

"Study of Morphometry factors Regressions of Chalus drainage basin using Statistical methods and mathematical models "

Mousavi harami . R¹ , Motamed . A² , Ahmadi,h³, Moghimi . A⁴

¹ - Professor of the Department of Geology , Ferdowsi University , Mashad

² - Professor of the Department of Geology , Islamic Azad University , Sciences and Research Branch , Tehran .

³ - Professor of the Department Of Natural Sources , Teharn University , Tehran .

⁴ -Faculty Member of the Department of Geology, Islamic Azad University , Lahijan Branch , Lahijan and

Ph.D.student in , Islamic Azad University Sciences and Research Branch , Tehran

Abstract

In this Study , we try to determine morphometryFactors Regressions of chalus drainage basin by Statitistical functions andmathematical Methods .

According to this study , a significant relation was found between Sub-basin areas and the length of drains in the form of linear and non- linear models (Exponential ,Quadriatic and cubic) .

Therefore , the largest drainage area belongs to grade 1 drains , and the Smallestdrainage area belongs to grade 5 and 6 drains Furthermore , using pearson Correlationcoefficient it can be concluded that the Length of grade 3 drains has the most effect onthe density of drain in chalus drainage basin .

Regarding the colinearity relations between area and altitude ($A = .018h$) , these two parameters cannot be used as independent Variables in regression models whose dependent variables are density of drain branch ratio (R_b) .

The Calculation of drain Frequency (F), Density of drain(D) and determination of the ratio F/D^2 in Chalus drainage basin indicates a linear relation ($F = .14D^2$)between the two parameters .

Consequently , this basin is in the stage prior to maximum drainage development ,regarding the evolution of drain network .

Keywords : *morphometry Variables , regression relations , mathematical models ,Statistical methods , density of drain , regression models , Pearson Correlation coefficient .*

Introduction

Drainage Basin refers to the area of a region where the runoff resulting from the rainfall in hat region is directed naturally to a single point called they "point of concentration" . If the point of Concentration is in the drainage basin , it is called a " closed basin " , and if the point of oncentration is located at the end of drainage basin . where the runoff can go out of the drainage basin "open basin" it is called an (Ali zadeh , 1381) . An awareness of the physiographical characteristic of a drainage basin together with the information obtained of the weather conditions of the region can show the quantitative and qualitative Functioning of the hydrological system of that busin(petilik , 1994).

In order to assess more accurately and to know the potentials of the drainage basin more, we can divide it into Smaller hydrological units (called sub-basin) and then to study each of them

(the units) separately . some of the physiographical and topographical features of a region including the slope and the height can control most of the climatical factors such as the temperature and its changes , the kind and quantity of annual rainfall , and the quantity of evaporation and transpiration , this yields to the formation of different kinds of regional weather conditions (Gurtz , 2000 , wang et . al., 2003 , Garsian et. al., 2004) .

Therefore, in geomorphological theological studies of a drainage basin , it is necessary to study the physiographical characteristics and morpho metrical factors and also the possible correlations and regressions between these factors beforehand .

The geographical positioning

The studied region is located in the north of IRAN and north range of middle Alborz 2 and in the south of Caspian sea in the geographical longitude of eastern 500 / 00¢ to eastern 500 / 35¢, and in the geographical latitude of northern 360 / 08¢ to northern 360 / 43¢ .The drainage basin of chalus river is leading to the drainage basin of Surd a brood river from west, the drainage basin of kurkuesar river from east, the drainage basin of karaj river from south , and the Caspian Sea from north(Figure 1) .



Figure 1: Geographic position of chalus drainage basin

Materials and Methods

In order to study the correlation and regression between morphometrical variables of the drainage basin of chalus river, first we divide it into smaller sub-basin (figure1) .According to this, the Chalus drainage basin is divided into four sub basin as:

- 1-The sub-basin of Elika-Duna, and kandeivan.
- 2- The sub-basin of Elite –Dalir.
- 3-The sub-basin of kojur(Hanisk).
- 4- The Sub-basin of Barar.

