Problems of Holocene Glacier Advances in Langtang, Central Nepal

Helmut Heuberger and Horst Ibetsberger
Department of Geography, University of Salzburg, Hellbrunner Str. 34. A-5020 Salzburg, Austria

Abstract

Shiraiwa and Watanabe's (1991) Holocene Langtang Stage is based upon a connection between the terminal moraine just above Langtang village and the Eastern Lirung Glacier, indicating an exceptional large Holocene Eastern Lirung Glacier. But this connection is untenable. This terminal moraine is a deposit of the Central Lirung Glacier. We replace, therefore, the Langtang Stage by our newly defined Lirung Stage, being of the same age as the Langtang Stage but of different extent.

Introduction

Langtang Lirung (7,234m), just above Langtang village (3,500m), is by far the highest mountain of the central Langtang Valley (Fig. 1). The relation between its former (local) glaciers and the former Langtang Valley Glacier (Fig. 1) is a key problem in the reconstruction of glacial fluctuations during the Holocene period. Our paper deals exclusively with this very special problem, referring particularly to the excellent paper of Shiraiwa and Watanabe from 1991.

Shiraiwa and Watanabe's Langtang Stage

Shiraiwa and Watanabe (1991) refined the moraine systems established by Heuberger et al. (1984) and Ono (1986) and, furthermore, Ono's (1986) stratigraphy around the present-day Langtang village. On the basis of convincing radiocarbon dates they interpreted the Holocene glaciation in this area anew, creating the Langtang Stage. Their reconstruction shows a Holocene advance of the Eastern Lirung Glacier into the Langtang Valley (at present-day Kyangjin Kharka, 3,900m), and extending 4.5km along the main valley, almost up to Langtang village (Figs. 1 and 2). This means that the Eastern Lirung Glacier would have extended, during the Langtang Stage, to a length of about two thirds more than during the maxima of the Little Ice Age. This is in comparison to the Holocene glaciation of the Himalaya as a whole and of other mountains, an exceptional result.

The key point of Shiraiwa and Watanabe's (1991) hypothesis is their interpretation of the large terrace of what is predominantly till between Langtang village and Shingdum. This terrace terminates with a big step just above Langtang Village. This step is interpreted by Shiraiwa and Watanabe as being a terminal moraine of the Langtang Stage.

About 350m east of this step the terrace was eroded by Yumthang Chu. A large exposure in the incision of this stream (Fig. 2: 'Yumthang Exposure') is the

reference point for all stratigraphical interpretations of this area (photograph: Shiraiwa and Watanabe 1991). In the Yumthang exposure two different units of glacial sediments are visible (Ono 1986). The upper unit is Shiraiwa and Watanabe's 'Upper Till'. This till belongs to the above-mentioned terminal moraine of the Langtang Stage. In the Yumthang exposure, Shiraiwa and Watanabe found a buried A horizon beneath the Upper Till. Its radiocarbon date (3,650 ± 320 BP) is the maximum date of the Langtang Stage.

