ICIMOD

FOR MOUNTAINS AND PEOPLE

Climate Change in the Himalayas

INFORMATION SHEET #3/09

Climate change has become a major issue in the Hindu Kush-Himalayan region. If average temperatures increase as predicted, all aspects of human and natural life will be affected. The mountain regions are particularly vulnerable, both because warming trends are higher and because the impacts are magnified by the extreme changes in altitude over small distances. Life in the Hindu Kush-Himalayan region also relies strongly on the monsoon systems, and these may be altered by climate change. Locally, people's ability to adapt will be challenged; further away, changes in the Himalayas could affect the life and livelihoods of the 1.3 billion people living in the river basins downstream. Good data and information is needed to assess the current situation and to make reliable predictions that can be used as a basis for planning. But poor accessibility, low population density, and lack of infrastructure, have led to low rates of data collection and a general lack of reliable data for the region.

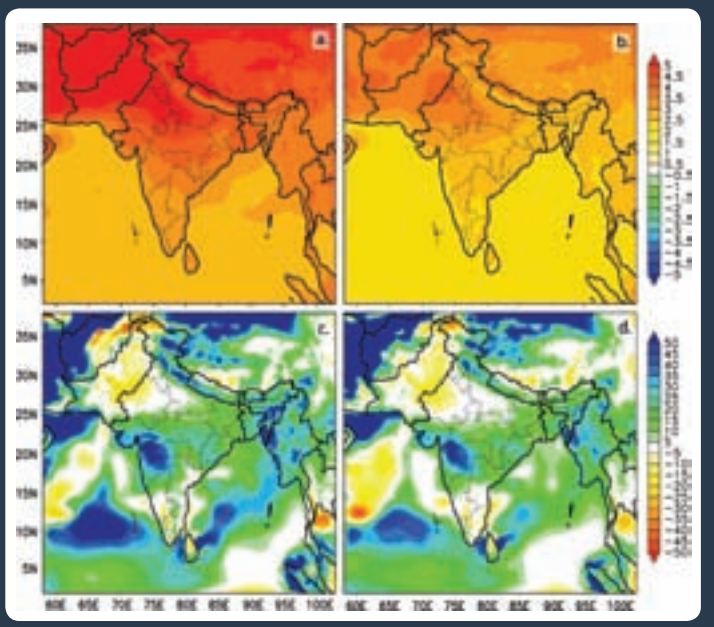
The global situation

Temperature increase is widespread over the globe, with higher than average trends in many of the world's highlands. On average the global temperature rose by 0.74°C over the last hundred years (1906-2005), with more than half of this rise, 0.44°C, in the last 25 years. Eleven of the twelve years between 1995 and 2006 rank among the twelve warmest years since 1850 when records of global surface temperature began. The number of extreme precipitation events – like heavy rainfall and severe storms – appears to have increased, and there is some indication that there has also been an overall increase in precipitation, although the confidence in these estimates is lower than for temperature. According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2007): "Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations," (about 436 parts per million CO_2-equivalent in 2008).

Climate change in the Hindu Kush-Himalayas

The rates of warming in the Hindu Kush-Himalayan region (HKH) are significantly higher than the global average. Within the region, the rates in the western Himalayas, eastern Himalayas,

Projected changes in surface air temperature (a. and b.) and summer monsoon precipitation (c. and d.) towards the end of the 21st century, for emission scenarios A2 (left column) and B2 (right column; Rupa Kumar et al. 2006)



and the plains of the Ganges basin over the last 25 years are lower (0.01-0.03°C per yr), and those for the central Himalayas (Nepal) and the Tibetan Plateau (based on limited station data), appear to be considerably higher (0.04 to 0.09°C per yr and 0.03-0.07°C per yr, respectively). The measurements in Nepal and Tibet also indicate that warming is occurring at much higher rates in the high altitude regions than in the low altitude areas; the vast low elevation areas of India do not show any significant signs of warming.

The monsoon rainfall in India and Nepal is highly correlated with large scale climatological phenomenon like El Niño, but as yet the total rainfall has not shown any distinct trends related to climate change. However, there are signs of changes in the dates of onset and retreat of the monsoon as well as the number and frequency of extreme precipitation events, although more analysis is still needed to confirm this.

