Mountains and Climate Change

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FOR MOUNTAINS AND PEOPLE

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

Mountains and climate change

Mountains occupy 24% of the global land surface area, and are home to 12% of the world's population. Most mountain people depend directly on mountain resources for their livelihood and wellbeing, and an estimated 40% of the world population depends indirectly on them for water, hydroelectricity, timber, biodiversity, and other ecosystem services. There is increasing awareness of the impact of climate change on mountains. These highly fragile ecosystems are experiencing accelerated rates of change, with potentially significant consequences for the rest of the world.

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 up to 3 billion people benefiting from food and energy produced in the river basins. Recently, changes in the river systems and their basins have directly impacted on the wellbeing of these people.

Climate change in the HKH

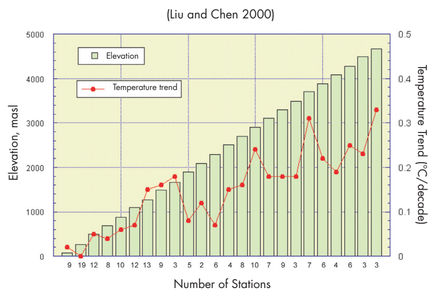
The HKH region has shown consistent trends in overall warming over the past 100 years. Studies in Nepal and China have shown that temperatures are rising at higher rates in high altitude areas. With rising temperatures, the areas covered by permafrost and glaciers are decreasing in much of the region. 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 reserves. Likewise, the spread of invasive species and pathogens has been exacerbated by climate change, with significant impacts both on ecosystems and human health.

ca.1956 Imja Glacier (Khumbu, Nepal) Photo: Erwin Schneider courtesy of Ass. for Comp. Alpine Res., Munich Archives A Byers, TMI

2007 Imja Glacier Photo: Alton Byers, The Mountain Institute

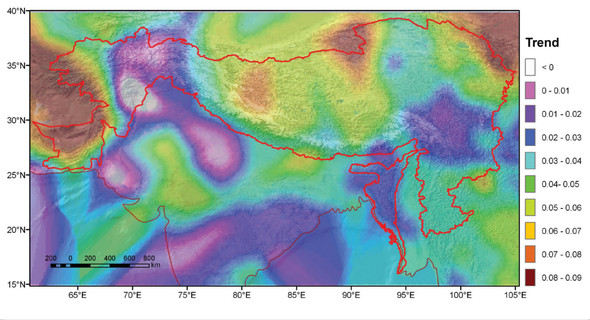
Dependence of warming on elevation on the Tibetan Plateau

(Liu and Chen 2000)



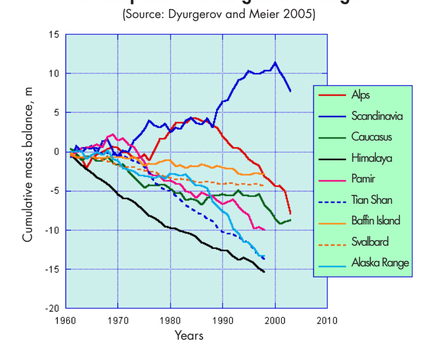
Spatial distribution of annual temperature trends in the greater Himalayan region for the period 1970–2000

(Data Source: New et al. 2002)



Rapid retreat of greater Himalayan glaciers in comparison to the global average

(Source: Dyurgerov and Meier 2005)



Regional mean maximum temperature trends in Nepal from 1977–2000 (°C per year)

(Source: updated from Shrestha et al. 1999)

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

Average annual increase in temperature at different altitudes on the Tibetan Plateau and surrounding areas 1961–1990 (°C per decade) (Source: Liu and Hou 1998)

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

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 globalisation, 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.

Linkages between climate change, biodiversity, ecosystem services, and human wellbeing (adapted from MA 2003)

CLIMATE CHANGE
- Temperature
- Precipitation
- Atmospheric composition
- Variability & extremes

HUMAN WELLBEING

Security
- A safe environment
- Resilience to ecological shocks or stresses such as droughts, floods, pests
- Secure rights and access to ecosystem services

Basic material for a good life
- Access to resources for a viable livelihood (including food and building materials) or the income to purchase them

Health
- Adequate food and nutrition
- Avoidance of disease
- Clean and safe drinking water
- Clean air
- Energy for comfortable temperature control

Good social relations
- Realisation of aesthetic and recreational values
- Ability to express cultural and spiritual values
- Opportunity to observe and learn from nature
- Development of social capital
- Avoidance of tension and conflict over a declining resource base

Freedom and choice
- Ability to influence decisions on ecosystem services and wellbeing
- Opportunity to achieve what an individual values doing and being

BIODIVERSITY

(ecosystem, habitat, species)
- Number
- Distribution
- Abundance
- Composition
- Interaction

ECOSYSTEM FUNCTIONS

ECOSYSTEM SERVICES

Provisioning services
Food and fodder, fibre, fuel, timber, pharmaceuticals, biochemicals, genetic resources, fresh water & air

Cultural services
Spiritual and religious values, knowledge system, education and inspiration, recreation & aesthetic values, sense of place

Supporting services
Primary production, provision of habitat, nutrient cycling, soil formation and retention, oxygen production, water cycling

Regulating services
Invasion resistance, herbivory, pollination, seed dispersal, climate regulation, pest and disease regulation, natural hazard protection, erosion regulation, flood regulation, water purification

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