In the current study, first we will calculate the morphometrical parameters of the basin with the use of Arc view and Arc GIS Softwares . (tables1,2,3,4) , and then by means of spss 15 software also we will determine the regressions and correlation between morphometrical parameters .

Discussion

1-The relationship coefficient between the area of the subbasin and the length of river branches.

There was a consistent meaningful regressions coefficient of more than 78% on the surface between the area and the variable related to the length of the river branches whereas in large drainage basins, the existence of such regressions between variables is a sign of an increase in the length of total branches of a river in relation to longer branches (Farifte, 1991).

In the drainage basin of chalus, the regressions of the area and the length of drains is meaningful in different degrees on different levels. There fore , for each of the branch , we can present models with the following forms (figures , 2-a , 2-b , 2-c , 2-d , 2-e , 2-f): 1- A Compound model for Grade Drains (channels of first degree)(L1) :

$$(\ln(A) = 1.035 + (L1)(53/599) .$$

2- A linear model for Grade (2) drains (L2) :

$$A = -144/128 + 47/645 (L2)$$

3- A quadratic model for Grade (3) drains (L3):

$$A = -206/10 + (L3)^2 \times (31,105) + (596/65) \times L(3)$$

4- A compound model for Grad (4) drains (L4):

$$\ln(A) = 3.376 + 2.97 (L4)$$

5- A cubic Model for Grade (5) drains (L5) :

$$A = 325/22 - (L5)^3 \times (844/672) + 169$$

6- A Quadratic model for Grade (6) drains

$$A = 925/787 + (L8)^2 \times (132/203) - (639/615) \times (L6)$$

According to the above mentioned models , we can conclude that the relations between the area and the length of different drains either in linear models or in non-linear models is direct, however , the length of gamed (2) drains have the most influences on the area of drains .

2- the relations between the density of drains and the length of drains in sub-basins

In order to determine the effects of the length of grade of them , we used the Pearson correlation coefficient(table,5).

The results obtained from this method shows that the grade(3) drains have the most effects (the Linear model) , and the grade(6) drains have the least effects on the density of drains. (Figures 3-a , 3-b ,3-c , 3-d , 3-e , 3-f)

3- The relation between the dense of drains and height:

The regressional analysis of the two above – mentioned parameters shows the existence of a exponential model with a high reliability ($R^2 = 98\%$) . We can show this relationship as the following equation.

$$\ln(D) = - \% 1H = D = e^{-\% 1h}$$

In the above equation D Equals the dense of drains and h is the height.

Having in mind that in chalus drainage basin there is a reverse relation ship between the dense of drains and the height, and also that most of the area of the basin is drained with grade 1,2,3, and 4 drains (Table, than) . we can conclude that most of the dense of the drains is related to Grade 1,2,3,4 drains (which are located in the height of 500-3500 meter) . These deains cause the most amount of erosion which is under the influence of tectonic , impact of the

region and less than this under the influence of the Lithology of the drainage basin .(figures 4-a,4-b,4-c,4-d,4-e)

4- The relationship between the area and the height.

To explain the relationship between the are and the height, first we should make it clear that whet har the two parameters have a collinear relationship? If there is no collinear relationship, we .can consider them as independent variables in a regressional model in which the independent variables are the dense of drains and branch ratio.

Noticing that the area and the height are colinear (with the reliability of $R^2=0/98$ and $pv =\%4$) according to the following model :

$$A=\%018H$$

Where A is the Area and H is height.