Analysis and predictions of climate change in the region are limited as there is not enough long-term high quality data available to support reliable modelling and validation. The topography is also very challenging; the extreme changes in height over short distances can lead to extreme changes in rainfall amounts and other climate-related events over a small area. This extreme topography presents a challenge both for measuring actual rainfall and for assessing other climate factors, especially as measuring stations are few and far between. Similarly, it is still difficult to develop models that take into account the influence of the local topography on the climate.

The Indian Institute of Tropical Meteorology (IITM) has developed one of the most comprehensive climate change projection studies in the region. The IITM study suggests that there will be a decrease in monsoon precipitation of up to 20% by the end of the century in most parts of south-eastern Afghanistan, the southern and eastern Tibetan Plateau and the central Himalayan range. Increases in the range of 20-30% are projected for the western Himalayas, and Kunlun, and Tien Shan ranges. All areas of South Asia are projected to warm by at least 1°C by the end of the century; in the Punjab area, a large part of Afghanistan, Badakshan, the western Nepal Himalayas, Himachal Pradesh, and the northern Tibetan Plateau, warming could be as high as 3.5-4°C. The rate of warming is likely to increase with increasing altitude, at least in Bhutan, Nepal, and Himachal Pradesh.

Impacts of climate change

Less water

One of the most visible impacts of climate change in the Himalayan region is the retreat of the glaciers, many at higher rates than glaciers in other mountain ranges. The permanent snowline has moved significantly higher, although the observations are too few to be able to quantify the actual loss of snow cover in the region. Continued deglaciation could have a profound impact on the water in the ten large river basins originating in the HKH region. River discharges are likely to increase for some time due to accelerated melting, but the flow is then likely to be lower as the storage capacity of the glaciers goes down. The effects are likely to be felt most severely in the arid parts of the region which are already very dry.

ICIMOD has studied the impact of projected climate change on the hydrological regime of some river basins, and shown a clear difference between the basins dominated by summer monsoon and those dominated by winter precipitation. These studies did not indicate that there would be a catastrophic scarcity of water, as commonly predicted, although uncertainties remain due to the coarseness of the models and lack of data for validation and calibration.

Glacial lake outburst floods

Glacial lakes have formed in many places in the area left at the foot of retreating valley glaciers. An inventory compiled by ICIMOD identified 8790 glacial lakes within selected parts of the Hindu Kush-Himalayas. Some 204 of the glacial lakes were considered to be potentially dangerous, that is liable to burst out leading to a glacial lake outburst flood (GLOF). There have been at least 35 GLOF events in Bhutan, China and Nepal during the 20th century.

Floods and drought

Floods and droughts are likely to increase as a result of a number of factors. An increase in seasonal change is predicted with more precipitation during the wet season leading to increased flood risk, and potentially drier dry seasons with increased risk for drought. Changes in the monsoon regime might lead to an overall increase in precipitation in some areas, and a decrease in others. There are also likely to be more flash floods resulting from increased numbers and magnitude of extreme precipitation events, and there may be greater direct runoff and less delayed runoff as less precipitation falls as snow.

Ecosystem services

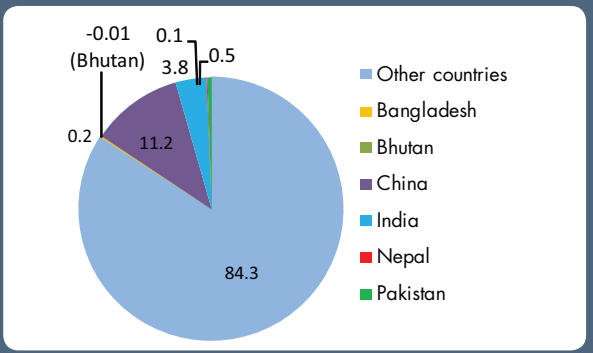
Climate change is affecting ecosystem services by affecting forest type and area, primary productivity, species populations and migration, the occurrence of pests and disease, and forest regeneration. The increase in greenhouse gases is also affecting species composition and changing the ecosystem structure, which in turn affects ecosystem function. The interaction between elevated CO_2 and climate change plays an important role in the overall response of net primary productivity. Climate change will have a profound effect on the future distribution, productivity, and ecological health of forests. There could be a significant reduction in alpine and cryospheric ecosystems and their services. A major expansion of the tropical zones would cover most of the middle mountains and inner valleys of the region, whereby the quality and quantity of ecosystem services are likely to change dramatically for the worse.

