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ERODED SOIL OF THE SLOPE OF WESTERN EXPOSURE NEAR THE SETTLEMENT ZABALA, PICHINCH PROVINCE, ECUADOR

Summary. *The soils of the western exposure slope in the equatorial Andes have been studied. The soils have been found to have low content of organic matter, not exceeding 0.49%. There is also a lack of Nitrogen and Phosphorus. The soils on the slope of the concave shape have a greater content of organic matter, compared to the sectors of the convex shape. Soils are eroded and have low fertility.*

Key words: *soil, slop, erosion.*

The study of soils losing their fertility as a result of erosion processes is one of the most urgent problems from the point of view of both theoretical and applied aspects. The peculiarity of the equatorial Andes lies in the diversity of the prerequisites for the development of erosion processes and the formation of eroded soils even within spatially close territories.

The study of soil differences depending on the angle of inclination, shape, length, and exposure of the slopes seems to be significant, for these aspects of equatorial Andes have not been studied thoroughly. This also concerns processes of linear and sheet erosion as a factor in soil degradation.

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 western exposure of the key area under study.

The study was conducted in 2018 at a site located in the equatorial Andes in the northern outskirts of the city of Quito, near the village of Zabala, in the province of Pichincha. The altitude is 2400–2800 meters. The slopes are covered with modern loose, easily eroded sediments.

According to the Instituto Nacional de Meteorología e Hidrología del Ecuador, 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 territory is characterized by favorable prerequisites for the development of erosion processes. A number of studies [1–3] were devoted to the study of erosion processes and eroded soils in this area.

The lands of the studied slope are not used in economic activities. The slope is 230 meters long with alternating sections of concave, convex and straight shapes. The slope angle varies from 9 to 18°. The foot of the slope adjoins the outskirts of the village Zabala. Linear forms of erosion on the studied slope are hardly present, with the exception of some inactive shallow furrows.

The following plant species are typical in the upper slope ecosystem: Croton wagneri, Kalonchoe fedtschenkoi, panicum prionitis, but vegetation is sparse.

Eucalyptus globulus Labill, croton wagneri, panicum prionitis dominate in the middle part of the slope. The following species dominate the lower part of the slope: Eucalyptus globulus Labill, croton wagneri, panicum prionitis.

General view of the slope is presented in the photo (Fig. 1).

The sampling points of soil are located in different parts of the slope, from the upper part, near the watershed, to the foot of the slope. The criterion for selecting the points of study was the nature of the relief of individual parts of the slope.

The table presents the results of the study.

The soil of the studied slope is characterized by a very low content of organic matter. In general, low

