Soil and geomorphological parameters to characterize natural environmental and human induced changes within the Guadarrama Range (Central Spain)

Web page:
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INTRODUCTION AND OBJECTIVES

Mediterranean mountain ecosystems are often complex and are seen as important sources of biological diversity (FAO 2015). They play a key role in the water and sediment cycle for lowland regions as well as preventing and mitigating natural hazards especially those related to drought such as fire risk. However, these ecosystems are vulnerable to changes due to their particular and extreme climatic and biogeographic conditions. Some of the main pressures on mountain biodiversity are caused by changes in land use practices, infrastructure and urban development, unsustainable tourism, overexploitation of natural resources, fragmentation of habitats, air pollution, particularly when located close to large population centers, and climate change.

The objective of this work is to select soil and geomorphological parameters in order to characterize natural environmental and human induced changes within the newly created National Park of the Sierra de Guadarrama (approximately 50 km NW Madrid) in Central Spain, where the presence of the Madrid metropolitan area is the main factor of impact.

This study is carried out within the framework of the Guadarrama Monitoring Network (GuMNet) of the Campus de Excelencia Internacional Moncloa, where long-term monitoring of the atmosphere, soil and bedrock are priority.

STUDY SITES

The Guadarrama Range is a part of the Central System, a mountain range more than 800 km long that divides the Central Meseta in the Iberian Peninsula. Altitudes range from 900 to 2000 m above sea level (a.s.l.) from the base to the summit (Peñalara peak, 2428 m a.s.l).

A total of ten monitoring stations are implemented in the study area. In order to represent different soil and geomorphological conditions, three stations have been selected (Fig. 1), including: 1) an alluvial plain in a lowland pasture area (La Herreria), 2) a slope in a mid mountain pine-forested area (Raso del Pino) and 3) high mountain grassland and rock area (Dos Hermanas).

The stations in the lowland and mid mountain areas represent the major human influence due to livestock keeping and forest use. Whereas, the high mountain site is mainly influenced by natural conditions, with evidences of frost heave.

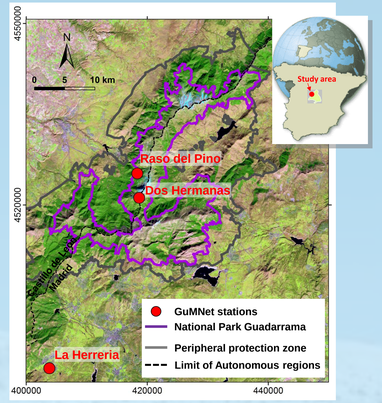


Fig. 1. Location of study sites.

METHOD

At each station, a site specific geomorphological description, soil profile description and sampling was carried out (Schoeneberger *et al.*, 2012). In the high mountain area information was obtained for monitoring frost heave activity and downslope soil movement (Garcia-Blanco and Palacios, 2004).

Basic soil laboratory analyses are being conducted to determine the physical and chemical soil properties and classification.

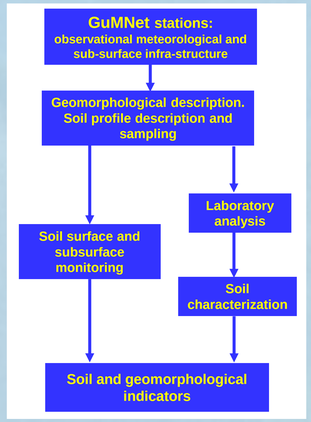


Fig. 2. Determining soil indicators

RESULTS

The soils show scarce development with *ochric* and *umbric* (Soil Survey Staff, 2014; IUSS Working Group WRB, 2015) as unique diagnostic horizons (Fig. 3-5).

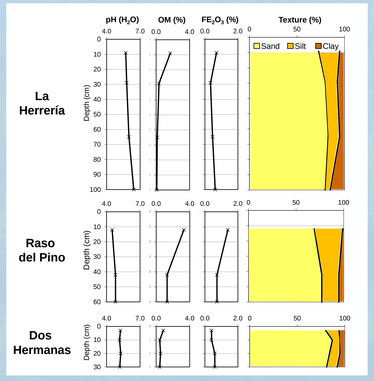
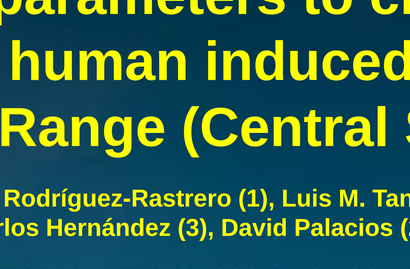


Fig. 6. Selected soil properties.



BRIEF PROFILE DESCRIPTION

A (0-18 cm): mineral; poorly structured and hard; few roots and pores. Moderately acid; poor in organic matter.

C_1 (18-40 cm): mineral; structureless and loose; >60% rock fragments; few roots. Moderately acid, very poor in organic matter.

C_2 (40-90 cm): mineral; structureless and loose; 40% rock fragments. Moderately acid.

C_3 (>90 cm): mineral; massive and very friable; few yellowish-brown mottles and iron-oxide soft nodules. Slightly acid.

