Relationships Between Effective Parameters in Barchans' Shape  
(Case Study: South-West of Maranjab)

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**Abstract:** Band-e-rig in Kashan is one of the rarest great sand sheet which has a variety of sand shapes and is located in the south of Salt Lake in Iran. The area under study is a part of Band-e-rig in the south-west of Maranjab which is 1.272 on the area square kilometers. In this study aerial photos and topography maps with ETM+ images are used to recognition sand figures. The procedure was based on field surveys and several visits to the area along with direct measurement of figures and finally statistical analysis the 30 sample dunes were selected for measurement. The selected 30 Barchan dunes have a height of typically between 2 to 8 m and are closely spaced, separated by few meters only. The aim of this project was to correlation between independent variables and Barchan width for about one year (from Nov. 2nd 2007 to Nov. 10th 2008). Results of investigation indicate a reasonably positive good linear relationship between the height of Barchan slip face (h) and distances of dune from axis right and left horns (Wa-Wb) whereas with geometrical changes in other variables, wide variations were observed in the width of barchans.

**Key words:** Morphometric % Barchan % Dune height % Horn width % Kashan Band-e-rig

**INTRODUCTION**

This paper examines morphometric relationships of Barchans dunes elements in the Kashan Band-e-rig area. A Barchan is crescent dune isolated on a firm coherent basement, such as Sabka, pediment or desert pavement [1]. The term has also been variously expelled Barchans, Barchane, barkan and barkhan [2] that also introduce Peykara in Iran. Barchan dunes occur if the wind comes steadily from the same direction throughout the year and if there is not enough sand to cover the entire surface [3]. This dune shapes occur in coastal and desert regions may be formed from sand, snow, or a combination of both are formed where vegetation is absent and have been described from virtually all latitudes [4-8]. Barchans are variously affected by secondary or oblique winds and may display horn extension or evolve into linear dunes [9-11].

By using linear relationship between width and rate of movement Barchans, in the Nazaka area, is stated that can estimate movement of sand dune by height and width of Barchans as smaller Barchans, migrate faster than larger Barchans. A large amount of dune work [12-19] has been dedicated to the geometrical characteristics of Barchans. Most researchers have focused on several main geometrical parameters, such as length, width, height and side slope and general relationships between them. For example, it has been found that the height of slipface is a linear function of the width of the horns. The shape of Barchans dunes of southern morocco was survived and proposed in sample model for dune shape, using data to determine the model parameters. Despite simplest, this model was able to explain the difference between Barchans where the crest and the brink coincide and those where they are separated [3]. In the Badin Jaran of China examined the general characteristics of the megadunes - lake alternation landscape by field survey and interpretation of aerial photographs. The aerial photograph was taken in 1960 and 1999. It shows that the landscape did not experience obvious changes over the latest 40 years. It indicates that the height of the megadunes differs from place to place so that the highest mega dune occurs in the south; along 40° N [20]. On Mars are assessed four methods to estimate the height of Aeolian dunes. These were 1- stereography 2- slip face length 3- profiling photoclinometry and 4- Mars orbiter laser Altimeter (MOLA) these techniques provide data on a range of morphometric parameters for dunes on Mars. They include dune height, width, length, surface area, volume and longitudinal and transverse profiles [21] as...
well as studied circumstance formation Barchans in the Mars and considered that Barchans, develop where wind is unidirectional and the available sand is insufficient to cover the entire dune field [22], however is observed Barchans in Strzelecki-Simpson desert, Australia that developed in areas where winds blow seasonally in opposite directions and described a peculiar deformation feature, the rear slipface that is not found in ordinary Barchans [23]. Some researchers in Minqin oasis, china is studied Barchans morphometry. In this research is stated that the height of slip face is proportional to the width of horns and the baseline can be roughly described by parts of an ellipse and parabola. They studied dune geomorphology using the theory of differential geometry and explained that geometrical characteristics of the brink can be quantitatively determined by its curvature and torsion [24].

The main aim of this research was to measurement of various parameters by forced of Barchan shape and to obtain linear relation type between widths of Barchan with independent variable and calculation of regression equation.

