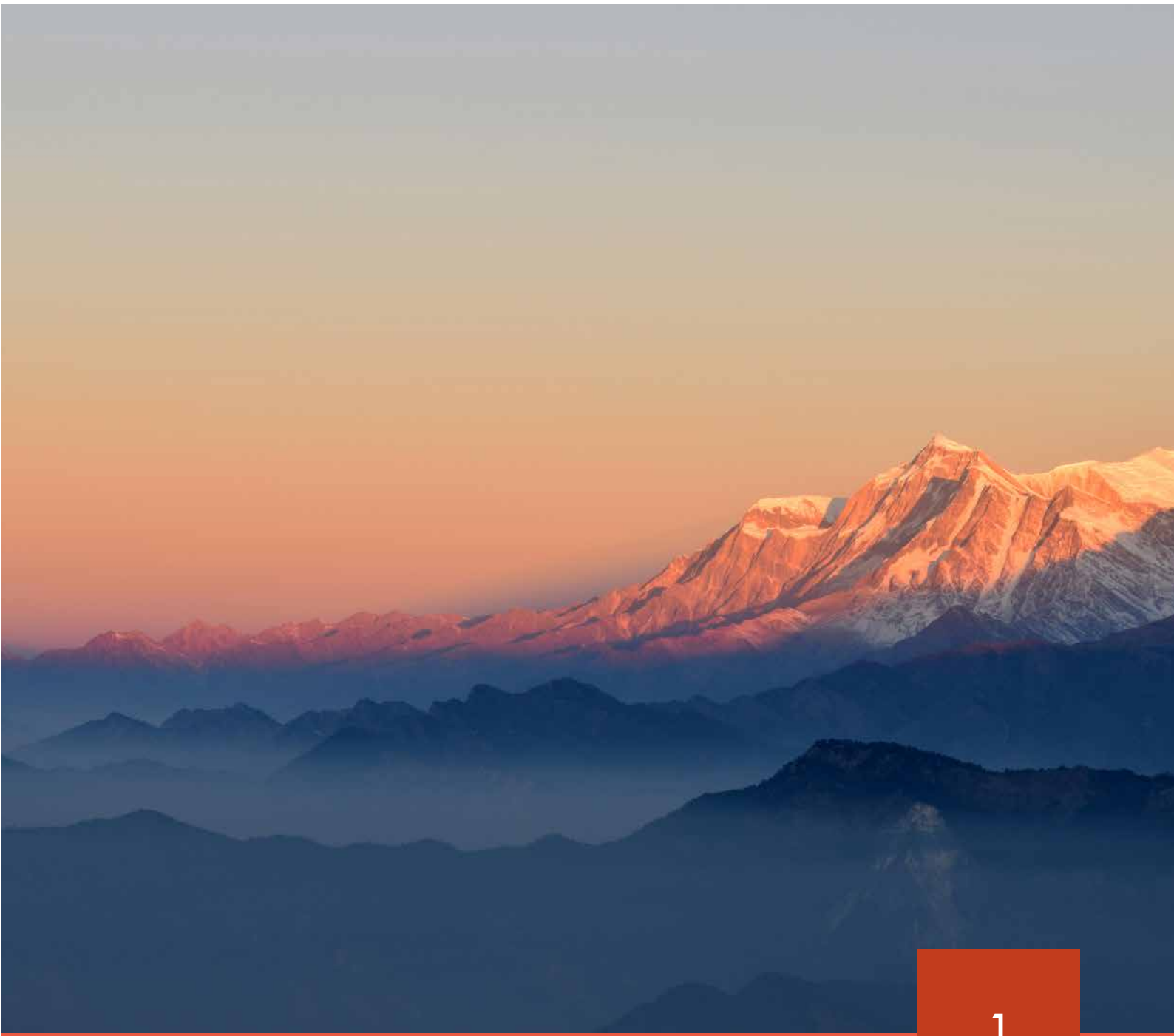
CARIAA
Collaborative Adaptation Research Initiative in Africa and Asia

HI-AWARE



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Even 1.5 Degrees is Too Much

Rising temperatures and wetter futures in South Asian glacier and snow-fed river basins

About HI-AWARE

HI-AWARE aims to enhance the adaptive capacities and climate resilience of the poor and vulnerable women, men, and children living in the mountains and flood plains of the Indus, Ganges, and Brahmaputra river basins. It seeks to do this through the development of robust evidence to inform people-centred and gender-inclusive climate change adaptation policies and practices for improving livelihoods.

