Specialized and research articles

Studying effective factors on formation of geomorphologic forms in KARKAS Mountain using GIS

Panthea Giahchi * (a), Jamshid Jedari Eyvazi (b), Mohammad Reza Servati (c), Payam Alemi Safaval (d)
(a) PhD, in Geomorphology, Geological Survey & Mineral Exploration of Iran, pgiahchi@gmail.com
(b) Scientific Board of Tehran University
(c) Scientific Board of Shahid Beheshti University
(d) MSc, Remote Sensing and GIS, Geological Survey & Mineral Exploration of Iran, payam.alemi@srbiau.ac.ir
(* Corresponding author: Panthea Giahchi)

Abstract
KARKAS Mountain is the highest peak in Natanz, Kashan .On the one hand due to the diversity of geomorphologic units for example diversity of heights, tilt of hillsides, valleys, types of faults, and age of rock units, types of units, glaciers, and sediment, on the other hand, due to geomorphic processes such as tectonics, dry and hot to cold period of climate, luxuriant vegetation and some areas without vegetation, landslides, and rock debris it can be described as a place for research in geology sciences.. This paper studies geomorphology of KARKAS Mountain and tries to interpret variety of forms and processes by using GIS. Due to the introduction of the gradient of the mountain, evidence and the fact that the slopes are currently active by internal earth activities (the dynamic forces), we conclude that, especially on the northern slopes of the mountains above 1700 meters high, it is very sensitive and its morphologic changes are happening very rapidly.

Keywords: KARKAS Mountain; GIS; Glacier Cirques; Geomorphic.

I. INTRODUCTION

The plateau of Iran is an important morphotectonic area that is located in the middle part of Alps-Hymalayas belt. Alborz and Zagros mountain ranges are two wrinkled systems of this belt among the most important heights of Iran [1]. The cause of height and the shape of the distribution of relief and also the latitude have a determining role in climate diversity in this region. These properties had also caused more climate diversity in comparison with other areas in the past [2].

Glaciers, and the governance of glaciers and inter-glaciers periods, had an important role in processing and revolution of relief. During the glacier periods, accumulation of large amounts of snow and ice on the hillsides and then during the inter-glacier periods, the melting of these ice masses had an impressive role in forming hillsides. This has an effect not only on creating shapes of glacier but also on creating series of incidents after itself [3]. The studied area is located in west of central Iran and in a part of tectonic holes in Qom-Ardekan and exactly covers a part of border stripe of morphotectonic unit of central Iran that is mainly formed by output and formation of third period [4]. This stripe in north-west/south-east affected by the flow is stretched by the big thrust of Zagros and Sanandaj-Sirjan zone and is generally known as Karkas mountain ranges [5]. Karkas Mountain is the highest summit in this mountain range. From the geology point of view the studied area is a part of middle technomagma belt and Urumia-Bazman (Fig.1).

Fig.1. Middle part of Urumia_Bazman and tectenomagma belt

From what the researches have done on this, the studies of Spotila et al., (2004) in chugach mountain, Alaska, Kirkbride et al., in Newzealand (1997) and in different parts of the world can be mentioned. Demergan in Iran did a survey on cirques of Oshtorankooh, Lorestan in 1890 and Boobak (1934), Deviz (1934) and Rite (1983) surveyed the effects of glaciers in mountainous zones in Iran [6]. Karkas in Natanz is one of the most suitable areas for studying the effects of each of five main factors that determine the type of landform including topography, time, material, climate, and vegetation. There exist heights from below 1000 meters to approximately 4000 meters and sediments from Paleozoic to the recent time and climates from hot and dry to cold and dry and from sedimentary to plutonic and from internal to external plutonic and from acid to base plutonic and from rather rich vegetation in low-pitched high areas to poor ones in low mountainous areas close to a plain.

II. MATERIAL AND METHOD

A. STUDY AREA

Karkas is the highest summit of border stripe of the big desert and among numerous central summits in Iran. This summit is located on $51^0 47^{/} 59^{//}$ E and $33^0 27^{/} 21^{//}$ N latitude that is limited to Goorabad valley and Hanjen in the north and Bozorgkashe village in the south and Ardehal in Delijan in the west and Natanz in the east. The area studied as vast as 497 square kilometers is covered with high mountains most of their summits more than 2700 meters above the sea level. This area includes a part of Gahrood (kahrood) mountain ranges.

