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Fluvial adjustments in response to glacier retreat: Skaftafellsjökull, Iceland

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Proglacial landscapes are highly sensitive to glacier retreat, and the retreat of glaciers around the world has accelerated since the mid-1990s. Changes in discharge and proglacial topography are likely to lead to changes in the morphology and functioning of proglacial rivers. However, at present, most of our knowledge of how rivers respond to glacier retreat is based on studies of landscapes formed during the retreat of glaciers from their Last Glacial Maximum extents. Few studies have examined year-on-year changes in glacier extent and related them to changes in proglacial drainage patterns.

This study describes changes to the proglacial drainage network of Skaftafellsjökull, Iceland from 1998 to 2011. Skaftafellsjökull has retreated at an average rate of 53 m per year since 1999. From 1999 to 2003, the river incised and formed a sequence of now abandoned channels and fluvial terraces extending $\sim$1 km downstream from the glacier. Retreat of the glacier from an over-deepened ice-contact slope meant that there was a strong positive correlation between the distance of glacier retreat and the amount of fluvial incision. Incision was episodic, occurring annually in response to drainage reactivation and reorganization. On an annual basis, the rate of retreat is moderately negatively correlated with the rate of incision. This is partly because the ice-contact slope decreases away from the position of maximum glacier extent, and also because more sediment is released with faster retreat, counteracting the effect of retreat down an ice-contact slope. From 2003 onwards, proximal terrace formation ceased, as a proglacial lake became established. Downstream of the lake outlet further incision deepened the channel, with most change occurring during a flood in 2006, where incision in the upstream confined reach was accompanied by downstream aggradation and terrace formation.

These observations indicate that proglacial changes in response to glacier retreat are a result of the interactions of river channel incision and terrace formation, aggradation, lake development, and flooding, which together control river channel changes, sediment redistribution and sandur stratigraphy. Further work is needed to extend this model away from lowland outlet glaciers into other proglacial settings.