

## Active landslides on the lateral moraines in the Kanchanjunga Conservation Area, eastern Nepal Himalaya

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This study identified the present development of landslide on the Holocene moraines (4,760-5,200 m) in the Kanchanjunga (Kangchenjunga) Conservation Area, eastern Nepal, which may result in disasters in future.

A tension crack with ca. 100 m in length runs parallel to the moraine ridge on the debris flow deposits (5050 m) between the lateral moraine and mountain slope near Pangpema Base Camp. On the right bank of the Kanchanjunga Glacier, ground surface of the sliding blocks, moraines, mountain slope, and other deposits such as debris flow deposits are almost completely covered by *Kobresia*. On the other hand, the landslide scars show the fresh outcrops without vegetation. Such landslide scars ranging from 1 m to 70 m in relative height are developed in a few rows on the right bank around the Kanchanjunga Glacier, and continuously extend for about 7.2 km although at some places they are not clear.

The interpretation of the air photographs taken in 1980 and field survey in 1989 clearly demonstrated that the landslides on the lateral moraines of the Kanchanjunga Glacier at the altitudes near the lower limit of the present permafrost (4,755 m: Ishikawa et al. 2001) have been created and enlarged between the two years. In the oblique air photographs taken in 1982, only one remarkable landslide scar can be seen on the lateral moraines near Lhonak and on the terminal moraine of the tributary glacier near Pangpema Base Camp. During the field survey in 1998, multiple landslide scars were observed at each site. This means that new landslides began to occur in this decade, especially in Pangpema and Lhonak. These new landslide scars are also identified in the 1992 air photographs.

With the help of the studies on the glacial chronology study (e.g., Asahi and Watanabe 2000), the surface level of the former Kanchanjunga Glacier was estimated: the glacial ice of approximately 100 m thick melted in the past century. This estimate is also supported by an old photograph of the Jannu

Glacier, some 9 km to the south, which is published in the book, "Round Kangchengjunga", by Freshfield (1903). Therefore, unloading by rapid deglaciation might be a cause of the landslide although deglaciation alone cannot explain the development of the landslides.

We applied electrical resistivity soundings to detect the existence of the permafrost. No clear existence, however, was confirmed with possible small bodies of the permafrost. The landslides may have been developed during the final stage of the permafrost melting.

Many fresh and small cracks on the moraine surface indicate that the landslides are enlarging even today. This enlargement could cause hazards when the area is developed: the landslides occur on major trails and camping site. In the New Zealand Alps, mountain trails and recreation huts have been moved or demolished as a result of landslides on lateral moraines (Blair 1994). Because the similar features are observed in other Himalayan regions as well, monitoring landslides at higher altitudes should be a priority concern.

### References

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