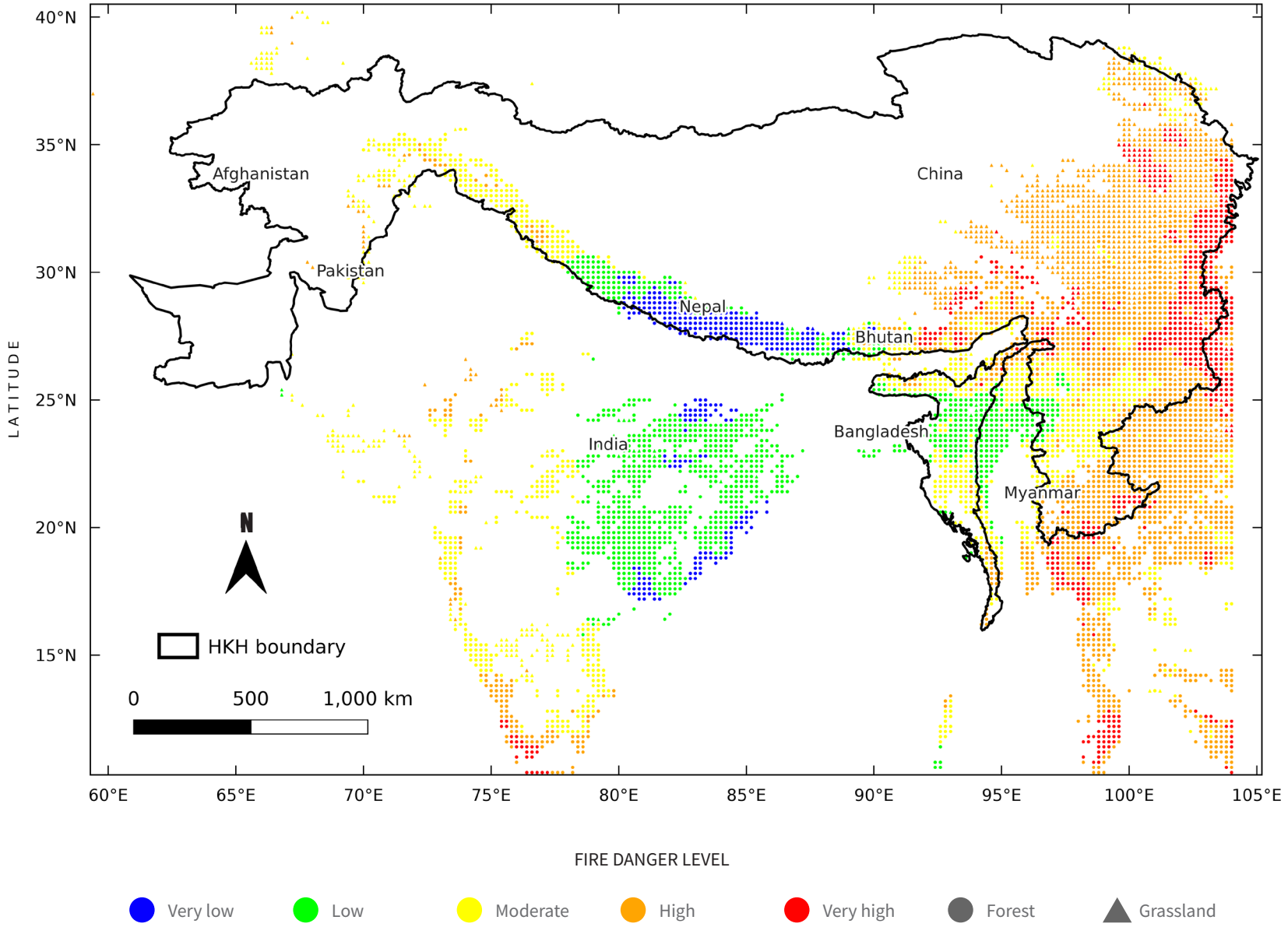
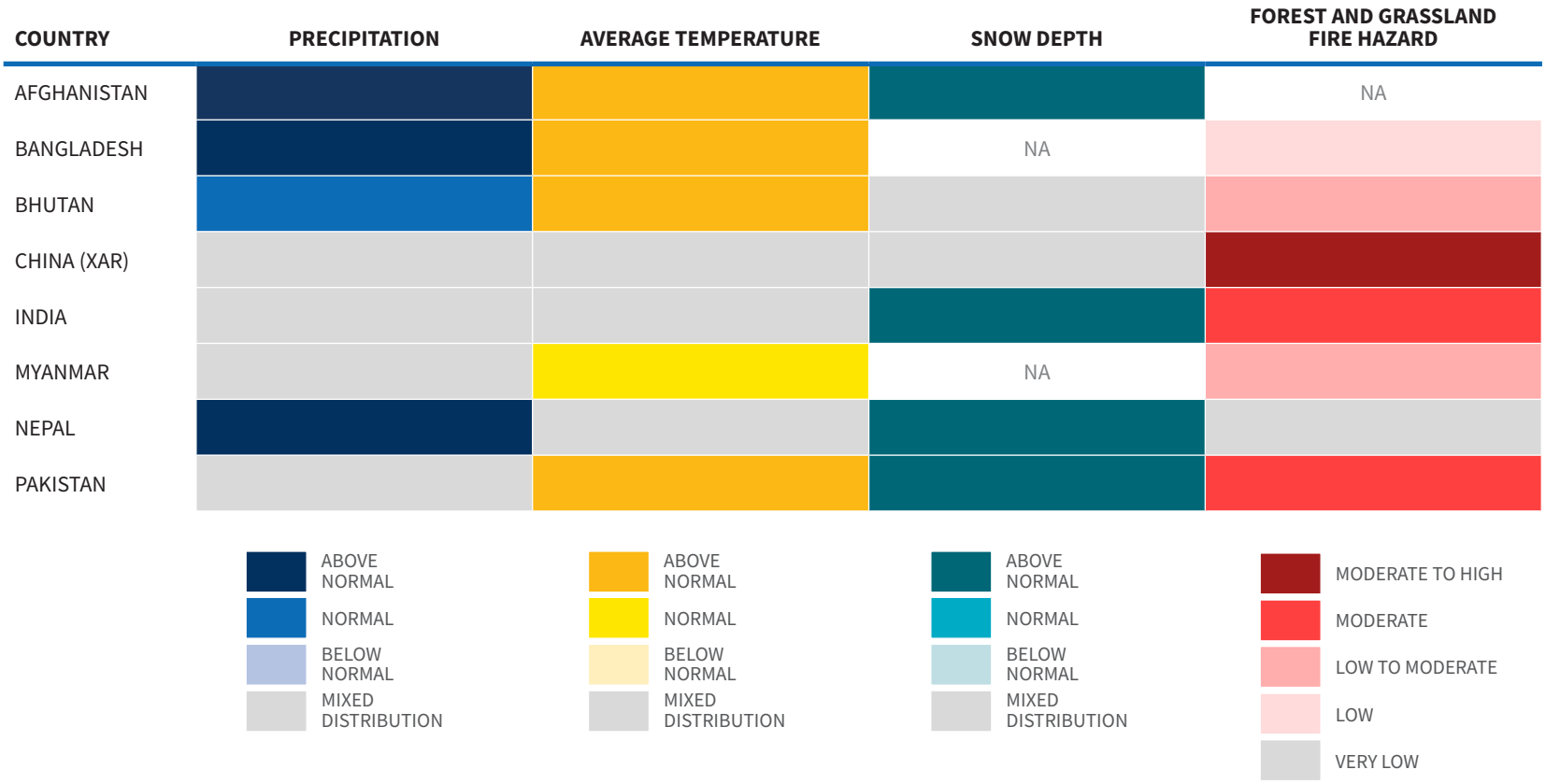


