

## Pedofoms mapping at the Águas Emendadas Ecological Station, Distrito Federal, Brazil.

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### Abstract

The great urban and rural development of the Distrito Federal (Federal Administrative District) in Brazil over the last 50 years has led to disordered land use and land occupation. To assess the current environmental scenario, detailed surveys of the available natural resources, especially soils, are required. The objective of this work was to evaluate the soils-landscape relations in a representative area of the region, the Águas Emendadas Ecological Station, and map its soil forms (pedofoms) using geotechnologies. The geographical distribution of the soils in the regional landscape was modelled according to the geological, geomorphological and pedological relations observed in the field. Based on this model, the available geological and geomorphological maps of the Distrito Federal, along with the Digital Terrain Model (DTM) and slope classification map produced in this work, were used to map the pedofoms. For the scale used in this work, the resulting pedofoms map was considered adequate and can subsidize detailed soil studies and environmental planning.

### Key Words

Soil digital mapping, pedogenesis, soils geography modeling, geoforms, geoprocessing.

### Introduction

The assessment of regional geology, geomorphology and pedology (pedomorphogeological) interactions can subsidize pedofoms mapping in relation to parent material. This makes it an essential component of pedogenetic studies, providing important information for predicting soil physical, chemical and mineralogical attributes. At the Águas Emendadas Ecological Station (ESECAE), an environmental conservation unit located in the NE portion of the Distrito Federal (Brazilian Federal Administrative District), the distribution of the different soil classes results from soil forming processes associated to the landscape's geomorphological evolution, both of which are controlled mainly by the geological substract. The ESECAE presents the main soil classes that occur in the Distrito Federal. However, the main source of information available on the geography of these soils is still the survey issued by the National Soil Survey Service at reconnaissance level (scale 1:100,000) in 1978 (Embrapa 1978). Recently, more detailed studies have been carried out, providing data that contribute to the understanding and interpretation of the region's soil distribution.

According to Freitas-Silva and Campos (1998), the ESECAE area is composed by rocks of the Paranoá Group: Unit **R<sub>3</sub>** - Sandy Metarhythmites, Unit **Q<sub>3</sub>** - Medium Textures Quartzites, Unit **R<sub>4</sub>** - Loamy Metarhythmites and Unit **PPC** - Carbonated Shale Rocks; which occupy 97% of the area, and rocks of the Canastra Group (chlorites schists and moscovite-quartz-schists), which represent the remaining 3%.

The geomorphological model used in this work was described by Martins and Baptista (1998), who discriminated the following geomorphological units in the DF: 1) High Plateau: flat surfaces; altitudes above 1135 m; 2) Intermediate Planes (Borders and Scarps): surfaces with different dissection levels, altitudes between 1080 and 1135 m; and 3) Plains: more recent dissection features, altitudes below 1080 m.

Geotechnologies have improved the cartographic representation of the dynamics of a landscape's natural resources, supporting environmental surveying, mapping and monitoring. Examples of the efficiency of geotechnologies in the characterization of landscape attributes related to soil distribution, based on digital terrain analysis are the works of Moore et al (1993). In Brazil, among the researchers working in this field, Ippoliti et al (2005) used Digital Terrain Models as a basis for soil survey and pedofom mapping. Combining geological data with geomorphological characterization information facilitates the identification

of the attributes of the soils formed, providing a sound basis for soil survey, and the preliminary mapping of a region's soil classes (Ippoliti et al. 2005; Lacerda et al. 2009).

The objective of this work was to determine the geomorphology, geology and soil distribution relations in the Águas Emendadas Ecological Station's landscape and map pedoforms using geotechnologies.

## Methods

The existing geomorphological, geological and pedological information on the DF, along with the corresponding thematic databases, were gathered. The SICAD-DF database's topographic maps at the scale 1:10,000 were used as reference material. Field surveys were carried out to observe the geological and geomorphological units and corresponding soil classes, to determine the related geoforms and pedoforms. Representative soils profiles of the different pedoforms were described according to Santos et al. (2005). Soil samples were taken for chemical and physical analyses and the soils were classified in compliance with the Brazilian Soil Classification System (Embrapa, 2006). These soil profiles were georeferenced using a Garmin IV GPS.

Using the ArcGis 9.1 software a digital database was created to input the 1:10,000 SICAD-DF topographic maps and the available geological and geomorphological maps. The ArcGis 9.1 3D Analyst module was used to obtain a DTM, which was reclassified into 3 altitude classes: 1.160 – 1.195m, 1.045 – 1.160 m and 935 – 1.045 m, respectively named High Plateau Geomorphic Unit, Intermediate Planes Geomorphic Unit (Scarps or Borders) and Vereda Valley Geomorphic Unit as proposed by Martins e Baptista (1998), in the ESECAE geomorphological surfaces map obtained in this work.

