Development of Indicators for the Global Goal on Adaptation: A Focus on the Hindu Kush Himalaya Region

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Abstract

The Global Goal on Adaptation (GGA), as reflected under the United Nations Framework Convention on Climate Change (UNFCCC), aims to enhance the adaptive capacity of nations facing the impacts of climate change. While the GGA emphasises tracking progress and providing support through thematic indicators, it is critical to have more context-specific indicators to address the unique vulnerabilities of certain ecosystems, such as mountain regions.

The Hindu Kush Himalaya (HKH) region is highly sensitive to climate change, with glacial melt, changing weather patterns and other environmental stresses leading to significant negative socio-economic impacts.

This paper focuses on the adaptation challenges and the vulnerabilities faced by communities in the HKH region. By reviewing existing work on the development of indicators for the GGA, and exploring the potential for integrating mountain-specific indicators, this paper contributes to a more comprehensive, inclusive and globally relevant framework for climate adaptation.

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Introduction

Climate change poses significant challenges to ecosystems and communities across the globe, with particularly devastating effects on mountain regions. In the context of the UNFCCC, the GGA was established as a mechanism to assess and accelerate progress in adapting to climate change.
The GGA focuses on tracking the progress of adaptation actions, and enhancing support for nations in addressing the impacts of climate change (United Nations Framework Convention on Climate Change. (n.d.)., 2023). As countries prepare for COP 30 and further UNFCCC processes, there is a growing recognition of the need to develop more nuanced and context-specific adaptation indicators. One such context is the vulnerability of mountain ecosystems, and the specific adaptation needs of mountain communities.

The HKH region, often referred to as the "Third Pole", is home to over 240 million people and contains critical sources of food, water, energy and biodiversity (Oli & Pandey, 2024). It faces unique challenges, including the rapid melting of glaciers, erratic weather patterns, and the vulnerability of local communities who depend on these fragile ecosystems.

Incorporating mountain-specific indicators into the GGA framework could address these vulnerabilities by enabling a better understanding of the adaptation action gaps, better tracking of adaptation efforts, and inform specific adaptation-related decisions in the region.

This paper explores the development of such indicators, reviews existing adaptation actions in the HKH region, and proposes new, mountain specific indicators to address these unique challenges.

Mountain Ecosystems and Climate Vulnerability: The HKH Region

The Inter-governmental Panel on Climate Change (IPCC) assessment findings from over the years - such as the special report on the ocean and cryosphere in a changing climate, and the cross-chapter on mountains in the Sixth Assessment Report (AR6) Working Group II - studied the vulnerability of mountain regions to climate change, highlighting significant impacts (Hock et al., 2019, Adler et al., 2023).

Changes in Cryosphere

The retreat of mountain glaciers around the world creates more glacial lakes and increases ground instability, contributing to sea-level rise and reducing the availability of water in the mountains and downstream. The region is undergoing rapid and largely irreversible cryospheric changes caused by climate change.

Glaciers in the HKH are retreating at a faster rate, with forecasts of up to 80% glacial volume loss by 2100, based on current emission trends (Molden et al., 2022). While initial glacial melt enhances water flow, in the long-term it endangers agriculture, hydropower and drinking water supply for millions downstream. Melting glaciers and permafrost damage mountain slopes, increasing the frequency and severity of landslides, rockfalls and glacial lake outburst floods (GLOFs). Approximately 200 glacial lakes are now considered at risk (Byers et al., 2022).

Ecosystem and Biodiversity Loss

The HKH region is one of the most diverse, extensive and unique mountain ecosystems of the world. Its vast mountain range spans eight countries: Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan. The region is crucial to both global and regional environmental systems, and is home to major river systems, glaciers and diverse ecosystems that provide critical services, such as water, food and biodiversity.

It provides essential ecosystem services to over 1.9 billion people in mountains and downstream communities of South Asia, supporting agriculture, hydropower and tourism industries that are vital to the region's economy. The region is also a biodiversity hotspot, and comprises a wide array of endemic species and unique ecosystems.