FIGURE 2: **DISTRIBUTION OF WINTER-SEASON PRECIPITATION, TEMPERATURE, SNOW DEPTH, AND FIRE HAZARD ACROSS THE HKH COUNTRIES**



Above normal: Higher than long-term average conditions
Normal/Near normal: Close to the long-term average conditions
Below normal: Lower than long-term average conditions
Mixed distribution: A mix of at least two different forecast categories across various regions within the country
NA: Not available

AFGHANISTAN

According to HKH-S2S forecast, Afghanistan is likely to experience above-normal precipitation across most parts of the country with the probability of this occurring ranging from 45% to 65% across regions. However, some areas in eastern Afghanistan are expected to receive near-normal levels of precipitation. Regarding average temperatures, the HKH-S2S indicates a high probability of above-normal conditions across the country, with probabilities ranging from 55% to 100% (such percentages in this Outlook indicate the probability that the forecast conditions will occur in each region or across regions). Southern Afghanistan shows a stronger signal for warmer-than-normal temperatures, with probabilities exceeding 70%, indicating a greater likelihood of a warmer-than-normal winter season in that region.

For snow depth, above-normal conditions are expected in the mountainous northeastern parts of the country, consistent with the forecast of above-normal precipitation. Probabilities in the northern areas reach 60%–70% or higher. In the central region, snow depth is expected to range from near-normal to above-normal, with probabilities ranging from 40% to 55%.

BANGLADESH

In Bangladesh, the HKH-S2S forecast indicates winter precipitation to be above normal across the central and northern parts of the country, with probabilities ranging from 45% to 70%. Near normal conditions are projected in the coastal areas along the coast.

Bangladesh is also likely to experience above-normal temperatures, showing a 50%–100% probability of warmer-than-normal conditions. The likelihood of fire hazards is generally low across the mapped forest and grassland areas of Bangladesh, with localised moderate hazard levels in the south.

