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ОПАСНЫЕ ЭКЗОГЕННЫЕ ПРОЦЕССЫ, ПРОИСХОДЯЩИЕ В КУРОРТНОЙ ЗОНЕ АМИРСОЙ И ПРИЛЕГАЮЩИХ ГОРНЫХ СКЛОНАХ, И ИХ АНАЛИЗ

Аннотация: В данной статье освещаются полевые изыскания, проведенные на горнолыжном курорте Амирсой и прилегающих склонах в Бостанлыкском районе Ташкентской области Узбекистана.

Ключевые слова: оползень, камнепад, сель, эрозия, селевой обвал, экзогенные процессы.

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HAZARDOUS EXOGENIC PROCESSES OCCURRING IN THE AMIRSOY RESORT AREA AND ADJACENT MOUNTAIN SLOPES AND THEIR ANALYSIS

Abstract. *This article highlights field survey work carried out at the Amirsoy ski resort and adjacent slopes in Bostanlyk District of Tashkent Region of Uzbekistan.*

Keywords: landslide, rockfall, mudflow, erosion, debris fall, exogenic processes

Introduction. At present, the accelerated development of the economy of our republic, the increasing level of urbanization, the increase of free time of the population, regular mental and physical work, changes in environmental conditions and other effects are leading to physical and psychological fatigue and the deterioration of people's health. In such cases, proper organization of recreation is important. Therefore, the demand for recreational and tourist activities is growing. This, in turn, requires the creation of special recreational and tourist facilities in places with favourable natural conditions for the organisation of health recovery and recreation.

Decree of the President of the Republic of Uzbekistan No. PD-5326 of 3 February 2018 “On additional organisational measures to create favourable conditions for the development of tourism potential of the Republic of Uzbekistan”, Decree No. PD-5611 of 5 January 2019 “On additional measures to accelerate tourism development in Uzbekistan”, and No. PD-3509 of 6 February 2018. “On measures for the development of inbound tourism”, Decree No. PD-3514 of 7 February 2018 “On Measures for Accelerated Development of Domestic Tourism” paves the way for the accelerated development of these sectors.

In particular, the Decree of the President of the Republic of Uzbekistan No. PD-5273 dated 5 December 2017 “On creation of the “Charvak” free tourism zone within the Chimgan-Charvak resort and recreation zone”, opened up wide opportunities and set important tasks for accelerated development of recreation and

tourism in the Western Tien Shan mountains, which have the highest recreational and tourist potential. Therefore, the recreational and tourist potential of the area is high. Scientific research aimed at exploiting them, identifying favourable areas, assessing the possibilities of existing ones, identifying and organising stationary observations of potentially dangerous natural processes occurring in them, as well as developing measures to reduce or prevent their danger are of great importance.

Based on the above, the objective of our work is to identify the areas where natural hazardous processes occur on the territory of the Amirsoy resort and adjacent mountain slopes, to identify the factors, causes of their occurrence and development, and to assess the degree of danger they cause.

Research study. The nature of the Amirsoy resort area has been studied by many researchers for various purposes. Natural-geographical processes and landscapes have been studied by N. A. Kogay (1964, 1979), Sh. S. Zokirov (1972), A. Zaynutdinov (1990), R. Yusupov (2005), Sh. M. Sharipov (2011), and recreational and tourist aspects have been studied by N. T. Shamuratova (2012) and Sh.G. Shomurodova (2020).

N.A.Kogay (1972) identified and characterised the Chirchik and Akhangaran river basins as an independent piedmont and mountainous natural-geographical okrug of Chirchik-Akhangaran. He divided the territory of the okrug into two regions - mountainous and foothill, as well as 19 landscapes and described each of them.

Sh. S. Zokirov (1972) divided the territory of Chirchik-Akhangaran okrug into *upper, middle and lower* regions and evaluated natural conditions of these regions for the purpose of agricultural development.

A. Zaynutdinov (1990), like Sh. S. Zokirov, divides the territory of the okrug into *upper, middle and lower* regions and has described 33 kinds of landscape.

P. Yusupov (2005) studied the distribution of natural-geographical processes on the territory of Chirchik-Akhangaran natural-geographical okrug.

