CARIAA
Collaborative Adaptation Research Initiative in Africa and Asia

HI-AWARE

3

More Severe Floods in the Indus, Ganges and Brahmaputra Basins Likely in the Future

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.

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Key Message

Floods will become more frequent and severe in the mountainous and downstream areas of the Indus, Ganges and Brahmaputra river basins, because of an increase in extreme precipitation events. Depending on the climate change scenario, the severity of flood events is expected to more than double towards the end of the century. Flood-resilient housing shows promise as an adaptation option to address this hazard.

Introduction

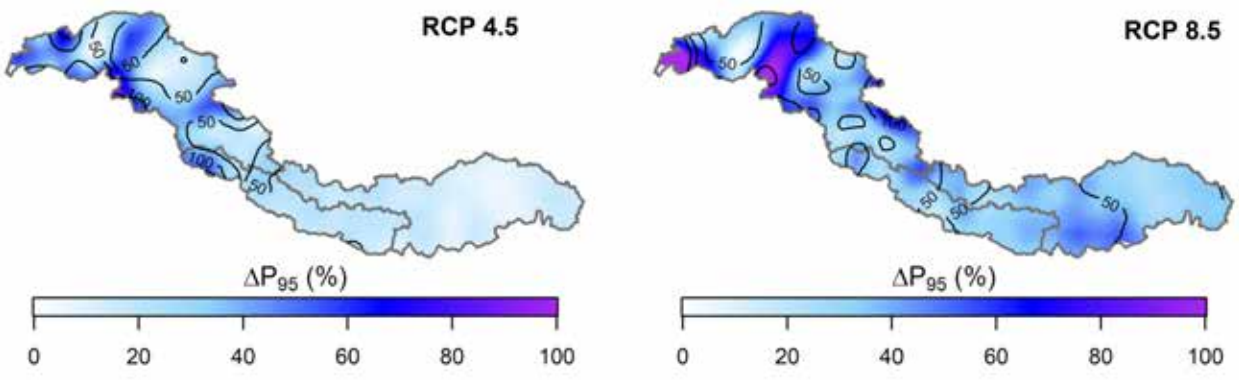
Floods cause damage to property, infrastructure, take lives and devastate communities. The South Asian region has a history of major flood disasters. The floods in Pakistan in 2010 affected one-fifth of the country's lands. In the 2017 floods that hit Nepal, India, and Bangladesh, more than 1,200 people died, 45 million people were affected, and property worth millions was destroyed.

In case floods become more severe under climate change, it will adversely affect communities and many social and economic sectors, such as agriculture, health, and hydropower in the Indus, Ganges and Brahmaputra river basins.

Knowledge about future changes in frequency and severity of flooding is a prerequisite for formulating and designing robust adaptation strategies targeted and reducing the risks posed by this hazard. It provides essential information for the design of infrastructure in the water sector (such as hydropower and irrigation), and for developing adaptation and mitigation options for communities threatened by floods.

Major Findings

To develop credible projections of future changes in floods HI-AWARE developed robust region-specific climate change projections for the Indus, Ganges and Brahmaputra river basins. These scenarios indicate that extreme precipitation events, the main driver for floods in the region, will likely increase in frequency and severity in the coming decades. Comparing 2100 to 2000 daily precipitation extremes increase by 3 to 104% depending on the region and scenarios as shown in the figure below. Peaks in five-day precipitation sums increase between 15 and 170%.

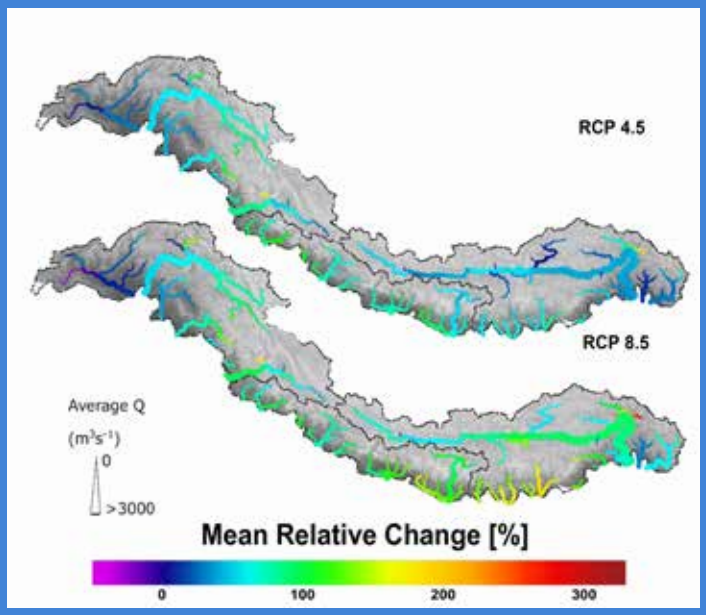


Caption: Changes in extreme precipitation event (P95) when daily precipitation amount is greater than the 95th percentile under RCP4.5 (left) and RCP8.5 (right) scenarios at the end of the 21st century (2071-2100) with respect to reference period (1981-2010). Contour values represent the ensemble range of the projections.

