

Plaine Morte Glacier Lakes - Hazard Assessment, Hazard Potential and Prediction

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INTRODUCTION

Changes in Switzerland's climate are expected to have major impacts on glaciers and subsequently on the hydrological regime as well as on the natural hazard potential of mountain regions. Glacier de la Plaine Morte is a plateau glacier located in the Bernese Alps at an altitude between 2700 and 2800 m a.s.l. Over the last 10 years, the mass loss of Plaine Morte was almost twice as high as the mean of glaciers in the European Alps (Huss et al, 2013). In the last 10 years, several glacier-dammed lakes formed during summer months due to glacier retreat (Fig. 1). All lakes are formed on imperme-

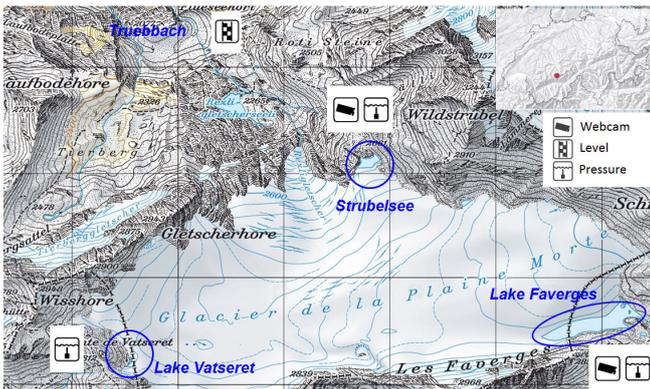


Figure 1. Overview of Plaine Morte glacier with elements of the early warning system

able sediments and are dammed by the ice on one side thus making them potentially unstable. All of them show a subglacial drainage system. From 2011-2015 the maximum volume of the largest lake Faverges increased from 1.1-2.0 Mio m³.

OUTBURST EVENTS

Lake Faverges represents a considerable hazard potential for the Simme valley north of the glacier. Through the deglaciation the lake volumes increased yearly (Fig. 2). The lake drains off through glacier mills and propagates through the subglacial drainage system. 2012-2014 the glacier lake outburst floods (GLOF) took part within 4 to 6 days (Fig. 3). In 2015 the GLOF was damped, probably

due to the new and poorly developed channel system in the ice. Therefore GLOF duration reached 8 days and the outburst discharge of the river Simme was much lower (Fig. 3).

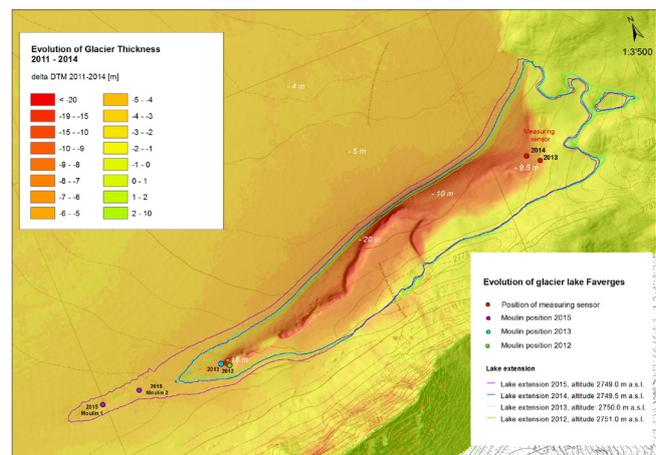


Figure 2. Evolution of glacier thickness and lake Faverges extension

HAZARD AND DAMAGE POTENTIAL

Thanks to the early warning system, the beginning of the lake drainage is easy to detect. It normally goes along with a brownish-milky water turbidity of the Truebbach. During the outbursts, the levels of the lake can change abruptly. The water is draining through subglacial flow channels and causes a flood wave that propagates down the valley towards the town of Lenk. So far the floods occurred in July / August. The river discharge in the Truebbach increases during the event by a factor of 7, the one in the Simme by 5. This approx. represents a 30-years event in the Simme river. Up to now, the events have not caused any harm. The major damage potential consists of a touristic walking path, a hotel and a campsite, several settlements as well as farmland. Depending on the predicted GLOF scenario, extensive areas might be affected including an important touristic cable car station.

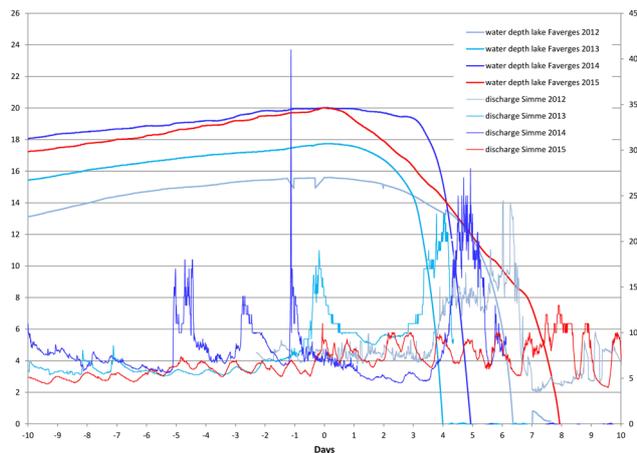


Figure 3. Water level of lake Faverges (above) and discharge hydrograph of river Simme (below) during glacier lake outbursts 2012 - 2015

EARLY WARNING SYSTEM

A real-time monitoring has been set up by the local authorities. It is operational during the summer months and consists of 4 different stations: The water level of the three lakes are monitored by pressure probes and webcams. The flow height of the Truebbach river is detected by a radar gauge. Measured data is constantly transmitted to an online data portal. Once drainage or flow height thresholds are surpassed, local authorities are immediately informed via prioritized SMS. An alarm triggers a pre-defined action plan in the town of Lenk.

PREDICTION AND CONCLUSION

With the ongoing retreat, a further increase of the lake is probable. The future evolution of lake Faverges will determine the need for additional protection measures.

A proper risk assessment is based on the three major stages of hazard identification and assessment, risk estimation and risk evaluation. Within the last years extensive assessment of Faverges's hazards has been done by collecting information about the physical processes involved, the magni-

KEYWORDS

glacier lake; early warning; glacier lake outburst flood; climate change; glacier retreat

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tude of the events and the probability of occurrence (Finger et al., 2013). Although glacier-dammed lakes draining subglacially tend to produce smaller floods than all other kinds of glacial lakes (RGSL, 2014), the damage potential in this case is large. Reducing glacial hazards in high mountain environments is generally technically and logistically challenging. Prevention and preparedness is preferable to disaster response.

Up to now, the GLOF process did not exceed the existing hazard map of the local municipality. Nevertheless, a scenario-based hazard study has been carried out, showing a pessimistic consideration of the lakes hazard potential. It is the task of local authorities, the cantonal natural hazard department and specialists to observe the ongoing processes and anticipate the critical point when further investigations and measures will be necessary.

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