

# Rapid proglacial delta growth from meltwater pulses in Lituya Bay, Alaska

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## Background

Tidewater glaciers in Alaska have shown the largest sediment yields worldwide. Over the past decades, rapidly growing proglacial deltas have formed in the fjords and bays along the glaciated coast of

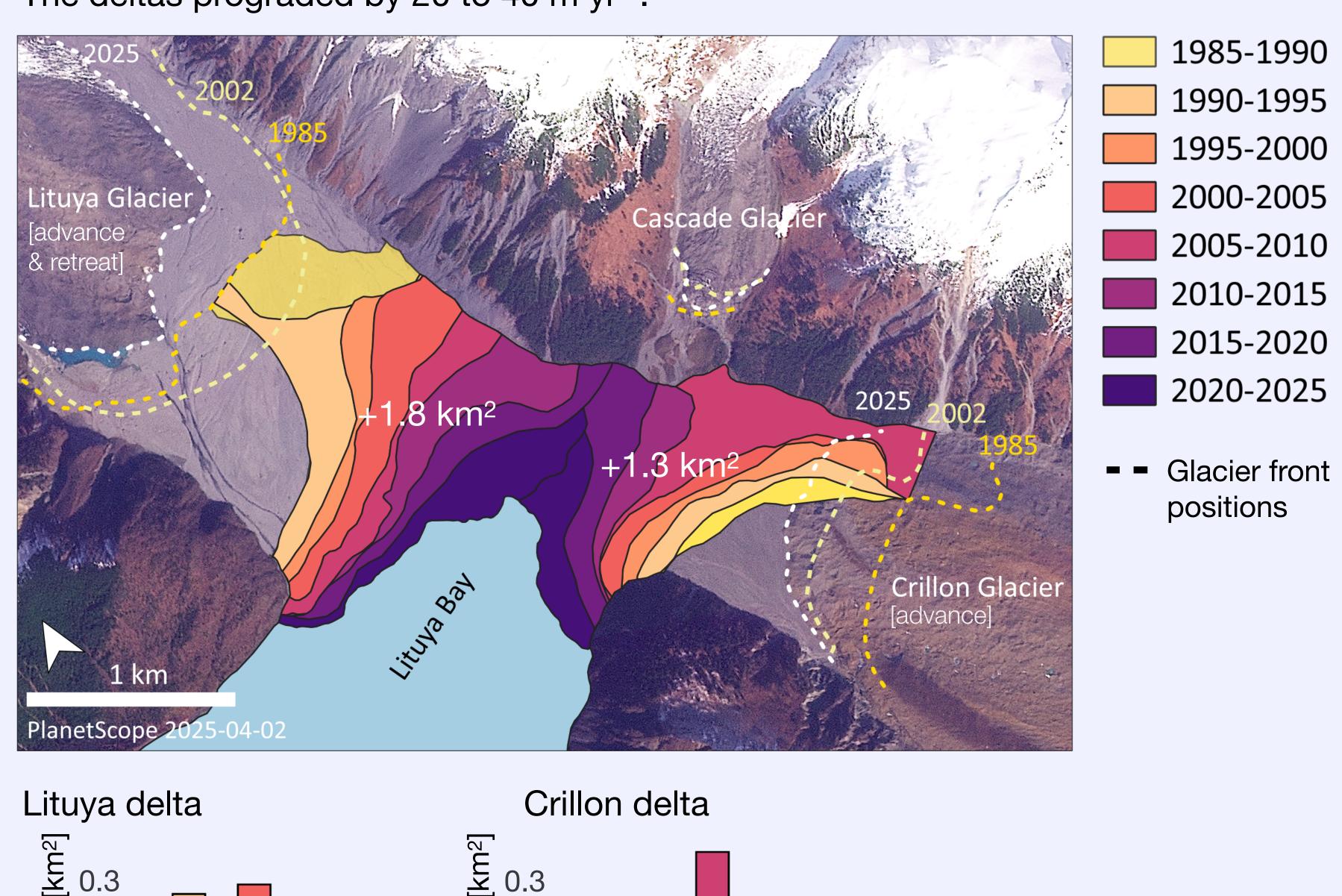
Yakutat 100 km

Alaska, buffering the sediment flux from land to ocean and altering coastal ecosystems. Lituya Bay, Alaska, U.S., is located along the NW-SE striking, tectonically active, Fairweather Fault and hosts three former tidewater glaciers. In the last four decades, two proglacial deltas have rapidly grown at the head of the bay, raising the questions:

How much did the deltas grow and why? Where is the sediment sourced from?