BHUTAN

The HKH-S2S forecast indicates a 40%–60% probability of normal precipitation across northern Bhutan. This indicates that winter season rainfall is likely to remain close to the long-term average, although regional and temporal variations may occur. Higher temperatures are expected along the periphery of southern Bhutan with a 40%–60% probability of above-normal conditions. Regarding snow depth, conditions are projected to range from normal in central Bhutan to below normal in its western and northern parts, with probabilities of approximately 45%–65%. The likelihood of fire hazards is moderate across much of Bhutan. Lower levels are forecast for parts of the west and south, with locally high levels of danger from fires in the north and east.

CHINA (XIZANG AUTONOMOUS REGION)

The HKH-S2S forecast indicates predominantly above-normal precipitation across the XAR, China, with probabilities ranging from 45% to 70%. Temperatures are likely to remain below normal in the southwest and along the southern periphery of the XAR, with probabilities exceeding 50%. Normal conditions are expected in eastern XAR with probabilities of 45%–65%. Regarding snow depth, above-normal conditions are expected in the southwestern border areas, with probabilities exceeding 50%, while normal to below-normal conditions are projected across eastern XAR, with below-normal probabilities of approximately 55%–70%. The level of fire hazard is seen as high to very high for southeastern XAR.

INDIA

The HKH-S2S forecast indicates a 50%–65% probability of below-normal precipitation across southern India, with near-normal conditions expected over the central region. In the northernmost parts of India, including the Northeast, some areas indicate above-normal precipitation with probabilities ranging from 45% to 70%.

Temperatures are likely to remain above normal, with probabilities exceeding 65% across the western periphery of the country. However, near normal conditions are expected in the northern states of Uttar Pradesh and Bihar. The northeastern part of the country is likely to have a mixed distribution of normal to above-normal conditions stretching from its southern to northern areas respectively.

As for snow depth, above-normal conditions are expected in state of Himachal Pradesh and the northernmost parts of the country with probabilities of 50%–65% in these areas. Very low to low fire hazard levels are projected across much of central and eastern India. However, parts of the west and northeast are forecasted to experience moderate to high fire hazard levels, with localised very high levels in the southern peninsula and north-eastern Himalayan region.

MYANMAR

Precipitation forecasts for this winter season in Myanmar indicate a mixed pattern. Central Myanmar is expected to receive above-normal precipitation, with the probability of this occurring ranging from 60% to 70% stretching towards the northeastern parts. In the eastern region, there is a 50%–60% probability of near-normal precipitation. Regarding temperature, the HKH-S2S forecast expects mostly normal conditions across the country, with probabilities ranging from 45% to 70%. In contrast, some areas in central Myanmar are expected to experience slightly below-normal mean temperatures. Fire hazard is moderate to high across northern and eastern Myanmar, with localised very high levels in the north and south. Much of the mapped forest and grassland areas in western and central Myanmar face low to moderate levels of fire hazard.

NEPAL

The HKH-S2S forecast indicates wetter-than-normal conditions across Nepal. The probability of above-normal precipitation ranges from 40% to 55%, with higher probabilities in central Nepal and lower probabilities in its eastern and western regions. The temperature forecast indicates a mixed pattern, with a 45%–50% probability of above-normal mean temperatures across the Hill regions. However, cooler-than-normal conditions are expected at higher elevations, with probabilities ranging from 55% to 60%. Regarding snow depth, above-normal conditions are expected in northern Nepal, with probabilities reaching 60%–70% or higher. The peak fire season in Nepal typically is during February–May. Very low levels of fire hazard are expected across most forest and grassland areas of Nepal in the period of this forecast, although localized low to moderate fire hazard is indicated along the western and eastern margins of the country.

PAKISTAN

According to the HKH-S2S forecast, Pakistan is likely to experience above-normal precipitation across most parts of the country. However, near-normal precipitation is expected in the southern regions, with probabilities ranging from 55% to 65%.

The HKH-S2S forecast indicates a likelihood of above-normal mean temperatures across the country, with probabilities ranging from 55% to 65%. The southwestern region shows a stronger signal for above-normal temperatures, with probabilities exceeding 70%. Above-normal snow depth is expected in the northern parts of Pakistan, with probabilities ranging from 55% to 70%, consistent with the forecast of above-normal precipitation. Moderate fire hazard levels have been forecast across northern Pakistan.



Implications of the winter season predictions for the HKH

The winter season is critical for the accumulation of snow across the HKH. It is especially important as snow acts as a natural water reservoir during winter. The amount and persistence of accumulated snow influence base flows in rivers, and the availability of water for irrigation and hydropower generation during the pre-monsoon season.

This Outlook may therefore provide policymakers and practitioners in the water, energy, agriculture, forestry, and disaster management sectors an early indication of where to prioritise preparedness ahead of the spring melt and pre-monsoon seasons.

