Policy Document
(Executive summary)
on

Impact of climate change on water resources of upper Indus basin (UIB): Major challenges and possible solutions

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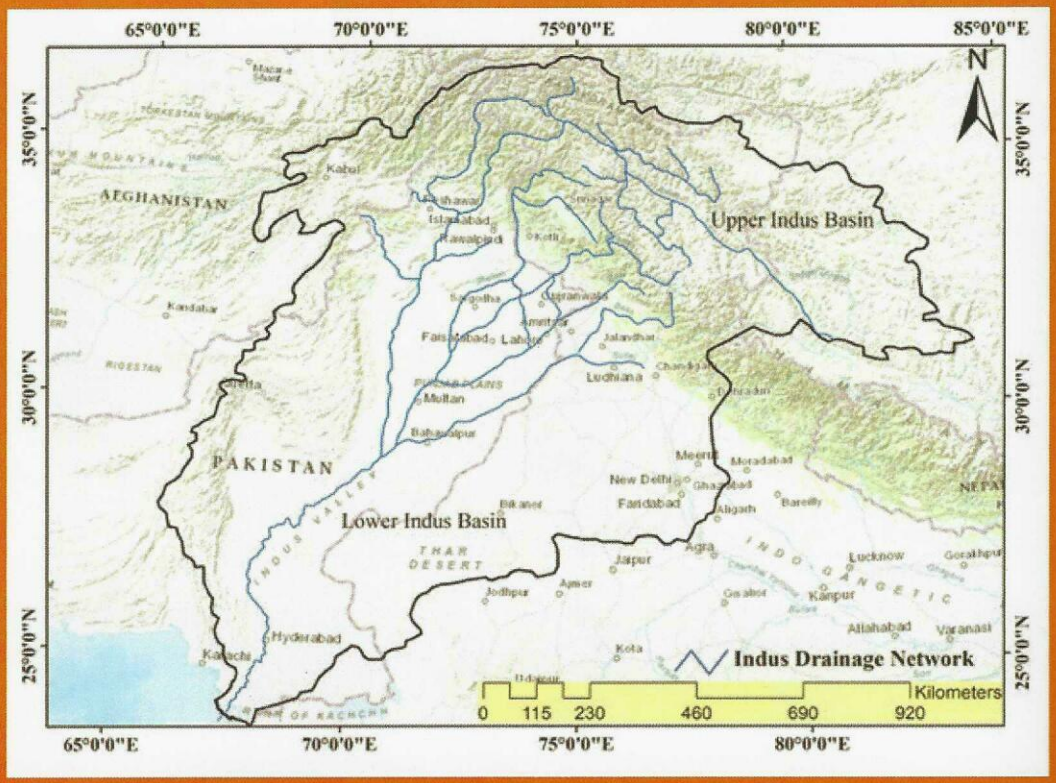
Impact of climate change on water resources of upper Indus basin (UIB): Major challenges and possible solutions

Himalayan rivers are a key source of fresh water to more than 1.3 billion people, supporting one of the most densely populated and water intensive agriculture regions in the world. The various sectors of economy including agriculture, tourism, hydropower are largely dependent on melt water originating from the cryospheric reserves of the Upper Indus Basin (UIB). Moreover, the rich biodiversity of the region is also dependent on the water resources of the basin. The water resources of the UIB are controlled by the behaviour and strength of western disturbances (WDs) and Indian Summer Monsoons (ISMs), which are the two dominant known weather systems bringing precipitation to the region. However, climate change is significantly altering the water resources of the UIB including cryosphere, permafrost, hydrology, etc. Consequently, diverse natural and socio-economic systems both upstream and downstream are adversely affected. If the rise in temperature persists and melt water supply declines, it is likely to threaten the livelihood and survival of more than one-sixth of the global population. It has also been projected that if the current trend of global warming continues there will be around 9% reduction in the glacial areas of the UIB by 2050, which will have a detrimental impact on the water availability for irrigation, power generation, tourism and other water dependent sectors in the UIB.