Climate change, compounded by pressures such as deforestation and land degradation, is significantly threatening biodiversity. Ecosystems are under threat from degradation, species loss and habitat alterations, especially since 67% of the HKH's ecoregions and 39% of its biodiversity hotspots are located outside of protected areas (Premlata et al., 2024).

Cold-adapted species are more vulnerable to habitat loss and extinction. Mountain communities, which rely primarily on agriculture and tourism, are experiencing economic hardship, displacement and psychological

effects because of changing landscapes, water scarcity and frequent natural disasters. This diminished biodiversity weakens the region's capacity to adapt to changing climate conditions, further exacerbating the challenges faced by its inhabitants.

Adaptation in the HKH Region and the Need for Monitoring

The HKH region faces different climatic conditions and a diverse set of threats from climate change. In line with mainstreaming adaptation actions alongside sustainable development, each country has developed tailored strategies that align with their specific vulnerabilities (ICIMOD, 2023).

These priorities are articulated through National Adaptation Plans (NAPs), which focus on a range of topics, from improving water management, enhancing agricultural resilience, protecting biodiversity and building disaster resilience to fostering climate-resilient infrastructure.

The key adaptation actions include promoting sustainable livelihoods, supporting climate-smart agriculture, strengthening early warning systems, and ensuring the participation of local communities in adaptation decision-making processes (Mishra et al., 2019a).

A study of these NAPs shows some of the key vulnerabilities, adaptation priorities and examples of adaptation strategies of the HKH countries, summarised in the table below.

Country	Illustrative Adaptation Priorities	Adaptation Strategies (examples)
Afghanistan	Desertification, water management, agricultural resilience, disaster risk reduction	Improving irrigation systems, promoting drought-resistant crops, restoring degraded lands, strengthening early warning systems (Islamic Republic of Afghanistan, 2009).
Bangladesh	Water resources, social safety and security, agriculture, fisheries and livestock, ecosystems and biodiversity	Protection from disasters and extreme events, development of climate resilient agriculture, promotion of nature-based solutions (Government of Bangladesh, 2023).
Bhutan	Water, agriculture and livestock, forests and biodiversity, health, and disaster risk reduction	Enhancing policy and institutional support, robust monitoring and evaluation (M&E) process, strengthening of research and data, capacity building (Kingdom of Bhutan, 2023).

Country	Illustrative Adaptation Priorities	Adaptation Strategies (examples)
China	Ecosystems including terrestrial resources, water resources and marine and coastal zones; food security	Monitoring of critical ecosystems, improvement of climate change observation network, integrated disaster risk management, water management (Chinese Ministry of Ecology and Environment, 2022).
India	Crop Improvement, Forestry, Water, Disaster Management	Eight Climate Missions, including National Mission for Sustaining the Himalayan Ecosystem and National Mission on Strategic Knowledge on Climate Change (Ministry of Environment, 2018).
Myanmar	Agriculture, forestry, public health, water resources, biodiversity	Climate resilient Agriculture, Community-based Reforestation, mainstreaming ecosystem-based adaptation (Republic of the Union of Myanmar, 2009).
Nepal	Agriculture and food security, forests, biodiversity and watershed management, health, disaster risk reduction	Multiple strategies across priority areas promoting climate resilient agriculture, integrated watershed management, promoting sustainable agriculture through agroforestry (Government of Nepal, 2021).
Pakistan	Agriculture water nexus, natural capital, disaster risk reduction	Multiple strategies across priority areas promoting climate smart water and agriculture practices, mainstreaming sustainable land management into ecosystem resilience (Government of Pakistan, 2023).

Gaps and Need for Monitoring

Adaptation efforts are crucial for helping communities in the HKH region cope with the growing impacts of climate change. However, these efforts must be elevated to address the increasing climate challenges and ensure long-term resilience.

