

# Study shows climate change disrupts seasonal flow of rivers

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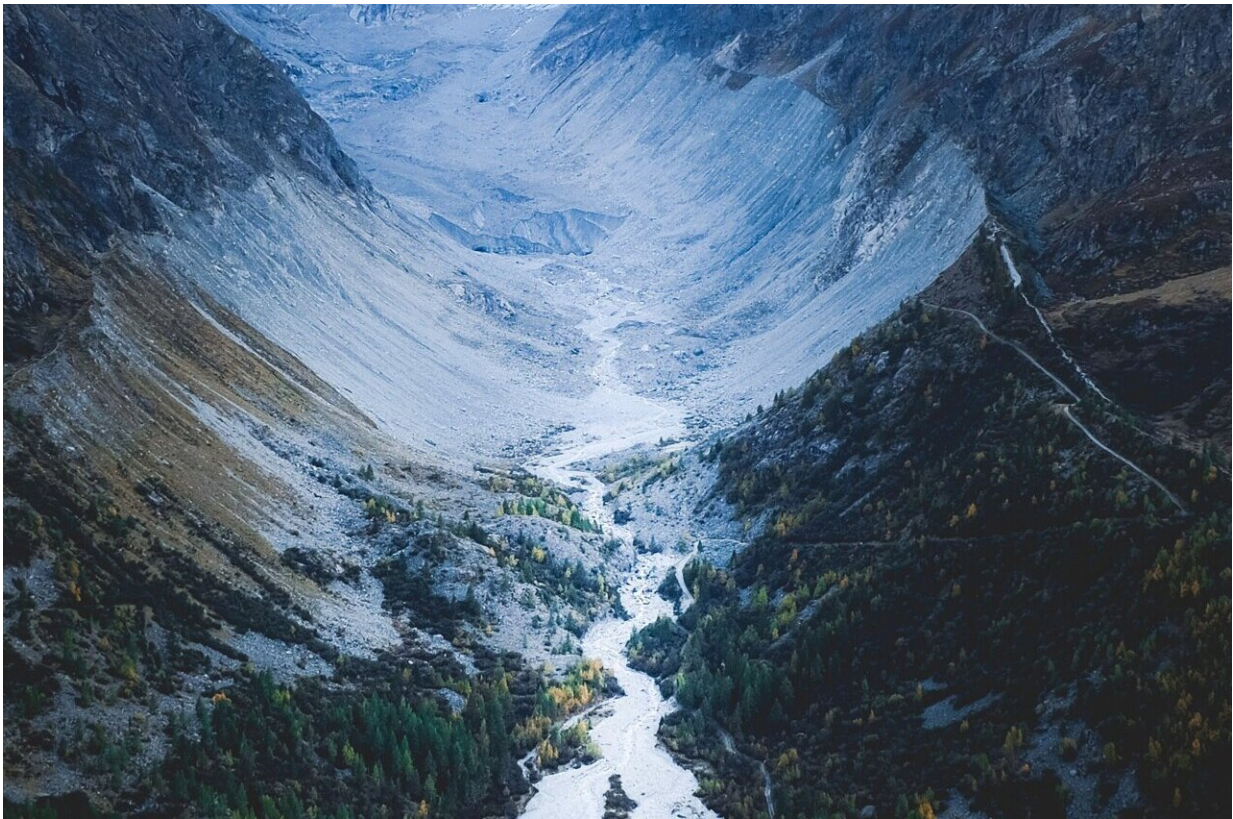


Photo of alpine river in Zinal, Switzerland. Credit: Yoal Desurmont

Climate change is disrupting the seasonal flow of rivers in the far northern latitudes of America, Russia and Europe and is posing a threat to water security and ecosystems, according to research [published](#) in

*Science.*

A team of scientists led by the University of Leeds analyzed [historical data](#) from river gauging stations across the globe and found that 21% of them showed significant alterations in the seasonal rise and fall in [water levels](#).

