The International Journal of Informatics Media and Communication Technology
ISSN (Print 2682-2105) (Online 2682-2881)

The Flash Floods hazards in The Shaik El-Shazly region in The Eastern Desert, Egypt, AGeomorphological study using GIS

Emad Abdel fattah Saleh Hafez

Lecturer of Physical Geography in the Geography Department, Faculty of Arts, Beni- Suef University

Abstract:

The Shaik El-Shazly region, a study area, is frequently exposed to flood hazards due to four drainage basins that are the primary sources of the Wadi Al-Sheikh basin, a major stream in the Wadi al-Khirit basin, which ends east of Kom-Ambu. The four drainages basin namely Umm Hirenah, Umm Samrah, Umm Sreha and Umm Dehesi, which all meet in the Shaik El-Shazly area and poses a natural hazard. The area has been exposed to multiple flash floods due to geological, surface topographic, and climatic factors. The most recent event was the 14 November 2021 flash flood, which caused the village of Shaik El-Shazly to drown and partially collapse the outer wall of Sidi Abu Hassan al-Shazly's mosque and warehouse due to runoff from Wadi Umm Samrah. The study determined the level of flash flood danger in four basins, with Umm Dehesi ranking first, followed by Umm Samrah, and Umm Hirenah and Umm Sreha having low probability of flash floods.

Keywords: The Shaik El-Shazly Wadi; Um Dehesi Hydrological factors; Hydrological budget; Hydrological probability of floods; Rainstorms Design floods.

Introduction

Natural hazards and disasters are increasing daily, posing threats to human life, property, and the environment. Humans are studying, understanding, and predicting these hazards to prepare defenses and protect their natural environment. Studying floods, their hazards, and addressing them is crucial due to their frequent and severe nature, sudden occurrence, and difficulty in prediction due to lack of meteorological data. This problem is more severe due to the majority of human stability areas outside valleys, and the majority of roads that enter these areas extend into the valleys, posing significant risks to transport and passenger movement. Flash floods are defined as a temporary flow containing many solids and characterized by a high-water level, as well as its sudden appearance and rapid flow and its rapid decline in quantity and speed. Despite the study area experiences low rainfall and drought, but is exposed to heavy sudden rainfall, leading to run-off in its dry basins.

Study Area

The Shaik El-Shazly region, the study area, is located in the southern center of the eastern Sahara east of Kom Ambo city at about 205 km and west of Bernice on the Red Sea coast at about 120 km and south of the Idfo-Marsa Alam Road at about 120 km. The study - area basins extend between the two latitudes of 24° 10' 5" - 24° 16' 33" north and longitudes 34° 37' 37" - 34° 44' 3" east, (Fig. 1). It is bounded on the east and south-east by the Medsus basin, a major stream of Wadi al- Khirit, and on the north, north-east and north-west by the Abu Hamamid basin, a major stream of Wadi al-Khirit, as well as by the west and south-west by the Umm Rebeh, a major stream of Wadi al-Sheikh.

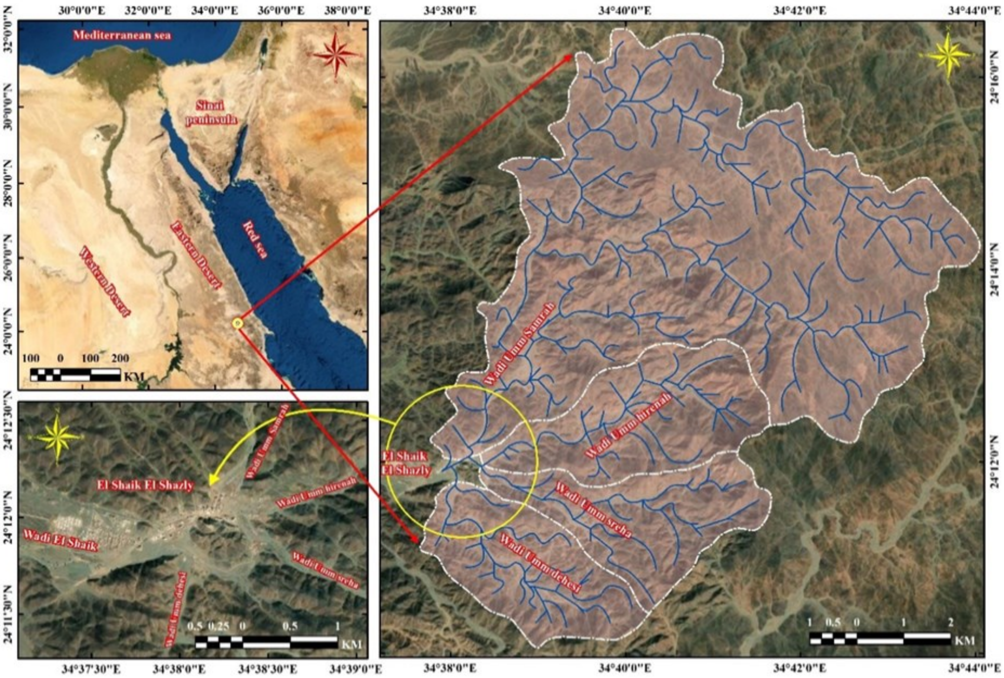

Fig. (1) location map of the Study Area

Geology

The study area's location within the Archaean shield, the foundation of Egyptian lands, is characterized by igneous and metamorphic rocks. This is evident in the flash floods characteristics of the basins, where igneous and metamorphic formations increase the rates of torrent flow. The study area's surface geological formations are presented as following: -

1. **Metagabbro to Metadiorite, Undifferentiated**: - Metagabbro-diorite complexes, also known as epidiorites-Diorite complexes, (Ghanem, M., 1972, p.178) are bulky rocks with colors ranging from green to grey. They cover 2.3% of the region's area and are found in two sectors: north in Wadi Umm Samra and south in Wadi Umm Dehisi. These formations are characterized by their bulky nature.
2. **Intermediate to acid Metavolcanic& Metapyroclastics**: - This formation is predominantly composed of andesite and rhyolite

rocks, which have metamorphosed with volcanic flows, covering 95.6% of the total area, occupying about 68.9 km2 in all drainage basins

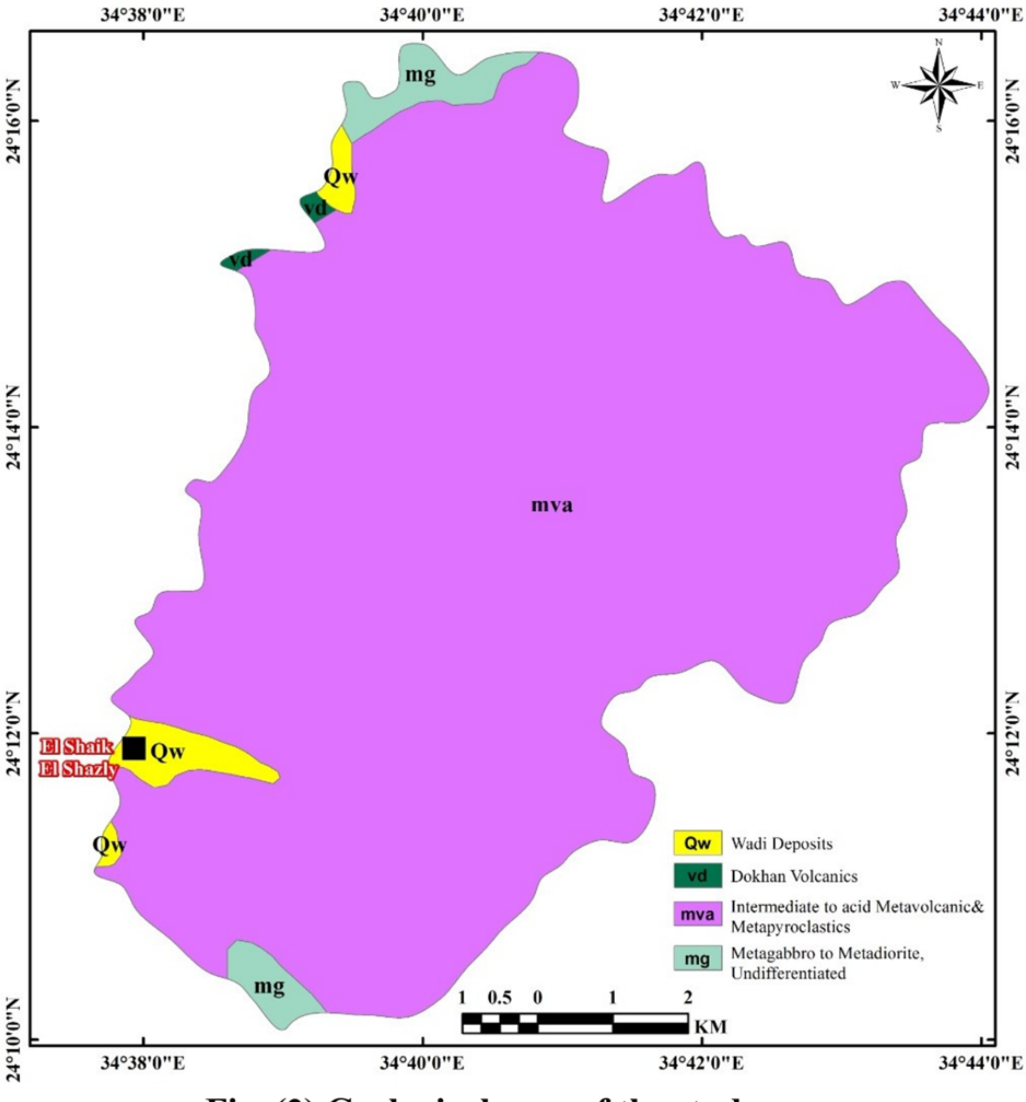

Fig. (2) Geological map of the study area

3. **Dokhan volcanics: -** Rock formations, including andesite, quartzite andesite, imperial porphyry, quartz radiosite, and quartzite trachyte, are among the oldest types of metamorphic volcanoes in Egypt, ranging in age from 639 to 581 million years,

(El Gaby et al, 1990, p. 182). These formations cover about 0.2 km2, representing 0.3% of the region's total area, and are found in a narrow area northwest of the region.

