

Zonation of Potential Risk of Rockslides in the Sarein-Alvares Road Using GIS

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Abstract: In every region, the true manifestation of unevenness evolves under the influence of a particular system of morphogenesis, which is a function of the climatic conditions governing that region. There is always a relationship between climate and the adverse effects of unevenness. The reactions of high mountainous areas and flat terrain to climatic elements are not identical. In this regard, altitude, volume, structures and in particular, the direction of mountain slopes contribute significantly to the weather conditions of mountainous regions. Furthermore, in geomorphologic studies of contemporary phenomena, the role of climate in morphogenesis, whether directly through climatic elements like precipitation, or indirectly as one of the many morphogenetic parameters, is of specific importance. The climatic conditions in the road connecting Sarein to Alvares ski resort are such that the intensification of morphogenesis is demonstrated through its effects on stones (mechanical destruction of stones) and in some cases affect morphological phenomena. In sum, climatic elements influence the erosion and manipulation of unevenness overlooking this road. However, the temperature and precipitation are of great importance due to their definite effects on erosion. One of the strategies to reduce damage from the instability of slopes is to identify regions that have the potential to be unstable. In this study, the role of climatic factors (such as temperature regime, precipitation etc.) in the activities of morphogenetic factors relevant to the slopes along the Sarein-Alvares ski resort will be evaluated the conditions of this region in terms of morphogenesis are specified and the sensitive and uneven points have been delineated.

Key words: Climate factors, morphogenesis system, slope instability, cryogenic, distinction of sensitive, unstable points

INTRODUCTION

Connecting highways by virtue of their extensive nature pass through various natural units each of which possesses particular geomorphological characteristics (Rajaei, 1994). The highway connecting Sarein and Alvares ski piste is currently influenced by slope processes, which in turn are affected by the climatic conditions prevailing, especially at elevated points of this route. The purpose of exploring the climatic factors in the region under study was not to merely classify the various weather conditions but rather the study of parameters that can intensify the morphogenesis of this area (Rezaaei, 1991). Identifying the sensitive and unstable points along this route was also among the main objectives of this study.

MATERIALS AND METHODS

In this study, satellite photos (August 2004) geological maps with a scale of 1:100,000 and topographic maps with a scale of 1:5000 were utilized and temperature gradients and precipitation were calculated using

regression equation and correlations between them were calculated. Seasonal indices of atmospheric precipitation and temperature readings for seven stations were calculated using Bull (1991)'s method and finally the sensitive and unstable points were identified using GIS Arc view.

The geographical situation of the region under study:

The road connecting Sarein and Alvares ski piste lies in the Western part of Ardabil Province and its geographical coordinates are 47°54-48°8'E and 38°8-38°12'N (Fig. 1).

RESULTS AND DISCUSSION

Determination of climate and its morphogenic type in the region under study:

On the basis of umbrage theory and considering the umbrage coefficient $Q_2 = 35.05$ and its relationship $m < -7$ in the region under study, the kind of climate borders between partially dry and cold and altitudinal climate. Other features of this climate include long winters and high snow coefficients. Furthermore, considering the parameters pertaining to de Martin's

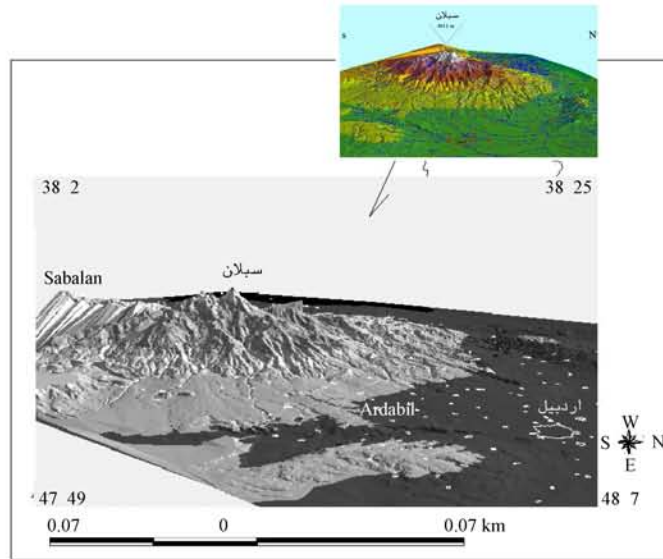


Fig. 1: The geographical situation under study

classification and determination of climate of regional stations the dryness coefficient for the whole area was calculated to be around $I = 16.59$ and the climate of the region was identified as partially dry.

