

THESIS ABSTRACT

Late Holocene glacier fluctuations in the eastern Nyainqêntanglha Range, southeastern Tibet

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Dissertation Online: <http://publications.rwth-aachen.de/record/480415/files/480415.pdf>

The eastern Nyainqêntanglha Range is located at the southeastern fringe of the Tibetan Plateau, representing one of the major pathways of monsoonal moisture from the foreland to the plateau. Owing to the combination of a rugged high mountain topography and abundant moisture, more than 8000 km² of the eastern Nyainqêntanglha Range are covered by monsoonal temperate glaciers. Previous studies have shown that these glaciers are particularly sensitive to climate change. The eastern Nyainqêntanglha Range's glaciers thus provide an important archive of past and present climate dynamics. The interplay of glaciers, topography and climate in this region is, however, hardly constrained to date. Furthermore, a consistent late Holocene glacial chronology, combining dating results with geomorphologi-

cal and sedimentological evidence, is still lacking. Several recent studies aimed to contribute to bridging these gaps by improving the understanding of spatial and temporal patterns of late Holocene glacier fluctuations in the eastern Nyainqêntanglha Range and identifying relevant climatic forcing mechanisms. Focus was put on the Little Ice Age (LIA) because its maximum glacier advance represents the last major turning point from an advancing to a retreating glacier regime, implying a transient state of glacial equilibrium. Aiming to achieve a consistent and well-constrained overall result, the study was conducted by application of a multi-proxy approach including glaciological, geomorphological, sedimentological and dendrochronological methods, aided by optically stimulated luminescence and

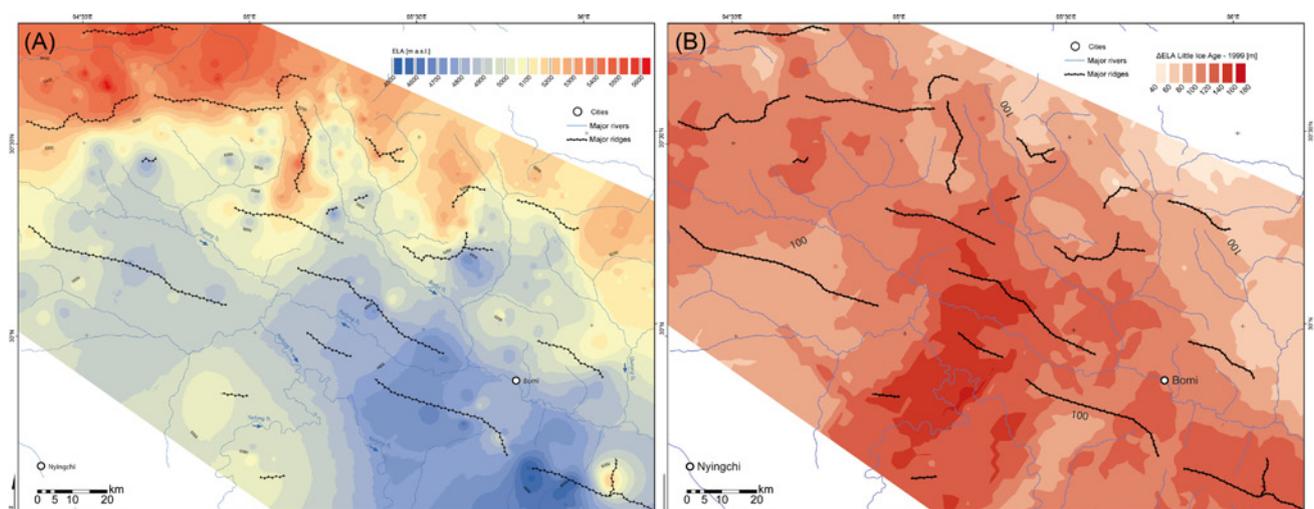


Fig. 1: High resolution spatial distribution patterns of glacier equilibrium line altitudes (ELAs) in the eastern Nyainqêntanglha Range, southeastern Tibet, as calculated by the 'refined toe-to-ridge altitude method' (rTRAM; cf. Loibl, Lehmkuhl & Griesinger, 2014). (A) Calculated rTRAM ELA results. ELA peaks and troughs are closely linked to topography, i.e., valley system and major ridges, indicating control exerted by orographic precipitation and leeward shelter, respectively. Note that the overall distribution of ELAs roughly traces the valley system on different scales, regional to catchment. (B) Difference between rTRAM values for the Little Ice Age (LIA) and modern stages (Δ ELA). The pattern vaguely resembles the distribution of precipitation in the study area, indicating that glaciers in continental/oceanic climates are reacting less/more sensitive to post-LIA climate change.

radiocarbon dating. In a remote sensing study, 1964 glaciers were mapped from a Landsat ETM+ scene and subsequently parameterized by DEM-supported measurements (LOIBL, LEHMKUHL & GRIESSINGER 2014). Analysis of the geomorphological evidence provided the basis to investigate patterns of modern glaciation and post-LIA changes quantitatively, revealing substantial retreat. An evaluation of different methods to calculate equilibrium line altitudes (ELAs) showed that a specifically developed refined toe-to-ridge altitude method (rTRAM) was more suitable than other methods in the study area's configuration of complex topography, lacking mass balance measurements, and error-prone hypsographic data. The results of the rTRAM studies provided insights into the complex topography–climate–glacier coupling and revealed the underlying patterns (Fig. 1). These included a combination of distinct insolation effects, channeling of moisture by the valley system, foehn effects in lee positions, orographic precipitation in luv positions, and large-scale hygric and thermal gradients (LOIBL & LEHMKUHL 2015). Additionally, analysis of glacier length and ELA changes showed that the sensitivity of the glacier's reaction to climatic changes is positively correlated to both size of the glacier and the grade of continentality (LOIBL, LEHMKUHL & GRIESSINGER 2014). Field-work-based work focused on the creation of a consistent morphosequence (LOIBL et al. 2015). The results yielded similar configurations and numbers of moraines at all studied settings, implying that similar climatic events affected the

whole region since the LIA. The geomorphological settings of the glacier forelands were, however, remarkably different, showing the substantial impact of the local topography–climate–glacier configurations. A critical evaluation of different relative and numerical dating methods provided constraints for a conceptual chronosequence. They suggest that the LIA comprised several distinct glacier advances, particularly an early advance before ~ 1500 CE and a succession to the maximum advance from the mid-17th to mid-18th century. After the LIA maximum, continued retreat that was only interrupted by short phases of stability followed, as evidenced by 2–3 recessional moraines in the investigated settings. The studies are synthesized and complemented in LOIBL (2015).

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