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COMPARATIVE ANALYSIS OF THE ERODED SOILS ON THE SLOPES OF THE CALDERON REGION, ECUADOR

СРАВНИТЕЛЬНАЯ ХАРАКТЕРИСТИКА ЭРОДИРОВАННЫХ ПОЧВ НА СКЛОНАХ В РАЙОНЕ КАЛЬДЕРОН, ЭКВАДОР

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Abstract. The paper presents the comparative analysis of the eroded soils on slopes. The analysis is based on the materials of field investigations and soil erosion loss models. The developed and earlier approved mathematical soil erosion models proved not to be effective for the Equatorial Andes zone. The results, in relative measurements, may be taken into consideration only as the prerequisites for potential soil erosion loss and be primarily used to support the choice of a key–site for field investigations.

The slope soils vulnerable to erosion were investigated. It is revealed that the soils are poor in organic matter, nitrogen, phosphorus and potassium. The comparative analysis of the soils on the steep slopes indicated insignificant change of their characteristics in accordance with the slope angle inclination.

Аннотация. Проведена сравнительная характеристика эродированных почв на склонах. Использовалось материалы полевых исследований и моделей эрозионных потерь. Применение разработанных и апробированных математических моделей смыва почв нельзя признать эффективным для зоны экваториальных Анд. Эти результаты можно рассматривать лишь как предпосылки потенциальных потерь почв от водной эрозии и измерять в относительных показателях, используя, прежде всего, как основу для выбора ключевых участков полевых исследований.

Изучены почвы, расположенные на склонах подверженных воздействию водной эрозии. Выявлено, что почвы бедны органическим веществом, азотом, фосфором и калием. Сравнительная характеристика земель на склонах разной крутизны показала незначительные изменения свойств почв как на круто наклонных, так и на относительно слабонаклонных участках.

Keywords: erosion, soil, slope.

Ключевые слова: эрозия, почва, склон.

Soil degradation caused by water erosion — one of the global burning problems — is studied primarily by agricultural and geographical sciences. The rate of the lands withdrawn from agriculture increases annually. The diversity of the perquisites for soil erosion in neighboring territories lying some kilometers or even hundreds of meters from one another is one of the peculiar characteristics of the Equatorial Andes alongside with the necessity to protect the farming lands from erosion, return degraded lands to farming and expand agricultural territories due to new areas never used before. It becomes even more important under the circumstances of social and economical situation and population growth. The aims of the research are to estimate the spatial distribution of the potential erosive risks and to compare eroded soils in accordance with the slope angle inclination.

Materials and Methods

The preliminary information was gathered by means of topographical plans, different age aerial photography, meteorological data provided by *Instituto Nacional de Meteorología e Hidrología del Ecuador (http://www.serviciometeorologico.gob.ec/)*. Mathematical model USLE / RUSLE was used. ArcGIS software was applied to receave the cartographical data of spatial distribution of the sectors with different rates of the potential soil erosion loss. Field investigations were carried out. Theodolite DGT 10 CSTBERGER/Digital was employed to investigate the slope morphometric characteristics. Soil samples were collected. The soil sampling analysis was carried out at the laboratory "*Agrocalidad*", Quito.

Results and Discussion

The investigation was carried out in the mountain area of the Equatorial Andes, The Republic of Ecuador. The key–site lies in the sub-equatorial area of the province of *Pichincha*, located in the administrative–territorial formation of *Calderon*, with elevation 2500–2800 meters above sea level. The slopes are mainly covered with recent sediments, soft and erodible. The mean temperature is 14 °C, slightly varying through the months. The average annual precipitation for the region is 700–800 mm. Liquid forms of precipitation prevail with a considerable proportion of rainfall. The greater part of precipitation is to fall in April. The erosive processes in the area have already been investigated, the results being presented in a number of research papers [1–3]. In general, the territory is characterized to be susceptible to erosion due to some key factors. The soils, being greatly eroded, are poor in organic matter. The lands of the key–site chosen for soil sampling are not used for farming. The investigation field is presented on Figure 1.

The soil loss analysis was performed using a wildly–accepted method of model USLE / RUSLE. The model includes such characteristics as topographic features (slope length and steepness), soil erodibility, rainfall erosion index, ground cover.

Earlier developed mathematical soil loss models [4–5] are still used, in Latin America as well [6–7]. ArcGIS software allowed receiving the information on the spatial distribution of the sectors with different rates of the potential soil loss due to erosion.

However, the previous researches [8] provide the conclusions that the soil erosion loss data received by using the mathematical model do not coincide with the field investigation results and appear to be overstated for steeply inclined slopes of the Equatorial Andes. Thus, appreciable errors may result from using the mathematical models developed for other natural conditions.

In this connection, the authors consider it inexpedient to determine average rate of soil erosion loss in absolute measures (tons per hectare annually) for such data are believed to be questionable.

