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Climate variability and glacial dynamics in the Himalaya and potential impacts on rivers

Dirk Scherler
University Potsdam, Institute of Earth and Environmental Science, Potsdam, Germany (dirk@geo.uni-potsdam.de)

Fill terraces are widespread phenomena in many Himalayan valleys and have been dated in a couple of places. Available results indicate river aggradation during the end of the last glacial cycle, when monsoon precipitation was relatively low. The switch from aggradation to incision presumably started in the early Holocene when monsoon precipitation increased again. While river incision can plausibly be related to enhanced discharge, the causes of aggradation are disputed. River aggradation and incision is ultimately dictated by the balance between sediment supply and water discharge, and some researchers invoked the release of glacial sediments as a cause for river aggradation.
In this contribution, I take a closer look at past and present Himalayan glacier dynamics and how their sediment supply may have varied in the past. New and available glacial chronologies from the Himalaya show that glacial extents during the last glacial cycle were much smaller compared to higher latitude mountain systems. Furthermore, glaciers retreated from their last glacial maximum extent, which occurred earlier during the last glacial cycle, over tens of thousands of years, and therefore more slowly and gradual than glaciers in Europe and North America, for example. These results indicate that the impact of Pleistocene glacier oscillations on river systems downstream was probably rather small.
The recent response of Himalayan glaciers to climate warming, however, shows that there are pronounced differences in short-term glacier dynamics, depending on glacier geometry and topographic relief. Glaciers with gentle-sloping gradients, which are frequent in the central Himalaya, typically build up moraine-dammed lakes as they melt back and down. Such lakes are particularly prone to catastrophic outburst, with devastating effects downstream. In contrast, glaciers with steeper gradients respond to climate warming by more gradual retreat and accordingly slow and gradual release of melt waters. I hypothesize that the contrasting response of glaciers in landscapes with different relief characteristics to climate warming, as observed at present, should also have occurred in the past and may therefore be manifested in the fluvial stratigraphic record. Such differences in glacier behavior are not unique to the Himalaya but a function of the glacial topographic setting and therefore relevant for other mountain systems on Earth.