These two parameters can not be considered as independent Variables in the mentioned correlation relationships (picture 8) . on the other hand , the relationship between the dense of drains and the area and also the relationship between the dense of drains and the height both follow a exponential function . This also is a reason to consider the relationship of the area and height as linear . Moreover, according to Table 2 , Grade 1,2,3,4 and 5 drains drain Larger area of the drainage basin , and Grade 6 drains drain Smaller area of the drainage basin . since most of the Grade 6 drains are located in the height of below 500 meters , we can consider this according to the findings of Doornkamp , 1990) due to the effect of factors such as the differentes of lithology , the amount of rain fall , and the different tectonic functioning in different patrs the drainage basin .

5- The relationship between the slop and the grade of the drain .

The existence of linear and nonwlinear relationships with high amount of reliability and low amount of error for the two parameters is according to the following models :

1- The linear model $x=n.2/09$

2- The non-linear model $x=e0/44n$

X= Tthe slope of the subbasin,n=The Grade of the drain

We can mention that the gradual progressive cutting of the drainage basin causes an increase in the averte slope in the length of the valley domain (according to the 5 phases of Gloks, 1970) , this can continue until the fifth phase , then we see a decrease in it (Athassios et al, 2005) .

The above – mentioned point indicates that the Grades 4 , and 5 drains have the most amount of slope , and due to this they have an in fluential role in the process of erosion and flood although they have a less important role in the dense of drains . (figures 5-a,5-b)

6- The relationship between the frequency of drains (F) and the dense of drains .

Since the frequency of drains and the dense of drains are obtained from the following equations (sham, 1989) :

$$F = \frac{\sum N_a}{A} \quad Nu= \text{the number of drain}$$

$$D = \frac{\sum L}{A} \quad L=\text{The length of drain}$$

$$D = \frac{\sum L}{A_{basin}} \quad A= \text{The area of drainage}$$

So we can write :

$$F/D = \frac{\sum N_u}{\sum L} = F/D_r = \frac{\sum N_u}{(\sum L)^r}$$

The frequency of drains in a drainage basin has a close relationship with the bed rock (Doornkamp, 1991). The obtained ratio (F/D) for chalus drainage basin is 0.14 (according to the finding of Chorely et al., 1990), therefore the drainage basin of chalus from the point of evolution of the drain network in the third phase (the phase before the maximum drainage development) (figure 6).

Results

1- since in chalus drainage basin, Grade -1 drains have the most amount of length, There is drains of the first grade drain more area compared to other drains (with Grades 2,3,4,5,6).

2- Since Grade 3 drains have less frequency compared to other drains (Grade 1,2,4,5,6), internal of evolution chalus basin is in the third stage (the stage prior the maximum drainage development).

3- since there is a colinearity relation between the area and the height (with high p.value and low percentage of error). we can not use these two parameters as independent variables in a regressional model whose dependent variables are the density of drain and the ratio of branch (Rb)

4- with the use of pearson correlation coefficient, it is made clear that in chalus drainage basin, the length of Grade 3 drains has the most amount of influence on the density of drain, and the length of Grade 3 drains has the least amount of influence on the density of drain. So in the process of erosion and flooding, Grade 3 drains are more important).

5-The colinearity and exponential relations between the slope of the subbasin and the grade of drains indicates that the gradual progressive cutting of the drainage basin causes an increase in the average slope in the domain of the valley. This continued until the third phase of the evolution of the drainage basin. This even can continue until the 5th phase (the beginning of the evolution of the drainage basin too, and then it can follow a decreasing process).

6-The results obtained from the morphometry of the drainage basin indicates that the average length of drain has the highest amount Elit –Dalir Sub-basin, and the least amount Barar sub-basin, Also, the comparison of the length of the drains with the same grade in Sub-basin indicate that grade 1 drains have that highest length, and grade 6 drains have the lowest length.

7- Furthermore, it has been shown that in chalus drainage basin the largest area of the basin which is drained by Grade1 drains belongs to kojur subbasin and the smallest area drained by Grade 1 drains belongs to Barar subbasin.

