

WATCH-HighNoon Open Science Seminar
Future of water resources in India under a changing climate
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Impacts of glacier retreat on Himalayan water resources

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SAGARMATHA Project Snow And Glacier Aspects of water Resources Management in The Himalaya



environment

As politicians from around the world meet in Bonn to try to rescue the climate talks from failure, **Paul Brown** reviews the snail-pace of progress and considers the future

Melt down

Four years ago, at a time when global warming was still a fringe issue, the United Nations World Commission on Damages and Losses (UNWCLD) published a report that predicted that the world's glaciers would melt by 2035. At the time, the report was widely regarded as a worst-case scenario. But now, as the world's glaciers melt at an alarming rate, the report is being seen as a prophecy.

Each year, an estimated 280 billion tonnes of ice melt from the world's glaciers. This water then flows into the world's rivers and oceans, raising sea levels. The report predicted that by 2035, the world's glaciers would have melted to the point where only 10% of the original ice would remain.

The report also predicted that the world's glaciers would melt at a rate of 30 metres per year. This is a significant rate of decline, especially in the central and eastern Himalayas, where the glaciers are melting at a rate of 15 metres per year.

Glaciers cover around 17 per cent of the Himalayas and contain thousands of cubic kilometres of water. Taken together with those on the neighbouring Tibetan plateau, they represent the largest body of ice on the planet outside the polar regions. For them, their meltwater makes up two-thirds of the flow of great South Asian rivers such as the Ganges, on which hundreds of millions of people depend.

But Hasnain's working group on Himalayan glaciation, set up by the ICSI, has found that glaciers are melting faster in the Himalayas than anywhere else on Earth. Hasnain says that as the glaciers disappear, the flow of these rivers will become less reliable and eventually diminish, resulting in widespread water shortages.

Meanwhile, the retreating glaciers have formed dozens of premature meltwater lakes. Water accumulation between the lip of the glacier and the ground of debris and rock, known as a proglacial lake, is a common sight in mountainous areas. These lakes burst, releasing enormous amounts of water, which has caused significant damage to nearby communities.

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Meltdown!

Glacial lakes may look the picture of tranquillity but in fact, they are a very real threat to thousands of people.

Ecology
Warming doubles glacier melt

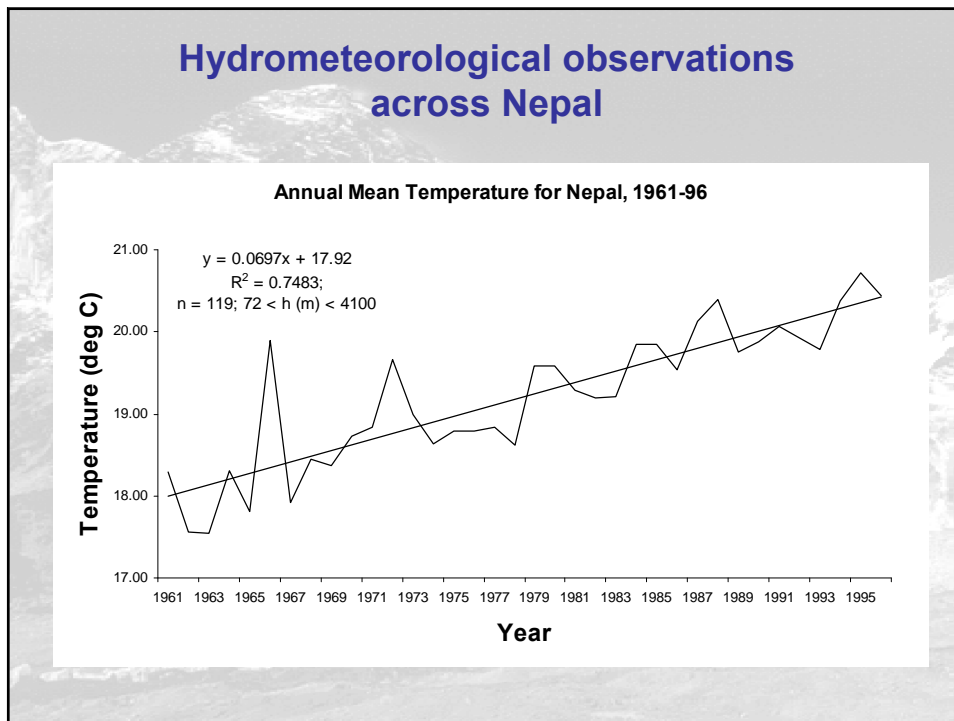
four-year study indicates that all the glaciers in the central and eastern Himalayas could disappear by 2035 at their present rate of decline.