4. **Wadi Deposits: -** The basins bottom contains a mix of surface sediments, including sand, shale, and gravel, found in the middle and lower sectors. Their sizes range from coarse in the upper and middle sectors to softer as we approach the estuary. These formations cover about 1.3 km2, accounting for 2.3% of the region's total area.

Topography

The study area is located in the southern center of the eastern desert, where the mountain range of the Red Sea Mountain range is crossed by the valleys descending from its surface towards the less elevated parts in the east and west, which led to the diversity of terrain characteristics along its four valleys, and the following is a presentation of some of the terrain characteristics of the region as follows:

1. **Digital Elevation Model**

Through the study of each of the topographic maps of the study area scale 1: 50.000 and scale 1: 250.000, as well as the digital elevation models provided by the US Geological Survey with 30m spatially distinctive resolution and satellite images of the type (Landsat-8 (Oli) 2013), based on the previous sources, the digital elevation model of the area was built, which showed the following:

- The height of the surface of the study area ranges between 506meters southwest of the study area at the confluence of the four basins, and between 1120meters, where some of the high peaks are north-east of Wadi Umm Samra, to the northwest of Jabal Abu Aqoub, and therefore it can be said that the terrain of the study area is about 614meters.

- The surface of the study area ranges in height from east to west, as in all basins that originate from the Red Sea mountains and end to the Nile River and its flood plain to the west, where the surface descends from the mountain peaks in the east towards the plain area in the west.

- It is estimated that about 20.3km2, representing about 28.4% of the total area of the study area, is located below the level of 600m. This area constitutes the minimum sewers of the four valley basins, while 0.4km2, representing 0.6% of the total area of the study area, is located above the level of 1000meters as the highest part of the study area, which is all located in the valley of Umm Samra and the valley of Umm Sereha.

- The altitude classes from 600 to 1000 meters cover 50.7km2, representing about 71% of the total area of the study area, which is the area of the eastern mountain slopes, which represents the lower sector of these slopes.

- The altitude categories cover 600 meters and more about 71.6% of the total area of the study area. These categories are concentrated to the east of the study area where the mountainous extension of the heights of the mountains of Abu Arakoub and Medus.

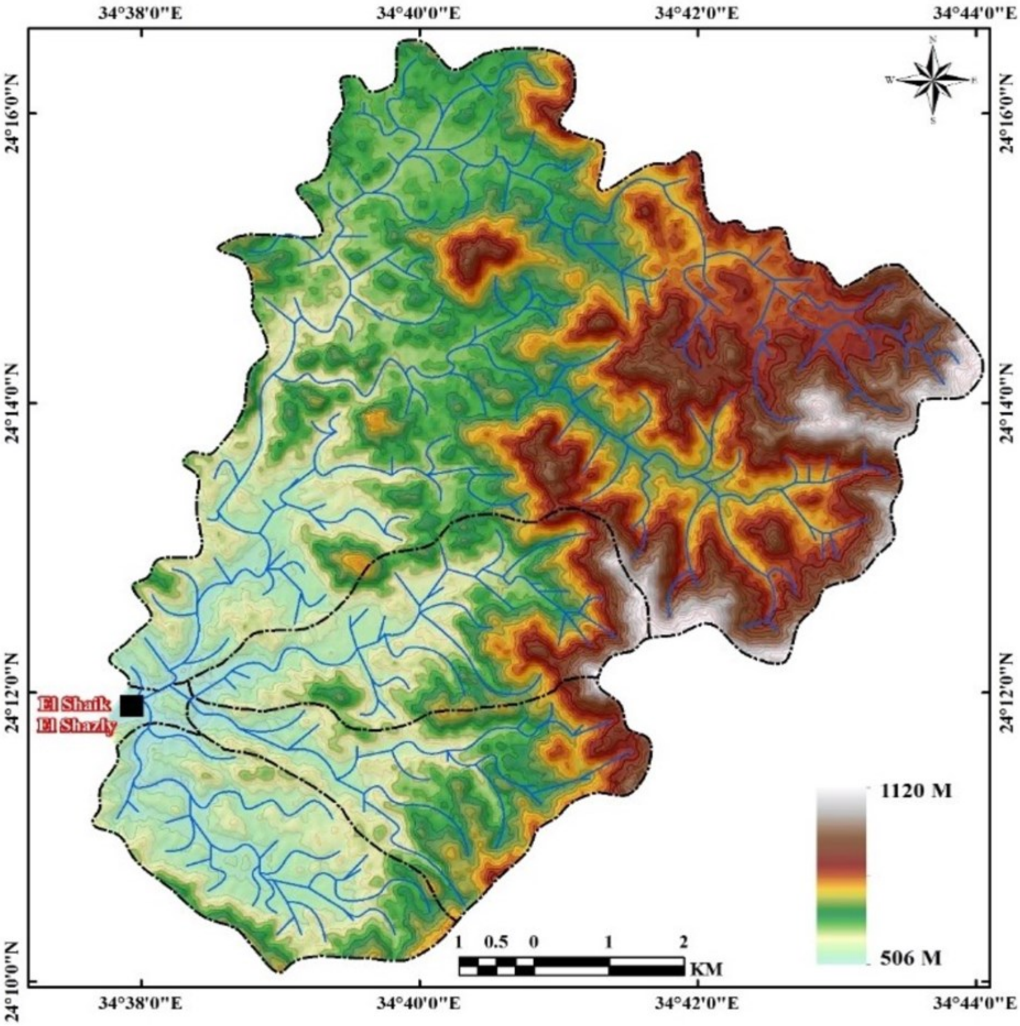

Figure (2) Topography of the study area

Table (1) Study Area Level Categories.

Elevations	W. Umm Samrah		W. Umm Hirenah		W. Umm Sreha		W. Umm Dehesi	
	Area (Km^2)	(%)	Area (Km^2)	(%)	Area (Km^2)	(%)	Area (Km^2)	(%)
-600	7.7	16.5	3.8	41.3	2.7	34.6	6.1	79.2
-700	18.1	38.8	3.2	34.8	3.4	43.6	1.5	19.5
-800	12.3	26.3	1.2	13	1.2	15.4	0.1	1.3
-900	6.5	13.9	0.6	6.5	0.4	5.1		
-1000	1.8	3.9	0.3	3.3	0.1	1.3		
-1100	0.2	0.4	0.1	1.1				
-1200	0.1	0.2						
Total	46.7	100	9.2	100	7.8	100	7.7	100

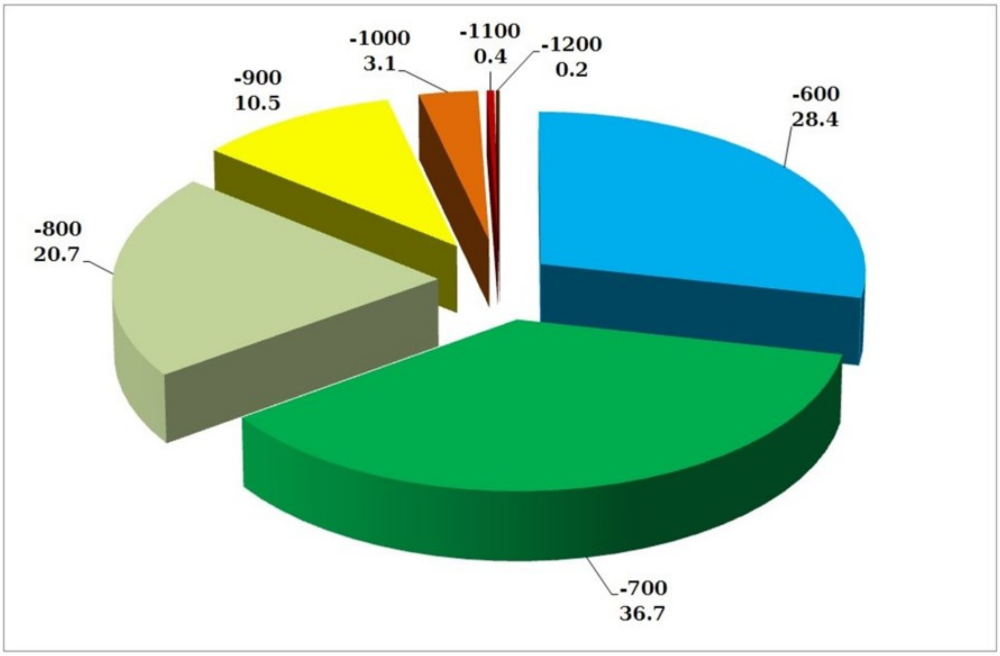

Figure (3) Elevation categories in the study area

2. Slops

Means the degree of slope, which is the angle confined between the surface of the earth, the slope and the horizontal plane. The study of the change in the shape of the slope from one place to another is useful in analyzing the shapes of the earth's surface and identifying the origin of its origin and stages of development. The scale of (Young, A., (1972) has been relied on in the study and classification of the patterns of land surface slopes in the study area, which are shown in Table (2) and Fig.s (4), (5) as follows:

- **Level and semi-planar lands**: These are those surfaces whose slope is less than two degrees, and this category covers about 4.1km2, representing about 5.7% of the total area of the study area, which represents a natural reflection of the surface condition in the study area, which is characterized by the mountainous surface of most of its sectors. These lands are found in dry valley estuaries and wadis.

- **Low slope land**: These are the surfaces whose slope range between (2-5 degrees) and cover about 8.4km2, representing 11.8% of the total area of the study area, and these lands appear inward from the distribution of the previous lands towards the mountain slopes.

- **Medium Slope Lands**: These are lands with a slope between (5-10 degrees) and cover about 15km2, representing about 21% of the total area of the study area. These lands are shown in the middle range of the region where the sides of the Red Sea Mountains are located.

- **Land above medium height**: These are the surfaces that have a gradient between (10-18 degrees). These lands cover about 22.4km2, representing about 31.4% of the total area of the study area. These lands appear on the sides of the highlands in the area and along the slopes of the wadis.

- **Extremely steep lands**: These are the surfaces whose slope range between (18-30 degrees) and cover about 19.0km2, representing 26.6% of the total area of the study area. These lands appear at the feet of the eastern highlands in the study area represented by the mountains of Abu Arqub and Medus.