The HI-AWARE consortium is led by the International Centre for Integrated Mountain Development (ICIMOD). The other consortium members are the Bangladesh Centre for Advanced Studies (BCAS), The Energy and Resources Institute (TERI), the Climate Change, Alternative Energy, and Water Resources Institute of the Pakistan Agricultural Research Council (CAEWRI-PARC) and Wageningen Environmental Research (Alterra). For more details see www.hi-aware.org.

This series is based on the work of the Himalayan Adaptation, Water and Resilience (HI-AWARE) consortium under the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA) with financial support from the UK Government's Department for International Development and the International Development Research Centre, Ottawa, Canada. CARIAA aims to build the resilience of vulnerable populations and their livelihoods in three climate change hot spots in Africa and Asia. The programme supports collaborative research to inform adaptation policy and practice.

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Key Message

The Indus, Ganges and Brahmaputra river basins are extremely susceptible to temperature increase. Under a 1.5 °C global warming scenario, these river basins would warm up by more than 2 °C on average by the end of this century. At higher altitudes this warming will be even more marked, due to elevation dependent warming. A 2 °C global warming scenario could lead to a warming of around 2.7 °C in these glaciated river basins. Currently, more likely climate change scenarios, specific for these river basins, suggest regional temperature increases between 3.5 and 6 °C by 2100. The majority of the projections also indicate overall wetter conditions in the future and increases in extreme precipitation events. This will lead to significant losses in glacier volume, from 36 to 64%, depending on the warming scenario, and impact timing of water flows and water availability.

Introduction

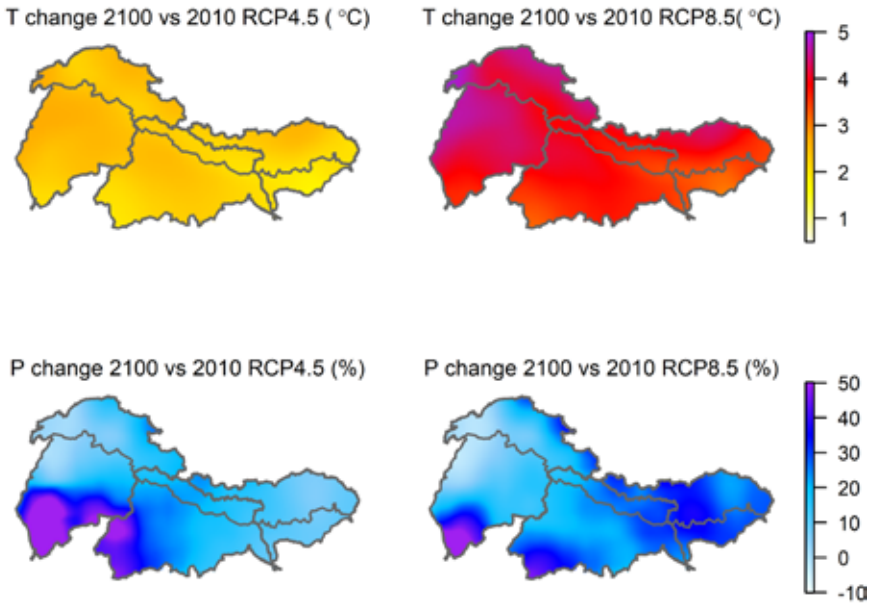
Developing countries and their inhabitants are considered to be more vulnerable to climate change than western countries. The glacier-fed Indus, Ganges and Brahmaputra river basins in South Asia are home to around 900 million people, which is projected to increase to almost 1.2 billion by 2050. With the increasing population, demands for water, food and energy will increase strongly too. The region is facing enormous challenges in adapting to already occurring climate change, which is impacting many different sectors, in addition to conventional development challenges that lead to adaptation deficits. Credible projections of future climate change and its impacts are essential for designing robust adaptation policies.

