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Effects of extreme events on the morphology of submarine channels: the case of the Elliot hazard cascade

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Submarine systems where the canyon head is directly connected to the river mouth arguably provide the best setting for *in situ* studies of turbidity currents since the sediment supply propelling them arrive in periodic pulses linked to fluvial freshet events. Consequently, the frequency of, and similarity between, the turbidity currents flowing through these systems make it easier for their channel morphology to evolve towards a state of dynamic equilibrium. Therefore, if an extreme event occurs that dramatically alters the system's sediment supply, it is reasonable to assume that submarine channels will undergo a period of rapid adjustment. This is the present scenario occurring in Bute Inlet following the recent Elliot Creek hazard cascade. Bute Inlet is one of the most actively monitored sites for turbidity currents in the world, and the extensive historical dataset that has been amassed at this site along with the rare Elliot Creek event provides the unique opportunity to study the impacts of extreme allogenic forcing mechanisms on the morphodynamics of submarine channels.

Preliminary measurements indicate that the turbidity in Elliot Creek has increased by ~40x compared to pre-slide measurements, and oceanographic measurements within a few days of the event show very high turbidity in ocean bottom water to a distance of almost 70 km from the delta. While the bathymetric survey since the landslide is so far constrained to the proximal region of the inlet, early results show that channel morphology was rapidly altered. Specifically, the submarine channel fed by Southgate River, which supplied water and sediment from the landslide and glacial outburst flood, was lowered by about 3m across the width of the channel bed. Conversely, the morphology of the channel fed by Homathko River has remained static between

the 2020 and 2021 surveys. Below the confluence of these two submarine channels, the cyclic steps that once dominated the bed morphology appear to have been largely infilled by a 1-2m thick drape of sediment along the inner half of the channel bend, whereas the outer banks have laterally eroded by upwards of 50m at some points. This trend of channel widening and lateral migration appear to be propagating down the system. Importantly, the nature of the slide suggests that sediment delivery will remain elevated with respect to background conditions for decades into the future, suggesting that the submarine channel may be in the process of adapting to an entirely new flow regime rather than reacting to a singular extreme flow event.