Subaquatic geomorphology of Walensee: Understanding subaquatic slope and delta instabilities and their implications in the perialpine realm

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Introduction & Goals

After a seismic survey and a sediment-coring campaign in 2007 to reconstruct the event history of Walensee (Fig. 1, Zimmermann, 2008), we acquired the first detailed lake-floor morphology with a high-resolution bathymetric map. This project will yield a geomorphologic map showing the major geomorphologic elements of Walensee in unprecedented detail, including major depositional and erosional processes, natural hazards (subaquatic mass movements and subaerial rockfalls) and human impact. This bathymetric map is complemented by sediment cores at selected locations. A specific goal is to investigate a potential subaquatic slope instability using short-core transects. We take a closer look at two specific areas in Walensee, which ultimately build the goal of this thesis:

- Quinten: We analyse a subaquatic mass movement with the help of sediment-core transects and try to determine when the last mass movement occurred, the size of the landslide deposit and the possibility of a next mass movement.
- Seez Delta: We analyse changes related to normal sedimentation patterns with the help of repeated (4D) bathymetry. Changes can already be seen within hours and days (Brucker et al., 2007, D.Vendettuoli et al., 2019) so we want to get a better understanding of delta depositional processes within a time window of six days during the survey.

Study site

Walensee is a perialpine lake located in eastern Switzerland between Glarus and St. Gallen. It is embedded in the Helvetic nappes and dominated by a wide variety of lithologies ranging from verrucano to subalpine molasse. It is located at 420 m above sea level and has a length of 15 km and 35 major inflows. 60% of the inflowing water comes from the Linth and 6% from the Seez. The only outflow is located in the east where the Linth Channel flows into Lake Zurich (Fig. 1).

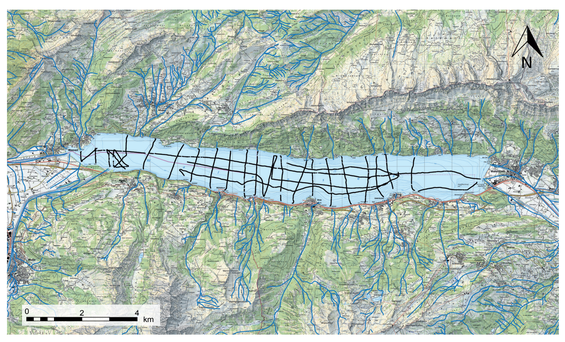


Fig. 1. Walensee with its inflow and outflow areas and the grid of the seismic profiles from previous work. (https://map.geo.admin.ch; Zimmermann, 2008)