**Field Area:** The source of this dune field lies between 34° 16’ 12” to 34° 17´ 05” N latitude and 51° 40´ 45” to 51°41´ 45” E longitude. Average altitude of area on the study is 820m above mean sea level. It is located on the south salt lake and south western Maranjab-rig in 30 km NE of Aranbidgol with an area of 1200×1060m (1.272km²). This sand sheet is part of Kashan Band-e-rig in Kashan with an area of 830 km² approximately. The maximum mean temperature varies from 10.2°C in January to 40.8°C in July while the mean minimum temperature varies from -0.3°C in January to 24.8°C in July. Average annual rainfall is about 138.4 mm.

**MATERIAL AND METHODS**

In this study aerial photos were provided in 1957 and 1994 (in scales 1.55000 and 1.40000 respectively) and topography maps with +ETM images of 2002 were taken to recognize sand figures and specify the target area. Next meteorological statistic of 1960 to 2005 were taken from Kashan synoptic station to determine status of climate condition and direction of dominant wind. Then seasonal and annual wind rose was designed by WRPLOT software. In the next stage, by surveying and observing the field, 30 figures Barchans were selected that were typical sampled by GPS and therefore geometric characters of Barchans were measured, using assessment tools finally by analysis and classifying the data we discussed the relation between effective parameters on Barchans figure, correlation analysis and regression by statistical software such as SPSS and Excel.

![Fig. 1: Situation of the field area and its Barchans’ location](image)
Table 1: Correlation coefficient matrix in using variables of regression equation

<table>
<thead>
<tr>
<th>Variable</th>
<th>h</th>
<th>La</th>
<th>Lb</th>
<th>Lo</th>
<th>Wa</th>
<th>Wb</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>1</td>
<td>.837**</td>
<td>.834**</td>
<td>.934**</td>
<td>.661**</td>
<td>.661**</td>
<td>.665**</td>
</tr>
<tr>
<td>La</td>
<td>1</td>
<td>.970**</td>
<td>.734**</td>
<td>.642**</td>
<td>.602**</td>
<td>.626**</td>
<td></td>
</tr>
<tr>
<td>Lb</td>
<td>1</td>
<td>.745**</td>
<td>.637**</td>
<td>.630**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lo</td>
<td>1</td>
<td>.542**</td>
<td>.550**</td>
<td>.549**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wa</td>
<td>1</td>
<td>.977**</td>
<td>.994**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wb</td>
<td>1</td>
<td>.994**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Significant in level 0.01 indicated that probability of its occurrence is equivalent to 99% and lack of its occurrence is the following figure one percent shows the normal curve of the population in histogram.

RESULTS AND DISCUSSION

Height and Width Relationship: In this work, the basic geometrical parameters were measured by using symmetrical barchans in this field with 1 to 8 m in height. The morphology of a Barchan is as illustrated in Fig. 2.

A reasonably good linear relationship between the height of slipface h and the width of horn W was found in many previous studies [12, 15, 25].

In this work we had a monthly surveying for a year on only those dunes which displayed a reasonably Barchanoideal shape.

Correlation and Regression Analyses: In geography investigation and quantity. This geography especially cases are not studied as single and individual but the interaction in relationship, effects and function of the phenomenon are significant. One of the methods to examine relationship and interaction rate in phenomenon is specify of correlation coefficient and subsequently regression equation for achievement of linear rate and relation type between phenomena. In this investigation, we used correlation coefficient to study for portion of each independent varies and it’s relation with Barchans shape that denoted a positive and significance correlation (Table 1).

We can easily find the degree of relationship linear observed frequenting and normal distribution by comparing the relating between variation in frequency of independent variables and normal distribution. Following normal curve drawing, we draw sample changes of population as histogram so as to specify conformity rate of observed frequencies and its normal distribution by comparing frequency changes of independent variables with its normal distribution (Fig. 4). Distribution of variables show, various parts of statistical population are not similar the histograms show Skewness and Kurtosis. Therefore barchans width (w) variable with 2.396 rate and the least Skewness is related to the distribution of height (h) variable with 0.198 rate (Fig. 4a.f). Also most of Kurtosis is related to distribution of barchans width (w) variable with 10.574 rate and the least Kurtosis is related to distribution of length of the right horn (lb) variable with -1.122 rate (Fig. 4c.f). The Relationship between variables is the simplest and the most general of relation that could be expressed as below:

\[ Y = a + bx \]

In this work we had a monthly surveying for a year on only those dunes which displayed a reasonably Barchanoideal shape. To review effective variable in Barchans shape we calculated linear relationship of each form of independent variables in association with dependent variable of Barchans width (Lo, La, Lb, h, Wa, Wb) until we find that the B coefficient indicating line slope shows how much variation in X for any single variation in Y.

