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Climate Change in the Tibetan Plateau Region: Glacial Melt and Future Water Security

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Key Points

- Climate change will have severe impacts on the Asian monsoon and the Himalayan glaciers.
- Increased glacial melting in the Himalayas, accompanied by increasingly unpredictable rainfall patterns, will have dire consequences, not only for food and water security, but also for the future of energy supplies in the Tibetan Plateau region.
- Nations in the region are taking important mitigation and adaptation steps. Such efforts need to continue and be supported by more government investments.
- If the region is to avoid any future disputes over water sources, persistent issues, such as water ownership and mutual distrust, need to be addressed. Multilateral agreements on these issues are essential.

Summary

The impacts of climate change in the Tibetan Plateau region, stemming from rising temperatures, increased variability in precipitation, extreme weather events and rising sea levels are likely to transcend environmental concerns and have severe socioeconomic implications.

Hundreds of millions of people depend on melt water from the Himalayan glaciers for their livelihoods. Over the past decade, annual mean rainfall has declined in the arid plains of Pakistan, and Northeast India. Meanwhile, parts of India, Nepal, and Bangladesh have seen an increase in extreme rainfall events. These changes, coupled with increasing glacial melt, have led to growing concerns regarding the future of water security in the Tibetan Plateau region.

States within the region are taking steps towards building climate resilience. A number of strategies have been put in place to assist their adaptation to climate change. No multilateral agreements have, however, been achieved. If the region is to mitigate potential competition and tensions over available water, while building climate change resilience, cooperation on a multilateral level is essential.

Analysis

The Tibetan Plateau covers an area of approximately 2,500,000 km^2. The glaciers in the Himalayans and Karakoram ranges cover a total area of approximately 40,800km^2 and are the sources of the major river systems of the Tibetan Plateau region. These glaciers supply water to almost 1.5 billion people in Asia; almost a quarter of the world's population. Estimates indicate that approximately six to 45 per cent of flows in the major rivers are dependent on glacial melt; this increases to 70 per cent in summer.

Reports indicate that the glaciers in the Himalayas are melting rapidly. An increase in glacial melt could cause significant disruptions to the region's future water security. The countries that depend most on water from the Tibetan Plateau are Bangladesh, Bhutan, China, India, Myanmar, Nepal, Pakistan, Thailand and the countries of the Mekong sub-region, Cambodia, Laos and Vietnam.

One in every five people in South Asia does not have access to safe drinking water and 1.8 billion people lack access to basic sanitation. With the regional population expected to exceed 2.2 billion by 2050, expanding access to safe water sources will prove challenging. The predicted decrease in water availability induced by climate change, therefore, will only exacerbate the situation.