Major Findings

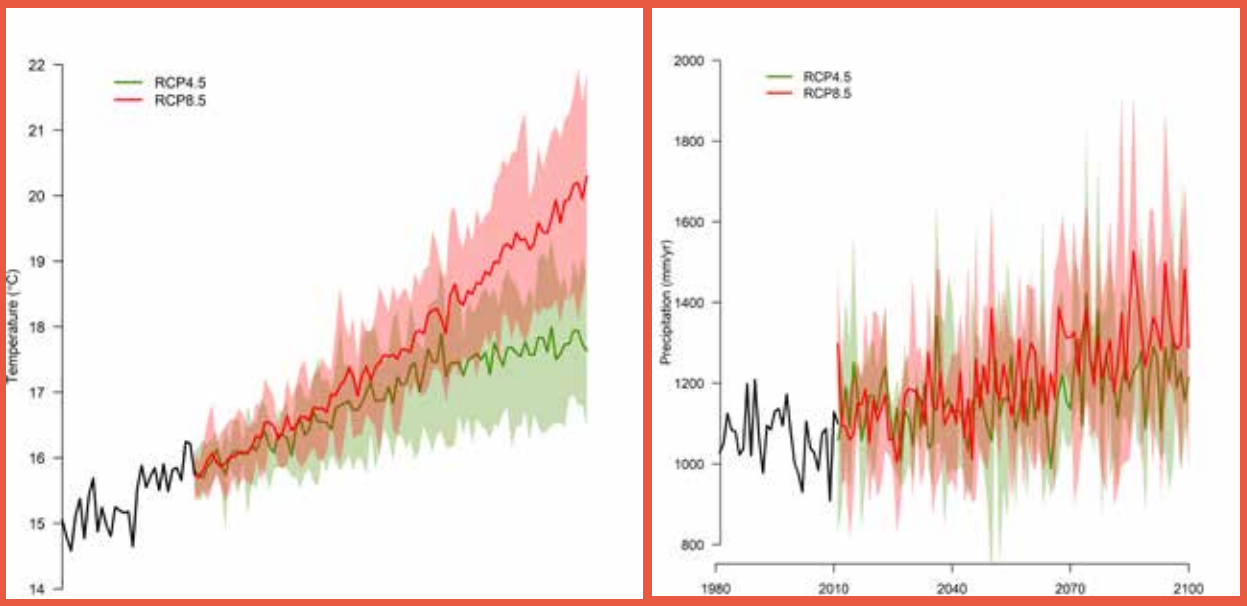
We rely on climate models to get estimates of future climate change. There are hundreds of climate models and it is a challenge to analyse what they project for a specific region. In HI-AWARE we selected an ensemble of reliable climate models which includes all possible futures for the South Asian river basins. These were downscaled to high resolution to make them suitable for climate change impact modelling. We then used a suite of state-of-the art hydrological models to generate robust high-resolution projections of future changes in snow and ice reserves, water availability, seasonal shifts in flows, and changes in river flow extremes.

Because high altitude areas tend to warm up faster than their surroundings, South Asian river basins warm up much quicker than other areas. Projections of mean air temperature indicate an increase ranging from 1.7 °C to 6.3 °C by 2100 compared to 2000 for the river basins as a whole. The precipitation changes have large uncertainties and range from –3.1 to +37.4%, showing that wetter conditions are more likely in the future. All projections show increases in warm spells, decreases in cold spells, and increases in extremely high precipitation events.

In the high mountains of the Hindu Kush Himalaya, these climatic changes will lead to a significant reduction in ice volume, ranging from 36 to 65% glacier mass loss, depending on the warming scenario.



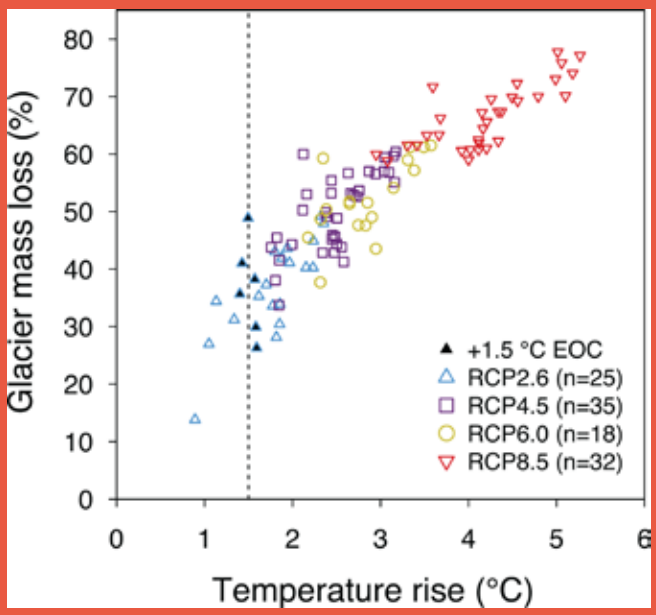
Projected changes in temperature (top) and precipitation (bottom) between 2010 and 2100 in the Indus, Ganges and Brahmaputra river basins for a medium-stabilization scenario (RCP4.5, left), and a high climate change scenario (RCP8.5, right).



