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Full Length Research Paper

Determination of desert areas in the view point of geomorphology using geographical information system: A case study of Ardestan, Isfahan

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Geomorphology mainly deals with the factor that affects the formation of earth crust, or in other words, it investigates the earth's surface reliefs and studies the origin and main factor which affect their formation, and finally, it deals with the deposit that stems from them. In this research, in order to determine and discriminate the desert region realm in eight regions of Ardestan (Isfahan province), the morphologic methods were used. For this purpose, using geomorphological and geological maps and integrating the data that are related to desert specific geomorphological landscapes, pediments, dunes, Yolk and Chrbh Kavirs, salinity land and wet margin, were identified. Subsequently, the landscape boundaries were modified and new landscape were identified and added to the old ones, using ETM aerial photographs. Finally, the aforementioned areas were introduced as Ardestan desert areas. Based on the conducted investigations, the development of desert specific geomorphological facies at the studied basin scope accounted for 60% of the area.

Key words: Geomorphology, desert area, aerial photographs, Ardestan.

INTRODUCTION

Deserts resulted from geomorphological phenomena, having been classified and defined in terms of morphological and structural characteristics. The studies on the determination and classification of deserts in the view point of geomorphology had been done by Sidronkov (1950), Clement (1954), Fedrich (1964) and Dersh (1962); afterwards, Hosseinzadeh (1999) conducted a similar study. At Sidronkov's investigation, in terms of morphology, deserts are classified into: two and one big depositional eras. The former is adjacent to the big mountain mass that involves playing with a thicken fluvial sediment, while the latter included the mountain landscape complex or elevations with shadow trenches and their most important feature, which is the original rack out crops on the earth surface. Clement classified deserts based on geomorphological facies which include: Kavirs, desert plains, dunes, badlands, out crops, alluvia fans that are formed at the end of the mountain valley and on plains and inferior lands between alluvial fans. Angew (1992) introduced soil and geomorphology, as well as vegetation, as a criterion for assessing deserts. For the fact that these factors have a little variation than climate, it is believed that boundaries of the arid region begin with geomorphological characteristic and terminate with soil and vegetation factors.

Mahmoodi (1988) has classified deserts of iron into two categories: coastal and internal deserts, with respect to the same geomorphological effects (including the volume and extent of height relief in the environmental condition of iron). They stated that landscape extension to include pediment, dune, Nepka, sebkha flooded beds in the course of water ways, Badlands, Yurdung, Clute, Reg plain or gravel plain, salt dome, bare lands and swamps, are all indicators for desert discrimination and determination (Khosroshahi, 2001).

Gholampoor (2008), while studying at Hormozgan province by determining the deserts realm area, concluded that deserts specific geomorphological facies accounted for 17.2% in the province. Hence, geomorphology

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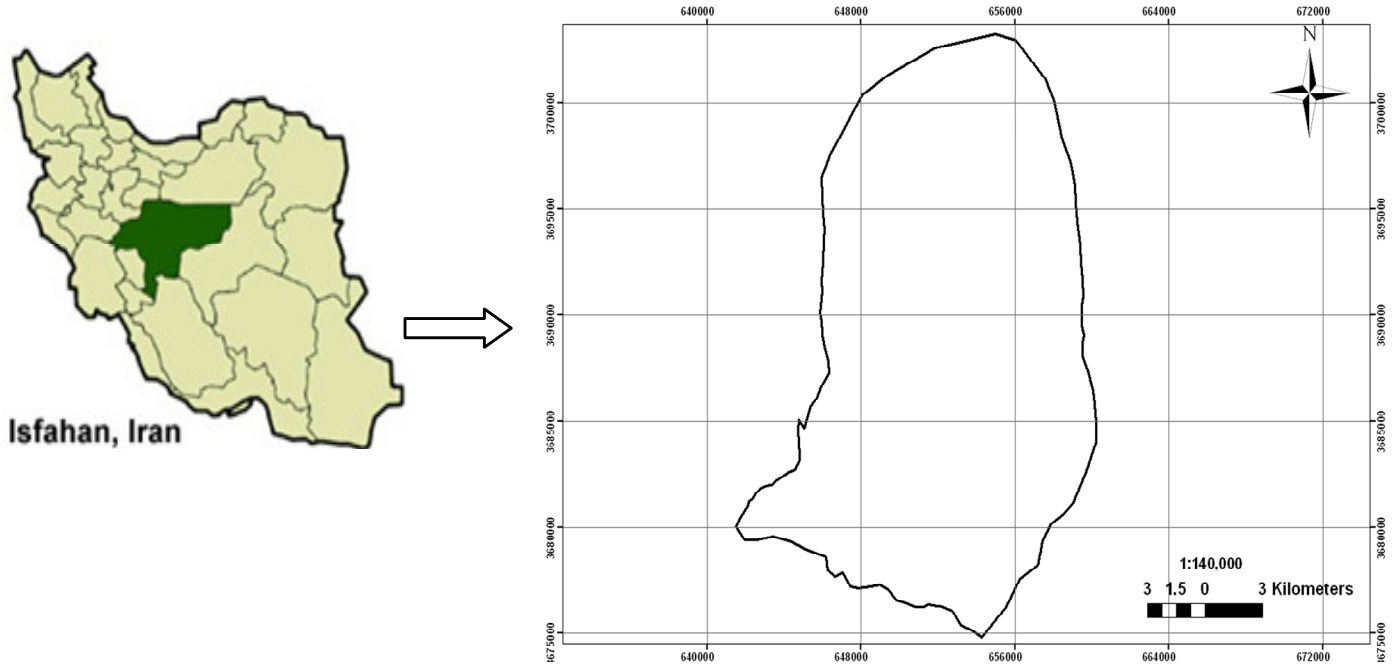

