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SOI: 1.1/TAS DOI: 10.15863/TAS

International Scientific Journal

Theoretical & Applied Science

p-ISSN: 2308-4944 (print) **e-ISSN:** 2409-0085 (online)

Year: 2018 **Issue:** 11 **Volume:** 67

Published: 30.11.2018 http://T-Science.org

QR – Issue QR – Article

SECTION 13. Geography. History. Oceanology. Meteorology.

R. Kravchenko
Ph.D., Universidad UTE,
Quito, Ecuador
roman.kravchenko@ute.edu.ec

M. Rosero
Universidad UTE,
Quito, Ecuador
mary.rosero@ute.edu.ec

ERODED SOILS OF A EASTERN EXPOSURE SLOPE IN THE NORTHERN PART OF QUITO, ECUADOR

Abstract: *The eroded soils of the eastern exposure slope with a steepness of 15-25 ° in the equatorial Andes were studied. Organic matter in soils does not exceed 1.06%. It is established that the content of organic matter depends on the site and the shape of the slope. Concave parts, as well as a sector in the upper part of the slopes, are characterized by the presence of soils with the highest content of organic matter. Whereas the soils on the convex parts of the slope contain a smaller percentage of organic matter. All parts of the slope have a low content of Nitrogen and Phosphorus.*

Key words: *soil, slop, erosion, organic matter.*

Language: *English*

Citation: Kravchenko, R., & Rosero, M. (2018). Eroded soils of a eastern exposure slope in the northern part of Quito, Ecuador. *ISJ Theoretical & Applied Science, 11 (67),* 205-208.

Soi: http://s-o-i.org/1.1/TAS-11-67-33 ***Doi***: crossref https://dx.doi.org/10.15863/TAS.2018.11.67.33

Introduction

The soil of the slopes in the areas of humid climate develop under the conditions of active influence of water-erosion processes. Within one site it is possible to observe differences in the properties of eroded soils, depending on the shape and steepness of the slope. A number of papers have been devoted to the study of these features [1- 7].

The eroded sloping soils of the equatorial Andes are not studied thoroughly, especially considering the different approaches to classification. In this geographic area there is a very significant diversity of natural conditions, even in geographically close areas located at the distance of the first kilometers and even hundreds of meters. Soil-forming rocks, microclimate and water regime can vary.

The purpose of this work is a comparative characteristic of eroded soils, depending on the angle of inclination and the shape of the slope of the eastern exposure in the equatorial Andes.

Materials and methods

Large-scale topographic maps and aerial photographs were used to select the key area. A field study was conducted in 2018. The DGT 10 CSTBERGER / Digital theodolite was used to study the morphometric characteristics of the slopes soil samples were taken. Soil analysis was performed at the Agrocalidad Laboratory in Quito. Meteorological indicators are obtained according to the “Instituto Nacional de Meteorología e Hidrología del Ecuador”.

Results and discussion

The study was conducted in the mountain-equatorial part of the Andes, in the area located on the northern outskirts of the city of Quito, near the village Zabala. The altitude is 2400 - 2800 meters. The slopes are covered with modern loose, easily eroded sediments. Significant elevation differences and slope angles create the necessary conditions for the formation of both downcutting and sheet erosion forms. General view of the slope is presented in the photo.

Figure 1. Study area. Eastern exposure slope.

The average temperature is 14 ° C and varies slightly over the months. Atmospheric precipitation falls in liquid form, with a significant proportion of heavy rain. The average annual rainfall is about 700 mm. The maximum amount of precipitation is marked in April. The minimum precipitation falls in August. In general, the territory is characterized by favorable prerequisites for the development of erosion processes.