The HKH-S2S winter forecast for November 2026–February 2027 indicates considerable spatial variability in precipitation, temperature, snow depth and fire hazards across the HKH, with implications for seasonal water availability and wildfire management. The above-normal precipitation projected across Afghanistan, Pakistan, the XAR (China), North India, Nepal, Bangladesh, and northern Myanmar could improve soil moisture. In high-altitude catchments, much of this precipitation is likely to fall as snow, which could enhance river flows in spring and summer. Reservoir operators, hydropower planners, and

irrigation authorities can factor this in the early release of water and sectoral allocation planning.

In addition, snow depth forecast suggest above-normal accumulation of snow in the higher reaches of Afghanistan, Pakistan, North India, and Nepal. This is consistent with studies showing that winter precipitation over the western Himalaya tends to be greater during El Niño years – and the current El Niño is very strong – although the strength of this relationship varies from event to event (Hunt et al., 2025). Studies also show that extreme winter precipitation events in the Karakoram and western Himalaya are more frequent during El Niño years (Cannon et al., 2017). Disaster management authorities should therefore plan for intense snowfall episodes, not only above-normal seasonal totals. Heavy precipitation could potentially lead to avalanches, localised flooding, and landslides in vulnerable mountain areas. Where above-normal snow depth coincides with above-normal temperatures, as projected for parts of Afghanistan and Pakistan, the risk of avalanches may be heightened: warming in the western Indian Himalaya has been linked to more frequent avalanches with longer run-out distances (Ballesteros-Cánovas et al., 2018), and rain falling on existing snowpack can amplify snowmelt and run-off, increasing the risks of floods and landslides, particularly in spring (Li et al., 2025; Maina & Kumar, 2023).

In these areas, disaster management authorities and road construction agencies should consider issuing avalanche advisories for high mountain passes and road corridors, building and pre-positioning snow clearance and search-and-rescue capacities, and stocking food, fuel, and medicines in settlements prone to being cut off. For agriculture, the enhanced precipitation could benefit winter crops by improving soil moisture and potentially reducing irrigation requirements. Seasonal forecasts cannot anticipate high-altitude slope failures such as the ice-rock avalanche that triggered the Gyirong–Rasuwa disaster of 26 August 2026. Where warm anomalies and heavy snowfall coincide, glacier and permafrost slopes ought to be tracked through dedicated monitoring and early warning systems.

Conversely, the below-normal precipitation projected across central and southern India could increase the pressure on water resources and constrain irrigation supplies, particularly where warmer-than-normal temperatures may increase evapotranspiration. The cooler weather forecasted in parts of the HKH could increase the risk of frost and affect crop growth and yields, especially in high-altitude farming areas; extension services here could provide advice regarding, and support frost protection for crops and livestock. Water and agriculture departments in areas facing prolonged dry spells could review drought contingency plans early, prioritise drinking water supplies, and promote drought-tolerant or short-duration winter crops. The below-normal snow depth projected for western and northern Bhutan and eastern XAR may also reduce the contribution of snowmelt to spring river flows, which water utility managers, hydropower operators, and irrigation authorities could factor into early water supply and drought planning.

The forest and grassland fire outlook for the HKH suggests an increased risk of fires in its eastern parts. Higher levels of fire hazard are indicated for southeastern XAR, and eastern and southern Myanmar during the winter season. Warmer conditions, particularly when combined with dry vegetation, low humidity, and prolonged dry spells, could increase the likelihood of fire ignition and spread of fires. The forest fire season in the HKH region traditionally falls between November and mid–May. However, the main fire season falls between February – which overlaps with this Outlook's forecast period – and May; satellite records for 2012–2021 show that this four-month period accounts for about 90% of the

annual forest fires in South Asia, with more than half the fire occurrences in the forests of the HKH, and over 70% of them typically caused by humans (Aditi et al., 2025). Forest departments and local governments in areas in which higher levels of fire hazard have been forecast ought to therefore begin preparedness before February by maintaining fire lines, raising community awareness about agricultural residue and pasture burning, and readying fire response teams and equipment.

Seasonal outlooks and short-range forecasts serve different purposes. Seasonal outlooks indicate how the odds of warmer, cooler, wetter, or drier conditions may shift over the coming months, which supports planning and preparedness. Short-range forecasts and observations indicate whether and when a specific event is likely to occur and ought to guide decisions to issue warnings or respond to events. Governments and NGOs can therefore get the most value from seasonal outlooks such as this one by using them to inform pre-agreed triggers and early actions, for example through forecast-based financing approaches (Coughlan de Perez et al., 2015).

Seasonal totals are, however, a limited guide to specific hazardous events. Flooding, for example, has been found to relate more closely to the number of extreme rainfall events than to seasonal rainfall totals (Coughlan de Perez et al., 2017). It is therefore advisable to consult regional and national hydrometeorological organisations regularly for the most up-to-date predictions. ICIMOD has also developed several short-range forecasting tools, capable of accurate short-term forecasts. These include (1) the High-Impact Weather Assessment Toolkit (HIWAT) for forecasts regarding precipitation, temperature, and lightning in Bhutan, Bangladesh, Nepal, and Pakistan up to two days in advance; (2) the Flash Flood Prediction Tool (FFPT) for discharge forecasts, specifically of rivers prone to flash floods, across Bangladesh and Nepal up to two days in advance; (3) the Streamflow Prediction Tool (SPT), specifically designed for predicting the discharge of larger rivers in Bangladesh, Bhutan, and Nepal up to 10 days in advance; for weather and river discharge forecasts across Nepal using estimates from the HIWAT and FFPT tools.