'These lakes burst, releasing enormous amounts of water'

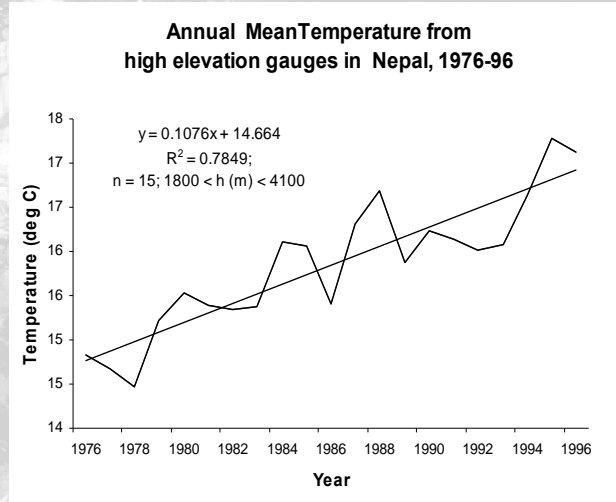
Hasnain warns that as the glaciers disappear, the flow of these rivers will become less reliable and eventually diminish, resulting in widespread water shortages.

African snows will be gone in 30 years

Global warming will destabilise entire regions, say scientists. **Lewis Smith** reports from Royal Geographical Society



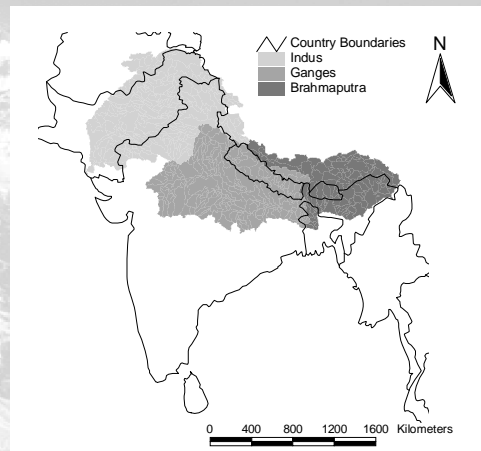
Hydrometeorological observations across Nepal



Assessing impacts on water resources

Develop a **macro-scale** model for the Indus, Ganges and Brahmaputra basins

... incorporating the first **regional glacier-melt** model



Assessing impacts on water resources

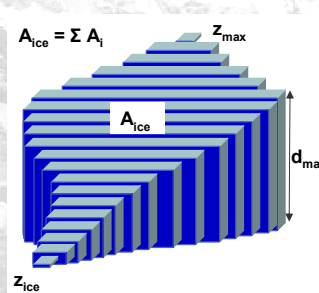
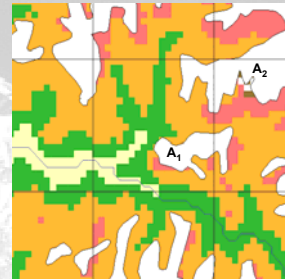
Develop a **macro-scale** model for the Indus, Ganges and Brahmaputra basins...

... incorporating the first **regional glacier-melt model**

... representing varying meltwater contribution from **retreating glaciers**

Glaciers “contributing” runoff to a cell “idealised” as a single glacier

... dimensions allowed to vary over time

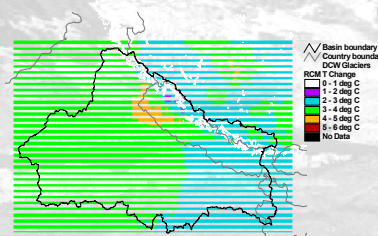
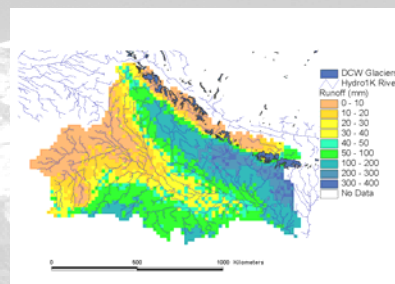