On the basis of Bull (1991)'s classification, in terms of atmospheric precipitation the area under study is partially dry due to precipitation between 250 and 500 mm with completely distinct seasons. Moreover, indices of seasonal precipitation and temperature (Bull, 1991) were calculated $SP = PW/Pd$, which in the region studied, indices of seasonal atmospheric variations for seven stations were calculated to be 4.4 mm for the whole area indicating moderate precipitation variability.

The index of seasonal variability in temperature was also calculated $St = Th-Tc$ and found to be $12.1^{\circ}C$, suggesting severe seasonal variability throughout the year. From the above information in determining climate and morphogenic type it is concluded that the area under study has a cold climate and its conditions of humidity are partially dry.

In such weather, the physical decomposition of rocks appears to be more prominent than their chemical decomposition (Motamad, 1989). To understand the dominant morphogenic condition in the area Peltier (1950)'s diagram (Selby, 1985) has been used. On the basis of Peltier (1950)'s method the climatic condition is such that through its impact on stones it leads to the intensification of morphogenesis. In some instances, geomorphological phenomena are influenced.

Temperature regime and its role in the morphogenesis of the region: Summer is of particular importance in terms of contraction and expansion of rocks in the region, which can lead to rock destruction (Gabler *et al.*,

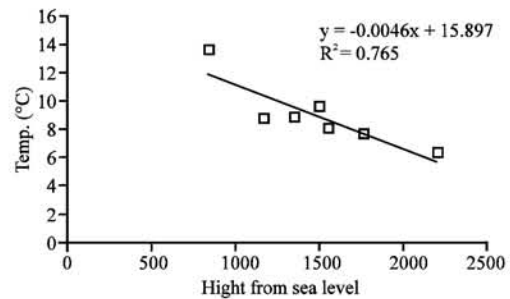


Fig. 2: Graph showing the mean annual temperature gradient at the stations of the region

2006). Given the temperature difference in the stations of the region, the temperature gradient was calculated to be about 0.46° for every 100 m difference in altitude (Fig. 2).

The largest fluctuation in temperature occurs in July and August and the least in October and November. Changes in temperature can indirectly affect rocks through water freezing (Mahmoodi, 1988). With temperature decreases and fluctuations in the cold months of the year (November-February) given that water is present in the pores of rocks, hydrostatic pressure exerted on the rocks increases.

The wide fluctuations in temperature during the warm months (July and August), melting and freezing processes are activated in the pores of rocks.

Consequently, physical destruction plays its role (Fig. 3 and 4) and under the forces of gravity, sliding processes, or the separation of materials from rock walls, facing the highway occurs (Luckman, 1976).

As observed in Fig. 3 and 4, the slopes facing the highway connecting Sarein and Alvares piste, considering their geological composition as they are composed of andesite rocks projecting from the slopes and therefore, exposed are strongly influenced by cryoclasty. This process is more active in the months of July and August when temperature fluctuations are more severe in the region. Apart from rocks exposed in the slopes, the asphalt of the road is also affected by cryoclasty. Due to severe temperature fluctuations and alternations in the freezing and melting of ice this process is conspicuous in the elevated points of the region. The roads in the region under study are considered a threat to the connection line.

Regime of precipitation and its effects on the morphogenesis of the region: The average annual precipitation in the region is estimated to be 316.8 mm. Precipitation, a climatic factor with an important role in the instability of slopes is considered a morphogenesis system in the region so that in routes where trenches have been dug by the ministry of roads and transportation in the Ardebil Province, mud excavation in this route and the creation of sections lead to the exposure of the unstable superficial geological constituents, which then become accessible to rain water or thawed snow as transportable materials.

Therefore, erosion from precipitation as the primary state of change in the slopes of the region studied is considered as superficial run off (Fig. 5) and in the slopes facing the road they serve as erosion, etching, and transportation materials.

