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Not My Fault: More tsunamis may be in our future

Lori Dengler for the Times-Standard

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Red line outlines approximate extent of the Barry Arm landslide in Prince William Sound, Alaska. Arrow is about 1.5 miles long.

The Alaska landscape is impressive to anyone but even more so to earth scientists. The mountains, outrageously complex geology, and more volcanoes, earthquakes, and glaciers than any other part of the country, makes it a haven for geologists of all stripes. I was fortunate to spend the last week in Anchorage at the annual meeting of the Seismological Society of America and had the opportunity to partake of a small bit of this extraordinary state.

The first five days were glorious, sparkling clear with barely a breath of wind. The weather was at its finest on the day of our Whittier – Prince William Sound field trip. Prince William Sound is the epicentral region of the 1964 M9.2 earthquake. The field trip notes included a discussion of what happened in '64 and how the town of Whittier was affected but our main focus was on future hazards, not the past.

Just getting to Whittier is exciting. Much of the hour and a half road trip is along the Turnagain Arm, a long fjord that branches off the head of Cook Inlet. The primary purpose of James Cook's third and final voyage was to find an inland passage from the Pacific to the Atlantic. Entering the broad inlet that would later bear his name, Cook was hopeful they were on the right track. The head of the fjord was a dead end and were forced to "turn again" leading to the name of the waterway.

The Turnagain fjord is also famous for its tidal range. With a thirty-foot difference between the highest and lowest water level, currents can reach speeds of 12 miles per hour. The rushing inflow up the fjord creates a tidal bore. The leading edge of the incoming tide forms a wave with a distinct face as it pushes upriver against the current. We were fortunate to pass the bore enroute. It appeared to be a few feet high but can reach heights of ten feet, high enough to draw a few intrepid surfers to catch a ride that can last for up to an hour. Of course, if you miss the wave, you have to wait 12 hours before the next one.

Turnagain arm ends at the now abandoned town of Portage, so named because of the ten-mile hike one has to make on land to reach Prince William Sound. Portage was destroyed in 1964 when the land sank about six feet, putting most of its buildings under water. The portage wouldn't be easy as Maynard Mountain, a three-thousand-foot-high ridge, separates Portage from Whittier.

The military had plans to develop the Whittier site before World War II as port with waters deep enough for submarines to enter surreptitiously. After the war began, construction was accelerated to complete the harbor and tunnel through the mountain so trains could travel from Whittier to Anchorage. After the war and five decades of controversy, the tunnel was adapted so that trucks, busses, and cars could finally drive the 2.5-miles beneath the mountain.

It's still basically a train tunnel. Traffic is allowed in one-way directions every half hour during daylight hours and stopped periodically to allow scheduled trains to pass through. A ventilation system with jet fans and continuous monitoring systems now keeps the air quality breathable. It is the longest drivable tunnel in North America.

Getting to Whittier is not the only unique thing about this town. Almost everyone lives in a single building – the Begich Towers. For a community with only 200 permanent residents, seeing a 14-story building in the center of town is a surprise. Designed in 1953, it was built to become the headquarters of the Army Corps of Engineers and part of planned expansion of military facilities. That expansion never came and after the '64 earthquake and tsunami, was converted to non-military use.

I digress. The purpose of our field trip was to highlight how climate change may impact earthquake and tsunami hazards. At first glance you might think earthquakes have little relation to a changing climate. Earthquakes are centered miles beneath the surface where the changing surface temperatures never reach. Frequency and size of earthquakes is primarily driven by tectonic forces deeper within the earth.

However, surface changes can have consequences at depth. The melting of glaciers causes the land to rise (isostatic rebound) producing stresses that may be responsible in part for some earthquakes. The melting of permafrost and changing groundwater distribution changes pore pressures and could nudge some faults closer to failure and can make areas more vulnerable to behaving like a fluid (liquefaction) when ground shaking does occur.

The link between climate change and tsunamis is clearer. The obvious connection is that higher sea level means more coastal areas are vulnerable to inundation. And it's not just the water height that is important. Higher water in ports and harbors means that a tsunami will produce stronger currents. Recent studies suggest that 50 years from now, a magnitude 8.8 earthquake in Alaska would produce currents in Los Angeles ports equivalent to what a M 9 would create today.

A second consequence of a warming climate is less obvious but potentially more hazardous. Glacial retreat means valleys once filled with ice are now exposed. The formerly ice-buttressed slopes are now much more vulnerable to landslides and some of them may be large enough to create extremely large tsunamis.

This is not a purely hypothetical argument. In the past 200 years, Lituya Bay in southeastern Alaska has had four tsunamis with heights of over 100 feet, all caused by landslides at the head of the Bay. The 1958 earthquake-triggered landslide produced waves of over 1700 feet above sea level, the highest ever recorded in modern times.

I knew about the tsunami history of Lituya Bay but didn't realize it likely had a climate change link until talking with colleague Bretwood Higman who pointed out that the melting and retreat of glaciers in this area roughly 400 years ago made the slopes above the Bay far more vulnerable to landslides.

The highlight of the field trip was a boat ride up Barry Arm where another Lituya Bay scenario could be unfolding. The three glaciers that feed into Barry Arm are all retreating rapidly, exposing slopes previously buttressed by ice. In 2019, a local artist noticed failures on the slope wall that caught the attention of scientists and the media.

The USGS has instrumented the landslide site with an array of instruments that, combined with NASA imagery, shows the landslide has shifted nearly 400 feet between 2010 and 2017. The current movement has been relatively slow, but the entire mile and a half wide zone could fail catastrophically, producing a tsunami large enough to swamp the marine traffic in the region and damage the Whittier harbor area.

The Barry Arm landslide is only one of hundreds of potentially vulnerable slopes in Alaska. Globally, the number is much higher as glacial retreat accelerates. Today, roughly 95% of all tsunamis are earthquake generated. That ratio could change as more frequent and larger landslides produce significant waves.

Note: Two sites for further exploration: The Whittier
https://www.npr.org/2015/01/18/378162264/welcome-to-whittier-alaska-a-community-under-one-roof
https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2020GL089800?campaign=woletoc

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