



DIPARTIMENTO DI SCIENZE DELLA TERRA  
UNIVERSITÀ DI PISA

# Geomorphological mapping as a tool to characterize and manage quarry dump deposits: the case study of Carrara marble basins

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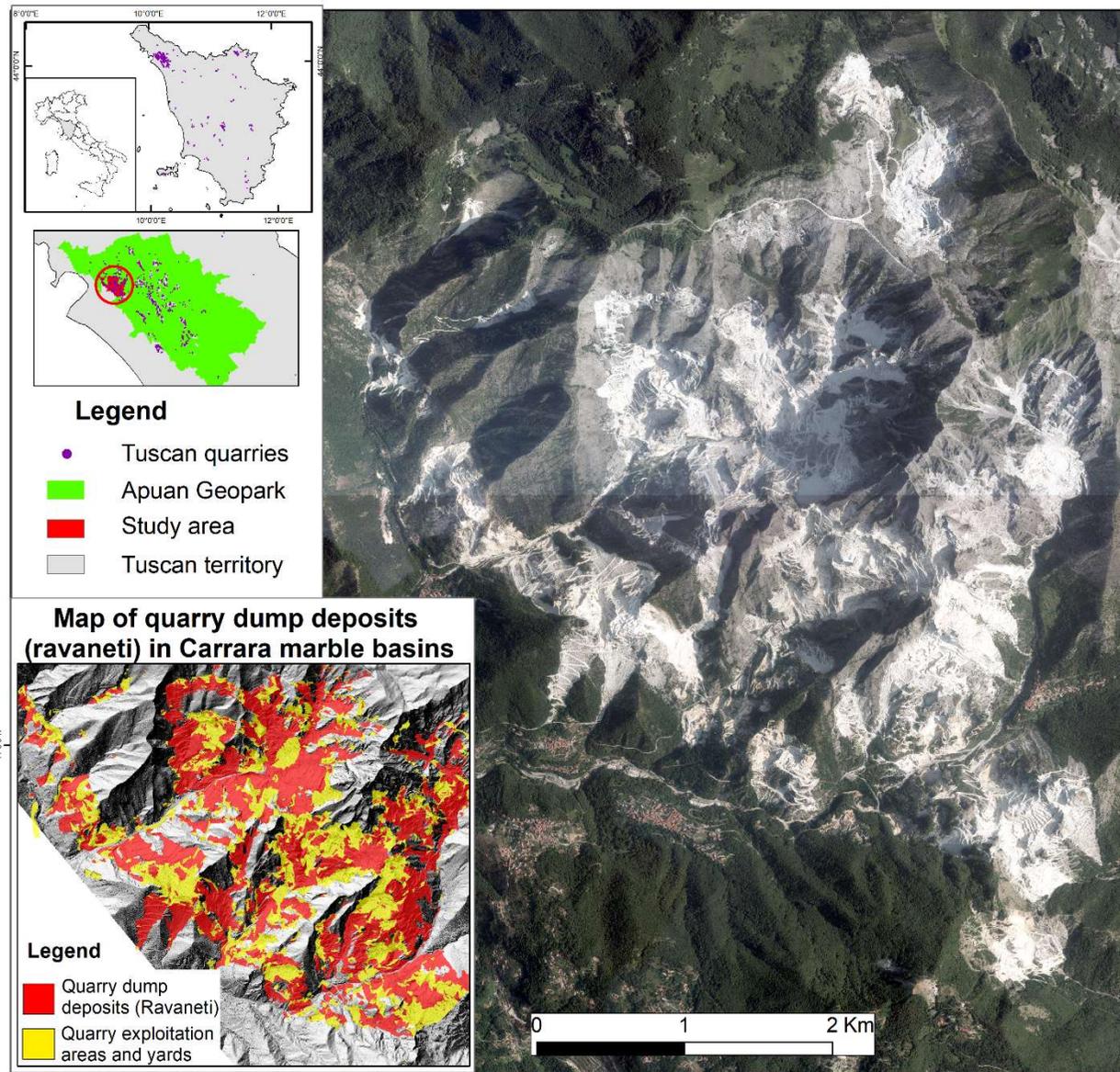
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## Study area: Carrara marble basins



Apuan Alps retain many naturalistic, geomorphological and geological elements including many geosites and are renowned in all over the world for the white marble of Carrara.

