

## Himalayan rivers will survive glacial retreat

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Activists have warned that global warming will rapidly melt the Himalayan glaciers feeding the major river basins of the Ganges, Indus and Brahmaputra, creating vast deserts, economic devastation, and, worst of all, wars over scarce water in the Indian subcontinent.

Indeed, The Economist magazine claimed in 2019 that "about 70% of the Ganges flow is contributed by meltwater from the Himalayan glaciers from where the river springs."

Security analysts have voiced other fears, including that the glacial retreat would exacerbate river water disputes among Pakistan, India, Bangladesh and China. These countries have a history of military conflict, so glacial shrinkage could spur water wars.

In 2007, the International Panel on Climate Change chimed in that global warming had accelerated the melting of Himalayan glaciers, which might disappear altogether by 2035. But how much do glaciers really contribute to river flow? A look at the science shows that fears of dried-up river beds are baseless.

To investigate the potential impact of glacial retreat, the Indian government commissioned a report by the co-author of this piece, glaciologist Vijay Kumar Raina, a former deputy director-general of the Geological Survey of India.

Raina's report showed that though the Himalayan glaciers had been retreating since the end of the last ice age, glacial retreat had decelerated, not accelerated, in recent decades.

To be clear, many glaciers have retreated, but others have remained stable or even advanced. Further research from the Indian Space Research Organization monitored 2,018 Himalayan glaciers for a decade ending 2010-11. It found that 1,752 glaciers were stable, 248 were retreating and 18 were advancing.

The most studied glacier is the Gangotri, the source of the Ganges, which Hindus view as holy. Its disappearance would be a religious tragedy. Earlier studies showed the glacier had retreated at an accelerated pace of 40 meters per year between 1962 and 1982, raising alarms.

But the glacier's retreat has slowed, averaging just 10 meters per year from 2001 to 2015. At this pace, the 30-kilometer glacier will last another 3,000 years. Hindus can relax.

Unlike glaciers in the Alps or Greenland, many Himalayan glaciers occur at higher altitudes above 4,000 meters, where melting is minimal, even in midsummer. Minimal melting, plus fresh snow, has actually caused some glaciers to grow. The highest glaciers may never melt fully.

A glacier is commonly called the source of a river, so glacial disappearance seems to portend desertification. But a glacier is merely the highest point of a river. The real source is every drop of rain falling in a river basin. The combined Ganges-Brahmaputra basin exceeds one million sq. kilometers and includes the place with the highest rainfall in the world.

It is rain that dominates river flows, with glaciers making only tiny contributions.

It is not surprising that scientists and activists get this wrong since early studies could not differentiate between the contribution of rain, snow and glaciers to river flows. More recent research has provided clarification.

Richard L. Armstrong, director of the Cooperative Institute for Research in Environmental Sciences at the University of Colorado, with research collaborators from eight countries, was the first to estimate separately the contributions to river flows of rain, snowmelt and glacial melt.

Rainfall was indeed the dominant contributor -- 94% in the Ganges, 65% in the Brahmaputra and 50% in the Indus. Glacial melt contributed barely 1% in the Indus and even less in the Ganges and Brahmaputra. Snowmelt contributed the rest and vastly exceeded glacial melt.

This is excellent news. Rain and snow will continue falling even after the glaciers disappear centuries hence, so river flows will be almost unaffected. No desertification or famine will follow.

Will climate change affect rainfall? Possibly, but the Indian Meteorological Department has recently predicted that rainfall will increase between 2021 and 2041.

Security analysts have further argued that even if glacial melt matters little for river flow most of the year, it is vital in the dry season from February to May and that shrinking glaciers will have security consequences due to tensions with water-sharing between subcontinental countries.

Again, Armstrong's research shows otherwise. River flows in the dry season depend overwhelmingly on snowmelt, not glacial melt, and security analysts typically fail to distinguish between the two. Glacial ice melts almost entirely between June and September when monsoon rains dominate river flows.

Since snow will keep falling and melting even after all glaciers eventually disappear, lean-season flows will be sustained. While neighboring nations may indeed still find things to disagree about, dividing up scarce water resources should not be one of them.

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