The slope classes map was also obtained from de DTM using the same software. This map was reclassified into 5 slope classes: 0-2%, 2-5%, 5-8%, 8-12% and 12 - >45%, which are directly related to the soil classes observed in the study area.

In compliance with the soil distribution model's criteria, the soil characterization and classification information and their association to the geological substrate, the geomorphological surfaces map and the slope classes' map were overlaid to obtain the ESECAE pedoforms map.

## Results

In the Águas Emendadas Ecological Station, Typic Rhodustox were observed on the flat to smooth sloping surfaces, over psamo-pelitic rocks of the Paranoá and Canastra Groups. These soils are correlated to the High Plateau and Borders Geomorphic Units, in the east portion of the study area. The Typic Rhodustox is also distributed in the Intermediate Planes Geomorphic Unit in the central-west portion of the area, usually along the drainage network.

Associated to this oxisol, Typic Haplustox, usually petroplinthic to concretionary (Plintustox), occur. These are similar to the Typic Haplustox with a predominance of goethite over hematite. This predominance is due to this mineral's greater stability under the poor internal drainage of the soil profile as a result of the presence of petroplinthites. In the study area the Typic Haplustox occupy flatter surfaces with slightly higher slopes than the Typic Rhodustox, especially in the High Plateau Unit at the east portion of the area, which corresponds to the Borders Geomorphic Unit – Sub-unit Notched Borders. The corresponding geology is represented by lithostratigraphic units of the Paranoá and Canastra Groups. These soils are characterized by the presence of petroplinthites, which can constitute a diagnostic horizon, and are important for the regional geomorphological evolution. Currently, the ferruginous concretions persist on the borders of the High Plateaus of the Scarps Geomorphic Unit in the NE portion of the study area.

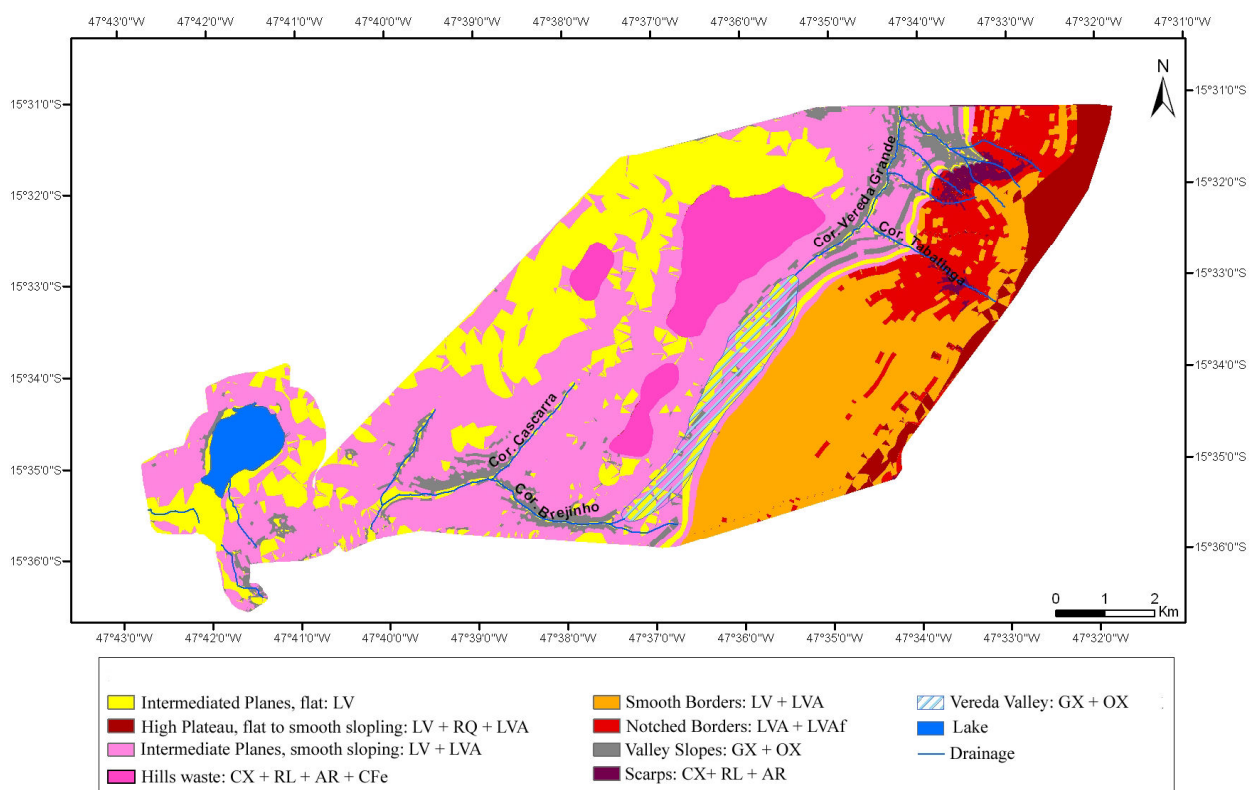
Typic Haplustent also occur in environments similar to the Oxisols, but heavily influenced by the geological substrate constituted by Q3 Unit Medium Textures Quartzites and R3 Unit Sandy Metarhythmites of the Paranoá Group. These lithologies occur in the east portion of the ecological station, coinciding with the development of the High Plateau Geomorphic Unit.