The study used data-based reconstructions and state-of-the-art simulations to show that [river flow](#) is now far less likely to vary with the seasons in latitudes above 50°N than previously, and that this could be directly linked to changes to the climate caused by [human activity](#).

Until now, evidence suggesting that [climate change](#) has had an impact on river flow [seasonality](#) has been limited to local studies or has failed to consider the impact of climate change brought about by humans explicitly.

In this study, the team used monthly average river flow measurements from 10,120 gauging stations from 1965 to 2014.

For the first time ever, they were able to exclude direct human interventions such as reservoir management or water extraction, to show that widespread reduction in river flow seasonality was driven by climate change.

Lead author, Hong Wang, a Ph.D. researcher at the University of Leeds and the Southern University of Science and Technology in China, said, "Our research shows that rising air temperatures are fundamentally altering the natural patterns of river flow.

"The concerning aspect of this change is the observed weakening of river flow seasonality, and that this is as a direct consequence of historical human-induced emissions. This signals a sustained and considerable

diminishment of river flow seasonality if air temperatures continue to rise."

## Human impact on river flow

Human activities are altering river flow patterns worldwide, both directly through flow regulations such as reservoirs, and indirectly through [land use change](#) and the impacts of climate change on air temperature, precipitation, soil moisture, and snowmelt.

Over two-thirds of the world's rivers have already been altered by humans even without considering the indirect impacts of increases in greenhouse gases and aerosols.

River flow seasonality plays a critical role in the predicted cycle of floods and droughts. A weakening of these peaks and troughs can threaten water security and freshwater biodiversity. For example, a substantial portion of the early meltwater from snowpack depletion may quickly flow into oceans and therefore not be available for human use.

Weakening river flow seasonality—for example, due to a reduction in spring and early summer river levels in snowmelt regions—can also have an impact downstream on riverbank vegetation and organisms living in the river itself.

## Gauging the seasonal flow

In northern North America, the researchers found that 40% of the 119 stations observed showed a significant decrease in river flow seasonality. Similar results were also observed in southern Siberia with 32% of stations showing a significant decrease.



Credit: Myriam Wares

There was a comparable pattern in Europe, with 19% of the river gauging stations experiencing a significant decrease—mainly in northern Europe, western Russia and the European Alps.

In addition, regions in the contiguous United States (the lower 48 states in North America, including the District of Columbia) showed predominantly decreasing trends of river flow seasonality overall, except for rivers in the Rocky Mountains and Florida.

In central North America, the research showed significant decreasing river flow seasonality trends in 18% of the stations.

By contrast, the researchers found a significant increase in river flow seasonality in 25% of the gauging stations in southeast Brazil, showing that changes to the water cycle are having a different impact in some parts of the world.

Dr. Megan Klaar, an Associate Professor in the University of Leeds School of Geography and a member of water@leeds, co-authored the research. She said, "The highs and lows of river flow during the different seasons provide vital cues for the species living in the water.

"For example, a lot of fish use particular increases in the water as a cue to run to their breeding areas upstream or towards the sea. If they don't have those cues, they won't be able to spawn."

The research concludes that there is a need to accelerate climate adaptation efforts to safeguard freshwater ecosystems by managing flows to try to recreate some of the natural systems and processes that are being lost.

Professor Joseph Holden, the Director of water@leeds and who supervised Hong Wang's research, added, "A lot of concern is based upon what climate change will do in the future but our research signals that it's happening now and that increases in air temperature are driving huge changes in river flow.

"We should be very concerned about what the future holds given accelerating climate change and begin to think about mitigation strategies and adaptation planning to alleviate the future weakening of seasonal river flow, particularly in locations such as western Russia, Scandinavia, and Canada."

**More information:** Hong Wang et al, Anthropogenic climate change has influenced global river flow seasonality, *Science* (2024). [DOI:](#)

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