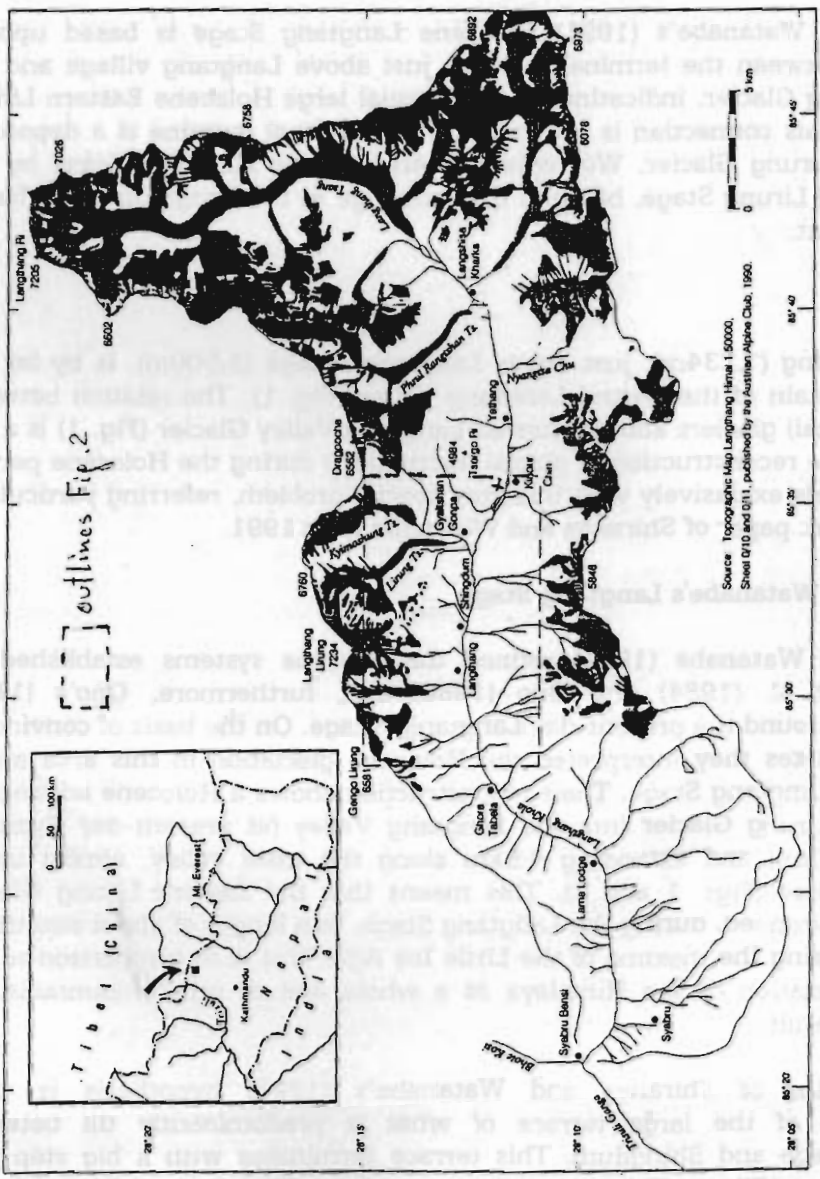
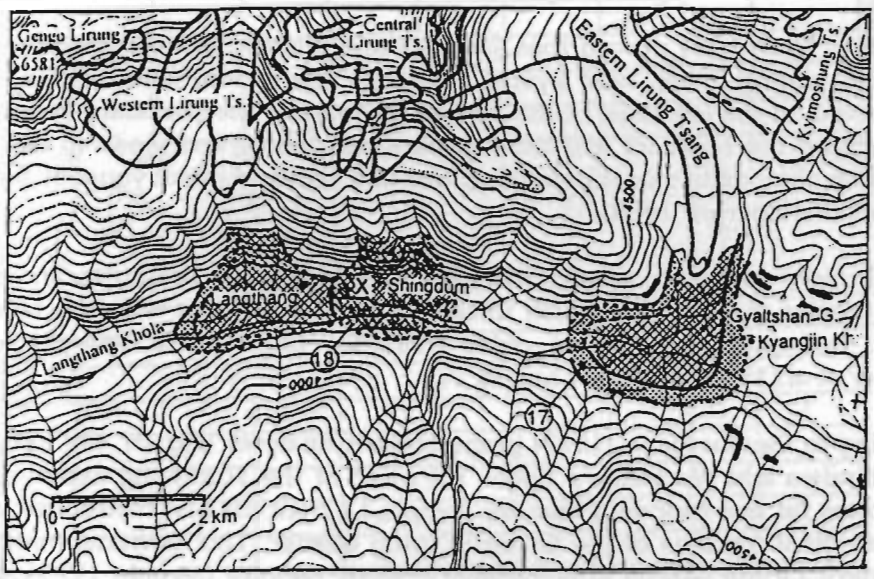


Figure 1: Langtang Valley: Location, Actual Glaciation (Cartography: W. Gruber)

It became, therefore, impossible to assign the terminal moraine above Langtang village to the Langtang Valley Glacier as Ono (1986) had done. A Langtang glacier of that extent was possible in the late-glacial, but not in the post-glacial (Holocene) epoch. This consideration may have influenced Shiraiwa and

Watanabe's above-mentioned reconstruction of the step above Langtang village as consisting of Holocene terminal moraine of the Eastern Lirung Glacier.

This hypothesis is based on the connection of this terminal moraine above Langtang village with the oldest lateral moraines of the moraine complex in front of the Eastern Lirung Glacier near Kyangjin Kharka and Gyaltshan Gompa across the main valley (Fig. 2).