Indus River Basin (IRB)

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Stemming out of the above concern, a 2 days national workshop on impact of climate change on water resources of UIB was organized at University of Kashmir by Prof. Gh Jeelani and Prof. M S Bhat as UIBN-IC initiative and a run up event of Y-20 consultation summit held under the aegis of India's G-20 presidency. The workshop is well within the Y-20 theme "climate change and disaster reduction- making sustainability a way of life". Besides the participation of local faculty and research scholars, the eminent scientists from Wadia Institute of Himalayan Geology (WIHG) Dehradun, Physical Research Laboratory (PRL) Ahmedabad, IIT Kharagpur, IIT Indore, IIT Roorkee, National Institute of Hydrology (NIH) Roorkee, Indian Institute of Geomagnetism (IIG) Mumbai, Jawaharlal Nehru University (JNU) New Delhi, Delhi University (DU) Delhi, G B Pant National Institute of Himalayan Environment (GBNIHE) Himachal Pradesh, Indian Institute of Science Education & Research (IISER) Pune, Central University of Jammu (CJU) Jammu and Department of Geology and Mining, J&K have actively contributed in the deliberations.

Inaugural photograph of 2 days national workshop on impact of climate change on water resources of Upper Indus Basin

During the workshop deliberations, the experts have expressed their deep concern that cryosphere is shrinking at an alarming rate in the UIB owing to recent accelerated warming trend. However, it was realized that the concern is based on the existing scientific observations and understanding, with scanty data base to derive credible and conclusive inferences. For example, the response of cryosphere to changing climate is usually presented in a generalized manner with little ground based observations from the UIB. There is no robust estimate on volume of the ice and its water holding capacity which is crucial for sustaining the hydrology of the rivers and streams in the region. Similarly, the crucial data pertaining to radiative forcing caused by the atmospheric deposition of the black carbon (BC) on the glaciers is lacking from the region. Moreover, as elevation dependent warming at the higher altitudes is much enhanced compared to its lower altitude counterparts, there is a need for monitoring the albedo change and its impact caused due to the grown exposure of barren rocky slopes related to the snow cover decline at annual and seasonal scale.

The variability and strength of the two dominant weather systems viz., WDs and ISMs has been observed for last several decades indicating a pervasive impact on the water resources of the Hindu Kush Himalayas in general and UIB in particular. This unusual behavior of WDs and ISMs is not yet fully understood. The experts were of the opinion that these weather systems need to be studied in light of the fluctuating behavior and mechanism of precipitating and non-precipitating WDs and ISMs under changing temperature and moisture inputs. In addition, the recent climate and weather data indicates that the severity and frequency of the extreme weather events is increasing and threatening the livelihoods and critical developmental infrastructure in the region. For example, the experts were of opinion that it is not only the extreme precipitation events that are responsible for the observed destruction in the region, but also the vast mass of unconsolidated sediments left behind by the receding glaciers locked in various amphitheater valleys that are potentially dangerous for human life and infrastructure. The classic example in the recent times of such a phenomenon is the debris flow induced disaster that led to the loss of more than 250 lives and colossal damage to infrastructure on August 2010, in Leh town of UIB.

The deliberations also identified various geological hazards which need to be investigated for the safety of the people and assets in rugged terrain of UIB. For example, a comprehensive study pertaining to the nature and distribution of unconsolidated sediments locked in various glacially vacated valleys and their quantification must be carried out to formulate a robust area specific disaster risk reduction (DRR) plan so that vital infrastructures and the lives of the people can be saved. Another major concern raised by the panelists was the floods caused essentially due to the failure of glacial lakes known as Glacial Lakes Outburst Floods (GLOFs). A preliminary study presented by an expert identified ~300 potentially hazardous lakes among more than 2000 glacial lakes in the UIB. Therefore, a thorough investigation focusing on exposure levels, vulnerability and hazard assessment and simulation of risk scenarios in context of flash floods and GLOF must be initiated on priority in the region.

The Indus River and its tributaries are known for generating high magnitude floods in the historical and geological past. The real time monitoring data pertaining to the flood history seldom go beyond last 50 years. In order to have a predictive model for the magnitude and frequencies of the floods in UIB it has been suggested that there should be a comprehensive study on the sediment record of past floods going back to at least last couple of centuries, with a doctrine PAST AND PRESENT IS THE KEY TO FUTURE.