SITE LOCATION

Toponym: La Herrería
Altitude: 925 m.a.s.l.
UTM easting: 0403818; ***northing:*** 4492995

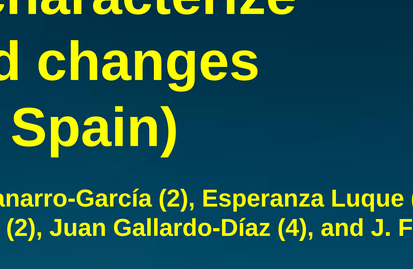
SOIL FORMING FACTORS

Relief: plain; lower slope; gradient: <2%
Vegetation: grassland
Parent material: alluvial-colluvial (gneiss-granite)
Climate (average annual P/T) and drainage: 884 mm/13.1°C ; moderate to well drained

SOIL CLASSIFICATION (preliminary)

Soil Taxonomy (Subgroup): *Typic Xerorthent (Soil Survey Staff, 2014)*
WRB-FAO (RSG with principal qualifiers): *Dystric Regosol (IUSS Working Group WRB, 2014)*

Fig. 3. La Herrería soil description.



BRIEF PROFILE DESCRIPTION

O (2-0 cm): Organic. Slightly altered scots-pine needles

A (0-24 cm): mineral; moderately structured and slightly hard; many roots and pores. Very strongly acid; moderately rich in organic matter ;

CB (24-60 cm): mineral; weakly structured and soft; >50% rock fragments; few roots. Very strongly acid; poor in organic matter.

R (>60 cm): slightly altered gneiss rock.

SITE LOCATION

Toponym: Raso del Pino II
Altitude: 1802 m.a.s.l.
UTM easting: 0418353; ***northing:*** 4525207

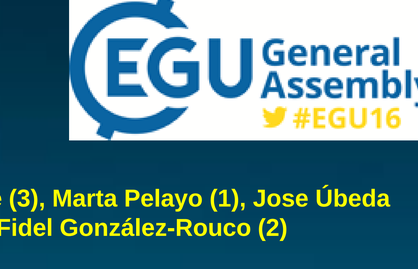
SOIL FORMING FACTORS

Relief: mountainous; upper slope; gradient: 15–30%
Vegetation: Scots-pine woodland
Parent material: gneiss
Climate (average annual P/T) and drainage: 1223 mm/6.9°C ; well drained

SOIL CLASSIFICATION (preliminary)

Soil Taxonomy (Subgroup): *Entic Humudept (Soil Survey Staff, 2014)*
WRB-FAO (RSG with principal qualifiers): *Leptic Umbrisol (IUSS Working Group WRB, 2014)*

Fig. 4. Raso del Pino soil description.



BRIEF PROFILE DESCRIPTION

A (0-6 cm): mineral; weakly structured and very friable; sandy texture; >25% rock fragments; many roots and pores. Strongly acid; poor in organic matter.

AB (6-14 cm): mineral; weakly structured and very friable; sandy texture; >40% rock fragments; common roots and pores. Strongly acid; very poor in organic matter.

C_1 (14-26 cm): mineral; structureless and loose; >50% rock fragments; few roots. Strongly acid, very poor in organic matter.

C_2 (26-40 cm): structureless and loose; >80% rock fragments. Strongly acid.

R (>40 cm): slightly altered gneiss rock.

SITE LOCATION

Toponym: Dos Hermanas
Altitude: 2231 m.a.s.l.
UTM easting: 0418673; ***northing:*** 4521170

SOIL FORMING FACTORS

Relief: mountainous; upper slope; gradient: 30-50%
Vegetation: psicroxerophilous grassland
Parent material: gneiss
Climate (average annual P/T) and drainage: 1350 mm/4.8°C (estimated); well drained

SOIL CLASSIFICATION (preliminary)

Soil Taxonomy (Subgroup): *Lithic Cryorthent (Soil Survey Staff, 2014)*
WRB-FAO (RSG with principal qualifiers): *Dystric Leptic Skeletic Regosol (IUSS Working Group WRB, 2014)*

Fig. 5. Dos Hermanas soil description.

These soils are strongly or moderately acid, which is favored by abundant rainfall and a parent material like gneiss and associated deposits. Under similar conditions of lithology, other soil forming factors such as geomorphology, climate and land use, provide differences in soil properties (*Fig. 6*) with regard to organic matter content and characterization which constitutes the main objective of a pedological monitoring.

Along with the intrinsic characteristics of the soils (*Fig. 6*), CO_2 emissions, moisture and temperature are basic factors related with soil carbon dynamics. The presence of pollutants like heavy metals, associated to emissions from urban areas, are considered as an indicator of soil degradation.

Geomorphological features of interest are mainly related to those that favor erosion and degradation processes and in this case shallow mountain soils are most at risk.

FUTURE TASKS

The soil and geomorphological parameters constitute a basis for site characterization in future studies regarding soil degradation; interaction between soil, vegetation and atmosphere with respect to human induced activities (e.g. atmospheric contamination and effects of fires); contributing to the knowledge of the carbon cycle, and the influence of heavy metal contaminants in the soils.

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ACKNOWLEDGEMENTS

This research is within the framework of Infrastructure GuMNet (Guadarrama Monitoring Network) funded by the International Campus of Excellence, Campus Moncloa through the CAIMON 2010 call. The authors acknowledge the support of the Parque Nacional de la Sierra de Guadarrama, Patrimonio Nacional (Servicio de Jardines y Montes, Dirección de Inmuebles y Medio Rural).

Background image: Etor Lucio (GUMNET, March-2014)