Exploring the Classification, Dynamics, and Control Measures of Landslide Processes in the Charvak Free Tourist Zone

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Keywords: Landslide Process, Factors, Dynamics, Classification, Measure, Mountain Slopes, Groundwater, Faults, Rock Porosity, Loess and Loess-Like Rocks, Consequent, Insequent.

Abstract: In recent years, the construction of new hotel complexes, cultural, recreational and shopping centres has been extensively carried out in Charvak free tourist zone, along with other economic activities, with a view to developing the tourism sector. Such construction work could provoke further landslide development on mountain slopes. This article describes in detail the classification, dynamics of landslide processes, one of the most frequently observed in Charvak free tourist zone, and measures to combat them.

1 INTRODUCTION

Ensuring the safety of citizens has always been one of the priorities of the state. In this regard, the Government of our Republic adopts resolutions and decrees aimed at ensuring the safety of the population and develops and implements into practice special programs, and instructions aimed at their implementation.

Section 7 of the Development Strategy of New Uzbekistan for 2022-2026, entitled "Strengthening the security and defense capability of the country, conducting an open, pragmatic and active foreign policy", consisting of seven priority areas developed on the principle of "From action strategy to development strategy", approved by the Decree of the President of the Republic of Uzbekistan dated January 28, 2022, No PF-60 "On the Development Strategy of New Uzbekistan", a systematization of measures to ensure the safety of the population and to prevent and deal with emergencies in tourist areas in an expeditious manner is outlined (President of the Republic of Uzbekistan. (2022, January 28). Decree No PF-6). In this development strategy, the main goals are the protection of the population and territories from dangerous processes that cause emergencies of a natural, man-made, and environmental nature.

In this regard, scientific research to reduce the risk of landslide processes is of relevance. From a scientific and practical point of view, it is important to study the classification, grouping, and dynamics of the landslide process depending on the factors that form it.

2 OBJECTIVES OF THE STUDY

The study aims to examine prevalent landslide processes, the dynamics of their types, and control measures within the Charvak free tourist zone. To achieve this objective, the following tasks are outlined:

- classification of landslide processes.
- examination of the dynamics involved in the occurrence of landslide processes.

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Khakimov, K., M. Janizakova, G., Sharipov, S., Safarov, E. and Boymurodov, D.
Exploring the Classification, Dynamics, and Control Measures of Landslide Processes in the Charvak Free Tourist Zone.
DOI: 10.5220/0012949100003882

In *Proceedings of the 2nd Pamir Transboundary Conference for Sustainable Societies (PAMIR-2 2023)*, pages 1033-1036
ISBN: 978-989-758-723-8

- investigation of measures to combat landslide processes and mitigate their impact.

3 DISCUSSIONS

The geological structure of the Charvak free tourist zone is characterized by limestone, sandstone, shale from different periods, and gravel-clay sediments dating back to the Paleogene and Neogene periods. These layers are overlaid by thick loess and loess-like rocks, which rapidly lose strength and swell in response to atmospheric precipitation. The region is also highly susceptible to seismic activity from earthquakes during the Lower (Q1) and Middle (Q2) Quaternary periods, contributing to a higher incidence of landslide processes compared to other areas in Uzbekistan.

A landslide refers to the phenomenon where rocks descend from the shores of seas, lakes, rivers, or mountainsides under their own weight along a specific slope. This occurrence arises when rocks on the slope lose their equilibrium due to various factors.

Landslides exhibit variations in size, structure, causes of formation, developmental conditions, mechanism, and dynamics, leading to different classifications. Various factors, including the causes of formation, properties, shape, and size, are considered when categorizing landslides.

A.P. Pavlov classified landslides into delapsing and detrusion landslides based on their starting point. N.V. Rodionov further categorized landslides into consistent, suffosion, and structural types based on the causes of their formation. F.P. Savarensky divided landslides into asequent, consequent, and insequent categories depending on the surface of rupture's location relative to the bedding line.

Asequent landslides occur on slopes composed of rocks with a homogeneous composition, including slides on slopes made up of loess-like rocks, typically displaying an arch-shaped slickenside. Consequent landslides are formed by the sliding of layers consisting of weathered rocks over the bedrock (Figure 1).

Insequent landslides are a category of landslides where the surface of rupture intersects with the bedding line of the rock strata. An illustrative example of this type is represented by stepped landslides (Figure 2: 1 - slumped clay rocks; 2 - loess and clay rocks; 3 - groundwater; 4 - Quaternary conglomerates; 5 - maximum level of water table rise).

