Coastal Alaska Parks

National Park Service
U.S. Department of the Interior

Ocean Alaska Science and Learning Center

Making Sense out of Chaos

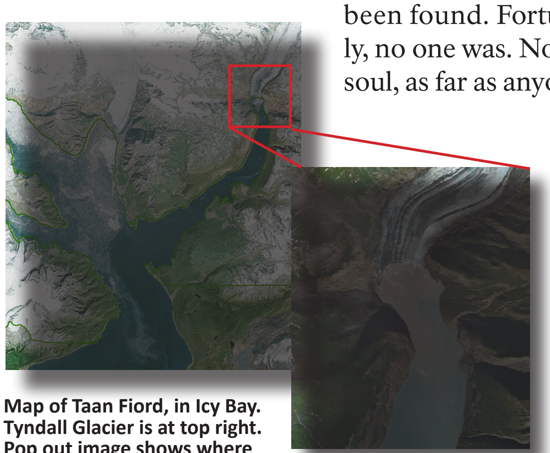
The Day it Rained Rocks

It was, literally, earth-shaking; so much so that a seismometer thousands of miles away picked up the vibrations. It contained enough force to push debris a mile under water, heaving it uphill onto the opposite shore, and generate a tsunami high enough to rival Seattle's Space Needle.

But this was no earthquake. It was a 60-second deluge of boulders, earth and trees. This high speed landslide occurred, undetected, in a remote slice of Alaska's Wrangell-St. Elias National Park and Preserve on October 17, 2015.

The Icy Bay landslide began when a mass of rock, perched 2800 feet above sea level gave way, unleashing over 150 million tons of debris. For perspective – rubble taken from the collapsed Twin Towers amounted to 1.5 million tons, requiring over 108-*thousand* truckloads to cart it away. Multiply that by 100, imagine it hurtling down a steep mountainside, and you begin to get the picture.

Anyone buried under that mass would have likely never been found. Fortunately, no one was. Not a soul, as far as anyone knows, had so much as a hair blown out of place. And if the scientific community has anything to do with it, that will be the case for the ineviable next time.



Map of Taan Fiord, in Icy Bay. Tyndall Glacier is at top right. Pop out image shows where the landslide entered the fiord. The tsunami extended the 8-mile length of the fiord, carrying logs and debris all the way to Icy Bay.

Precipitous fjords, rugged mountain terrain, glaciated valleys. . .this is the scenery that attracts millions to coastal Alaska. However, these same features are prone to just this kind of event. Glacier Bay National Park, alone, has experienced eight large landslides since 2012, and in 1958 a 90-million ton rockfall in the park's Lituya Bay triggered the largest known tsunami of modern times. As glaciers withdraw, destabilizing fiord walls, and thawing permafrost buckles the ground beneath them, more massive slopes are expected to give way.

Which perhaps explains the sense of urgency in the team of earth scientists, funded by the National Science Foundation and the National Park Service, that clambered around the base of this crumbled mountain in the summer of 2016. The sheer mass of the devastation dwarfed their forms as they picked their way over the rubble. A detached onlooker might have noted an element of the quixotic in their mission. They were, however, intent on building an accurate picture of what occurred; before vegetation reclaimed the stripped beaches, and sediment confounded the evidence; before this dynamic landscape reshaped itself once again. Before it happened somewhere more populated.

Tackling the Big Questions

When grappling with what happened, like the incident itself, one question triggers another, which unleashes still more. How much debris was there and how far did it go? Which slope will give way next, and when? Could it trigger another tsunami? If so, how big will it be and how fast will it travel?

The Icy Bay landslide provided the ideal opportunity to answer some of those questions. It occurred in terrain similar to that of more populated areas, and heavily visited sites. We have little understanding of tsunamis triggered by landslides, which behave differently than earthquake-generated surges. The sheer scale of the event magnified its impacts, making them easier to study. And, no one was harmed. It was, in a sense, the perfect experiment.