Owing to vast concentration of cirque glaciers and steep snow-laden slopes UIB is prone to avalanches, especially during winter, where vulnerable sections of the society in general and defence forces in particular suffer many causalities. Although the already conventionally identified winter avalanche prone zones are being monitored to some extent, the exact distribution and prioritization of avalanche prone zones during other seasons is almost missing. However, under the global warming scenario, there are studies to suggest that the timing of avalanche seems to have shifted towards late spring season due to the presence of wet snow. According to the experts who participated in the workshop there are innumerable slopes having scanty glacier patches in their upper reaches, likely to serve as new locations for wet snow accumulation, are going to be the potential sites for triggering the avalanches during the spring season. Considering the strategic significance and fast grown infrastructures, we need to revisit our approach towards assessing the threat posed by the avalanches in this region.

One of the major concerns raised by the experts is the drying up and/or fast-depleting groundwater fed springs and glacier fed streams (and groundwater). These water bodies are the life line of the marginal communities including more than 200 villages and a few urban towns in the UIB. Unfortunately, till date there is no reliable data on the quantified estimate of the groundwater in the region, although there are vast sedimentary deposits and fractured/weathered rocks which could be potential groundwater reservoirs. It is reasonable to assume that many of these deposits are the transient repository of the vital groundwater resource and if judiciously harvested, it can supplement the local requirement during the lean season. However, while harnessing the groundwater, it must be kept in mind that the water is potable and free from chemical contaminants which are usually found in waters having prolonged interaction with rocks and sediments of igneous origin. For example, high arsenic, one of the most toxic elements in water, is already reported in some wells in the region.

There was an overwhelming concern among the experts, that with the steady decline in the cryosphere cover and early melting of snow, the water availability during summer, when it is required the most for irrigation, may not be available in near future. It has been realized that there is, so far, no study focused on the water availability for the settlements that are located close (within 30 km) to cryosphere elements such as glaciers, permafrost and snow. These villages predominantly dependent on melt water from snow deposits and glaciers flowing down the valley from the higher reaches. Even though the people of the region are habituated to surviving in water-scarce situations based on their traditional knowledge and practices. The recent changes in weather patterns are impacting the water sources which call for revisiting the traditional water harvesting techniques of the local inhabitants blending it with the modern technologies, e.g., the innovative and effective adaptation measures such as creating multiple surface storages/reservoirs including artificial glaciers through check dams. Such measures would help in supplementing the water requirement for the irrigation and also for domestic consumption when it is required the most.

Along with the thinning down of glacier cover and decrease in the annual snow fall, concern raised by the experts during the proceedings of the workshop was the threat posed to the permafrost- a terrain which is permanently frozen and occurs in areas with below freezing point temperature. The sediments in the permafrost region contain significant amount of decayed organic material and are insulated from atmospheric interaction. Besides this, it also contains appreciable amount of greenhouse gases including the methane. Some of the experts working in this field have noticed that thawing of permafrost is steadily increasing in UIB as a consequence it is feared that the locked organic matter and the greenhouse gases are likely to contribute towards the increase in the localized warming trend. If that happens it would not only deplete the vital frozen water from the permafrost but is likely to accelerate the thawing of cryosphere consequently destabilization the precariously stabilized paraglacial debris slopes.

The UIB relies heavily on the floating population of tourists which is exponentially increasing every year. According to a conservative estimate, during 2023, more than 1.5 crore tourists visited the ecologically fragile region with a host population of a few hundred thousand only. Such a large floating population is heavily taxing the sensitive natural resources of the region. Since the tourism industry is the major source of economy, we have to assess the terrain carrying capacity so that its sustainability, ecological fragility and economic growth should not be jeopardised.
Finally, the experts have realized that there is an urgent need to investigate the impacts of climate change on the water resources of upper Indus basin (UIB) for societal, scientific and policy relevance in a comprehensive coordinated and time bound manner involving multi-institutional and multidisciplinary approach. In this context we are in a process of formulating a multi-institutional and multidisciplinary major research project to address and redress the range of ecological, environmental and societal problems of the UIB and suggest the viable sustainable solutions.
Pertinently the joint effort is in line with the objectives of climate change mitigation, disaster risk reduction and sustainable development related global programmes such as Paris Agreement (2016), Sendai Framework for Disaster Risk Reduction (2015-2030), Sustainable Development Goals (2015-2030) and G20 Presidency (India) and the national missions including Prime Minister's (PM's) 10 point agenda for DRR, National Mission for Sustaining Himalayan Ecosystem, National Mission on Himalayan Studies and Sustainable Infrastructure Development.

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