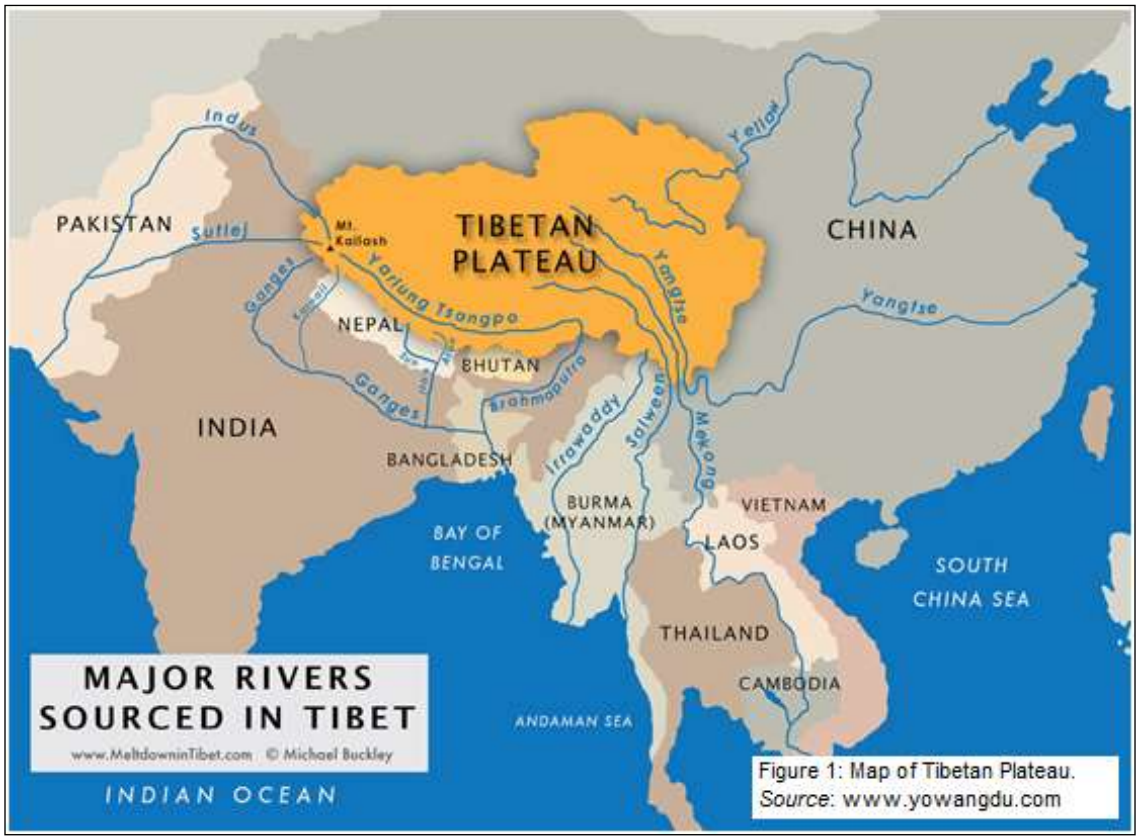

Figure 1: Map of Tibetan Plateau.
Source: www.yowangdu.com

Predictions on climate change

The latest Intergovernmental Panel on Climate Change (IPCC) report (2014) predicts that the Himalayan glaciers could lose between a third and half of their mass by 2100. Having revised previous predictions, which suggested total glacial melt in the Himalayas by 2035, the latest IPCC report still recognises the problem as a high priority issue. According to the IPCC an average surface temperature increase of 1.8 degrees Celsius from 2006, will result in glacial shrinkage of up to 45 per cent by 2100; with an increase of 3.7 degrees, the reduction would be closer to 68 per cent. Other studies have found that in the last three to four decades, warming in the Himalayas has been more than the average of 0.75 per cent over the last century. Some have confirmed that it is warming five to six times faster than the global average.

Climate change is also affecting the Asian monsoon. Official studies show the monsoon is erratic in four out of every 10 years. In 2012, specialists found a 4.5 per cent decline in monsoonal rain in the three decades to 2009. The simulations from the World Climate Research Programme's Third Coupled Model Inter-comparison Project predict that climate change will result in increased monsoonal precipitation over South Asia, East Asia and the western Pacific Ocean. Increased precipitation, along with increased glacial melting, could potentially have devastating consequences; as witnessed in Pakistan in 2010 when a fifth of the country's total land area was affected by flooding.

The height of the Himalayan mountain range has contributed to the development of the monsoonal rainfall pattern. Changes in the mountain region due to glacial melting could therefore have a direct impact on the monsoon. The monsoon is extremely important for

the farmers of the region, who rely on its rains for food production. In India alone, monsoonal rainfall contributes 85 per cent of the country's annual rainfall. Changes to monsoonal rainfall patterns could affect agricultural productivity and thus reduce food security.

Uncertainty

In 2012, a report by the UN Environment Program's global environmental alert service identified that a lack of reliable and consistent data was impeding the gathering of scientific knowledge on the state of the Himalayan glaciers. Uncertainty surrounding the effects of climate change on the glaciers, as well as the constitution of the glaciers themselves, makes it difficult to identify the most effective ways to counteract the effects. Scientists have discovered that some glaciers in the Karakorum Range are in fact advancing. In their report, they suggest that the amount of debris – rocks and mud – strewn on a glacier's surface plays an important role in whether that glacier melts. Conflicting data regarding climate change impacts on the Himalayan glaciers highlights a need for further research and data collection. This will require significant investment from regional states to obtain more accurate information on the composition of the glaciers and the impacts of climate change.

Current emissions

China is the world's biggest emitter of greenhouse gases. In 2011, a fifth of the world's total fossil fuel carbon dioxide emissions came from China's coal, which was also responsible for more than 80 per cent of the country's eight gigatons of fossil fuel emissions that year. India is also amongst the biggest contributors to fossil fuel emissions, with its carbon dioxide emissions having increased by 7.7 per cent from 2012 to 2013. Greenhouse gases, natural and human induced, are the major factor behind climate change. In the past century, human activities have substantially increased the amount of those gases in the atmosphere, resulting in global warming. Because bigger states are producing the bulk of those emissions, it is important that they take the lead in reducing emissions.