Figure 1. Geographical situation of the study area.

studies, earth relieve identification and the main process forming them is important. In this research, in order to determine and discriminate the desert region realm in eight regions of Ardestan (Isfahan province), the morphologic methods were used.

MATERIALS AND METHODS

Study area location

Ardestan catchment is located at 115 km2 in the north of Isfahan province. Ardestan city is between 33˚ 12′ to 33˚ 26′ N and 52˚ 38′ to 50˚ 39′ E (Figure 1).

The northern part of the catchment is flat and is related to the Kavir plain, while its southern part is mountainous. The lowest point in the area, with 980 m in height, is located in the center of the playa, while the highest point is 2850 m.

Hence, vegetation and temperature are different in the north and south. The north climate is dry and warm, while the south has more temperate climate.

As a whole, Ardestan climate is dry, warm and diurnal, while summer and winter variations are high (Tahmasebi, 2003). Due to dry nature, gravelly, sandy and salin soil in north, high evaporation in south, area is too poor and its vegetation type is dry-steppe. Based on ten years morphological statistic data, in this city, precipitation has reported 117mm in a year which is in form of disperse storms. Temperature are +48° (centigrade) and -10° at the warmest and the coldest day of year respectively (Moradi, 2006).

Methods of research

In this study, the topographical and geological maps in the Ardestan province were digitalized after the georeference operations at ARCGIS 9/2 version medium, and then the desert specific geomorphological information found in the maps with a scale of 1:100000 were extracted. At the end, using the integrated and aerial maps from the topographical and geological maps, the photographs interpretation was carried out based on the most appropriate natural components (Mohtashamnia, 2007). This map has been digitalized by the geomorphological information system and its realm has been determined by field visitation as far as possible. As such, the corresponded facies controlled the needed modifications exerted on the aforementioned areas introduced as desert maps (Gholampur, 2008).

RESULTS AND DISCUSSION

The morphological characteristics and geographical position of each geomorphological unit at Ardestan, which was identified using geological maps and aerial photographs, and which was digitalized in Arc GIS medium is shown subsequently.

Lithological features in the studied area

Quaternary fluvial deposits in the area are involved in old fluvial terrace, alluvial fans Javandasht terrace, Javandasth alluvium and fluvial bed deposits. The oldest deposits related to quaternary are located in the north of the region that is adjacent to the marginal plain of Degh sorkh. This formation, sometimes, creates elevated terrace in the pediment and is completely separated from other alluvial units in terms of morphology. We observe that alluvial plain consisted of sand, clay and silt, and

Table 1. Lithological features in studied area.

Area (ha)	Sign	Stone	Period	Age	Row
4788	Ev	Lava and volcanic	Eocene	Tertiary	1
228	Eo	Basalt, andesite and gnglvmra			2
2781	Eat	Gnglvmra and pyrvklastyk			3
1493	Ei2	Aygnmbrnyt and Rhyolite			4
658	Ed	Diabase and sand stone			5
1935	Q4p	Quaternary and salt pan			6
3028	Q1ap	Very old alluvial plains, sand, gnglvmra, rock and gravel	Quaternary	Fourthly	7
9499	Q2ap	Old sediments, gnglvmra, sand and rock			8
2571	Q3e	Sand dune			9
6765	Q3ap	New deposits and low sedimentary plains			10

Table 2. Facies' study area.