Sh.M.Sharipov (2011) conducts research on the geoecological approach to nature protection in Tashkent region, i.e. taking into account the specific and

geoecological situation of each geosystem and the differentiated implementation of measures. He proved that the geoecological situation in the Tashkent region changes from the riverbed to the watersheds, obeying the laws of altitude zone, gave practical recommendations and suggestions for the implementation of differentiated environmental measures.

Sh.G.Shomurodova conducts research to identify natural geographical factors and objects that form the basis for the development of tourism in the Chimgan-Charvak resort-recreation zone and to develop measures for their rational use.

Research methodology. The research was carried out using field research GIS techniques, cartographic and archive materials.

The main part

The Amirsoy resort was built for skiing and active mountain tourism in winter and for providing tourists with recreational and recreational tourism services in the warmer months. (Figure 1).

The Amirsoy resort is famous for its ski resort, the area is located on the northern slope of the Moygashgan ridge and includes the Amirsoy basin, the left tributary of the Beldirsoy headwaters. Its area is 892 hectares. Construction of 2 suspended cableways over 3 km in length and 8 pistes over 10 km in length, including 28 relief pistes of 21.3 km for snowboarding during the winter season, is underway.

Figure 1

In addition, special tracks have been created for riding ATVs

In order to make productive year-round use of the area's tourist opportunities, ski resort centres, specially equipped slopes for skiing and snowboarding, ski lifts, cable railways, entertainment facilities (play centres, swimming pools, etc.) as well as other domestic, public and tourist facilities should be built in the long term. The construction of structures requires organization on a scientific basis. After all, the fact that nature is constantly evolving on the basis of its own laws, striving to maintain its stability, can negatively affect the sustainability of anthropogenic systems built by humans. This situation can limit the recreational tourism potential of the region (disturbances on major highways, microclimate change due to reduced vegetation cover, decrease in natural attractiveness as a result of erosion processes, etc.) and cause significant economic damage.

Based on the above considerations, field research was conducted to study the natural processes in the Amirsoy resort area and adjacent mountain slopes. Initially the object of the study, the structure of the area, was studied by remote sensing of the area modified by anthropogenic impacts and the construction of engineering structures. The pros and cons of atropogenic effects were observed during the study. Negative effects were more often observed in the vicinity of motorways. This is due to the fact that steep slopes are “cut” for road construction, increased

soil moisture under the influence of spring water, the presence of loess and loess-like rocks with high water capacity, decreased strength of rocks, increased gradient of the slope, etc. (Figure 2). This circumstance leads to the occurrence of slope collapses on some sections of the road, surface erosion, landslides, resulting in deformation of the roads and their overlapping by landslide rocks. Special measures (e.g. trees planted as terraces, drainage wells and special protection structures) were applied in road sections where the above situations could occur (Fig.3,4).

Figure 2. The situation on the slopes cut for road construction

Figure 3. Seedlings planted as terraces

However, our observation revealed that some of the measures did not ***fully*** justify themselves, for example that the protection structure built was intended to contain a certain volume of landslide, but it was filled with landslide rock, which in some places exceeded the volume and rolled over the protection structure, causing it to shift (30-35 cm).

Figure 4. The protection wall was filled with sliding rocks and surpassed some parts

Below are the processes occurring in the Amirsoy resort area and adjacent mountain slopes and their geographical analysis (Table 1).

Table 1

№	Type	Dimension, sq.m.	Coordinates of the studied points	The factor of formation	Presence of precaution	Expected danger
1	Ongoing landslide	2135	41°28'59,45" N 69°56'59,92" E	The slope is steep, there is loess and groundwater	A drainage well is dug	Fills the south-western part of the reservoir with silt
2	Gullying and landslide	507	41°29'04,34" N 69°57'03,86" E	A cluster of ground filled sai and paved the way	Absent	10-15 m part of the road will be disturbed
3	A mudflow channel	-	41°28'57,21" N 69°57'02,47" E	Convergence of the 3 seasonal sais, snowmelt during the rainy season (April-May)	Existing, constructed a reservoir to collect mudflow water and an additional drainage channel	Destruction of the reservoir, canal and bridge