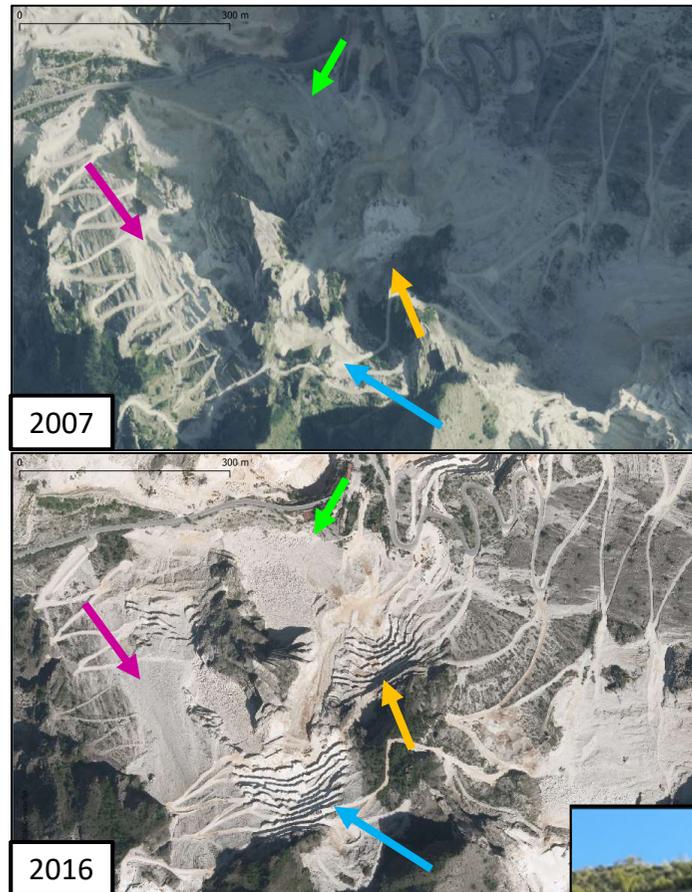
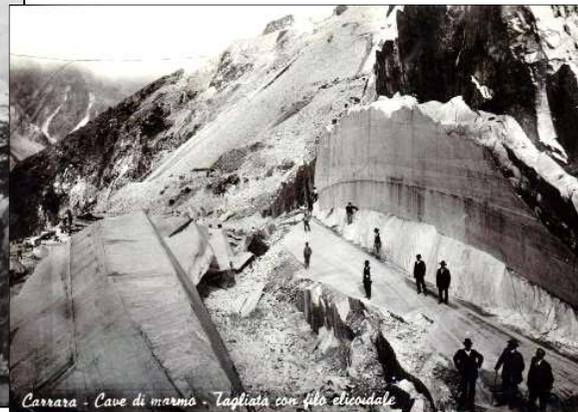


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Marble has been exploited since pre-Roman time determining nowadays a high density of quarries, among the highest in the world

## High dynamicity and Cultural heritage of *ravaneti*

Quarry dump deposits accumulated during centuries, locally called *ravaneti*, retain typical textural characteristics closely linked to the different techniques adopted over time for marble extraction. Therefore, quarry dumps represent a key access for reconstructing the evolution of the Apuan marble exploitation. For this reason, ancient *ravaneti* assume an inestimable value within the historical and cultural heritage of Italy