B. METHOD

After gathering fundamental data from library resources and surveying topographic maps of the area studied, the numeral model was prepared and checked with the two maps 1:100000 of Natanz and Taragh that lead to segmentation of morphologic ponds (Fig2).

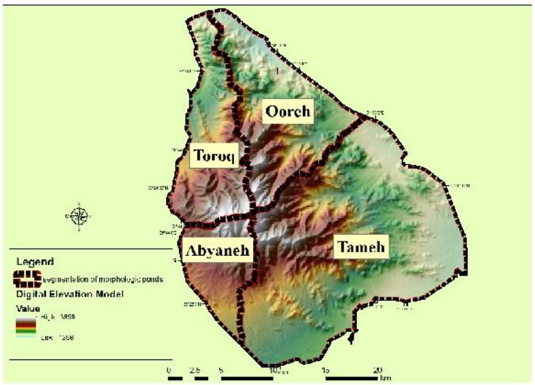

Fig. 2 Segmentation of morphologic ponds

Using the topographic map and high numeral model, the location of glacier circus in Karkas Mountain was characterized and by comparing that with the pictures from NASA, the accuracy of the location was confirmed (Fig.3).

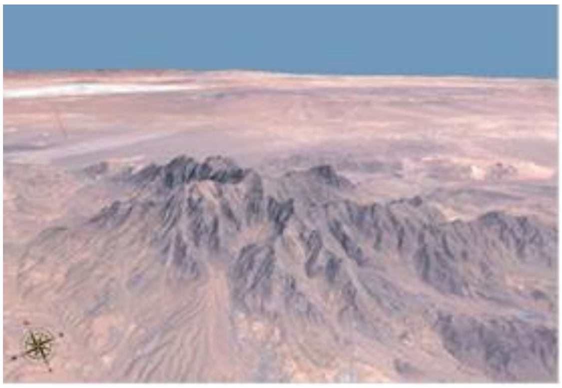

Fig. 3 NASA Image of Karkas Mountain

Using magnetization map from geology organization of the country, the active faults of Karkas Mountain were shown (Fig.4).

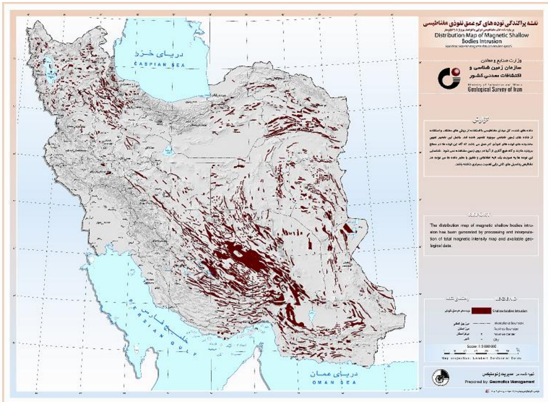

Fig.4 Distribution map of Magnetic shallow bodies Intrinsic

Topographic and other maps were used to indirectly observe landforms and glacier geomorphic phenomenon and geology maps were used for zoning geomorphologic units. This map, after classification in four classes, determined the limits of geomorphic stages (Fig.5).

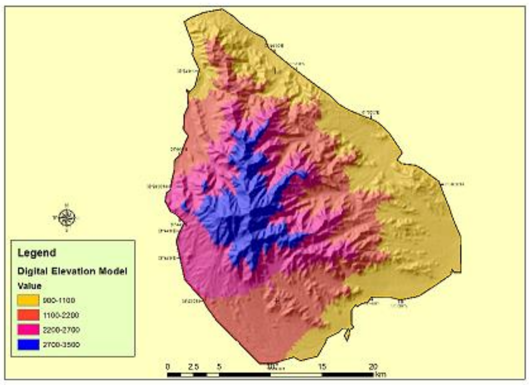

Fig.5 Four stages of erosion or geomorphic

At the end, to make sure about the accuracy of the operation with field studies, glacier evidence in the area were observed and measuring of probable snow borderline and also measuring the heights of the glacier circuses above 2700 meters was done and finally considering the present temperature of the area, the limits and width of the glaciers in that area were followed.

