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Salahaddin University-Erbil

On Some Mathematical Applications in Geology

Research Project

Submitted to the department of (Mathematic) in partial fulfillment of the requirements for the degree of BSc. in (forth)

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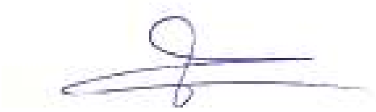
Signature: 

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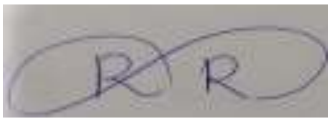
Signature: 

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Abstract

Mathematics is used in many fields of life and plays a very important role in other science branches such as chemistry, physics, biology, and sports. In this research, we are study mathematical applications in Geology and we focus on the applications of statistics, statistical graphics, ratio and proportion in Hydro meteorological data approaches such as water availability elements, monthly rainfall variation, Monthly rainfall variation, Annual rainfall variation and seasonal rainfall variation. Moreover, we sturdy relative humidity, water losses elements, wind speed and sunshine duration. Moreover, we study morphometric methods for assigning a numerical order to links in a stream network and identifying and classifying types of streams based upon their number of tributaries. At the end of this project we study Archie's Law and their applications.

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Introduction

Mathematics is essential in all aspects of life, including time tracking, driving, and cooking, as well as jobs in accounting, finance, banking, engineering, and software. These functions require a strong mathematical background, and scientific experiments by scientists need mathematical techniques. They are a language to describe scientists' work and achievements. Geology literally means "study of the Earth." Geology, also known as geoscience or earth science, is the primary earth science that studies how the earth formed, its structure and composition, and the various processes that act on it. In this work we focus on Mathematical applications in Geology especially the applications of statistics, statistical graphics, ratio and proportion in Climate change, Hydro meteorological data approaches, Hydro meteorological data approaches, Morphometric and Stream order.

This work consists of two chapters. In chapter one we study Hydro meteorological data approaches such as water availability elements, monthly rainfall variation, monthly rainfall variation, annual rainfall variation and seasonal rainfall variation. Moreover, we sturdy relative humidity, water losses elements, wind speed and sunshine duration. In chapter two we study morphometric especially stream order which are methods of assigning a numeric order to links in a stream network. They can be used for identifying and classifying types of streams based upon their number of tributaries. Furthermore, we study Archie's Law. In both chapters we solve many examples that illustrate the applications.

Chapter one

Statistical applications in Climate and hydrometeorology

In this chapter we study some mathematical applications in Geology and we focus on Climate changes and Hydro meteorological data applications. In this chapter we mainly review and highlight the works of (sulaiman, 1994), (Michael, 1988), and (Saeid, 2014).

1.1 Climate (sulaiman, 1994), (Saeid, 2014)

According to the Koppen classification, the climate of the Kurdistan region is arid and semi-arid; it is hot and dry in summer and cold and wet in winter, with shorter spring and autumn seasons compared to summer and winter. During the winter, the Kurdistan region is influenced by Mediterranean cyclones that move east to northeast over the region. The Arabian Sea cyclones move northward, passing over the gulf carrying a lot of moisture and dumping a lot of rain on the Kurdistan region. The region is also influenced by very cold polar air masses, which move downward with the polar jet streams to the gulf. European winter cyclones will occasionally move eastward to the southeast part of Turkey and over the mountainous region of Kurdistan, bringing heavy rain and snow. Precipitation typically falls as rain at lower elevations and as snow and rain at higher elevations. The annual average precipitation increases from the southwest to the northeast, ranging from 300mm in the lower part of the region to 1200mm in the highlands. Precipitation seasons begin in mid-October and last until late November. During the summer, the region is influenced by subtropical high pressure belts and Mediterranean anticyclones. The subtropical high pressure system that moves from west to north and northeast, passing over the Arabian Peninsula and transporting sand and dust. In hot summers, the maximum daily temperature can reach 50 degrees Celsius, while in cold winters, the minimum daily temperature can drop to -10 degrees Celsius.

The studied area is in Duhok Governorate; Aqra city, which is part of the Greater Zab River Basin, has a mountainous climate that is wet in winter and dry in summer. The studied area, however, is part of the High Folded Zone. The majority of the High Folded Zone, according to the updated World Map of the "Koppen - Geiger Climate Classification," lies within the region of the main semiarid climate, with steppe precipitation and hot arid temperature conditions. The High Folded Zone lies between the arid to the savannah climate morphogenetic regions according to the Peltier diagram. Nevertheless, during the last decades, significant changes have occurred concerning the decrease in rainfall and increase in dust storms. In the studied area the Climatic Data are being compiled by using the Argo-meteorological data about Aqra station because this station is the nearest station to the study area. The Aqra meteorological station located at (36 43 56- N) and (43 51 56- E) and an elevation of (635) m. The data of the period (2004- 2014) used to determine the meteorological parameters for the study area. Hydro meteorological approach for water balance is widely used when the output of a small basin, within which urbanization occupies a part, is known. Mostly, such output is not always available, therefore, empirical approaches were considered. Thus the input parameters for such water balance are used to clarify a possible period of water surplus and deficit. These parameters are mainly of two groups, the first group represents the elements of water availability, while the second group includes elements of water losses.

1.2 Hydro meteorological data approaches: (Michael, 1988), (Saeid, 2014)

1.2.1 Water Availability Elements:

The rainfall and relative humidity are the most important parameters of water availability, and resources to restrict the climate and water surplus. There are no meteorological stations in the studied area, therefore, this study used Aqra meteorological Station.

1.2.2 Rainfall variation analysis:

Rainfall analysis is important in different domains such as agricultural planning, water resources planning, runoff prediction, climatological studies, environmental studies, stream flow estimation and human life activities. The amount, intensity and areal distribution of rainfall are essential factors in many hydrologic studies. Rainfall varies geographically, temporally and seasonally. Regional and seasonal variation of rainfall is very important for water resource planning. Temporal of rainfall intensity are extremely important in the rainfall-runoff process in urban area. Rainfall is also highly affected by meteorological elements and elevation from sea level, so simple and multiple correlations were found between these variables. The data of the period (2004-2014) used to determine (the mean monthly, annual, and the seasonal variation), the standard deviation and the coefficient of variation of the studied area.