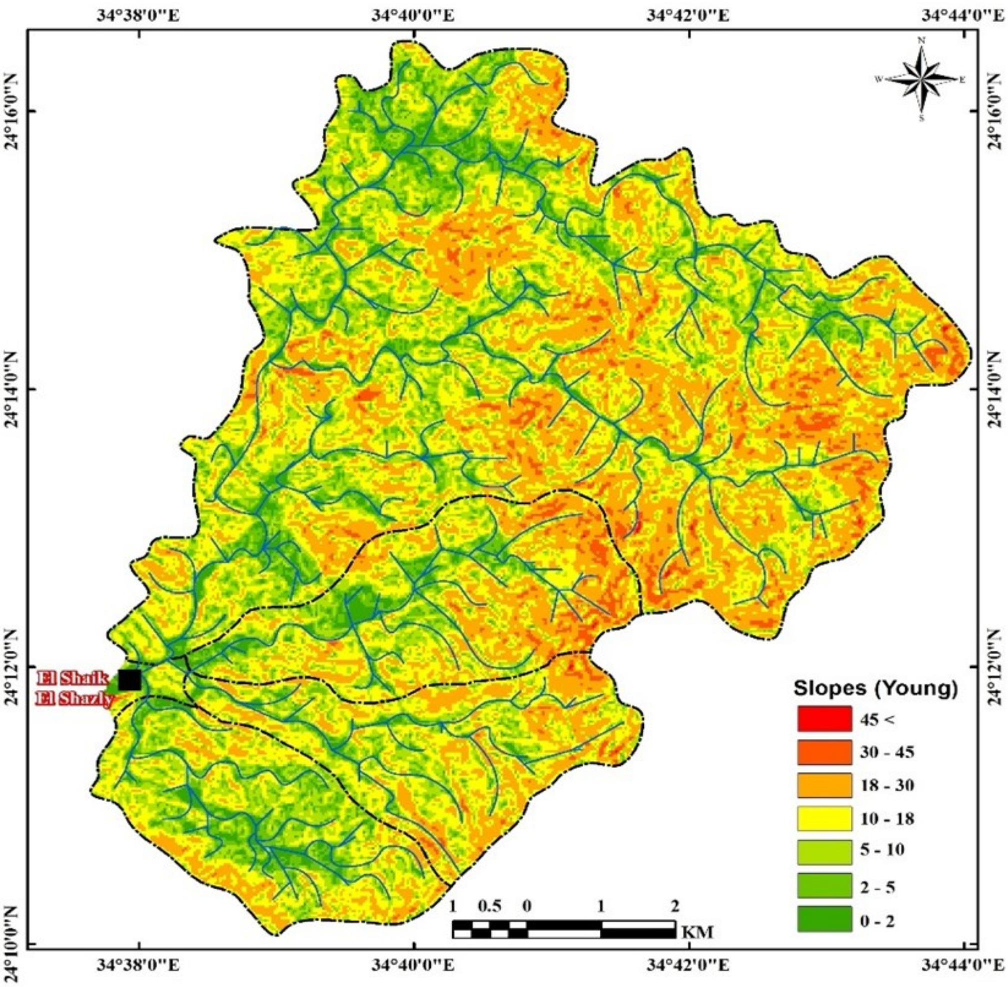

Fig. (4) Slops of the study area surface

- **Very steep lands**: These lands range from (30-45 degrees) and cover about 2.1km2, representing about 2.9% of the total area of the study area. These lands are shown in the areas below the mountain peaks in the study area.

- **Vertical cliffs**: These are the lands with a slope of more than 45 degrees and cover about 0.4km2, representing 0.6% of the area of the area, and appear in the areas of the mountain peaks from which the valleys in the region originate.

- It is noted that land with **slopes of more than 10 degrees** covers about 61.5% of the area of the area, while land with a lesser slope covers about 38.5%, which reflects the nature of the topography of the area and cut it by the drainage network.

Table (2) Major regression patterns in the study area

Slope Degree	W. Umm Samrah		W. Umm Hirenah		W. Umm Sreha		W. Umm Dehesi	
	Area (Km^2)	(%)	Area (Km^2)	(%)	Area (Km^2)	(%)	Area (Km^2)	(%)
0 - 2	2.5	5.4	0.6	6.5	0.3	3.8	0.7	9.1
2 - 5	5.3	11.3	1.1	12	0.7	9	1.3	16.9
5 - 10	9.5	20.3	1.7	18.5	1.6	20.5	2.2	28.6
10 - 18	14.5	31.1	2.7	29.3	2.8	35.9	2.4	31.1
18 - 30	13.3	28.5	2.6	28.3	2.1	26.9	1	13
30 - 45	1.4	3	0.4	4.3	0.2	2.6	0.1	1.3
45 <	0.2	0.4	0.1	1.1	0.1	1.3		
Total	46.7	100	9.2	100	7.8	100	7.7	100

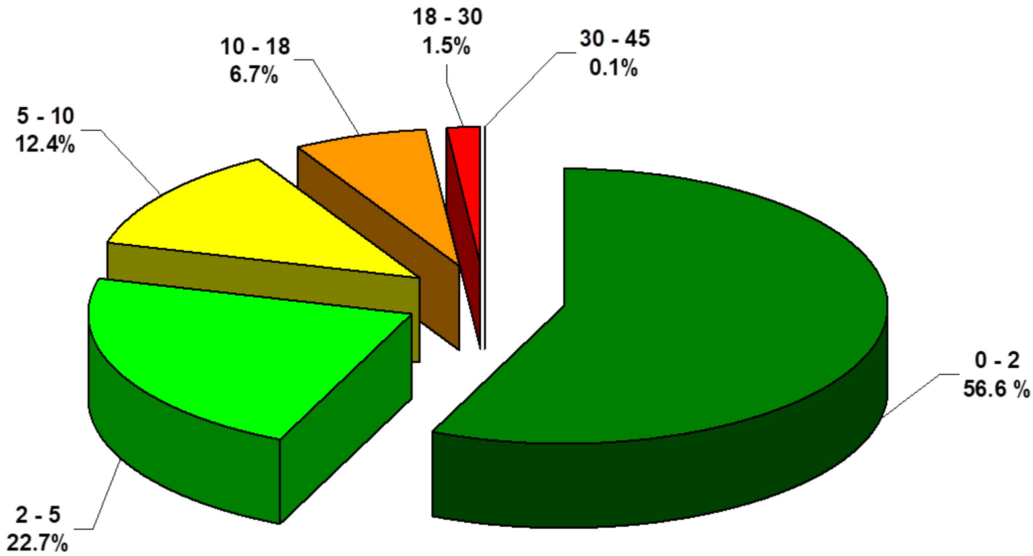

Fig. (5) Patterns of the terrain of the study area

3. Aspects

It is clear from the study of Table No. (3) and Fig. No. (6), (7) that:

- **Flatlands**: means flat lands that do not take a tendency to any direction. These lands cover about 7.6km2, representing about 10.6% of the total area of the study area. These lands appear in the stomachs of the dry valleys, especially in the area where they meet each other.

- **Northward**: Covers land that is heading north and sloping between (0 – 22.5 degrees) and(337.5 – 360 degrees) and north-east and sloping between (22.5 – 67.5 degrees) and north-west and sloping between (292.5 – 337.5 degrees), all covering about 28.2km2 Panama, which is about 39.5% of the area. These lands are clearly visible in the southern sides of the wadis, especially since most of the sewers go from east to west and thus the northern slopes are shown on its southern side. It is also noted that some of the valley's stem from the northeast direction and are headed towards the southwest, such as the valleys of Umm Samra and Umm Harina, which affected the direction of the surface of the study area in the north, northeast and northwest directions.

- **Southward**: It covers the lands that go southward and slope between (157.5 – 205.5 degrees) and southeast and slope between (112.5 – 157.5 degrees) and southwest and slope between (205.5 – 247.5 degrees), all of which cover about 22.9km2, representing 32.1% of the total area of the region. These lands represent the north, north-east and north-west streams of some of the region's wadis.

Table (3) Gradient Trends in the Study Area

Aspect	W. Umm Samrah		W. Umm Hirenah		W. Umm Sreha		W. Umm Dehesi	
	Area (Km^2)	(%)	Area (Km^2)	(%)	Area (Km^2)	(%)	Area (Km^2)	(%)
Flat	5	10.7	0.9	9.8	0.8	10.3	0.9	11.7
North	9.6	20.6	2	21.7	1.6	20.5	2	26
North East	4	8.6	0.4	4.3	0.5	6.4	0.6	7.8
East	3.8	8.1	0.5	5.4	0.4	5.1	0.6	7.8
South East	4.4	9.4	0.9	9.8	0.7	9	0.6	7.8
South	5.1	10.9	1	10.9	1	12.8	0.7	9.1
South West	5.3	11.3	1.3	14.1	1.1	14.1	0.8	10.4
West	4.7	10.1	1.1	12	0.9	11.5	0.7	9.1
North West	4.8	10.3	1.1	12	0.8	10.3	0.8	10.4
Total	46.7	100	9.2	100	7.8	100	7.7	100

- **Eastward**: These lands have a slope angle ranging between (67.5 – 112.5 degrees) and cover about 5.3km2, representing about 7.4% of the total area of the study area. These lands are shown in the southern sources of Wadi Krioni, the tributary of Wadi Umm Samra, and the southern sources of Wadi Umm Dahisa.

- **Westward**: These are the lands whose surface slope angle ranges between (247.5 – 292.5 degrees) and covers about 7.4km2, representing about 10.4% of the total area of the study area. These lands appear in the upper sources of medicines where the western slopes of the Red Sea Mountain range.

