

# ANALYSIS OF HAZARDOUS EXOGENIC PROCESSES IN THE “AMIRSOY” RESORT AREA WITHIN THE CHARVAK FREE TOURIST ZONE

**Dilbarkhon Fazilova Shamuradovna**

Space researches laboratory, Ulugh Beg Astronomical Institute of Uzbekistan Academy of Sciences

**Dilshodahon Azimovna Azimova**

National University of Uzbekistan, PhD student

**Okhunjonova Dildora Komiljon kizi**

National University of Uzbekistan, PhD student

**Djumabayeva Salomat Kamiljanovna**

Chirchik State Pedagogical University, teacher

**Shomurodova Shakhnoza Gayratovna**

Chirchik State Pedagogical University, head of department, Teacher

**Khakimov Kamoliddin Abdukarimovich**

National University of Uzbekistan, head of department, Teacher

**Abstract.** *This study presents a comprehensive geographical analysis of hazardous exogenic processes occurring within the “Amirsoy” resort area, located in the Charvak Free Tourist Zone, and its adjacent mountain slopes. Based on integrated field investigations, interpretation of aerospace imagery, GIS-based spatial analysis, and cartographic materials, the spatial distribution, morphological characteristics, and driving factors of landslides, slope failures, rockfalls, gully erosion, and debris-flow processes were systematically evaluated.*

*The results identified 24 hazardous exogenic process sites within the study area. The majority of these processes were found to be associated with anthropogenic impacts, particularly slope cutting during road construction and groundwater emergence. The effectiveness of engineering protection measures was critically assessed, and scientifically grounded recommendations were*

*developed for long-term monitoring and sustainable infrastructure planning in mountainous tourist environments.*

**Keywords:** *landslides, debris flows, rockfalls, erosion, loess deposits, anthropogenic impact, monitoring, hazard assessment.*

## **Introduction**

In recent years, mountain-recreational tourism has been developing rapidly in Uzbekistan, accompanied by the construction of modern tourism infrastructure based on natural resources. In particular, the Amirsoy Resort, located within the Charvak Free Tourist Zone, has become one of the country's major mountain-skiing and recreational centers. The study area is situated within the morphodynamically active sector of the Western Tien Shan mountain system and is characterized by complex relief, steep slopes, loess and loess-like deposits, groundwater discharge zones, and seasonal snowmelt processes.

The construction of large-scale tourism facilities in mountainous regions directly affects the stability of natural geosystems. Slope cutting, road construction, installation of engineering structures, and reduction of vegetation cover represent anthropogenic factors that may intensify exogenous geomorphological processes. Under such conditions, landslides, collapses, rockfalls, gully erosion, and debris-flow processes pose serious threats not only to the natural environment but also to infrastructure facilities and tourist safety.

The Amirsoy mountain resort area is located on the slopes adjacent to the Charvak basin and is geologically composed of loess-like sediments, proluvial deposits, and metamorphic formations. These materials tend to lose stability under increased moisture conditions. In particular, slope excavation for road construction, insufficient drainage systems, and groundwater emergence may significantly accelerate landslide processes.

From this perspective, a comprehensive geographical assessment of hazardous exogenous processes occurring in the study area constitutes a relevant

scientific task. Evaluating the interaction between natural and anthropogenic factors, identifying spatial patterns of process distribution, and scientifically determining hazard levels are essential for ensuring the sustainable development of tourist areas.

The objective of this research is to identify hazardous exogenous processes occurring within the Amirsoy resort area and adjacent mountain slopes, analyze their morphology and development factors, assess their potential impact on infrastructure facilities, and develop scientifically grounded recommendations for monitoring and mitigation measures.

The results of this study will contribute to sustainable territorial planning, hazard management, and the provision of geocological safety within the Charvak Free Tourist Zone. 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 antropogenic 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.

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).

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

**Table 1**

<b>№</b>	<b>Type</b>	<b>Dimension, sq.m.</b>	<b>Coordinates of the studied points</b>	<b>The factor of formation</b>	<b>Presence of precaution</b>	<b>Expected danger</b>
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 southwestern 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).

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.

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.

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.

### References

1. Ўзбекистон Республикаси Президентининг 2017 йил 5 декабрдаги ПФ-5273-сон “Чорвоқ” эркин туристик зонасини ташкил этиш тўғрисида”ги Фармони.

2. Ахмедов Н.А., Далимов Т.Н. Геологическая карта Чаткала-Кураминского региона. Масштаб 1: 200000. Главные редакторы: – Т.: 2004.

3. Ахмедов Н.А., Далимов Т.Н. Карта месторождений рудопроявлений золота и серебра Чаткало-Кураминского региона. Масштаб 1:200 000. Главные редакторы: –Т.: 2004.

4. Зайнутдинов А. Роль новейших тектонических движений в формировании природных условий // Авт. дисс. на соис. уч. ст. к.г.н. – Т.: 1990.-24 с.

5. Закиров Ш.С. Природные условия бассейна р. Ахангаран и опыт их оценки для целей сельскохозяйственного производства // Авт. дисс. на соис. уч.ст. к.г.н. – Т.: 1972.-24 с.

6. Ibragimova, R.A., Sharipov, S.M., Abdunazarov, U.K., Mirakmalov, M.T., Ibraimova, A.A. (2019). Aral physical and geographic district, Uzbekistan and Kazakhstan. Asia Life Sciences, 21(1), 227-235.

7. Khakimov K.A., Sharipov S.M., Boymurodov D.U. (2021). Landscapes of Bakhmal district of Uzbekistan and their territorial differentiation. *Nature and Science*, 19(11):1-7]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). <http://www.sciencepub.net/nature>. 1. doi:10.7537/marsnsj191121.01.
8. Sabitova N.I., Stelmakh A.G., Tajibayeva N.R. (2020) Mapping of landslides and landslide processes in Uzbekistan using relief plastics (on the example of the Chirchik basin). *InterCarto, InterGIS*, 26, 572-583 p.
9. Шамуратова Н.Т. Ўзбекистонда экологик туризм ва унинг табиий географик жихатлари. Геогр. фан. номзоди. илм. дар. олиш учун ёзилган дисс. – Т.: 2011.
10. 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.
11. 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.
12. Sharipov Sh.M. (2018). The extent of destruction of landscapes in the Tashkent region. *European science review. Scientific journal. Vienna*. 3–4. 106-111.
13. Sharipov Sh., Khakimov K., Boymurodov D. (2019) The extent of destruction of Landscapes in the Tashkent region. *Bulletin of National University of Uzbekistan: Mathematics and Natural Sciences*. Vol. 1: Iss. 4, Article 5.
14. Шомуродова Ш.Ф. Чимён-Чорвоқ курорт-рекреация зонасида туризмни ривожлантиришнинг табиий географик асослари. Геогр. фан. фал. доктори (PhD) илм. дар. олиш учун ёзилган дисс. – Т.: 2011.

15. Юсупов Р. Табiiй географик комплексларнинг шаклланишида табiiй географик жараёнларнинг роли. Г.ф.н. илм. дар. олиш учун тақдим эт. дисс. – Т.: 2005.-120 б.