Area (ha)	Facies	Type	Unit	Area (ha)	Facies	Type	Unit
1520.3	Reg plain	Cover	Pediment	6290	Rock mass and detrial cone	Irregular domain	Mountain
724.7	Dry river						
3448.4	Sand dune			283.5	Water erosion		
536.1	Agricultural area			2184	Alluvial fan	Erosion	Pediment
618.9	Bouffant	Plain clay	Playa	185.7	Water erosion		
408.9	Wet and sticky area			4179.7	Reg plain		
258.2	Broccoli-shaped	Kavir		769.7	Agricultural area		
482	Salt pan			3700.5	Reg plain	Appendage	
560.5	Polygon surfaces			769.7	Agricultural area		
700.3	White and wet area						

sometimes caused fragments in the southern edge of Degh Sorkh basin. In the same region, young alluviums are observed in the rout of the river and they are very diverse in terms of sorting and forming dimension. The finest alluvium deposits are located on Degh Sorkh river. The main reason for the deposition of fine grain sediments such as clay, silt and sand, along with salt and gyps, is a declination of the river and stream energies in the inferior region. This sedimentation is extended in the margin of Degh Sorkh river across the most inner part of it. The aeolion sand, followed by clay and salty sand are the most important sediment in Degh Sorkh kavir (Khosroshahi, 2001). However, the lithological features in the area are illustrated in Table 1.

Geomorphology maps preparation

Much care must be taken to determine facies boundaries. For the purpose of using land satellite photographs and ETM present aerial photographs, the geomorphological preliminary facies maps were prepared. This map has been referenced at the photographic system and all facies boundaries are monitored by the usage of GPS in the field. This requires much experience and skills, and also, it involves the knowledge that experts have about all geomorphological facies which can easily separate them in the field (Ekhlaspur, 1992). The facies in the area are illustrated in Table 2.

Gravely plain facies

This plain is found as a leveled surface on the western north of the studied area. This plain originated from sedimentation by streams in the past. Subsequently, wind erosion was added and the fine particle was carried by the wind. Finally, the entire fine particle was removed from the area, and the course particles such as gravel and sand remained. Consequently, every part of the area was covered by medium size gravel which wind could not carry. Some sediments have red or black color, which mostly resulted from iron oxide and manganese in which there is a little SiO2. This phenomenon results from the ascending iron and manganese oxide due to capillarity by server evaporation (Figure 2).

