MOUNTAINS AND CLIMATE CHANGE

A Need for Mountain Perspectives

Impacts of Climate Change on Ecosystem Services in the Hindu Kush – Himalayas

Environmental Change and Ecosystem Services

International Centre for Integrated Mountain Development (ICIMOD), Kathmandu, Nepal

ICIMOD

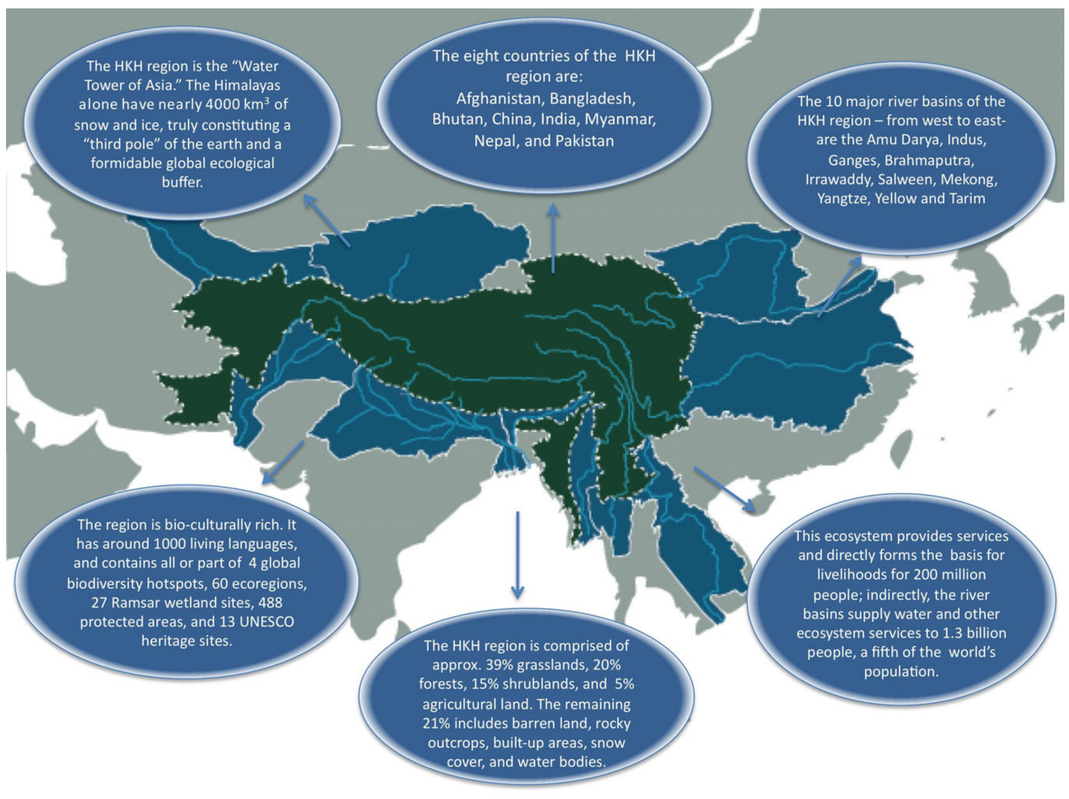
FOR MOUNTAINS AND PEOPLE

Mountains and Climate Change

Mountains occupy 24% of the global land surface areas, and are home to 12% of the world's population. About 10% of the worlds population depends directly on mountain resources for their livelihood and wellbeing, and an estimated 40% depends indirectly on them for water, hydroelectricity, timber, biodiversity, and other ecosystem services. Increasing awareness is highlighting the impact of climate change on mountains. Recent evidence confirms these highly fragile ecosystems are experiencing accelerated rates of change, with potentially significant consequences for the rest of the world. Source: Schild 2008

Ecosystem Services in Hindu Kush-Himalaya (HKH) Region

The HKH (over 4.3 million km^2) stores a large volume of water in the form of ice and snow, and regulates the flow of the ten major river systems in the region. It is endowed with rich natural resources and global biodiversity hotspots, providing many ecosystem services directly to the 200 million people living in the HKH, and indirectly to the 1.3 billion people living downstream, with the number of people benefitting from food and energy produced in the river basins totaling 3 billion people. Recently, changes in the river systems and their basins have directly impacted on the wellbeing of billions of people.