Methods

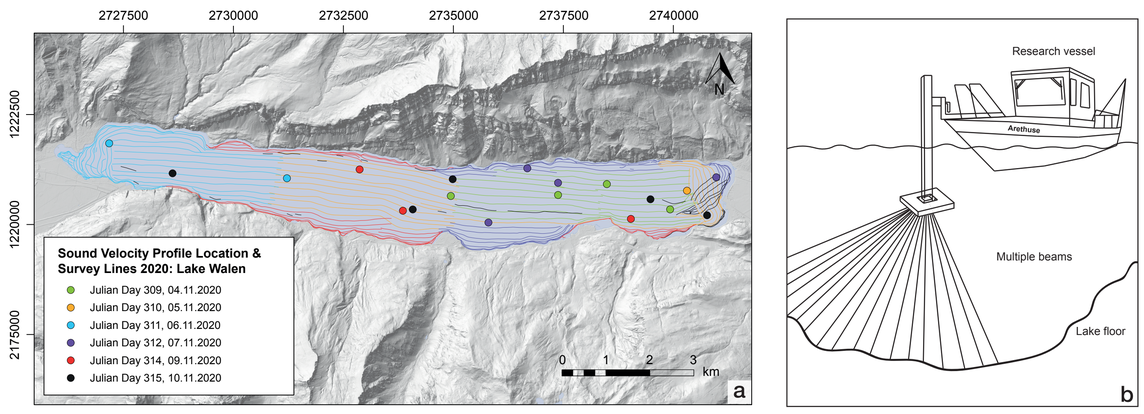
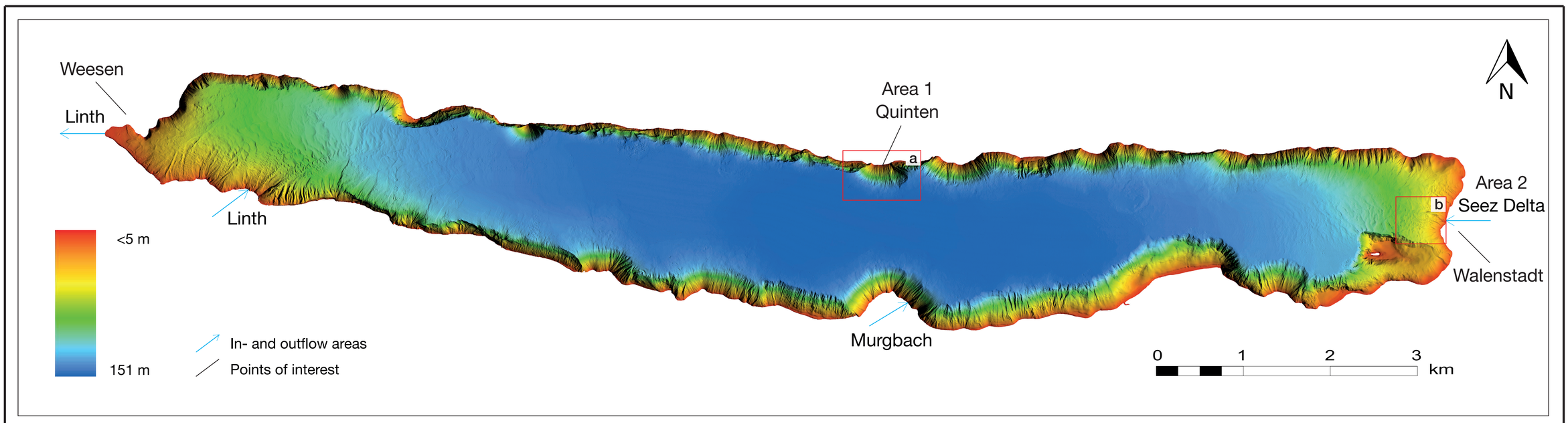


Fig. 2. Grid of the bathymetric survey lines 2020 with the sound velocity profile locations (a) and the used multibeam echo sounder (b). (https://map.geo.admin.ch, modified)

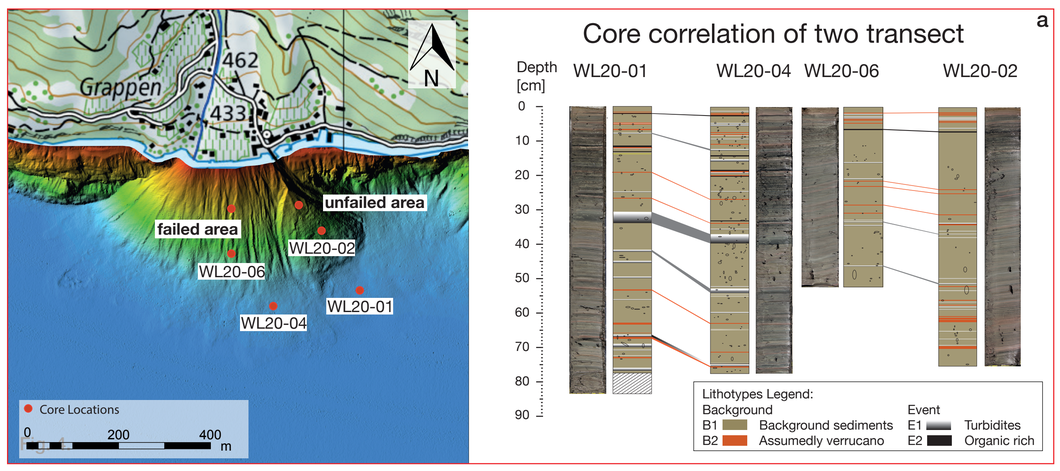
1) Bathymetry:
- Research vessel with a multibeam sonar system (Fig. 2b) for the bathymetric data acquisition
- Processing of the bathymetric raw data with Caris HIPS & SIPS 10.3
- Revealing subaquatic, geomorphologic features
- Calculation of a 4D map of the Seez Delta