ACTUAL AND FORMER LIRUNG GLACIERS IN LANGTHANG

actual glaciers | Gyaltshan Stage | Lirung Stage | late-glacial stages

X Yumthang exposure (18) samples Fig. 3

Top. Sources: Helambu Langthang 1:100000 published by Arbeitsgemeinschaft für vergleichende Hochgebirgsforschung, Munich 1987; Names and actual glaciers from Map Langthang Himal 1:50000, published by the Austrian Alpine Club, 1990.

Figure 2: Central Langtang Valley: Late Glacial and Holocene Stages (after Ibetsberger 1993 - Cartography: W. Gruber)

New Facts and Considerations

We finished our field work in this area in 1991 without knowing of Shiraiwa and Watanabe's results. Our project, continuing the project of Heuberger et al. (1984), was sponsored by the *Fonds zur Förderung der wissenschaftlichen Forschung* (Vienna). We cooperated with soil scientists from Bayreuth University, Germany (Prof. W. Zech and his team). The results of the Bayreuth group are contained in Bäumler et al. 1996.

We contest the connection proposed by Shiraiwa and Watanabe's between the terminal moraine above Langtang village and the lateral moraines of the Eastern Lirung Glacier. In the following, we will briefly present some arguments in support of our opinion.

A reconstruction of Shiraiwa and Watanabe's Eastern Lirung Glacier during their Langtang Stage shows that this glacier was less than 100m thick when it turned into the main valley. It is hard to imagine that this thin glacier in the broader main valley could have reached the terminal moraine above Langtang village.

Our survey from 1991 proved that Shiraiwa and Watanabe's left lateral moraine of their Langtang Stage, near Kyangjin Kharka, has a clear continuation. It can be observed on the left slope of the Langtang Valley as the boundary between till that includes big boulders and local slope wash debris, and leads to the broad ridge of an obvious terminal moraine, close to a series of much younger terminal moraines (Ibetsberger 1993).

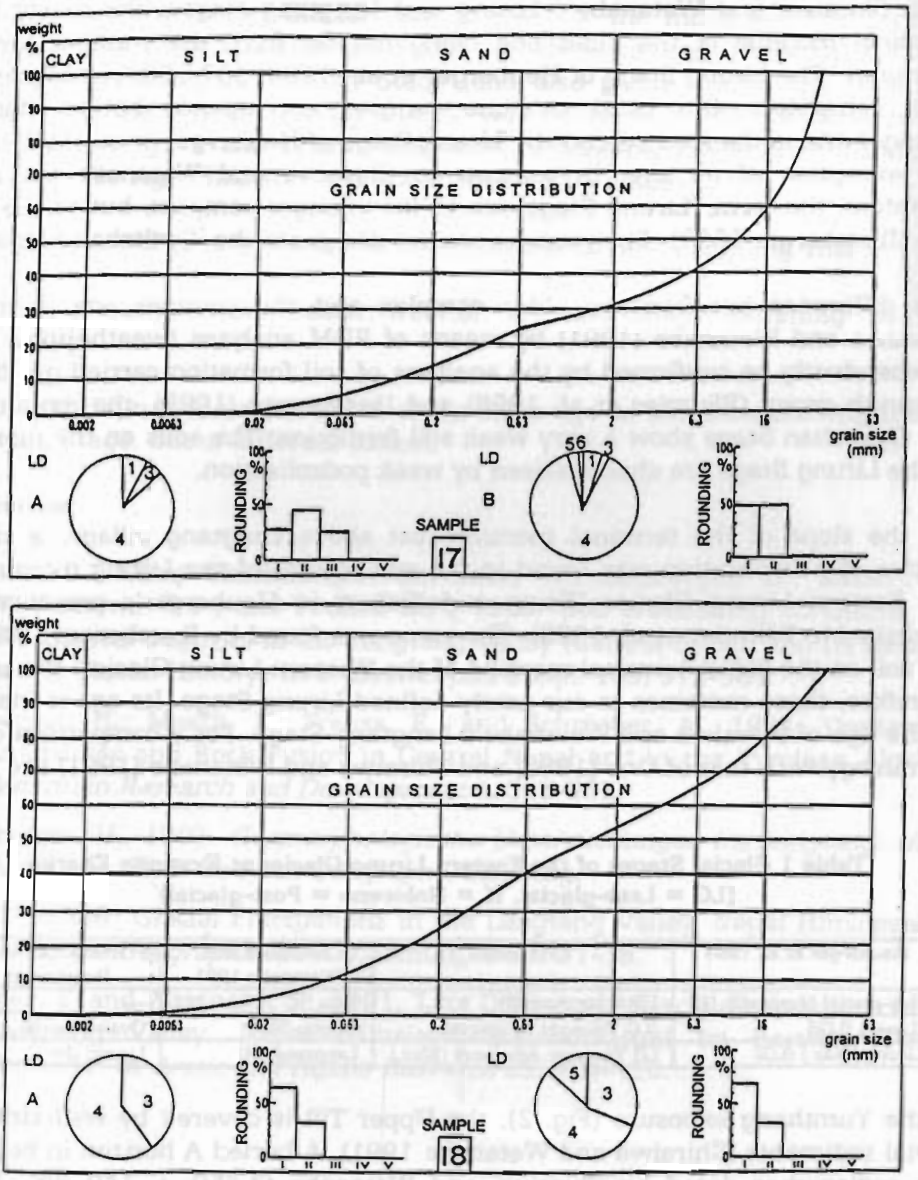
The still older moraines around Kyangjin Kharka (Fig. 2) belong to an Eastern Lirung Glacier that was not much thicker but still in contact with the Langtang Glacier. Soil profiles of these older moraines prove their late-glacial age (Bäumler et al. 1996, profiles 4 and 8).

