Morphodynamics of glacier lakes in the Western Italian Alps resutling form continued glacier shrinkage: past evidences and future scenarios

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MORPHODYNAMICS OF GLACIER LAKES IN THE WESTERN ITALIAN ALPS RESULTING FROM CONTINUED GLACIER SHRINKAGE: PAST EVIDENCES AND FUTURE SCENARIOS

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The disappearance of glacier masses is producing substantial modifications in high mountain environments. At the end of the Little Ice Age (LIA) glaciers started to retreat and glacially sculpted morphologies became exposed offering suitable conditions for lakes formation (frontal moraines and glacier-bed overdeepenings) and successive evolution (enlargement, decrease, disappearance), as shown by Emmer et al. (2015) and Salerno et al. (2014).
The overall aim of the present work is to contribute to enhance knowledge on the glacial landscape evolution from the past (beginning of the XX century) to the future focusing on alpine glacier lakes. The main objectives are to: 1) understand where and when glacier lakes formed and how they developed; 2) assess where future lakes will appear, considering future glacier retreat scenarios.
We adopted a multiscale (regional and local) and multitemporal (past, present and future) approach integrating different information technologies (GIS, aerial photogrammetry, remote sensing, modeling and georadar) and focusing on the glaciated Western Italian Alps (Piemonte and Aosta Valley regions).
The first goal was reached through the production and successive analysis, by historical maps and orthophotos interpretation, of six glacier lakes inventories (related to the 1930s, 1970s, 1980s, 1990s, 2006-07, 2012) integrated with information from the glaciological surveys (1927-2014) stored in a dedicated database (Viani et al, 2016). Main findings are: about 250 lakes have been recognized within LIA boundaries; the majority of lakes are dammed by the bedrock (fig. 1a); there are interesting examples from the Gran Paradiso Chain of 1920s and 1970s moraine-dammed lakes (fig. 1b); supraglacial lakes were found on the surface of Miage (fig. 1 c) and Belvedere debris-covered glaciers; the disappearance of lakes was mainly due to infilling processes (fig. 1d); lakes progressively increased in number and area (fig. 1d) until 2006-07.
Concerning the assessment of possible future lakes, we tested and validated the Glacier Bed Topography model version 2 (Frey at al., 2014; Linsbauer et al., 2016) in the study area by using existing lakes inventories, GPR data and morphological criteria (Frey et al., 2010). We found that about 60 possible overdeepenings (>10000 m^2) could appear in the future and could be filled with water (fig. 2). Their total area will be 4 km^2 and their volume 0.6 km^3. Possible future lakes will be located mainly in the Monte Rosa massif and in the Gran Paradiso chain.
Having a wide temporal and spatial overview of glacier lakes will help understanding how present glaciated areas will develop in the future from a glaciological and geomorphological point of view. In addition, it will support the management of future landscape both as an opportunity (tourism,

hydropower production) and risk (glacier lake outburst floods), as discussed in Haeberli et al. (2016).

