EGU2020-3310, updated on 06 Jul 2022
https://doi.org/10.5194/egusphere-egu2020-3310
EGU General Assembly 2020

Ground and Dead Ice in Alpine Proglacial Areas – Sensitivity towards Climate Change since 1850, Recent Dynamics and Future Trends

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As the climate warms, the earths' cryosphere melts. Among the regions with the highest sensitivity to recent climate change are the high altitudes of the European Alps. This can be seen most clearly in the melting of glacier ice. Most glaciers show a strong receding trend since the last maximum extent during the little ice age (LIA) around AD 1850. When glaciers retreat, they leave behind a characteristic paraglacial landscape in a transient state from glacial to non-glacial conditions. Dominated by large amounts of unconsolidated glacial sediments they show an extremely high geomorphic activity.

However, these proglacial areas can still hold ice even decades after the glacier has left. In a simplified manner, this can be conceptually described by two main mechanisms: i) When glaciers retreat parts of the glacier front are often decoupled from the main glacier. These so-called dead ice bodies can remain for years, especially when they are buried by a thick debris cover and thus protected from atmospheric conditions. ii) Particularly in high-elevated glacier forefields, the thermal regime can be suitable for the direct transition from a glacial to a periglacial environment, compassing the aggradation of permafrost ice in areas that have been released from the glacier.

Climate warming speeds up in recent times, related with an enhanced receding of glaciers and growing alpine proglacial areas. Ground and dead ice are among the most important drivers of geomorphic activity in these regions, though in the long-term it is most likely, that it will melt out as well. How fast this will happen and in what stage it may play a role in stabilizing these environments is not yet fully clarified. Therefore, a better knowledge on ice distribution and dynamics in alpine proglacial regions is needed. Additionally, the quantification of ice and water contents is crucial in terms of potential hazardous processes, regarding the supply of (drinking) water and hydropower.

Here we present a new (PhD-) project in close cooperation with the DFG-funded research unit SEHAG, which is at the beginning of its implementation. Focussing on ground and dead ice we aim i) to assess the current distribution, ii) to reconstruct dynamics since the LIA, iii) to reveal recent and future trends (aggradation, degradation and persistence), and iv) to quantify effects on sediment dynamics in three Central Alpine proglacial areas. We combine different geophysical techniques with a focus on electrical resistivity tomography, water isotope analysis and ground

(surface) temperature measurements with high-resolution geomorphic change modelling.