A study by Ramanathan et al. in 2007 demonstrated that 'atmospheric brown clouds' consisting of aerosols, particularly black carbon soot, play an important role in glacial melting[1]. Small cooking stoves burning wood, especially in India and China, release soot. When snow absorbs these particles, it becomes darker and starts absorbing more sunlight, resulting in glacial warming. Proposed actions to mitigate such effects and adapt to climate change impacts must take into account household practices that contribute to warming if they are to be effective.

[1] Ramanathan A, et al. (2007), "Warming trends in Asia amplified by brown cloud solar absorption", *Nature*, vol. 448, pp. 575-578

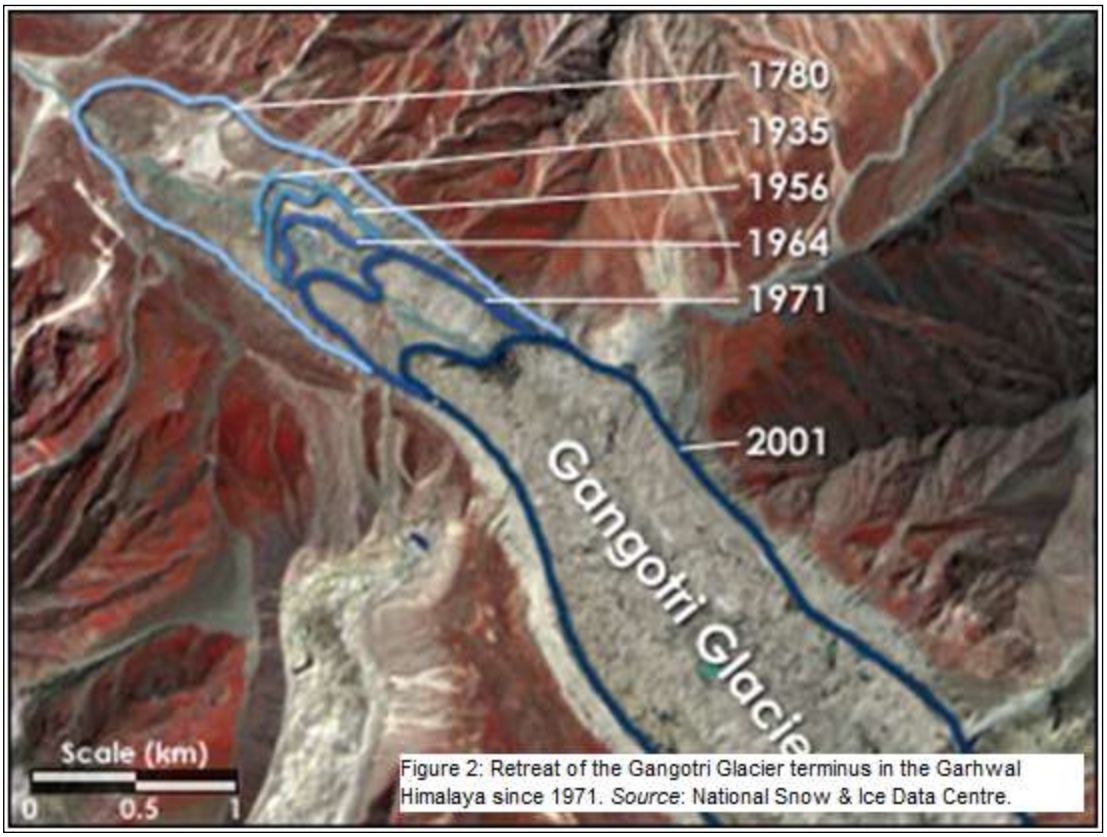

Figure 2: Retreat of the Gangotri Glacier terminus in the Garhwal Himalaya since 1971. *Source*: National Snow & Ice Data Centre.

Climate Change Impacts

Nearly 20 per cent of the world's population depends on the freshwater rivers fed by the Himalayan glaciers. Because glaciers are melting faster than they are accumulating ice, the Himalayan region stands to lose its glacier 'insurance' in the long-term. Climate change induced water scarcity will negatively impact the region's agricultural productivity, energy production and the health of its population.

Glacial shrinkage and rising temperatures

Temperature increases and glacial melt will provide more water in the short-term. Predictions indicate that the quantity of run-off water from melting glaciers will rise until at least 2050. Coupled with increased precipitation, more run-off water will lead to increased flooding events. These, in turn, will increase the risks of diarrheal diseases due to deterioration in the quality of drinking water. The incidence of waterborne diseases, such as malaria or cholera, is likely to grow. A proliferation of mosquito infestations is also expected.