2) Coring:
- 3 sediment-core transects (6 short-cores in total with a maximum length of 83 cm) with a gravity corer and GPS for navigation
- MSCL (multisensor core logger) scanning (density and magnetic susceptibility) and lithology analysis and interpretation in the laboratory

Results



Area 1: Quinten - Subaquatic mass movement



Area 2: Seez Delta - 4D Bathymetry

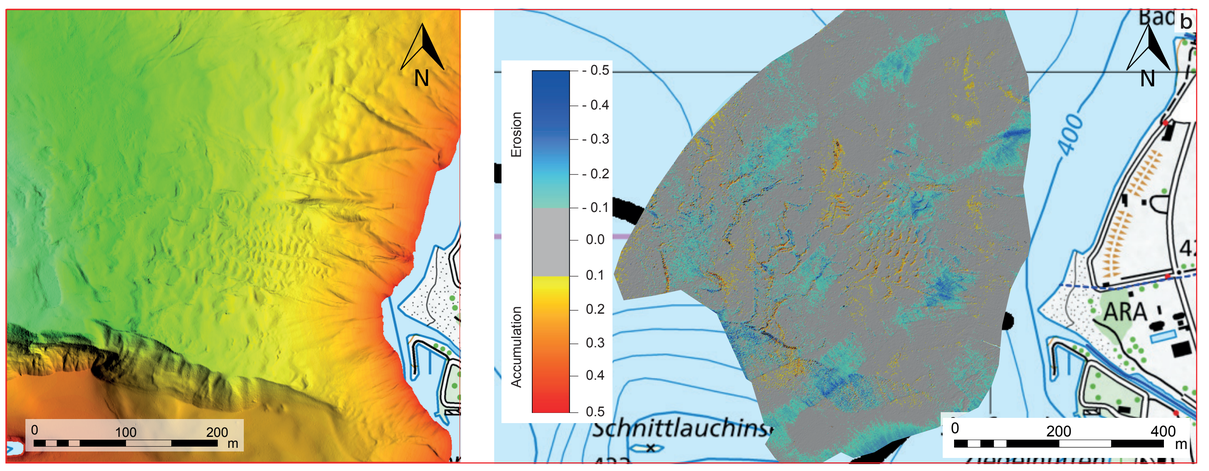


Fig. 3. The new bathymetric map of Walensee with its main in- and outflow areas and points of interest (top) and a closer look to the two main investigated areas (bottom). The area 1 in Quinten (a) shows two core transects from an unfailed part in the east across a failed part in the east. The area 2 at the Seez delta (b) shows a calculated difference map of a 4D bathymetry within six days of the survey. Accumulation and erosion of up to 40 cm can already be seen in this small time scale.

Conclusions

The first high-resolution bathymetric map of Walensee allows a categorisation in geomorphologic zones from delta and basin areas till traces of rockfalls and artificial impacts. The 4D Bathymetry over several days gives us first ideas on sediment processes on small and short scales.

In the Quinten area, steep deltas indicate lateral varying stability conditions as we got traces of mass movements on one and an unfailed area that is prone to failure on the other side. Despite of the three core transects, we don't reach the potential failure plane, what means, that it is probably located in greater depth.

At the Seez Delta, accumulation and erosion of several cm can already be seen within days. Changes in deposition are not only flood-related but can also be seen in calm conditions as no flood occurred within the acquisition window, these processes are interpreted as the normal "background" processes within this delta.

References

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