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FOR MOUNTAINS AND PEOPLE

The Changing Himalayas

The impact of climate change on water resources and livelihoods in the greater Himalayas

BRIEFING PAPER #2/09

Key points

- In the Hindu Kush-Himalayan region, climate change, together with other drivers, will have a profound impact on water accessibility, people's vulnerability to water-induced hazards, and socioeconomics. Society will need to improve its adaptation strategies.
- There is a need to close the knowledge gap on the cryosphere and the availability of water resources in time and space. Basin wide water availability scenarios should be developed and linked to water demand and socioeconomic development.

This *Briefing Paper* is addressed to policy and decision-makers at all levels. It aims to trigger consideration and discussion of policy options for assessing the impact of climate change in the greater Himalayas.

The high Himalayan and inner Asian ranges have the largest areas covered by glaciers and permafrost outside the polar regions. The ice and snow covers an area of more than 112,000 sq.km, providing important short and long-term water storage. The region and its water resources play an important role for biodiversity, agriculture and hydropower, serving more than 1.3 billion people in the downstream basin areas of ten large Asian rivers that originate in the mountains. Environmental services provided by the natural resources are the basis for a substantial part of the region's total GDP and have an importance far beyond the region.

The Himalayas have great climatic diversity as a result of the local topographical characteristics with high peaks, steep slopes, and deep valleys. The mountains act as a barrier to atmospheric circulation for both the summer monsoon and the winter westerlies. A large part of the annual precipitation falls as snow, particularly at higher altitudes. Climate change is affecting the amount of snow and ice and rainfall patterns and there is an urgent need to understand these changes and the implications for downstream water availability and the impact on livelihoods.

Extracted from M Eriksson et. al. The Changing Himalayas published by ICIMOD in 2009. Please see original for references. Available at http://books.icimod.org/index.php/search/publication/611

Observed and projected effects of climate change

Climate change is predicted to lead to major changes in the strength and timing of the Asian monsoon, inner Asian high pressure systems, and winter westerlies. The impacts on precipitation river flows, groundwater recharge, natural hazards, and the ecosystem, as well as on people and their livelihoods, could be dramatic.

Climate change is projected to compound the pressures on natural resources and the environment associated with rapid urbanisation, industrialisation, and economic development. It will potentially have profound and widespread effects on the availability of, and access to, water resources. By the 2050s, access to freshwater in Asia, particularly in the large river basins, is projected to decrease. China and India, the two leading rice producers in the world, rely on irrigated agriculture in the Ganges, the Yangtze, and the Yellow river basins for rice cultivation. Unless urgent measures are taken to mitigate the impacts of climate change, the economic advances in these countries could be severely curtailed.

In Asia, it is very likely that warming during this century will be significant in arid regions and the Himalayan highlands, including the Tibetan Plateau. Warming will affect the amount, timing and distribution of precipitation, resulting in increased droughts and floods; cause increased glacial retreat, leading to loss of water storage capacity, destabilisation of slopes, and glacial lake outburst floods; result in increased snowmelt and runoff, affecting river water supplies; and reduce permafrost coverage, altering vegetation composition. Climate change will also involve changes in the frequency and magnitude of extreme weather events, and substantial fluctuations in weather patterns, particularly in combination with intensified monsoon circulation.

Consequences for livelihoods and the environment

Climate change is likely to have both positive and negative effects on people's lives, although the negative effects may prevail overall. The environmental impact will be strongly affected by the speed at which natural adaptation can take place, in relation to the speed of the change.

The location and area of natural vegetation zones on the Tibetan Plateau will change substantially under projected climate change scenarios. Areas of temperate grassland and cold temperate coniferous forest could expand, while temperate and cold deserts may shrink. The vertical distribution of vegetation zones could move to higher altitudes. Climate change may also result in a shift of the boundary of the farming-pastoral transition region to the south in Northeast China, which may increase grassland areas and provide more favourable conditions for livestock production. However, the transition area of the farming-pastoral region is also an area of potential desertification, which will be aggravated by more frequent and prolonged droughts. At high altitudes and latitudes, crop yields should increase because of reductions in frost and cold damage. Irrigated lowland agriculture, found in all of the large basins receiving their runoff from the Hindu Kush-Himalayan system, is likely to suffer from lack of water in the dry season.
Mountain ecosystems contain a series of climatically

Principal rivers of the Himalayan region – basin statistics

	River		River basin			
River	Annual mean discharge m^3/sec[a]	% of glacier melt in river flow[b]	Basin area (km^2)	Population density (pers/km^2)	Population x1000	Water availability (m^3/person/year)
Amu Darya	1,376[a]	not available	534,739	39	20,855	2,081
Brahmaputra	21,261[a]	~ 12	651,335	182	118,543	5,656
Ganges	12,037[a]	~ 9	1,016,124	401	407,466	932
Indus	5,533	up to 50	1081,718	165	178,483	978
Irrawaddy	8,024	not available	413,710	79	32,683	7,742
Mekong	9,001[a]	~ 7	805,604	71	57,198	4,963
Salween	1,494	~ 9	271,914	22	5,982	7,876
Tarim	1,262	up to 50	1,152,448	7	8,067	4,933
Yangtze	28,811[a]	~ 18	1,722,193	214	368,549	2,465
Yellow	1,438[a]	~ 2	944,970	156	147,415	308
Total					1,345,241	

