Meticulous modelling

Ir Eddy Moors discusses glacial retreat in the Himalayas and the need for improved climate and hydrological modelling for the development of adaptive solutions to help the region continue to thrive

What is the primary function of the HighNoon project? What inspired its creation?

The project tackles the climate change induced impacts on glacier and snow melt in the Himalayas and the differences in precipitation – especially monsoon timing and location. These changes are affecting the water resources of the Ganges river basin. At present there is a knowledge gap on the extent and the timing of these changes. The HighNoon project contributes to the improvement of the regional climate modelling and hydrological modelling. The aim is to improve our understanding of the expected changes in water resources in the region. Based on these findings the HighNoon project is developing adaptation measures to mitigate the possible consequences of the changes in water resources as well as the possible changes in water demand due to socioeconomic changes. In order to achieve realistic options, a participatory approach is used.

How is climate change affecting the hydrological system of Northern India? What impact is this having on the environment, people and economy of the region?

There are two main issues. The first is the temperature rise and change in snowfall in the Himalayas, mainly causing changes in the hydrological system in the upstream parts of the Ganges river basin. These changes in the hydrological regime may cause glacier lake outburst flows and/or reduced water available for eg. hydropower generation. The second issue is the change in precipitation, which may affect the present agricultural practice, especially of rain-fed crops, but may also increase irrigation water demand.

What impact is climate change having further down the perennial rivers of the north: The Ganga, Indu and Brahmaputra? Does a change in the North affect the whole country?

The effects of glacier and snow melt in the Himalayas are reduced further down the river; it will be almost negligible at the lower part of the river. The changes in monsoon precipitation will be different in different parts of the country. Because food production and consumption is not restricted to district or state boundaries, changes in one state will affect other states as well.

What is the current rate of glacial retreat in the Himalayas? How does this compare with the natural rate and climate change predictions?

This is a complicated question to answer and at present there is no straight answer. Generally speaking, the presently available datasets suggest a significant decrease in volume of the smaller and lower lying glaciers. The glaciers in the Eastern part of the Himalayas show a tendency to decrease while some of the glaciers in the western part show a tendency to increase. However, the data coverage is low and no definitive number can be given.

Furthermore, what are the projected long-term implications of climate change on the spatial and temporal distribution of water resources in Northern India in relation to the Indian summer monsoon?

The regional climate models that were run for the HighNoon project show a clear increasing trend in average temperature, and a large variability – both in time and space – in precipitation. The average precipitation data for the Ganges basin does not show a clear trend. However, at smaller spatial scales there are trends in precipitation but they differ from one area to the other.

What progress have you made in the development of appropriate and efficient response strategies for extreme hydrological events? How prepared is the region at present?

At present we are still working with the stakeholder groups in the phase of assessment and acknowledgement of the historic and present situation. We are using this phase of the stakeholder process to develop awareness of the consequences of possible future changes due to climate change and/or socioeconomic changes. For this we developed a framework to involve stakeholders at different levels which we are implementing at three case study sites distributed along the Ganges river basin.

Are there any other aspects of you work that you would like to discuss?

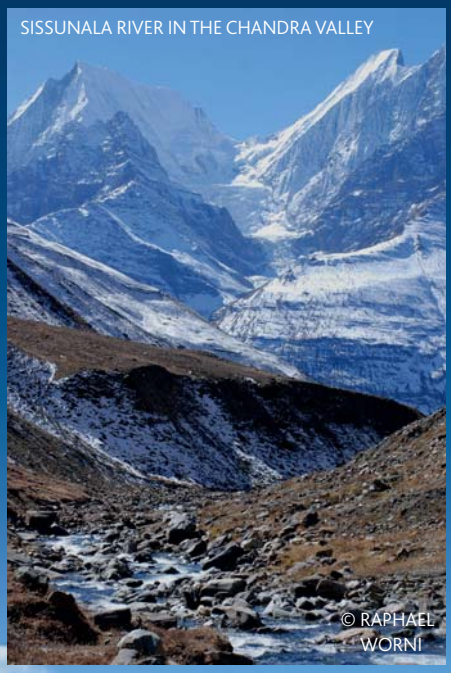
Another important part of the HighNoon project that needs to be stressed, besides the biophysical changes related to climate change, are the socioeconomic changes that are taking place and that are foreseen for the future. Climate change primarily drives water availability while the latter drives the water demand. In view of the limited water resources available during critical moments in the year the major challenge is to develop a partitioning of the water resources such that it encompasses sustainability in combination with prosperity and equity.

Adapting to the flow

Climate change is widely analysed from a biophysical point-of-view, however the socioeconomic consequences can be just as drastic. The **HighNoon** project investigates both sides of the story in the Ganges river basin

THE GANGES RIVER permeates many areas of life as it flows from the western Himalayas in Northern India into Bangladesh before emptying into the Bay of Bengal. Spiritually, it is the most important river for Hindus, who worship at the river by bathing in it to pay homage. Not only a source of spiritual significance, the river also provides physical nourishment and support to millions of Indians living along its riverbanks and some 500 million people living around its basin.

Based on discharge, the Ganges falls in the top 20 of the world's rivers. Its water is especially vital to roughly two-thirds of India's population who rely on agriculture for their livelihoods. Water from the Ganges basin is important for all major sectors, from agriculture and power generation to domestic water supply. In northern India, this water is supplied by two different sources. The first is from the thousands of Himalayan glaciers that compose the largest body of ice after the polar caps. When these glaciers melt naturally with the changing of the seasons, their run-off forms a reservoir which supplies water to the Ganges and other rivers in the area, such as the Indus and Brahmaputra. The second source of water for this region is from India's monsoon season, which runs from June to September.