1.2.3 Monthly rainfall variation:

Varies considerably in the study area. The mean annual rainfall is the sum of twelve months long term monthly average rainfall. The average monthly rainfall of ten years of the period (2004-2014) is utilized for preparing rainfall variation. Increasing trend in the rainfall during January to May, and declining trend during May to August are noticed. Then it gradually increases from September onwards, reach the peak value in the month of the highest mean monthly precipitation rate is recorded in January which is (177.65mm) and the lowest mean monthly precipitation rate is recorded in June, July, & August are (0.15mm and not recording rainfall data in July and August). The mean, standard deviation, and coefficient of variation using in this analysis. The Mean is the most used measures of central tendency common to summarize a large number of values is the rate and rate widely used in daily life an average per capita income and agricultural production rate for a particular crop. And often referred to as the center of gravity or balance point for a range of views.

$x - = \sum x / n$

Where:

$x - = Mean\ monthly\ rainfall\ for\ giving\ periods.$

$\sum x$= summation of each monthly rainfall for giving periods of one month.

N = Number of years for giving periods.

However, standard deviation is defined as a measure used to know the dispersion of a set of specific values for the middle computational, and is extracted in all operations take into account the distribution values. (Hogg, et al., 2019)

$SD = [\sum(x - x -) 2 / N]$ 0.5 where:

$SD = Standard\ deviation.$

$X = Monthly\ rainfall\ for\ giving\ periods\ of\ one\ month.$

$X - =$ $Mean\ monthly\ rainfall\ for\ giving\ periods.$

$N =$ $Number\ of\ years\ for\ giving\ periods$

In order to standardize the SD for data series, it is divided by the mean value to produce Coefficient of variation, which is a useful measure for comparative purposes where an annual series is normally distributed and where mean totals are not low.

$$C.V\ \% = (SD\ /\ Mean) * 100$$

The computed mean monthly rainfall values, standard deviation (Barbara & Susan, 2013), and coefficient of variation of Aqra meteorological station for the period of (2004 – 2014) are given in Table (1) and shown the mean monthly rainfall variation

Table1: The Maximum, Minimum, Mean, Standard deviation, and Coefficient of Variation (%) of Monthly Rainfall of Aqra meteorological station for the period (2004-2014).

Months	Max (mm)	Min (mm)	Mean	SD	C.V %
January	376.2	115	177.65	73.41	41.32
February	254.5	84	145.64	50.88	34.93
March	192	40	83.71	46.31	55.32
April	175	12.4	77.13	55.06	71.38
May	53.5	0.5	23.38	18.31	78.33
September	12	0	4.31	4.83	112.08
October	126	0	30.59	37.36	122.13
November	178.5	0	58.41	47.9	82
December	311.9	25.4	116.53	91.11	78.19

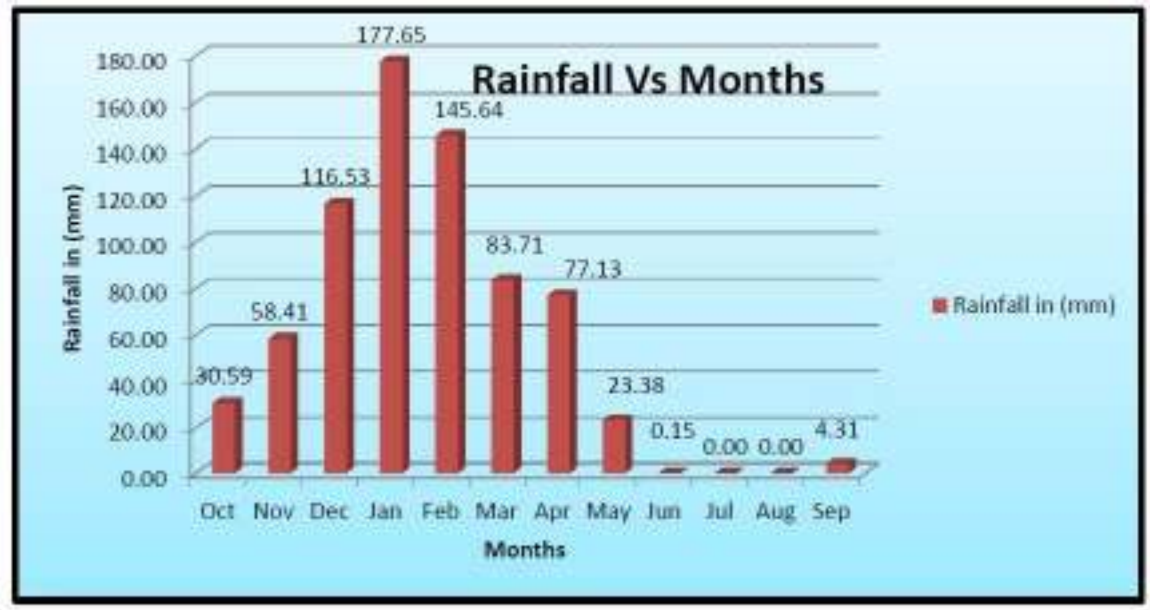


Figure 1.1: Mean monthly Rainfall of Aqra station for the period (2004-2014).

1.2.4 Annual rainfall variation:

The annual rainfall is the sum of twelve months long term monthly average rainfall. The average annual rainfall of ten years of the period (2004- 2014) is utilized for preparing annual rainfall variation. The maximum annual rainfall in the year (2012/2013) was (932.9) mm and the minimum mean annual rainfall shows in the period (2007/2008) are (445.6) mm. The mean annual rainfall was (717.5mm) (Table 2 and Figure 2).

Table2: Annual Rainfall variation, mean, standard deviation and coefficient of variation from Aqra meteorological station during period (2004-2014).