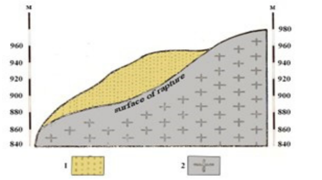

Figure 1: Scheme of a consequent landslide.

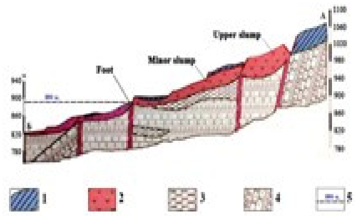

Figure 2: Longitudinal geological profile of an insequent landslide in Mingchukursai.

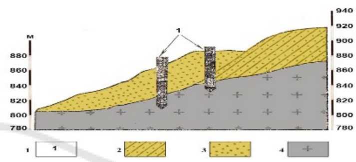

Figure 3: Figure 3. Schematic section of strengthening the steep slopes of Sijjak terrace, where a landslide is likely to occur, by means of underground column piles.

Furthermore, various scholars, including A.M. Drannikov, N.N. Maslov, E.P. Emelyanova, G.O. Mavlonov, and Niyazov, have identified several types of landslides. The diversity in the classification of landslides arises from the varied conditions, causes, and structures contributing to their formation.

The dynamics of landslide processes refer to changes in their structure and properties, as well as the speed of movement per unit time, encompassing the stages from initiation through progression to cessation. The factors causing landslides on slopes exhibit varying characters and magnitudes over time, resulting in fluctuations in the rate of rock sliding. Consequently, the period of landslide processes can be segmented into three stages:

Stage of Preparation for Slumping: During this stage, natural phenomena (such as earthquakes or precipitation) and human activities influence a decrease in slope strength. Although no slumping has occurred, initial signs of a landslide, including the formation of cracks in the slope, become apparent.

Slumping Stage: This stage marks the occurrence of a landslide, and the speed of the landslide may vary. Some landslides exhibit initial rapid movement, followed by a slower pace, or vice versa. The landslide speed at our research site exceeds that in other parts of Uzbekistan, reaching several meters per second. Flowing and sliding landslide types, triggered by precipitation, exhibit particularly rapid movement during this stage, leading to destructive events such as the damage to economic structures and, at times, fatalities.

Stage After Slumping Occurs: Subsequent to a landslide, the slope's strength undergoes a complete transformation. The slumped mass, if not eroded by flowing water, becomes a supportive element for the slope, often reducing the slope angle and increasing its strength. However, new factors emerge, impacting the slope's strength. The vegetation covering slopes affected by landslides may be washed away, leading to increased erosion processes and enhanced washout of the subsoil layer.

The occurrence of a landslide process has significant effects on the relief and the mechanical composition of the subsoil layer. For instance, landslide cirques (troughs) and table plains may form on the slopes, altering the geomorphological structure. In large landslides, such as stepped landslides, the mixing of different rock types results in changes in specific gravity, volume, and porosity.

Moreover, landslide processes can alter hydrogeological conditions, affecting groundwater regimes and leading to the formation of springlets and wetlands on slopes. These changes impact the moisture content of rocks, affecting their strength.

Landslide control involves mitigating the effects of landslide-forming factors and, in some cases, completely eliminating them. Given the various factors and types of landslides, a variety of measures are employed. For instance, underground column piles are installed against consequent and insequent types of landslides, while retaining walls are erected on slopes where delapsing and detrusive landslides occur.

To prevent the dislodgement of landslide bodies, underground column piles, retaining walls, and counter dams are commonly employed. The design and implementation of these measures involve calculating the size of the landslide body and the forces holding it in place. Underground pile columns are drilled on slopes at risk of landslides, and these boreholes are filled with reinforced concrete mortar. The piles of the column that cross the surface of the rupture connect the landslide body with the mass not involved in the sliding (Figure 3: 1 – underground column piles; 2 – loess-like and clayey rocks; 3 - loess rocks; 4 - gravels and conglomerates).

Implementation of measures to fortify slopes using underground pile-columns has been conducted extensively across various locations within our research facility. This strategy is aimed at preventing landslides on the steep slopes surrounding the Charvak Reservoir. The base of these slopes comprises sediments from different periods, with the upper section covered by loess-like and clayey rocks.