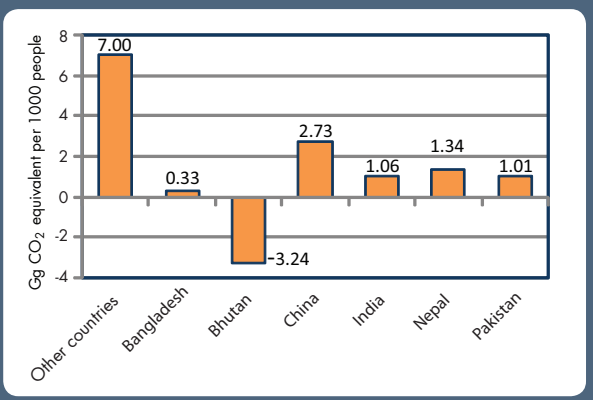
People's well-being

Climate change can affect people's wellbeing in a variety of ways. It is likely to exacerbate the existing food insecurity and malnutrition. Vector-borne diseases such as malaria and dengue fever are likely to move to higher altitudes. Water-borne diseases are also likely to increase with the increasing water stress accompanied by the lack of safe drinking water and basic sanitation in the region. Deaths and morbidity associated with extreme and erratic weather are also likely to increase. Climate change will have differentiated impacts which could be more severe for women, and poor and marginalised groups.

Contribution of the HKH countries to global greenhouse gas emissions

Six countries in the Hindu Kush-Himalayan region have prepared greenhouse gas inventories (Bangladesh, Bhutan, China, India, Nepal, and Pakistan). Together these countries emit approximately 17% of the total global greenhouse gas emissions (right above), which is low compared with their area and population (right below). The average emissions from the HKH part of these countries is likely to be much lower than the country average as the mountain regions are sparsely populated and much less industrialised. There is a considerable disparity between the countries with China emitting 12% of the global total, India 4%, and Bhutan acting as a net sink. The emissions from these countries are expected to increase further with future economic growth (UNFCC). (The relative values are approximate as the inventories refer to different years)





ICIMOD and climate change

ICIMOD carries out a wide range of activities related to climate change, including the following:

- Working towards generating regional baseline data, particularly on cryosphere and climate change, and developing mechanisms for sharing of data and information. The HKH region is considered as lacking the data needed to assess climate change and its impacts accurately. The problems relate both to lack of data and analyses, and to a lack of appropriate mechanisms for data and information sharing and dissemination (including, for example, lack of long-term data sets and problems with data quality). ICIMOD's focus is on developing baseline data and information and reducing gaps and uncertainties. Recently, ICIMOD has developed the concept of using a transect approach to focus efforts for long-term monitoring.
- Updating the inventory of glaciers and glacial lakes in the region and extending to other areas; detailed studies of the rate of glacier retreat and monitoring of potentially dangerous lakes in selected sub-basins; and a GLOF risk assessment, which includes state of the art field studies, and downstream impact and socioeconomic assessments.
- Documenting community adaptation strategies to climate related stresses, particularly too much and too little water; assessing the vulnerability of communities with the aim of helping to build their resilience to climate related hazards developing; a climate-induced risk mapping approaches.
- Monitoring carbon flux in six sites in India and Nepal to evaluate the role of community-managed forests in climate stabilisation; and working with other partners at policy level to recommend recognition of community forestry as an important carbon sink in the new treaty that will replace the Kyoto Protocol.

- Carrying out an assessment of climate change vulnerability of the mountain ecosystems in the Eastern Himalayas, including an analysis of stakeholders' perceptions of climate change; and developing plans to strengthen the transboundary landscape and corridor development process and scale up transboundary cooperation and habitat connectivity to address the challenges of conservation of biological resources and human well-being using a more community-based and integrated approach.

Further reading

IPCC (2007) *AR4: Climate change 2007*. Geneva: IPCC. www.ipcc.ch

UNFCC (no date) *Greenhouse gas inventory data*. http://unfccc.int/ghg_data/items/3800.php

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