III. RESULTS OR FINDINGS OF THE RESEARCH

Studies show that Karkas mountain, the highest summit in the center of Iran which was formed by collision of two plates of Arabia and Iran, has an almost homogenous and unique morphology because on latitude $33^0\ 27^{/}\ 21^{//}$ temperature doesn't normally reach the freezing level but in Karkas there is enough glacier evidence that caused a big glacier circus as vast as 1680 m^2 on 2700 meters height (Fig.6).

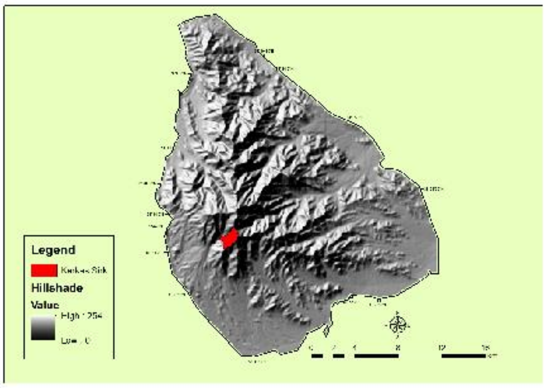

Fig. 6 Location of Karkas Mountain Glaciers Sirk

Dividing parts of Karkas Mountain shows that the south-west valley was formed by glacier erosion and the other three valleys were dug by rivers. The existence of river terrace wherever there is tectonic forces function indicates climate intermittence. This comes from the fact that usually in cold periods more sediments are carried to the river and less materials exit from that therefore in these periods there is sedimentary accumulation and the flow in the contrary in hot periods with the increase of water flow and re-digging the bed of the river is deeper, hence we can relate sedimentation to cold periods and erosion to hot periods and the result of this procedure is observed as river terrace and it is considered as a cold climate [7]. The evidence mentioned above in field surveys were confirmed (Fig.7).


Fig.7 Results as river terrace

In this survey gradients and thresholds caused new division in this mountain which is mentioned as geomorphologic stages. (Fig.5)

IV. DISCUSSION AND CONCLUSION

Researches discuss mountainous stages considering vegetation and slopes, heights, weather and hydrology are neglected and/or brought up as a second matter and in this level also mostly climate, soil, and sometimes hydrology was noticed and geomorphologic phenomenon were always paid little attention to or considered as not very important. Maybe one of the most controversial geomorphic filed is topics related to quaternary climate changes and their feedbacks. Iran, because of its vast variety in its geomorphic environments and on the other hand because of these shapes being widespread has attracted the attention of many researches so far [8]. In this mountain, considering these disorder and eventually borders and thresholds, different erosion systems which are effectively active before our eyes, we can divide this mountain into four erosion or geomorphic stages (Fig.5) that are as followed:

Upper or high stage: higher than 2700meterse
Middle stage: between 2200-2700 meters
Lower stage: between 1100-2200 meters
Very low stage: lower than 1100 meters

Studying gradients and indexes shows that this mountain has a special environment regarding its morphology. Morphology and weather have caused the emergence of different morphoclimatic systems and with the increase in height the impacts of these systems become more effective. Generally the amount of erosion increases in higher altitudes.

Surveying the existing morphologic shapes and especially morphologic evidence related to ser, quaternary and on one hand their location and height state and on the other hand the conditions of present and past climate were used to reach a conclusion.

To make the map of same temperature areas in ser, quaternary period the annual average temperature for the bottom of glacier circuses in the area which are located on 3000 meters height 4 to 6 degrees centigrade was spotted for July [9]. Since the stability of glaciers depends on climatic conditions and the average temperature of the time, to study the expanse limits of glaciers, after making the map of Karkas glacier cirque, field and direct observation of glacier cirque was done to be referred to.

