

Why this year's record glacial outburst flood likely won't be Juneau's worst

By Anna Canny, KTOO - Juneau - August 14, 2023



Suicide Basin, the birthplace of Juneau's annual glacial outburst floods, sits about two miles above the terminus of Mendenhall Glacier. (Anna Canny/KTOO)

Three scientists shuffled across the vivid blue ice of the Mendenhall Glacier, following a silty channel carved between a steep mountain slope and the glacier's edge. They wove around dripping, house-sized blocks of ice, heading toward a trail near the mouth of the channel.

An icy chute 10 feet deep sits slightly downhill, at a precipice high above the glacier's terminus. Three days earlier, a torrent of water had carved the chute after forcing its way through the ice dam that holds water in Suicide Basin — the source of the flood and the place where the scientists were going.

The water then ran down to Mendenhall Lake and spilled out into the Mendenhall River, which rose nine feet in a matter of hours. It was the **worst glacial outburst flood in Juneau's history.**

The scientists began a steep ascent up the face of the mountain, scrambling over loose boulders to the lip of Suicide Basin. Moving away from the blue expanse of the glacier, they stood at the edge of a deep, bowl-shaped valley, dwarfed by three steep peaks surrounding it.

Before the flood, this valley had been filled to the brim with 13 billion gallons of water. Now it was empty.



Eran Hood, Ed Neal and Abby Watts follow the icy path up a channel where waters from Suicide Basin coursed through on their way to Mendenhall Lake (Anna Canny/KTOO)

The team's leader, University of Alaska Southeast hydrologist Eran Hood, peered down at the jumble of ice lining the bottom.

"This is crazy. I've never seen it collapse down so far," Hood said. "I think something has fundamentally changed."

There were just a few gray-green pools of meltwater at the bottom. But dark high-water marks stained the rock face more than 100 feet up, evidence of the water that had accumulated here for months before emptying suddenly.

The basin drains like this every year. The glacier, which blocks its mouth, acts as a dam. Throughout the spring and summer, the basin fills with rain and meltwater until the water builds enough pressure to crack through the ice. Then it works its way through those cracks and out under the glacier, triggering the start of a glacial outburst flood.

Most years, the flooding has been minor. But this year, it tore through the Mendenhall Valley with more force than ever before, gnawing through the riverbank and undermining homes that once seemed safe. Two homes were swept away completely, and dozens of people have been displaced.

For decades to come, the neighborhoods downstream in Juneau will be at the mercy of the ever-changing basin. Hood and his team went up to learn more about how, precisely, the basin is changing — and about what those changes might mean for future floods in Juneau.

A new lake

The floods started in 2011. But Hood, who has been studying the glacier for more than two decades, remembers a time before that.

"The entire basin was once filled with the glacier," Hood said. "So there was no room for water."

Then, about a decade ago, a piece of the glacier broke off and rapidly receded up the hill, exposing the basin. The remnants of that retreat are still visible at the basin's head, where a last, large chunk of ice still perches on the cliff. That chunk is now known as Suicide Glacier.

At the basin's edge, Hood and research assistant Abby Watts assembled a tall, black tripod and laid out a miniature helipad, for a drone. The drone took off with a whir and flew to the far side of the basin.



By doing repeated drone flights, researchers can build a 3D model to estimate the volume of water held in Suicide Basin. The basin is almost entirely empty after the flood on Saturday, Aug. 5, 2023 with just a few remaining pools of meltwater at the bottom (Anna Canny/KTOO)

For about three hours, the drone flew back and forth across the basin, taking thousands of overlapping photos to capture every crack and crevice on the surface of the basin. Using a

process called photogrammetry, Hood's team can use the photos to build a three-dimensional map of the basin.

Understanding the basin's shape matters because that determines how much water it can hold — and that partly determines how badly the river can flood. The National Weather Service builds its glacial outburst flood forecasts based on the volume of the basin.

This year, those forecasts were off. The initial flood warning from the Weather Service predicted a peak flood stage of over 10 feet by Sunday morning, which would cause only minor flooding. The actual peak was nearly 15 feet — three feet higher than the river had ever flooded before.

An unsolvable problem

Figuring out the size and shape of the basin is complicated, because it's changing all the time — one of its sides is made out of ice. Scientists believe the basin is growing. They estimate that the amount of water it can store has increased by about 15% over the last five years. But they're not sure exactly how it's growing.

There are a few different factors that might come into play. On one end of the basin, the vivid blue on the glacier's face indicates frequent calving. Large chunks of ice break off onto the bottom of the basin, adding to the existing jumble of icebergs left behind by the Suicide Glacier's retreat.

Scientists believe the ice has been melting faster and faster in recent years.

"The more all of this ice sitting in here can melt, the bigger this flood can be" Hood said.