Climate Change in the HKH

The HKH region has shown consistent trends in overall warming over the past 100 years. Studies in Nepal and China have shown that temperatures are rising at higher rates in high altitude areas than in other areas. With rising temperatures, the areas covered by permafrost and glaciers are decreasing in much of the region. Many of the Himalayan glaciers are receding at a rate faster than the world average. In many areas, a greater proportion of total precipitation appears to be falling as rain. As a result, snowmelt begins earlier and winters are shorter This affects river regimes, ecosystems services including water supply, agro-ecological adaptations, and livelihoods, as well as causing natural disasters. In addition, this has significant implications for biodiversity and conservation efforts, as species ranges may shift outside of historical limits or existing biosphere reserves. Likewise, the spread of invasive species and pathogens has been exacerbated by climate change, with significant impacts both on ecosystems and human health.

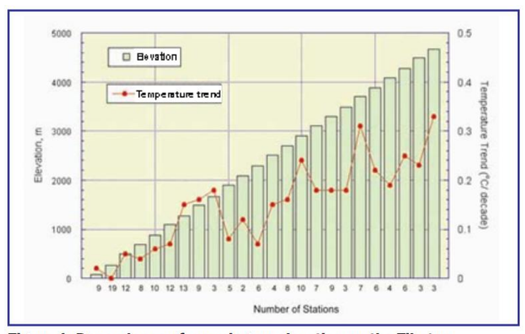
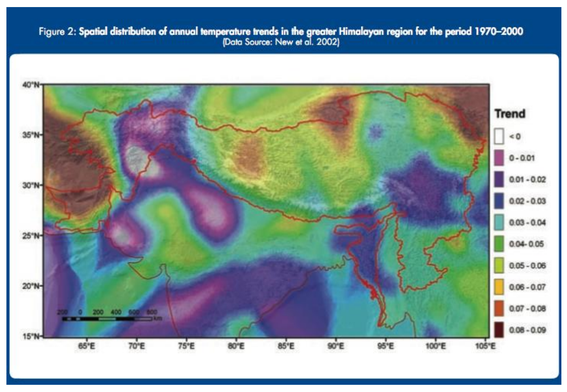


Figure 1: Dependence of warming on elevation on the Tibetan Plateau (Liu and Chen 2000)



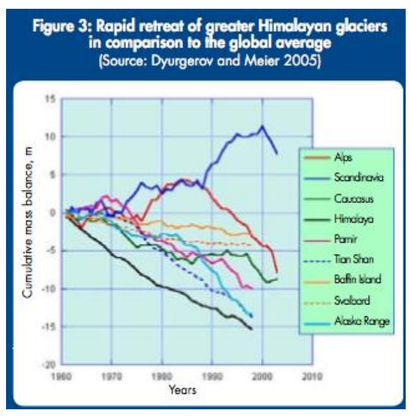


Table 4a: **Regional mean maximum temperature trends in Nepal from 1977–2000 (°C per year)**

Region	Seasonal				Annual
	Winter (Dec-Feb)	Pre-monsoon (Mar-May)	Monsoon (Jun-Sep)	Post-monsoon (Oct-Nov)	(Jan-Dec)
Trans-Himalayas	0.12	0.01	0.11	0.1	0.09
Himalayas	0.09	0.05	0.06	0.08	0.06
Middle Mountains	0.06	0.05	0.06	0.09	0.08
Siwaliks	0.02	0.01	0.02	0.08	0.04
Terai	0.01	0	0.01	0.07	0.04
All Nepal	0.06	0.03	0.051	0.08	0.06

Source: updated from Shrestha et al., 1999

Table 4b: **Average annual increase in temperature at different altitudes on the Tibetan Plateau and surrounding areas 1961–1990 (°C per decade)**

Altitude (m)	No. of stations	Spring	Summer	Autumn	Winter	Annual average change
<500	34	-0.18	-0.07	0.08	0.16	0.00
500-1500	37	-0.11	-0.02	0.16	0.42	0.11
1500-2500	26	-0.17	0.03	0.15	0.46	0.12
2500-3500	38	-0.01	0.02	0.19	0.63	0.19
>3500	30	0.12	0.14	0.28	0.46	0.25