8- The calculation of the frequency of the drains (F) and the density (D), also the determinate on of the ratio of F/D^2 in chalus drainage basin indicates a linear relation ($F=0.14D^2$) and shows that this basin is located in the third stages (the stages prior to maximum drainage development) regarding the evolution of drain network.

References

- 1- Alizade . Amin (1998), "principles of applied hydrology" , 519 p.
- 2- Athanassios Ganas , Spyros pavlides , vassilios karastathis (2005) , "DEM – Based morphometry of range – front escarpment in Attica , Central Greece , and its relation to fault , Geomorphology , volume 65 , issue 3-4 , pages 301-319 .
- 3- Chorley , R.j , morgan (1962) , "Comparison of morphometric features unacca mountains , Tennessee and North Carolina Datmoor , England , Geo . Sco . Am . Bul . 73 pages 117-34 .
- 4- Chorley . J . Richard , schumm . A . Stanley , sudden . E . David (1990), "Geomorphology " , 455 p.
- 5- Doornkamp , G . A . M. king , Ven te Chow , (1991) , "quantitative Analysis in geomorphology " , 368 p .
- 6- Garcin . M , poisson , B (2004) . "High rates of geomorphological processes in a tropical area : the Remparts River case study (Re union Island , Indian ocean) , Geomorphology .
- 7- Goovaerts . p (2000) , "Goeostatistical approaches for incorporating elevation in to the spatial interpolation of rainfall " , Journal of Hydrology 227 , pages 113 – 129 .
- 8- Maria . jose , Lopez . Garcia , camarasa . M . Ana (1999) , "use of morphological units to improve drainage network extraction from a DEM" , International journal of Applied Earth observation and goinformation , volume 1 , issues 3-4 , pages 187 – 195.
- 9- pitlick . J (1994) , "Relation between peak flow , precipitation and physiogeraphy for five mountainous regions in the westen USA , journal of Hydrology , 158 , pages 219-230 .
10. Wang . H . Hall , C . A . S . Scatena , F . N . Fetcher (2003) , "Modeling the spatial and temporal variability in climate and primary productivity across the Luquillo mountains" , Puerto Rico , Forest Ecology and management , 179 , pages 69 – 94 . cxf

Table 1 : morphometric properties of sub-basins of chalus drainage basin

Ratio branch (Rb)	Grade and length of drain				Grade of drain	Density of drain	Length of drain	elevation (m)	Slope (%)	area (km ²)	Sub-basin name
2.28	4.869	4	57.308	1	6	0.146	85.157	2980	18.01	581.281	Kandevan and duna
	3.233	5	11.849	2							
	0.614	6	7.284	3							
3.51	-	4	60.565	1	3	0.425	85.113	2213	6.41	200.011	Elite(dalir)
	-	5	10.577	2							
	-	6	13.971	3							
2.52	4.418	4	67.138	1	6	0.139	104.501	2275	8.09	746.804	kojur
	1.820	5	19.020	2							
	4.507	6	7.827	3							
2.68	-	4	22.503	1	3	0.275	32.614	1877	4.34	118.599	barar
	-	5	5.218	2							
	-	6	4.893	3							
2.49	9.287	4	207.514	1	6	0.243	401.728	2132.9	4.32	1646.695	basin
	5.053	5	46.664	2							
	5.121	6	33.975	3							

Table 2 : morphometric properties of sub-basins of chalus drainage basin

(km) Length of drain in sub-basin	Grade and area						area (km) ²	Sub-basin name
	6	5	4	3	2	1		
85.157	4.191	22.068	33.235	49.720	80.881	391.183	581.281	Kandevan and duna
85.113	-	-	-	32.831	24.855	142.324	200.011	Elite(dalir)
104.73	32.138	12.977	31.504	55.812	135.626	478.744	746.804	kojur
32.614	-	-	-	17.793	18.975	81.830	118.599	barar
307.614	36.329	35.045	64.739	156.156	260.337	1094.081	1646.695	basin