Yearly	Annual Rainfall in (mm)	Mean	(Annual-mean)^2	SD	C.V %
2004-2005	732.5	717.5	225	166.46	23.2
2005-2006	781.6		4108.81		
2006-2007	780.8		4006.89		
2007-2008	445.6		73929.6		
2008-2009	590.3		16179.8		
2009-2010	929.6		44986.4		
2010-2011	703		210.25		
2011-2012	445.9		73766.6		
2012-2013	932.9		46397.2		
2013-2014	832.8		13294.1		
Total	7175		277105		

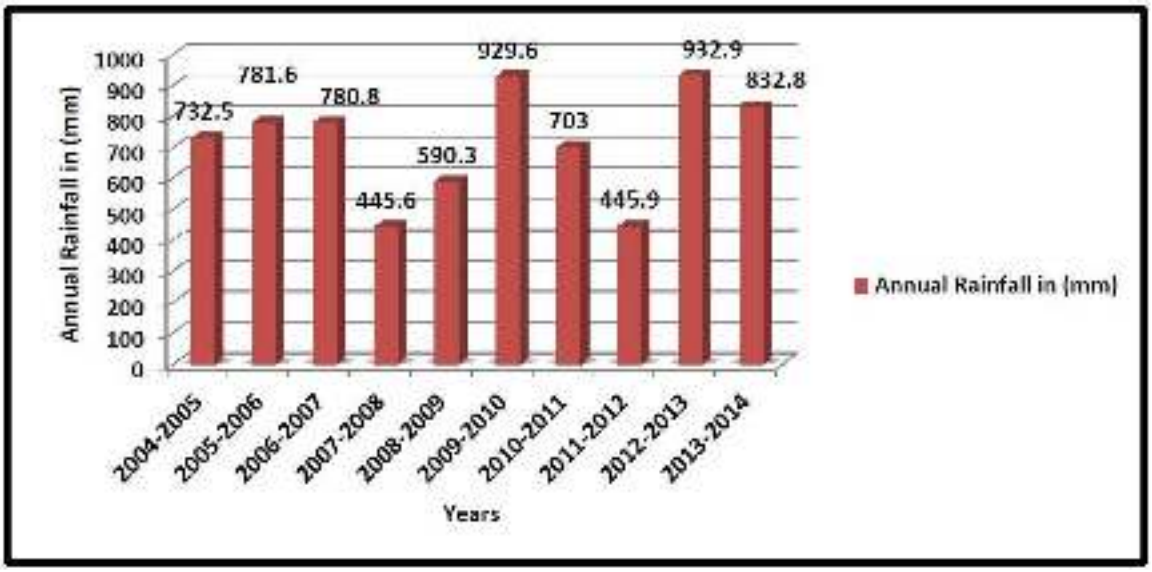


Figure 1.2: Annual Rainfall Variation in (mm) of Aqra meteorological station for the period (2004-2014).

1.2.5 Seasonal rainfall variation : (sulaiman, 1994)

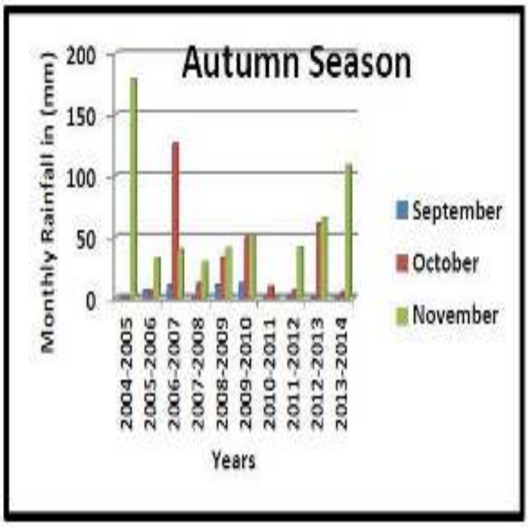
It is an important characteristic of rain in the region, according to that, the annual rainfall can be divided into two seasons; dry season and wet season and the two are not equal. Dry season represents four-month (summer months) which includes June, July, August, in addition to the month of September of the autumn. While the wet season starts from October and ends at the end of May. Depending on the climate year in Kurdistan region, which are four seasons; each season represents three months. The seasonal rainfall variation and (mean, standard deviation, and coefficient of variation) over the period of (2004-2014) of the studied area has been determined and presented in the table (3), the variation of seasonal rainfall in the figure (1.3).

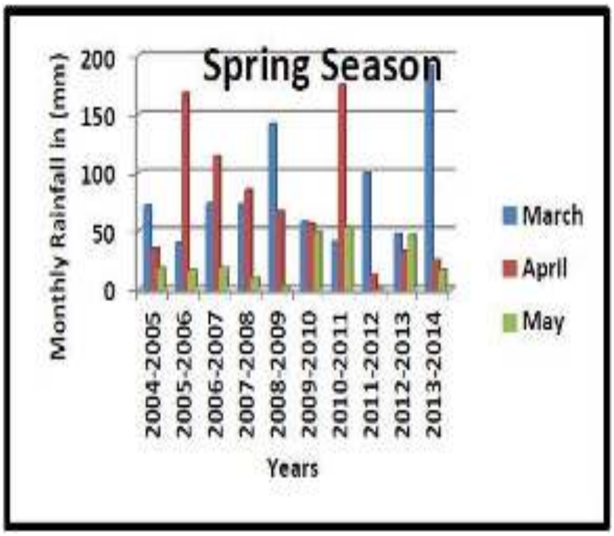
Table 3: Mean, Standard Deviation, and Coefficient of Seasonal Rainfall Variation of Aqra meteorological station for the period (2004-2014).

Autumn Season								
Years	Sep	Oct	Nov	Total	Mean	$(Total-Mean)^2$	SD	C.V %
2004-2005	0	0	178.5	178.5	93.31	7257.34	54.81	58.74
2005-2006	7	5.4	32.2	44.6		2372.66		
2006-2007	10.6	126	39.3	175.9		6821.11		
2007-2008	0	11.9	29	40.9		2746.81		
2008-2009	10.5	32.9	40	83.4		98.21		
2009-2010	12	49	51.3	112.3		360.62		
2010-2011	0.5	9	0	9.5		7024.12		
2011-2012	1.5	6.8	41	49.3		1936.88		
2012-2013	0	60.3	64.8	125.1		1010.60		
2013-2014	1	4.6	108	113.6		411.68		
Total				933.1		30040.03		

Winter Season								
Years	Dec	Jan	Feb	Total	Mean	$(Total-Mean)^2$	SD	C.V %
2004-2005	26.5	204.5	198	429	439.82	117.07	141.23	32.11
2005-2006	68.9	189	254.5	512.4		5267.86		
2006-2007	144	115	138	397		1833.55		
2007-2008	26	127	84	237		41135.95		
2008-2009	60.5	120	115	295.5		20828.26		
2009-2010	311.9	141	201	653.9		45830.25		
2010-2011	104.2	205.8	114	424		250.27		
2011-2012	25.4	145	113.6	284		24279.87		
2012-2013	185.9	376.2	118.3	680.4		57878.74		
2013-2014	212	153	120	485		2041.23		
Total						199463.06		