Assessing impacts on water resources

Estimate **baseline** (1961-90) conditions (average annual and seasonal runoff) at 20km x 20km grid resolution

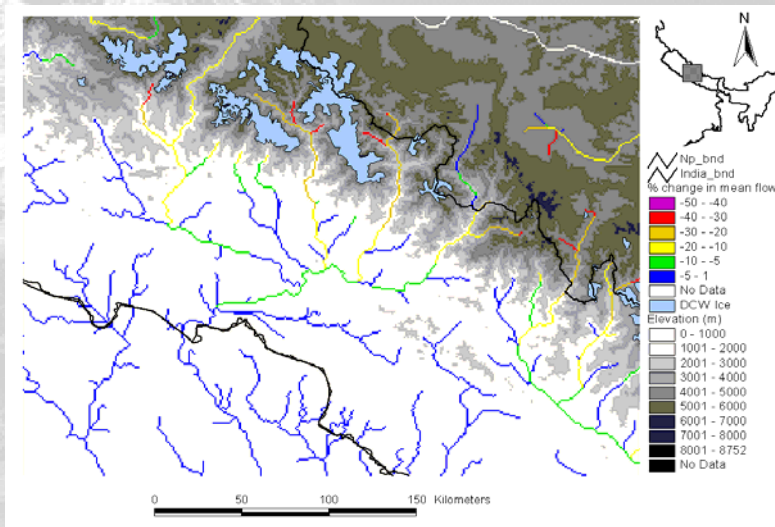
Apply variety of **climate change scenarios**: hypothetical (e.g. $+0.06^{\circ}\text{C}\cdot\text{a}^{-1}$) and RCM-based (HadRM2)

Impacts assessed in terms of **relative changes in long-term river flows**, at decadal time-steps for the next 100 years