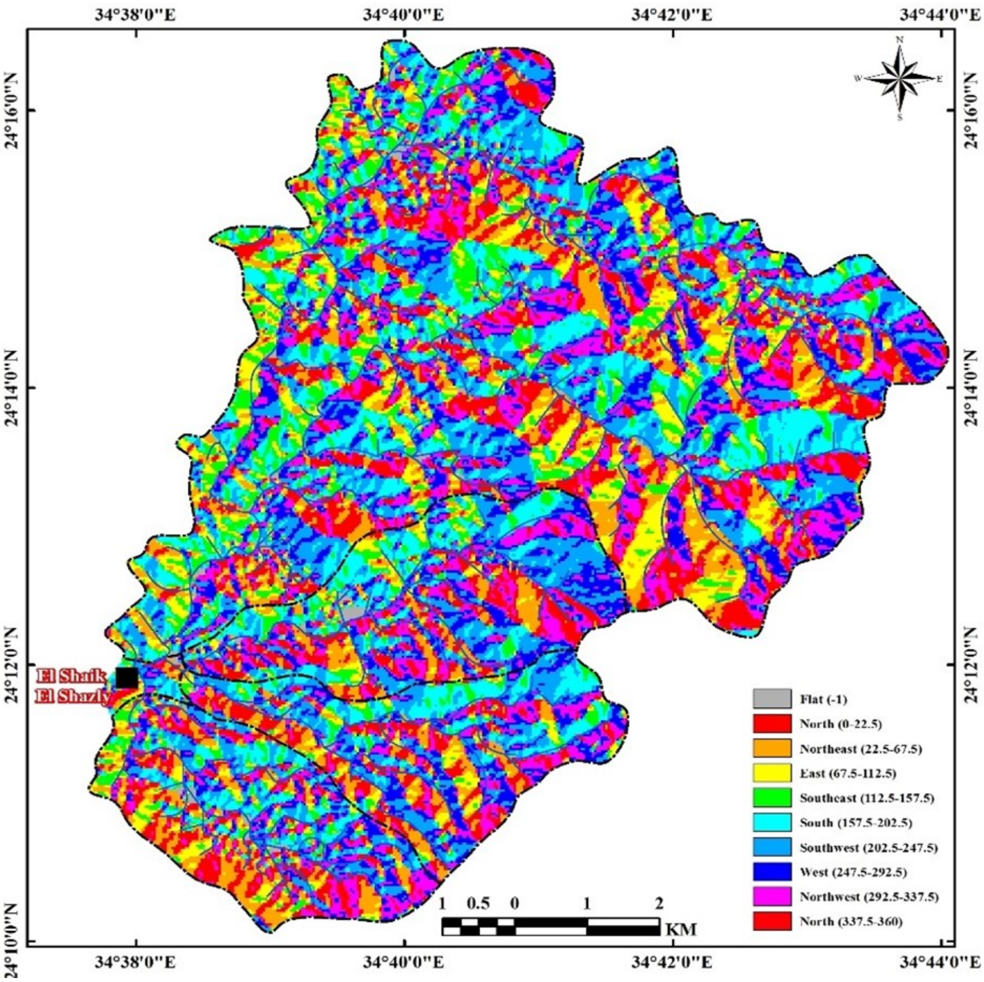

Fig. (6) Aspects of the study area

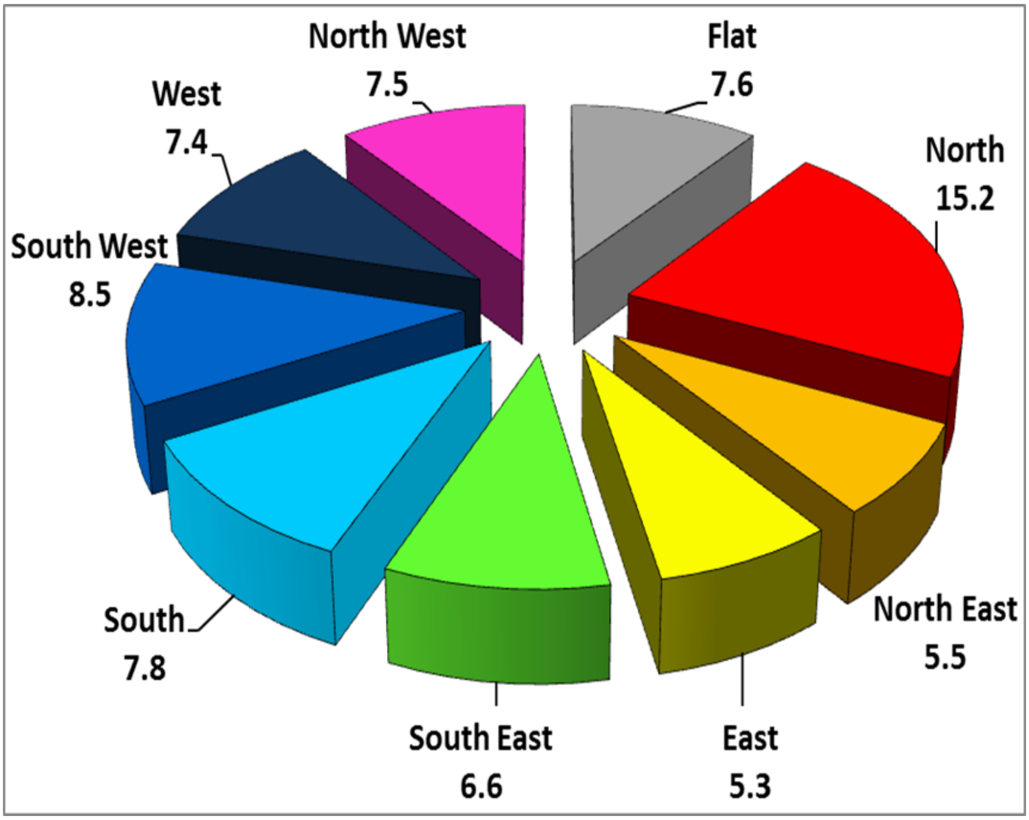

Fig. (7) Aspects categories of the study area

Basins Morphometry

Table (4) shows the morphometric characteristics of the water drainage basins and networks in the study area, which shows the following: -

1. **Basins Dimensions**

The basins of the study area are characterized with their small dimensions, ranges between (7.7 - 46.7 km2), their lengths range between (4.4 - 11.2 km) and their average width between (1.5 - 5.6 km) and their perimeter between (11.7-38.8 km). Therefore, these basins are dangerous because one rainstorm can cover and affect them, and moreover the loss of water due to leakage and evaporation decreases. Besides, short-length basins are also most dangerous, as runoff water takes less time to reach the wadis outlets. Furthermore, in these short wadis the surplus water increases because the losses through evaporation and leakage becomes less than the longer wadis.

Table No. (4) The morphometric characteristics of the water drainage basins.

	W. Umm Samrah	W. Umm Hirenah	W. Umm Sreha	W. Umm Dehesi	Mean
A (km2)	46.7	9.2	7.8	7.7	17.85
LB (Km)	11.2	5.6	5.4	4.4	6.65
W (Km)	5.6	1.7	1.5	2.1	2.73
Pr (Km)	38.8	13.9	14.5	11.7	19.73
Re	0.69	0.61	0.58	0.71	0.65
Rc	0.39	0.60	0.47	0.71	0.54
Ish	0.37	0.29	0.27	0.40	0.33
SH	1.60	1.29	1.46	1.19	1.39
K	0.67	0.85	0.94	0.63	0.77
Rlw	2.00	3.29	3.60	2.10	2.75
Rf	607	499	481	242	457.25
Rh	54.2	89.1	89.07	55.0	71.84
Rr	1.56	3.59	3.32	2.1	2.64
Rn	1.35	1.11	1.10	0.62	1.05
Gn	0.44	0.22	0.22	0.20	0.27
Hi	0.08	0.02	0.02	0.03	0.04
Sl	3.11	5.11	5.10	3.15	4.12
Kc	4	3	3	3	3.25
Snu	149	28	21	26	56
Slu (Km)	104.2	20.5	17.9	19.7	40.58
Rb	5.4	5.5	4.3	4.5	4.93
D (km-1)	2.23	2.23	2.30	2.56	2.33
F (km-2)	3.19	3.04	2.69	3.38	3.08
Rm	0.45	0.45	0.44	0.39	0.43
Lo	1.12	1.12	1.15	1.28	1.17
Rt	3.84	2.01	1.45	2.22	2.38

A area of the basin (km2), LB basin length (km), W basin width (km), Pr perimeter of the basin (km), Re elongation ratio, Rc circularity ratio, Ish shape index, SH compactness ratio, K Lemniscates ratio, Rlw Length / Width Ratio, Rf relief (m), Rh relief ratio, Rr Relative relief, Rn ruggedness number, Gn Geometric Number, Hi Hypsometric Integral, SI % slope index, kc order of trunk channel, Snu sum of stream numbers, Slu sum of stream lengths (km), Rb bifurcation ratio, D drainage density by Horton method (km-1), F stream frequency (km-2), Rm Stream Maintenance Ratio, Lo length of overland flow (km), Rt texture ratio (Km-1).

1. **Basins Shape**

The basins of the region appear to be semi-circular, with the circularity ratio ranging between (0.58-0.71) while the elongation ratio ranged between (0.58-0.71). Thus, these basins tend more likely to be semi-circular than rectangular in shape. Therefore, during flood the wadi's level of severity becomes highly destructive. The shape index also varied between (0.27-0.4), which indicates that these basins have a triangular shape, thus alleviating degree of the severity of flood flow therein. On the other hand, the low Lemniscates ratio values, which ranged between (0.63-0.94), indicate an increase in the ellipticity ratio of these basins approximating the circular shape, thus raising their hazard rates. Whereas the high compactness ratio values, which ranges between (1.19-1.60), indicates the irregularity and inconsistency of most of the study area wadis, the significantly meandering circumferences of these wadis and that they are still at an early stage of their erosional cycles and thus their highly hazardous. Further, the high Length / Width Ratio values, which ranges between (2.0-3.6), indicate that the study area is in the youth stage, as most of its basins tend to be elongated. The current climatic and geological conditions may cause this stage to extend further.

2. **Basins Topography**

The topographic characteristics of the study area basins shows high values of maximum relief (m), compared to some of the Red Sea mountain basins sloping towards the Nile, due to their small area and that they are less extended westwards through the mountain range. These values range between (242-607 m), while the relief ratio values ranges between (54.2-89.1 m/km), these high relief ratios reflect the short lengths of the basins and it's high maximum relief ratios. Also relative relief ranged between (1.56-3.59), which reflects the intense rock resistance to erosion factors, as it is located inside the igneous rocky mountain mass, while the value of the ruggedness number ranged between (0.62-1.35), which reflects the erosion stage that the drainage basins of the region experience. However, the value of the geometric number ranges between (0.20-0.44), this low value indicates a greatly steep slope surface. The value of the Hypsometric Integral ranged between (0.02-0.08), this revealses that the study area is affected by various erosion factors, while the values of slope index (%)), which ranged between (3.11-5.11), indicate the high rates of relief slope as it occurs within the Red Sea mountain range.