In the course of constructing roads leading to the eastern, northern, and southern areas of the Pskem recreation area and the Chimgan-Charvak recreation area, there were instances where it was necessary to traverse the slopes of the Ugam, Pskem, and Chatkal ranges, which exhibited steep gradients and relative heights of approximately 200-250 meters. This topography leads to a decrease in the strength of mountain slopes and an elevated risk of landslides. To mitigate this risk, one preventive measure involves the construction of retaining walls.

Retaining walls are positioned at the base of the slope to impede rock sliding, thereby reducing the likelihood of landslide processes and preventing the failure of highways. To ensure the stability and longevity of these walls, drainage systems are incorporated on the back of the slope. The primary function of drainage is to safeguard the retaining wall from deterioration by collecting water originating from the top of the slope and between the landslide body.

In cases where the thickness of the landslide rock and the slope's steepness are minimal, counter dam barriers are commonly employed to halt the landslide. These barriers enhance the slope's stability by cutting away the convexity at the top of the slope and relocating it to the foot of the slope (Figure 4: 1 - counter dam; 2 - site of cut-out convexity; 3 - base consisting of hard rock). This approach results in a decrease in the slope's gradient and an increase in the force supporting the lower part of the landslide body.

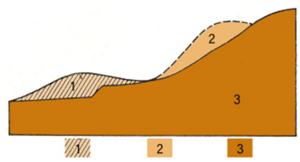

Figure 4: Scheme to increase the strength of slopes by levelling their gradient and erecting a counter dam.

If the sedimentary rocks beneath the landslide body lack resistance to external influences, they will rapidly deteriorate upon exposure. In such scenarios, applying measures like constructing a counter dam by cutting out the convexity on the slope is impractical. These measures are only viable when there are robust igneous or metamorphic rocks beneath the landslide body.

Furthermore, the planting of trees on slopes contributes to temporarily halting landslide processes. To achieve this, long-rooted trees such as walnut, poplar, and pine should be planted in a staggered manner on the slopes. Planting trees in areas where the landslide body is no thicker than 4-5 meters proves to be particularly beneficial.(Zokhidov, 1988- Sharipov et. al., 2022)

4 CONCLUSIONS

When formulating a classification for landslide processes and the corresponding preventive measures, it is crucial to consider factors such as the circumstances triggering the process, the extent of the affected area, the shape, the thickness of the landslide body, and similar characteristics. Additionally, it can be asserted that the dynamics of a landslide are contingent upon the intensity of the influence exerted by the factors contributing to its occurrence. This is due to the fact that the impact of these factors varies over time.

REFERENCES

President of the Republic of Uzbekistan. (2022, January 28). Decree No PF-60 on the development strategy of new Uzbekistan.

Zokhidov, S. (1988). Engineering Geology. Tashkent: Oqituchi. (in Uzbek)

Mavlonov, G. O., Krilov, M. M., & Zokhidov, S. (1976). Fundamentals of Hydrology and Engineering Geology. Tashkent: Oqituchi. (in Uzbek)

Sharipov, Sh. M., Safarov, E. J., Boymurodov, D. O., & Azimova, D. A. (2022). Impact of climate change on landslide processes in Charvak free tourist zone. Journal of Geography and Natural Resources SJIF, 6.037, 94-101. https://doi.org/10.37547/supsci-jgnr-02-01-13

Sharipov, Sh. M., Boymurodov, D. O., Khakimov, K. A., Safarov, E. D., & Gozibekov, A. Kh. (2021). Hazardous exogenic processes occurring in the Amirsoy resort area and adjacent mountain slopes and their analysis. Proceedings of the Uzbek Geographical Society, 60, 5-15.

Ibragimova, R. A., Sharipov, S. M., Abdunazaro, U. K., Mirakmalov, M. T., & Ibraimova, A. A. (2019). Aral Physical and Geographic District, Uzbekistan and Kazakhstan. Asia Life Sciences, 21(1), 227-235.

Sharipov, S. M., Gudalov, M. R., & Shomurodova, S. G. (2020). Geologic Situation in the Aydar-Arnasay Colony and Its Atropny. Journal of Critical Reviews, 7(3), 461-468.

Sharipov, S. M., Shomurodova, S. G., & Gudalov, M. R. (2020). The Use of the Mountain Kars in the Tourism Sphere in Cort and Recreation Zone of Chimgan-Charvak. Journal of Critical Reviews, 7(3), 475-481.