This Outlook is best used to bolster readiness, such as reviewing contingency plans, releasing preparedness funds, and pre-positioning supplies, in advance of the short-range forecasts that will guide responses.

Annexes

The following maps (Figures 3–5), representing long-term average conditions (‘climate normal’), provide an overview of typical patterns in precipitation, and 2 m minimum and maximum temperatures during the winter season (November to February), for an overall understanding of what this season usually looked like in the HKH region. These maps are based on 15 years’ data (from 2010 to 2024) generated using the HKH-S2S forecast system.

FIGURE 3: **LONG-TERM AVERAGE PRECIPITATION FOR THE WINTER SEASON (NDJF) BASED ON THE HKH-S2S HINDCAST FOR 2010–2024**

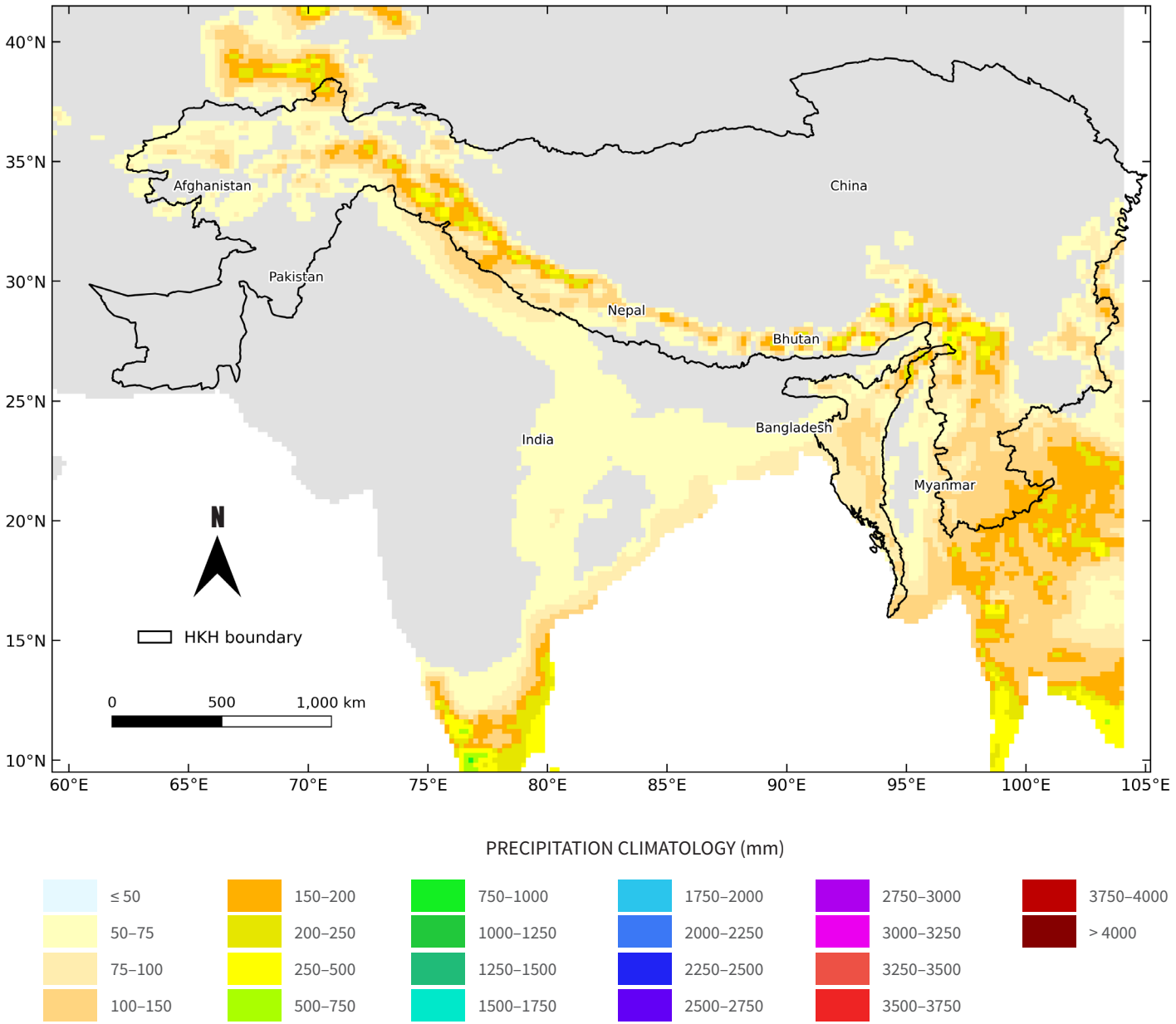


FIGURE 4: **LONG-TERM AVERAGE 2 m MINIMUM TEMPERATURE FOR THE WINTER SEASON (NDJF) BASED ON THE HKH-S2S HINDCAST FOR 2010–2024**