A key issue is the lack of comprehensive, localised data collection systems, which hampers the ability to track climate impacts and adaptation progress. The absence of baseline data, particularly in remote mountainous areas, makes it difficult to assess the effectiveness of adaptation actions (Malik & Ford, 2025).

Additionally, there is no standardised monitoring framework across HKH countries, making it challenging to compare progress or co-ordinate efforts. Long-term monitoring and evaluation mechanisms are also lacking, leaving

gaps in understanding the sustainability of local adaptation strategies (Mishra et al., 2019).

These challenges hinder the effective implementation of National Adaptation Plans and climate resilience efforts. Strengthening data collection, technical capacities, and co-ordination, while engaging communities, is essential for creating sustainable, effective adaptation strategies. The Global Goal on Adaptation can help address these gaps.

The Global Goal on Adaptation (GGA) and Indicators

The landmark 2015 Paris Agreement established the GGA, to develop "adequate adaptation response(s)" to the "global temperature goal", leading to enhanced adaptive capacities, the strengthening of resilience and the reduction of vulnerabilities to climate change (United Nations Framework Convention on Climate Change, 2015).

Under the Paris Agreement, Parties are required to contribute to periodic stocktakes, reviewing the adequacy and effectiveness of adaptation efforts, as well as evaluating progress towards achieving the global adaptation goal. By tracking adaptation progress, enhancing co-ordination, and mobilising resources, the GGA strengthens climate resilience.

Despite its significance, it took six years of consistent advocacy from developing countries to bring the GGA into mainstream negotiations. This culminated in the Glasgow–Sharm el-Sheikh Work Programme at COP 26, aimed at fast-tracking the GGA's operationalisation, followed by the launch of the UAE Framework on Global Climate Resilience at COP28. Under this framework, Parties initiated the two-year UAE–Belém Work Programme to develop GGA indicators.

Progress and Plans for the GGA

Since 2022, the GGA has gained momentum, with significant progress on adaptation indicator definitions and methodologies, facilitated by the Glasgow-Sharm el-Sheikh and UAE-Belém work programmes.

The GGA framework, under the UAE Framework for Global Climate Resilience, includes 11 global adaptation targets to be met by 2030, with seven thematic targets—water, health, biodiversity, food, infrastructure,

poverty and culture—and four targets for the adaptation cycle: Climate risk assessments, planning, implementation and monitoring (United Nations Framework Convention on Climate Change, 2022).

These targets will be measured through a series of indicators, currently being developed by 78 technical experts, including from Bhutan and ICIMOD (United Nations Framework Convention on Climate Change, 2021).

The indicators of the GGA framework, which are currently under discussion and are being narrowed down by the expert group, serve as a comprehensive tool to assess adaptation progress (Leiter, 2024). The development of these indicators has been a collaborative process, involving input from a diverse range of stakeholders, including countries, international organisations and scientific communities, to ensure that the indicators are globally relevant while being flexible enough to reflect local context.

The work on the indicators involves mapping and compiling of existing indicators by the Adaptation Committee and finalisation of no more than 100 indicators, including development of new indicators by the Expert group to be adopted at COP 30 in Belem, Brazil in November 2025.

Importance of Mountain-Specific GGA Indicators

While GGA targets are global ambitions and require progress to be measured at that level, it is important to highlight the local and context-specific nature of adaptation needs and interventions. While national indicators capture national circumstances, the GCA should also incorporate context-specific indicators, particularly in areas that face distinct and disparate vulnerabilities.

For example, mountain ecosystems have unique environmental, socio-economic and cultural characteristics that may not be fully addressed by generalised indicators. Instead, they need adaptation indicators that are sensitive to mountain vulnerabilities, such as glacial melt, water scarcity and biodiversity loss.