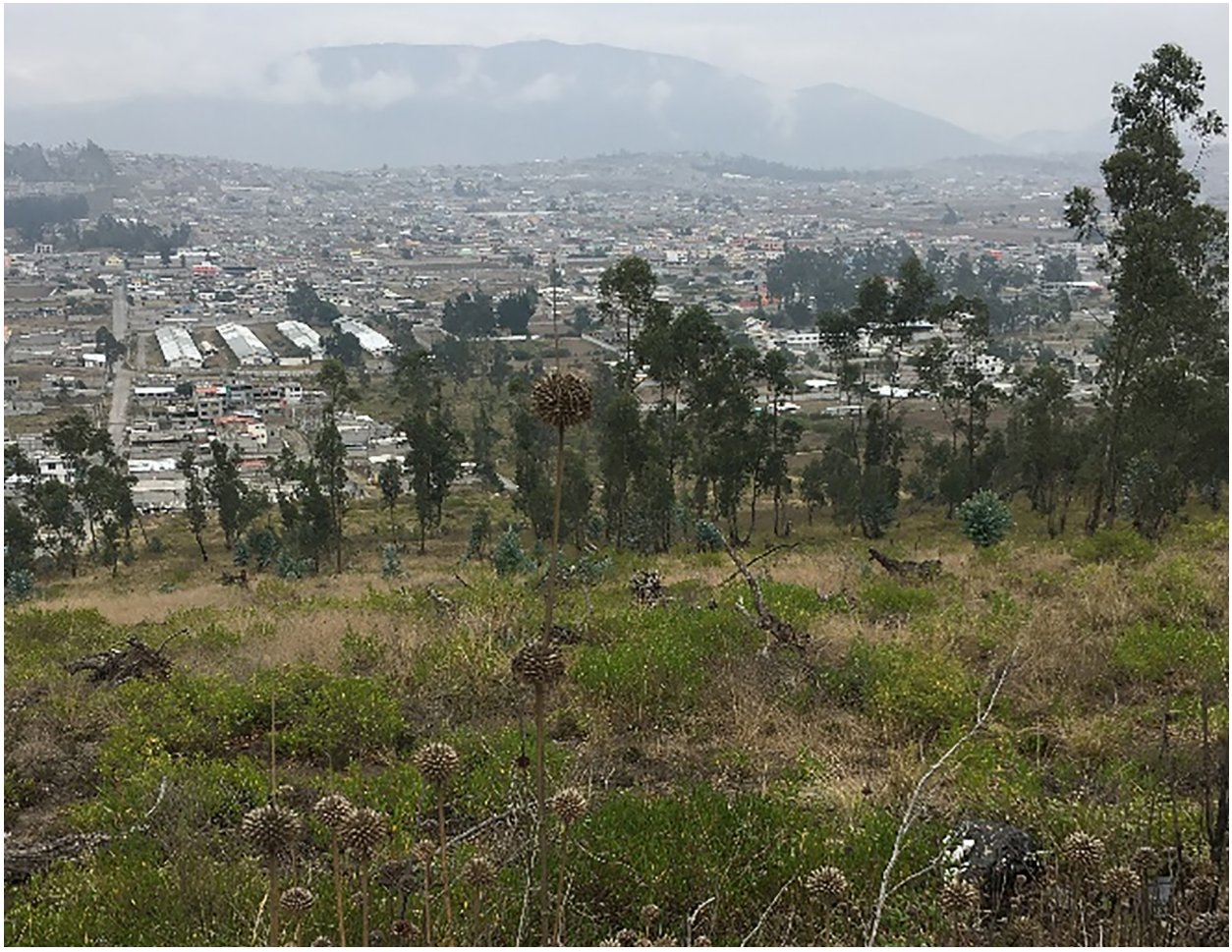

Fig. 1. Study area. Western exposure slope

content of organic matter in the humus horizon of the soil is typical for the slopes of the Ecuadorian Andes. In particular, according to the interpretation of "Agencia Ecuatoriana de Aseguramiento de Calidad Agro" in this territory these indicators are estimated as follows: organic matter above 2% is already considered as high; from 1 to 2% — the average level and less than 1% — a low level.

However, even among the poor soils of this region, indicators obtained for the upper part of the slope (0.05 and 0.09%) look extremely low. In this part of the slope, landslide processes in the upper part of the soil are observed.

It should be noted that there are differences depending on the part and shape of the slope. Thus, the lowest content of organic matter was found for the convex part of the slope (0.05%), whereas the slope of the concave shape in its lower part is characterized by the highest rates of 0.49%. This is probably the result of the influence of the shape of the slope on the dynamics of erosion-accumulative processes. The concave part of the slope creates more favorable prerequisites for the accumulation of the washed-off material and somewhat reduces the activity of sheet erosion of the upper soil horizon. Analyzing textures, we can observe a lower percentage of sand for this part of the slope with a larger share of silt compared to other sectors.

The soils on all sectors of the slope are extremely poor in Nitrogen and Phosphorus. Low content of Potassium is noted for sectors 1 and 5; average for sectors 2 and 3, and high for the concave part of the slope in sector 4. Also for sector 4, a high Calcium content was found, with an average level for other parts of the slope. A high level of Magnesium and Copper is typical for all sectors.

The soil over the entire length of the slope was found to have a low content of Iron, Manganese and Zinc. It can also be noted that the concave sector 4 contains higher percentage of Manganese and Copper compared to other parts of the slope.

In conclusion, we can say that the slope under study contains low amount of organic matter, not exceeding 0,49%. Soils of the slope in its concave parts are found to have more organic matter in comparison to convex parts of the slope.

The soils of the slope are extremely poor in Nitrogen and Phosphorus, as well as Iron, Manganese and Zinc. High content of Copper and Magnesium is typical of all parts of the slope.

The soils are eroded and have very low fertility.

Table 1

Soil characteristics of the western-exposure slope

Parameters		Sector 1 Slope angle 14° Distance from the watershed divide 20 m Convex shape of the slope	Sector 2 Slope angle 18° Distance from the watershed divide 71 m Straight shape of the slope	Sector 3 Slope angle 18° Distance from the watershed divide 95 m Straight shape of the slope	Sector 4 Slope angle 15° Distance from the watershed divide 131m Concave shape of the slope	Sector 5 Slope angle 9° Distance from the watershed divide 202 m Straight shape of the slope
Organic matter (%)		0,05	0,09	0,20	0,49	0,42
Nitrogen (%)		—	—	0,01	0,02	0,02
Phosphorus (mg/kg)		< 3,5	< 3,5	< 3,5	< 3,5	< 3,5
Potassium (cmol/kg)		0,18	0,25	0,35	0,42	0,17
Calcium (cmol/kg)		2,21	2,59	2,27	4,51	2,28
Magnesium (cmol/kg)		0,88	1,17	1,39	2,42	1,07
Iron (mg/kg)		<15,0	<15,0	<15,0	<15,0	<15,0
Manganese (mg/kg)		0,47	0,76	1,30	4,03	1,57
Copper (mg/kg)		5,26	6,25	8,82	9,70	5,61
Zinc (mg/kg)		<1,60	<1,60	<1,60	<1,60	<1,60
pH		7,38	7,54	7,24	7,59	6,40
Textures	Sand (%)	68	70	64	52	70
	Silt (%)	20	16	24	36	20
	Clay (%)	12	14	12	12	10

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