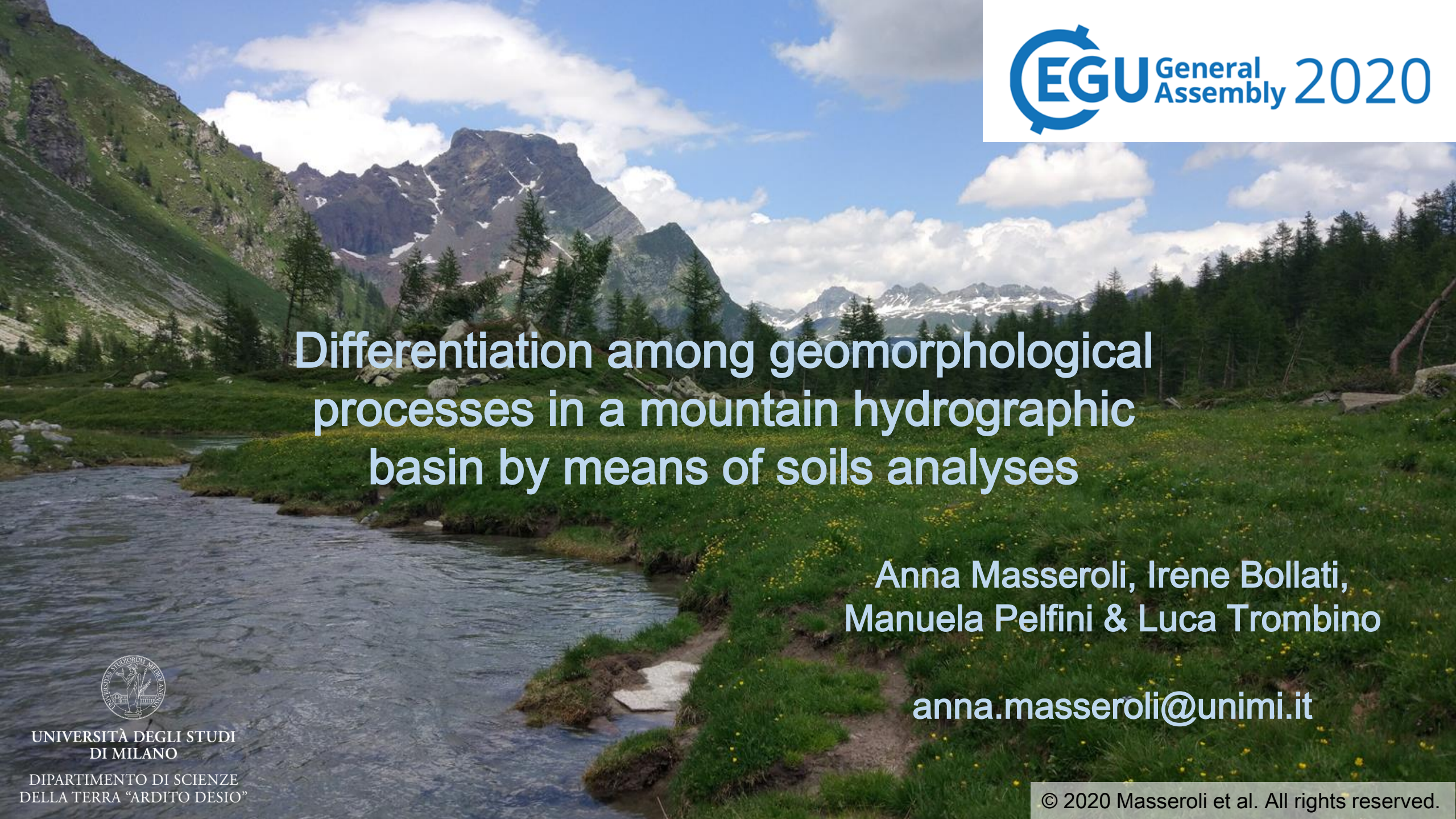

Differentiation among geomorphological processes in a mountain hydrographic basin by means of soils analyses

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Mountains regions are usually characterized, according to their geological and structural setting, by an articulated relief, where **gravity and water-driven processes** occur with an increasing intensity following glaciers retreat. Denudation processes affecting mountain slopes may vary according to local conditions controlled by different factors (e.g., lithology and structural setting of bedrock, climate, relief features).

