

Monitoring and modeling physical weathering of Draix marls and its effect on erosion.

Summary

The objective of the project is to study the effect of rock physical weathering on erosion. The study will be based on Draix-Bleone critical zone observatory, which is located on a very erodible marly substrate. A variety of physical processes are responsible for the weathering of marl resulting in the formation of a layer of fragments, called regolith, which can later be mobilized for erosion. The first approach will consist in monitoring at a local scale the characteristic of the regolith (thickness, grain-size distribution, porosity) and the possible controlling factors (soil temperature and moisture). These measurements will be used to create a 1D model of the seasonal dynamics of regolith. The second approach will be to spatialize and implement this description into a landscape evolution model (Landlab) to simulate the effect of regolith dynamics on catchment-scale erosion. This model will be calibrated based on sediment flux data from Draix observatory then used to test the effect of climatic hypotheses on erosion.

Context

Erosion and sediment fluxes have important impacts on torrential hazard and water quality. However, despite decades of studies on sediment transport, it is still difficult to predict sediment yield from small mountain catchments. In such places, sediment fluxes are controlled not only by floods and available hydraulic power, but also by sediment availability. Sediment sources for erosion are the result of weathering that transforms fresh bedrock into a fragmented and porous layer of rocks, called regolith, through physical, chemical and biological processes. The project is focused on the « Terres Noires » formation, in the South-East of France, which is a major contributor of fine sediments to the Durance and Rhone rivers. This formation is characterized by deeply incised badlands with scarce vegetation. The marl lithology is weathered into a regolith layer which is the main source of sediments for erosion. Characterizing this regolith, its seasonal variability, its sensitivity to climate and its impact on sediment yield, is therefore crucial to predict sediment yield from these catchments and their future evolution under climate change.

Objectives

The PhD project aims at:

- Quantifying the seasonal evolution of the regolith and relate it to climatic forcing.
- Quantifying how regolith impacts catchment scale sediment yield and its intra and interannual variability.
- Combining previous items, estimating the sediment yield response to climate change scenarios.

Methods

The project will combine:

- Field measurements to quantify regolith seasonal evolution (on Draix-Bleone observatory, see <https://oredraixbleone.irstea.fr/>)

- Numerical modeling, at the local scale (vertical profile) and at the catchment-scale to study the impact of weathering on sediment yield (landscape evolution model Landlab)

Collaborations

The numerical modeling part of the project will be addressed in collaboration with Greg Tucker from the University of Colorado in Boulder. The PhD student could spend 2/3 months in Boulder to learn Landlab code and interact with the developing team.

Geophysical campaigns will be run to complement regolith characterization in collaboration with Sylvain Pasquet (OZCAR/IPGP)

The PhD student will also be integrated in the OZCAR community for the study of the critical zone in the GIS Draix-Bléone. He/she will participate to the meetings of OZCAR and GIS Draix-Bléone.

Organisation

The student will be supervised by PhD director Peter Van Der Beck (IsTerre), and co-supervisor Caroline Le Bouteiller (IRSTEA ETNA).

He/she will join Ecole Doctorale Terre Univers Environnement in Université Grenoble Alpes (UGA).

He/she will be hosted in IRSTEA, Research unit ETNA, team STRIM.

The PhD starts in autumn 2019.

Profil recherché

- Has completed and obtained a master degree when the PhD starts
- Trained in geosciences or mechanics/physics
- Interested and skilled in quantitative methods, if possible experienced in numerical modeling
- Interested and motivated for fieldwork
- Rigorous, well-organized, curious ...
- Driving license not compulsory but very useful for fieldwork
- Good level in English, motivated to learn French if needed

References

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