The Barsem disaster

Barsem Village is located on a large alluvial fan and adjacent smaller fluvial terraces. Around 1500 people lived in this village located in the south-eastern corner of Tajikistan, next to the border with Afghanistan, about 20 km upstream of Khorogh, the main town in Badakhshan.

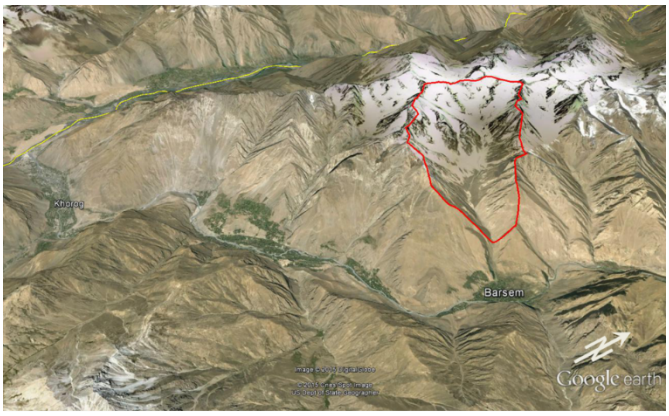


Image: Google Earth, September 2015

Photo by Sven Fuchs, 28 Aug. 2015

At least 14 major debris flows occurred in the Barsem Valley (24 km^2) between 16th and 20th July 2015 during an exceptional period of hot weather combined with exceptional rainfall.

The flows transported large volumes of debris on the fan at Barsem. According to a rough estimate, the area covered is 300,000 m^2 and has an assumed average thickness of 6 m with volume of the order of 1.5 million m^3. This is comparable to the Dasht glacial lake outburst flood of August 2002 (Dasht, in Roshtkhala District, Tajikistan). The debris flows formed a natural dam in the Gunt Valley. The maximum height of the deposits could be of the order of 20 m. A lake formed behind the dam, having a length of about 2 km and a volume of approx. 4.5 million m^3.

About 80 homes were completely destroyed both on the fan (as a result of the mudflows) as well as in the lake (as a result of flooding); fortunately all but one inhabitants could be evaquated. The mudflows also covered around 30 ha of cultivated land, broke up the Pamir Highway, a key route for both trade and tourism, and damaged electrical cables leading from the nearby Pamir 1 power station into the capital city, Khorog. End of August 2015 the Pamir Highway could be re-opened on a makeshift route along the new lake. An evacuation camp, developed by FOCUS Humanitarian Assistance together with the government, served as temporary shelter for the families who lost there house. NDR Consulting GmbH together with University of Bern (Institute of Geography, Dr Margreth Keiler) and BOKU Vienna (Dr Sven Fuchs) conducted a first assessment about 6 weeks after these events. The source of the sediments is located in a push moraine at an altitude of approx. 4200 m asl. The satellite image of June 2003 (Google Earth) shows an area that is at that time still snow and ice covered. End of August 2015 the starting zone looked like a vertical wall; therefore, it must be assumed that this area is/was frozen and that the permafrost had possibly melted over the past few years and, finally, during the exceptionally hot summer of 2015. A similar situation was observed during the 1987 debris flow events in the Saas Valley (Oberwald, Goms) (Zimmermann and Haeberli 1992).


Barsem starting zone (left; photo by Sven Fuchs, 28 August 2015). The steep (almost vertical) scar is an indication that the debris is still frozen. A similar condition was observed in August 1987 in the Swiss Alps at Saas Glacier, Oberwald, Valais (right; photo by Wilfried Haeberli, ETH, 27 August 1987).

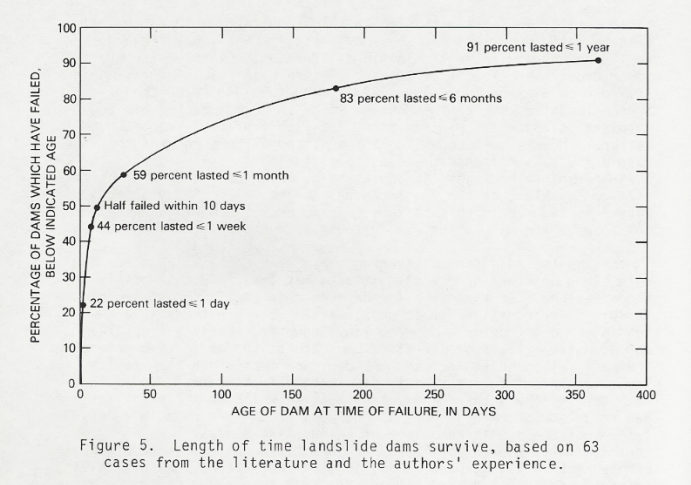
The erosion within a thick scree deposit is of huge dimensions: an average cross-section of at least 500 m^2 can be assumed over a reach of at least 1000 m length. This is definitely bigger than what has been overserved during the Saastal event in 1987.


Barsem erosion in debris (left; photo Sven Fuchs, 28. Aug. 2015) and similar condition at Saas Glacier, Oberwald, Valais (right, photo Markus Zimmermann, 16 July 1989). The arrow points to a person standing beside the eroded channel (event 1987)

Large parts of these eroded sediments were deposited on a terrace about 1000 m below the source. The remaining flows further eroded the channel of Barsem creek over the whole length. Similar phenomena could be observed in a site in the Bernese Oberland (Rotlaui) where a debris flow considerably eroded the bed, even in the fan area (500,000 m^3).


Channel erosion at Baresem creek (left, photo Markus Zimmermann, 28 August 2015) and Rotlaui, Switzerland (right, photo Markus Zimmermann, 3 Sept. 2013).

The deposits created a natural dam in Gunt Valley and dammed Gunt River. It can be assumed that the natural dam is rather stable because: a) the debris flows transported huge boulders armouring the "spill way"; b) the slope of the active channel is rather gentle (less than about 8 %); c) the water at the outflow is completely clear, therefore, already in August there was neither superficial erosion occurring, nor through seepage. According to an empirical study (Schuster 1986[1]), about 22 % of such dams collapse within 1 day and 50 % within the first 10 days. If the dam survives 6 months its failure probability is 17 %. Nevertheless, a collapse of the Barsem dam cannot be completely excluded; particularly in the coming melt season further erosion is possible.



Length of time landslide dams survive, based on 63 cases from the literature and the author's experience (Schuster 1986, p. 10).

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[1] Schuster, Robert L (ed.), 1986: Landslide Dams: processes, risk and mitigation. American Society of Civil Engineers, 164 p.