The succession of slope stability and instability phases can be registered in the **soil record** as **paleosols** or buried surfaces. Therefore, an exhaustive investigation of soils and paleosols could provide information to infer the spatial-temporal variation of the denudation/deposition processes.

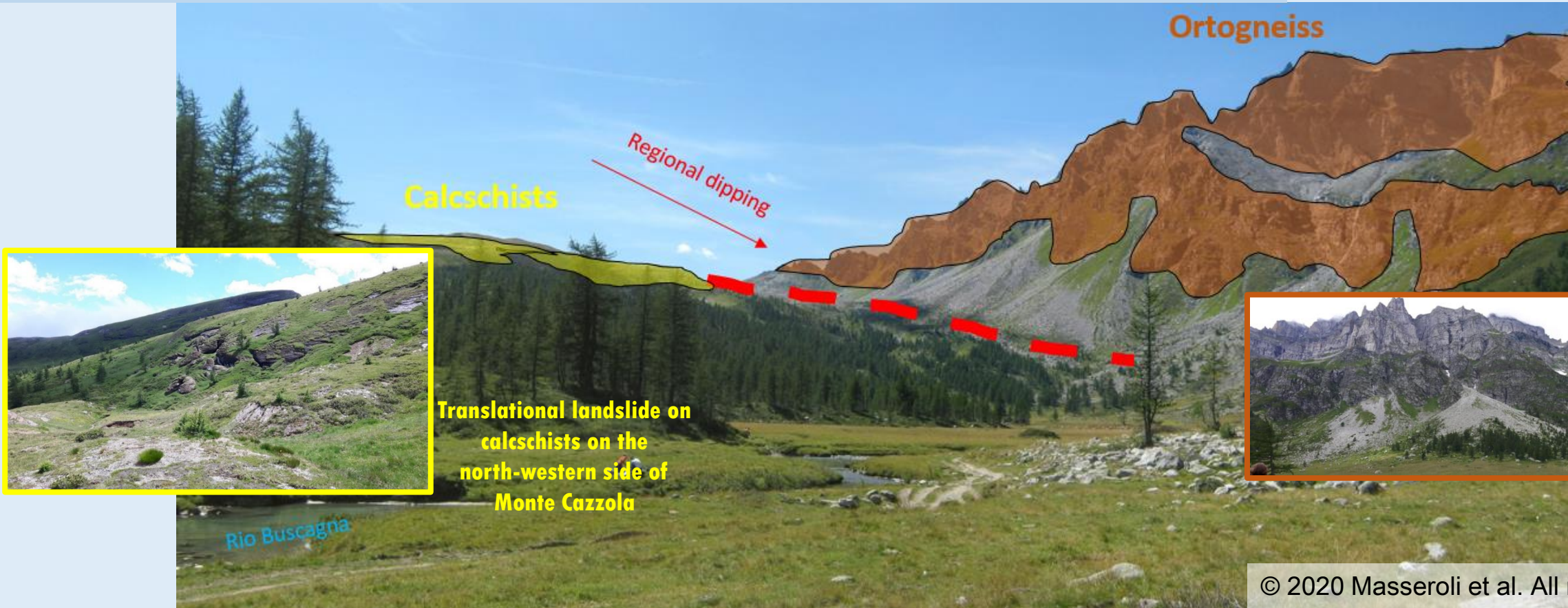
Aim of the study

The main aim of this study is the reconstruction of the dynamic interplay between erosion and sedimentation that have been characterizing the landscape evolution of the Buscagna Stream hydrographic basin (Veglia-Devero Natural Park, Lepontine Alps) during the Late Holocene, analyzing how the geomorphic processes are recorded in soils as properties and pedological features.

Study Area

The hydrographic basin of the Buscagna stream is located in the Lepontine Alps, at the border between Italy and Switzerland. It belongs to a protected area: the ZSC e ZPS IT1140016 “Alpi Veglia e Devero – Monte Giove”, including the Veglia-Devero Natural Park.

The basin is characterized by an evident asymmetry between the valley slopes in terms of lithology (calcschists on the southeastern slope versus ortogneiss, micaschists and spots of ultramafic rocks on the northwestern slope), and by a structural control on the relief. This differentiation is also responsible for the great landforms variability and the geomorphic dynamics dissimilarities between the slopes.

