Rapidly changing river patterns found in High Mountain Asia pose challenge for region's energy future

August 13 2025, by Julia Westbrook

Upper Bhotekoshi River, Nepal. Credit: Jonathan Flores, UMass Amherst

An international team of researchers led by the University of Massachusetts Amherst has tracked changes in more than 114,000 rivers in High Mountain Asia over a 15-year period. The paper, published in AGU Advances, reported that nearly 10% of these rivers saw an increase in flow, with an increasing proportion of that water coming from glacial ice melt compared to precipitation.

This water serves billions of people from China, India and Southeast Asia to Turkmenistan; is sensitive to climate change; and plays a key role in the sustainable development of this region through hydroelectricity generation.

Using satellite observations and computer models from 2004 to 2019, the team found that 11,113 rivers experienced an increase in river discharge, or the amount of water flowing through them at any given time.

"We're seeing these rapid changes, which is consistent with a lot of other studies. We've just given it a finer lens and therefore assessed it more concretely and quantitatively than it's ever been done before," says Colin Gleason, UMass Amherst Armstrong Professor of civil and environmental engineering.

The smaller, upstream rivers of the Syr Darya Basin (which spans parts of Uzbekistan, Tajikistan and Kazakhstan), Indus Basin (Pakistan, India, China and Afghanistan), and China's Yangtze and Yellow River basins were most affected by these increases.

One issue with this increase occurring in upstream rivers is that it can disrupt hydropower, which is critical for energy security in the region. "For example, in Nepal, about 80% of their energy sources come from hydropower," says Jonathan Flores, UMass Ph.D. student and first author on the paper.

Increased river flow subsequently increases stream power. This may sound like a benefit for hydroelectricity, but in reality, it means that the river can push more and larger pieces of sediment downstream.

Upstream, Koshi River, Nepal. Credit: Jonathan Flores, UMass Amherst

"The dams are designed for specific stream power or discharge," Flores says. "With that design, it has a limit for energy generation as well. The capacity and the energy supply stay the same, but the sediment that is clogging up the turbines and reducing the capacity of the reservoir increases." This, ultimately, limits the amount of energy a plant can generate or raises the cost of doing so.

Their research also traced the source of this increased water. Depending on the region, these changes were driven by different factors.

"There are hot spots that we found in the region," says Flores. The eastern part of the Indus is getting wetter because of increased precipitation and changes in monsoon patterns.

Overall, river discharge in the western part of High Mountain Asia, namely the Syr Darya, Amu Darya and Western Indus rivers, increased by 2.7% year over year, with an increasing proportion of that water coming from glaciers. Every year, 2.2% more of the water discharge in a river can be attributed to glacial melt rather than precipitation.

High Mountain Asia is referred to as the "Third Pole" in China, making it a key area of climate change research. "The first things to respond to warming climate are snow and ice," says Gleason. "You see it in Greenland, you see it in Antarctica, and you see it here."

The shift will have significant consequences for water use. Gleason describes water as a bank: precipitation is like a paycheck. It makes deposits into your checking account that you use for your day-to-day withdrawals.

"Your glacier is like your savings account," he says. "You really don't want to touch it. It just kind of drips your low interest rate over time. If there's a year-on-year percent increase in flow coming from a glacier, it would suggest that, if those trends continue at that pace, you could be looking at diminishing glacial water stocks."

Gleason highlights that planners will need to consider the shift because glacial water is more seasonally predictable than precipitation. "The real effect is: it changes the stability of how much water is coming into your hydrostem. If you're building a drinking water or hydropower system reliant on glaciers providing a stable water supply, are you ready for that stable supply to change, and will the glacier even still be there 100 years from now?"

More information: J. A. Flores et al, Accelerating River Discharge in High Mountain Asia, *AGU Advances* (2025). DOI: 10.1029/2024AV001586

Provided by University of Massachusetts Amherst