

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

FOR MOUNTAINS AND PEOPLE

### Mountains and climate change

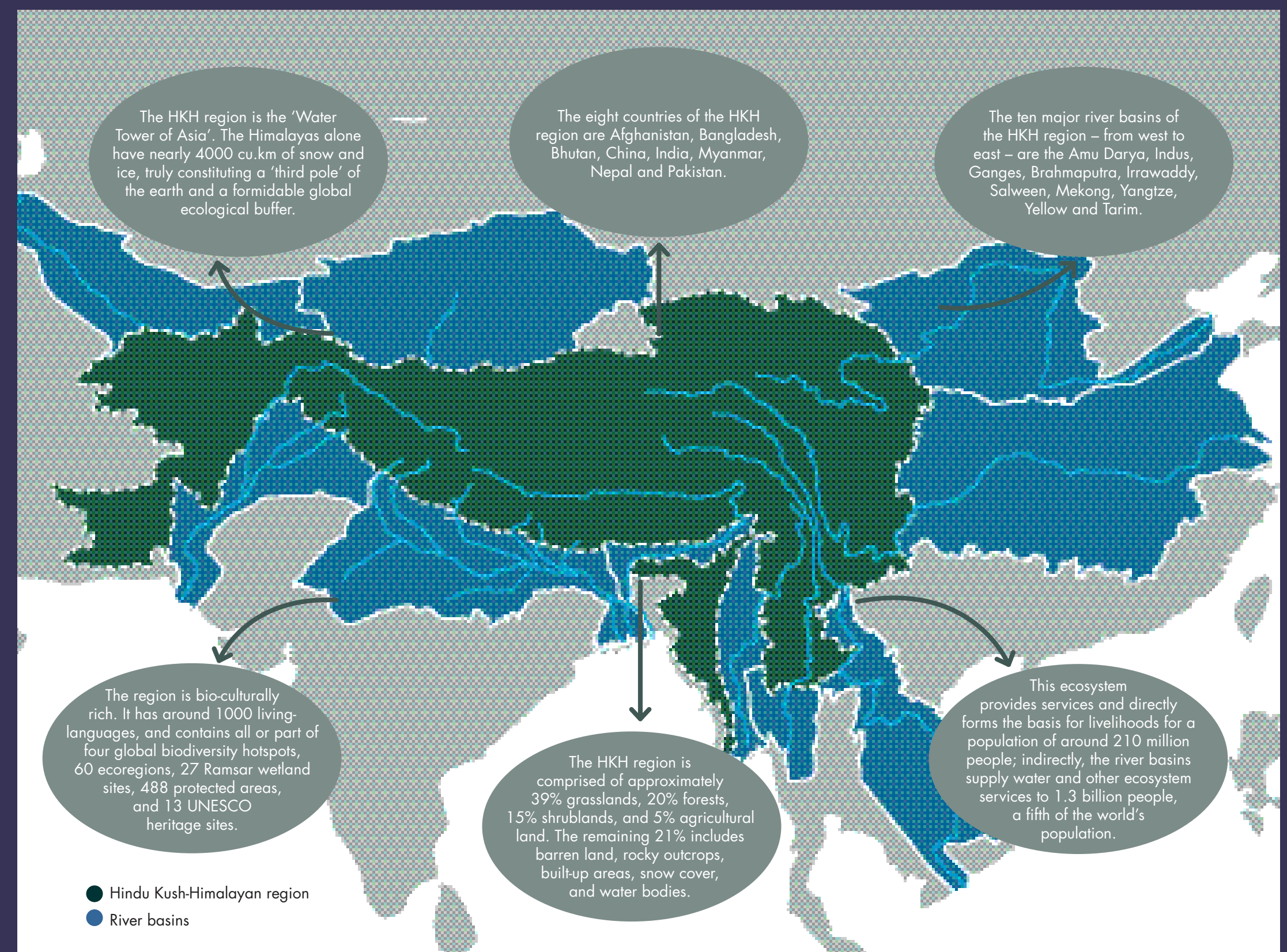
Mountains occupy 24% of the global land surface area, and are home to 12% of the world's population. Most mountain people depend directly on mountain resources for their livelihood and wellbeing, and an estimated 40% of the world population depends indirectly on them for water, hydroelectricity, timber, 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<sup>2</sup>) 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, ecosystem 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.