The obtained results may be considered as the perquisites for soil erosion and calculated in comparative measures.

The analysis of the perquisites for potential soil loss cannot encourage either direct transmission to absolute values or theoretical or applied conclusions.

Figure 1. The investigation field. The zone of Calderon. Ecuador.

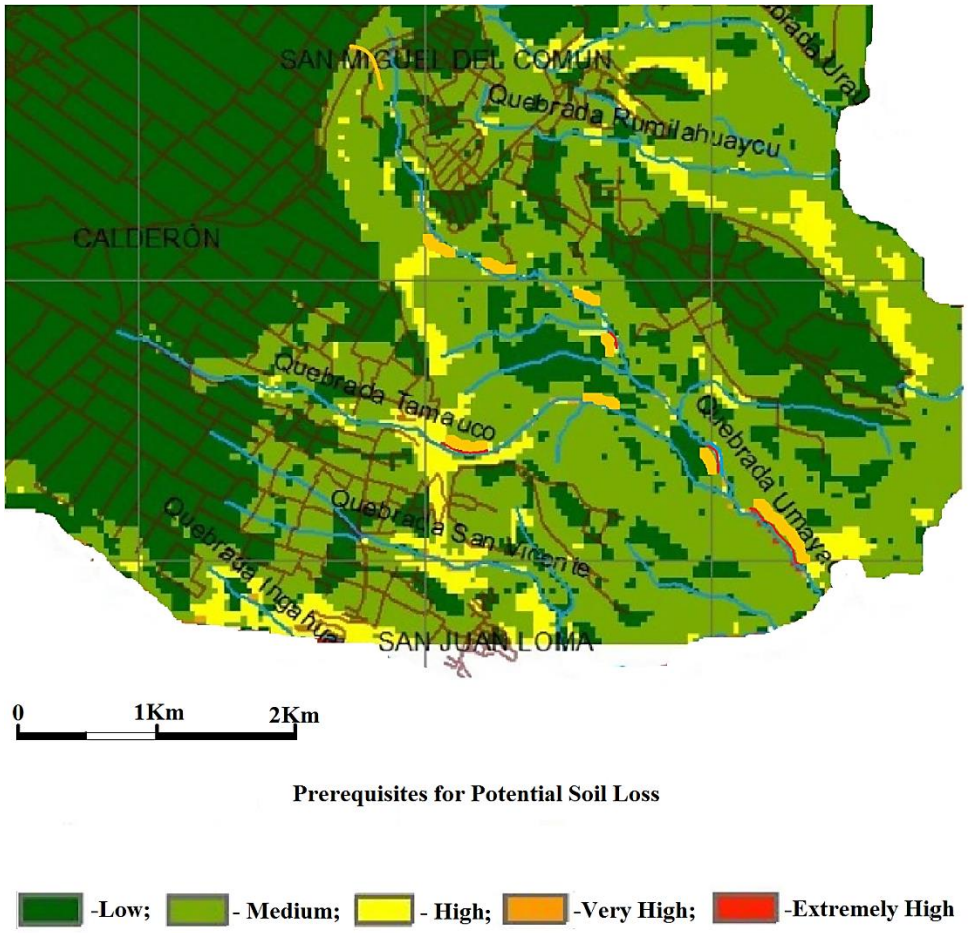

Figure 2. Prerequisites for potential soil loss. A map fragment of the Calderon zone.

Still, the received information (Figure 2) appears basic for choosing key–sites to carry out field investigations. A soil loss estimate must be produced using various methods.

A way to research the problem is to analyze the soils in accordance with the slope inclination angle. The authors carried out the investigation within one key–site boundaries. The surface soil samples were taken on south– and north–facing slopes. The results are presented in Table 1.

Table 1.

SOIL CHARACTERISTICS ON THE SLOPES OF THE KEY–SITE IN THE CALDERON ZONE

Slope exposure	*Slope angle*	*pH*	*Organic material (%)*	*Nitrogen (%)*	*Phosphorus (ppm)*	*Potassium (cmol/kg)*
North-facing	5 – 7 °	7,57	0,54	0,03	<3,5	0,13
	14–16 °	7,63	0,6	0,03	<3,5	0,04
	23–25 °	8,27	0,53	0,03	<3,5	0,17
South-facing	5 – 7 °	7,57	0,56	0,03	<3,5	0,07
	14–16 °	7,71	0,80	0,04	<3,5	0,21
	23–25 °	6,86	0,29	0,01	<3,5	0,08

The investigated soils are rather poor. The key–site is not used for farming. The obtained results are of particular interest due to the comparing of such important index as organic matter content in the samples taken on the slopes of different steepness. Particularly, the soils of the northern slope are characterized by insignificant changes. The especially remarkable fact is that the soils on the slopes with inclination angle of 5–7 ° and the ones on the steeply inclined slopes (with inclinations up to 25 °) reveal almost identical data.