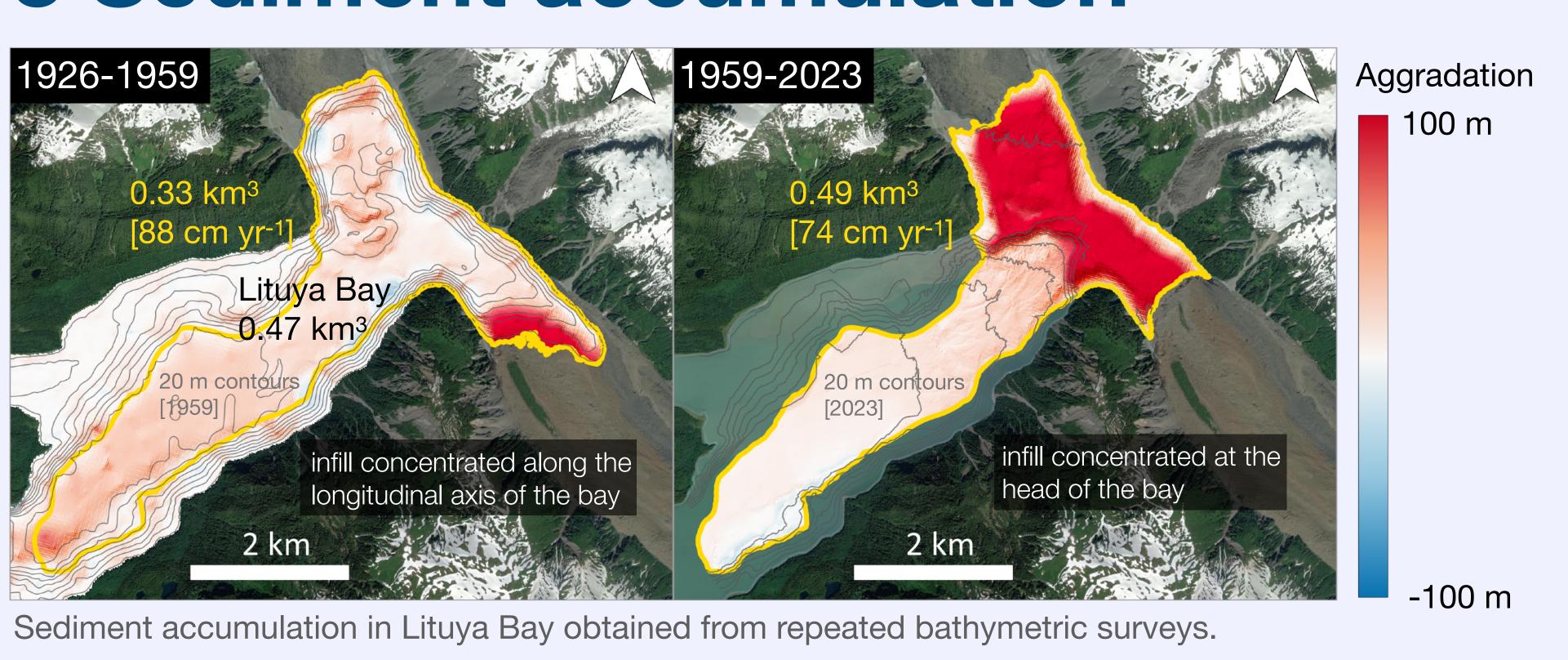
# 2 Delta growth

The deltas prograded by 20 to 40 m yr<sup>-1</sup>.



# Areal progradation of Lituya and Crillon deltas [1985-2025].

### 3 Sediment accumulation



### Removal of subglacial sediments produced during tidewater glacier Why did Lituya delta retreat grow faster than Crillon delta? Flood boulders Lituya delta Lituya Glacier Crillon delta $0.21 \text{ km}^3$ $77 \text{ km}^2$ $0.10 \text{ km}^3$ [1959-2023] [1959-2023] ... Landslides Crillon Glacier 87 km<sup>2</sup>

#### At water depths from 60 to 80 m, the slope of Lituya delta exhibits a series of channels hosting downslope-asymmetrical cyclic steps, indicative for high-density turbidity currents.

5 m contours

[2019 LiDAR]

The wavelength of the bedforms ranges from ~10 to 30 m and increases with increasing distance to the delta front.

2 km

### Key findings

- > ~1 km³ of sediments accumulated in Lituya Bay between 1926 and 2023.
- > The material largely derives from erosion of subglacial sediment and bedrock eroded during the outburst floods.
- > A larger catchment, the outburst floods, and pronounced glacier thinning, which may have increased subglacial meltwater availability and, in turn, sediment transport capacity, likely contributed to the faster growth of Lituya delta compared to Crillon delta.

