A SURVEY OF TACONNAZ ICE-FALL FROM TERRESTRIAL PHOTOGRAMMETRY

IDENTIFICATION OF PRECURSOR SIGNS OF SERAC FALLING EVENTS AND ASSOCIATED DISCHARGED VOLUMES

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INTRODUCTION

A terrestrial digital photogrammetry survey has been set-up to identify precursor signs and quantify volumes and return period of serac calving events in Taconnaz ice-fall (Mont Blanc range, Chamonix, France). In this particular glacier, serac downfalls from an ice cliff act in triggering large avalanches in winter. Largest avalanches constituted of a mixture of snow and ice can reach the avalanche defence structure protecting downward habited areas in the Chamonix valley. A general warming of this cold glacier might also change sliding conditions at the bedrock and modify the ice discharge rates from the cliff. In order to identify precursor signs of serac falls and understand the relation that links calving event occurrences and their intensity, a remote topographic survey has been initiated.

CONTEXT AND SITE DESCRIPTION

Glacial hazards are generally classified into three main categories: (a) those related to pro-glacial lakes and their possible outburst, (b) sudden draining of intraglacial water bodies, and (c) ice falling events (from serac to entire parts of glaciers). Glacier de Taconnaz is a hanging glacier in the Mont-Blanc area (Chamonix, France) with an upper accumulation area stretching from Dôme du Goûter (4300 m a.s.l.) down to a 600-wide ice cliff at an altitude of about 3300 m a.s.l.. The hazard associated with the Taconnaz Glacier belongs to this latter category. However, it is not the ice fall as such that leads to a risky situation, but the fact that in winter, large falling ice blocks can destabilize recently fallen snow over the lower part of the glacier, leading to large avalanches (Naaim et al., 2010) in this exceptional path of 7 km long between 4000 and 1000 m a.s.l. (see Fig. 1). Indeed, ice collapsing in summer usually dot not lead any damage. On the other hand, a statistical analysis of 75 nearby recorded events shows that avalanches initiated from the Taconnaz glacier poorly correlate with local peak avalanche activity or with occurrences of recent snowfalls in the area (Rapin, 2001). This is in line with an external triggering factor such as falling seracs as cones from all recent major avalanches systematically revealed a substantial amount of ice. A precursor study (Le Meur and Vincent, 2006) has identified a 182 days return period form largest volumes of calved ice and the glacier flow discharge and ice cliff upper lip position as controlling parameters. This new survey has also a particular interest in the context of climate change and the warming of high altitude cold glaciers.

THE DIGITAL PHOTOGRAMMETRIC DEVICE

The great distance (more than 3 km) required for monitoring the ice cliff discard using laser scanning to get digital elevation models. We use instead lost cost, broad consumer non metric cameras (Canon©5DMKII) equipped with low distortion fix focal lenses (100 mm, f/2.8) operating with an automatic time lapse timer (4-5 per day). Image shutting is fixed at f/8 and ISO 100 sensitivity in raw 12 bits RVB (color) format. The resolution is 5616 x 3744 (21.1 Million pixels). Both devices are

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powered by a 12V lead battery and a solar panel. Mean ground pixel sizes in the ice cliff area of interest are about 25 cm, which considering the stereoscopic base (distance between cameras) of 236 m, makes that less than 50 cm of error is expected for positioning. Image orientation takes on 6 ground control point whose coordinates where determined from differential GPS (L1&L2). Best possible orientation results in residuals of about 11 cm in ground coordinates which corresponds to less than 2 µm in the image's coordinate system. Restitution is performed manually by plotting in stereoscopic vision (anaglyph) with possible help of stereo-correlation on GIS software (ArcGis© 9.3 + Stereo Analyst ERDAS© extension) to gets digital elevation models (DEM).

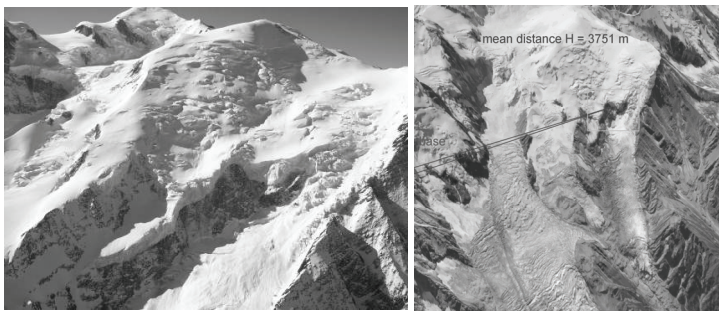

Fig. 1 Left: Taconnaz ice-fall and its 600 m-large ice cliff. Right: Location of the couple of cameras 3700 m apart the ice cliff (©Géoportail)

PRELIMINARY RESULTS

During the first year of survey, a major event was recorded between the 12 and 13 of August 2010. Restitution of 2 couples of image taken just before and after the serac fall, and the difference calculated between the 2 DEMs indicated of volume of about 200 000 m^3 (see Fig. 2). The main uncertainty in this estimation comes from hidden faces of the serac and which may contribute to an additional volume of 15 000 m^3 (underestimation). A second event of 50 000 m^3 was detected on the 23 of February 2011. The fluctuations of the position of the ice-ridge suggest a nearly 180-days cycle.

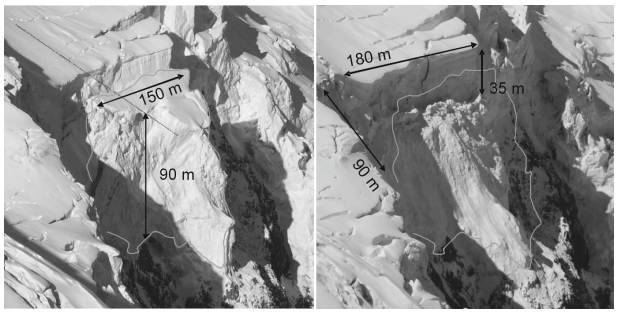

Fig. 2 Left: Image dating from the 12 of August before the serac fall. Right: Image from the 13 of August. Characteristic dimensions are indicated.

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