According to Ibetsberger's (1993) granulometric analyses (Fig. 3), his sample 18 from Shiraiwa and Watanabe's Upper Till south of the Yumthang exposure (Fig. 2) indicates far less rounding than his sample 17 from the just mentioned, newly found terminal moraine of the Eastern Lirung Glacier. This terminal moraine of the Eastern Lirung Glacier still contains granitic pebbles (sample 17) similar to the glacial deposits further up the main valley. In the Upper Till there is no granitic material (sample 18). It is, therefore, not probable that Shiraiwa and Watanabe's Upper Till between Langtang village and Shingdum is a deposit of the Eastern Lirung Glacier (see also Bäumler et al. 1996, 385-386).

But if the terminal moraine above Langtang village and the Upper Till that extends up the valley as far as Shingdum was not deposited by the Eastern Lirung Glacier, we must pose the question: which glacier accumulated this Upper Till and moraine? Our answer: these glacial deposits originated most probably from the Central Langtang Glacier on the steep southern slope of the Langtang Lirung peak (Figs. 1 and 2), as exactly shown, for the first time, on the map 'Langthang Himal, West', 1:50,000, of the Austrian Alpine Club (Alpenverein), 1990. Its two tongues terminate at about 4,800m. But extending further during the Holocene advances, this glacier must have sent ice avalanches down to the bottom of the Langtang Valley around Shingdum and Möndrong, similar to what the Western Lirung Glacier did west of Langtang village (Shiraiwa and Watanabe 1991) when it formed a secondary (regenerated) glacier.

Advances of the Eastern Lirung Glacier: Terminology

Just in front of the Eastern Lirung Glacier are the moraines of Shiraiwa and Watanabe's (1991, Fig. 1) Yala Stages (= Little Ice Age), not shown in our Figure



A fraction 16-63 mm. diameter B fraction 6.3-16 mm. diameter LD lithologic distribution I angular II subangular III subrounded IV rounded V well rounded 1 granite, fine grained 2 granite, coarse 3 migmatite 4 gneiss 5 micaschists/ phyllite 6 greenschists

Figure 3: Granulometry of Samples (Locations in Fig. 2 (after Ibetsberger 1993.)

2. Further we distinguish two different moraine complexes that partly accord with Shiraiwa and Watanabe's Lirung and Langtang stages, the newly found terminal moraine of the older one being not far from the younger terminal moraines. The Lirung Stage of Heuberger et al. (1994, 357-358) is comprised of both complexes. Our older moraine complex corresponds better than the younger one to the idea behind the Lirung Stage of Heuberger et al. (1984), with the exception of its age. In contrast to Shiraiwa and Watanabe we apply, therefore, the term, 'Lirung Stage' not to the younger complex, but to the older one (Ibetsberger 1993). The younger one we designate the 'Gyaltshan Stage'.

