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What comes in must not come out - proglacial lake sedimentation patterns and trapping efficiency derived from ground penetrating radar and echo sounding

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Since the late 1990s a proglacial lake developed following the retreat of the Obersulzbachkees glacier in the Austrian Alps. The lake formed behind a bedrock ridge at an altitude of 2,200 m covering an area of 152,000 m^2. Since its formation the lake is monitored by the local authorities that operate two runoff monitoring stations at the lake outlet stream. In a previous study sediment output from the lake was recorded during two years (2010/11). This study seeks to investigate sedimentation patterns and storage volumes in the lake using two different geophysical methods. The aim of the project is to assess sediment input and discuss the lake's impact on the fluvial sediment transport system of the valley. The study is part of the FUTURELAKE project that seeks to model the formation of new glacier lakes and their possible future evolution in the Austria Alps.
We investigated lake morphology and lake sedimentation using ground penetrating radar (GPR) and echo sounding data from measurements in 2009 and 2015/16. GPR data was collected in winter on the frozen lake surface and in summer from a boat using different antenna frequencies (100/200 MHz). Lake morphology is best described as a bowl shaped hollow with a maximum length of 650 and a width of 460 m. The bowl has a flat bottom and asymmetrically shaped sides along the length axis with a steeper slope of more than 50° inclination towards the lake outlet and a gentler slope following an extended shallow shore area towards the glacier. The maximum depth of the lake decreased from 42.5 m to 35.6 m depicting lake sedimentation between 2009 and 2015. Two tributaries enter the lake from the south draining two parts of the decomposing Obersulzbachkees glacier. Sediment input from these creeks is responsible for delta formation at this end of the lake. Two other tributaries enter the lake on the longer sides from opposite directions (east and west) both draining other separated parts of the glacier ensemble. Sediment input from these tributaries is much smaller compared to the other tributaries. The GPR data allows for a differentiation of sediment characteristics and sources. Glaciofluvial sediment input into the lake results in deposition of locally stratified fine sediments at the upper end of the lake. Below the steep lateral slopes along the eastern and western shore coarse debris is deposited in the lake resulting from erosional processes of the lateral moraine deposits covering these slopes. The latter represents the ongoing paraglacial adjustment of these recently deposited lateral moraine sediments.
In a first approximation, we calculated 75,000 m^3 of sediment deposited in the lake between 2009 and 2015. This value refers to an annual sediment delivery into the lake of 600 $t/km^2/a$. Compared to the previously measured fluvial sediment output of 450 $t/km^2/a$ the trapping efficiency of the Obersulzbach lake would be around 25%. This number strongly differs from a previously assessed value of up to 90% by Geilhausen et al. (2013) and raises questions about possible factors influencing sediment trapping at this location.