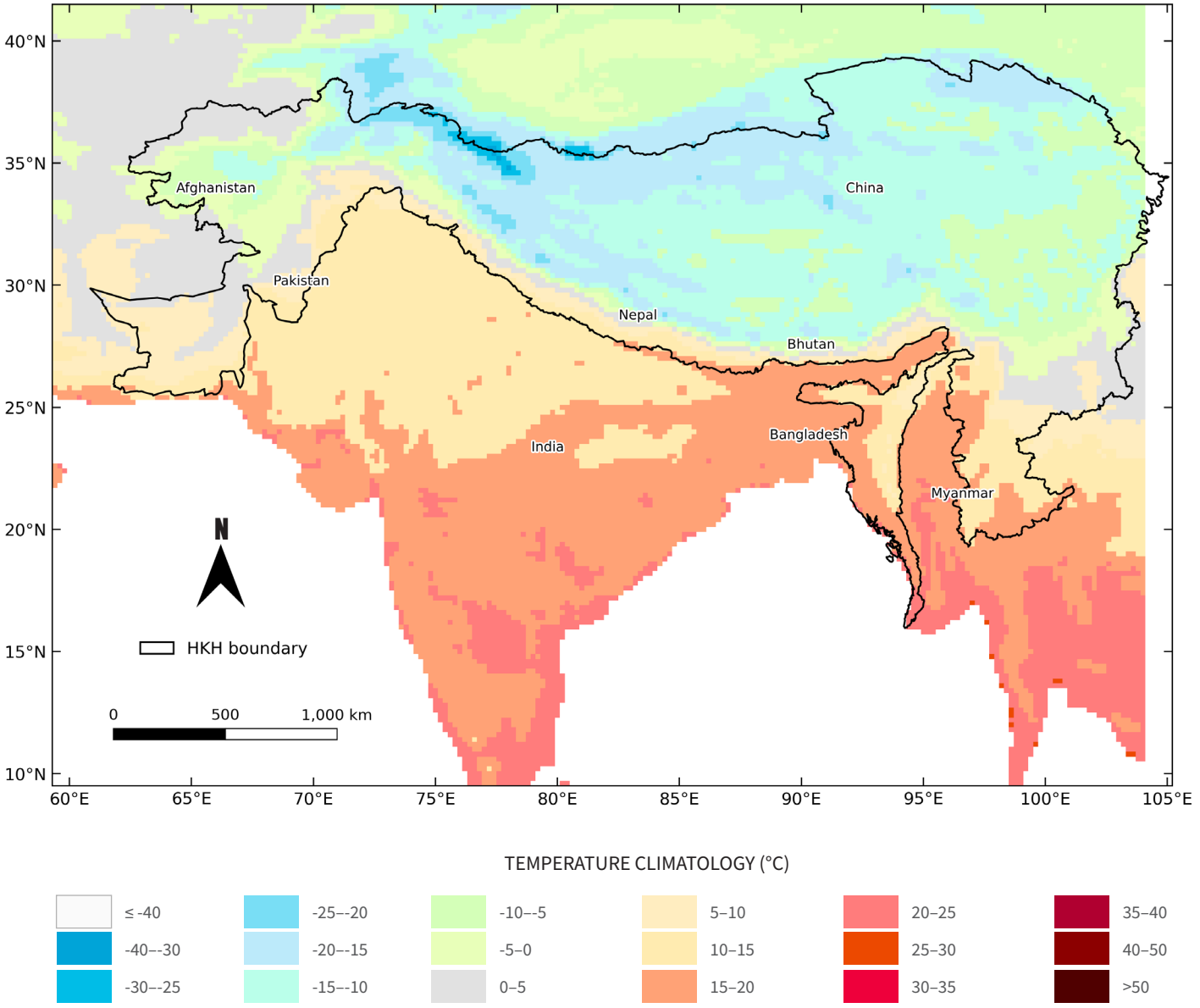
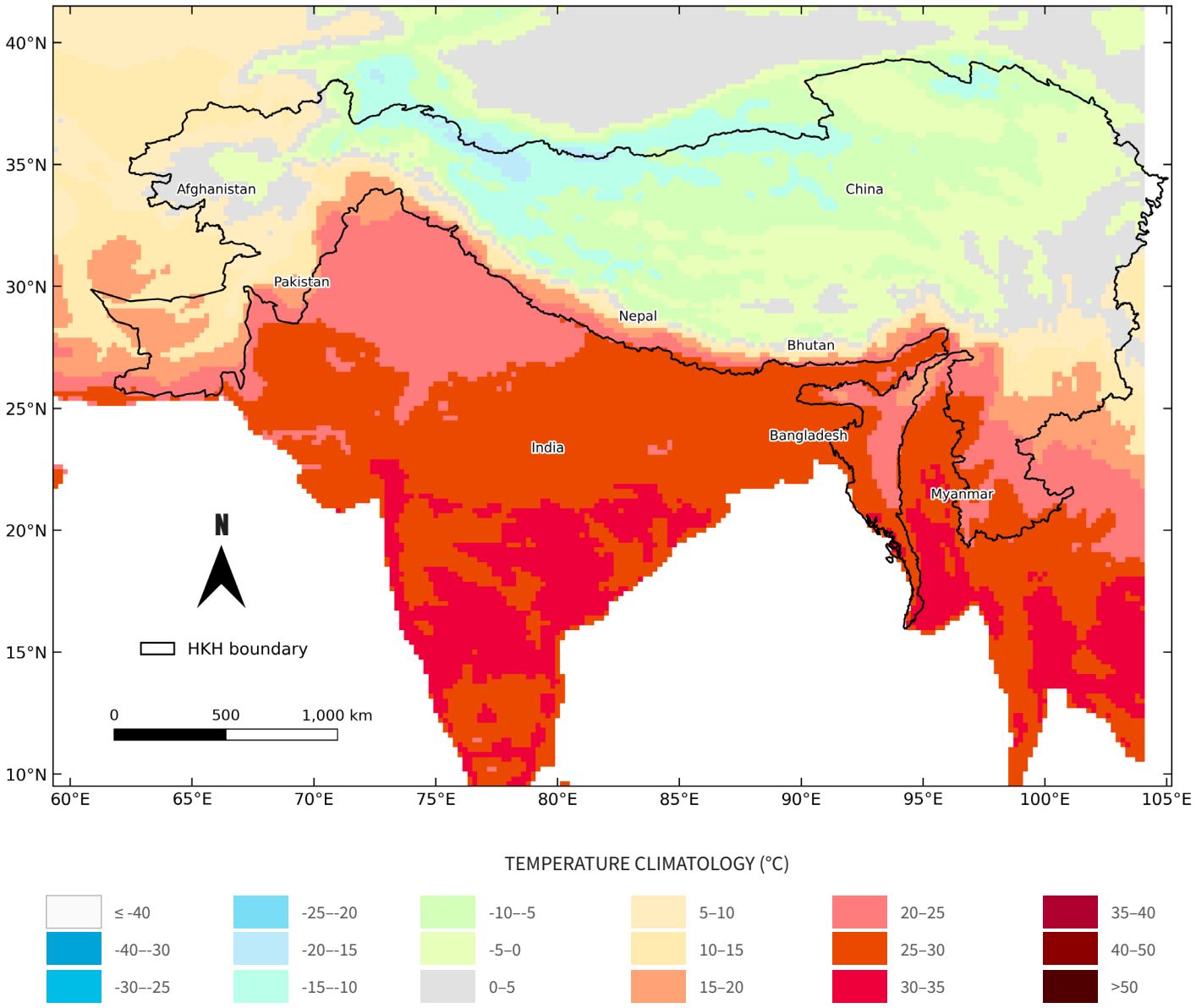