A. PROCESSES GLACIERS

Among suitable factors for formation of glaciers are high amounts of snow and low temperature in summer. Erosion and weathering in form of frost, and mechanical destruction also moderately appear. But chemical destruction in that is low.

A glacier can be considered as a sedimentary system in which material aggregation is either carried, or settled in response to increase or decrease of force.

For the movement of glacier there are three groups of procedures that interfere which are contractually called internal changes of shape, slide of base, and changes of bed. The pace of most glaciers in most part of their route is 3 to 300 meters a year but this pace could reach 1 to 2 kilometers a year in slope frozen hillsides [10].

B. GLACIER EROSION

The period of quaternary is divided to pleistosen and holocene. The first one is in accordance with glacier period and the second one with post glacier period. The temperature in pleistosen altered many times. In mild zones the average dropped for between 8 to 10 degrees and in tropical zones it dropped for four degrees so in different parts of the earth, glacier zones vastly expanded and the start of the fourth frost was from one million years ago and continued to 100000 years ago [11].

Along with the movement of ice and destructive material in that, the view of the surface of the earth changes.

Shapes that are fundamentally formed by glacier erosion are rare and include two groups. The one that is along the flow and includes whaleback and stone drumlin shapes and the one that is partly along the flow and includes sheepback shapes [12].

According to field observations the effects of glacier morphology in Karkas hillsides are very well recognizable and distinguishable from 2500 meters height. Among the most important ones are glacier cirques on above 2700 meters height. In the upstream of Gavbast in the south of the big village and at the end of these two valleys there are two glacier cirques ending in this village on above 2700 meters height (Fig.6). At the end of each of these cirques there is a stone crag made of cretaceous lime. The bottoms of these cirques are covered with moraine mass between 10 to 15 meters thick. The water nets of this moraine mass are cut paralleled to the slope of the valley, but glacier effects such as subsidence pits caused by melting buried ice cores can still be seen in mountainous heights of the area as enclosed pits. The erosion of the river is directly related to 3 factors of slope, amount of water, and alluvia. The most erosion happens where these three factors coexist [13]. In Karkas Mountain U-shaped valleys in the downstream of the glacial cirques on 2500 meters height is another form Morney shapes that can be seen in mountainous heights.

Beside that at the bottom of most of valleys with glacier origin in these levels of height, a coating of moraine sediments is seen. The expanse of moraine sediments is up to 2500 meters high. In some parts the dimensions of these pieces are so large that it seems impossible for the present drainage net to be able to carry them even in the time of the most amount of water and this is the best reason that they are moraine, especially that they are located in places that from the petrology point of view they show no match with formations around them in the hillsides of the valley and are kilometers far from their origin. The dimensions of some of these moraines are so large that even the possibility of them being carried in heavy flood conditions in the past rain periods is far from imagination. Moraine pieces are spread to 2500 meters heights and this shows that glacier tongues existed up to this height. In downstream, glacier cirques with present moraine pieces on the sides of the valley that is located as a high terrace to present talweg in this valley shows the previous level of glacier flow on this altitude. Besides that, the bottoms of wide valleys in this area are all made of moraine terraces (Fig.8).

Fig.8 Moraine terraces

The flow of rivers with the origin of winter-snow melt that doesn’t have much water flow have dug the surface of this moraine bed and now this moraine bed dominates the present bed of the river as terraces.

In a part of northern hillsides of Karkas mountain and the end of Qamsar valley in a place locally called Meydan on 2200 meters height there is a hill like a drumlin that is the remains of moraine coating erosion at the bottom of this valley. Lower height of this moraine mass in relation to the surface expanse of moraines of the areas shows that it is older and on the other side it shows the end limit of expansion of moraines up to this height.

Therefore, referring to the present evidence during field studies and surveying the temperature in the past, the border of glacier tongues' expansion was definitely 2500 meters and probably 2200 meters high at the end of Qamsar valley. From 2500 downward to about 1000 meters according to the evidence and also previous studies and opinions of other researches it is classified as fluvial 1 morphodynamic zone. Hence, except for shapes of erosion caused by washing drainage net there are no other effects seen. Only in villages' routes and the distance of balance curve 1200 and 1700 meters sedimentation of the river is seen as a sequence of river terrace. There are specifically 4 sequence terraces along some of the rivers of the area. The most distinctive of these terraces are formed in Abyaneh valley route. Because of springs saturated with calcium bicarbonate in hillsides of the valleys and sedimentation between terraces sedimentations of these formations are coherent with Travertine sedimentation.