Results

%change in mean flow - Narayani basin - 50% deglaciation



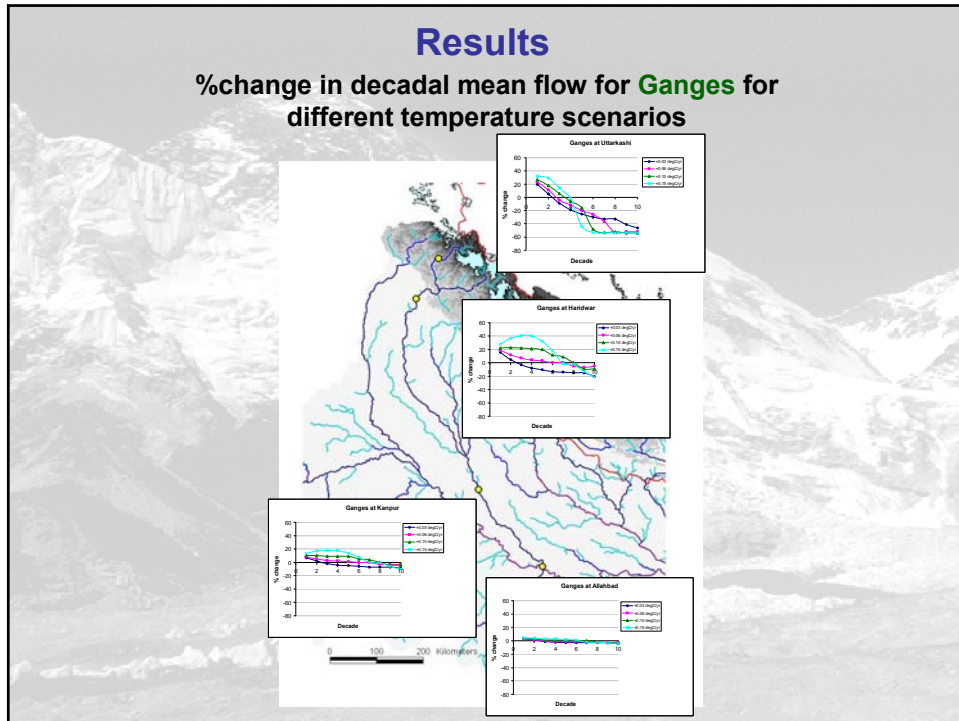
Results

%change in mean flow - Indus basin - 50% deglaciation



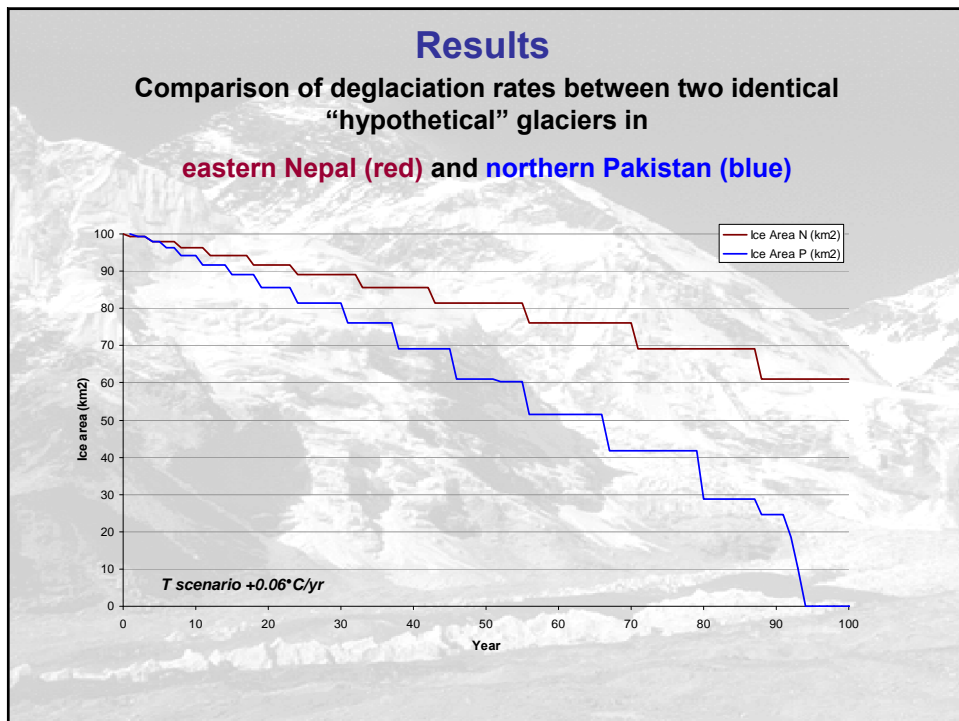
Results

%change in decadal mean flow for Ganges for different temperature scenarios



Results

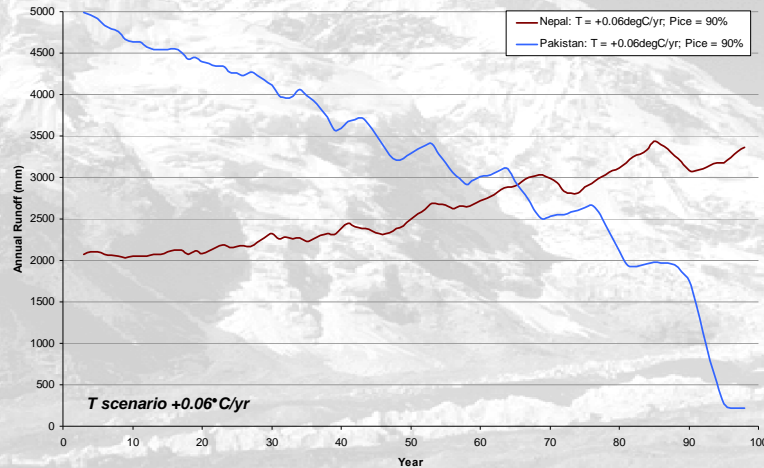
Comparison of deglaciation rates between two identical "hypothetical" glaciers in eastern Nepal (red) and northern Pakistan (blue)



Results

Comparison of annual runoff between two identical
“hypothetical” glaciers in

eastern Nepal (red) and **northern Pakistan (blue)**



Conclusions

Impacts differ regionally (E-W) and within catchments

Highly glacierised catchments and catchments where glacier meltwater is significant are most vulnerable

**Variation in precipitation is an important factor
(protects glaciers from melting; mitigates downstream impacts)**

Rivers in humid east less susceptible to deglaciation impacts than those in the arid west

**Some areas could benefit from increased water availability;
others may suffer significant reductions**

Unlikely that *all* glaciers will vanish by 2035!