Spring Season								
Years	Mar	Apr	May	Total	Mean	$(Total-Mean)^2$	SD	C.V %
2004-2005	71.5	35	18.5	125	184.22	3507.01	50.20	27.25
2005-2006	40	168	16.6	224.6		1630.54		
2006-2007	74	113.6	18.8	206.4		491.95		
2007-2008	72.7	85	10	167.7		272.91		
2008-2009	141.5	66.9	3	211.4		738.75		
2009-2010	57.8	56.6	49	163.4		433.47		
2010-2011	41	175	53.5	269.5		7272.68		
2011-2012	99.7	12.4	0.5	112.6		5129.42		
2012-2013	46.9	33.8	46.7	127.4		3228.51		
2013-2014	192	25	17.2	234.2		2498.00		
Total				1842.2		25203.26		





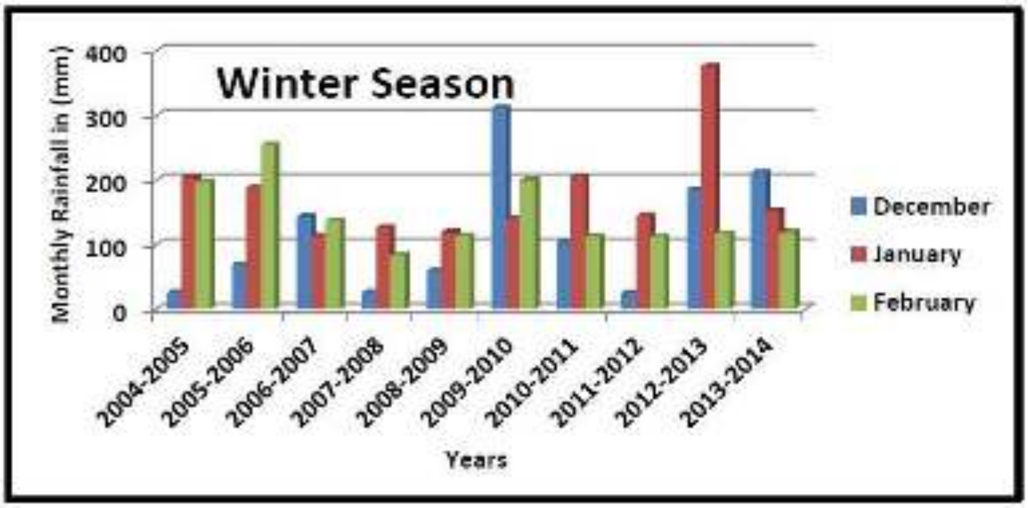


Figure 1.3: Seasonal Rainfall variation of Aqra meteorological station for the period (2004-2014)

Generally, the series of data for which the coefficient of variation is large indicates that the group is more variable and it is less stable or less uniform. If a coefficient of variation is small, it indicates that the group is less variable and it is more stable or more uniform. Coefficient of variation is used to know the consistency of the data. By consistency we mean the uniformity in the values of the data/distribution of the arithmetic mean of the data/distribution. A distribution with smaller C.V than the other is taken as more consistent than the other. According to table (1, 2, and 3) the results of coefficient of variation analysis of monthly, seasonal and annual C.V showed that the values of Autumn months and season were the highest among all others, the values of C.V for (Sep., Oct., Nov., and Autumn season) were (112.08, 122.13, 82, and 58.74) respectively. While the values for winter months and season were the minimum among all other months and seasons, as the values for (Dec., Jan., Feb., and Winter season) were (78.19, 41.32, 34.93, and 32.11) respectively. And the results of spring months and season (Mar., Apr., May., and Spring) were (55.32, 71.38, 78.33, and 27.25) respectively. And the annual value of C.V equal to (23.2). All these values of C.V indicate that the rainfall of winter and spring seasons were nearly uniform and consistent and of less variable in their values.

The rainfall of winter and spring is the most effective for creation of discharge in the Gibbel stream which means that the stream discharge will reflect the same characteristic of consistency and uniformity.

1.2.6 Relative Humidity:

The ratio of the actual vapor pressure of saturated vapor pressure called relative humidity. It is a measure of how much moisture an air mass is holding, and it is related reversely to temperature and evaporation. Generally, the relative humidity of air mass is stated in percentage. Relative humidity values over 80 % indicate humid conditions under which evaporation rates are expected to be low. Otherwise, relative humidity values which are less than 60% indicate dry conditions under which evaporation rates are expected to be high. The Relative Humidity data records at Aqra meteorological station within the studied area, which cover the period (2004–2014), are shown in Table (4) below. The computed average, maximum, and minimum relative humidity for this station are given in this Table. The average annual relative humidity is about (46.41 %). The highest average monthly relative humidity occurs in winter season, which reach (74.55%) in January, while it drops to (22.45%) in the summer period in August

Table 4: Mean monthly Relative Humidity (%) recorded at Aqra station for the period (2004-2014)

Months	R.H (%)	Months	R.H (%)	Months	R.H (%)	Months	R.H (%)
Oct	39.06	Jan	74.55	Apr	50.30	Jul	22.47
Nov	53.48	Feb	71.88	May	39.61	Aug	22.45
Dec	65.06	Mar	61.11	Jun	28.76	Sep	28.10

