— a change that might be connected to processes deep in the atmosphere.

"Trying to connect events that are happening at one level to events happening in another tells you how well coupled the whole atmosphere is," says Leigh Fletcher, a planetary astronomer at the University of Leicester, UK.

As Juno probes deeper and deeper into the planet's atmosphere, researchers hope to get information on a layer of hydrogen compressed into a liquid by increasing pressures. That liquid conducts electricity, which powers Jupiter's enormous magnetic field. Deeper still, the spacecraft will look for evidence of a core — a dense nugget of heavier elements that most scientists think exists, but has never been observed. Juno will make precise measurements of how Jupiter's gravity tugs on the spacecraft, which should reveal whether a core is present.

POLE POSITION

Juno will also get an unprecedented glimpse of Jupiter's poles. To avoid the most dangerous radiation belts that surround the gas giant — which over the lifetime of the mission could fry the spacecraft with the equivalent of more than 100 million dental X-rays — Juno will take a long elliptical dive around the planet on every orbit. The spacecraft will fly directly over Jupiter's magnetically intense auroras, and could spot unusual circulation patterns that resemble a hexagon-shaped feature parked on Saturn's north pole.

The lessons that scientists learn from Jupiter will apply to other gas giants, including those outside the Solar System. "If we understand how it formed, we'll have a much better handle on giant-planet influences in planetary systems around other stars," Fletcher says.

Juno will provide scientists' last chance to look at Jupiter for a long time. It is scheduled to make 37 total orbits before performing a kamikaze run in early 2018, burning up inside the planet's clouds to keep it from contaminating the moon Europa. The only other mission planned to the gas giant is the European Space Agency's Jupiter Icy Moons Explorer (JUICE) spacecraft, which could launch as early as 2022 and will focus mainly on the moon Ganymede. ■

Population growth and agriculture have stressed the Indus, which flows the length of Pakistan.

CLIMATE CHANGE

Indus River waters shrinking

Cooler, cloudier summers slow snowmelt in Himalayas.

BY JANE QIU

The Indus River, which supports the lives of 300 million people, is supplying Pakistan with less water than it did 50 years ago, particularly in the spring and summer, researchers have found. The news comes as demand for water is projected to rise sharply.

The findings contradict previous predictions that the river's volume would stay the same, or even grow, as climate change kicks in, although that increase is likely to occur in the next several decades, another team has found.

Danial Hashmi, a hydrologist at the Pakistan Water and Power Development Authority in Lahore, reported the river's shrinkage for the first time in February at a conference in Kathmandu. Further data from India have also shown seasonal shifts. "The Indus is certainly changing, and local communities are feeling the pinch," Shresth Tayal, a glaciologist at the Energy and Resources Institute in New Delhi, told a meeting in Columbus, Ohio, last month.

The Indus flows through India, Afghanistan and China before reaching Pakistan, which it crosses from north to south. For decades, population growth and agriculture have stressed the river, which, for 10 months of the year, dries up before it reaches the sea. Because demand is set to rise by 30% by 2025, "water shortage will be the single most destabilizing factor, not only for Pakistan but the entire region", says Arif Anwar, principal researcher at the International Water Management Institute in Lahore.

But since the 2009 'glaciergate' scandal — in which it emerged that the Intergovernmental Panel on Climate Change had mistakenly included in its fourth assessment report

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a prediction that the Himalayan glaciers would disappear by 2035 — there has been a widespread belief that water resources in the region are stable, at least for now. Research by several groups even suggested that climate change might provide some relief in the short or medium term, thanks to faster melting of the glaciers that supply the river, and increased precipitation.

Hashmi's data, which are unpublished, come from a network of hydrological stations in Pakistan that span the main stem of the Indus and three of its tributaries. They show that the total water supply fell by 5% between 1962, when the hydrological stations were built, and 2014.

"A reduction of 5% over five decades may not seem a lot," says Walter Immerzeel, a hydrologist at Utrecht University in the Netherlands, who led one of the studies that projected an increase in water supply in the Indus (A. F. Lutz *et al. Nature Clim. Change* **4,** 587–592; 2014). "But if the trend persists, there could be devastating implications for water resources."

Hashmi's team finds that the river's shrinkage is seasonal, with a decrease in flows between April and August that exceeds a slight increase during the rest of the year. And it reports a temperature drop across the four Pakistani river basins in the summer months — even though the region is getting warmer overall. Because snow- and glacier melt contribute to 50–85% of river flow in those catchments, the team suspects that cooler springs and summers result in less melt and that this can explain the shrinking river.

"It's a fascinating finding," says Tobias Bolch, a glaciologist at the University of Zurich in Switzerland. He notes that it is consistent with a phenomenon known as the Karakoram anomaly, in which some of the glaciers in the region have become stable or even grown — in contrast to most mountain glaciers globally, which are retreating rapidly in response to climate change.

"If the trend persists, there could be devastating implications for water resources."

Another study presented at the February meeting suggested a possible reason for the region's cooler summers. As the overall climate warms, monsoons increasingly invade the mountain chains of the Indus upstream, where glaciers reside, says study co-author Hayley Fowler, a climate modeller at Newcastle University, UK. Her modelling work shows that when monsoons penetrate into the region and push dry westerly winds northward, summer temperatures drop. The team suspects that monsoonal clouds hovering over a region that is normally hot and dry in the summer may have a cooling effect.

The limitations of climate models and the scarcity of field measurements in the region make it hard to predict how Himalayan water resources will change, says Immerzeel. However, the latest work by him and his collaborators — which took the Pakistani data into account — finds that things will get much worse, but only in the long term. Using state-of-the-art climate models, and assuming a scenario in which global greenhouse-gas emissions peak around 2040, the team found that the flow of water in the river system will stabilize or even increase in the next few decades — consistent with its previous results. But once glaciers have become depleted and regional temperatures have started to rise, water scarcity will ensue: the researchers predict a 15% drop between 2071 and 2100 compared with 1971–2000 levels, Immerzeel says. The team has submitted a paper for review.

In any case, there is a pressing need for Pakistan to boost its water-storage capacity and efficiency of water usage, says Mobin-ud-Din Ahmad, a hydrologist at the Commonwealth Scientific and Industrial Research Organisation in Canberra, Australia. Right now, its reservoirs can hold only 30 days' worth of the country's water needs — compared with 800 days in Australia and 150 days in India. "It's an extremely dangerous situation, especially now, when severe droughts are increasingly common," he says. ■