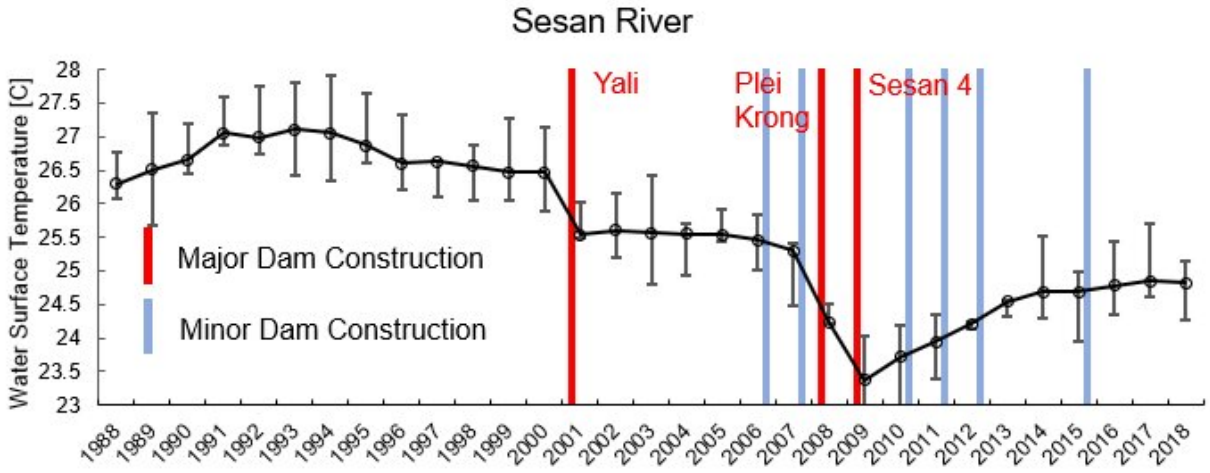
Hydropower dams cool rivers in the Mekong River basin, satellites show

February 14 2020, by Sarah McQuate



Using satellite data to monitor the surface temperature of the Sesan River over time, the team saw temperature drops that corresponded with the completion of major dams (labeled in red), but not minor dams (labeled in blue). During dry season of 2001, the Sesan River had a 1.8 F (1 C) temperature drop, which corresponded with the completion of the Yali dam. Then between 2008 and 2009, the temperature dropped again by another 3.6 F (2 C) after two more dams -- the Sesan 4 and the Plei Krong -- were completed. Credit: Bonnema et al./Environmental Research Letters

Hydropower dams, which use flowing water to turn a series of turbines to generate electricity, provide a source of energy that doesn't rely on fossil fuels. But they also disrupt the flow of rivers, and impact the fish

and people that live there.

Scientists have been monitoring many environmental effects of dams, including how they affect a river's temperature—and could potentially threaten the fish downstream.

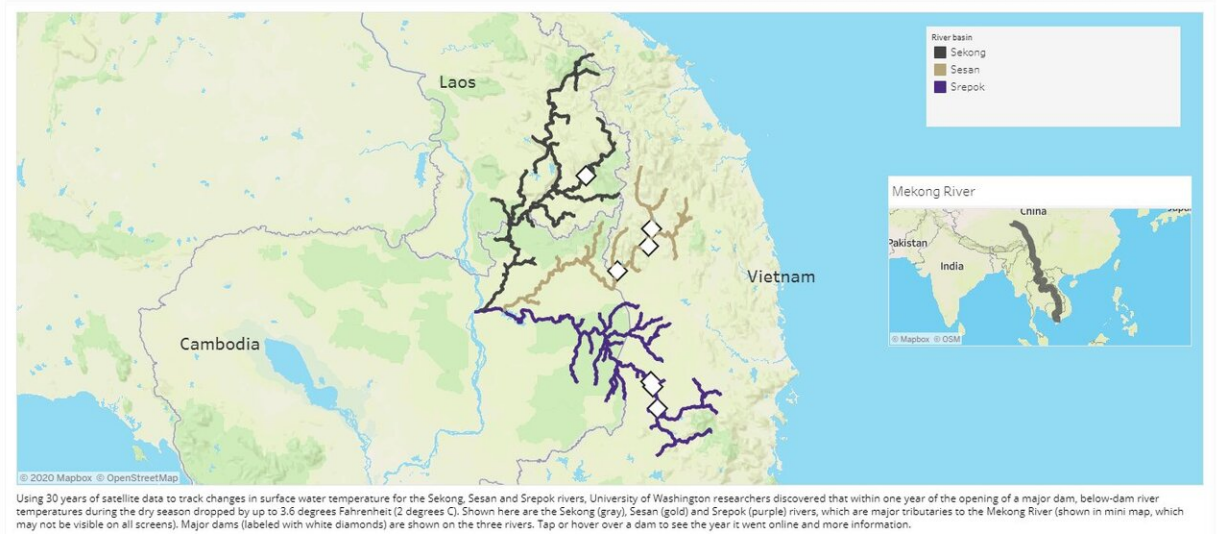
Researchers at the University of Washington were interested in studying how several hydropower dams affected the temperature of three major rivers in Southeast Asia's Mekong River basin. Since 2001, each river has seen the construction of at least one major dam, with more planned. The three rivers converge into the Mekong River, which people rely on for fish and irrigation for rice and other crops.

