Deltas of sediment are pushing into Glen Canyon as Lake Powell disappears

Researchers at the University of Utah and the U.S. Geological Survey are studying how the sediment is impacting the reservoir.

Lake Powell • As the Colorado River approaches the still waters of Lake Powell, the pace of the current quickens.

Chains of standing waves form out of nowhere, grow in size until they are capped with white foam, and then disappear a few minutes later. Giant hunks of mud calve from the banks to form islands, splitting the river into narrow channels that branch and bend.

[Related: Spilling water from Flaming Gorge to feed Lake Powell, feds will try to keep Glen Canyon Dam operational**]**

The river picks up sediment until it is as dark as espresso and as thick as a chocolate milkshake. Great expanses of cracking mud, half a mile wide, stretch beyond the river banks, devoid of a single plant or blade of grass.

Then, when the river meets the reservoir, everything goes still. Flocks of white pelicans alight on sandbars where the current ends.

The silt drops from the water almost immediately and the water turns to a chalky turquoise. Within ten miles, Lake Powell is as clear as a reef in the Bahamas, shelves of sandstone visible ten feet below as bass zip through the shadows. All of the sediment has drifted to the bottom of the lake.

The transition zone between flowing river and reservoir is what scientists refer to as the delta, and it's migrating toward the Glen Canyon Dam as Lake Powell has dropped to record

low levels.

(Zak Podmore | The Salt Lake Tribune) The sun rises above cracking mudflats deposited just above where the Colorado River meets Lake Powell on April 11, 2022.

A separate delta is moving down the San Juan River to the south, a tributary to the Colorado that carries less water but more sediment.

“Rivers are generally very efficient transporters of sediment, whereas large bodies of water (lakes, reservoirs, oceans) are very good at trapping sediment,” said Cari Johnson, geology and geophysics professor at the University of Utah. “Where those two very different sets of processes meet is the delta, which makes it all the more important to study this large and

highly mobile slug of sediment."

Johnson and her students are currently analyzing the pace at which both deltas have advanced since 2000, a period of time that has seen plummeting water levels on Lake Powell thanks to high water use in the Southwest and the driest period in the Colorado River basin in at least 1,200 years.

Using publicly available satellite imagery, Johnson's team have calculated that the delta of the San Juan has moved by an average of over 120 feet per day over the last 22 years, pushing a mass of sediment dozens of miles downstream into areas that were once covered by Lake Powell.

"We're seeing pretty remarkable rates of change in where that delta front was sitting," Johnson said, "on the order of 10, 20 kilometers [six to 12 miles] in a year, or in a couple of years, moving up or down."

Deltas are highly dynamic and mobile, Johnson said, eroding into themselves and then getting flooded again if the reservoir level rises.

Hannah Hartley, a master's student studying geology and sedimentology at the university, played a key role in the project when she began comparing satellite images from the lower San Juan for a class. Two images taken in March and June of 2017 showed a dramatically different location for the

delta after the spring runoff brought up reservoir levels.

“I was shocked when I first figured it out,” Hartley said. “It’s one thing to compare the satellite images, which are pretty drastic. Then I had to actually calculate how far that was.”

In the span of four months, the delta had moved by nearly 12 miles. Hartley has continued to research the delta movement with Johnson since completing the class project.

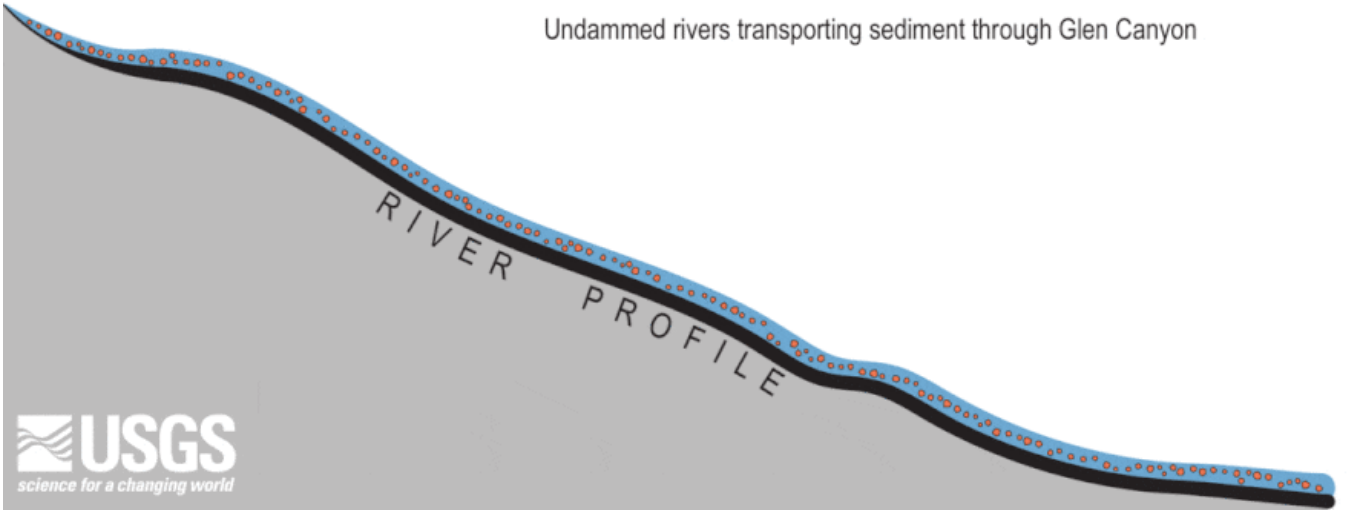
The upper reaches of the reservoir have been so filled with sediment that the location of the deltas is determined by a number of factors. Lake Powell is currently filled to less than a quarter of its capacity, but the deltas are dozens of miles downstream of where they would have been when the reservoir first filled to its current level in the 1960s.