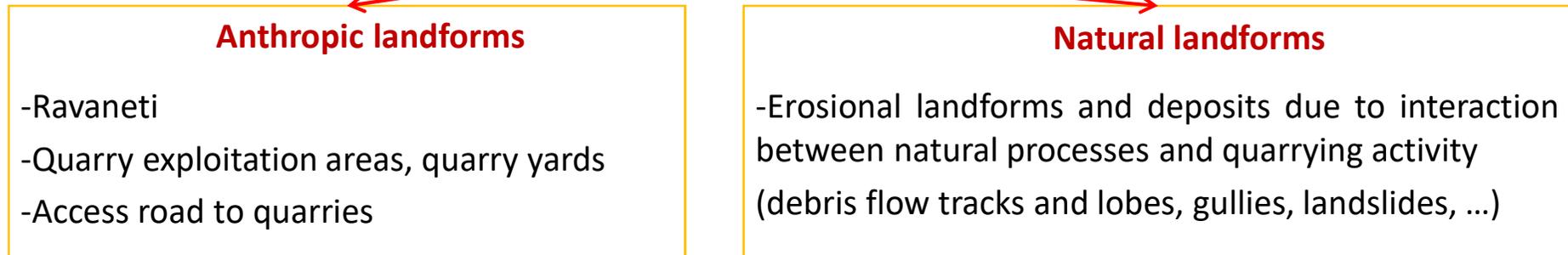


Pluri-millennial quarrying activity composes a dynamic and outstanding anthropic landscape. During the last decades widespread debris flows frequently affected the area representing serious hazardous events for quarrying activity, infrastructures as well as urban centres



- **Interpretation** of aerial photographs (1954-2017)

paying particular attention to landforms strictly related to quarrying areas



- **Data management in GIS environment:**

-manually digitization of landforms in vector domain (3 geometries: point, line, polygon ) operating at a scale between 1:500 and 1: 1000 directly on the more recent high resolution orthophotographs

-Data collection into a properly created database (joined with .shp)

**Database:**

Vector domain  
(\*.shp)  
+  
Attribute table  
(\*.dbf)

- **Criteria adopted for the geomorphological characterization :**

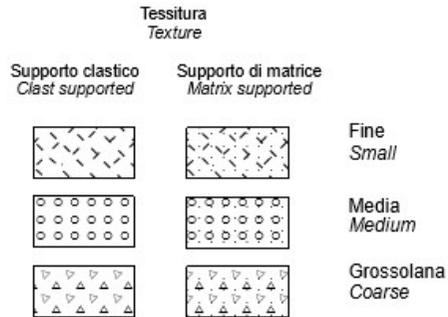
Natural landforms: guidelines proposed by Italian researchers for identifying landforms according to morphogenesis, morphodynamic, morphochronology (guidelines proposed by the Gruppo Nazionale Geografia Fisica e Geomorfologia (1993) and guidelines proposed for the fieldwork and preparation of the Geomorphological Map of Italy at a scale of 1: 50.000 (*Gruppo di lavoro per la Cartografia Geomorfologica, 1994*))

Anthropic landforms: guidelines of the Geomorphological Map of the Carrara Marble Basins (Baroni et alii, 2010)