From 1000 to 1200 meters exactly from where the line of slope changes in Karkas Mountain, it is where the summit of alluvial fan in the level of sides of the floodway pediments forms. From this point a gentle slope generally less than 3 to 5 percent as long as more than 15 to 20 kilometers to the border of Bande-rig that is the lowest point, it has created a flat plain. The change of base level and the dominance of dry to semidry conditions after glacier period and decrease of river's water flow have caused stability in gully route in the surface of this alluvial fan. This phenomena has caused deep digging of gullies especially in upper parts of alluvial fans so in some parts the formation of the third period in the bed of this gullies and under the coating of alluvial fan sediments are shown. Of course the effect of subsidence of central hole and floodway hole should not be ignored because the digging of the bed of the river is not homogenous in the whole surface of plains in the area. This factor of difference shows the impact of tectonic activity in different parts. While the effect of climate changes in short distances cannot be the origin of these differences, the existence of knolls in the upper part of plains and downstream of the slope change line of the base of the hillside shows the amount of tectonic effect even in periods before the last quaternary glacier period. What is certain is that in the margin of the mountainous area and lower than 2000 meters of height there are many spas with much more water flows that suggests wet periods and the dominance of rain conditions in this area. Considering these geomorphologic evidence it is possible to present specific height levels for the formation of heritages mentioned in a profile of Karkas heights to Bande-rig and floodway pit as shown in table 1.

TABLE 1 HEIGHT DIVISION AND GEOMORPHIC EVIDENCE OF GLACIER PERIOD

Morphoclimatic zone	**Height border (meter)**	**Geomorphologic evidence**
Glacier	Above 2700	Glacier Cirques, glacier erosion effects
Solifluction	2500 to 2700	Glacier flows, moraines at the bottom of the valleys, effects of hillside movements and solifluction
fluvial	1200 to 2500	Zone of hillside washing in rain time, shapes of gullies, groove and ditch erosion, river terraces, travertine formations made by active spring sedimentation in rain periods

REFERENCES

[1] Pedrami, M., *Reviewing time stratigraphy of neogene quaternary, geology organization of the country*, 1366.
[2] Mahmoodi, F., *Evolution of Iran's relief in quaternary, journal of geographic researches*, issue 23, 1376.
[3] Yamani, M; Moghimi, E; Azizi, Gh; Bakhishi, K., *Determining Holson morphoclimatic territories in heights of west of Kordestan province*, Natural geographic researches, issue 4, pages 1 to 14, 1392.
[4] Darvishzadeh, A., *Geology of Iran*. Payam noor university publications, 1376.
[5] Servati, M., *zone geomorphology of Iran*. Geography organization of army forces, 1381.
[6] Jedari Eyvazi, J., *geomorphology of Iran*, Payame noor university publications, 1383.
[7] Alijani, B and Kaviani, M., *Basics of meteorology, SAMT publications*, 1371.
[8] Bobek, H, *Future and formation of the great desert and floodway, arid zone Research center*, university of Tehran, 1959.
[9] Pedrami, M. *Pleistocene and Paleo climate in Iran*. Geo, I, Surv, Tehran 1982.
[10] Hassanalizadeh, D., *Geomorphology of Karkas in Natanz*. Thesis of M.A Shahid Beheshti University. Advisor professor Servati, 1374.
[11] Yamani, M., *Geomorphologic evidence of glacier borders in Karkas hillsides*, 1386.
[12] Rabbani, N. Shayan, Gh. *Geomorphology, Motoon-e-darsi publications*, 1371.
[13] Haririan, M., *Cognition of the body of the earth*. Islamic Azad University, 1369.
[14] Geography organization of the country, topographic map scale 1:100000
[15] Geology organization of the country, geology maps scale 1:100000
[16] Weather forecast organization of the country, climate and weather statistics. www.nasa.gov