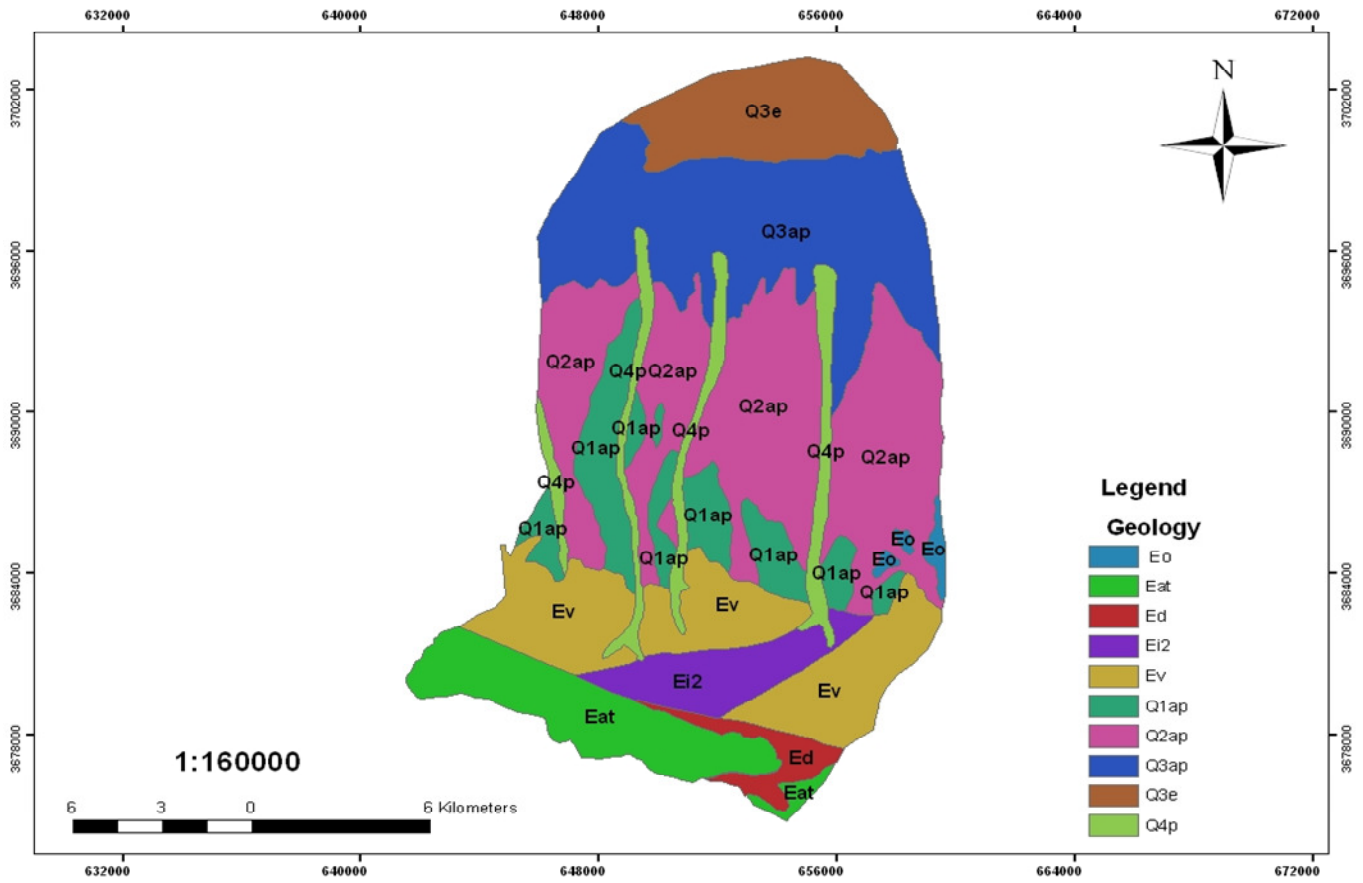

Figure 2. Geology map of the study area.

Sand surface facies

This facies is found in the northern part of the area, extending across the eastern north and western north sand facies. It is observed that the facies is formed in a place where the velocity of the wind decreases (without running into barrier). Nonetheless, Barkhans and dunes are, generally, the most important sand formation region of this area.

Dry river facies

This facies, far from elevations, is formed by run offs at north and western north elevations. Due to the decline in energy, particle size gradually decreases and they are in one direction.

Puffed facies

In this facies (Figure 3), ground water is close to the earth surface and because of the present of salts in water, the salts ascend by capillarity, while the water evaporates at the surface and the salt that is crystallized appears as puffed in the surface. The halophytes plants are extended in this area and they form small hills under bushes because of the aclian deposition.

Wet surface facies

This facies is close to the water table, so that the surface of the land is sometimes saturated because of a high level of salinity. However, only helophyte plants have the ability to grow here.

Broccoli-shaped facies

This is the part of the kavir that is adjacent to the dunes, affected by the turbulated wind current and which is covered by an extremely thin layer of sand. When the kavir is moist and when there are remainders of sand, the facies will be deposited with a mixture of clay and salt, and then, the eolian sands that have morphology of wind and side erosion will be affected by chemical de-gradation. While this leads to decrease slope at the Kavir

Figure 3. Facies map of the study area.

margin towards the inner part of the kavir, abrasion at the salts' surface by energy of the wind, due to the dropping water table, will be possible. In addition to the broccoli-shaped land, the kavir margin polygon is a form of landscape whose height sometimes reaches 10 cm (Ahmadi, 2006).

Sebkha facies

NaCl has strident to loss clay coherence which decreased its resistance. This salt can be contracted at the surface and it formed a thin layer of pure salt which has a conservational role against the wind erosion. However, there is no vegetation in the facies and the coldest day of the year, respectively.

DISCUSSION

Given the studied characteristics, the region consisted of specific morphological units, types and facies in which the gravel plains, among specific desert morphological facies and wet facies, have the most and least area, respectively. Diminishing of the river and the streams energy, led to very fine particle deposit sedimentation such as clay, silt and sand, along with salt and gyps at the inferior area.

This sedimentation phenomenon extended from Degh Sorkh River to most interior part of it. The aelian sand, followed by clay and salty sand are the most important sediments in Degh Sorkh. Having surveyed each of the aforementioned facies, the corresponded units, incorporated in the form of maps and desert realm, were

Figure 4. Map of the studied desert realm, with emphasis on geomorphology.

determined in the view point of geomorphology (Figure 4).

The results showed that desert specific geomorphological landscapes are also observable at different types of kavir facies and they account for 60% of Ardestan basin.

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