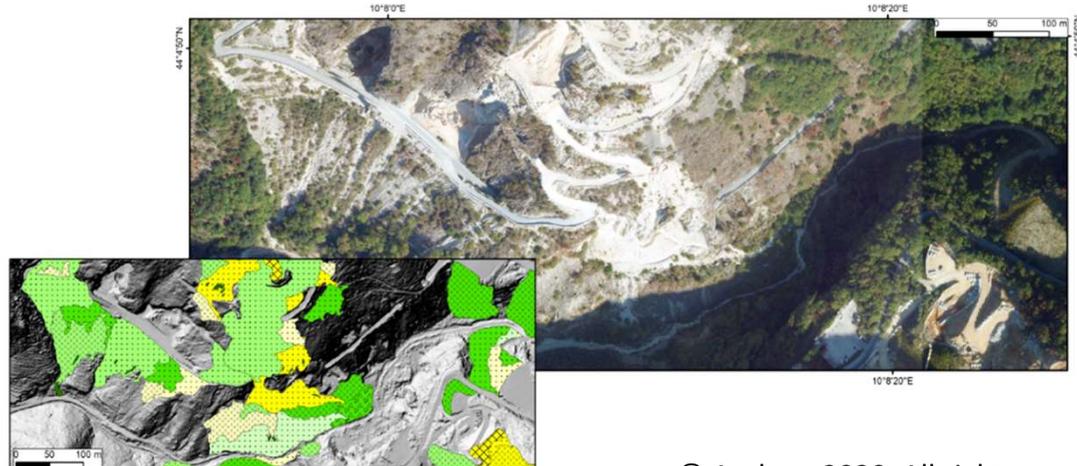
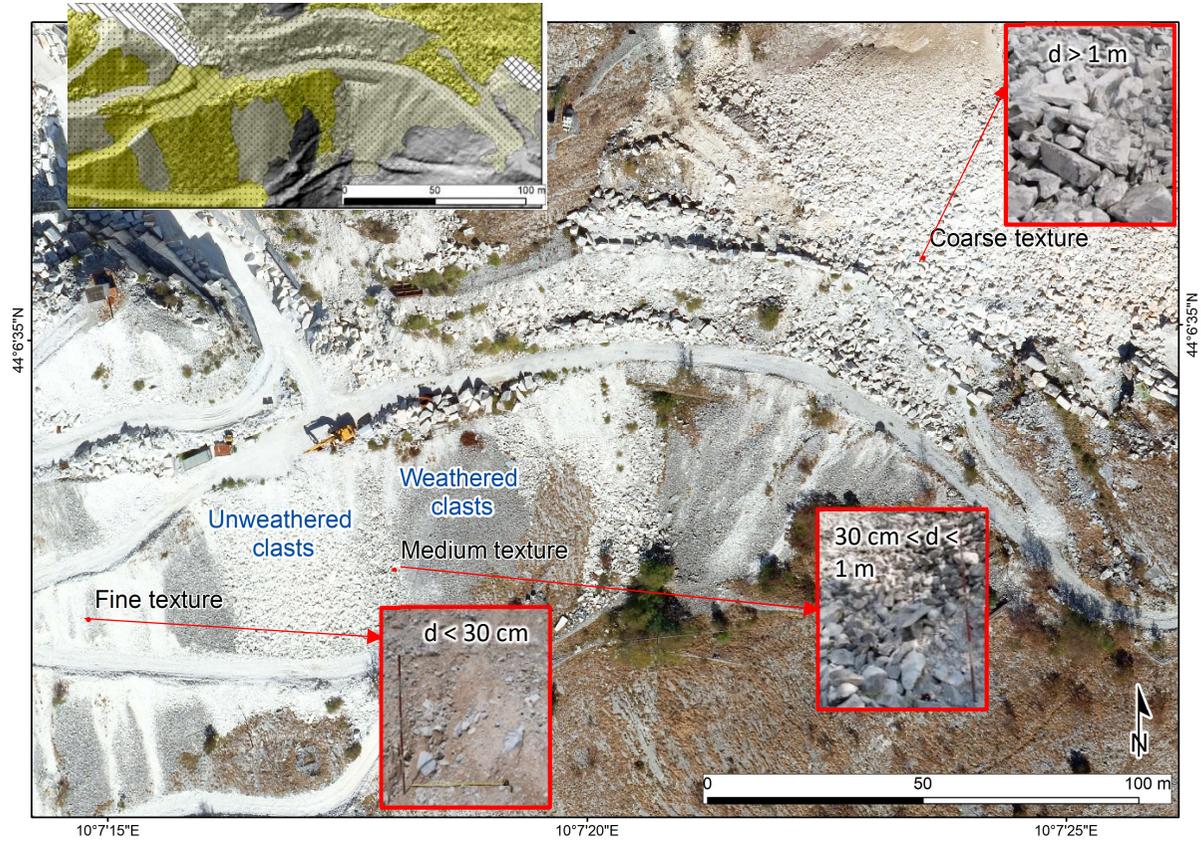
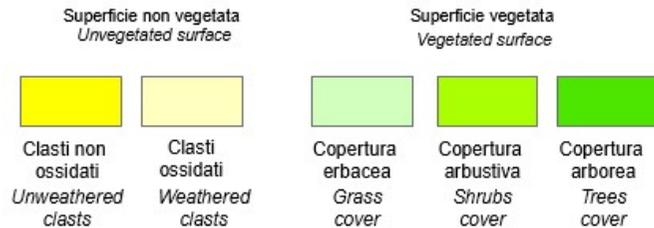
- Criteria adopted for the geomorphological characterization of *ravaneti* :