Developing Mountain-Specific Indicators for the GGA Framework from HKH Region

The development of mountain-specific climate adaptation indicators can build on existing frameworks, such as the GGA indicators, which already incorporate elements of the UNFCCC adaptation reporting framework. This process focuses on vulnerability assessments, adaptation planning, and the integration of measures into national policies.

Insights from other Global Processes and other Regions

The Sustainable Development Goals (SDGs), particularly SDG 13 on climate action, help develop metrics like national adaptation plans and climate policy integration (Fuldauer et al., 2022). These frameworks can be refined for mountain contexts to create specific indicators, such as biodiversity conservation, glacial melt monitoring, and the resilience of mountain infrastructure. The Sendai Framework for Disaster Risk Reduction can also be utilised to address the increased disaster vulnerability of mountain communities (Zimmermann & Keiler, 2015).

Regional examples from mountain regions worldwide can provide valuable insights for developing mountain-specific indicators. In the Alps, adaptation indicators track the impacts of glacier retreat on water resources, agriculture, and tourism (Salim & Ravanel, 2023).

In the Andes, indicators focus on community-based adaptation strategies, integrating traditional knowledge into climate planning and ecosystem restoration (Dupuits et al., 2022). The Rocky Mountains use indicators to monitor forest health and the impact of frequent wildfires due to climate change (Halofsky et al., 2017).

These examples emphasise the need to monitor mountain ecosystem variables, like glacier dynamics, water security, and biodiversity, alongside the socio-economic impacts of climate change on local populations.

HKH GGA thematic focus

Although, all GGA thematic areas are relevant to the HKH, the specific context of the region focuses mainly on the following thematic areas: Water, health, biodiversity, food, infrastructure and poverty, with mountain-specific indicators being crucial in assessing the region's unique climate challenges.

Water resources are a critical focus, especially for mountain regions reliant on glacier-fed rivers and snowmelt. Glacial dynamics and river flow indicators can aid in tracking both water availability and community safety (Milner et al., 2009).

Agriculture and livelihoods also fall under the GGA, where adaptation is for strengthening food security and climate resilience. Key indicators might include mountain cropping patterns, water management practices, and the effects of migration (Tarolli & Straffelini, 2020). These would help assess the changing nature of agriculture in mountain regions globally.

Biodiversity is another crucial thematic area, especially in mountain ecosystems that host unique and vulnerable species. Monitoring species distribution, habitat quality, and ecosystem health is essential in regions like the HKH, where habitat degradation and invasive species threaten endemic biodiversity (Premlata et al., 2024).

Disaster risk reduction is also a priority, as climate change increases the frequency of extreme events like landslides and floods. Indicators on disaster preparedness, resilience, and early warning systems are critical for monitoring adaptation efforts in these areas (Mishra et al., 2019).

Health and well-being are equally important, particularly in regions where changing climates affect the availability of water and increase the risk of diseases. Health indicators, such as the prevalence of climate-related diseases and the accessibility of healthcare, are essential for tracking adaptation progress and ensuring that mountain communities can manage the health impacts of climate change (Dhimal et al., 2023). These indicators can all be integrated into the GGA framework to support the global monitoring of adaptation in mountain regions.

The following table highlights how the existing targets and thematic areas under the GGA can highlight mountain-specific targets and indicators, as pointed out in submissions made by the ICIMOD and Bhutan to the UAE-Belem Work Programme in 2024 (Maharajan & Hussain, 2021).

