






Exogenic Hazards in Amirsoy Resort Area: Analysis and Mountain Slope Impact

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Abstract: This study investigates the environmental impacts of the Amirsoy ski resort and nearby slopes in the Bostanlyk District, Tashkent Region, Uzbekistan. Rapid economic growth and urbanization have increased the need for leisure and tourism, necessitating the development of sustainable recreational facilities. Through field surveys, remote sensing, and GIS techniques, the study identifies natural hazards such as landslides, erosion, and mudflows. It evaluates the effects of anthropogenic activities on the region's stability and suggests measures to mitigate these risks. Key recommendations include enhancing slope stability, maintaining vegetation cover, and implementing protective infrastructure. Long-term monitoring is essential to ensure the sustainable development of the Amirsoy resort while preserving its natural environment.


1 INTRODUCTION


Physical and psychological exhaustion as well as a decline in people's health are currently being caused by our nation's economy's rapid development, rising urbanization, population growth, increased free time, regular mental and physical labor, changes in the environment, and other factors. It's crucial to plan your amusement wisely in these situations. As a result, there is an increasing need for leisure and tourism-related activities. Thus, in order to organize recreation and health recovery, it is necessary to provide unique tourism and recreational facilities in areas with favorable environmental conditions. Nose PD-5326 of February 3, 2018, No. PD-5611 of January 5, 2019, and No. PD-3509 of February 6, 2018, issued by the President of the Republic of Uzbekistan, respectively, "On additional organizational measures to create favourable conditions for the development of tourism potential of the Republic of Uzbekistan." The fast growth of these sectors is made possible by Decree No. PD-3514 of February 7, 2018, "On Measures for


Accelerated Development of Domestic Tourism," which addresses measures for the development of inbound tourism.


With regard to the acceleration of the development of recreation and tourism in the Western Tien Shan mountains, which have the greatest potential for both, the President of the Republic of Uzbekistan's Decree No. PD-5273, dated December 5, 2017, "On creation of the "Charvak" free tourism zone within the Chimgan-Charvak resort and recreation zone," in particular, opened up a wide range of opportunities and assigned significant tasks. As a result, the region has a lot of potential for tourism and pleasure. It is crucial to conduct scientific research to identify and organize stationary observations of potentially dangerous natural processes occurring in them, identify favourable areas, evaluate the possibilities of existing ones, and develop strategies to lessen or eliminate their danger. Based on the aforementioned, the goal of our study is to locate the locations of naturally hazardous processes on the grounds of the Amirsoy resort and nearby mountain slopes, to pinpoint the elements and

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causes behind their emergence and growth, and to evaluate the level of risk they pose.

2 LITERATURE REVIEW

Numerous scholars have examined the Amirsoy resort area's nature for a variety of reasons. N. A. Kogay (1964, 1979), Sh. S. Zokirov (1972), A. Zaynutdinov (1990), R. Yusupov (2005), Sh. M. Sharipov (2011), and N. T. Shamuratova (2012) and Sh.G. Shomurodova (2020) have all investigated natural-geographical processes and landscapes. The river basins of the Chirchik and Akhangaran were recognized and described by N.A. Kogay (1972) as separate piedmont and mountainous natural-geographical okrugs of the Chirchik-Akhangaran. He distinguished between the okrug's two mountainous and foothill sections and listed 19 distinct landscapes, each with its own description. In order to facilitate agricultural growth, Sh. S. Zokirov (1972) separated the Chirchik-Akhangaran okrug's land into three regions: top, medium, and lower. He then assessed the natural conditions in each of these areas. Similar to Sh. S. Zokirov, A. Zaynutdinov (1990) classified the okrug's area into upper, medium, and bottom parts. He also identified 33 different types of landscape.

The distribution of natural-geographical processes within the Chirchik-Akhangaran natural-geographical okrug was investigated by P. Yusupov in 2005. Research on the geocological approach to nature conservation in the Tashkent region is carried out by Sh.M. Sharipov (2011), who takes into consideration the unique geocological circumstances of each geosystem and the differentiated execution of actions. He proved that the geocological 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.

3 RESEARCH METHODOLOGY

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

The main part: In order to provide visitors leisure and recreational tourism services throughout the

summer months, the Amirsoy resort was constructed with skiing and active mountain tourism in mind. (Figure 1).

The Amirsoy resort, which is well-known for its ski resort, is situated on the Moygashgan Ridge's northern slope and contains the Amirsoy basin, which is the left tributary of the Beldirsoy headwaters. It has 892 hectares of area. Two suspended cableways measuring three kilometers in length and eight pistes measuring ten kilometers, including twenty-eight relief pistes measuring two and a half kilometers for winter snowboarding, are being built.

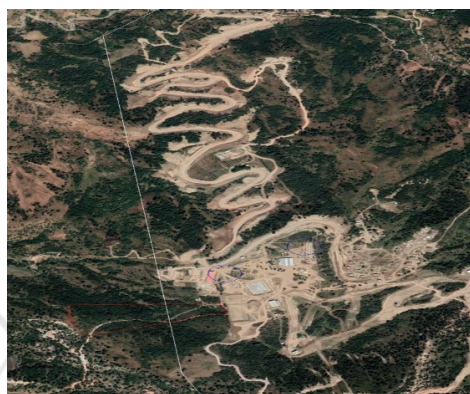


Figure 1: Specific routes designed for ATV riding.

