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Tree-ring dating of colonized moraine surfaces in deglacierized areas of Greater Caucasus Mountains

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Since the end of the Little Ice Age (LIA) glacial advance, mountain glaciers of temperate zone have experienced an accelerated retreat accompanied by an increased production, transport and accumulation of glacial sediments. In these deglacierized areas, the development of a chronology for sediment deposition in the glacier forefronts remains challenging. Indeed, various dating methods are applicable but only few of these are capable to cover the last centuries with a high resolution. Amongst these methods, dendrochronological dating offers the possibility to reconstruct minimum ages of the moraines with a yearly resolution, providing a detailed chronology for glacier dynamics. Tree-ring dating relies on the assumption that the age of the oldest tree represents an estimate of the minimum age of the moraine resulting from the glacier movements. Although the Caucasus Range is one of the most heavily glaciated areas of temperate zone, field evidences and historical records point out that mountain glaciers are already in accelerated decline in response to climate warming since the LIA. In this respect, the main purpose of our study is to document historical changes of the Challaati glacier, located in Mestiachala river basin, over the last centuries by using tree-ring dating coupled with field survey investigations. The methodology involves the application of dendrochronology and geomorphological field mapping completed by GPS records. A total of 120 living Scots pine trees (Pinus sylvestris) growing on glacier forefield have been sampled with Pressler increment borers of various lengths. Tree-ring widths were measured with an accuracy of 0.01 mm using a LINTAB 5 measurement station (Rinntech, 2019). The quality of the visual cross-dating was statistically checked using the COFECHA program. In order to reduce uncertainties in dating the colonization age of moraines, various corrections were applied, including: (i) the reconstruction of the number of missing rings to the pith (pith offset estimation); (ii) the determination of age-height relationships for the study site (tree age estimation at the coring height corresponding with years a sapling needs to grow to breast height); and (iii) the determination of the ecesis, which is related to the period from the stabilization of the moraine surface to the germination and establishment of the first trees. Tree-

ring analyses coupled with GPS records and geomorphological mapping of glacier forefield allowed us to reconstruct multiple stages of glacier recession, and also to calculate the retreat rates since the end of LIA. Therefore, this study highlights the usefulness of tree-ring dating coupled with field survey investigations to improve our knowledge and understanding of glacier forefield changes, but also to provide a robust dataset for the modelling the retreat of glaciers at various scales.

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