For data sources see M Eriksson et.el 2009

Devastated houses after a flash flood near Pokhara, Nepal

different zones within short distances and elevations and are thus sensitive to global warming. Most areas already show signs of fragmentation and degradation. The impacts of climate change on forest ecosystems include shifts in the latitude of forest boundaries and the upward movement of tree lines to higher elevations; changes in species' composition and in vegetation types; and an increase in net primary productivity.

The impact of climate change on health can be summarised in three main categories: (i) direct impacts in the form, for example, of drought, heat waves, and flash floods; (ii) indirect effects due to climate-induced economic dislocation, decline, conflict, crop failure, and associated malnutrition and hunger; and (iii) indirect effects due to the spread and aggravated intensity of infectious diseases caused by changing environmental conditions. Endemic morbidity and mortality due to diarrhoeal diseases associated with floods and droughts are expected to rise as a result of changes in the hydrological cycle. Positive effects from climate change on the health status of certain populations in the Himalayan region are also possible.

Valuable infrastructure, such as hydropower plants, roads, bridges, and communication systems, will be increasingly at risk as landslides, flash floods and glacier lake outburst floods increase with climate change, the complexity and variability of river flow generation will increase. Hydropower generation will be affected if there is a decrease in the already low flows during the dry season. Structural inequalities that make adaptation by poor people more difficult will need to be levelled. They are already facing poor health, susceptibility to floods and landslides, and a lack of adequate shelter, food, and water. Their capacity to adopt new adaptation strategies must be enhanced.

Lack of knowledge – unknown downstream effects

The impact of climate change on the Himalayan cryosphere is not understood sufficiently to be able to estimate the full scale of the downstream impact of reduced snow and ice coverage. Baseline studies are lacking for most areas and the varied Himalayan topography and climatic variability mean that extrapolations from studies carried out elsewhere do not give an accurate picture. In mountain areas the extreme topography causes temperature and precipitation to vary over very short distances, which makes projections difficult. Equally, poor accessibility, low population and poor infrastructure, means that little direct 'data is collected'. Three levels of impact of climate change can be identified: i) local effects; ii) downstream effects; and iii) global feedback effects. The development of adaptive strategies can be approached from the perspective of each of these three different levels. All three levels are interlinked and interrelated – and also full of uncertainty.

Given the current state of knowledge about climate change, determining the diversity of impacts is a challenge for researchers, and risk assessment is needed to guide future action. The lack of data related to climate and water in the region hinders a comprehensive assessment of changes in extreme climatic events.

Imja lake at the foot of the retreating Imja glacier, Khumbu, Nepal

Policy recommendations

- **Link science and policy:** Good science based on credible and salient knowledge can lead to good policies in the context of climate change and mountain specificities; similarly information is needed that is unbiased and relevant and useful to policy-makers.
- The Himalayas are not well represented in global models because of their coarse resolution. **Regional climate models** need to be constructed with a higher resolution, and run for shorter periods (20 years or so).
- **Supporting community-led adaptation:** Vulnerability and local level adaptation can be addressed through 'bottom-up' community-led processes built on local knowledge, innovations, and practices. Communities should be empowered to adapt based on their own decision-making processes and participatory technology development with support from outsiders.
- **Forest recovery (or transition),** through policy intervention and the participation of local communities in forest management, should be continued.
- The mountains of the greater Himalayas provide abundant services to the downstream population in terms of water for household purposes, agriculture, hydropower, tourism, spiritual values, and transport. **Payment for ecosystem services** would compensate mountain communities for their efforts in ensuring these services; policies should be formulated for such payments.
- **Novel and affordable technologies and energy resources** that do not emit greenhouse gases are needed. There are notable examples in the region including hydropower, solar energy and biogas, bio-diesel, wind energy, and micro-hydropower.
- **Regional cooperation in transboundary disaster risk management** should be put on the political agenda. The focus should be on empowering communities to adapt to a changing climate and environment based on their own decision-making processes and participatory development of technology.
- **National adaptation plans of action (NAPAs)** are currently being prepared by countries under the initiative of the UN Framework Convention on Climate Change. NAPAs need to pay more attention to sectors such as water, agriculture, health, disaster reduction, and forestry, as well as the most vulnerable groups.
- **Integrated water resource management (IWRM)** should include future climate change scenarios and be scaled up from watersheds to river basins. Water allocation for households, agriculture, and ecosystems deserves particular attention. Water storage based on local practices should be encouraged in mountain regions.

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