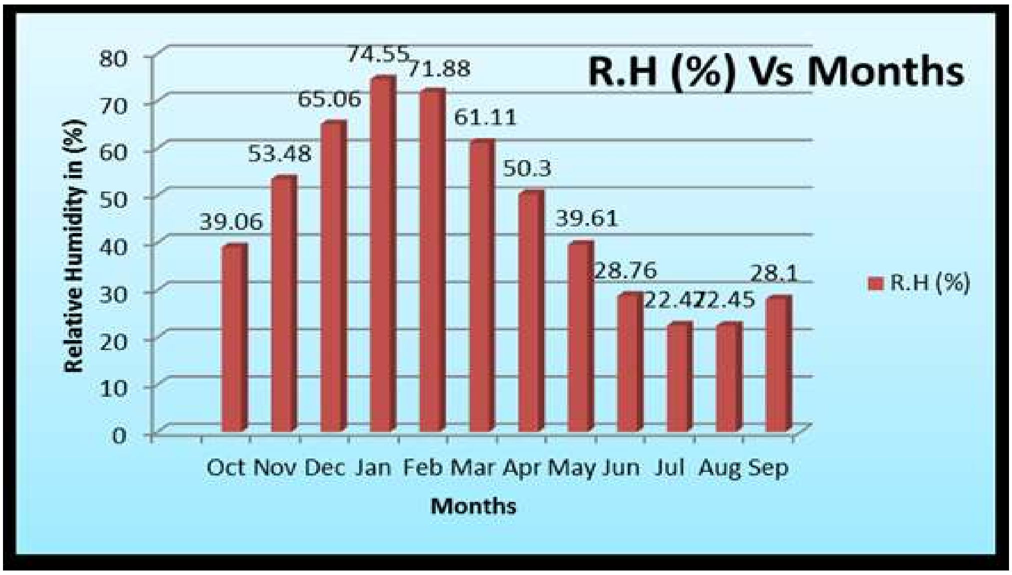


Figure 1.4: Mean monthly Relative Humidity (%) recorded at Aqra station for the period (2004-2014).

1.3 Water Losses Elements:

1.3.1 Temperature:

The temperature is reversely correlated with rainfall and relative humidity, and its most important factor in increasing the evaporation and evapotranspiration. In general, temperature differs considerably between summer and winter and between day and night. The average monthly temperature values for the period (2004-2014) was calculated, and the maximum mean monthly temperature was 33.03/T°C in July, and the minimum mean monthly temperature was 4.99 /T°C in January. The average annual temperature was 19.25/ T°C (Table 5) and Figure (1.5) show the average monthly temperature for the period (2004-2014).

Table 5: Mean monthly Air Temperature (T°C) recorded at Aqra station for the period (2004-2014)

Months	Tem (Tc)	Months	Tem (Tc)	Months	Tem (Tc)	Months	Tem (Tc)
Oct	21.70	Jan	4.99	Apr	16.41	Jul	33.03
Nov	13.36	Feb	6.99	May	23.72	Aug	32.93
Dec	8.90	Mar	12.29	Jun	29.02	Sep	27.70

Figure 1.5: Mean monthly Air Temperature (T°C) recorded at Aqra station for the period (2004-2014).

1.3.2 Wind speed:

Wind directions, dominant in the studied area as recorded in the Aqra meteorological station are between northeast and west. The average wind velocity is about (1.66 m/Sec) with minor variations during the year. The calculated average and maximum wind speed values at Aqra station are given in (Table 6). The highest average monthly wind speeds recorded in June is (3.07 m/Sec) and lowest average monthly wind speeds recorded in February is (1.23 m/Sec). The average annual wind speed is about (1.66 m/Sec).

Table 6: Mean monthly Wind Speed recorded at Aqra station in (m/Sec) for the period (2004-2014)

Months	W. speed (m/sec)	Months	W. speed (m/sec)	Months	W. speed (m/sec)	Months	W. speed (m/sec)
Oct	1.55	Jan	1.32	Apr	1.66	Jul	1.98
Nov	1.28	Feb	1.23	May	2.13	Aug	1.67
Dec	1.38	Mar	1.24	Jun	3.07	Sep	1.47

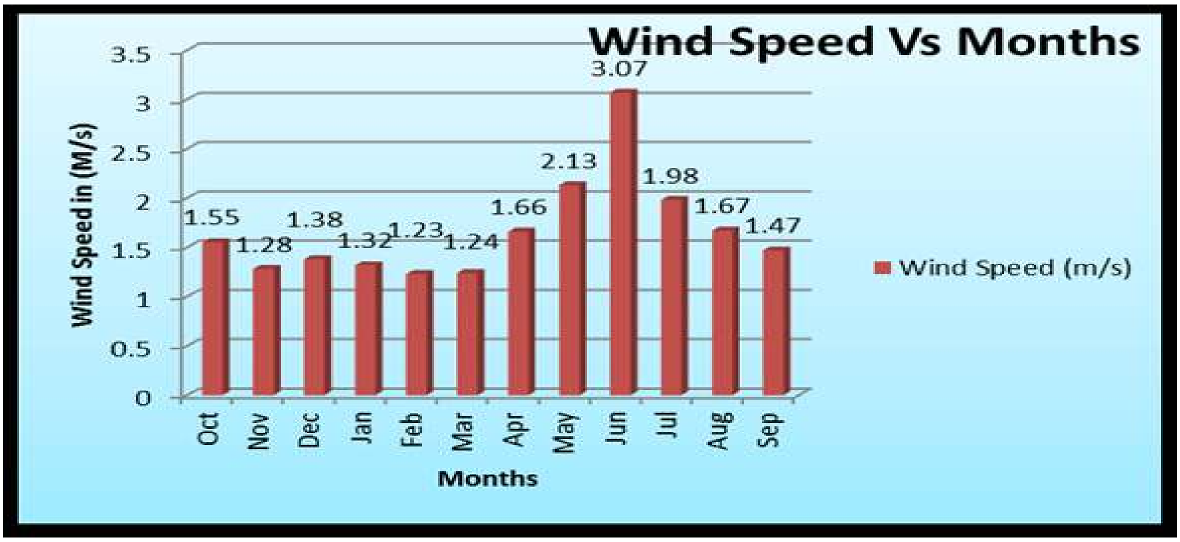


Figure 6: Mean monthly Wind Speed recorded at Aqra station in (m/Sec) for the period (2004-2014).

1.3.3 Sunshine Duration:

Sunshine shows the length of day hours. The mean monthly maximum sunshine was 12.40 hours/day in July, while the mean monthly minimum was 4.50 hours/day which was recorded in January. The mean annual was 8.17 hours/day for the period (2004-2014)

(Table 7). Table 1.7: Mean monthly Sun Shine duration recorded at Aqra station in (HR/day) for the period (2004-2014).

