

**Workshop Report for International Workshop on *Water and Air Challenges in the HKH under Climate and Environmental Change: Opportunities using a Trans-disciplinary Approach* at ICIMOD, Kathmandu, 7-9 November 2014**

The Hindu Kush-Himalaya (HKH) region sits at the junction between numerous disciplines, between tropical and mid-latitude meteorology, mountain weather, glacier dynamics, subsistence agriculture and ongoing climate change. At the same time, the region is undergoing huge changes in society, via out-migration, changing gender roles, and continued development contrasting with extreme poverty. The HKH region thus provides a unique opportunity for end-to-end science directly connected with society. Our workshop was funded by Universität Hamburg and the Cluster of Excellence “Integrated Climate System Analysis and Prediction” (CliSAP) in Germany, and University of Reading Department of Meteorology and the Walker Institute for Climate System Research in the UK. The workshop was kindly hosted by, together with in-kind support from, the International Centre for Integrated Mountain Development (ICIMOD) in Kathmandu, Nepal. We sought to address the above issues and ways forward for collaborative trans-disciplinary research; the following represents a synthesis of the discussions.

The climate of the HKH region has distinct seasonality relating to the summer monsoon and mid-latitude western disturbances (predominantly) during winter but increasingly seen as interacting with the summer monsoon flow causing extreme events. Hydrological work over the region finds the monsoon to dominate in the eastern end of the Himalayan arc, with mid-latitude systems further west. Modelling of the regional climate is difficult owing to the steep orography and model biases, yet future projections in a warmer world generally suggest increasing monsoon precipitation. This contrasts with model results and observations of the recent past, which suggest declining precipitation, and there is evidence from large-scale experiments and those focusing on the local HKH scale that polluting aerosol emissions are to blame. Many questions remain over whether climatic and air quality-health effects arise from local or remote emissions or both. It is clear that the full complexity of aerosol effects also needs to be considered in models in order to simulate observed trends.

The HKH region as the water towers of Asia or third pole environment is also highly glacierized, and so with warming also comes snow and ice melt, which is potentially exacerbated with elevation, a mechanism still not fully understood. With increased melt there is also increased glacial runoff but measurements are complicated by the imprecise methodology, for example on the contribution of the different components (snow and ice melt or rain) to the entire discharge. Implications abound for water supply for irrigation affecting vegetation and cropping, and effects on groundwater recharge. The huge potential for hydropower also bestows great advantages for the region in terms of security of power supply and financially, yet local communities displaced by dams and those nearby may often not benefit.

Further uncertainties in glacial melt arise from thin debris cover, the thickness and extent of which are not well known and, depending on the depth of the debris layer may enhance or ameliorate melt. In addition, recent research highlighted significant mass

loss from most debris-covered glaciers in the HKH region, potentially attributable to enhanced melt at exposed ice cliffs and supraglacial ponds as well as ice dynamics. The combined effect of soot and natural dust emissions can lower glacier or snow-pack albedo and increase the melt rate. However, the impact of dust or the combined effect of both pollutants is poorly understood. Dust emissions could also be exacerbated by land-use change.

Permafrost is a further important component of the cryosphere that impacts on hydrology. Initial studies indicate that ice-rich permafrost bodies such as rock glaciers potentially store significant ice but they are randomly mapped and their occurrence and characteristics are poorly understood. In addition, the existence of permafrost and its thawing could also affect local and downstream vegetation and groundwater.

It is not only changing climate that poses challenges to the HKH region. Future population growth under various economic development scenarios, as an example for India, suggests at least a doubling of food requirements by 2050. When these projections are coupled with climate and other changes, perhaps with more variable rainfall and stream flow, it becomes clear that water and food security are at risk. Some change also comes from farmers themselves: for example, the increased planting of cash crops such as tomatoes under new poly-tunnel systems brings increased water needs and poses new challenges.

The requirement of local HKH mountain villagers for water supply evokes a surprising paradox. Water seems to be everywhere, yet at the same time it can be inaccessible down steep valleys, requiring hard manual labour for water carrying or manual pumping, or sufficient power to pump electrically. In some regions, the strong seasonality also yields periods of abundance and many months without rain. Traditionally, springs have often been used for local supplies but they are often unmapped and local knowledge has not been collated to maintain such systems. Past pressures to clear up ponds due to malarial concerns have led to an inability to recharge these springs and renewed efforts by ICIMOD have worked with communities to re-establish them under careful safeguards, as well as building capacity within the villages to maintain them. Over-pumping and locking away of some traditional spring resources also lead to pressures on supply.

Village agricultural communities are also faced with tremendous challenges due to migrating populations, especially out-migration of generally working-age men to foreign markets. This presents a double-edged sword for the communities, leaving the elderly to raise children while women are performing intensive labour tasks on the land. Stress is also increased from the taking-on of non-traditional family roles. But remittances from expatriate workers also bring improvements, often leading to purchase of the land on which farming families work, improved homes, and better education.

The workshop's second day comprised a variety of site visits in the Kavre district, to ICIMOD activities and village communities. Efforts are being undertaken to maintain and adequately recharge springs, as described above, as well as work with community activists to identify what water is being used and maintenance techniques. Elsewhere, insights were gained into the typical farming lifestyle, and the community perceptions of

the changes under which they are living. Community impacts studies are also seeing training taking place and giving encouragement to continuity of rainfall measurements, allowing change to be observed and understood.

Looking forward, we propose a consortium to tackle these issues in end-to-end research, taking on board the typical physical science *eagle-eye view*, and community-driven *toad's-eye view* of changes in circumstance. This will involve the bringing together of disciplines, and small-to-large scales, and overcoming of problems relating to inadequate data. We identified possible funding routes to develop such a proposal to tackle questions of change in the HKH region, to be put together in 2015.

### Organizing committee

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### Local host

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### Walker Institute support

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