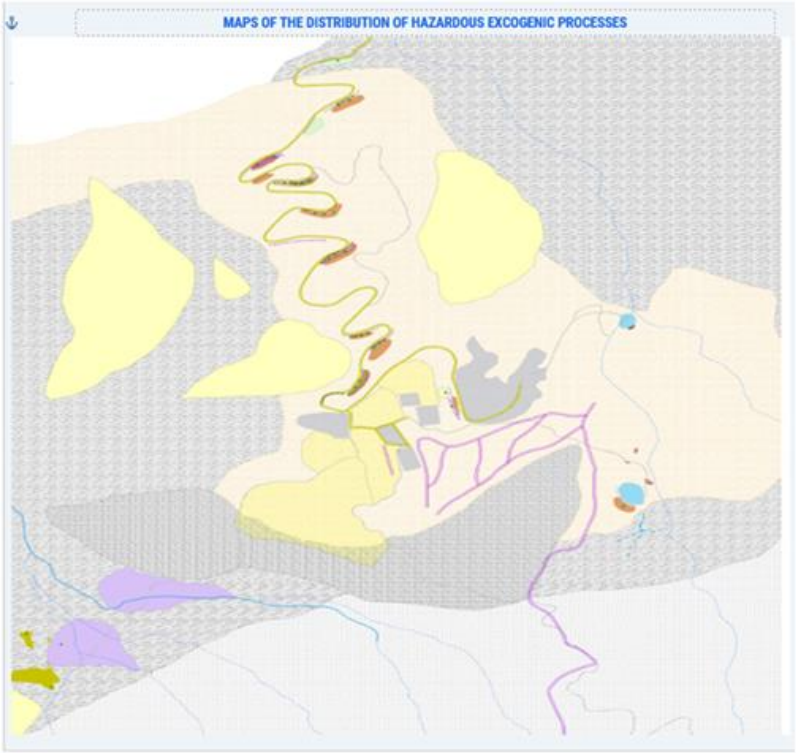
4	There is a possibility of a landslide	268	41°29'07,60" N 69°57'00,26" E	Accumulated ground, filled in the sai and paved the way	Absent	Landslide deposits are accumulating in a 10-15 m section of the road
5	A surface landslide	201	41°29'09,86" N 69°57'01,66" E	Accumulated ground, filled in the sai and formed an artificial plain	Absent	Niches are forming
6	There is a possibility of a landslide	482	41°29'24.32" N 69°56'59.27" E	Steepness is high (40-50°), with clay loess and spring water	Absent	Causes damage to the reservoir
7	Ongoing small landslides	1161	41°29'15.95" N 69°56'36.78" E	The spring water was affected and there is loess	Ornamental tree seedlings are planted	100-110 m part of the road will be damaged
8	An old landslide (cirque)	302	41°29'18.62" N 69°56'33.85" E	The spring was affected	-	-
9	There is a possibility of a landslide	4100	41°29'19.73" N 69°56'23.15" E	Slope has been cut for the construction of the road, the spring water has increased moisture content in the soil, there are loess and loess-like rocks with greater water holding capacity, the degree of rock strength has decreased, the slope gradient has increased	Natural tree and shrub plants were cut and tree seedlings were planted every 2 m. A protective structure was built on a certain part	200 m part of the road will be damaged
10	Ongoing landslide	3123	41°29'24.69" N 69°56'25.71" E	Slope has been cut for the construction of the road, the spring water has increased moisture content in the soil, there are loess and loess-like rocks with greater water holding capacity, the degree of rock strength has decreased, the slope gradient has increased	A protective structure was built, but it was filled with sliding rocks	A 130 m section of the road may be completely filled with sliding rocks