Months	S. Sh. D (Hr/day)	Months	S. Sh. D (Hr/day)	Months	S. Sh. D (Hr/day)	Months	S. Sh. D (Hr/day)
Oct	7.50	Jan	4.50	Apr	7.20	Jul	12.40
Nov	7.00	Feb	5.80	May	8.70	Aug	11.20
Dec	5.10	Mar	6.20	Jun	12.10	Sep	10.30

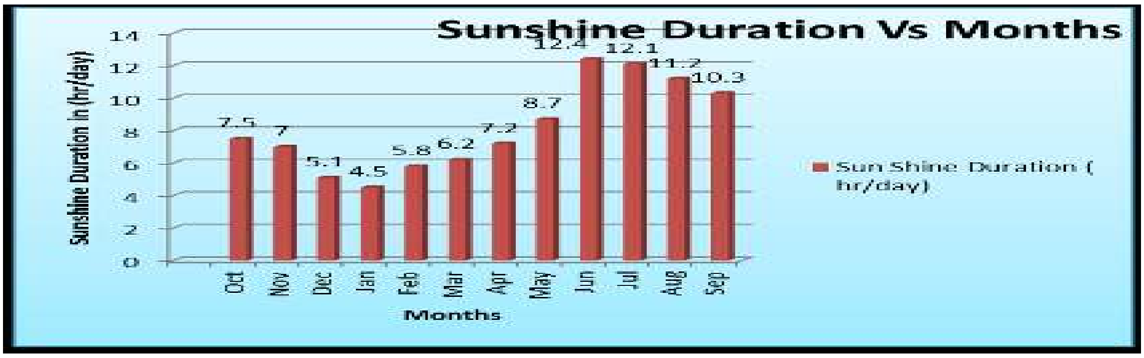


Figure 1.7: Mean monthly Sun Shine duration recorded at Aqra station in (HR/day) for the period (2004-2014).

Chapter two

Morphometric and Archie's Law Applications

In this chapter we study the applications of Morphometric and Archie's Law applications and we illustrate it by solving some examples. In this chapter we mainly review and highlight the works of (Newson, 2007), (huggett, 2004), (Mussett & m, 2009) and (M, 2009).

2.1 Morphometric: (Newson, 2007), (huggett, 2004)

Morphometry is defined as the measurement of the shape. Morphometric studies in the field of hydrology were first initiated by R.E. Horton and A.E. Strahler in the 1940s and1950s. The main purpose of this work was to discover holistic stream properties from the measurement of various stream attributes.

2.1.1. Stream order:

Stream ordering is a method of assigning a numeric order to links in a stream network. This order is a method for identifying and classifying types of streams based upon their number of tributaries.

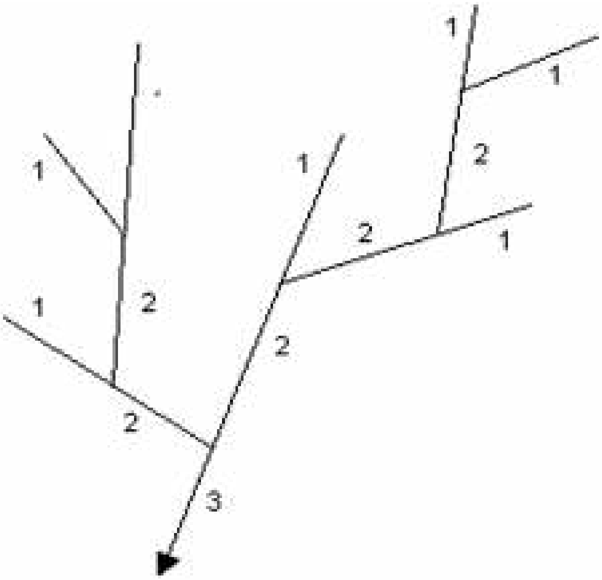
Two common methods of stream ordering are those proposed by Strahler (1957) and Shreve (1966).

2.1.2 Strahler (1957) - Stream order:

In both methods, exterior links are always assigned an order of 1. In the Strahler method, stream order increases when streams of the same order intersect. Therefore, the intersection of two first-order links will create a second-order link, and the intersection of two second-order links will create a third-order link. The intersection of two links of different order, however, will not result in an increase in order.

Strahler (1957)-Stream order:

Streams ordered by the Strahler method



2.1.3 Shreve (1966)-Stream order:

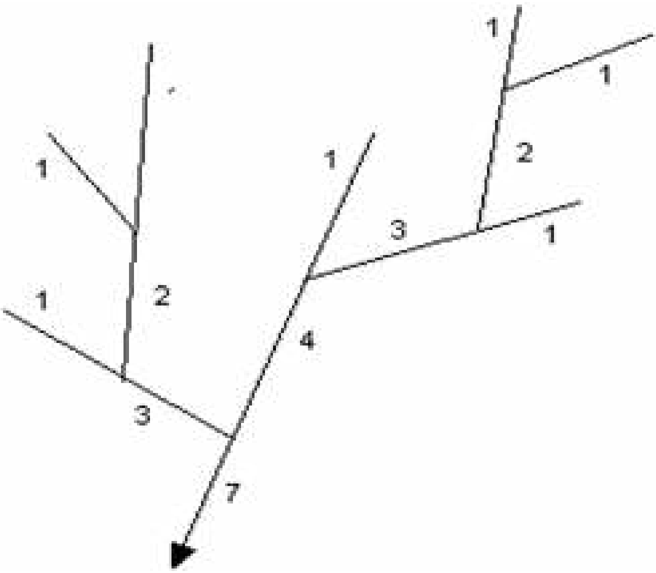
The Shreve method accounts for all links in the network. Here, as with the Strahler method, all exterior links are assigned an order of 1. For all

interior links in the Shreve method, however, the orders are additive. For example, the intersection of two first-order links creates a second-order link,

the intersection of a first- and second-order link creates a third-order link, and the intersection of a second- and third-order link create a fifth-order link. Because the orders are additive.

Shreve (1966)-Stream order:

Streams ordered by the Shreve method



Drainage Basins

•Classify patterns of streams in a basin

" •**First-order"** streams are smallest

•Any basin will have more first-order streams than any other category. Think of these as headwater streams.

– Where 2 similar-ordered streams come together, they increase in order.

» 1 & 1 = 2

» 2 & 2 = 3

» 3 & 3 = 4

– 2 streams of same order must be joined to increase in order.

Otherwise, keep the higher number for the next stream.