**TEXTURE, WEATHERING AND VEGETAL COVER OF DEBRIS**

Ravaneti  
Quarry dump deposits

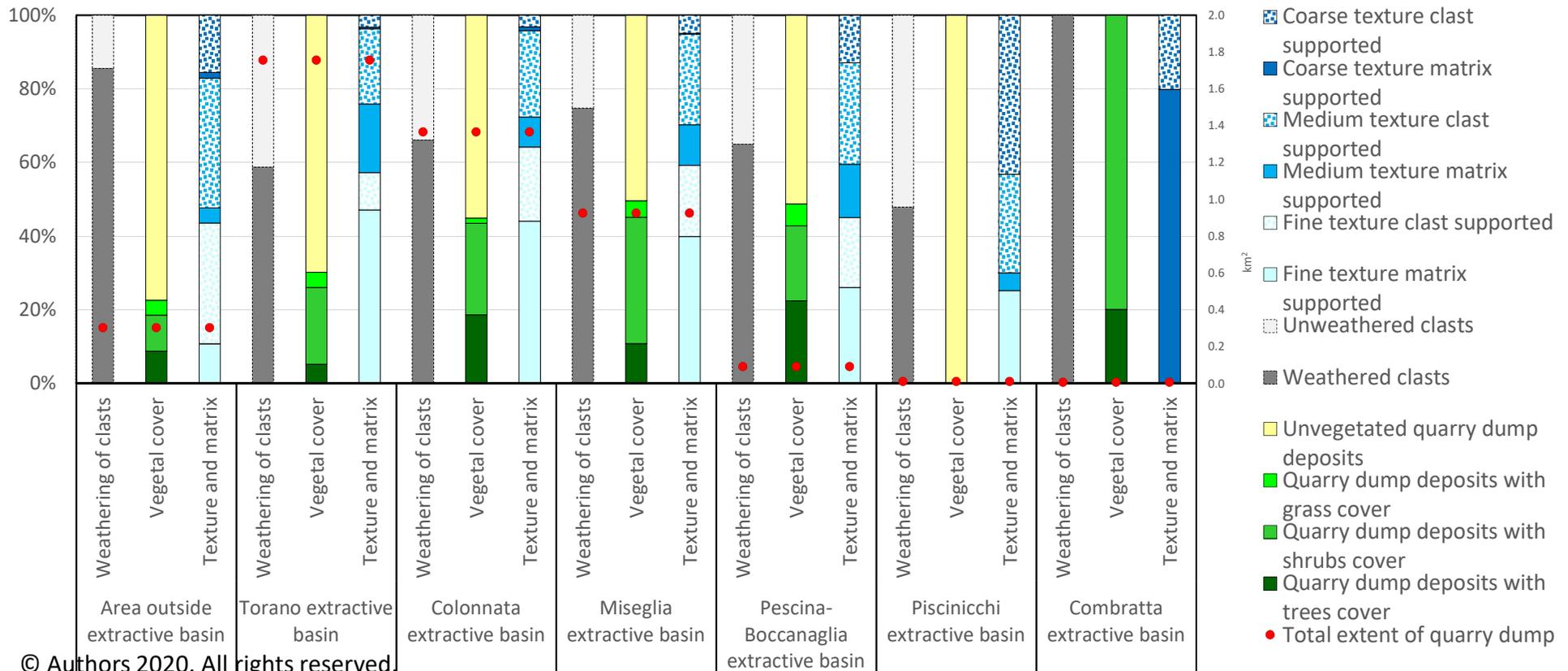
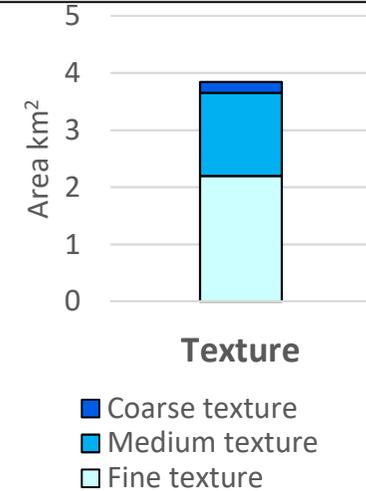
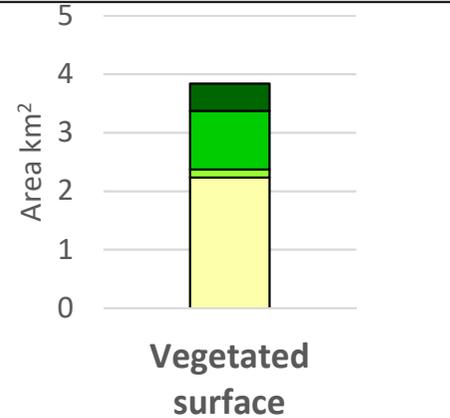
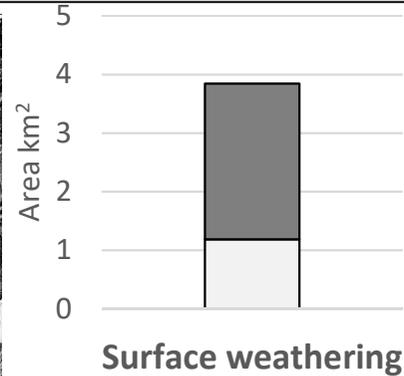
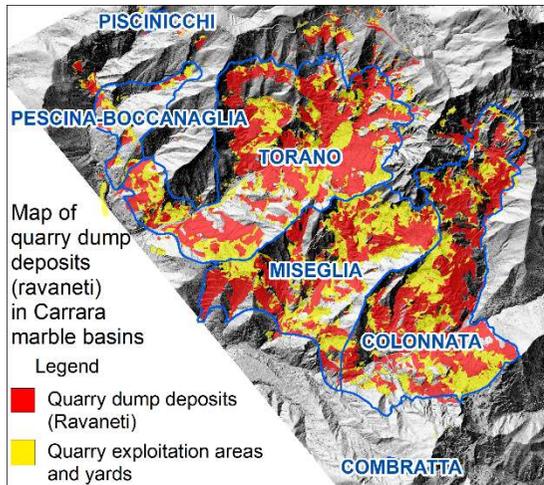