The Hydromorphic soils occur in the ESECAE landscape in association with Vereda Valley Geomorphic Unit, constituting large low flat areas in which drainage has been recently implanted. Concretionary Plintustox and Typic Plintustox are also observed. The former appear in the vast areas along the Vereda

Valley Geomorphic Unit while the latter occupy the smooth slope valleys where hydromorphism is minimized.

In the Scarps Geomorphic Unit, where slope degrees are higher Haplustept and Haplustent, usually Dystrophic, are observed associated to surface quartzite rocks. In the ESECAE these soil classes are found in the more dissected drainages, particularly in the northeast of the area. They belong to the lithostratigraphic units Q3 (Medium Textures Quartzites) and R3 (Sandy Metarhythmites) of the Paranoá Group. These soil classes are also found, more sporadically, in the central-west portion of the ESECAE, in Hills Waste, with altitudes up to 1,065 m, along the Intermediate Planes Geomorphic Unit.

The relations between soils and pedoforms of the study area could be established and are presented in Figure 1. The pedoforms suggested for the ESECAE are described below:



**Figure 1.** Map of the Águas Emendadas Ecological Station's pedoforms.

**- High Plateau, flat top (plateaus) to smooth sloping: LV + RQ + LVA**

East portion of the area, High Plateau Geomorphic Unit, with altitudes between 1,160 and 1,195 m, predominantly flat relief, 0 to 2% slope class: Typic Rhodustox (LVd).

In the northeast and southeast portions of this pedoform the geological substrate must be correlated, as a function of the more superficial presence of quartzite of the Lithostratigraphic Unit **Q3** (Medium Textures Quartzites) and **R3** (Sandy Metarhythmites) of the Paranoá Group: Typic Troppsammet (RQ). Portions of the pedoform with slope classes of 2 to 5%: Typic Haplustox (LVAd).

**- Smooth Borders: LV + LVA**

Central-southeast portion of the area, Smooth Borders Geomorphic Unit, with altitudes varying between 1,045 and 1,160 m, 2 to 5% slope: Association of Typic Rhodustox (LVd) + Typic Haplustox (LVAd).

**- Notched Borders: LVA + LVAdf**

Central-northeast portion of the area, Notched Borders Geomorphic Unit, with altitudes varying between 1,045 and 1,160 m, slopes between 5 to 8%: Association of Typic Haplustox (LVAd)+ Plinthic Haplustox (LVAdf).

**- Scarps: CX + RL + AR**

Northeast portion of the area, Scarps Geomorphic Unit, with altitudes varying between 1,160 and 1,195 m, slope class of 12% to > 45%: Association of Typic Haplustept (CXTbd) + Typic Haplustent (RLd) + Rocks

(AR).

**- Intermediate Planes, flat: LV**

Central-west portion of the area, Intermediate Planes Geomorphic Unit, with altitudes varying between 935 and 1,045 m, slopes between 0 and 2%: Typic Rhodustox (LVd).

**- Intermediate Planes, smooth sloping: LV + LVA**

Central-west portion of the area: Intermediate Planes Geomorphic Unit, altitudes between 935 and 1,045 m, slope class of 2 to 8%: Association of Typic Rhodustox (LVd). + Typic Haplustox (LVAd).

**- Vereda Valley: GX + OX**

Central portion of the area, Vereda Valley Geomorphic Unit, with average altitudes of 1,035 m, slopes between 0 and 2%, reaching up to 5%: Histosols (GX + OX).

**- Valleys Slopes: FX + FF + LVAf + CX**

Borders of drainage valleys, Intermediate Planes Geomorphic Unit, slopes reaching up to 45%: Association of Typic Plintustox (FX) + Concretionary Plintustox (FF) + Plinthic Haplustox (LVAdf).+ Typic Haplustept (CXTbd).

**- Hills Wast: CX + RL + AR + CFe**

Intermediate Planes Geomorphic Unit, altitudes reaching 1,065 m, slope between 2 to 5%, and higher in some places: Typic Haplustept (CXTbd) + Typic Haplustent (RLd) + Rocks (AR) + Ferruginous Concretions (CFe).

## Conclusion

Based on the assessment of the pedomorphogeological relations it was possible to model the distribution of geoforms and associated pedoforms of the study area. From this model, the pedoforms of the Águas Emendadas Ecological Station were mapped. The resulting map constitutes a detailed database that can be used for sustainable environmental studies and planning in the Distrito Federal.

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