3. **Drainage Network**

As shown in table 5and Fig. 8 the drainage networks in the region are small. Amongst all basin streams of the region, only wadi Umm Samrah reached the fourth order, while other basins reached the third order. Stream numbers ranges between (21-149 stream). Stream lengths (km)) ranges between (17.9-104.2km).

Bifurcation ratio ranges between (4.3-5.5). Therefore the water drainage system in the region is dangerous, as short length streams have less loss of water and water reaches the basin outlet within a short period of time.

Table (5) Water Drainage Network in the Study Area

Wadi	Order 1		Order 2		Order 3		Order 4		Total	
	Num	(km)	Num	(km)	Num	(km)	Num	(km)	Num	(km)
Umm Samrah	121	54.1	24	22.8	3	21.5	1	5.8	149	104.2
Umm Hirenah	24	13.4	3	4.6	1	2.5	-	-	28	20.5
Umm Sreha	17	9.8	3	4.3	1	3.8	-	-	21	17.9
Umm Dehesi	20	13.3	5	2.1	1	4.3	-	-	26	19.7
Total	182	90.6	35	33.8	6	32.1	1	5.8	224	162.3

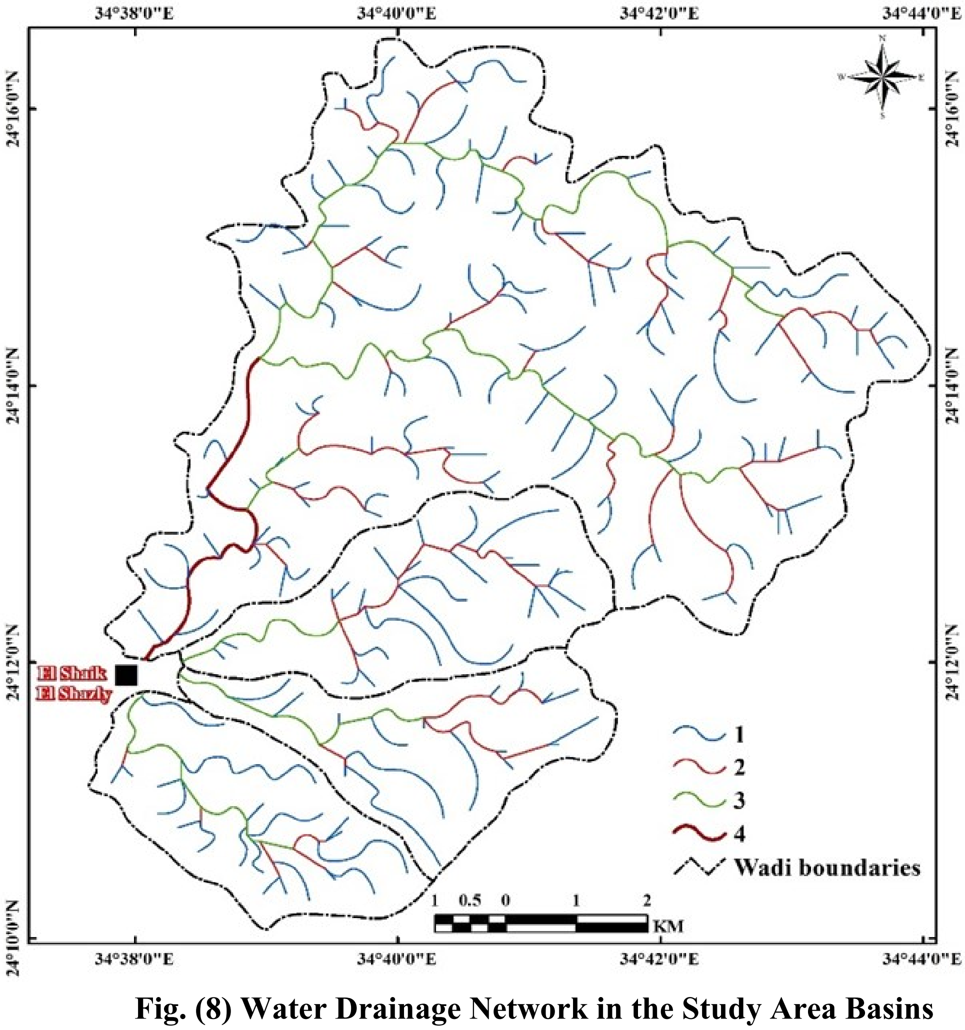

Fig. (8) Water Drainage Network in the Study Area Basins

2. Drainage Density

The basins of the study area have a low drainage density ranging between (2.23-2.65 km/km2), due to the conditions of geological structure, drought and it's small area.(Schumm, 1977, p.22) illustrates that the drainage density rises weak rocks and impermeable soil and decreases in case of hard rocks and high permeability soil. While some researchers went further asserting the ability to identifying the type of rock and its characteristics through recognizing the drainage density. According to a study of (Smith.K, 1950, pp. 655-668), the basins of the region are also characterized by a rough topographic texture ratio, with a value ranging between (1.45-3.84 Hungary/km) this returns to the geological igneous structure of study area which contributed to decreasing the number of streams in the area. Stream frequency ranges between (2.69-3.38 conduits/km2), ranging between low to medium values, indicating a fewer number of tributaries, which as a result reduces the possibility of floods and enhances leakage so as to feed groundwater reservoirs, (Elshamy, I.Z., 1985, p.353). Whereas the values of Stream Maintenance Ratio ranges between (0.39-0.45 km2/km), which means that every 0.39-0.45 km2 of basin area feeds 1km of stream length. This proves the vastness of the basin area to the detriment of it's short length drainage streams networks which resultes in a decrease in the drainage density. Finally, the region's basins have low overland flow rates (km), ranging from 1.12-1.28km/km2, this returns generally to the low drainage density due to geological conditions of the study area.

Flash flood runoff affecting factors.

Flood flow is affected by several factors, the most important of which are:

1. Climate factors:

There is no doubt that climatic factors play an important role in forming flood flow. A combination of various climatic elements coincides to form floods. Thus, we are necessarily ought to shed light some prevailing climatic elements in the area which can somehow affecting the formation of floods and increase their intensity. The study of the climate of the study area was based on the data of Ras Banas Meteorological Station.

Table (6) Climatic characteristics in the study area

month	Max.temp. C	Min. temp. C	Rang temp. C	Mean temp. C	Relative Humidity (%)	Evaporation (mm)	Wind speed (km/h)	Rain (mm)
Jan.	25.3	14.3	11	19.7	55	8	11.2	1.8
Feb.	24	12.1	11.9	18	56	8.2	11.6	1.9
Mar.	25.1	12.7	12.4	18.9	51	9.3	11.8	1.2
Apr.	27.6	14.9	12.7	21.3	48	12	19.2	1.4
May.	31.8	18.6	13.2	25.3	39	16.8	19.9	1.8
Jun.	35.3	21.9	13.4	28.8	34	20.4	22.5	1.8
Jul.	37.5	24.5	13	31.3	28	25.3	24.6	-
Aug.	37.7	25.2	12.5	31.6	33	22	19	-
Sep.	38.2	24.8	13.4	31.7	34	21.1	18.7	-
Oct.	36.8	24.8	12	30.8	36	20.9	22.9	-
Nov.	33.8	21.4	12.4	27.6	47	14	11.8	4.4
Dec.	28.4	17.5	10.9	22.7	55	9.2	12.5	10.6
Mean	31.8	19.4	12.4	25.6	43	15.6	17.1	3.1

- **Temperature:**

The general average of maximum temperature at the Ras Banas station was 31.8 degrees, while the annual average minimum temperature was about 19.4degrees, whereas the annual average temperature range was about 12.4degrees, which is to some extent a high rate that has significant effects on the weathering and erosion processes acting on rocks in the study area, most of which has igneous structure, leading to an increase in the rates of weathering and erosion. This leads, most significantly, to granular and mass disintegration and sheeting of the rocks preparing them to next flood runoff, as these deposits fill the wadis forming an environmental danger in the estuary areas as well as on human communities along the water stream. The rising temperature also leads to high evaporation rates, which increases the amount of lost water and thus reduces the hazards of flood runoff, and vice versa.

- **Relative humidity:**

Relative humidity is considered an impressive element that affects many natural and atmospheric processes, as it is one of the factors that help to maintain the latent heat. As its rates increases it hinders the effectiveness of ground radiation and reduces the evaporation rate, as air is saturated with water vapor and therefore does not need extra water vapor. Whereas, when air doesn't contain relative humidity, it becomes more likely vulnerable to lose its heat quickly. generally, relative humidity in Egypt decreases in the southward direction, with the diminishing effect of wet winds.

Relative humidity is also one of the important elements of climate affecting the activity of natural processes of weathering of all kinds, which leads to the disintegration of rocks and their decomposition in preparation for carrying them and transferring them by other geomorphological processes, the most important of which is torrential water, and therefore its impact is that its high rates increase the probability of carrying torrents for a large amount of crumbs and sediments. The annual average of relative humidity in the study area was about 43%, increasing to 56% in

February while decreasing in July to 28%.

- **Evaporation:**

As an element of the climate, evaporation contributes significantly to flood runoff. The increase in its rates leads to the increase in the rates of lost water and thus reduce the water clarity of runoff and therefore increases the hazards of flood runoff. The average annual evaporation in the study area reached about 15.6mm, rising to 25.3mm in July, while dropping to 8.0mm in January.

- **Wind:**

Wind is one of the most important elements of the climate in terms of geomorphology. Its impact extends to many human and economic fields. It is considered a factor for moving clouds and bringing rain. However, the relief features of the study area affect the winds blowing on it, as its main directions tend towards the north and northwest. In general, the northern winds are the prevailing winds in the study area, with a blowing rate of about 46.1%, followed by the northwest winds by 18.4%, followed by the western winds by 10.2%, while the lowest wind direction is in the south-east direction by 0.2%, followed by the south by 1.6%, and then the southwest by 1.7% . As for the wind speed, its average speed in the study area is about 17.1km/h, this average rises to 24.6/h in July and 22.9km/h in October, while it declines to 11.2km/h in January.