FIGURE 5: **LONG-TERM AVERAGE 2 m MAXIMUM TEMPERATURE FOR THE WINTER SEASON (NDJF) BASED ON THE HKH-S2S HINDCAST FOR 2010–2024**



References

Aditi, K., Pandey, A., & Banerjee, T. (2025). Forest fire emission estimates over South Asia using Suomi-NPP VIIRS-based thermal anomalies and emission inventory. *Environmental Pollution, 366,* Article 125441. https://doi.org/10.1016/j.envpol.2024.125441

Ballesteros-Cánovas, J. A., Trappmann, D., Madrigal-González, J., Eckert, N., & Stoffel, M. (2018). Climate warming enhances snow avalanche risk in the Western Himalayas. *Proceedings of the National Academy of Sciences, 115*(13), 3410–3415. https://doi.org/10.1073/pnas.1716913115

Cannon, F., Carvalho, L. M. V., Jones, C., Hoell, A., Norris, J., Kiladis, G. N., & Tahir, A. A. (2017). The influence of tropical forcing on extreme winter precipitation in the western Himalaya. *Climate Dynamics, 48*(3–4), 1213–1232. https://doi.org/10.1007/s00382-016-3137-0

Coughlan de Perez, E., van den Hurk, B., van Alast, M., Jongman, B., Klose, T., and Suarez, P. (2015). Forecast-based financing: An approach for catalyzing humanitarian action based on extreme weather and climate forecasts. *Natural Hazards and Earth System Sciences, 15*(4), 895–904. https://doi.org/10.5194/nhess-15-895-2015