The increase in intense rain events will also have a negative impact on fisheries. Bank scouring will destroy in-stream ecosystems and flush nutrients further downstream, reducing river health. This will reduce fish spawn survival and, in the long–term, the number of adult fish available for consumption.

Rising temperatures are creating thousands of unstable glacial lakes in the Himalayas. The growing volume of melt water dangerously increases the risk of flooding from sudden glacial lake outbursts. Breaches would discharge a huge volume of water and debris, causing many casualties, the demolition of critical infrastructure, and the destruction of agricultural fields, resulting in food insecurity.

Over the long-term, glacial shrinkage will reduce water supplies in dry seasons, creating increased variability in water availability. The region can expect to experience shorter, more intense, rainfall and lengthier drought periods. The fertile plains of the Ganga, Indus and Brahmaputra depend on the rivers flowing from the glaciers. Reduced water availability and lengthier drought periods will diminish regional agricultural productivity. The World Bank has estimated that crop yields could decline by up to 30 per cent in South Asia by the mid-21st century. Higher temperatures are also expected to result in a decline in rice yields. Fish production will also face losses due to rising temperatures, reduced precipitation and more droughts, as overall river flow reductions affect fish migration.

Countries in the region are increasingly turning to hydropower to meet their energy demand. Seasonal melt water is the main source of power for hydroelectric dams on the glacier-fed rivers. Estimates indicate that a one per cent reduction in stream flow could reduce electricity output by roughly three per cent. Changing river flows could, therefore, have important consequences for energy production in the region.

The food and water security of almost two billion people in South and Southeast Asia will be affected by alterations to the water cycles of the Tibetan Plateau. Because the region is one of the fastest growing in the world, climate change impacts will further strain its capacity to supply food and water, thereby inhibiting the potential for food security.

Increased monsoonal variability

Rainfall contributes 59 per cent of the flow of the Indus River and 85 per cent of this is received during the monsoon. There is, therefore, a need to make water storage a priority. Moreover, with declining monsoonal periods, aquifers are less likely to receive the water required to replenish groundwater supply.

Crops are extremely sensitive to changing rainfall patterns. They can easily be destroyed if not subject to the right climatic conditions. Increasingly unpredictable rainfall patterns, accompanied by the potential development of El Nino weather conditions during the monsoon, have the potential to wipe out crops, resulting in food insecurity for an entire season.

Changing rainfall patterns have serious consequences for peoples' livelihoods. Smallholder farmers are often forced to take out loans to buy seeds to sustain agricultural production. The destruction of an entire season's production pushes farmers into debt and increases the price of food. Consequently, levels of poverty also rise. Between 2010 and 2012, according to The Parliament of India, 5,535 Indian farmers committed suicides because of debt and loss of livelihood caused by drought and crop losses.

Climate change will have dire socioeconomic consequences for the Tibetan Plateau region. Glacial melt in the Himalayas presents a severe threat to long-term water security, affecting some 1.5 billion people on the Plateau and in downstream states. Food security, energy production and health security are also severely threatened by climate change. Those impacts need to be addressed rapidly and effectively; and mitigation and adaptation strategies must be put in place. Failure to do so will increase the already serious risk of regional insecurity.

Actions on climate change

Mitigation

If China does not curb its coal use, forecasts predict that it will exceed 15 gigatonnes by 2030. This would make it almost impossible to keep global warming from exceeding an increase of two degrees and avoiding the most severe effects of climate change. It is, therefore, crucial that states commit to the mitigation of climate change and the reduction of emissions.

China has committed to reducing its CO_2 emissions by 40 to 45 per cent per unit of GDP below 2005 levels by 2020, through a reduction in fossil fuel use. The country also aims to cut energy consumption by more than 3.9 per cent in 2014, resulting in a decrease in coal consumption of 220 million tonnes. China is a world leader in renewable energy production. It possesses the largest installed capacity of wind farms and is the highest producer of hydroelectricity worldwide. In 2012 alone, China invested US$67.7 billion in clean energy. In September 2013, the Chinese government announced an anti-smog plan that would cut the country's reliance on coal to less than 65 per cent of its energy needs by 2017, down from 66.8 per cent in 2012.

In India, the National Action Plan on Climate Change was established in 2008. The Plan sets the goal of improving water use efficiency by 20 per cent, through pricing and other measures. Other targets include the conservation of biodiversity, the re-afforestation of six million hectares of degraded forest lands, the support of climate adaptation measures in agriculture and gaining a better understanding of climate science, impacts and challenges. Budgetary allocations for the Plan, however, have been inadequate and progress so far has been slow.