At the same time, the calving from the glacier's face may have allowed the basin to get wider, therefore holding more water. That means there's both more meltwater and more space to store that water. That's one theory about why this year's flood was so much bigger.

"But then, the dam is decreasing in height because the glacier is melting away," Hood said.

"So we've got these two competing factors."



Eran Hood holds a drone remote, with the Mendenhall Glacier in the background. The drone survey will help Hood and his team determine how changes in the glacial ice shapes flood potential in Juneau (Anna Canny/KTOO)

So it's hard to nail down how much water the basin can hold — and that's still just one variable that determines how bad flooding can be. The trickier part is understanding how that water drains from the basin.

Hydrologist Ed Neal of Alaska Hydroscience sat watching the drone from a boulder, facing the roughed-up surface of the glacier.

Beneath that ice, he said, water is always flowing. Even if the basin's volume stayed constant, the way the water gets out could change — and that's just as important for knowing how bad a flood will be.

"Say you got X amount of water. If you let it out of a garden hose, it's gonna take a long time to drain," Neal said. "If you let it out of a firehose, it'd take a short time to drain it."

Usually, the dam at Suicide Basin releases more gradually. As water pressure builds up in the basin, it creates small cracks in the ice that let the water leak out slowly under the glacier. Over time, the water melts those channels larger and larger, increasing the flow.

But there are also many existing stream channels, deep under the glacier, that feed into the Mendenhall River all year long. If the water draining from the basin were to tap into one of those, it could release much, much faster.



Blocks of ice left behind by last weekend's glacial lake outburst flood in Juneau, Alaska. Flood waters coursed through this channel before raising water levels downstream in Mendenhall River (Anna Canny/KTOO)

One theory about the ferocity of this year's flood is that the calving at the glacier's face might have exposed those existing channels to the basin's water. But pinpointing the drainage channel is nearly impossible.

"Somewhere in there, under that jumble of icebergs, is where the water released," Hood said. "We'd love to study that. But it's not accessible."

This leaves scientists with what is, for now, an unsolvable equation. With the drone survey, they can only find one variable. Which means that predicting Juneau's outburst floods will remain a bit of a crapshoot.

Worse to come

Glacial outburst floods are not exclusive to the Mendenhall Glacier — **Andean** and **Himalayan** communities have seen outburst floods that killed thousands of people. One **recent study** estimated that 15 million people globally are threatened by them.

Human-caused climate change is largely to blame. Retreating glaciers around the world have created unstable lakes that are dammed by ice or sediment. When those dams fail, they can send huge walls of water crashing down populated valleys.

So far, warming temperatures have not made the floods more frequent. But they have accelerated glacial melt, which is creating new glacial lakes and making existing lakes bigger. That means when glacial dams fail, the potential for devastation is greater.



The Mendenhall Glacier dams water in Suicide Basin. As the glacier calves, it could be creating more storage space for water. That could cause bigger glacial outburst floods in the future (Anna Canny/KTOO)

The Mendenhall Glacier has been receding for centuries, but warming temperatures fueled by human pollution have made it thin and retreat much more quickly.

"If the glacier hadn't receded, there would be no outburst flood," Hood said.

While the larger phenomenon of glacial outburst floods is driven by climate change, Hood said this year's hot summer didn't contribute much to the severity of this year's flooding — and big storms don't add much water to the basin, either.

But Juneau's glacial outburst flooding could be made worse by other climate-driven changes. Extreme rainfall is becoming more frequent across Southeast Alaska. If a glacial outburst flood were to coincide with a drenching rainstorm — if the river were already swollen with water when the basin emptied — that could be bad.

"Now, you might have a 50-year flood happening every year, or every other year," Neal said. "If you stack that on a big rainfall peak, you're gonna start having some serious energy."

And that's not far-fetched. This time last year, **Juneau was drenched** by an atmospheric river.

A house and condo buildings in the 4400 block of Riverside Drive hang precariously over the Mendenhall River after their foundations were eroded away during record high water from a glacial outburst flood on Saturday, Aug. 5, 2023. (Mikko Wilson/KTOO)

Meanwhile, many of the homes along the river were built on soft, loose sediments that erode easily. In this year's flood, it was rapid erosion rather than inundation that caused the worst damage.

And Hood says the threat posed by glacial outburst floods will hang over Juneau until the Mendenhall Glacier melts down to the point where it can no longer dam the basin. That will likely take decades — and Hood would be surprised if Juneau doesn't see even worse floods before it happens.

"It's unlikely that we would have experienced the largest flood within the first 10 years or so," Hood said.

So the hundreds of residents who live along the bank of the Mendenhall River can't know what's coming from year to year — but they should expect something worse than what happened last weekend, eventually.

The results from Hood's drone survey aren't in yet, but he says one thing is for sure. High above Juneau, the basin keeps growing.

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