11	Ongoing landslide	2916	41°29'26.15" N 69°56'23.80" E	Slope has been cut for the construction of the road, the spring water has increased moisture content in the soil, there are loess and loess-like rocks with greater water holding capacity, the degree of rock strength has decreased, the slope gradient has increased	A protective structure was built, but it was filled with sliding rocks and deformed. The road, as well as the gutter, has been deformed by moisture	A 100 m section of the road may be completely filled with sliding rocks
12	Ongoing landslide	4953	41°29'37.66" N 69°56'19.82" E	Slope has been cut for the construction of the road, the spring water has increased moisture content in the soil, there are loess and loess-like rocks with greater water holding capacity, the degree of rock strength has decreased, the slope gradient has increased	A protective structure was built, but it was filled with sliding rocks	A 160 m section of the road may be partially filled with sliding rocks. Widens out towards the power station at the top of the slope
13	There is a possibility of a landslide	2148	41°29'44.59" N 69°56'19.43" E	Slope has been cut for road construction, there are loess and loess-like rocks with greater moisture capacity, the degree of rock strength has decreased, the slope gradient has increased, and the moisture content has increased due to the impact of spring water	A protective structure was built, but it was filled with sliding rocks	A 80 m section of the road may be completely filled with sliding rocks
14	A collapse and an ongoing landslide	2005	41°29'49.06" N 69°56'16.00" E	Slope has been cut for road construction, there are loess and loess-like rocks with greater moisture capacity, the degree of rock strength has decreased, the slope gradient has increased, a spring crop out to the surface	A protective structure was built, but it was filled with sliding rocks	A 80-90 m section of the road may be partially filled with sliding rocks
15	A surface landslide	1608	41°29'49.63" N 69°56'9.61"E	Slope has been cut for road construction, there are loess and loess-like rocks with greater moisture capacity, the degree of rock strength has decreased, the slope gradient has increased, a spring crop out to the surface	A protective structure was built, but it was filled with sliding rocks	A 90-100 m section of the road may be partially filled with sliding rocks

16	There is a possibility of a collapse and landslide	4622	41°29'52.95" N 69°56'11.84" E	Slope has been cut for road construction, there are loess and loess-like rocks with greater moisture capacity, the degree of rock strength has decreased, the slope gradient has increased, a spring crop out to the surface	A protective structure was built, but it was filled with sliding rocks. Nor will it stand up to	A 60-70 m section of the road may be completely filled with sliding rocks. As a result of a landslide, the road above can slide
17	A debris fall	1312	41°29'57.51" N 69°56'16.46" E	The slope is composed of proluvial (rock, debris, clay) rocks and has been cut for road construction, the rock strength has been reduced and the slope gradient has increased	A protective structure is not built	A rock may fall on the road
18	Ongoing small landslides	4361	41°30'0.25" N 69°56'19.48" E	Slope has been cut and a terrace made to build the road, there are loess and loess-like rocks with greater water holding capacity, the level of rock strength has been reduced, spring water crop out everywhere	A terrace and a protective structure was built	A 160-180 m section of the road may be partially filled with sliding rocks
19	A debris fall	1697	41°30'7.14" N 69°56'20.36" E	The slope is composed of proluvial (rock, debris, clay) rocks and has been cut for road construction, the rock strength has been reduced and the slope gradient has increased	Tree seedlings were planted, no protective structure was built	A rock may fall on the road
20	Slope erosion	1243	41°30'13.72" N 69°56'27.75" E	The slope is composed of clayey rocks and has been cut for road construction, the rock strength has been reduced and the slope gradient has increased	The protective structure is not built	Niches form on the slope
21	A mudflow channel	-	41°28'47.06" N 69°55'58.04" E	A lot of snow accumulates at the top and the slope is steep, with intensive snowmelt during the rainy season (late March/early May)	Absent	Can wash away infrastructure facilities
22	A mudflow channel	-	41°28'41.09" N 69°55'52.88" E	A lot of snow accumulates at the top and the slope is steep, with intensive snowmelt during the rainy season (late March/early May)	Absent	Can wash away infrastructure facilities
23	A mudflow channel	-	41°28'37.32" N 69°55'49.04" E	A lot of snow accumulates at the top and the slope is steep, with intensive snowmelt during the rainy season (late March/early May)	Absent	Can wash away infrastructure facilities

24	A landslide	18031	41°28'21.76" N 69°55'32.42" E	Lithology consists of a mixture of clayey and loess-like rocks, with hard metamorphic rocks beneath, the slope is steep, and there are springs	Absent	Infrastructure facilities cannot be built

At the Amirsoy resort area, you can see cirques of ancient landslides in the middle and lower parts of the slopes, as well as in the “triangular” cuestas consisting of separately protruding Paleogene limestones. In addition, 7 large-scale ancient landslides were detected in the northern parts of the resort. The 2017-2018 survey identified 22 ancient and modern landslides. During our study (September 2021) it was observed that in some of them the landslide continued, 1 large-scale landslide (41 ° 29'52.95 "N, 69 ° 56'11.84" E) and several small landslides occurred (there are signs of sliding in about 10 places) (Figure 5).