To address the problem of soot particles released from cooking stoves, in 2009 the Indian government launched the National Biomass Cook Stoves Initiative. The project's objective is to provide efficient cooking stoves to rural areas, in an effort to reduce air pollution. Projections suggest that over four per cent of India's estimated greenhouse emissions could be avoided if that initiative succeeded.

Although China, and to a lesser extent India, are making critical mitigation announcements, only following through from policy to action will make a difference. The extent to which both countries will commit to implementing their declarations remains to be seen.

Adaptation

While tackling climate change through emissions reduction is critical to reduce predicted impacts, adaptation to changes is equally important in sustaining livelihoods.

In India, an estimated 40 to 50 per cent of supplied water is wasted through pipe leakages. Addressing this issue would considerably reduce the strain produced by increasing water demand. Any reduction in the amount of wasted water would help in alleviating pressure from climate change impacts on water availability. To this end, Australia is helping India strengthen its water resources management through the India-Australia Water Science and Technology Partnership.

Cambodia, the Lao People's Democratic Republic (Lao PDR), Bangladesh and India have agreed to cooperate in developing multi-scale climate change adaptation strategies for farming communities. The project has already developed a number of successful practices, including: the double cropping of monsoon rice, using short-duration varieties; the use of improved rice varieties (including drought and inundation tolerant species); and the implementation of strategic irrigation. Altering crop varieties in response to climate change is an important strategy to sustain livelihoods and reduce the vulnerability of rural populations.

In Bangladesh, floating gardens have been introduced in the Gaibandha district, which is affected by floods during the monsoon. Floating gardens are inexpensive, sustainable and allow farmers to grow food on flooded lands. Although the raw materials to build the raft are not always available and gardens sometimes need to be set up at a distance from the household, floating gardens offer an agricultural alternative and sustain food production under climate variability.

More investment is needed to further understand climate change and to develop more adaptation strategies. Greater regional cooperation is needed to effectively adapt to climate change and mitigate its effects.

The importance of multilateralism

To effectively address climate change impacts on water security in the Tibetan Plateau region, there is a need for a regionally integrated water resources management approach. Important factors such as soil health, erosion and land-use management must be considered to increase agricultural productivity and hydropower production while conserving natural resources. To achieve these goals, investment is essential to improve technology and infrastructure. This will prove a formidable challenge for most States in the region, which are not only faced with climate change, but also population growth and rapid urbanisation.

To reduce the risk of competition for decreasing shared water sources, greater regional cooperation is required. No multilateral water agreements have yet emerged in the region. As the Hindu Kush-Himalayan Network Consortium pointed out in 2010, cross-border cooperation for water governance, management and long-term security is crucial. The

consortium suggested the establishment of a cross-border governance framework, to allow for greater cooperation and information sharing.

Persistent issues

A number of issues stand in the way of greater regional cooperation to adapt to climate change and mitigate its effects. Firstly, sovereignty concerns continue to be a priority for governments, thus undermining regional interests. Energy security is also often prioritised over environmental conservation. Finally, mutual distrust obstructs effective political action. Strengthening cooperation on climate change adaptation and mitigation across the Sino-Indian border is a paramount issue for a positive water future in the region.

Although China is seemingly responding to climate change impacts, it still remains one of the only nations without any institutionalised water sharing agreement with downstream countries. This has long concerned its regional neighbours, given China's control over the sources of all the major rivers in the region. It is important that Beijing prioritises engagement with its neighbours through multilateral agreements to increase regional water security. China, however, has little incentive to do so at present.

Conclusion

Climate change is expected to have a significant impact on food and water security in the Tibetan Plateau Region. Although data on the effects of climate change, and particularly on glacial melting is conflicting, it is evident that changes in precipitation and temperature increases are leading to increased vulnerability in the region.

Climate change is affecting the seasonality of rainfall, which impacts agricultural productivity, health, food and water security, and the stability of states. An overall reduction in annual precipitation is further straining water availability.

The Tibetan Plateau is a densely populated region, which is still experiencing rapid growth rates. With a large percentage of the region's population already living in poverty and without access to freshwater, climate change has the potential to exacerbate water insecurity and other vulnerabilities across in the entire region.

Environmental changes are set to reshape the dynamics of transboundary water sharing in the region. To ensure sustained water security within the Tibetan Plateau Region and prevent socioeconomic, resource and political tensions from escalating, the priority must be placed on greater regional cooperation.

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