We extract data necessary for the width and height slipface of Barchans by field work. Results of calculations as regression equation are shown below:

\[ W = 6.72h + 16.256 \]

Status of Prevailing Winds in the Study Area: Role of wind determine the creation of Barchan, movement direction and its rate. To understand status of wind blow we used statistical Kashan synoptic station during 31 years from 1966 to 2005 and calculated wind blow speed direction by WRPLOT Soft ware. Wind blow rose results show that the predominant wind of the area is in winter and spring seasons influenced by western wind with west direction. Whereas dominant wind in autumn and summer originate, from mid and north east, it enjoys less frequency compared with winter and spring seasons and also yearly windrose of Kashan station displays wind is blow direction to prevail upon north east wind blow direction 84.9 percent of recorded wind is regarded as
Fig. 2: Schematic illustration of a Barchan

Where:

\( L_o \) = The horizontal distance along the axis of symmetry from the trailing edge to the upper edge of the slipface.
\( L_a \) = Length of the left horn.
\( L_b \) = Length of the right horn.
\( h \) = The slipface height.
\( W_a \) = Distance of symmetry axis from the edge of left horn.
\( W_b \) = Distance of symmetry axis from the edge of right horn.

Fig. 3: View of a Barchan and its effective parameters

calm winds. In data analysis of winds with lower 4 knot there was no attention paid to sands replacement and Barchans’ movement creation due to its little effect (Fig. 5). Drawing wind rose represents several dominance and tributary during various seasons of the year that accounts for existence of several Barchans linear and phenomenal asymmetric barchans in study area.

CONCLUSIONS

In this work we evaluated elements of linear and phenomenal Barchans to determine of correlation type and Geometric parameters relationship and then the linear height – width relationship was calculated.

La, Lb, Lo, h, Wa and Wb are Morphometric parameters each affecting the Barchans width. In this study we considered linear rate and relation type between efficacious parameters in Barchans’ width until we specified the share of each from the said factors in Barchans’ width increase and decrease. Results express significant correlation (i.e. \( P > 0.01 \)) between all the independent variables and the dependant variables Barchans’ width. The results of quantities analysis show 98.9 and 98.8 percent of dune distance variation from the left and right axe respecting which are influenced by Barchans’ width. Looking at 0.994 rate of correlation coefficient at the level of 0.01 can indicate high correlation in independent parameters with Barchans’ that in fact
Fig. 4: The undulation linear diagram of elective variables frequency in relationship with trait of elective variables
Fig. 5: Seasonal and yearly wind rose Kashan synoptic station in statically period (1966-2005)
Fig. 6: Relationship between Barchan’s width and independent variables (Wa, Wb, h, La, Lb, Lo)

proves symmetry of the studied Barchans. Data show that 39.7, 39.2 and 30.1 percent of variations in Lb, La and Lo also under direct effect of the width of Barchans respectively. With a look at linear histograms, we can make the following deductions:

C Linear relation between W and Wa and Wb are complete direct relation that is the more distance of dune axe between left are right horns, the more width of Barchans (Fig. 6a,b).
C Linear relation between W and h in said area dose not display complete direct linear relation in Barchans with slip face of height (h) between 3.5 to 5 meter increases. Barchans’ width increases with accretion of directly h but in Barchans’ width h with smaller than 3.5 and larger than 5 meter. Barchans’ width indicates significant except in some curves (Fig. 6c).
C Linear relation between Barchans’ width (W) and length of right and left horns (Lb, La) is not a direct linear Barchans’ width with increase of horns length which shows positive and ascendant process in Barchans’ width length of right and left horns between 4 to 6 meters but in samples with length of
right and left horns less than 4 meter and more than 6 meter not only show increase of Barchans’ width but also display height decrease in width of Barchans (Fig. 6.e.d).

C. Linear relation between width and distance from slipface to tail of Barchan does not show complete direct linear relation. Whereas in Barchans between 32 to 37 m and 43 to 45 m, the distance from slipface to tail of Barchan with Barchan width is complete direct linear relation, such that with addition of distance from slipface to tail of Barchans said above Barchans’ width increase in Barchans with smaller and larger than this range when width of barchans decrease the distance of slipface to tail of Barchans will decrease (Fig. 6.f).

REFERENCES

19. Missing