Using 30 years of satellite data, the team discovered that within one year of the opening of a major dam, downstream river temperatures during the dry season dropped by up to 3.6 degrees F (2 degrees C). The cooling persisted where the rivers meet the Mekong River, which showed, at most, a 1.4 F (0.8 C) cooling. The researchers published their findings Feb. 13 in the journal *Environmental Research Letters*. The team is also speaking about related research Feb. 15 at the American Association for the Advancement of Science annual meeting in Seattle.

"People have modeled how far they could see a cooling effect after a hydropower dam goes in. In the U.S., that cooling tends to be localized around the dam. But what we see in the Mekong is like, 'Wow!'" said senior author Faisal Hossain, a civil and environmental engineering professor at the UW. "Everything has happened very dramatically in the last 20 years. Lots and lots of dams were just suddenly coming on, left and right. And now we can see this cooling effect that is no longer localized, but continuing into the river system. We've never seen anything like it, to the best of our knowledge."

The researchers used Landsat satellites to track changes in surface water

temperature for the Sekong, Sesan and Srepok rivers. The satellites capture the heat, or infrared radiation, from the rivers.



Using 30 years of satellite data to track changes in surface water temperature for the Sekong, Sesan and Srepok rivers, University of Washington researchers discovered that within one year of the opening of a major dam, below-dam river temperatures during the dry season dropped by up to 3.6 degrees Fahrenheit (2 degrees C). Interactive map available here. Credit: Rebecca Gourley/University of Washington

"With these data, we're looking at the temperature emissions from the rivers. It's like night vision: Warmer things give off more emissions, colder things give off less," said lead author Matthew Bonnema, a postdoctoral researcher at NASA's Jet Propulsion Laboratory, who completed this research as a UW doctoral student in civil and environmental engineering. "These satellites have been predominantly used over land, not water, because you need to be looking at a big enough area. But there's almost 40 years of Landsat data that works great

for large rivers that people are only recently starting to take advantage of."

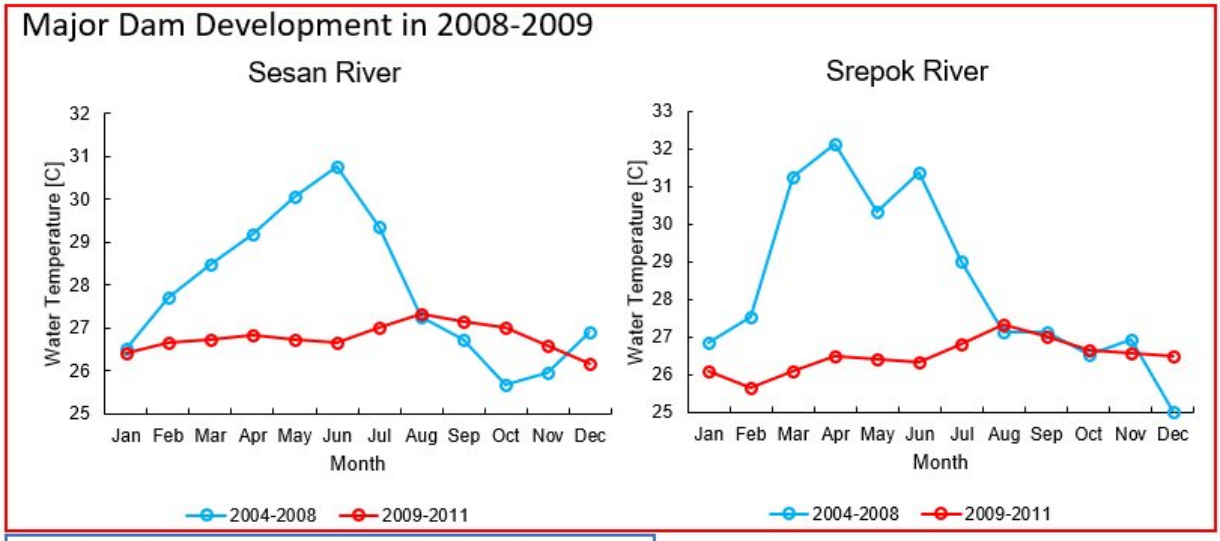
Using satellite data to monitor river temperature has a caveat: clouds block the satellites' view of the Earth. So the team could only monitor changes during the region's dry season. Still, the researchers were able to detect decreases in river temperature within a year after major dams on all three rivers came online.