Source: Liu and Hou 1998

1956 Photograph of Imja Glacier (Khumbu, NEPAL)
(Photo: Fritz Muller; courtesy of Jack Ives)

2006 Photograph of Imja Glacier (Khumbu, NEPAL)
(Photo: Kappenberger; courtesy of Alton C Byers)

Source: Erikson et al 2009

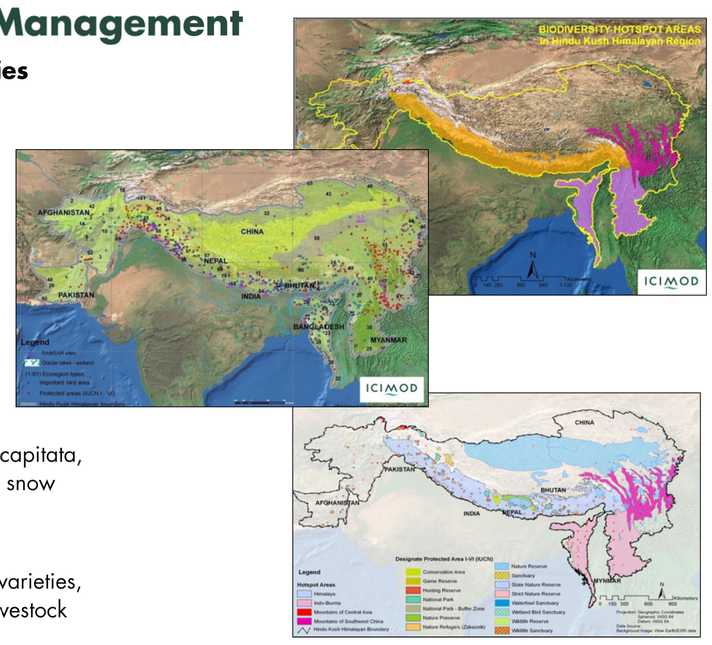
Biodiversity Conservation and Management

Sensitivity to Climate Change: Vulnerable Entities

- Global Biodiversity Hotspots (4 Hotspots cover 32% of HKH);
- Protected Areas - 488 (39% of HKH);
- Global 200 Ecoregions – 60 (30 critical & 12 represented)
- Important Bird Areas - 1106
- UNESCO Natural Heritage Sites - 3

Critical Ecosystem/Habitats:

- Ephemeral Habitats (seasonal)
- Riverine island ecosystems e.g. Majuli of Assam
- Wetlands and associated biodiversity
- Sub-alpine and alpine transition zones (ecotone)
- Sub-alpine and alpine meadows
- Transboundary areas



Critical, Threatened and Endangered Species:

Endemic species (Mantesia, Panax, Ilex khasiana, Osbekia capitata, insectivorous plants), Brahmaputra dolphins, alpine species, snow leopard, tiger, various jungle cats, musk deer

Genetic Diversity At Risk:

Upland variety of rice (dryland/wetland), indigenous bean varieties, cucurbits, citrus, medicinal plants, orchids, yaks and other livestock

Source: ICIMOD 2009 – MacArthur Foundation Project

Assessment of Climate Change Vulnerability of Ecosystems in Eastern Himalaya

Goal
Understand trends, perception and impacts of climate change on biodiversity in the Eastern Himalayas (EH)

Eastern Himalayas (EH)

Refers to the 524,190 sq km of area, stretched across 82.700 E-100.310E latitude and 21.950N-29.450N longitude, from eastern Nepal to Yunnan in China, incorporating whole of Bhutan and parts of India and Myanmar

Aim

- To understand climate change, threats and impacts on key physical and biological units.
- To understand peoples' perception on climate change.
- To explore research gaps to build future knowledge base on issues and policies related to climate change
- To bring stakeholders' ideas and opinions for future interventions

Methods used

- GIS and RS tools for maps
- Regional Climatic Models (HadRm2, PRECIS) based analysis
- Thematic white paper researches on biodiversity; climate-observed trends and projections; water; hazards; wetlands; and human well-being
- Questionnaire and interview based survey
- Thematic national and regional consultations

Major findings

Climatic trends/projections

- There is increased magnitude of warming with elevation, with areas >4000m experiencing the highest warming
- Observed warming is 0.01 to 0.06^{0}C yr^{-1}
- Annual mean temperature is expected to increase by 2.9^{0}C by the middle of the century
- HadRM2 gives projection of milder winter with enhanced precipitation

Potential Impacts

- Climate change impact in the EH to be more pronounced than global average
- Hydrological change to impact functions and services of wetlands
- Successional shift from wetlands to terrestrial ecosystem
- Increased degradation of peat land, bog, swamp and marshland
- Change in ecotone and microenvironmental endemism
- Vertical species migration and extinction
- Dominance of invasive and xeric species
- Reduced productivity of alpine and cryospheric ecosystems
- Reduced agrobiodiversity and their production, decline of genetic diversity