Alterazione superficiale e copertura vegetale  
Superficial weathering and vegetal cover



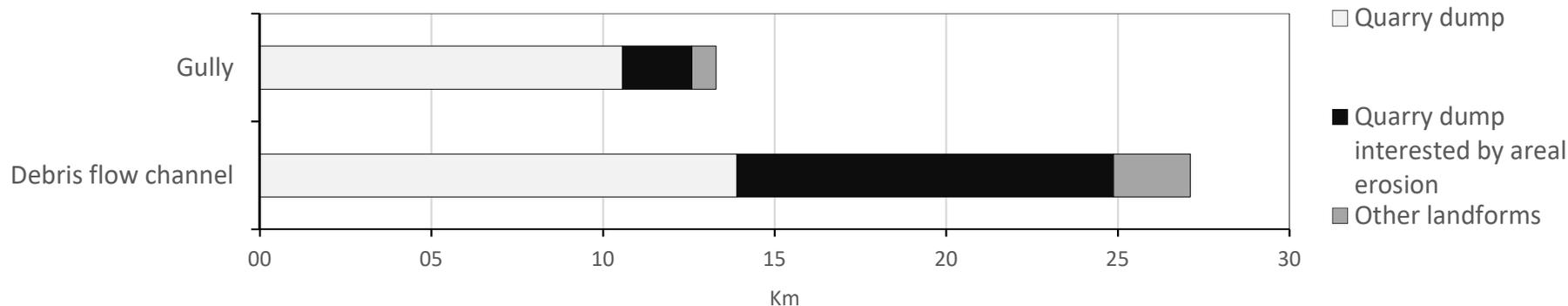


# Results: geomorphological characterization of quarry dumps

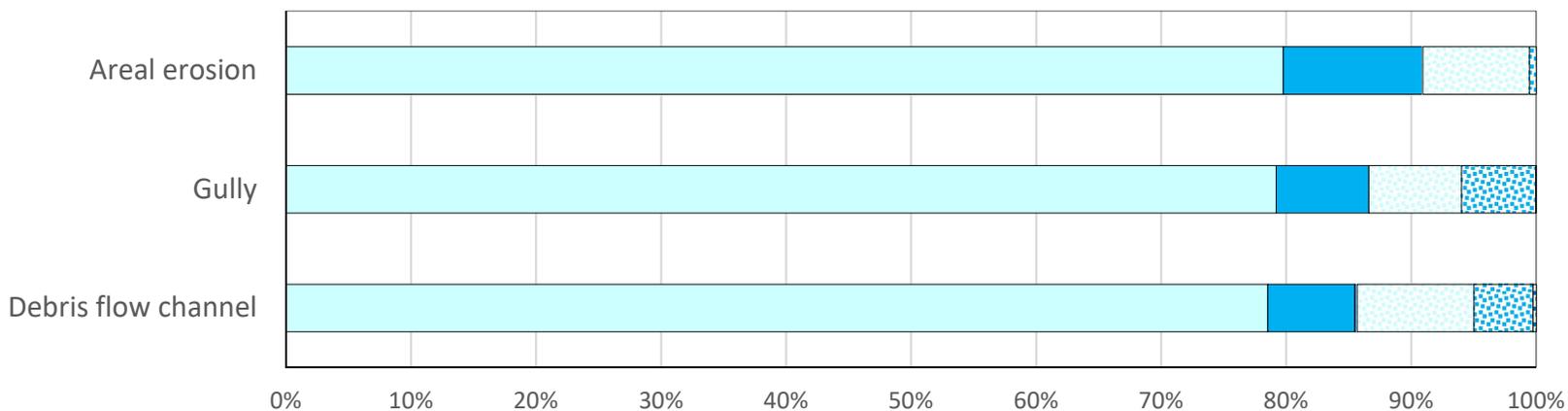


# Results: slope instabilities on quarry dumps

## Total length of linear erosional features



## Distribution of slope instabilities on quarry dump deposits



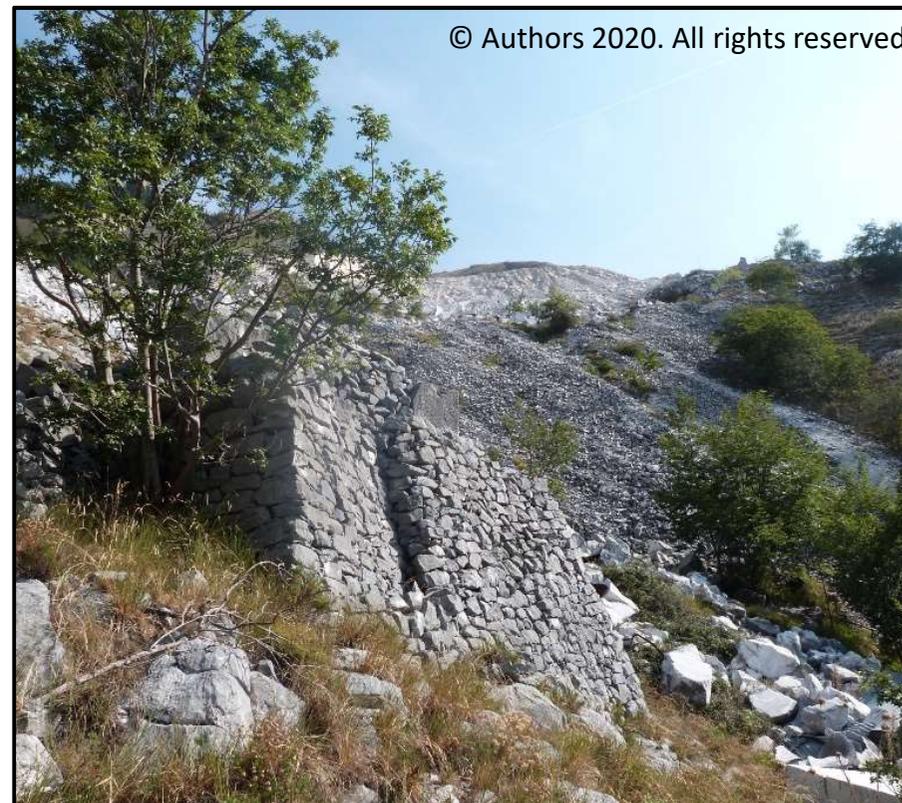
### Quarry dump deposits:

- Fine texture matrix supported
- Medium texture matrix supported
- Coarse texture matrix supported
- Fine texture clast supported
- Medium texture clast supported
- Coarse texture clast supported

Geomorphological mapping allow to characterize landscape features of this peculiar region concerning anthropic landforms originated by millennial quarrying activity. The geomorphological characterization represents a relevant tool for the monitoring and management of *ravaneti* suggesting both potentially removable and potentially worthy of geo-conservation quarry dumps on the bases of i) their historical heritage, ii) their role in slope instabilities, and iii) their role in preventing hazardous flooding events, being this sector among the rainiest regions of Europe.

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