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Glacier outburst floods from Ghulkin Glacier, upper Hunza Valley, Pakistan

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Outburst floods from Ghulkin Glacier in 2008 caused localised damage to properties, land and infrastructure of Ghulkin village and to the Karakoram Highway in the upper Hunza Valley of northern Pakistan. The unexpected nature of the floods highlights a poor understanding of glacial flood potential related to advancing glaciers in the Karakoram. Here we describe the Ghulkin floods and examine the broader glaciological controls on flood generation.

Ghulkin Glacier is an active mountain glacier, its steep (up to 12˚), debris-covered snout bound by a continuous latero-terminal moraine. Three separate outburst floods during May and June 2008 exited the right lateral moraine close to the glacier terminus, resulting in two separate flood paths; one flowing down the existing outwash fan that resulted in no damage and the other flowing directly through properties and land of Ghulkin village. In 2008, the snout of Ghulkin Glacier was overriding its terminal moraine, and local villagers report an associated increase in debris flows and rock fall since 2005. High surface velocities (of the order of 50 m a^{-1}) near the terminus are associated with the current period of advance, and an increase in the number and size of transient supraglacial lakes during the melt season has been observed.

Assessment of the processes and characteristics of the summer 2008 floods provides a conceptual model for local glacier hazards associated with advancing mountain glaciers in the Karakoram. Crevasses and seracs associated with the high flow velocities have steep, debris-free ice cliffs that melt rapidly during the summer ablation season and provide a route for the meltwater to enter the englacial drainage system. Meltwater is stored temporarily in supraglacial, and probably englacial, settings; whilst drainage is facilitated by the formation of new, or reorganisation of existing, conduits under the active ice conditions. The steep glacier surface gradient and active ice results in efficient drainage and in turn provides a route for meltwater to reach the glacier terminus. Local variations in glacier surface topography and the position of englacial conduits determine the exit point for englacially transported flood waters. Switching of the flood exit point through the moraine occurs when channels become choked with boulders as a result of glaciofluvial undercutting of steep moraine slopes.