### 4 Catchments

Despite similarities in glacier size and setting, the catchment size of Lituya delta likely exceeds the catchment of

Hypothetical catchments of Lituya delta (orange) and Crillon delta (red) based on



### 5 Outburst floods

Since the 1970s, sediment laden floods from **Desolation Lake** flooded Lituya delta near annually and strongly imprint the morphology of the delta [1-5]. The surface of Lituya delta is dissected by deep channels.

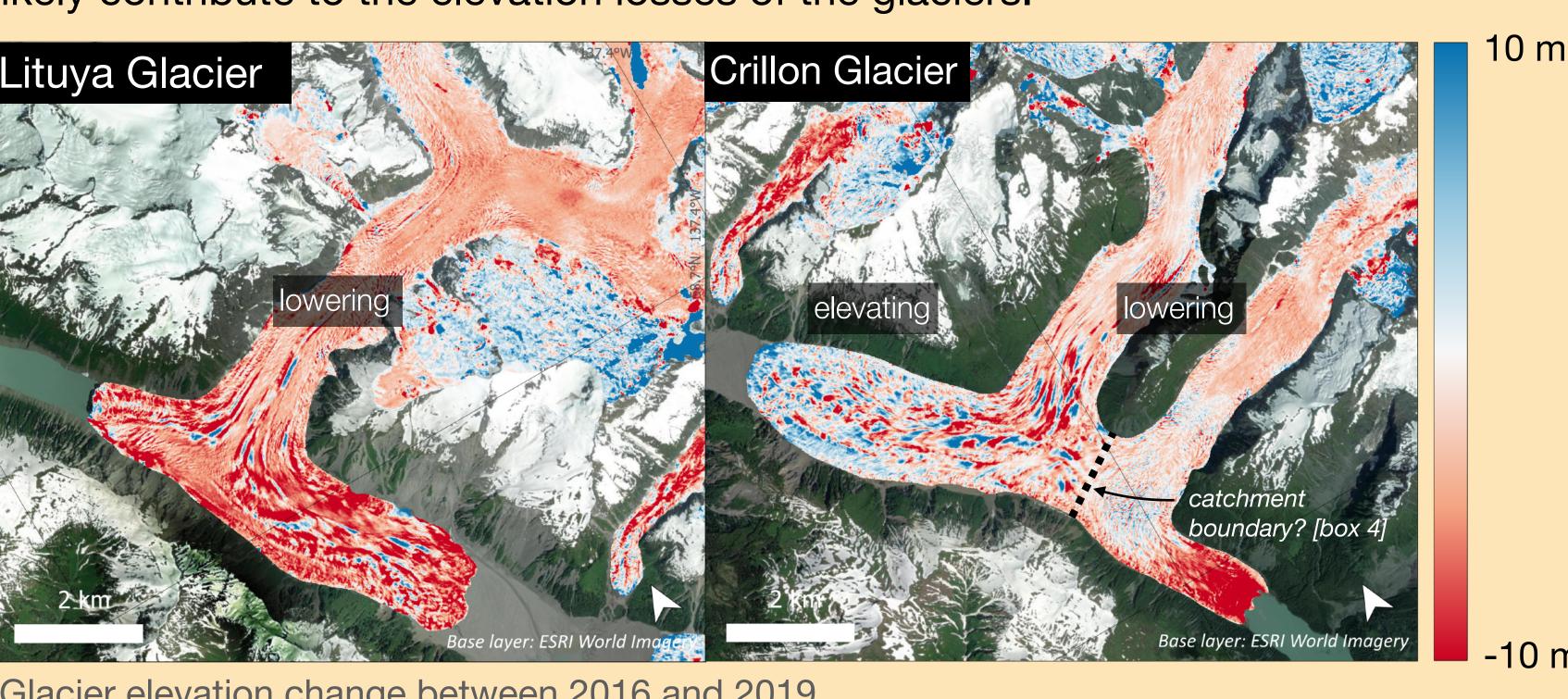




Lituya delta during the 2024 outburst.

### 6 Glacier elevation change

Besides ice thinning, the removal of subglacial sediments and bedrock erosion likely contribute to the elevation losses of the glaciers.

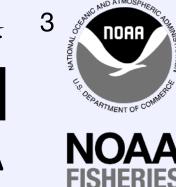


### 7 Implications

The deltas now occupy the steepest parts of the bay, preventing direct subaerial rock slide impacts into former deep water, thus reducing the hazard of landslide-generated tsunamis.

The rapid progradation of the deltas limits the time for sediment compaction and hence, might promote future delta front failures.













Bedrock gorge

Ice kettle

Trim line





Cyclic steps created by

the outburst floods of

Desolation Lake