State-of-the-art hydrological modelling tools were subsequently used to analyse how future climate change translates into changes in extreme river flows throughout the three river basins. The average river flow is projected to increase in all three upper river basins: roughly 50% in the upper Indus, 30%–40% in the upper Ganga, and 25%–50% in the upper Brahmaputra towards the end of the century.

Depending on the scenario, the intensities of 'once in 50 years' flood events are expected to increase by 40%–110% on average in the upstream areas and 115%–150% in the downstream areas of the river basins towards the end of the century. Increasing flood intensity will adversely affect different sectors, both upstream and downstream.

Investigating the effectiveness of adaptation options HI-AWARE conducted pilot studies for climate and flood resilient housing. This type of housing, with provision for shelter, safe drinking water, ecological sanitation and home solar systems was tested in the Teesta basin. It shows to be effective to increase the resilience of the most vulnerable groups living on flood plains and sand bars. Communities and local leaders including Parliament Members have positively responded to the innovation.



Changes in 50-year return period discharge (flood event which has a 1 in 50 chance of occurring in any given year) under RCP4.5 (top) and RCP8.5 (bottom) scenarios at the end of the 21st century (2071-2100) with respect to reference period (1981-2010). The thickness of any given line represent the average discharge of the reference period for that river.

A second flood resilient habitat framework in Bihar is looking at multiple adaptation interventions, for developing a resilient habitat in the riverine flood-prone alluvial plains of North Bihar in general, and the extremely challenged areas of those within the embankments in particular. This involves three key components: Housing, safe drinking water and sanitation. The fourth component informs and contributes to each of the previous three, and focuses on processes of co-existence before, during and after floods. This flood-resilient habitat, is geared towards a planned adaptation intervention that deals not just with floods but also with its concomitant problems.

A flood resilient habitat being piloted in the Teesta flood plains in Bangladesh

Policy Action

Knowledge about the future changes in floods is a prerequisite for formulating adaptation measures to address this hazard. Given the large range in the projections resulting from a large range in possible climatic futures, it is essential to take the full range into account to design robust adaptation strategies.

Although floods are projected to increase practically throughout the entire Indus, Ganges and Brahmaputra river basins, the magnitude of the increase varies spatially and therefore the projections should be consulted for each case separately.

The design of infrastructure in or near rivers needs to take into account the future increases in flooding.

Since floods are projected to increase everywhere in the basins, it is of utmost importance to prepare the communities localized in flood-prone areas. A possible adaptation measure is flood-resilient housing, which proved to be successful in increasing resilience for the most vulnerable communities.

Looking Ahead

A set of region-specific robust climate change scenarios for the Indus, Ganges and Brahmaputra river basins indicates that extreme precipitation events in the basins will increase strongly. As a result, floods will become more frequent and severe throughout the river basins. Depending on the climate change scenario, the severity of flood events is expected to more than double towards the end of the century. Future design of infrastructure in flood-prone areas needs to take into account the projected changes in frequency and severity of flooding events. Similarly, vulnerable communities in areas at risk need to be prepared. Flood-resilient housing shows promise as an efficient adaptation measure to address this hazard.

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

Lutz, A. F., Immerzeel, W. W., Kraaijenbrink, P. D. A., Shrestha, A. B. and Bierkens, M. F. P.: Climate change impacts on the upper Indus hydrology: Sources, shifts and extremes, PLoS One, 11(11), doi:10.1371/journal.pone.0165630, 2016a.

Lutz, A. F., ter Maat, H. W., Biemans, H., Shrestha, A. B., Wester, P. and Immerzeel, W. W.: Selecting representative climate models for climate change impact studies: an advanced envelope-based selection approach, Int. J. Climatol., 36, 3988–4005, doi:10.1002/joc.4608, 2016b.

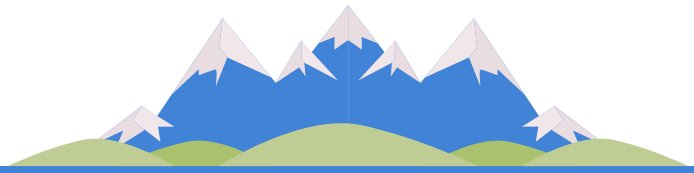
Wijngaard, R. R., Lutz, A. F., Nepal, S., Khanal, S., Pradhananga, S., Shrestha, A. B. and Immerzeel, W. W.: Future Changes in Hydro-climatological Extremes in the Upper Indus, Ganges, and Brahmaputra River Basins, PLoS One, accepted, 2018.

Additional references:

Nepal, S.: Impacts of climate change on the hydrological regime of the Koshi river basin in the Himalayan region, J. Hydro-environment Res., 10, 76–89, doi:10.1016/j.jher.2015.12.001, 2016.

Nepal, S., Flügel, W.-A., & Shrestha, A. B. (2014). Upstream-downstream linkages of hydrological processes in the Himalayan region. Ecological Processes, 3(19), 1–16.

Nepal, S. and Shrestha, A. B.: Impact of climate change on the hydrological regime of the Indus, Ganges and Brahmaputra river basins: a review of the literature, Int. J. Water Resour. Dev., 31(2), 201–218, doi:10.1080/07900627.2015.1030494, 2015.



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