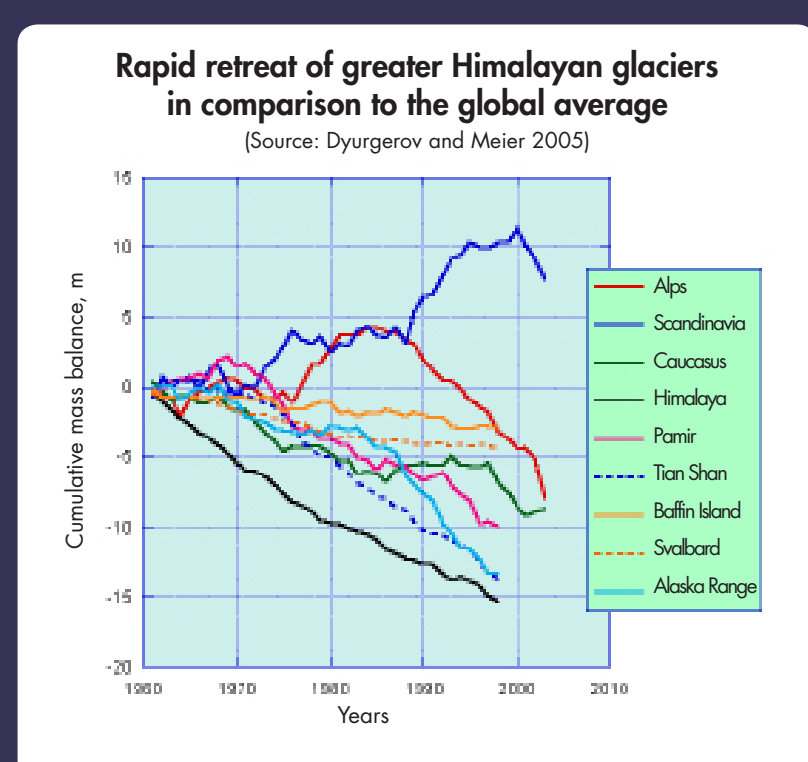
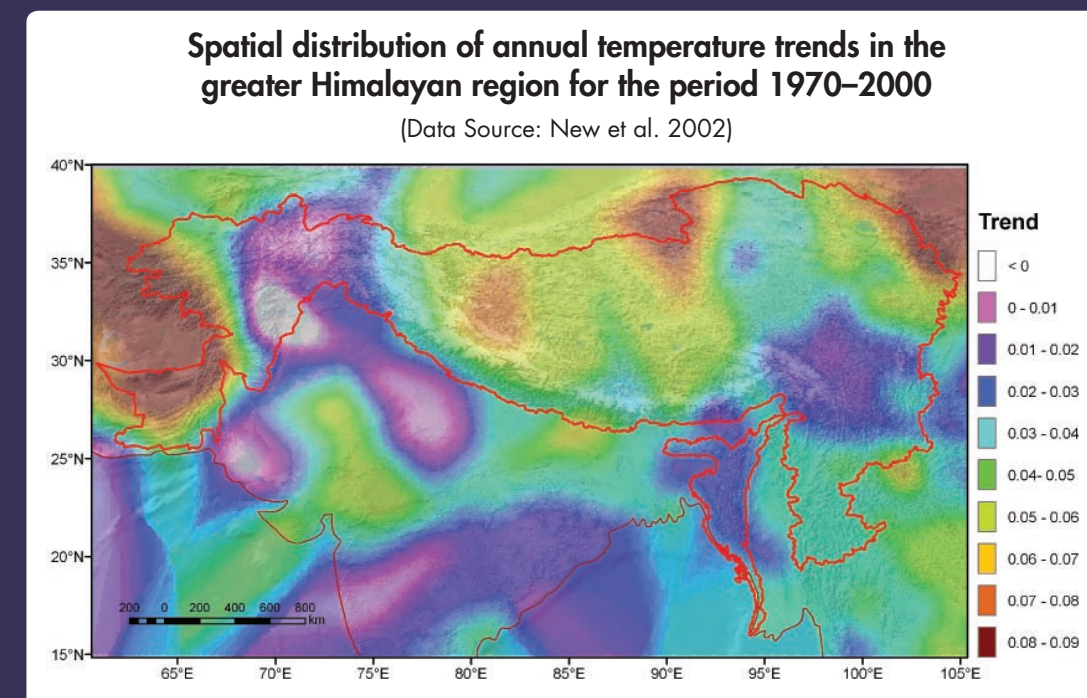
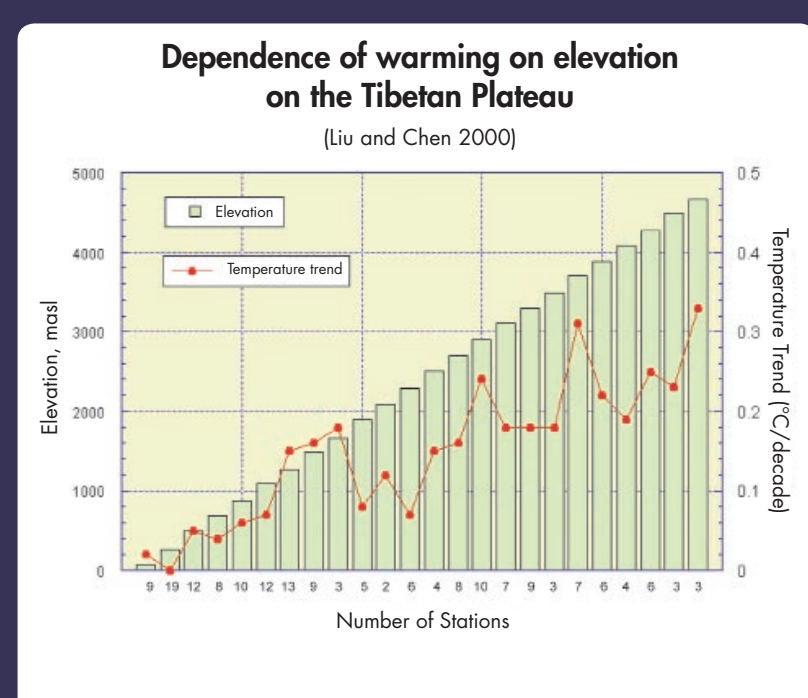
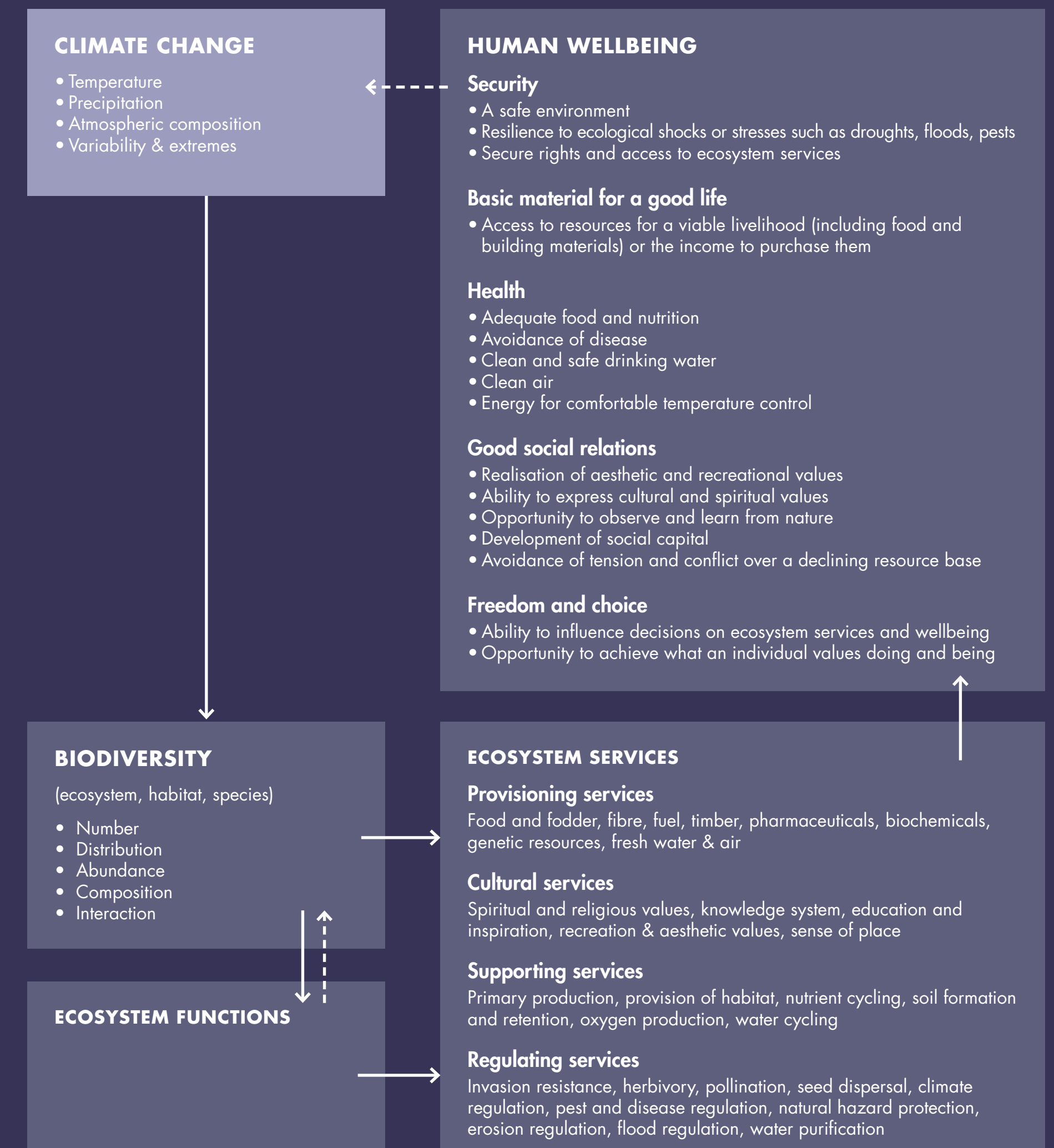


ca. 1956 Imja Glacier (Khumbu, Nepal) Photo: Erwin Schneider courtesy of Ass. for Comp. Alpine Res., Munich Archives A Byers, TMI



2007 Imja Glacier Photo: Alton Byers, The Mountain Institute

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



**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)	
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
<math>-500</math>	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.