Table (7) Wind Directions in the Study Area

	North	North East	East	South East	South	South West	West	North West	calm
Wind Dirc.	46.1	4.4	4.7	0.2	1.6	1.7	10.2	18.4	12.1

- **Rain:**

Rain is the main element in the flow of floods, as the volume of flood flow depends on the precipitation, for this reason the study of rain in the study area is important. In general, the average of precipitation in the study area is 3.1mm, rising to 10.6 mm in December, while it declines to 1.2 mm in March, and ceases completely during summer.

2. **Hydrology of drainage basins**

Table (8) shows the hydrological characteristics of the study area basins, which shows the following:

- The interval between the beginning of rainfall and the beginning of runoff (Lag-Time) ranges between (13.1-76.4 minutes), such a very short time contributes to raising the runoff level of severity in the study area wadis.

- The time that rains falling at the farthest point of the water divide line takes to reach the outlet of the basin in the form of running water (concentration time) ranges between (21.8-127.4 minutes), which is a very short time that reflects the short lengths of these basins and the danger of their runoff.

Table (8) Hydrological characteristics of the water drainage basins.

	W. Umm Samrah	W. Umm Hirenah	W. Umm Sreha	W. Umm Dehesi	Mean
TC	127.4	34.6	33.5	21.8	54.33
TL	76.4	20.8	20.1	13.1	32.6
Dr	47.7	11.1	9.5	9.4	19.43
Dv	77.9	19.5	17.4	18.9	33.43
Td	0.391	0.123	0.122	0.135	0.193
Lt	5.28	9.71	9.67	12.12	9.195
Pre	1961400	386400	327600	323400	749700
EL	91065	17940	15210	15015	34807.5
Lti	4755.9	257.6	209.04	134.5	1339.26
Se	2885.0	178.8	150.4	164.2	844.6
L	98705.9	18376.4	15569.4	15313.7	36991.4
Ru	1862694	368024	312031	308086	712709

TC concentration Time, TL Lag – Time, Dr Drainage rate, Dv Drainage Volume, Td Discharger Time, Lt Water speed, Pre precipitation, EL Evaporation Losses, Lti Lag time infiltration, Se Seepage, L total losses, Ru Run off.

- The volume of water passing through the area of a square kilometer measured by cubic meters per second (drainage rate) ranges between (9.4-47.7 m3/s), which are fairly low values that reflect the small size of these basins and their short dimensions.
- The total amount that can be spent by the drainage network of the basin (drainage volume) (Drainage Volume) ranges between (17.4-77.9 thousand cubic meters), which are low values that emphasize the small dimensions of these basins and the decrease of net runoff from them
- The period of time required to discharge the basin's whole amount of water from upstream to the outlet area at the estuary (Discharge Time) ranges between (0.12 - 0.39

hours), which are low values indicating the danger of runoff of these basins. • While water speed in these basins ranges between (5.28-12.12 km/h), these values that indicate the danger of runoff.

3. Hydrological balance of drainage basins

The hydrological balance is based on the estimating the volumes of precipitation falling on the drainage basins and estimating the losses by evaporation and leakage to determine the net runoff and thus to recognise to what extent runoff is potential or not. The hydrological balance will be studied through the following elements:

- **Volumes of precipitation on drainage basins:**

The volume of precipitation for each basin depends on the basin's area. Estimating the volume of precipitation considerably depends on the basin's area and the biggest largest precipitation volume it received during a single day. Being the nearest station to the study area, the largest precipitation volume during a single day - on the Ra's Banas station (64mm) on 24/11/1996 - was used for this purpose. The volume of precipitation on the study area basins was estimated using two ways. The first is the method of (Ball, j. ,1937) through the following equation:

$$A \times Rain \geq 10\text{-}8\ mm \times 750$$

Where A is the area of the drainage basin.

In case the precipitation volume value was 64 mm, the volume of precipitation on the basin was about (1.9-0.39-0.33-0.32 million m3) for the basins of Um Samra, Um Harina, Um Surah or Dahisi, respectively.

The second method is that of (Finkel, 1979, p.461), which is concerned with estimating the maximum flood rates m3/s, the annual runoff volume m3 as well as the duration of the flood per hour according to three possibilities; the first is a very low probability of 2%, which gives a large amount of water, the second is a low probability of 10%, which gives a medium amount of water, and the third is a high probability of 80%, which gives a low amount of water. Table (9) shows the probabilities of runoff according to the equation (Finkel, 1979, p.461), which illustrates the following:

Table (9) The probabilities of runoff for the drainage basins in the study area.

Wadi	Area (Km2)	Drainage Volume $m^3 \times 10^3$			Max. Drainage rate m^3/sec.			Discharger Time (h)		
		2%	10%	80 %	2%	10%	80%	2%	10%	80%
Umm Samrah	46.7	3371.7	1238	7.9	200.8	73.8	0.5	16.79	16.77	15.80
Umm Hirenah	9.2	664.2	243.8	1.6	39.6	14.5	0.09	16.77	16.81	17.78
Umm Sreha	7.8	563.2	206.7	1.3	33.5	12.3	0.08	16.81	16.80	16.25
Umm Dehesi	7.7	555.9	204.1	1.3	33.1	12.2	0.08	16.79	16.73	16.25
Total	71.4	5155	1892.6	12.1	307	112.8	0.75	16.79	16.78	16.13

studying of the above table illustrates that:

- Based on the probability of 2%:

It is noticeable that the expected annual runoff volume for the study area's four basins reached 5.2 million m3. According to this probability, wadi Umm Samrah is the largest area's basins with an expected runoff of 3.37million m3, representing 65.4%, followed by the Um Harina Basin with an expected runoff of 0.66 million m3, and the Um Dahisi Basin comes in the last order with an expected runoff vokume of 0.55 million m3. The expected drainage rate at the peak of runoff the according to this probability is 307m3/s, of which 200.8m3/s are particularly for Um Samra Basin with 65.4%, while the runoff duration according to this probability is 16.79 hours.

- Based on 10% probability

According to this probability expected runoff volume reached 1.89 million m3; this value ranged between 1.2238 million m3 in wadi Umm Samrah as the largest basin in terms of water volume and 0.204 million m3 in the wadi Um Dahisi basin as the least water volume expected for basins. The expected drainage rate at the runoff peak according to this probability is 112.8m3/s, where that value ranged between 73.8m3/s for Um Samra the largest basin and 12.2m3/s Um Dahisi as the smallest basin. The flood duration according to this probability reached 16.78 hours.

- Based on the probability of 80%

The expected flood flow according to this probability was 12.1 thousand m3, where this value ranged between 7.9 thousand m3 for Umm Samra Basin as the largest basin in terms of water quantity and 1.3 thousand m3 for Umm Dahisi Basin as the least basin in terms of the expected water quantity. The expected drainage rate at the runoff peak according to this probability is 0.75m3/s. This value ranged between 0.5m3/s for Um Samra as the largest basin and 0.08m3/s for Um Surahah and Um Dahisi representing the smallest basins. The runoff duration according to this probability reached 16.13 hours.

- **Volume of Loss:**

Losses by evaporation and seepage affect the flow process, as the runoff flows with the surplus rain remaining from evaporation and seepage. Their impact extends further after the start of runoff, as they affect the possibility that the runoff continues to run through the tributaries to reach the main wadi or it stops it and does not go farther.

- **Loss by evaporation:**

Considerably, as the study area is located in the semi-arid zone, it has high evaporation rates as a result of high temperature, especially during summer. However, there are some factors that affect evaporation, whether positively or negatively. Short time of precipitation and its concentration reduce the chances of evaporation. Also, time of precipitation also affects evaporation, as precipitation during the day increases evaporation rates. If precipitation occured during the night, the evaporation rates are low. In addition, the basin surface slope affects evaporation. Evaporation increases on low slope surfaces while decreases on steeply sloping surfaces. Evaporation during runoff was estimated relying on evaporation data from Ras Bass station. The rainstorm time is the time that water stays in the surface soil layers, which is estimated at about 3hours. Then 3 hours are divided by the hours of a single day, and the result is multiplied by the average evaporation rate recorded in the study area monitoring station, which is estimated at about 15.6mm, to obtain the evaporation rate during the storm, as follows: $3 \div 24 \times 15.6 = 1.95$mm/storm, then multiplying this value by the basin's metric area to obtain the expected evaporation value for each drainage basin, which is illustrated in Table (8), where the value of Evaporation Losses ranged between 91.065 thousand m3 for the Wadi Um Samra basin and 15.015 m3 for the Wadi Um Dheisi basin.

- **Seepage during lag time:**

Seepage is the movement of water through the soil surface. Soil has a maximum water absorption limit, as it cannot absorb more than this limit, which is known as the Infiltration Capacity. When precipitation volume is larger than the absorption capacity of the soil, runoff begins to form by collecting water above the soil surface. The volume of seepage through the soil depends on the permeability of the rock, the degree of surface slope, as well as the depth and type of the surface layer covering the wadi beds. Seepage during lag time can be calculated using the following equation:

Leakage during lag time = (area x lag time (hr) x0.08 mm/ min)

Seepage during lag time is defined as the seepage that occurs with the beginning of precipitation and continues until water appears on the ground surface and then begins to flow. Its value in the study area basins ranged between 4.75 thousand m3 in Umm Samra basin and 134.5m3 in the Umm Dahisi basin.

- constant seepage during the basins' drainage:

Constant seepage value expresses the volume of water leaking through the main bed rock lying beneath the surface sediments that cover the sides and val beds of wadis. constant seepage during basin's drainage time is calculated using the following equation:

Constant seepage values = basin area x basin drainage time x s

where ***s*** = constant represents the main rock type 0.158.

Constant seepage values ranged from 2.88 thousand m3 in Umm Samra basin to 150.4m3 in Umm Sereha basin.