The long-term construction of ski resort centers, specifically designed slopes for skiing and snowboarding, ski lifts, cable railways, entertainment centers, swimming pools, and other domestic, public, and tourist facilities is necessary to maximize the area's year-round tourism potential. Building buildings need scientifically based organization. After all, the sustainability of anthropogenic systems created by people may be adversely impacted by the fact that nature is continually changing according to its own rules in an effort to preserve its stability.

This condition has the potential to significantly harm the region's economy in addition to limiting its potential for recreational tourism (disturbances on main highways, microclimate changes owing to lower plant cover, decline in natural beauty as a result of erosion processes, etc.).

Field research was done to investigate the natural processes in the Amirsoy resort region and surrounding mountain slopes based on the aforementioned factors. At first, remote sensing of the region altered by human influences and engineering development was used to examine the research's object, the area's structure. During the investigation, the benefits and drawbacks of antropogenic effects were noted. The vicinity of freeways was more frequently associated with negative impacts.

This is caused by a variety of factors, including the "cutting" of steep slopes for the building of roads, increased soil moisture from spring water, the existence of loess and rocks that resemble loess with a high water capacity, weakened rocks, an increased slope gradient, etc (Figure 2). This situation causes surface erosion, landslides, and slope collapses on some parts of the road, which deforms the roadways and causes landslide rocks to overlap them. In road sections where the aforementioned scenarios may arise, specific measures (such as trees planted as terraces, drainage wells, and unique protective structures) were implemented (Figure 3, Figure 4).



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



Figure 3: Road section.



Figure 4: Road section.

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).

The processes taking place in the nearby mountain slopes and Amirsoy resort region, together with a geographical study, are listed below (Table 1).

Table 1: Geographical Study of Processes in Nearby Mountain Slopes and Amirsay Resort Region.

No	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	A protective structure was built,	A 90-100 m section of the road may be

				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	but it was filled with sliding rocks	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 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

In the center and lower portions of the slopes in the Amirsoy resort area, as well as in the "triangular" *cuestas* made up of independently projecting Paleogene limestones, are cirques left over from past

landslides. Furthermore, seven extensive prehistoric landslides were found in the resort's northern regions. In the 2017–2018 survey, 22 historical and contemporary landslides were found. In September 2021, when we conducted our investigation, we found that the landslide was still occurring in some of the areas, that there was one large-scale landslide (located at 41 ° 29'52.95 "N, 69 ° 56'11.84 "E), and that there were other little landslides (approximately ten locations showed evidence of sliding) (Figure 5).

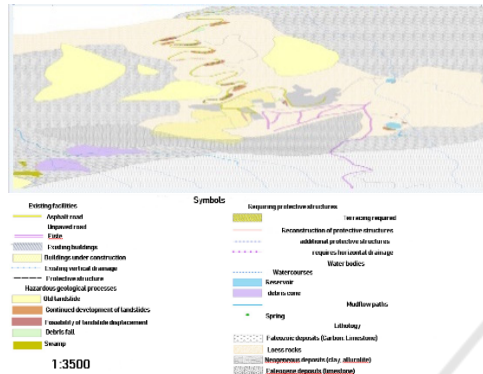


Figure 5: Hazardous exogenic processes' distribution map in the Amirsoy resort region.

Groundwater is primarily responsible for the "decline" in the stability of the distributed rocks and the production of landslides, according to an analysis of the geological and hydrogeological parameters of the Amirsoy resort area. Furthermore, there is a risk of debris fall since the slope is made up of proluvial (rock, debris, and clay) rocks that have been cut for road building, which has decreased the strength of the rocks and increased the slope's gradient (Fig. 6). The stones are tiny, but if they fall on a roadway, they might pose issues for passing cars.

The Amirsoy resort is situated in an area where the aforementioned processes are likely to occur, and any disruption of the slopes' inherent stability may result in their growth. This is indicated by the nature of the relief formation and the present intensification of landslides, minor collapses, and debris falls.

Additionally, mudflow channels surrounding the Amirsoy resort region were examined. The slope is steep and the upper portion accumulates a lot of snow; mudflows from snowmelt during the precipitation season (late March to early May) did not negatively affect the resort area. A reservoir for collecting mudflow water and an extra drainage route were constructed at the intersection of multiple mudflow channels (sais). By taking this action, the chance of mudflows will be decreased and a summertime water supply will be increased (Figure 7).

Furthermore, the development of the Amirsoy resort region has had an impact on the local flora, which has increased erosion in the areas where there is little to no plant cover.



Figure 6: A reservoir to collect mudflow water.



Figure 7: A reservoir to collect mudflow water.

4 SUGGESTIONS

Establish stringent oversight of slope and structure stability through visual and instrumental observations (topographic and geodetic measurements, hydrological and hydrogeological monitoring) of naturally hazardous processes in the resort area of Amirsoy. Maintain the current grass cover and add more to sparsely populated slopes to prevent erosion processes. Ensure safety precautions are taken to reinforce the incline where the earth is slipping on the entry roads leading into the Amirsoy resort area. Avoid additional cutting of mountain slopes during road construction, and implement protective measures where cutting has occurred. Avoid obstructing natural groundwater exits (spring sources) during the construction of engineering structures such as roads and protective facilities. Base projects aimed at preventing natural hazardous

processes on predictive forecasts derived from long-term monitoring data. Prevent the accumulation of melted snow and rainwater on slopes, near buildings, and structures during snowmelt and precipitation.

5 CONCLUSIONS

In order to develop appropriate recommendations for protection against hazardous natural processes, regular studies of this area and adjacent mountain slopes are required, 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 after further completion of construction work.

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