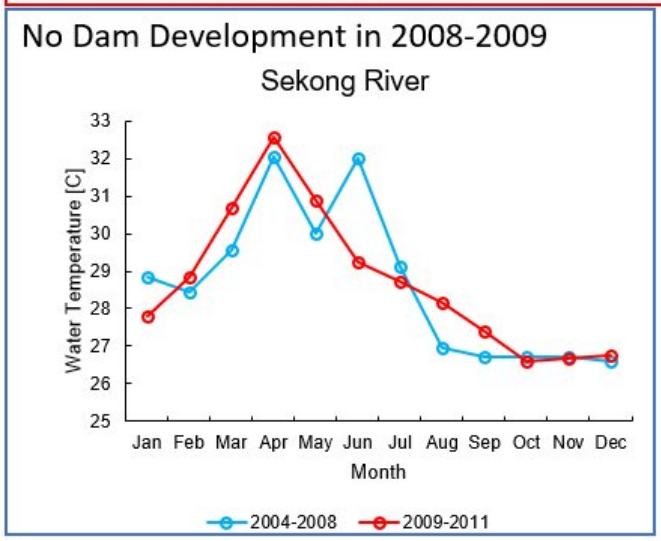
During dry season of 2001, the Sesan River had a 1.8 F (1 C) temperature drop, which corresponded with the completion of the Yali dam. Then, between 2008 and 2009, the temperature dropped by another 3.6 F (2 C) after two more dams—the Sesan 4 and the Plei Krong—were completed.

Similarly, in 2009, the Srepok River cooled by 2.5 F (1.4 C) in the dry season after a network of four dams came online.

And in 2015, the Sekong River temperature dropped 1.3 F (0.7 C) the year after the Xe Kaman dam was completed on the Xe Kaman River, a tributary to the Sekong.

These rivers also had sensors that monitored river temperature year-round between 2004 and 2011. Before 2009, all three rivers had a similar temperature pattern: The water started to warm up at the beginning of the dry season, around November or October, and then cooled off once the wet season started in April or May.





The Sesan, Srepok and Sekong rivers had sensors that monitored river temperature year-round between 2004 and 2011. Before 2009 (labeled in blue), all three rivers had a similar temperature pattern: The water started to warm up at the beginning of the dry season, around November or October, and then cooled off once the wet season started in April or May. But after 2009 (labeled in red) the Sesan and the Srepok rivers, which had major dams built during that time, stayed cool year-round. Credit: Bonnema et al./Environmental Research Letters

But after 2009, the Sesan and the Srepok rivers, which had major dams

built during that time, stayed cool year-round.

"At the beginning of the wet season, the dams start to have more water than they can store, so they're letting it go in a controlled way," Bonnema said. "As the wet season goes on they're like, 'OK, let's fill up the reservoir' and hold the water. Then when dry season comes, they have this big water supply that they let out over the course of the dry season.

"If you look at the river flows after a dam goes in, you end up with more water in the dry season and less water in the wet season than before. The dry-season water also happens to be colder because it's pulled from deep within the reservoir. That brings the river temperature down closer to what it is in the wet season."

The team investigated whether anything else might be driving these temperature drops, such as air temperature, precipitation or land use in the surrounding region. Precipitation stayed mostly the same over the 30-year period. The air temperature showed a slight warming trend. The land around the rivers had been deforested during that period, but researchers said that is often linked to water warming, not cooling. That points to the role of the dams.

The Sekong, Sesan and Srepok rivers combine into one river, which eventually enters the Mekong River, a central feature of the Southeast Asian ecosystem. The team found that this infusion once warmed the Mekong so that the river was, at most, 0.72 F (0.4 C) warmer downstream of the confluence than it was upstream. But after 2001, the trend reversed, with the rivers now slightly cooling the Mekong River. The river is now up to 1.4 F (0.8 C) cooler—not warmer—downstream of the confluence.

The cooler water could have an effect on the fish that live downstream, the researchers said.

"They're going to keep building these dams," Bonnema said. "If you look at where new dams are planned in the 3S Basin, they're building closer and closer to the Mekong. These are also big dams, which means the impacts on the Mekong will likely be more significant—these temperature changes are going to get more dramatic. So the question is how do we work with these dams to minimize their effect? My recommendation is that we slow down and think things through."

More information: Matthew Bonnema et al, Hydropower's hidden transformation of rivers in the Mekong, *Environmental Research Letters* (2020). DOI: 10.1088/1748-9326/ab763d

Provided by University of Washington