GEOMORPHOLOGICAL MAPPING AS TOOL FOR INTERPRETING ALPINE IDROGRAPHIC BASINS EVOLUTION: THE CASE STUDY OF THE EASTERN SECTOR OF THE ALPE VEGLIA (LEPONTINE ALPS)

Master degree thesis
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The Quaternary Period is featured by climate changes and related glacial and interglacial intervals, testified for instance by variations in the glacial cover extension along mountain chains, as the European Alps.

Alpine temperate glaciers are sensitive indicators of the climate variations. Furthermore, their expansion and retreat produce typical erosional and depositional landforms that are still today widely recognizable in the mountain basins.

During the Holocene there was some significant glacial advance events, as the Little Ice Age (LIA), which anyway didn't reach the Last Glacial Maximum's (LGM) occurred during the Pleistocene Epoch. In between, at the end of LGM, and after the LIA, started a gradual glacial retreat leading the establishment of paraglacial condition, characterized by a transitional rebalancing phase typical of deglaciated areas. This phase is characterized meanly by gravity and water processes inducing, among the others, stability slope reduction, caused by slope's tensional rebound or by permafrost degradation and melting, or hydrologic regimes variations. Consequences of these processes can be found several kilometres along the hydrographic network, far from glacier current position.

In order to study and understand the processes that have taken place in a deglaciated area, and their spatial and temporal extent, the use of geomorphological mapping has a great importance, as it allows the spatial representation of relief landforms, providing morphometric, morphographic, morphogenetic, morphodinamic and morphochronologic information, and data on the relations with the bedrock (lithology and structures).

The aim of this work was the realisation of the geomorphological map of the eastern sector of Alpe Veglia (Lepontine Alps), as aid to the interpretation of the evolution of this glacio-structural basin. It is indeed featured by a high geomorphologic and naturalistic heritage in general, being part of the Veglia-Devero Natural Park.

This work involved two fieldwork seasons (2020 and 2021), integrated by remote analyses performed before, during and after the data collection on the field. The remote analyses and map digitalization were performed using Quantum-GIS (vers. 3.4.5.)

Remote analyses based on ortophotos and digital terrain models available from the Regione Piemonte WebGIS and download platform, made it possible to define and detail the geographic, hydrologic and

glaciological context of the study area. Through these resources, including raster, shapefile and Web Map Services, it was possible to fill in the lack in terrain data especially in remote areas, since the analysis spread through a high-altitude area.

The fieldwork, widely documented by photographic material, allowed the direct study of the landscape landforms and the bedrock. A few stratigraphic sections were also analysed to determine the origins of surface deposits by observation of texture and composition. Geographic location of all measurements and photographs, as well as the most relevant morphological features, were recorded by GPS tracking systems and integrated with remote analyses results.

Then, a GIS project was set, containing punctual, linear and polygonal shapefiles symbols were used as codified by the ISPRA guidelines of the thematic "Quaderno 13" (I Quaderni, serie III, del SGI — Italiano (isprambiente.gov.it)). The geomorphologic elements were represented in the geomorphologic map through symbol colours related to the main morphogenetic processes and with an intensity varying according to the activity of the processes.

Finally, the map was completed with a legend and additional elaborates to facilitates the reading and the interpretation, including the geomorphologic processes map, obtained by aggregating the landforms according to the genetic process (Fig1).

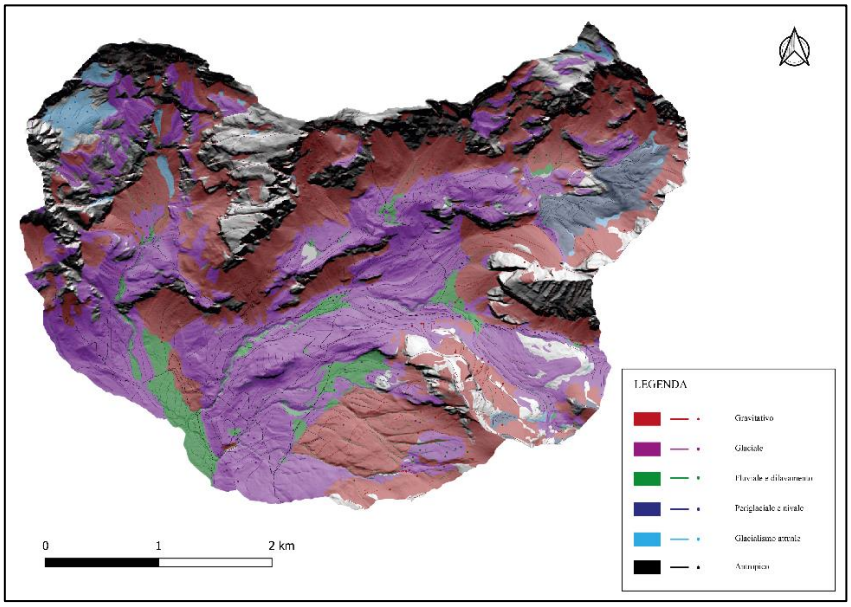

Figure 1. Geomorphologic processes map

Interpretations have shown that the most widespread landforms in the study area are those related to past glacial processes, while the current glacial modelling is confined to less than 2% of the study area. Today, much of the territory is dominated by active gravity processes, especially along high-slope slopes, and fluvial, in typical low-slope areas, with minor contributions from water run-off, periglacial and nival processes, that in many cases reflect the general trend of climate change.

Finally, a temporal succession of the geomorphologic events that has been affecting the study area was proposed, integrating the thematic cartography with the reconstruction of the Holocene evolution of the Alpe Veglia available in literature. The stages are the following ones:

I. *Last Glacial Maximum* (approx. 18 Ky BP): associated to the glacial erosion landforms observed at the higher altitudes, as around the Caldaie hollow, and to the ancient deposits in the Veglia plain.