Thematic Area	Global Target	Potential Mountain-specific Target	Potential Mountain-specific Indicators
Water	Significantly reducing climate-induced water scarcity and enhancing climate resilience to water-related hazards towards a climate-resilient water supply, climate-resilient sanitation and towards access to safe and affordable potable water for all	Number of mountain communities facing water stress decreased by 30% At least 30% increase in development and implementation of springs management plans in the mountains Enhanced resilience of mountain water resources by managing meltwater from glaciers and snowpack for water supply in dry seasons	Number of mountain springs revival Change in number of water accessibility populations Changes in mountain glacier mass balance, permafrost, and snowpack Change in the extent of mountain spring shed ecosystems over time Trends in the proportion of mountain land under drought over the total land area
Food Security	Attaining climate-resilient food and agricultural production and supply and distribution of food, and increasing sustainable and regenerative production and equitable access to adequate food and nutrition for all	Reduced prevalence of undernourishment and malnutrition in the mountains with more focus on women and marginalised groups Improved productivity and income of small-scale farmers through sustainable, resilient and inclusive practices in mountains. Improved diversities in production systems and diets in mountain areas. Improved investment in infrastructure, research, technology and solutions for mountain food systems.	% mountain population with access to diverse and healthy diets % reduction in post-harvest losses in mountain agriculture. % population of pastoralists and communities with difficult farming conditions covered under social protection programmes on food and livelihood security % increase in productivity and income of small farms in mountains % of abandoned/un-utilised agricultural land in mountains brought under cultivation of diverse crops

Thematic Area	Global Target	Potential Mountain-specific Target	Potential Mountain-specific Indicators
			% of agricultural land in mountains with improved irrigation Number of climate resilient, inclusive and regenerative solutions related to water, soil health, pests and renewable energy scaled in mountain agriculture % population of women and marginal groups engaged in agricultural value chains in mountains % households living in vulnerable mountain areas to climatic risks covered by the crop insurance scheme % agricultural area in mountains under future smart crops and drought resistant crop varieties Number of resilient livestock species promoted in mountain areas Length of roads (in km) built and improved to strengthen the access of mountain farmers to market and collection centers Investment (in USD) made in food value addition related infrastructure in mountains Quantity of agricultural loss to diseases

Thematic Area	Global Target	Potential Mountain-specific Target	Potential Mountain-specific Indicators
Biodiversity	Reducing climate impacts on ecosystems and biodiversity and accelerating the use of ecosystem-based adaptation and nature-based solutions, including through management, enhancement, restoration and conservation and the protection of terrestrial, inland water, mountain, marine and coastal ecosystems.	At least 30% of the fragile cryosphere dependent ecosystems such as high-altitude rangeland and wetlands, mountain forest and riverine ecosystems are restored to enhance resilience.	Change in mountain green cover index Change in mountain ecosystem productivity (rangeland, forests, agriculture) through mountain specific nature-based solutions/ecosystem-based adaptation and restoration Changes in health of glacier-fed ecosystem Change in population status of mountain endemic species Increase in mountain protected areas and Other effective area-based conservation measure (OECMs) along with connectivity Proportion of degraded mountain ecosystems restored
Infrastructure	Increasing the resilience of infrastructure and human settlements to climate change impacts to ensure basic and continuous essential services for all, and minimising climate-related impacts on infrastructure and human settlements	Increased investments to effectively manage waste, enhanced adaptive capacity, increase green open areas to build ecosystem resilience in the mountains Enhanced infrastructure resilience to cryosphere-related hazards caused by glacier and permafrost changes	Multi-hazard risk zones developed for mountain areas to identify safe and high-risk areas Number of people moved to safe areas in mountain Number of early warning systems instituted in prone and vulnerable mountain areas to multi-hazards Decrease number of deaths from climate climate-related impacts on infrastructure and mountain settlements Proportion of local governments in mountain areas that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies

Thematic Area	Global Target	Potential Mountain-specific Target	Potential Mountain-specific Indicators
Health	Attaining resilience against climate change related health impacts, promoting climate-resilient health services, and significantly reducing climate-related morbidity and mortality, particularly in the most vulnerable communities	Reduced mortality rates of mountain communities resulting from air and water pollution Minimise human-wildlife interaction to prevent pandemics Reduced health impacts related to cryosphere such as due to meltwater contamination	Change in water, air pollution and vector born related deaths in the mountains and downstream Number of local governments practicing one health concept Incidence of health issues related to cryosphere changes such as waterborne diseases due to meltwater from glaciers and permafrost thaw Decrease in incidents of human wildlife interaction in and around mountain protected areas and corridors
Poverty	Substantially reducing the adverse effects of climate change on poverty eradication and livelihoods, by promoting the use of adaptive social protection measures for all.	Human, economic and ecosystem losses are minimised from climate change using mountain specific nature-based solutions and ecosystem-based adaptations. Number of deaths, missing persons, and directly affected persons attributed to cryosphere and other-related disasters in mountains per 100,000 population Direct economic loss attributed to cryosphere-related and other mountain disasters	Change in number of GLOFs, avalanches, landslides, and flash floods Change in loss and damage value including human and economic losses Number of mountain specific adaptation plans in place Measure economic losses caused by glacier melting, permafrost thaw, and snowpack changes in mountain regions. Number of early warning and disaster management plans in place The proportion of degraded mountain ecosystems restored and connectivity between the protected areas and isolated habitats connected.

Thematic Area	Global Target	Potential Mountain-specific Target	Potential Mountain-specific Indicators
Culture	Protecting cultural heritage from the impacts of climate-related risks by developing adaptive strategies for preserving cultural practices and heritage sites and by designing climate-resilient infrastructure, guided by traditional knowledge, Indigenous peoples' knowledge and local knowledge systems.	The shared cultural and natural heritages of mountains preserved by promoting and strengthening traditional climate change adaptation practices	Number of culturally important sites and natural heritages in mountains promoted and strengthened in their management effectiveness. Number of preventive measures taken for preservation of traditional knowledge and practices contributing to cultural and natural heritages Mountain heritage preservation policy in place and functional with positive results A strategy developed and implemented on sustainable and climate resilient tourism in culturally important sites in the mountains.

The Role of Bhutan and Other HKH Countries in the UNFCCC Process

Bhutan played a pivotal role at COP 28 in anchoring mountains into the GGA and Global stocktake (GST) decisions. Building on this leadership and momentum, Bhutan has the expertise, programmes and visibility to contribute to this process. HKH countries can play a crucial role in the UNFCCC process by leveraging their internal adaptation frameworks to support the development of mountain-specific indicators for the GGA.

COP 30 will be a pivotal moment for global climate adaptation, marking the completion of the UAE–Belém Work Programme on Indicators. A group of 78 experts, including representatives from UN bodies, regional organisations, and parties, will present a list of 100 indicators for adoption at the conference. Notably, experts from Bhutan and ICIMOD, representing the HKH region, are among those selected, providing an opportunity to propose unique, mountain-specific indicators.

Way Forward

These indicators must reflect the specific environmental, social and economic contexts of mountain regions. Bhutan, with its Gross National Happiness framework, which emphasises environmental sustainability and resilience, is well-positioned to advocate for indicators addressing mountain ecosystem vulnerabilities (Islam et al., 2022).

Additionally, countries in the HKH can leverage existing national monitoring systems, such as disaster risk assessments, to develop a more localised, effective approach to adaptation. By sharing knowledge and best practices, HKH countries can address common challenges, like managing glacial lakes or improving mountain agriculture resilience.

Bhutan's experience in integrating climate change adaptation into its policies can offer valuable lessons to its neighbours.

Developing mountain-specific indicators will require strong institutional frameworks for consistent data collection and analysis. Bhutan's robust climate adaptation governance could serve as a model for expanding efforts to monitor mountain vulnerabilities, such as glacial melt or land

degradation. This would contribute to a comprehensive evidence base for the GGA framework, enhancing global adaptation strategies.

Ultimately, the creation of mountain-specific indicators will increase the HKH region's influence in global climate policy, attracting international support and resources for climate resilience, and ensuring mountain communities are not left behind in global adaptation efforts.

Integrating mountain-specific indicators into the Global Goal on Adaptation (GGA) framework is crucial for accurately measuring, tracking adaptation progress and enhancing support for adaptation efforts in these vulnerable regions.

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