Vulnerable entities

- Region's economy less resilient to current climatic variability
- Stresses due to water scarcity, food security, water-borne diseases, GLOF, flash floods to increase communities vulnerabilities
- Isolated protected areas with little or no habitat connectivity
- Brahmaputra and Ganges river basin
- Riverine island, Ephemeral and cloud forest ecosystems, Alpine shrubs and meadows
- Agroecosystems in high altitudes of eastern Nepal, Sikkim, Bhutan, Arunachal Pradesh and TAR
- High altitude rangelands
- Endangered, restricted range species(endemic) and trans-Himalayan migratory birds

Peoples' Perception

- Perceived as a consequence of diverse human activities causing pressure on resources
- Associated in context to warming weather condition, hazards, outbreak of pests, food and water shortage
- Adoption towards change in cropping pattern
- Better farmland productivity in high altitude, less in lowlands
- Changes in phenology

Key Recommendations

- Build awareness and capacity of institutions and public to help respond to climate change impact and implications
- Improve knowledge base through applied climate change research and policy analysis to understand magnitude and direction of climate trends and impacts
- Support implementation of people oriented adaptation strategies into actions on ground and piloting
- Ensure long-term monitoring of climatic conditions and its impact on climate sensitive environmental and socio-economical units
- Implement ecosystem based integrated water resource management policy
- Adopt landscape approach to conservation and management of biodiversity promoting habitat connectivity through conservation corridors, reducing impact of non-climate stress on ecosystems
- Analyze and remold existing inter-sectoral policies to strengthen and support effective traditional and customary practices to cope and adapt to climate change

Source: ICIMOD 2009 – MacArthur Foundation Project

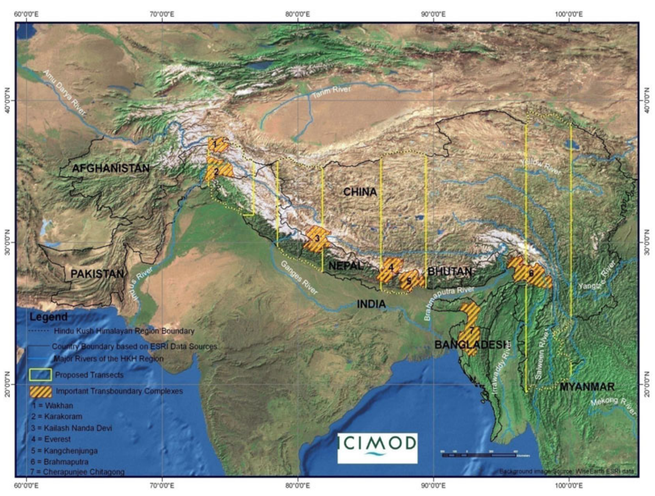
Trans-Himalaya Transect: The Need to Reduce Scientific Uncertainty in the HKH

- **HKH - Data 'White Spot'**

  IPCC Fourth Assessment reported that the HKH is a data deficit region (IPCC 2007), and high uncertainty for mountains in general, especially for the IPCC Climate Change Scenarios. Due to remote, rugged or otherwise difficult terrain, and lack of national resources, much of this region is poorly covered or not monitored by scientific efforts, including sparse data collection for meteorological, climatic, ecological, biodiversity, and socio-economic dimensions of environmental change.

- **Trans-Himalaya Transect Concept**

  A HKH regional network and sampling framework comprised of four north-south transects and seven trans-boundary landscapes, for coordinated long term monitoring of biodiversity, and ecological, environmental, and climatic change in the HKH region. Facilitation of an ongoing assessment of environmental impacts, biodiversity and other ecosystem components, and change processes associated with climatic and other environmental change.



The Need for a Mountain Perspective in the UNFCCC Post Kyoto Agreement

While climate change is a global problem requiring a global solution, mountain systems are particularly sensitive to climate change and must be considered separately. Climate change has emerged as the most prominent force in global change, however, it is embedded in a matrix of drivers including globalization, population growth, and local landuse change. This presents challenges in the disaggregation of climate change impacts and consequently, in the complexity involved in dealing with them. Generally, mountainous areas contribute very little to the output of carbon and other polluting gases. Instead they act as a central climate regulatory system, while at the same time being particularly affected by climate change. Responding to climate change in mountain regions calls for very specific tailor-made solutions. In particular, upcoming REDD agreements should take into consideration the unique attributes of mountain ecosystems. (Source: Schild 2008)

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