SISSUNALA RIVER IN THE CHANDRA VALLEY

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Any changes in these water supplies would have a major impact on human wellbeing and ecosystem functioning. Unfortunately, as a result of climate change, many short-term and long-term effects are taking place and changing the status quo of the region. An increase in river productivity in the north is expected to take place in the short term, as rising temperatures from climate change are expected to melt greater portions of the glaciers than in the past. Though this means a more abundant water supply for the present, in the future this will result in a decrease in flow, as the glaciers will have receded and be unable to recover in increased temperatures.

India's monsoon season is also being affected by climate change, which is partly controlled by snow cover and the time of the year in which snow falls on the mountains. The current trend of colder winters with more snowfall causes the snow to cool down the summer air. Since monsoon formation relies on a warm temperature gradient, the result is a less severe monsoon season. Data from the historical period showed that a reduction of 15 per cent of the Summer Monsoon Rainfall is associated with a reduction of 9 per cent of the food grain production. The states of Rajasthan, Gujarat, Madhya Pradesh, and in the northern part of Maharashtra and the southern parts of Bihar and Uttar Pradesh are expected to be hit the hardest.

Recognising these changes and the challenges they pose, the HighNoon project has been formed to predict the negative effects of these changes in the hydrological system of Northern India and to implement adaptive measures. Project Coordinator Eddy Moors explains the project's ambitions: "The HighNoon project aims to improve the existing knowledge on the future changes in glacier and snow melt as well as changes in monsoon precipitation. The project will provide among others an estimate on changes in glacier volume based on available in situ station data and remote sensing images. In addition a measurement station will be installed at the outlet of one of the smaller glaciers in the Ganga Basin as a small contribution to help improve the data coverage, also after the lifetime of the project". The data will go a long way to help researchers understand the effects of climate change on the area, as current data contains many gaps and conflicting measurements.

DIVERSE TARGET AREAS

The efforts of the HighNoon project are anticipated to result in applicable adaptation measures as a result of improved climate


GOPGANG GATH GLACIER LAKE

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modelling. The models will allow the project members to form realistic scenarios for snowmelt and monsoon patterns and regional socioeconomic scenarios, all of which will lead to better understanding and assessment of the changes taking place in India's water resources.

The adaptive strategies developed by HighNoon are expected to help three different areas to cope with changes: biophysical vulnerability, social vulnerability, and technological vulnerability. The project has adapted a multi-sectoral approach to combat the effects of climate change and aims to make changes at both the local level with citizens, and on a governmental level through policy changes: "At present we are with the stakeholder groups still in the phase of assessment and acknowledgement of the historic and present situation," Moors points out. "We are using this phase of the stakeholder process to develop awareness of the consequences of possible future changes due to climate change and/or socioeconomic changes."

The first target area, biophysical adaptation, means project members will be looking into diversifying the region's crops and promoting more tolerant crop varieties that have a greater chance of withstanding the shorter vegetation time that results from the delayed onset of monsoon season. Secondly, HighNoon will work to construct adaptive models for social vulnerability, thus highlighting the socioeconomic consequences of climate change on the population. This target area relies heavily upon promoting education for the villagers and other stakeholders. The project will look at how villagers spend their profits in time of wealth and crop abundance to assess their sustainability and benefit for future generations when the availability of water resources are changing. Finally, adapting to technological vulnerability is another key area of concern. This sector will take measures to support new irrigation technology, and improve water conservation and harvesting techniques.

ASSEMBLING ALLIANCES

The work being undertaken over the course of HighNoon's lifespan will benefit from several key partnerships to achieve its goals. The project consortium includes three Indian institutes and will collaborate largely with other projects such as the Integrated Project Water and Global Change (WATCH) project, a European Union's Sixth Framework Programme (FP6) supported programme. Similar to HighNoon, WATCH is focused on understanding the relationship between water cycles and resources and the effects of climate change. Its target area is not just limited to India, but also branches into the implications for Europe.

It is also a priority for HighNoon to spread awareness of the situation that the Ganges river region is facing to the general public. Moors sheds light on how the project benefits from outside collaborators and intends to share its results with the wider public: "The HighNoon project works with the different stakeholders in the case studies and organises knowledge dissemination events such as conferences, summer schools and distributes newsletters. All these activities are aimed to commit people to the objectives of the HighNoon project."

This work is particularly important as India continues to thrive as a country both socially and economically on the world scene. An increasing population and financial growth will put an even tighter strain on the country's water demand in terms of food and electricity production and across a diverse number of additional sectors. These needs, compounded by additional stress from climate change, will raise new challenges for the country and for researchers.

INTELLIGENCE

HIGHNOON

CLIMATE ADAPTATION

OBJECTIVES

To assess the impact of Himalayan glaciers retreat and possible changes of the Indian summer monsoon on the spatial and temporal distribution of water resources in Northern India and to provide recommendations for appropriate and efficient response strategies that strengthen the cause for adaptation to hydrological extreme events.

PARTNERS

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The Energy and Resources Institute, India

UK Met Office, UK

University of Salford, UK

Indian Institute of Technology, Delhi, India

University of Geneva, Switzerland

Max Plank Institute for Meteorology, Germany

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HighNoon