“The river is not just dropping the sediment into a bathtub,” Hartley said, “it’s actively modifying the bottom of the tub and filling it up as well.”

As the rivers move into the historic reservoir bed, they flow high above their historic channels on top of thick lake deposits, some of which are over 100 feet deep. Because the old channels are filled, the deltas can keep moving downstream even if reservoir levels are stable.

Delta movement can also be sporadic, Johnson and Hartley said, staying relatively static for a while and then moving

rapidly as reservoir levels drop or as rivers run high.



(Casey Root | United States Geological Survey) This animation shows how deltas of sediment formed in Lake Powell and how they've moved as the reservoir level declines.

Part of the motivation for the construction of the Glen Canyon Dam, which began to fill Lake Powell in 1963, was to trap sediment that was filling the Lake Mead behind the Hoover Dam.

“Lake Powell is unique in the way that it’s shaped,” said Casey Root, a hydrologist for the U.S. Geological Survey’s Utah Water Science Center. “It’s extremely long and extremely thin, so it naturally buffers the dam against sediment simply by keeping the deltas really far away from the dam.”

Root published a paper earlier this year with a colleague that looked at how quickly Lake Powell is filling with sediment and was based on joint research conducted by the U.S. Geological Survey (USGS) and the Bureau of Reclamation,

which manages the Glen Canyon Dam.

The paper found that Lake Powell lost 6.8% of its storage capacity between 1963 and 2018 due to the sediment that had been deposited in the reservoir bed, but the vast majority of the sediment was trapped in the far upstream reaches of the reservoir.

At that rate, it would take roughly 700 years for Lake Powell to completely fill with sediment, but the reservoir will cease to be useful long before that, Root said. Due to the current dry period in the basin known as the Millennium Drought, Lake Powell's level has dropped from its full capacity in 1999 to its current level, around 23% of its capacity.

The reservoir's decline has exposed sediment in Cataract Canyon and elsewhere, allowing it to wash downstream. The Moab-based Returning Rapids project is documenting how that process is exposing rapids in lower Cataract that were once buried in muck, but that sediment isn't leaving the system; it's moving downstream and filling new areas.

If Lake Powell stays low or continues to decline, which is likely according to climate models, it will lose storage capacity more quickly as the deltas move into the lower reservoir. Root compared the way rivers move sediment to a snow shovel that fills with snow and then pushes it out to the sides, filling bays and side canyons.

Because the deltas' movement are influenced by so many factors, Johnson said it's difficult to project how quickly they'll move into areas of the reservoir that were once available to houseboats.

