A sediment flux time series from a proglacial area: insights into sediment dynamics of glaciated catchments

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In recent years hydropower operators and others (e.g. Micheletti et al., 2015) in the Swiss Alps have observed increased erosion in glaciated regions, resulting sedimentation in reservoirs and abrasion of infrastructure downstream. This material could originate either subglacially or from newly created proglacial areas (PGA) formed as glaciers retreat and are often comprised of unconsolidated and easily erodeable material (e.g. Church and Ryder, 1972). To determine sediment fluxes from these PGAs, we examine the Griesgletscher in eastern Valais and compare these data with catchment characteristics, such as hydrology and glacier morphology, to better understand sedimentation and erosional processes.

By subtracting digital surface models made from annually-collected aerial photographs from 1986 to 2014 covering the PGA, we calculated annual sediment fluxes from the PGA. This data suggests that erosion has increased exponentially since 1986, a predominatly product of the larger PGA caused by glacier retreat. However, six of the 26 years examined experience net deposition in the proglacial area, suggesting the importance of the subglacial sediment source or transport of material from other parts of the basin. Additionally, within the last seven years examined, three years experienced extreme amounts of erosion from the PGA, while two years experienced a comparable amount of deposition.

Catchment hydrology was modeled over the study period to better understand the relationship between sediment dynamics and runoff. When examined through the entire study period, erosion is correlated with maximum three to seven day discharge and higher runoff volume; these higher flows could provide the water necessary to remove large amounts of material from the PGA. Conversely, deposition is correlated with runoff variability and maximum discharge over short time periods (less than three days). These are associated with high subglacial water pressure (e.g. Iken and Bindschadler, 1986), possibly increasing subglacial erosion, subsequently depositing sediment in the PGA as the water leaves glacier and its flow speed is reduced.

Lastly, comparison of four lake bathymetries from the Griesgletscher's proglacial reservoir, suggests that 10 to 50% of sediment deposited in the reservoir originates from the PGA. The remaining material must come from subglacial sources or other parts of the basin, which expel large quantities of sediment. By examining these relationships, we have been able to gain valuable insight into the processes controlling proglacial erosion and their relative importance in the catchment's sediment dynamics.

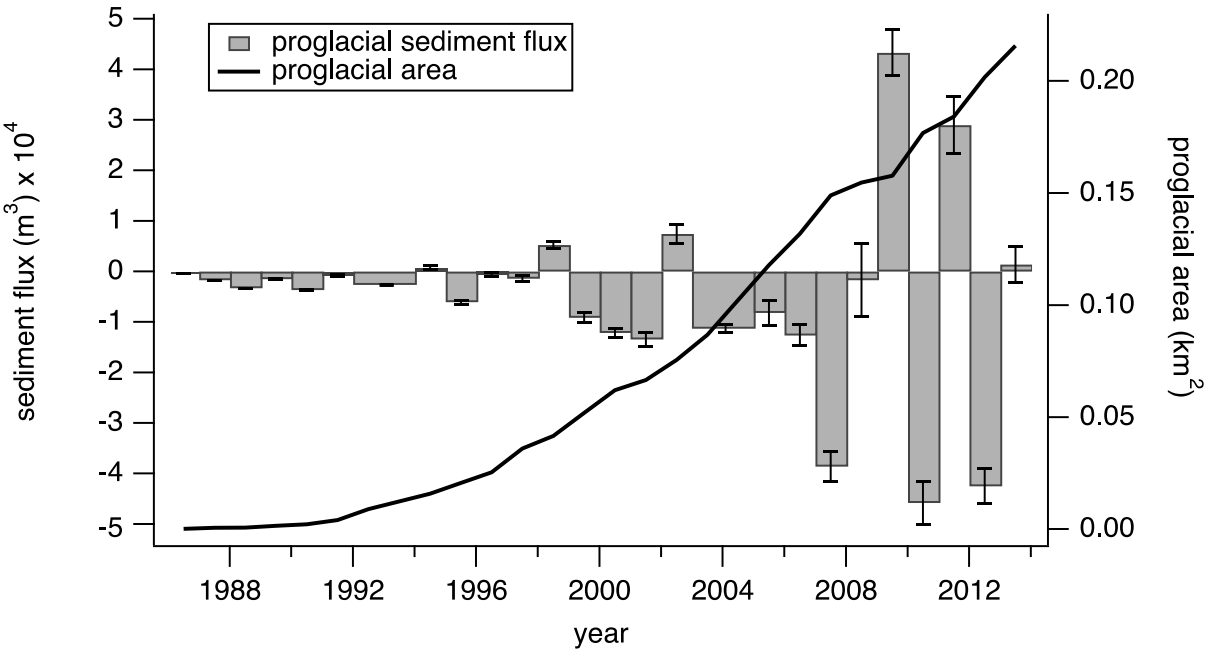

Figure 1. Annual volumetric sediment flux from the Greisgletscher's proglacial area from 1986 to 2014. Negative values denote net erosion, while positive values show net deposition in the proglacial area.

REFERENCES

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