Application of a multidimensional integrated approach to the study of glaciers and related glacier lakes dynamics in the Italian Alps

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It is expected that the rapid retreat of glaciers, observed in the European Alps and other mountain regions of the world, will continue in the future. One of the most evident and relevant consequences of this phenomenon is the formation of new glacier lakes in recently deglaciated areas. Lakes, especially in densely populated areas, represent potential risks (i.e. lake outburst and consequent flood) and opportunities (tourism, hydroelectricity, water reservoir).

The aim of our work is to improve the knowledge on glacier retreat phases and the formation and evolution of glacier lakes, strongly dependent on dynamics of glacial masses. Here we present a multiscale (regional and local), multitemporal (past, present and future) and multidisciplinary (GIS, remote sensing and modeling) approach and its application to the glaciated Western Italian Alps (Piemonte and Aosta Valley).

First, we analyzed historical topographic maps (by IGMI) and aerial orthophotos (by Italian National Geoportal) in QGIS environment, and produced 6 different glacier lake inventories related to the 1930s, 1970s, 1980s, 1990s, 2006-07 and 2012. Inventory updated at 2015 is under processing by applying a semi-automatic method (NDWI) on Sentinel 2A imagery.

Inventories provided: a general overview of the morphometric, geomorphologic and geographic features of lakes of each time period; information about the spatiotemporal evolution of the lake population; basic data for further applied purposes.

The second step concerns the assessment of the location of future lakes using the GlabTop 2 (Glacier Bed Topography model version 2). The model requires a minimum set of input data (DEM and glacier outline) and allows the identification of glacier bed overdeepenings. We tested the model on the Rutor Glacier using a DEM and glacier outline derived from historical data (aerial photos of the 1954 GAI flight) representing conditions before the proglacial lake formation. Comparison between modeled overdeepenings and existing lakes in the proglacial area shows correspondence in their location and geometries. Now we are applying the model also on present-day DEMs and glacier outlines and comparing the modeled bed topography with in-situ geophysical investigations (GPR surveys). GlapTop2 can be applied over larger areas of the Western Italian Alps in order to assess locations of possible future lakes to facilitate identification of potentially hazardous conditions and dynamics.

Interpretation of whole data complex will offer better understanding of the dynamics between glaciers and related glacier lakes. Results are of considerable significance for the assessment of future changes of dynamic mountain environment both in term of resources and natural hazards.