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Possible future lakes resulting from continued glacier shrinkage in the Aosta Valley Region (Western Alps, Italy)

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Aosta Valley (NW-Alps, Italy) is the region with the largest glaciarized area of Italy (133.73 km^2). Like the other alpine regions it has shown a significant glacier retreat starting from the end of the Little Ice Age (LIA, ca. 1850 AD), by losing about 60% of its glaciarized area.
As a direct consequence of glacier shrinkage, within glacially-sculpted landscapes, glacier-bed overdeepenings become exposed, offering suitable conditions for glacier lakes formation. In the Aosta Valley region, about 200 glacier lakes have been recognized in different time periods within LIA maximum extent boundaries, mainly dammed by bedrock landforms. With respect to human activities, glacier lakes represent both opportunities (e.g. Miage lake for tourism) and risks (e.g. outburst flood of the Gran Croux lake above Cogne in August 2016) in such a densely populated and developed region.

The objective of this contribution is to assess locations of possible future glacier lakes in the Aosta Valley by using the GlabTop2 model (Glacier Bed Topography model version 2). Understanding where future lakes will appear is of fundamental importance for the identification of potential hazards and the interpretation of conditioning factors and dynamics.
We first assessed ice thickness and consequently glacier bed topography over large glaciated areas of the region, by using both glaciers outlines related to 1999 (provided by the GlaRiskAlp project) and the regional DEM of 1990 (provided by the Aosta Valley Region) as input data. We performed several runs by varying different input parameters (e,g.: pixel size and basal shear stress). Then we compared modelled results on selected test glaciers (Rutor and Grand Etrèt) with available GPR data. As a validation, we also carried out a GPR survey during summer 2016 on the central area of Indren Glacier (Monte Rosa massif) where GlabTop2 shows the presence of a possible subglacial overdeepening morphology.

We found that ice thickness and consequently the number and area of overdeepenings are very sensitive to the selected pixel size: the number of lakes increases from about 50 to 150 for a resolution of 60 m or 20 m respectively, while keeping the other parameters constant . The main variation in ice thickness (which doubles or triples according to a higher resolution) are shown mainly for glaciers larger than 1 km^2 (such as the Rutor Glacier); for the many smaller glaciers (i.e. Grand Etrèt) changes are less relevant and in accordance with GPR data (about 30-40 meters of ice thickness in the central part). At Indren Glacier, thanks to the GPR survey, we verified the presence of the overdeepening and we found a good correspondence between the modelled and the measured ice thickness (about 50 meters in the centre).

As a main result we provided a map of possible future lakes in Aosta Valley. Information about their location and geometry analysed in relation with the conditions of the surrounding environment (i.e. slope instabilities from IFFI landslide inventory; glacier lakes from existing inventories; human infrastructures) will support timely forecasting of hazardous scenarios and proper water management from glaciers.