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State and fate of a proglacial lake – insights on sediment deposition at Lake Sulz, Eastern Alps, Austria.

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Increased formation of proglacial lakes resulting from glacier melt is an indicator of climate change in mountain areas. Within the alpine sediment cascade, glacial lakes represent important sediment sinks often located at elevated locations along the cascade path. Formation of glacial lakes significantly reduces sediment output from glaciated watersheds thus affecting sediment budgets and downstream fluvial sediment availability. The reduction of flow velocity when entering a lake causes sedimentation and formation of delta and lake deposits. Accommodation space (i.e. lake volume), grain size and flow velocity are the dominant parameters determining the amount of material deposited within or transferred through the lake and thus determine the trapping efficiency as well as lake lifetime. Recent studies show that lake lifetime of high alpine lakes is highly variable between a few decades and many centuries to thousands of years. Quantification of lake sediments allows quantifying sediment delivery rates from high alpine catchments and reconstruction of erosional dynamics and catchment connectivity conditions. Since glacial lakes represent sources of natural hazards like outburst floods, lake lifetime is also relevant from a risk perspective.

We present results of repeated geophysical measurements at Lake Sulz, a proglacial lake that evolved since 1998 in the Obersulzbachtal, Hohe Tauern, Austrian Alps, in front of the Obersulzbachkees glacier. The lake has an area of 165,000 m^2 and is located at an altitude of 2200 m. Lake volume is about 2.5 M m^3 with maximum depths of around 35 m. We used echo sounding, sub-bottom profiling and ground-penetrating radar to monitor changes of water depth, lake bottom and sediment deposition between 2009, 2015 and 2018. Acoustic methods were used to assess changes in the open water section, mainly deposition during retreat of the glacier tongue and of fine sediments at the lake bottom. A large delta has formed at the distal part of the lake with shallow water levels that prohibit access by boat. We applied ground-penetrating radar on the frozen lake surface to quantify and characterise delta deposits and document changes of the delta deposition from the proglacial streams entering.

We quantified mean annual sediment deposition at the lake bottom of about 25.000 m^3/a, and delta deposition of about 100.000 m^3/a. We also observed a local decrease of lake bottom levels after the glacier tongue completely retreated from the lake, which is attributed to melt of ice at the bottom of the lake. Assuming ongoing sedimentation rates, lake filling will be completed within the next 25-30 years. With growing distance between the glacier tongue and the lake due to glacier melt, we assume that sediment delivery will decline following deposition within the evolving glacier forefield. We will discuss our findings in relation to sediment sources, and geomorphological and glaciological changes within the catchment within the last 15 years.