Table 3 : geomorphological properties of sub-basins of chalus drainage basin

F/D2	D	F	$\sum Nu$	Grade6	Grade5	Grade4	Grade3	Grade2	Grade1	area	(Nu) number of drain Sub-basin name
0.370	0.146	0.796	465	3	22	16	26	103	295	581.281	Kandevan and duna-elika
0.12	0.425	2.184	437	-	7	49	33	85	263	200.011	Elite(dalir)
0.425	0.139	0.822	614	1	17	36	74	129	357	746.804	kojur
0.250	0.275	1.897	225	-	-	28	17	40	140	118.599	barar
0.179	0.243	1.057	1741	4	46	129	150	357	1055	1646.695	basin

Table 4 : ratio branch in sub-basins of chalus drainage basin

total Rb	5to6	4to5	3to4	3to	1to2	Rb Sub-basin name
2.57	4	0.58	2.28	3.06	2.93	kandevan
2.69	4	2.75	1.09	2.33	3.28	Elika
2.33	2	1.5	2.66	3.25	2.26	duna
3.33	-	7	0.67	2.57	3.09	Elite(dalir)
2.86	5.66	2.11	2.05	1.74	2.76	kojur
2.48	-	-	1.6	2.35	3.5	barar
2.39	2.7	2.8	1.16	2.38	2.95	basin