- Total loss:

Total losses refer to the volume of precipitation lost either by evaporation or seepage, and accordingly determine the net runoff volume, and to illustrate whether there a runoff occured or not. The total loss is calculated by combining the values evaporation and seepage losses that were previously calculated as follows:

Total Loss = Evaporation during runoff+ seepage during lag time + constant seepage values

The total losses in the four basins of the study area, Umm Samra, Umm Harina, Umm Surha and Umm Dheisi, reached about (987.1-18.4-15.6-15.3 thousand m3), respectively. This value is to some extent high considering the climatic conditions mentioned previously as well as the surface characteristics and geological structure of the area.

- **Volumes of net runoff in drainage basins:**

Net runoff means the remaining of water after deducting the loss by evaporation and seepage from the total precipitation volume. The increase in net runoff implies an increased probability of runoff. Thus, net runoff is calculated by subtracting the total losses from the total precipitation.

Net runoff = total precipitation – total losses

The value of net runoff in the four basins of the study area; Umm Samrah, Umm Hirena, Umm Sreha and Umm Dehesi (1.86-0.368-0.312-0.308 million m3), respectively. This is the volume of water that supposed to reach the wadi outlet in case of a storm with a precipitation rate of 64mm.

Basin Runoff Danger Degree

To determine the runoff severity level in the drainage basins of the study area, the morphometric properties of the four drainage basins of the area, Um Samrah, Umm Hierna, Umm Sreha, and Umm Dehesi, were studied to determine the general hazards of runoff in the study area basins. The severity level of each drainage basin was determined by submitting all the factors - about 38 parameters - that this study relied on wholly without disregard or removing any of them. The severity level of the drainage basins of the study area was calculated according to the following steps:

1. Submitting all parameters relied upon in the study of the area's basins.
2. Dividing these parameters in terms of severity level into two main groups as follows:
   - The first group: includes the parameters in which the high values express the high severity, which includes the following parameters (area - elongation - circularity - shape - compactness - maximum relief - texture ratio - relative relief - ruggedness - slope - stream order - stream numbers - drainage density - stream frequency - overland flow - texture ratio - drainage rate - drainage volume - runoff speed - total precipitation - net runoff)
   - The second group: includes the parameters in which the low values express the high severity, which includes the following parameters (length - width -perimeter - lemniscates - length/width ratio - geometric number - hypsometric integral - stream length - bifurcation - stream maintenance - lag time - concentration time - discharge time -evaporation during the discharge time - lag time infiltration time - constant seepage values -total losses)
3. Calculating the severity level for each of the parameter of the drainage basins and networks through the following equation

$$\text{Hazard degree} = \frac{4(X - X_{\min})}{(X_{\max} - X_{\min})}$$

where (***X***) expresses the value of the parameter whose severity level is intended to be calculated. while Max expresses the highest value among any of the parameters of the drainage basins, while Min expresses the lowest value for the same parameter, whereas the number (4) expresses the severity level that will be relied upon. The following severity levels have been determined for the drainage basins in the area as follows:

- Low severity score (1) less than 1.0
- Medium severity level (2) from 1.0 to less than 2.0
- High severity score (3) of 2.0 – less than 3.0
- Too high severity level (4) from 3.0 up

Table (10) shows the severity values of the study area drainage basins concerning all elements, which represents the quotient of dividing the parameters' value for the study area drainage basins by the value resulting from the severity level equation, to rank that parameter for these basins in their severity level order. It is noted through studying this table that the single basin can be ranked in any of the severity level order according to any of the parameters, while the field (Total score) indicates the sum of combining the severity values in each basin at the level of all parameter, whereas the field (Mean) indicates the average severity level in those basins after dividing the sum of combining those values by their number. Also, through studying data in this table reveals that the value of severity level in study area ranges between 2.2 degrees in of Umm Hierna and Umm Sreha basins and between 2.8 degrees Dehesi basin. Accordingly, the area basins are classified as hazardous runoff basins as they take that order.

Table No. (11) shows the combined severity for the study area drainage basins according to severity parameter, as severity levels in each parameter category were combined altogether to recognize the severity level of this category in the drainage basins. This table reveals the following:

1. The combined category **(Geometry)** includes the sum of severity values for the study area drainage basins, the sum of basin dimensions parameters (area - length - width -perimeter). It reveals that the study area basins take the order of too high severity namely (Um Hierna - Um Sreha - Um Dehesi) and the medium severity order in Um Samrah Basin.
2. The combined category **(Shape)** includes the sum of severity values for the study area drainage basins, the parameters of basin shape (elongation - circularity - compactness - lemniscates-length/width ratio), where (Um Samrah - Um Dehesi) take the too high severity order, while (Um Hierna - Um Sreha) basins take the medium severity order.
3. The combined category **(Topography)** includes the sum of severity values for the study area drainage basins for the basin relief parameter (maximum relief - relief - relative relief - ruggedness value - the geometric number - the hypsometric integral - slope degree), where (Umm Hirenah - Umm Sreha) basins are in the too high severity order, while the Umm Samrah basin is in the high severity order and Umm Dehesi basin is in the medium severity order.
4. The combined category **(Drainage network)** includes the sum of severity values for the study area drainage basins for the drainage network parameters (stream order - stream numbers - sewage lengths - bifurcation - drainage density - stream frequency - sewage maintenance - overland flow - texture ratio), where Umm Dehesi basin is in the too high severity order, while Umm Samrah

basin is in the high severity order, whereas Umm Hirenah and Umm Sreha basins are in the medium severity order.

5. The combined category **(Hydrology)** includes the sum of severity values for the study area drainage basins for the hydrological parameters of the study area basins (lag time - concentration time - drainage rate - drainage volume - drainage time - runoff speed), where Umm Dehesi basin is in the too high severity order, while the rest of basins are in the high severity order.

Table No. (10) severity values for the study area drainage basins at the level of all elements.

	W. Umm Samrah	W. Umm Hirenah	W. Umm Sreha	W. Umm Dehesi
A (km2)	4	1	4	1
LB (Km)	1	4	4	4
W (Km)	1	4	4	4
Pr (Km)	1	4	4	4
Re	3	1	1	4
Rc	1	3	1	4
Ish	3	1	1	4
SH	4	1	3	1
K	4	2	1	4
Rlw	4	2	1	4
Rf	4	3	3	1
Rh	1	4	4	1
Rr	1	4	4	1
Rn	4	3	3	1
Gn	1	4	4	4
Hi	4	1	1	1
Sl	1	4	4	1

KC	4	1	1	1
Snu	4	1	1	1
Slu (Km)	1	4	4	4
Rb	1	1	3	4
D (km-1)	1	1	1	4
F (km-2)	3	2	1	4
Rm	1	1	2	4
Lo	1	1	1	4
Rt	4	1	1	1
TC	1	4	4	4
TL	1	4	4	4
Dr	1	4	4	4
Dv	4	1	1	1
Td	4	1	1	1
Lt	1	3	3	4
Pre	4	1	1	1
EL	1	1	1	4
Lti	1	1	1	4
Se	1	1	1	4
L	1	1	1	4
Ru	4	1	1	1
Total score	86	82	85	107
Mean	2.3	2.2	2.2	2.8

6. The combined category **(Water Budget)** includes the sum of severity values for the study area drainage basins for the hydrological balance parameters (precipitation volume -

evaporation during the drainage time - lag time infiltration - constant seepage values - total losses - net runoff), where Umm Dehesi Basin is in the too high severity order, while the Umm Samrah Basin is in the high severity order whereas Umm Sreha and Umm Hirenah basins are in the medium severity order.

Table No. (11) combined severity values in the study area drainage basins according to the severity order.

	W. Umm Samrah	W. Umm Hirenah	W. Umm Sreha	W. Umm Dehesi
Geometry	1.8	3.3	4.0	3.3
Shape	3.2	1.7	1.3	3.5
Topography	2.3	3.3	3.3	1.4
Drainage network	2.2	1.4	1.7	3.0
Hydrology	2	2.8	2.8	3.0
Water Budget	2.0	1.0	1.0	3.0

Flood probability and severity order

(Al-Shami, 1992) model was relied upon to determine the probability of floods. It is based on three parameters; bifurcation ratio, stream frequency and drainage density. The model is divided into three sections, the first category is refered to as (A) and it refers to basins with a high flood probability and a low probability of groundwater, (B) category refers to basins with a medium probability for both flood and groundwater and (C) category refers to basins with a low flood probability and increase in groundwater level. Fig. (9) shows the application of the Al-Shami model on the study area basins, which shows that the study area basins are in category (B) with a medium flood probability according to the both parameters of Bifurcation Ratio and Stream

Frequency. Whereas, all basins are in category (C) with a low flood probability and high groundwater according to both Bifurcation Ratio and Drainage Density parameters, except for Umm Dehesi Valley, which is in category (B) with a medium probability for both flood and groundwater.

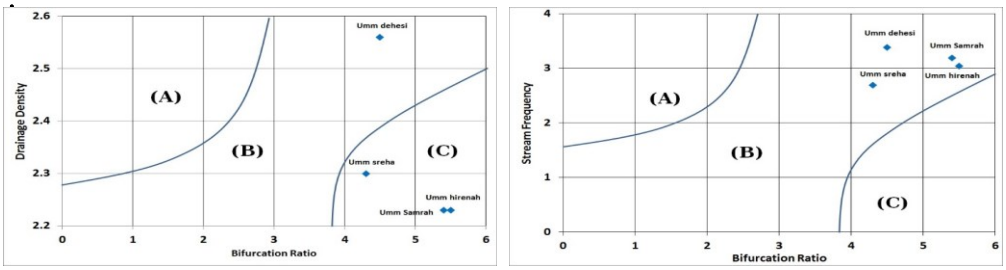

Fig. (9) Flood probability and severity order for the study area basins

Estimating the probability of rainstorms repetition in the study area.

