

Geographical sciences

UDC 551.4.042

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**THE EFFECT OF GULLY EROSION ON THE FORMATION OF
SCREES AND ROCK FALLS IN THE SECTOR OF ZABALA,
PICHINCHA PROVINCE, ECUADOR**

Summary. *A study was conducted on the effect of the number and length of gullies on the development of rock falls and screes on the eastern slope near the city of Quito in the Equatorial Andes. It has been established that gullies with a length of more than 400 m have the most significant effect on the formation of rock falls and screes at the foot of the slope. The total number of gullies is not a significant factor in the development of these geomorphological processes.*

Key words: *gully, erosion, scree, rock falls, slop.*

Equatorial Andes with a diverse combination of slopes of different morphology are the territory of increased activity of geomorphological processes and associated risks.

The development of such slope processes as landslides, scree and rock fall is typical for these natural conditions. Along with these processes, linear erosion forms are widely represented.

The explored territory is located in the equatorial Andes near the northern outskirts of the city of Quito, near the settlement Zabala, Pichincha province. The altitude is 2400-2800 meters. The slopes are covered with modern loose, easily eroded sediments. In particular, according to the studies previously carried out [1], the texture of the soil at a depth of about 2 m has the following characteristics: Sand 54 %, Silt 38 %, Clay 8 %. At a depth of about 4 m - Sand 56 %, Silt 34 %, Clay 10 %. In the middle and lower parts of the slopes there are outcrops of rocks.

In the studied area, the average temperature is 14 ° C. Atmospheric precipitation falls in liquid form, with a significant proportion of heavy rain. The average annual rainfall is about 600-700 mm. The slopes reach a length of 950 m. The slope angle varies from 5 ° to 45 °. In the lower part, the slopes are usually steep. Linear forms of erosion are widespread. The territory of the slopes is not used in economic activities. A number of papers [1-5] have been devoted to the study of geomorphological risks in similar natural conditions.

A comparison was made at three key sites with similar morphometric characteristics of the slopes. The area of each site was one square kilometer. All sites are located on the same slope of the eastern exposure. Section 1 occupies the southern part of the study area. However, in spite of the similarities in the morphology of the slopes, differences in the presence of such erosion forms as gullies have been revealed.

A comparison was made of the number of rock falls and scree on the studied areas. This paper took into account the scree and rock falls in the lower part of the slope, which are important in terms of the impact on infrastructure. In particular, the paper has an assessment of the potential risk of blocking a local road at the foot of the slope. Figure shows a scree at the foot of the slope.

Fig. 1. Scree at the foot of the slope



As a rule, in this area, rock falls and scree develop simultaneously. Therefore, they were combined into one group for counting. For the analysis of linear forms of erosion, the ArcGIS 10.3 program was used based on the study of orthophotos provided by the Instituto Geográfico Militar. Further field studies of gullies, talus and rock falls were carried out. The table presents the results of a

comparison of number of gullies on a territory and the presence of rock falls and screes.

Table 1

THE RATIO OF GULLIES OF DIFFERENT LENGTHS AND POTENTIALLY DANGEROUS ROCK FALLS AND SCREE

Gullies of different length	Site 1		Site 2		Site 3	
	The number of gullies	The percentage of gullies	The number of gullies	The percentage of gullies	The number of gullies	The percentage of gullies
Up to 200 m	71	91	48	73	34	56
200 – 300 m	7	9	9	14	8	13
300 – 400 m	0	0	4	6	5	8
400 – 500 m	0	0	2	3	7	11
500 – 600 m	0	0	1	2	3	5
600 – 700 m	0	0	0	0	3	5
Over 700 m	0	0	1	2	1	2
Total	78	100	65	100	61	100
Over 400 m	0	0	4	6	14	23
The number of screes and rock falls	2		3		12	

A total of 204 gullies were counted. Section 1 is characterized by the largest number of gully forms. However, the smallest number of rock falls and screes are revealed on it.

Comparative analysis of the length of the gullies gives a different picture. Thus, in the first section, gullies with a length of more than 200 m make up only 9%, and erosional linear forms with a length of more than 400 m are not noted.

While in areas 2 and 3, gullies with a length of more than 400 m make 6% and 23%, respectively.

Also, in area 3 with the largest number of gullies over 400 m, there is a sharp increase in the number of rock falls and screes.

This is due to the fact that short gullies, as a rule, are "cavins", side branches from the main "trunk" of the gully bed. They are represented largely in the middle and upper part of the slope at smaller angles of inclination. That is why they do not have an impact on the activation of rock falls and screes at the foot of the slope.

The number of gullies of the greatest length which "cut" the slope from its foot have a significant impact on the development of rock falls and scree.

However, not only the mouth part of the gully can provoke geomorphological risks. Long gullies divide the slope into separate fragments and thereby increase the risk of loss of stability of the soil.

Conclusions: A study was conducted on the influence of the number and length of gullies on the development of potentially dangerous geomorphological processes. It has been established that the total number of gullies on a slope is not a factor increasing the risk of the formation of rock falls and scree. When comparing the three sites on the eastern exposure slope near the city of Quito in the Equatorial Andes, it was found that gullies with a length of over 400 m have the most significant effect on the formation of rock falls and scree at the foot of the slope.

References

1. Kravchenko, R., Flores, Y. G., & Pareja, E. S. (2017). The colluvial deposits in the gullies of the northern part of the Quito region, Ecuador. *Bulletin of Science and Practice*, (4), 191–195.

2. Krávchenko, R. (2013) Influencia de los sedimentos de las quebradas en el desarrollo de las formas de erosión / R. Krávchenko // Enfoque UTE. V.4, № 2. – P. 35–44.
3. Las amenazas por movimientos en masa de Colombia (2017) Bogotá, Servicio Geológico Colombiano. - p. 319.
4. Movimientos en Masa en la Región Andina: Una Guía Para la Evaluación de Amenazas (2007) Buenos Aires, Publicación Geológica Multinacional. - p. 404.
5. Vargas, C. (2000) Criterios para la clasificación y descripción de Movimientos en Masa / Boletín de Geología. - Vol. 22. - Núm. 37. – P. 39-67.