Thus, the developed mathematical models used to calculate the rates of annual soil erosion loss in tons per hectare appear inapplicable in the conditions of the Equatorial Andes. Organic matter content increases slightly on the middle parts of both south and north–facing slopes. The slopes are almost straight. The middle parts of the slopes have no evident sagging.

The investigated soils are poor in nitrogen, phosphorus and potassium. Potassium content is close to the average rate of the natural zone only on the middle part of the south–facing slope.

The comparative analysis of both north and south–facing slopes proves that the degree of erosion does not differ in principle. In general, the problem of differences in the erosion process on the slopes of different exposure in the Equatorial Andes still demands detailed investigation. The complicated combination of microclimate factors within each located site necessitates the variety of results when investigating the territory on a large scale.

Conclusions

The developed and earlier approved mathematical models of soil erosion loss proved not to be effective for the Equatorial Andes zone. The results, in the relative measurements, are to be taken into consideration only as prerequisites for the potential soil loss caused by water erosion. The results could also be used as the basis to choose key–sites for field investigations.

The comparative analysis proved insignificant changes in the soil characteristics on the slopes of different inclination.

The degree of soil erosion on both north– and south–facing slopes does not differ in principle.

References:

1. Kravchenko, R. (2013). Influence of sediment from the Gullies in the development of erosion forms. *Enfoque UTE*, 4, (2), 35–44.

2. Kravchenko, R. A. (2016). Accumulation of organic matter in the linear forms of erosion in the northern part of Quito, Ecuador. 8th International Scientific and Practical Conference “Science and Society”, London, 110–114.

3. Guerrero, D. D. (2016). Análisis del desarrollo de los procesos de erosión y formas de relieve erosivas en la Parroquia de Calderón, Provincia de Pichincha: Trabajo previo a la obtención del título de Ingeniero Ambiental y Manejo de Riesgos Naturales. Quito, Universidad Tecnológica Equinoccial, 140. (In Spanish).

4. Renard, K. G., Foster, G. R., & al. (1991). RUSLE: Revised universal soil loss equation. *J. Soil and Cons.,* 46, 30–33.

5. Wischmeier, W. H., & Smith, D. D. (1978). Predicting Rainfall Erosion Losses: A Guide to Conservation Planning. Agriculture Handbook, no. 537, Washington, D. C.: United States Department of Agriculture, 65.

6. Clérici, C., García Préchac, F. (2001). Aplicaciones del modelo USLE/RUSLE para estimar Pérdidas de suelo por erosión en Uruguay y la región sur de la cuenca del Río de la Plata. *Agrociencia*, 5, (1), 92–103. (In Spanish).

7. Delgado, M. I. (2010). Modelización de la pérdida de suelo en sierras del Sudoeste de la Provincia de Buenos Aires. *Rev. FCA UNCuyo*, 42, (2), 1–14.

8. Kravchenko, R. A., Arias, V. H., & Guerrero, D. D. (2017). On the correspondence of erosional soil loss models and the results of field studies in mountain area of Ecuador. *Science and World,* 1, (2), 114–115.

Список литературы:

1. Kravchenko R. Influence of sediment from the Gullies in the development of erosion forms // Enfoque UTE. 2013. V. 4. №2. P. 35–44.

2. Kravchenko R. A. Accumulation of organic matter in the linear forms of erosion in the northern part of Quito, Ecuador // 8th International Scientific and Practical Conference “Science and Society”. London, 2016, P. 110–114.

3. Guerrero D. D. Análisis del desarrollo de los procesos de erosión y formas de relieve erosivas en la Parroquia de Calderón, Provincia de Pichincha: Trabajo previo a la obtención del título de Ingeniero Ambiental y Manejo de Riesgos Naturales. Quito: Universidad Tecnológica Equinoccial, 2016. P. 140.

4. Renard K. G., Foster G. R. et al. RUSLE: Revised universal soil loss equation // J. Soil and Cons. 1991. V. 46. P. 30–33.

5. Wischmeier W. H., Smith D. D. Predicting Rainfall Erosion Losses: A Guide to Conservation Planning. Agriculture Handbook. №537. Washington, D. C.: United States Department of Agriculture, 1978. 65 p.

6. Clérici C., García Préchac F. Aplicaciones del modelo USLE/RUSLE para estimar Pérdidas de suelo por erosión en Uruguay y la región sur de la cuenca del Río de la Plata // Agrociencia. 2001. V. 5. №1. P. 92–103.

7. Delgado M. I. Modelización de la pérdida de suelo en sierras del Sudoeste de la Provincia de Buenos Aires // Rev. FCA UNCuyo. 2010. T. 42. №2. P. 1–14.

8. Kravchenko R. A., Arias V. H., Guerrero D. D. On the correspondence of erosional soil loss models and the results of field studies in mountain area of Ecuador // Наука и мир. 2017. Т. 1. №2 (42). С. 114–115.

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