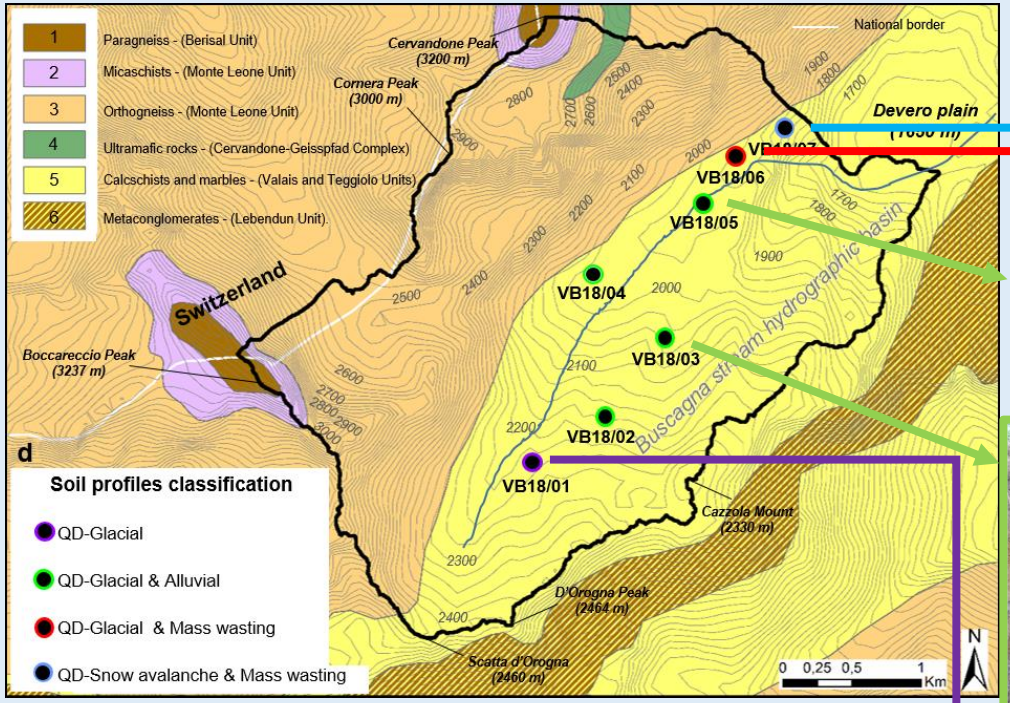


Translational landslide on calcschists on the north-western side of Monte Cazzola

Debris fan on the south-eastern facing gneiss slopes

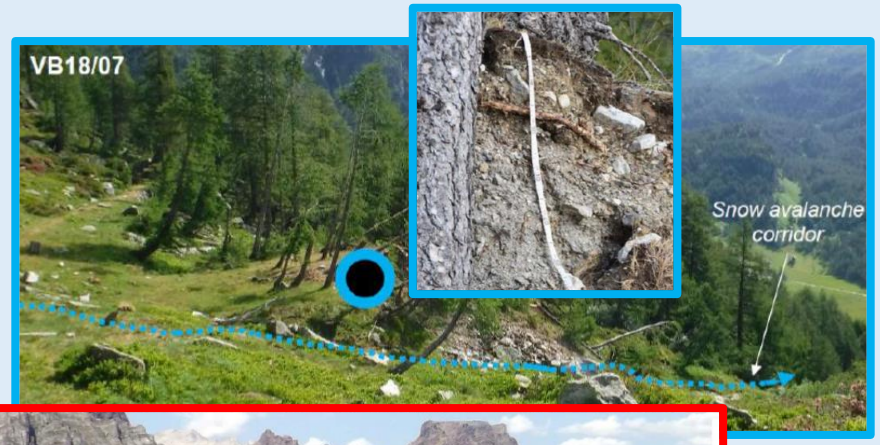
Methods

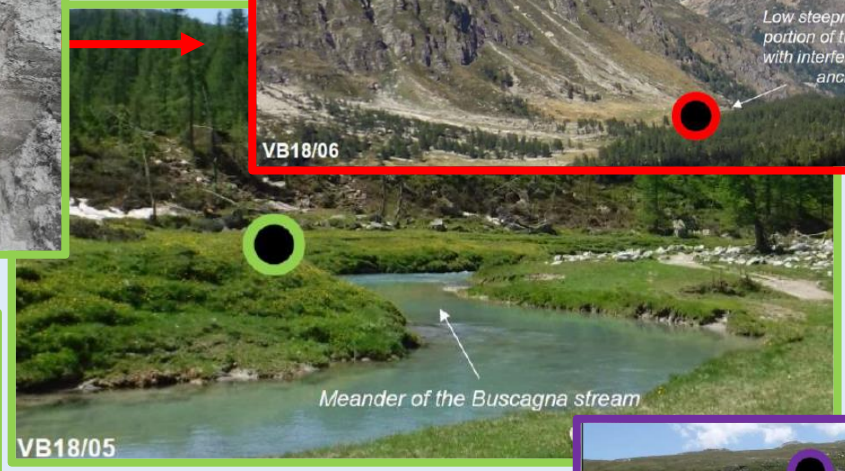
In order to reconstruct the different dynamics affecting the slopes, **7 soil profiles** were investigated by means of field and laboratory (particle size distributions, pH, Organic C content, Total Carbonates content, Aluminum and Iron oxides content) characterizations.