The difference between the older complex and the younger one, found by Shiraiwa and Watanabe (1991) by means of RDM analyses (weathering), could independently be confirmed by the analyses of soil formation carried out by the Bayreuth group (Bäumler et al. 1996) and Ibetsberger (1993): the moraines of the Gyaltshan Stage show a very weak soil formation. The soils on the moraines of the Lirung Stage are characterised by weak podzolisation.

On the slope of the terminal moraine just above Langtang village, a similar degree of podzolisation was found in the soil to that of our Lirung moraines of the Eastern Lirung Glacier (Kemp and Siebert in Heuberger's presence, not published in Bäumler et al. 1996). The same was found by Ibetsberger (1993) in the soil on the oldest terminal moraine of the Western Lirung Glacier. We assign, therefore, these moraines to our newly defined Lirung Stage. Its age is identical to the age of Shiraiwa and Watanabe's Langtang Stage. For a comparison of our terminlogy with that of Ono (1986) and Shiraiwa and Watanabe (1991) see Table 1.

Table 1 Glacial Stages of the Eastern Lirung Glacier at Kyangjin Kharka (LG = Late-glacial, H = Holocene = Post-glacial)

Heuberger et al. 1984	Ono 1986	Shiraiwa and Watanabe 1991	Heuberger and Ibetsberger
Neo-glacial Maximum (H)	Little Ice Age (H)	Yala (H)	---
(Lirung [LG])	(LG Younger Advances)	Lirung (H)	Gyaltshan (H)
Lirung (Max.) (LG)	LG Younger Advances (Max.)	Langtang (H)	Lirung (H)

In the Yumthang exposure (Fig. 2), the Upper Till is covered by well-stratified fluvial sediments (Shiraiwa and Watanabe 1991). A buried A horizon in between was radiocarbon-dated by Shiraiwa and Watanabe (2,850 $\pm$ 140 BP). These sediments are interpreted by all authors as having been caused by the formerly advancing Western Lirung Glacier damming the main valley. We cannot decide if this damming by the Western Lirung Glacier was due to the still progressing glacier of our Lirung Stage or the readvancing glacier of the Gyaltshan Stage.

Conclusion

The glacial maximum stage of the Holocene epoch was our newly defined Lirung Stage, now replacing Shiraiwa and Watanabe's (1991) Langtang Stage. During this stage, not only two but three glaciers of the Langtang Lirung deposited terminal moraines in the main valley (Fig. 2).

(a) The Eastern Lirung Glacier, just in front of the much younger terminal moraines of our Gyaltshan Stage (= Shiraiwa and Watanabe's Lirung Stage). During our Lirung Stage (and also partly during the Gyaltshan Stage), the Eastern Lirung Glacier was connected with the Kyimoshung Glacier (Figs. 1 and 2) and, therefore, remarkably longer than during the Little Ice Age (Shiraiwa and Watanabes's Yala Stages).

(b) The Central Lirung Glacier, between Shingdum and Langtang village

(c) The Western Lirung Glacier, west of Langtang village, damming the main valley

This newly defined Lirung Stage is of the same age as Shiraiwa and Watanabe's Langtang Stage, but of different extent.

References

Bäumler, R.; Kemp-Oberhetinger, M.; Zech, W.; Heuberger, H.; Siebert, A.; Madhikarmi, D.P.; and Poudel, K.P., 1996. 'Soil Weathering on Glacial and Glacifluvial Deposits in the Langtang Valley (Central Nepal) and Its Relation to the Glacial History'. In *Z. Geomorph.*, Suppl. 103, 373-387.

Heuberger, H.; Masch, L.; Preuss, E.; and Schröcker, A., 1984. 'Quaternary Landslides and Rock Fusion in Central Nepal and in the Tyrolean Alps'. In *Mountain Research and Development* 4, 345-362.

Ibetsberger, H., 1993. *Geomorphologische Untersuchungen im Langtang, Nepal Himalaya.* Ph.D thesis in Geography, Salzburg.

Ono, Y., 1986. 'Glacial Fluctuations in the Langtang Valley, Nepal Himalaya'. In *Göttinger Geographische Abhandlungen* 81, 31-38.

Shiraiwa, T. and Watanabe, T., 1991. 'Late Quaternary Glacial Fluctuations in the Langtang Valley, Nepal Himalaya, Reconstructed by Relative Dating Methods'. In *Arctic and Alpine Research* 23, 404-416.