Coughlan de Perez, E., Stephens, E., Bischiniotis, K., van Alast, M., van den Hurk, B., Mason, S., Nissan, H., & Pappenberger, F. (2017). Should seasonal rainfall forecasts be used for flood preparedness? *Hydrology and Earth System Sciences, 21*(9), 4517–4524. https://doi.org/10.5194/hess-21-4517-2017

Hunt, K. M. R., Baudouin, J.-P., Turner, A. G., Dimri, A. P., Jeelani, G., Pooja, R. C., Cannon, F., Arulalan, T., Shekhar, M. S., Sabin, T. P., & Palazzi, E. (2025). Western disturbances and climate variability: A review of recent developments. *Weather and Climate Dynamics, 6*(1), 43–112. https://doi.org/10.5194/wcd-6-43-2025

Li, Y., Sun, F., Chen, Y., Fang, G., Li, Z., Duan, W., Qin, J., Zhang, X., & Li, B. (2025). Unraveling the complexities of rain-on-snow events in High Mountain Asia. *npj Climate and Atmospheric Science, 8*(1), Article 118. https://doi.org/10.1038/s41612-025-00943-y

Maina, F. Z. & Kumar, S. V. (2023). Diverging trends in rain-on-snow over High Mountain Asia. *Earth's Future, 11*(3), Article e2002EF003009. https://doi.org/10.1029/2022EF003009

World Meteorological Organisation (2026). El Niño set to become very strong, raising risks of extreme weather into 2027. WMO. https://wmo.int/news/media-centre/el-nino-set-become-very-strong-raising-risks-of-extreme-weather-2027

About ICIMOD

The Hindu Kush Himalaya (HKH) region stretches 3,500 km across Asia, spanning eight countries – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan. Encompassing high-altitude mountain ranges, mid-hills, and plains, the HKH is vital for the food, water, and energy security of up to two billion people and provides a habitat for innumerable irreplaceable species. It is also extremely fragile and vulnerable to the impacts of the triple planetary crisis of climate change, pollution, and biodiversity loss. The International Centre for Integrated Mountain Development (ICIMOD), based in Kathmandu, Nepal, is an international knowledge organisation focused on the HKH region, working since 1983 to support green, inclusive, and climate-resilient development. Our work is guided by our Strategy 2030, Medium-Term Action Plan V (2023–2026), and the associated Results Framework, and our various policies. Learn more on our website.

About BNU

Beijing Normal University (BNU), established in 1902 and which includes its Department of Geography established in 1928, is a leading institution in geosciences and disaster risk research in China. BNU advances research on natural hazards, hazard monitoring, risk assessment, forecasting, and early warning systems via its State Key Laboratory of Earth Surface Processes and Disaster Risk Reduction. The university collaborates with international organisations, including the WMO and UNESCO, to strengthen meteorological disaster risk reduction. Its research and operational services contribute to disaster preparedness, emergency responses, climate adaptation, and sustainable development. Learn more on our website.

About IAP-CAS

The Institute of Atmospheric Physics, Chinese Academy of Sciences (IAP-CAS), established in February 1928 as the institute of Meteorology of Academia Sinica, was the first research centre engaged in meteorological research in modern China. The IAP-CAS now researches all aspects of the atmospheric sciences, and is committed to conducting cutting-edge research into the interactions between the physical, chemical, and biological processes in the atmosphere and other components of the Earth system. It aims to advance theoretical knowledge, and develop new methods and technologies to advance the monitoring and forecasting of weather, climatic, and environmental conditions. Focusing on furthering both scientific and technological advancement and China's strategic needs, its research promotes the development of meteorology, marine resources, the ecological environment, agriculture, aerospace, water conservation, resources, and healthcare. Its research contributes to disaster risk reduction and mitigation, addresses global changes, and promotes the sustainable development of the economy and society. Learn more on our website.

BNU acknowledges funding support from the National Natural Science Foundation of China (NSFC) (No. 42475022). IAP–CAS acknowledges funding support from the NSFC for the HI-Rain project (No. W2412139), implemented in collaboration with ICIMOD, Dalian Maritime University, China, the Department of Hydrology and Meteorology, Nepal, and the Department of Local Governance and Disaster Management, Bhutan. The project forms part of the Seamless Prediction and Services for Sustainable Natural and Built Environments (SEPRESS) programme, led by the Hong Kong University of Science and Technology, and is endorsed by UNESCO's International Decade of Sciences for Sustainable Development and the WMO's World Weather Research Programme.

ICIMOD and its Regional Member Countries gratefully acknowledge the generous support of Austria, Norway, Sweden and Switzerland for core and programme funding, and the Adaptation Fund, Australia, Canada's International Development Research Centre, the European Union, Finland, Germany, Global Affairs Canada, Japan's Sasakawa Peace Foundation, the United Kingdom, and the World Bank for project funding.

© ICIMOD 2026

International Centre for Integrated Mountain Development
GPO Box 3226, Kathmandu, Nepal
T +977 1 5275222 | E info@icimod.org | www.icimod.org