As shown in Fig. 5, Topographical slopes and climatic features of the region studied, especially plenty of rainfall and snowfall and the melting of snow has led to temporary concentrated waterways and a morphogenic factor threatening the connecting roads.

Wind processes and its morphogenic effects: Erosion, transport and deposit of substances as a consequence of wind processes on the surface of the earth are termed wind activities (French and Harry, 1992). In fact, powerful winds are characteristic of periglacial regions (French, 1996). The region under study is influenced by easterly winds in spring and summer in addition to regional winds during fall and winter. Apart from the transport of fine deposits, these winds cause the transport of snow and to the surface of the connecting road ultimately leading to road obstruction in winter.

The road connecting Sarein and Alvares ski piste is a place of interest for domestic and international tourists in different seasons of the year especially during summer

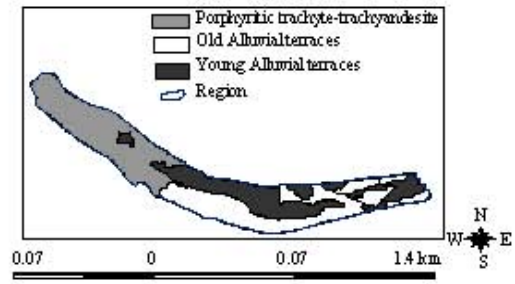


Fig. 3: Geological map of the region under study

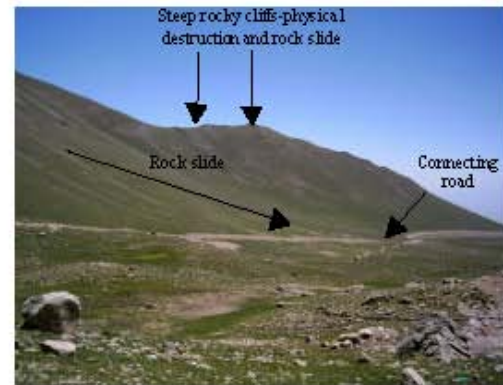


Fig. 4: Physical destruction of rocks (cryoclasty process) in slopes facing the road connecting Sarein and Alvares ski piste



Fig. 5: Performance of incidental waterways on the slopes

and winter. Most of the slopes facing this connecting road are covered with superficial constituents. In view of climate factors and their role in the morphogenic activity, the indices of atmospheric precipitation variability and seasonal temperature variability in the area as well as the data obtained, it can be said that in morphoclimatic terms, the climate conditions are such that they intensify

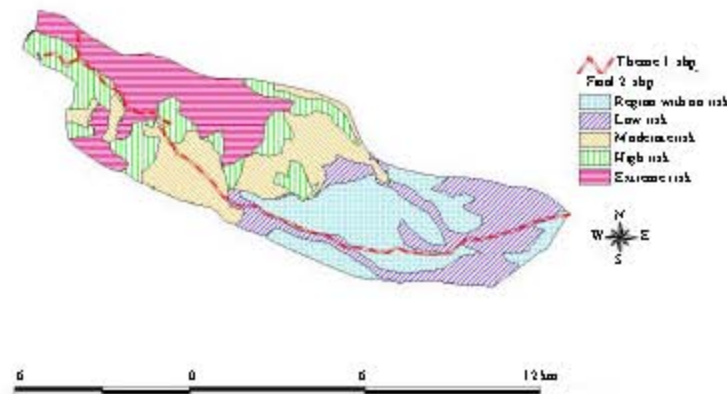


Fig. 6: Zonation of potential risk of rockslides on the Sarein-Alvares connecting road

morphogenesis through their effects on rocks (mechanical destruction) and on road asphalt (cryoclasty). Furthermore, heavy rainfall in spring, especially during April and May, threatens the connecting road through transportation of sediments in the slopes and through rain water erosion. In fact, the lithology and climatic conditions (temperature fluctuations, freezing and humidity) have combined to threaten some roads with landslides and rockslides.

These conditions are generally more acute in places, where the road is immediately adjacent to slide prone slopes. As observed in Fig. 6, in elevated and mountainous sections, the connecting road is exposed to severe and moderate risk while parts of the road that pass through low lying regions are exposed to little danger of rockslides.

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