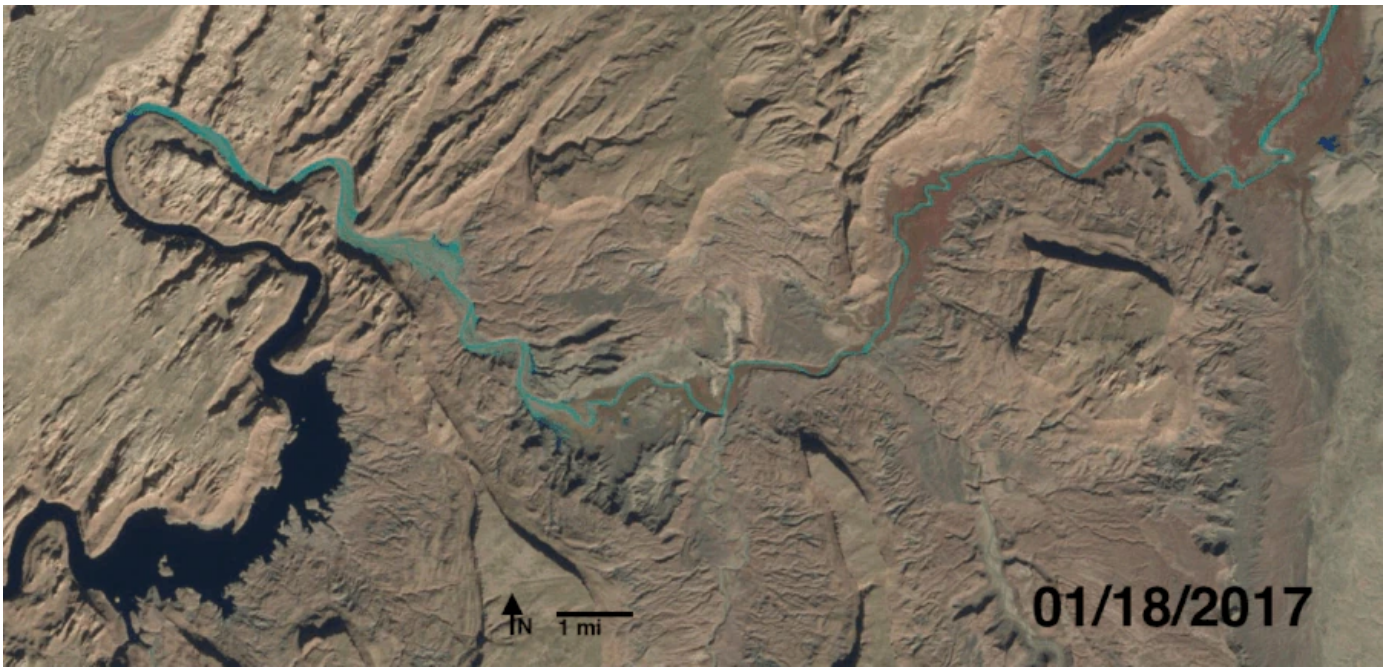
(Francisco Kjolseth | The Salt Lake Tribune) Cari Johnson, a geology professor at the University of Utah, and Jack Schmidt, a professor at Utah State University's Center for Colorado River Studies, analyze the so-called Dominy Formation in Waterhole Canyon, one of the tributaries of the Colorado River in Cataract Canyon. The mountains of sediment illustrate the high water mark once reached by Lake Powell before its retreat as flooding events slowly carve away at the sediment.

The delta of the Colorado River is over 125 miles from the dam, but the San Juan delta has been marching closer to the

confluence with the Colorado in recent years and is now just 27 miles away. If the San Juan delta reaches the main channel of the Colorado, would it deposit so much sediment in the canyon that it would divide the lake into two? It's difficult to predict.

"I can see that being a problem for water travel as you get just a pile of mud building up in one specific location [such as at the confluence] and no way of modifying that," Hartley said, "no natural force coming along and washing some of it downstream."

But that's not likely to happen soon, Hartley said, especially if the reservoir levels stabilize or come back up. Lake Powell can only drop by 160 more vertical feet before the water level reaches the lowest outlets on the Glen Canyon Dam, an elevation known as deadpool.



(Hannah Hartley) Animation showing the San Juan River delta's movement in

2017, when the delta moved nearly 12 miles upstream due to rising levels in Lake Powell.

The deltas do present an interesting challenge for boaters in their current state, however.

John Sells, a former river guide who works at a boat service company in Denver, encountered the Colorado's delta in 2019 at the end of a Cataract Canyon trip through Canyonlands National Park.

Low reservoir levels and a lack of maintenance have made the traditional boat ramp at the end of Cataract extremely difficult to use, and Sells' party was in heavy 22-foot rafts, so they decided to continue across Lake Powell to Bullfrog Marina.

At the delta, they encountered one of the most challenging sections of the trip.

"Sand waves were smashing over our boats," Sells said. "And then you look back and they would just disappear. Eight-foot-tall 'mudbergs' were collapsing. It was like trying to navigate through something you've never seen."

Sells returned several times to track changes to the delta, posting the videos to YouTube and documenting dramatic shifts in the river's course even in the span of a day.

"It's a historic event," he said. "It feels like a dying reservoir."

Zak Podmore is a Report for America corps member for The Salt Lake Tribune. Your donation to match our RFA grant helps keep him writing stories like this one; please consider making a tax-deductible gift of any amount today by clicking here.