PHYSICAL GEOGRAPHY, GEOMORPHOLOGY AND GEOARCHAEOLOGY

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Processes and landforms witnessing past and present climate variability and landscape changes: from extreme environments to Mediterranean areas, from natural to human environments

This research group developed in the framework of the Doctoral Program in Earth Sciences is aimed at detecting, describing and analysing surface processes driving the evolution of landscape features and evolution of extreme (and fragile) environments of our Planet (glaciers and glacierized regions, frozen ground areas, high-mountain areas, deserts and their semi-arid margins) and the Mediterranean region. The monitoring and valorisation of natural assets undergoing geomorphic changes due to natural or human-induced processes is a further focus of the research group. The research embraces different topics: from geomorphology to soil science, from geochronology to dendrogeomorphology, from geoarchaeology to geoheritage, from surface processes to geomorphological hazards, from geomicrobiology to climatic geomorphology.
Several labs in the Department (Soils and Sediments Lab, Remote Sensing and GIS Lab, Physical Geography and Dendrogeomophology Lab, Micromorphology Lab, SEM Lab) are equipped for analysing and processing data at different scales of resolution, thus supporting this research.
In addition, the scientists of the Physical Geography and Geomorphology Team have developed robust cooperation with foreign institutes and universities thus assuring the fundamental exchange of ideas and data and constituting an actual occasion for the PhD students to improve their results and findings.

The Tutors will provide expertise in Geomorphology, Geoarchaeology, Geopedology and Palaeopedology, Quaternary Geology, Dendrogeomorphology, Geoheritage analysis. Within the PhD program in Earth Sciences the research topics to be developed are described below.

1) Human-environmental interaction: a geoarchaeological approach to landscape archaeology and site formation
The climate-environment-human nexus is complex and the mutual and multidirectional interaction between them started in the prehistory. Geoarchaeology offers various tools to investigate the interplay between natural and anthropogenic processes shaping the landscape and permits to understand the formation processes of an archaeological site and of the landscape that ancient human people settled and exploited. Our team is investigating many archaeological contexts dating from the Middle Palaeolithic to Classical periods and distributed along the Italian Peninsula, Africa, the Levant and Arabian Peninsula. We offer the opportunity to undergo multifaceted geoarchaeological investigations from site to landscape reconstruction and vice versa and looking at characterize the Anthropocene.

2) Biogeochemistry of rock weathering: from pristine natural settings to cultural heritage conservation.
Rock weathering, the initial phase of pedogenesis, is controlled by numerous physical, chemical, and biological processes. The holistic understanding of rock surface decay requires
the comprehension of the bio-geo-chemical phenomena that transform lithic substrates. Our team consists of chemists, physicists, geologists and microbiologists who collaborate to investigate rock weathering under extreme environmental conditions such as warm (e.g. the Sahara) and cold deserts (e.g Antarctica), and stone-built heritage. In the latter, we are also attempting to discern between inactive and on-going decay processes to ultimately suggest mitigation strategies for sustainable preservation of cultural heritage.

3) Quaternary evolution of the landscape
Quaternary climatic changes triggered a number of transformations on the landscape that are embedded in Quaternary landforms, deposits and paleosols. We are investigating the Mid-Upper Quaternary evolution of many regions of northern Italy mapping and dating features in glacial and periglacial environments, geomorphological evolution of arid and semiarid regions that in the Late Quaternary suffered major palaeohydrological changes, driven by long-term and rapid climatic changes. We offer the opportunity to investigate the effect of climatic changes on the landscape evolution and their effect on human groups in Italy, Ethiopia, Kenya, Tunisia, and Oman.

4) *Sensitive environments: response to climate change*
The high altitude environments are among the most sensitive to climate change. Indeed, in mountain landscapes, biological and abiological responses to variations in climatic conditions are particularly evident. The multidisciplinary approach, which connotes our team, based on the study of the interface among lithosphere (quantitative

geomorphology, topographic survey, geopedological analysis), atmosphere (climate data analysis), biosphere (dendrochronological and dendrogeomorphological analysis) and hydrosphere allow us to well characterize the response of sensitive environments to the ongoing climate change.
Since climatic changes characterizing the Holocene are triggering and acceleration climate-related geomorphological processes, a particular attention is given for the study of the response to the ongoing climate change of high altitude areas affected by water driven processes. In this sense, transformations affecting landforms undergoing paraglacial evolution are monitored and quantified, with a seasonal resolution, through topographic survey and dendrogeomorphological analysis. Our investigations, carried out in different areas of the Italian Alps and northern Apennines, offer the opportunity to use different analytical methods and testing advanced techniques of geopedological analysis (e.g. stable isotopes, Rock-Eval pyrolysis), in order to reconstruct the evolution of high altitude environments during the Holocene.

5) Geoheritage analysis and fallouts on educational strategies
Specific methodologies for assessing, monitoring and valorising geoheritage are also developed. Sites of geomorphological interest are detected to monitor changes due to natural and human-induced surface processes and to assess their evolution rate as well as degradation context. Monitoring of geosites also aims to establish the consequent fallouts on scientific values of the sites themselves (representativeness, integrity, ecological value) and the related geomorphic hazard, linked with geosites fruition and their degradation in the perspective of geoconservation. Moreover, sites of geomorphological interest, as component of geoheritage and of georesources, will act as open-air laboratories, where to develop and test innovative educational strategies addressed to students of different level.