Table 1. SOIL CHARACTERISTICS OF THE ESTERN–EXPOSURE SLOPE

Parameters		Sector 1 Slope angle 18° Distance from the watershed divide 34 m Straight shape of the slope	Sector 2 Slope angle 24° Distance from the watershed divide 103 m Straight shape of the slope	Sector 3 Slope angle 25° Distance from the watershed divide 158 m Convex shape of the slope	Sector 4 Slope angle 20° Distance from the watershed divide 215 m Concave shape of the slope	Sector 5 Slope angle 24° Distance from the watershed divide 336 m Convex shape of the slope	Sector 6 Slope angle 25° Distance from the watershed divide 458 m Straight shape of the slope	Sector 7 Slope angle 15° Distance from the watershed divide 748 m Concave shape of the slope
Organic matter (%)		1,01	0,95	0,66	1,06	0,70	0,90	0,57
Nitrogen (%)		0,05	0,05	0,03	0,05	0,04	0,05	0,03
Phosphorus (mg/kg)		9,6	9,7	9,5	6,7	6,4	7,3	6,1
Potassium (cmol/kg)		0,45	0,25	1,39	0,28	0,72	0,28	1,01
Calcium (cmol/kg)		7,07	5,53	15,65	6,03	15,44	7,70	20,06
Magnesium (cmol/kg)		3,50	1,70	2,52	1,50	2,02	1,27	2,28
Iron (mg/kg)		45,1	34,5	23,1	34,3	23,4	28,5	22,1
Manganese (mg/kg)		1,47	1,77	0,72	0,76	0,53	1,14	0,48
Copper (mg/kg)		8,85	12,80	4,17	8,21	4,30	7,28	4,10
Zinc (mg/kg)		<1,60	<1,60	<1,60	<1,60	<1,60	<1,60	<1,60
pH		7,87	7,68	9,07	8,33	9,30	8,12	8,40
Textures	Sand (%)	62	66	46	70	60	62	56
	Silt (%)	26	24	46	20	30	30	34
	Clay (%)	12	10	8	10	10	8	10

The most part of the slope has a straight shape, with separate sections of convex and concave shapes. The slope is steeply inclined. In a slope ecosystem, the following plant species are typical: Croton wagneri, Dodonea Viscosa, Agave americana L., Kalanchoe fedtschenkoi, Festuca arundinacea. Also some specimens of woody vegetation such as Eucalyptus globulus Labill are present in the upper part of the slope.

The table shows the distance of each sampling point from the watershed divide.

The criterion for selecting the points of study was the nature of the relief of individual parts of the slope. In general, the soil content of the slope is characterized by a low content of organic matter.

A number of studies [8 - 10] were devoted to the study of erosion processes in this area. The lands of the studied slope are not used in agriculture widely represented. A line that does not intersect the gully forms was selected for the soil study. The length of the studied slope is 800 meters. The sampling points for soil samples are located in different parts of the slope, from the upper part near the watershed divide to the foot of the slope. The table presents the results of the study.

The highest rates of 1.06% were found in sector 4 on the concave slope. Probably, the concave shape of this part of the slope affects the dynamics of erosion-accumulation processes with more favorable accumulation conditions of the washed-off material. On the contrary, in areas of a slope with a convex shape (sectors 3 and 5) a reduced content of organic matter was recorded - 0.66 and 0.70%, respectively. A more active impact of soil erosion should be typical for these areas. It should be noted that a relatively high content of organic matter of 1.01% was found in sector 1. Apparently, it is influenced by the location of the site in the upper part of the slope, near the watershed with an insignificant volume of surface flowing water, which does not yet have sufficient energy to influence sheet erosion. Sector 7 at the bottom of the slope is worth a separate mention. This area has a concave shape and an inclination angle of 15 °, the minimum of all the parts of the slope studied. However, it is here that the lowest organic matter content is found - only 0.57%. This is due to the characteristics of soil-forming rocks. In the lower part of the slope there are numerous outcrops of rocks. The soil is stony and vegetation is very sparse, which has a negative effect on the accumulation of organic matter.

Soil of all parts of the slope is characterized by a very low Nitrogen content. If we use the recommendations for the interpretation of the results developed in the "Agencia Ecuatoriana de Aseguramiento de Calidad Agro", then for the mountainous region of Ecuador, a low content of Nitrogen is considered to be up to 0.15%. Content from 0.16 to 0.3% is already estimated as average. The soils of the studied slope contain only up to 0.05% Nitrogen.

A low Phosphorus content was also found for all parts of the slope.

The soils are alkaline. The potassium content is medium or high (over 0.4 cmol / kg). The maximum content of 1.39 cmol/ kg is noted for sector 3 - the convex part of the slope with a low content of organic matter. In all parts of the slope, a high content of Calcium is observed, increasing on the convex parts of the slope, reaching maximum values of 20.06 cmol / kg in stony soils of the lower part of the slope.

The soils of the slope are characterized by a high content of Magnesium and Copper. Low Zinc and Manganese content is detected. For most sectors, the average Iron content is confirmed, except for the high content at the top of the slope.

Conclusions

The soils of the eastern slope surveyed in the equatorial Andes are eroded and not fertile. The content of organic matter does not exceed 1.06%. It is established that the content of organic matter depends on the site and the shape of the slope. Concave parts, as well as a sector in the upper part of the slopes, are characterized by the presence of soils with the highest content of organic matter. Whereas the soils on the convex parts of the slope contain a smaller percentage of organic matter. All parts of the slope have a low content of Nitrogen and Phosphorus.

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