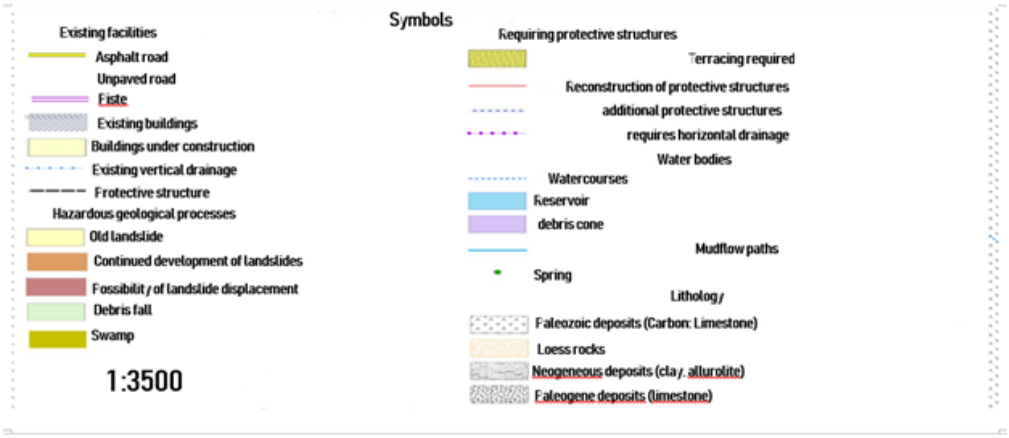


Figure 5. Map of distribution of hazardous exogenic processes in the Amirsoy resort area

Analysis of the geological and hydrogeological conditions of the Amirsoy resort area showed that the main reason for the "decline" in the stability of the scattered rocks and the formation of landslides is groundwater. In addition, the fact that the slope is composed of proluvial (rock, debris, clay) rocks and cut for road construction, reduced the strength of the rocks, increased the gradient of the slope, there is a risk of debris fall (Fig. 6). Due to the small size of the stones, they are likely to cause problems for moving vehicles if they fall on highways. The nature of the relief formation and the current intensification of landslides, small collapses and debris falls indicate that the Amirsoy resort is located in an area where the above processes are likely, and any violation of the natural stability of the slopes can lead to their development.

Mudflow channels around the Amirsoy resort area were also studied. A lot of snow accumulates in the upper part and the slope is steep; mudflows caused by melting snow (late March-early May) during the precipitation season did not have a negative impact on the resort area. At the convergence of several mudflow channels (sais), a reservoir for collecting mudflow water and an additional drainage channel were built. This measure will reduce the risk of mudflows and provide an additional source of water in the summer (Figure 7).

In addition, along with the creation of the Amirsoy resort area, its flora has also been affected, resulting in accelerated erosion in the sparse parts of the vegetation cover.

Figure 6. A slope where there is a risk of debris fall

Figure 7. A reservoir to collect mudflow water

Suggestions:

Taking into account the above, during the construction and operation of facilities in the resort area Amirsoy it is recommended to:

1. Organisation of strict control over the stability of slopes and structures by conducting visual and instrumental observations (topographic and geodetic measurements, monitoring of hydrological and hydrogeological observations) of natural hazardous processes;

2. Preservation of existing grass cover and planting them on sparse slopes to prevent the development of erosion processes;

3. To ensure the adoption of protective measures to strengthen the slopes along which the ground is sliding, along the access roads to the territory of the resort Amirsoy. When building roads, additional cutting of mountain slopes must be avoided and protection structures must be built in the cut areas;

4. During the construction of engineering structures (roads, protective structures and various other facilities) natural groundwater outlets (spring sources) should not be blocked;

5. Prevent the accumulation of melted snow and rainwater on slopes, near buildings and structures during snowmelt and precipitation;

6. Projects aimed at preventing natural hazardous processes should be built or organized on the basis of forecasts developed based on the results of long-term monitoring.

Conclusion. Taking into account the results of the study of the access road from Beldirsoy to the resort area Amirsoy and the inevitable violation of the natural state of the mountain slopes in the first years (5-10 years) after further completion of construction work, it is necessary to continue regular studies of this area and adjacent mountain slopes in order to develop appropriate recommendations for protection from hazardous natural processes.

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