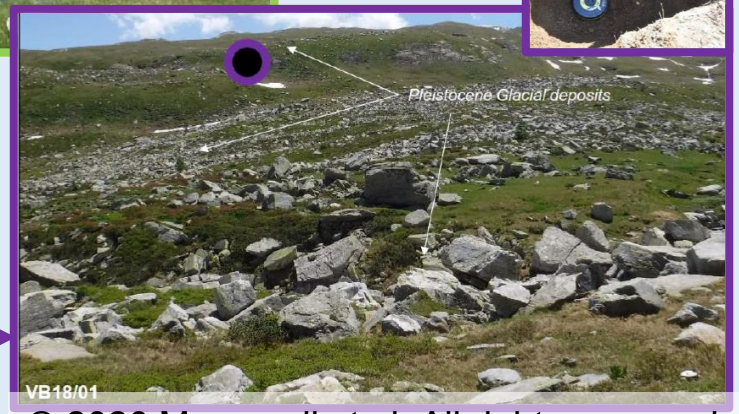


Modified from Masseroli et al., submitted

The soil profiles were selected in **different morphological contexts**, along two downslope transects on the two sides of the valley.



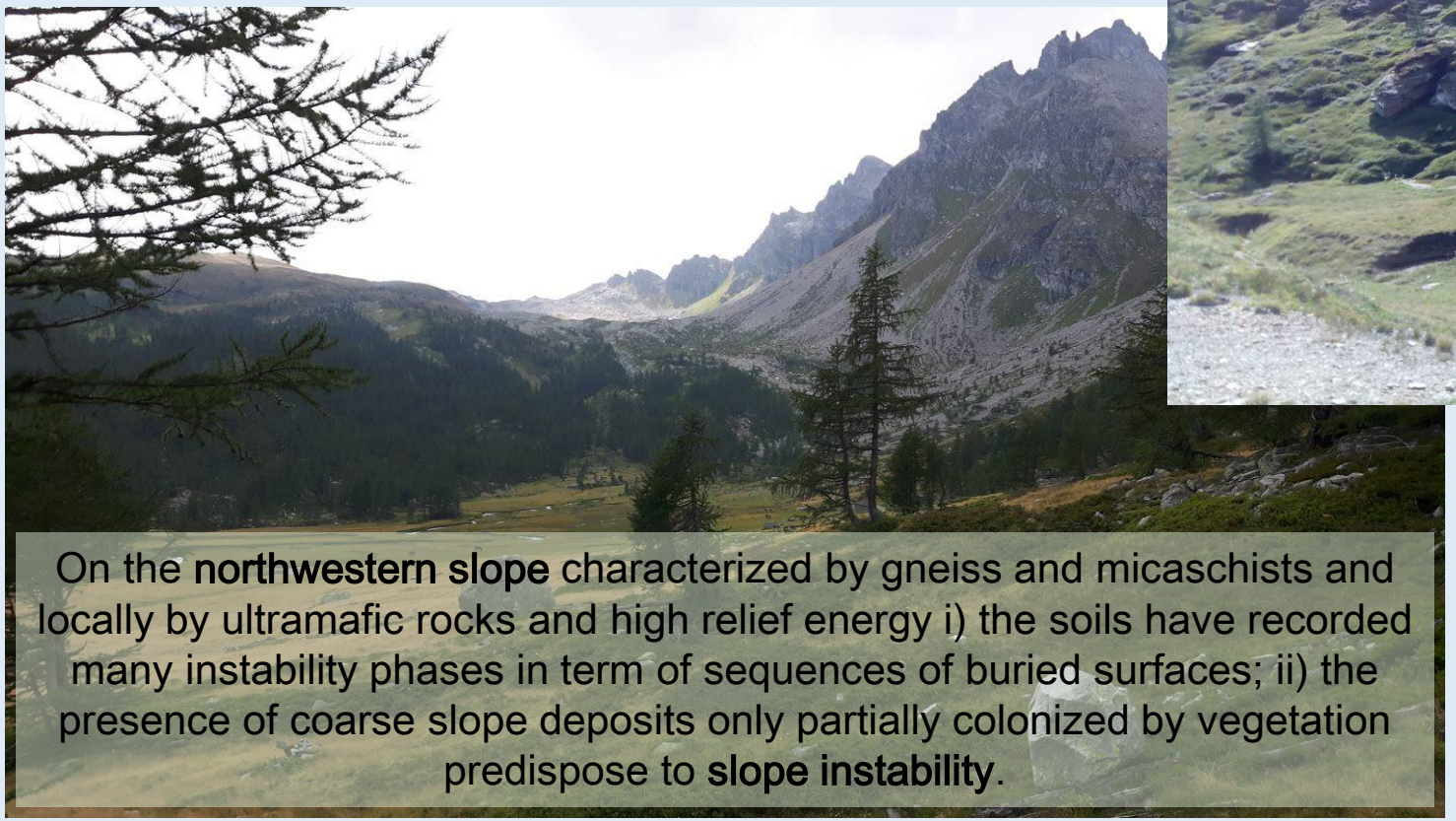




Results and Discussion

The **soils recorded in a different way the instability phases** occurred in the two opposite flanks of the hydrographic basins, underlining changes in predominant erosion processes, which are also related to the varying bedrock both in term of lithology and structural settings.

On **the southeastern slope** characterized by a calcschists bedrock and by less steep slopes i) the gravity erosion processes are less intense; ii) the presence of vegetation cover and a developed soil promote the **slope stability**.



On the **northwestern slope** characterized by gneiss and micaschists and locally by ultramafic rocks and high relief energy i) the soils have recorded many instability phases in term of sequences of buried surfaces; ii) the presence of coarse slope deposits only partially colonized by vegetation predispose to **slope instability**.

Results and Discussion

The results show that the investigated soil profiles are characterized by **different soil units**, identifiable by the presence of grain size discontinuities and/or **stone lines** or **buried organic horizons.**

The presence of **different pedological units** underlines the occurrence of separate events of pedogenesis alternated to phases characterized by slope instability and intensification of denudation and related degradation/aggradation processes.

VB18/01 and **VB18/03** recorded **two phases of stability**: the upper horizons of the soils show weak to moderate development, whereas the lower profiles portion are characterized by depleted grey E horizon and illuvial accumulation of Fe and Al oxides in Bhs horizon, testifying a relatively long and intense biochemical weathering phase, which led to the development of a **podzol**.