Projected changes in air temperature (left) and precipitation (right) averaged over the Indus, Ganges and Brahmaputra river basins for a medium-stabilization scenario (RCP 4.5), and a high climate change scenario (RCP 8.5). Shading shows the uncertainty in the climate projections.

Shifts in water availability are expected to result from a combination of increased rainfall, decreased snowfall changing glacier melt patterns and changes in precipitation patterns. Overall, an increase in water supply is expected for the coming decades due to increases in meltwater and rainfall, , but due to lack of storage infrastructure and more extreme flows, this may not always be beneficial.

In rivers with very high glacier melt contribution (in the Indus basin) overall water supply may decline after 2050, although this is subject to large uncertainty because of indeterminate precipitation projections in this basin. In the Ganges and Brahmaputra basins overall water supply will likely keep increasing throughout the 21st century due to increases in rainfall. Due to earlier onset of melt, flows in spring will likely start to rise earlier and similarly flows in autumn will increase due to longer melt generation. Furthermore, all modelling scenarios show strong increases in the frequency and magnitude of extreme river flows throughout the basins.



Projected changes in glacier ice mass loss in High Mountain Asia for 2100 compared to 2005 for different climate scenarios. The shown temperature rise is for the future compared to the preindustrial era (~1850).

Policy Actions

The projected changes in climate will lead to a range of impacts across different sectors. These include increases in floods, landslides, sedimentation, droughts, heat waves, and shifts in water availability. A 1.5 or 2.0 °C scenario would already lead to significant impacts. However, our projections based on the full range of possible future climate scenarios indicates much larger changes. We therefore stress that the 1.5 °C (or even the 2.0 °C) scenario is not suitable for robust climate change adaptation planning, and emphasize that the formulation of robust climate change adaptation policies should be based on the full range of climate change projections.

Urgent action is required to adapt to the imminent changes. We have generated robust evidence for climate change and impacts for the entire Indus, Ganges and Brahmaputra basins and presented generalized trends in this brief. However, projections have high spatial variation and therefore the actual impacts, and desired response in terms of adaptation planning, need to be determined on a case-by-case basis.

Looking Ahead

Because mountain areas warm up faster than surrounding lands, the Indus, Ganges and Brahmaputra river basins are exceptionally susceptible to temperature increase. Climate change scenarios for the region indicate regional temperature increases between 3.5 and 6 °C between 2000 and 2100. Overall wetter conditions are very likely in the future. Alla projections indicate increases in extreme climate events, which will result in increases in droughts, floods and other climate hazards, with likely large negative impacts on food security and human health.

This brief is based on the following HI-AWARE publications:

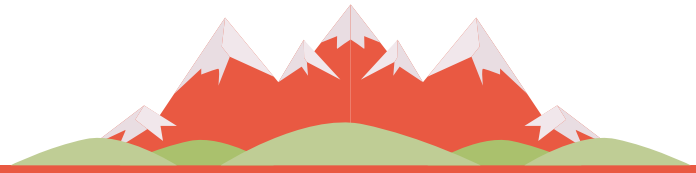
Lutz AF, ter Maat HW, Wijngaard RR, Biemans H, Syed A, Shrestha AB, Wester P, Immerzeel W.W. (2018) South Asian river basins in a 1.5 °C warmer world. Regional Environmental Change, under review.

Kraaijenbrink PDA, Bierkens MFP, Lutz AF, Immerzeel WW (2017) Impact of a 1.5 °C global temperature rise on Asia's glaciers. Nature 549:257–260. doi: 10.1038/nature23878

Lutz AF, ter Maat HW, Biemans H, Shrestha AB, Wester P, Immerzeel, WW (2016) Selecting representative climate models for climate change impact studies: an advanced envelope-based selection approach, International Journal of Climatology, 36, 3988–4005, doi:10.1002/joc.4608.

Wijngaard RR, Lutz AF, Nepal S, Khanal S, Pradhananga S, Shrestha AB, Immerzeel WW (2017) Future changes in hydro-climatic extremes in the Upper Indus, Ganges, and Brahmaputra River basins. PLoS One 12:. doi: 10.1371/journal.pone.0190224.

Wijngaard RR, Biemans H, Lutz AF, Shrestha AB, Wester P, Immerzeel WW (2018) Climate change vs. Socio-economic development: Understanding the South-Asian water gap. Hydrology and Earth System Sciences, under review.



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