» 1 & 2 = 2

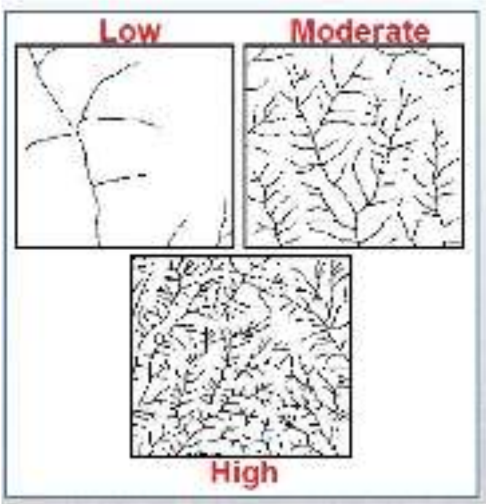
» 1 & 3 = 3

» 2 & 4 = 4

» 5 & 12 = 12

Morphometric parameters

Stream Frequency: (Fs): is a measure of number of a stream segments per unit area.



$Fs = \Sigma Nu / A$

Where:

$Nu = stream\ order$

$A = basin\ area\ (km^2)$

$Morphometric\ parameters:$

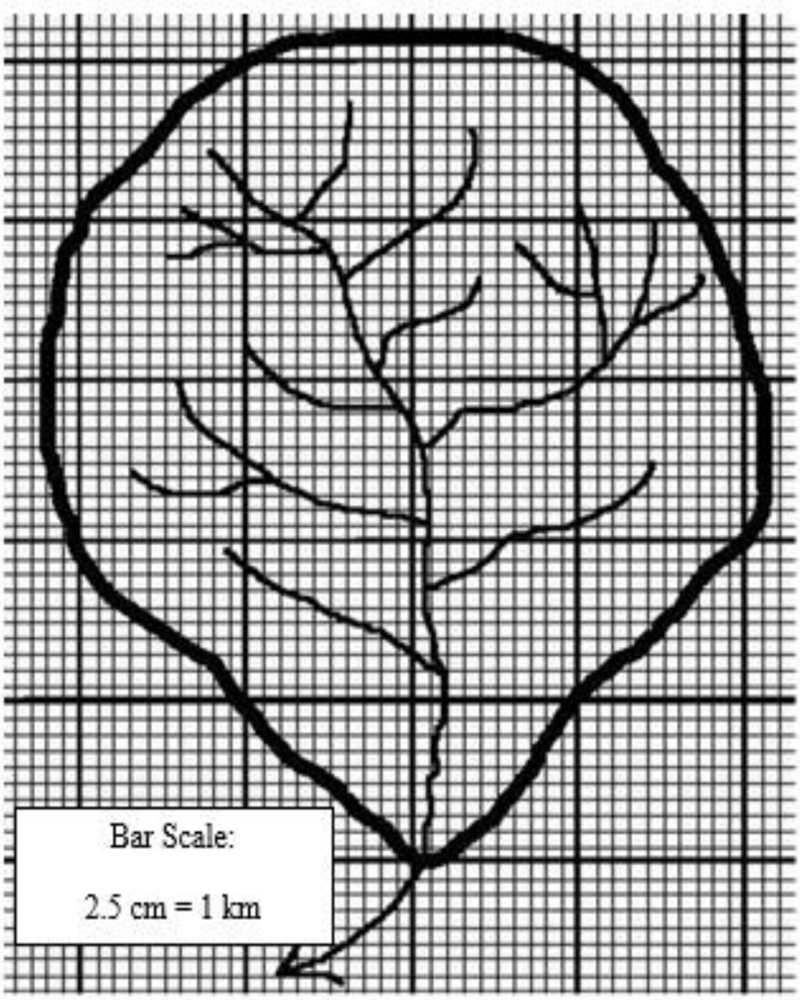
$Fs = \Sigma Nu / A$

$A = basin\ area\ (km^2)$

$Is\ determine\ by$ Dot Grid Method

- $Complete\ square = \quad cm^2$
- $In\ complete\ square = \frac{}{100} cm^2 = \qquad cm^2$

$Area = Complete + In\ completed * scale$



- Dot Grid Method
- Complete square =? cm²
- In complete square= 100/??cm²= ??cm²
- Area = Complete + In completed * scale

$Area\ =$ Uncompleted squares are $\left(4.62\ = \frac{469}{100}\right)$ +Complete squares are (11)

$Scale\ 2.5\ =\ 1km$

$1\ cm\ =\ \ x$

$X\ =\ 0.4km$

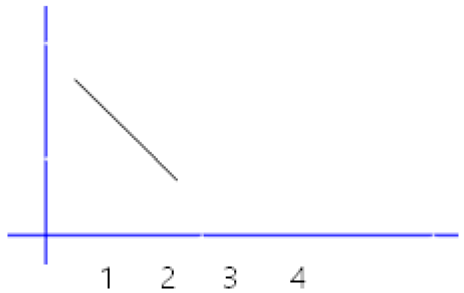
$1\ cm^2\ =\ \ 0.4\ ^2 =\ 0.16km^2$

$Area\ =\ (11 +\ 4.62\ )\ \times\ scale$

$\quad =\ 2.5\ km^2$

Log

Nu



stream order

stream order	stream order Nu member
1^{st}	15
2^{nd}	5
3^{rd}	2
4^{th}	1
	23 = Nu

$$Fs = \frac{\varepsilon nu}{A} = \frac{23}{2.5} = 9.2$$

Stream Order	**Stream No.** **Nu**	**Stream Freq.** **Fs=Nu/A**
1	15	9.2
2	5	
3	2	
4	1	
Total	23	

2.2 Archie's Law (Mussett & m, 2009) **,** (M, 2009)

Archie's law is an empirical effective in sedimentary successions. It relates resistivity with some factors. After modification it states that:

$$\boldsymbol{\rho = 0.7\varphi^{-2}S^{-2}\rho_w}$$

Where: ρ: the formation resistively , φ: porosity, S: the saturation and

ρ_w: the resistively of water in the aquifer

Example:

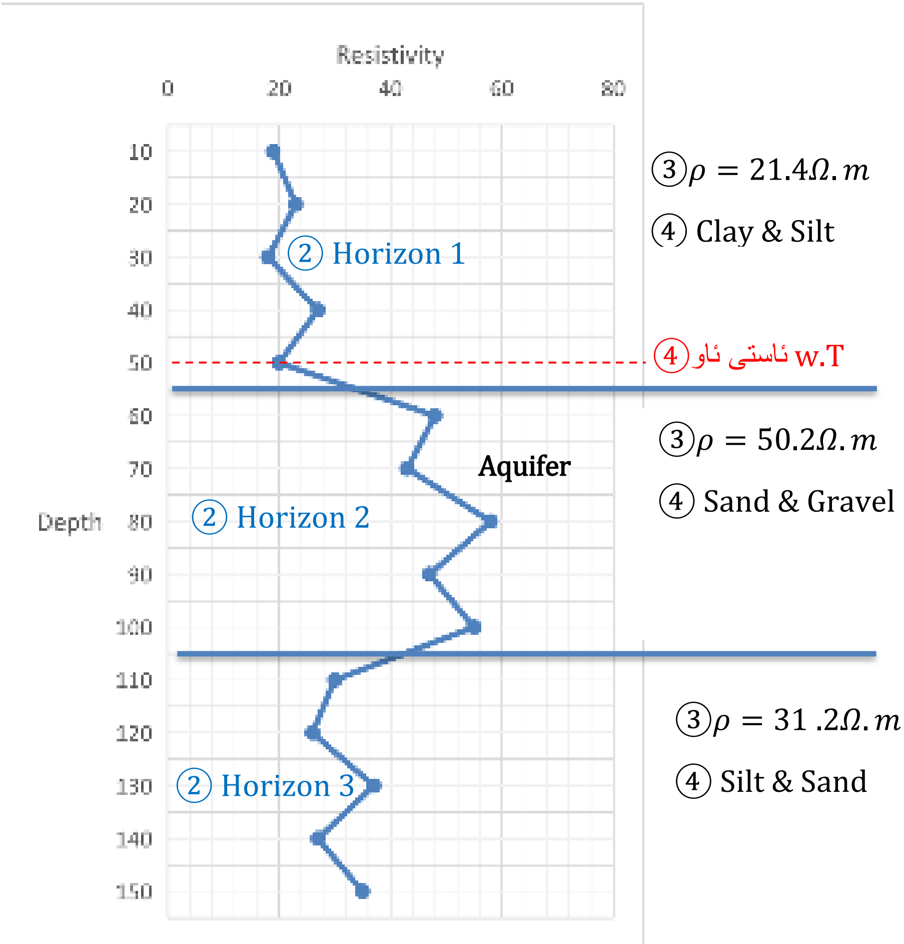
The following table represents of a resistively log in a certain borehole. You have the following information:

1. The whole penetrated succession is composed of mixture of clay, silt, sand and gravel in different ration.
2. Water table in adjacent area has a depth of 40 – 60 m.
3. The resistivity of water = 1.9 ohm.m.
4. The Porosity = 0.23.

Depth (m)	$\rho(\Omega.m)$	**Depth (m)**	$\rho(\Omega.m)$
10	19	90	47
20	23	100	55
30	18	110	30
40	27	120	26
50	20	130	37
60	48	140	27
70	43	150	35
80	58		

Required:

1. Draw the relation between the depth and resistively.
2. How many horizons you have?
3. Estimate the average resistivity values for different horizons.
4. What are the main constituents of these horizons? And detect the water table.
5. Estimate the degree of saturation.
6. In one cube meter, how much water could be yielded?



Relationship between Resistivity & Depth

⑤ $\rho = 0.7\ \varphi^{-2}S^{-2}\rho_w$

$50.2 = 0.7(0.23)^{-2}S^{-2}1.9$

$50.2 = 1.33(0.23)^{-2}S^{-2}$

$50.2 = 24.14\ S^{-2}$

$S^{-2} = \frac{50.2}{25.14} = 1.997$

$S^{-2} = \frac{1}{S^2} = 1.997$

$\therefore S^2 = \frac{1}{1.997}$

$S = \frac{1}{\sqrt{1.997}} = 0.71 = 71\%$

For Checking:

$\varphi = \frac{Volume\ of\ porosity}{Volume\ of\ rock}$

$0.23 = \frac{Volume\ of\ porosity}{1}$

$\therefore Volume\ of\ porosity = 0.23\ m^3$

⑥ $Degree\ of\ Saturation = \frac{Volume\ of\ water}{Volume\ of\ porosity}$

$0.71 = \frac{V.of\ water}{0.23}$

$\therefore Volume\ of\ porosity = 0.71 \times 0.23 = 0.16\ m^3$

پوختە

بیرکاری لە زۆربەی بوارەکانی ژیاندا بەکاردێت و ڕۆڵێکی زۆر گرنگی هەیە لە لقەکانی تری زانست وەک کیمیا، فیزیا، زیندەزانی و وەرزش. لەم توێژینەوەیەدا ئێمە لێکۆڵینەوە لە بەکارهێنانە بیرکارییەکان دەکەین لە جیۆلۆجی و ئێمە جەخت دەکەینەوە لەسەر بەکارهێنانی ئامارەکان، گرافیکی ئاماری، ڕێژە و ڕێژە لە نزیکبوونەوەکانی داتای هایدرۆمێتێرۆلۆجی وەک توخمەکانی بەردەستبوونی ئاو، گۆڕانی مانگانەی بارانبارین، جیاوازی بارانبارینی مانگانە، جیاوازی بارانبارینی ساڵانە و جیاوازی بارانبارینی وەرزی. لەگەڵ ئەوەشدا ئێمە شێیەکی ڕێژەیی بەهێز دەکەین، ئاو توخمەکانی لەدەست دەدات، خێرایی با و ماوەی تیشکی خۆر لەگەڵ ئەوەشدا، ئێمە لێکۆڵینەوە لە میتۆدەکانی ڕێکخستنی مۆرفۆمێتریک و ستریم دەکەین بۆ دیاریکردنی ڕیزبەندی ژمارەیی بۆ بەستەرەکان لە تۆڕێکی لێشاو و ناسینەوە و پۆلێنکردنی جۆرەکانی لێشاوەکان لەسەر بنەمای ژمارەی لقەکانیان .لەکۆتای پرۆژەکەدا لێکۆلینەوە لەیاسای ئارجی و جێبەجێ کردنەکانی دەکەین.

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