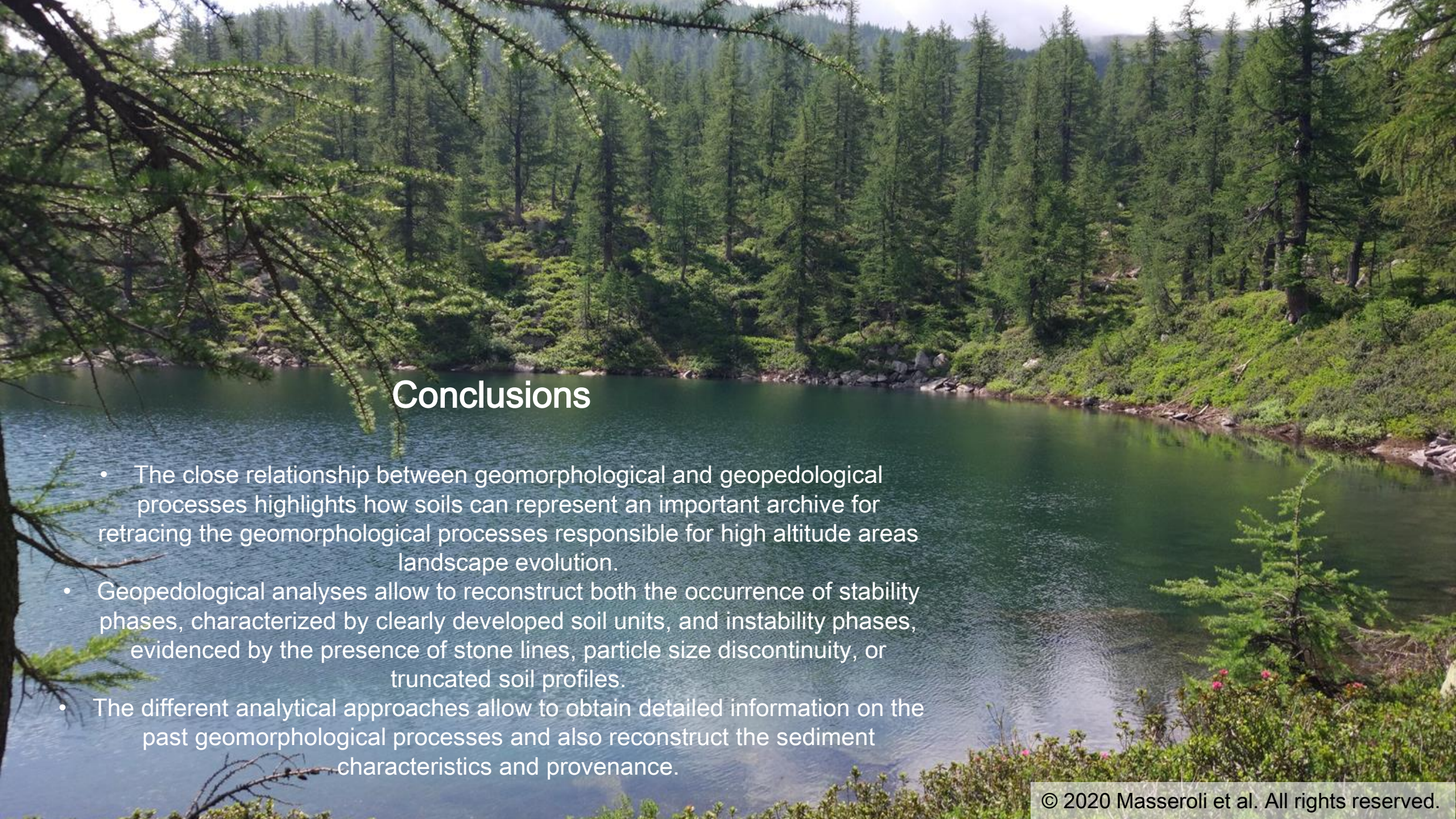
Results and Discussion

The characterization of **soil mineral component** underlines the presence of different material sources, linked to action of a **variety of agents** (e.g., gravity, water, snow, wind), which have contributed to landscape evolution in term of sediment erosion, transport and deposition.

In **VB18/05** profile **5 different pedological units**, with a moderate degree of development, are found. The soil profile recorded mainly the **geomorphic dynamics related to the water action**: the deposited material is dominated by sand-sized particles and, according to the soil chemical analysis, the provenance is consistent with the **local geology.** Moreover, the presence of abrupt increment of the **silt fraction** (+20-30% of the above or below horizons) at 142 cm deep could indicate an **aeolian influence**. Since the coarser compositions (greater abundance of fine sand) of the founded layers than the loess of the Po Plain, the sediment could derive from a closer source differently from traditional loess; however more investigations are needed.

The **VB18/06** profile is characterized by the presence of **three pedological units** with low to moderate degree of pedogenetic maturity. The profile seems to be significantly influenced by erosion/deposition processes. The **instability phases** recorded by soils are mainly related to **slope processes** (e.g. water-, gravity- and snow-related processes) affecting the area. The **stone line** located between the units 1 and 2 underlines the occurrence of a slope instability event probably due to debris accumulation by gravity, a process not more currently active at soil profile location.

VB18/07 is characterized by a lot of coarse material (gravel content > 45%) due to the continuous rejuvenation caused by **avalanche processes**. The **chemical analysis** (pH, Total Carbonates content, Fe and Al content) suggest a different chemistry of the parent material then the other profiles, probably related to the presence, upslope, of **ultramafic rocks**, outcropping intercalated to gneiss and micaschist, whose debris is included in the down valley deposits.



Conclusions

- The close relationship between geomorphological and geopedological processes highlights how soils can represent an important archive for retracing the geomorphological processes responsible for high altitude areas landscape evolution.
- Geopedological analyses allow to reconstruct both the occurrence of stability phases, characterized by clearly developed soil units, and instability phases, evidenced by the presence of stone lines, particle size discontinuity, or truncated soil profiles.
- The different analytical approaches allow to obtain detailed information on the past geomorphological processes and also reconstruct the sediment characteristics and provenance.