II. *Tardiglacial stage* (18 Ky – 11.55 Ky BP): it is related to the deposits of the Alloformazione di Cantù, which includes almost all of the mapped glacial depositional landforms, nearby la Balma hamlet and Lago Del Bianco moraine complex (Fig.2).

III. *Postglacial stage* (approx. from 11.5 Ka BP to the present): it is featured by most of the water-related landforms, as the Stalaregno plain peat bogs and the little alluvial plain of Pian du Scricc and Pian Sass Mor, by gravity-related landforms and observed periglacial and nival landforms, as the rock glacier complex of the Caldaie hollow (Fig.3). The glacial landforms observed at the higher altitudes in the Mottiscia basin, are also related to this Postglacial stage, including the LIA deposits and erosional features. Finally, the landforms related to paraglacial processes featuring the area especially after the LIA, are included here.

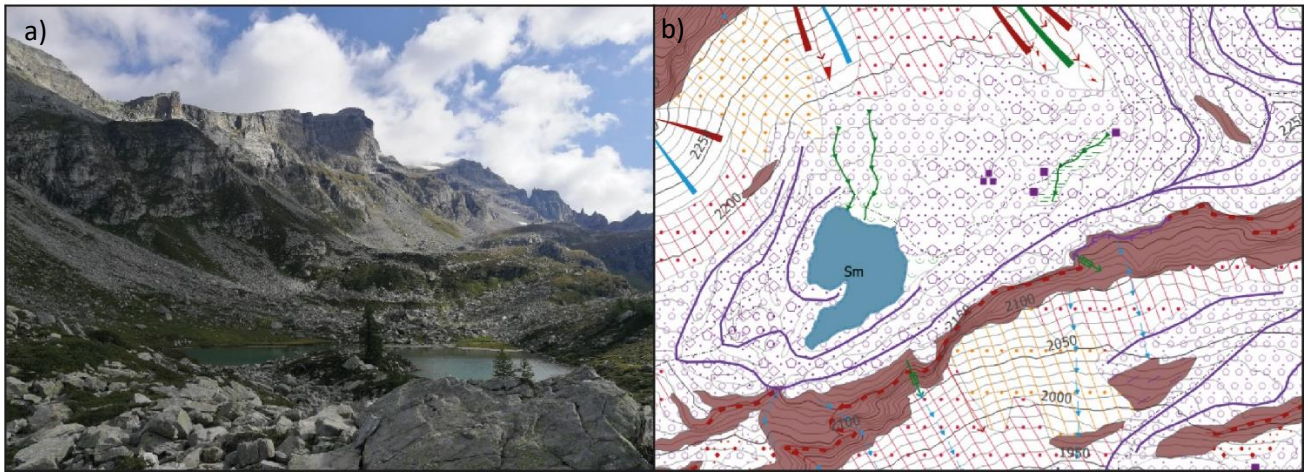

Figure 2.a) Photography of the the morenic anphitheatre of the Del Bianco Lake; b) part of the geomorphologic map on the Del Bianco Lake anphitheatre. Clearly visible are the western portion, with frontal moraines barring the basin, and lateral moraines along the eastern boundary.

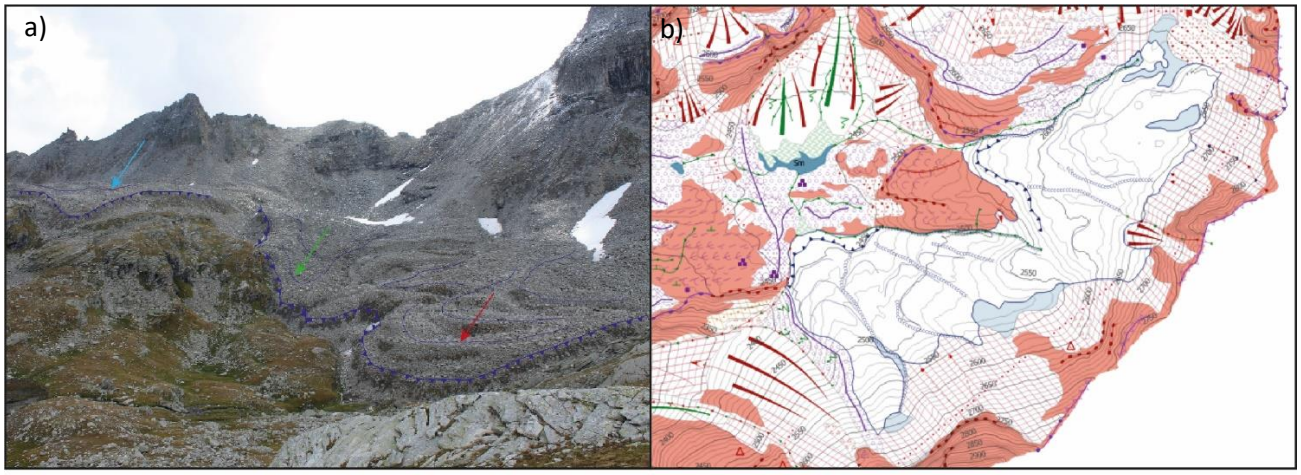

Figure 3. a) View on the rock glaciers of the Caldaie basin. b) Part of the geomorphological map on the rock glaciers of the Caldaie basin, it is possible to see the rocky outcrop that divides the two rock glaciers, which in the apical part appear united, into the two separate fronts.

Among the future perspectives emerging from this thesis there is the need to conduct detailed analysis and absolute dating of some of the landforms and deposits mapped, that are key-feature to determine the effective stage of development and in order to correlate the events reconstructed by spatial relations between landforms on the realized geomorphological map.

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