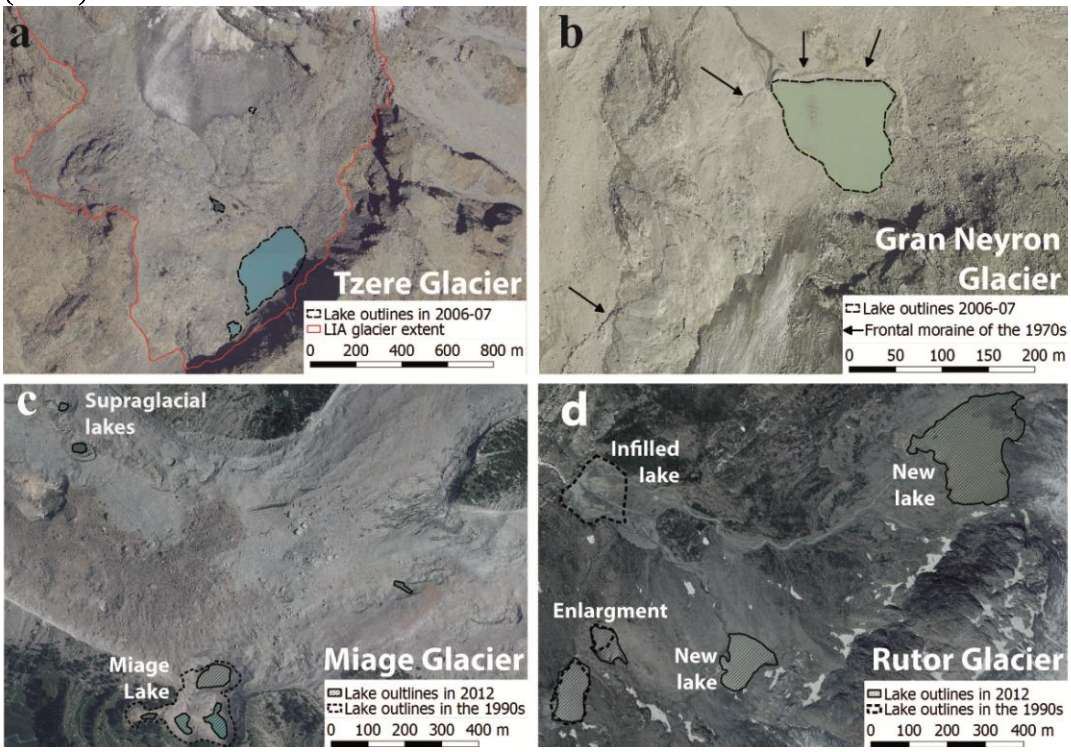

Fig. 1. a) bedrock-dammed lakes; b) moraine-dammed lake; b) supraglacial lakes and fractioning of the Miage lake after the 1990s; c) processes of infilling, enlargement and formation of new lakes.

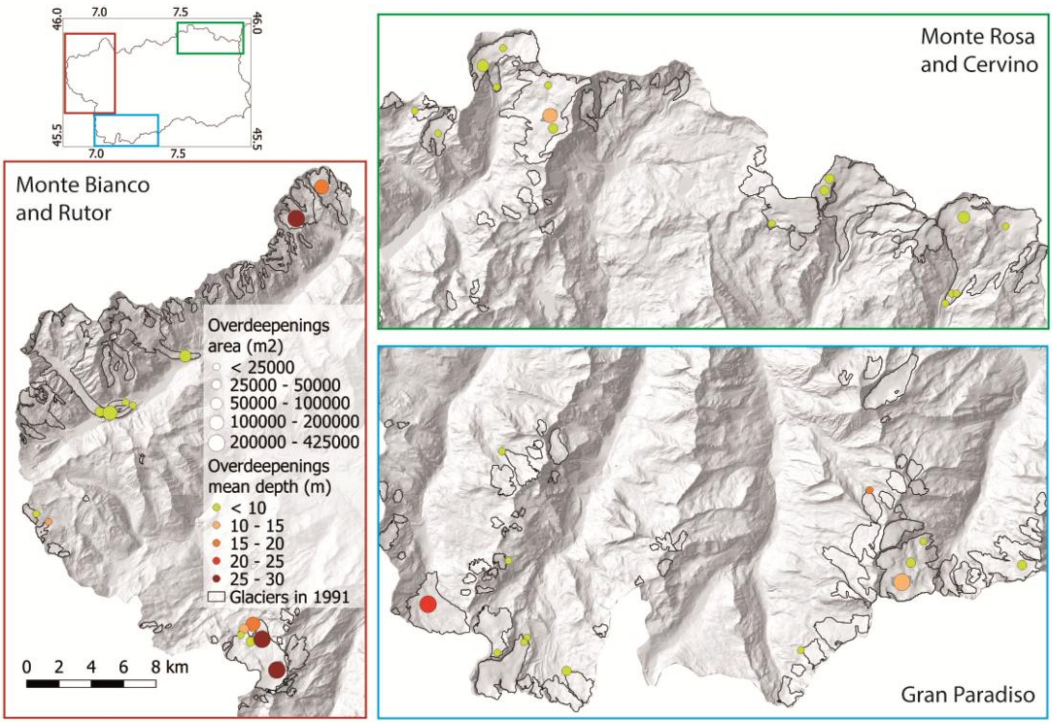

Fig. 2. Location of overdeepenings modeled with GlabTop2 for the main massifs of the Aosta Valley. The size of the points refers to the area of the overdeepenings and the color to the mean depth.

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