What Can We Learn From this Event?

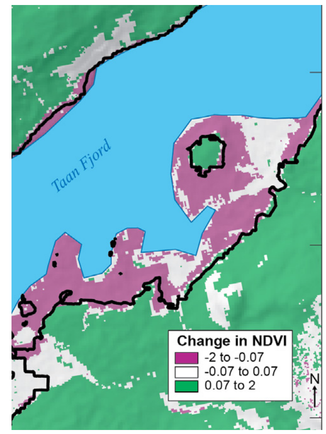
A geologist (orange speck - center of photo) hikes up a ridge to find the tsunami's high water mark. At over 600 feet, Taan Fiord tsunami runups are among the highest ever recorded. Ground Truth Trekking.

Several studies have already come out of the 2016 expedition, with more pending. And, while none provide definitive answers, all contribute crucial insight for predicting and planning for large-scale geologic events.

Dr. Anja Dufresne led a team of geologists on a study to map landslide deposits – the boulders, hummocks and sediment - strewn about the landscape, in order to better understand how a landslide behaves when it makes contact. In this, the Icy Bay affair provided a golden opportunity; rarely do landslides spew their contents onto such contrasting environments. Dr. Dufresne and her team found debris on the land, on top of Tyndall Glacier, and in the fiord waters. They contrasted debris distribution in each scenario. They studied digital models and satellite imagery for clues to what triggered the slide. They examined rock surfaces and deposit sediment to reconstruct the mechanics of its movement.

While further interpretation of the data is pending, useful information has already emerged. The study confirmed, for example, that this collapse was a long time in the making. Like an aging spine gradually caving in on itself, the mountainside had been in a decades-long slump that began when Tyndall Glacier withdrew its buttressing walls. The study revealed that, just as the glacier (or its absence) was reshaping the valley, landslide debris was reshaping the glacier, impeding its calving, stretching it out and lowering its terminus. They identified previously undetected signatures unique to large landslides that will aid in identifying others long buried. Such findings will help pinpoint not only ancient slides, but future hazard zones as well.

A separate study by graduate student Colin Kretz Bloom, focuses on chapter two of this tumultuous story. Nearly 90% of the landslide mass entered Taan Fiord, an arm of Icy Bay, triggering the tsunami. Extending inland up to 600 feet above sea level (more than 100 feet is considered extreme), this massive surge lent itself well for assessing a tsunami's potential. In particular, the study looked for lasting surface evidence of the upwelling in the alluvial fans feeding into Tyndall Glacier. These malleable surfaces, it contends, preserve obvious terrain modifications. The results, therefore, may be used to predict impacts to heavily-populated coastal areas, found throughout southern Alaska.



Vegetation loss caused by the tsunami shown here in pink. The black line indicates D-Claw's simulation of tsunami inundation. D. George.

What happens to all that momentum when high speed landslide meets big water? A third study attempts to answer that using software, known as D-claw, designed to simulate flows that involve mixtures of both water and sediment. Research Mathematician D.L. George and his team employed a mathematical computation which treats both landslide and tsunami as a single mass. This method enabled them to simulate landslide motion, wave generation, and shoreline inundation patterns which closely matched what actually occurred in Taan Fiord. This newly-developed model, the study proposes, will provide a more reliable tool for evaluating a tsunami's potential threat to nearby communities, such as its size, its inland reach, and how soon it might arrive.

Ultimately, each study will uniquely enhance our understanding of large-scale geologic events. Their findings will be vital for informing critical decisions the next time a mountain collapses in Alaska's rugged, spectacular and rapidly changing fjord lands.

A team of earth scientists at the landslide site discusses their discoveries and makes plans for the next day. Ground Truth Trekking

The Ocean Alaska Science and Learning Center promotes stewardship through education and research of the marine influenced ecosystems of Alaska's coastal national parks. For more information contact: Benjamin Pister, benjamin_pister@nps.gov.