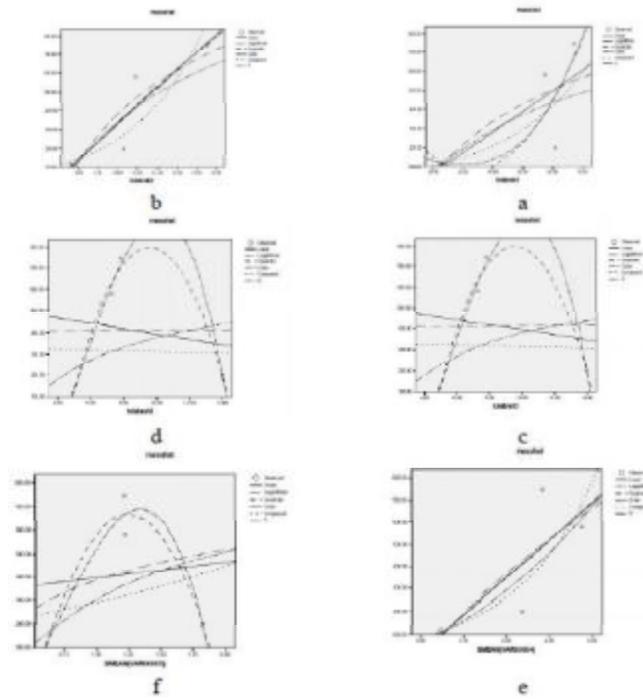


Figure 2 : relationship between area of sub-basins and length of drains

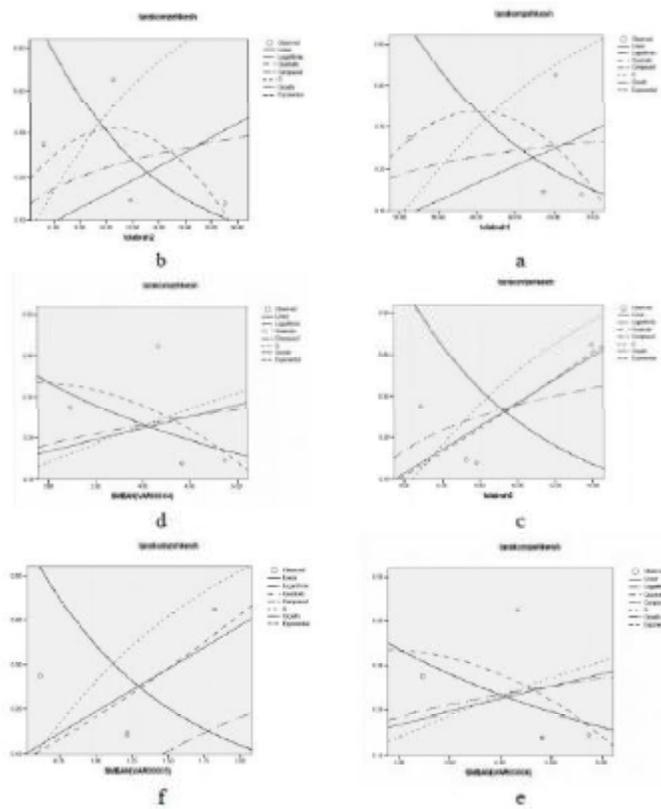


Figure 3 : relationship between density of drains and length of drains

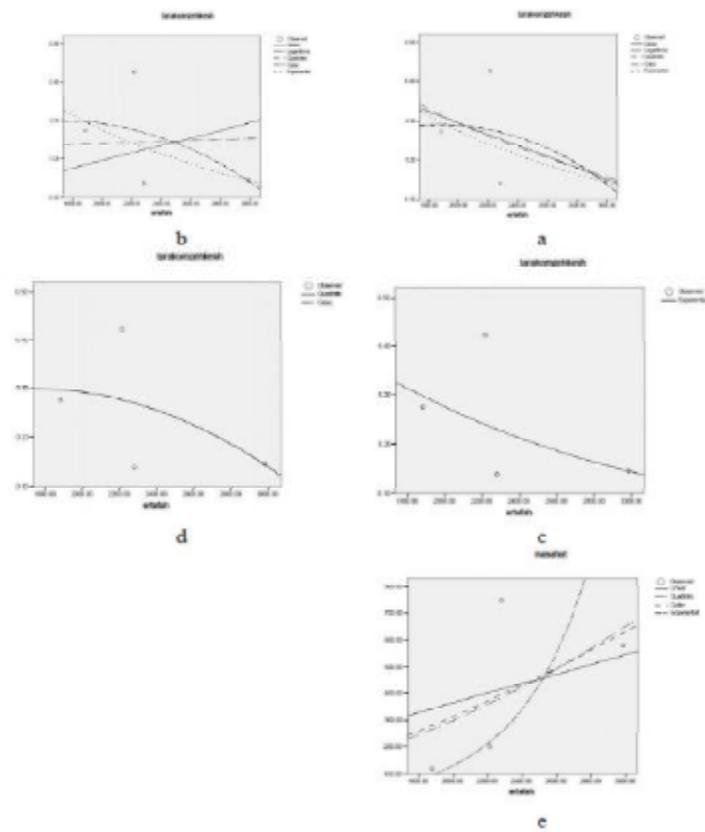


Figure 4 : relationship between density of drains and elevation

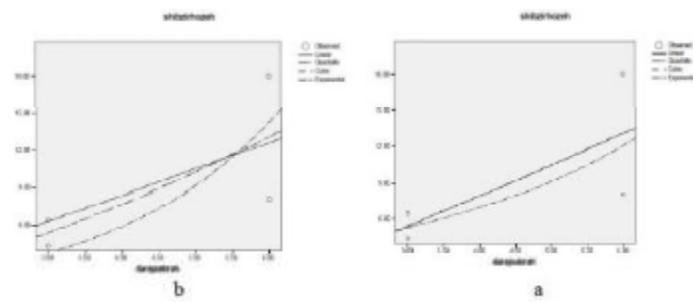


Figure 5 : relationship between slope and grade of drains

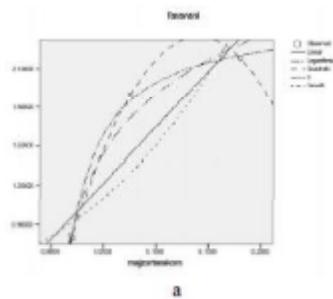


Figure 6: relationship between number and density of drains