To estimate the flood probability and repetition time in the study area, data from the monitoring stations in the study area were relied upon to obtain the largest precipitation volume received during a single day which reached (15) observations. The maximum value among these observations was in Suez station, as it was 64mm in 1966 and 60mm in 1991 (Rain max (mm)). These values were sorted in descending order so that the highest precipitation value is in the first rank, followed by the other values in descending order (Rank) as shown in Table No. (12). (Gheith,H. , Sultan,M. (2002), PP. 36-55) Also, the precipitation volume over the Red Sea mountains (RRSM) was calculated, which was 25% higher than that recorded previously at the same period, according to a study by (Gheith&sultan, 2002). Further, runoff probability in the study area (P (%)) was calculated using the equation (Critchley & Siegert, 1991) which is as follows:

$$P(\%) = \frac{m - 0.375}{N + 0.25} \times 100$$

P = probability in % of the observation of the rank m
m = the rank of the observation
N = total number of observations used

$$T = \frac{100}{P} (\text{years})$$

Table (12) Estimating the repetition probability of rainstorms in the study area.

interval	year	Rain $_{max}$ (mm)	RRSM	Rank	P (%)	T_p (yr)
0	1966	64	80	1	4.1	24.4
2	1968	12.2	15.25	11	69.7	1.4
0.2	1968	16	20	7	43.4	2.3
11	1979	48	60	5	30.3	3.3
0.1	1979	11.9	14.88	12	76.2	1.3
7	1986	14.21	17.76	9	56.6	1.8
5	1991	60	75	2	10.7	9.3
0.1	1991	48	60	4	23.8	4.2
3	1994	14	17.5	10	63.1	1.6
0.1	1994	50	62.5	3	17.2	5.8
2	1996	10.1	12.63	14	89.3	1.1
1	1997	16.2	20.25	6	36.9	2.7
15	2012	10.01	12.51	15	95.9	1
4	2016	10.98	13.73	13	82.8	1.2
2	2018	14.44	18.05	8	50	2

The repetition time of floods was estimated through the previous equation which is inversely proportional to the flood probability; as the greater the probability of floods, the less the repetition time will be, and vice versa. Based on the foregoing, the repetition probability of the flood occurred on November 24, 1966, is about 24.4 years, which happened on October 21, 1991. As for the flood of November 5, 2018, the repetition probability was estimated at about two years, which actually happened on March 11, 2020 in the Arab Republic of Egypt. It is expected that the flood of 2016 will be repeated with equal strength within approximately 7 years; by 2023.

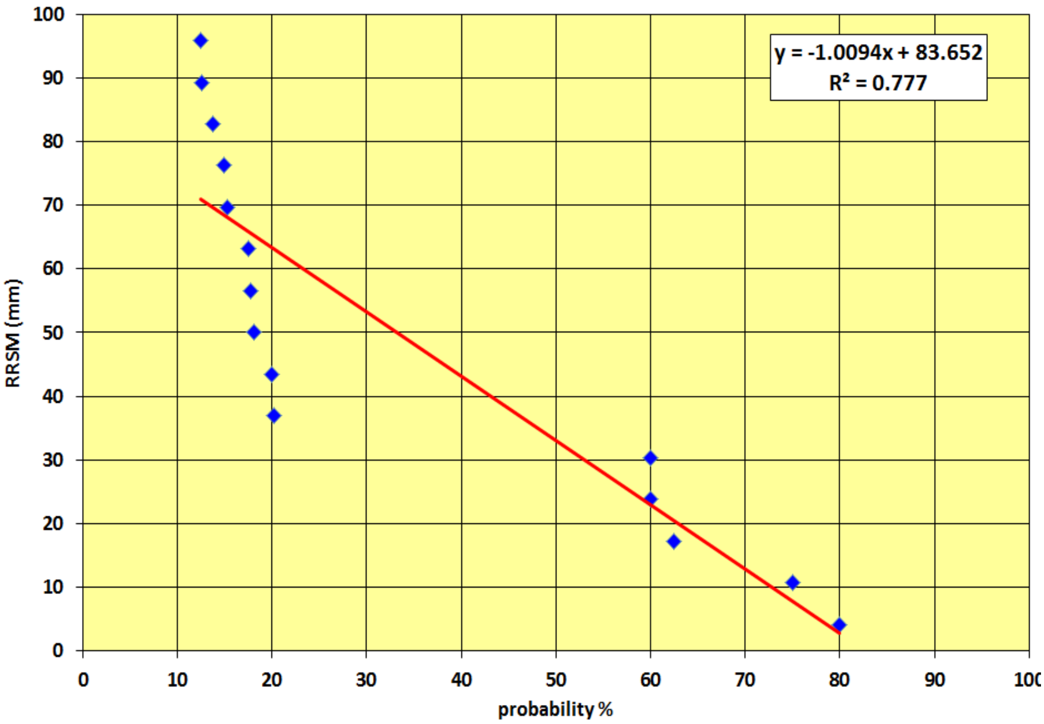

Fig. (10) The repetition probability of rainstorms causing floods in the study area

Estimating the precipitation density and design floods in the study area

To estimate precipitation density and it's return period and design floods in the study area, the data of the monitoring stations in the study area were relied on to obtain the largest precipitation during a single day in these stations, which reached (15) observations. Then calculating rain depth during some of the required frequency periods, namely (2-5-10-25-50-100 years), by applying the Gumbel's statistical distribution (Maximum Likelihood), which led to the prediction of the next precipitation volume in terms of the maximum precipitation volume during a single day:

Table (13) Estimating the design depth of future rainstorms in the study area.

Return Period (year)	Rain Depth (mm)
2	22.5
5	38.2
10	48.6
25	61.7
50	71.4
75	77.1
100	81.1

It is noticeable from data in the previous table that the maximum precipitation expected during a single day rises with the extention of frequency period, as it can be 22.5mm during the return period (two years), while it is expected to reach (81.1mm) during the return period (100 years) .

Through the above, it is possible to predict the precipitation volume that can be discharged through each of the the study area basins during the various return periods in terms of net runoff of these basins, as shown in Table No. (14) .

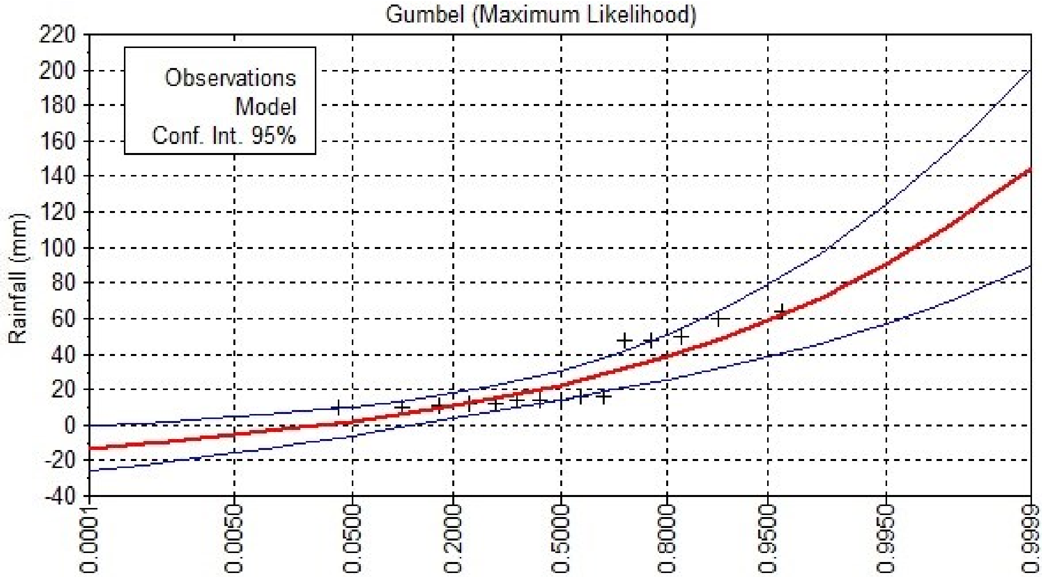

Fig. (11) Estimating the depth(thickness) of precipitation expected to fall on the study area.

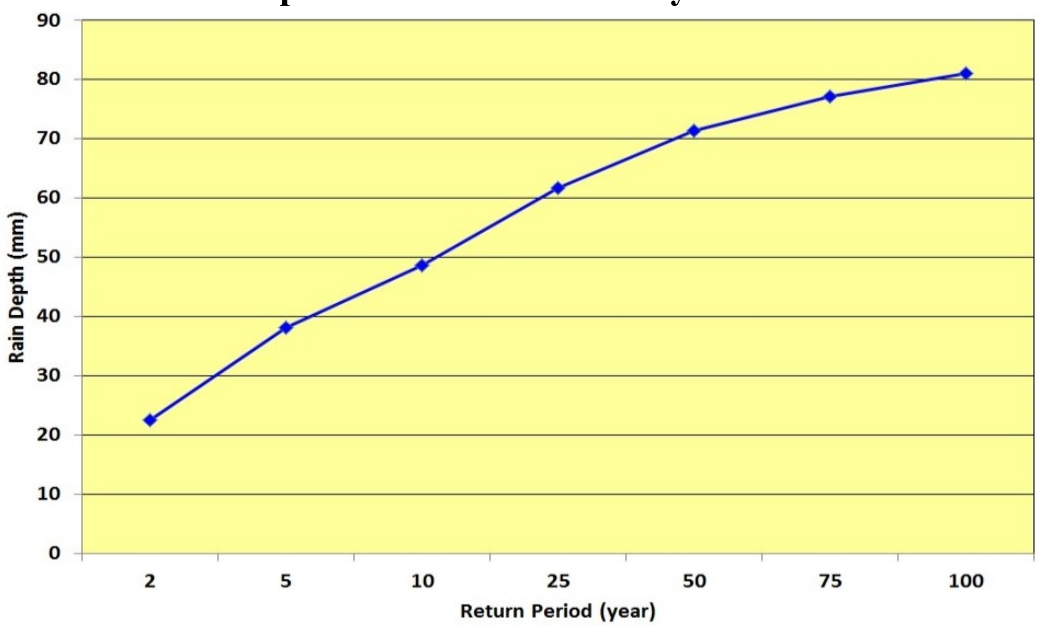

Fig. (12) Estimating the area's precipitation volume expected at different periods.

Table (14) Estimating the volume of water expected for the area's basins at different periods.

Return period	W. Umm Samrah	W. Umm hirenah	W. Umm sreha	W. Umm dehesi
2	507862.5	100050	84825	83737.5
5	1057755	208380	176670	174405
10	1422015	280140	237510	234465
25	1880843	370530	314145	310117.5
50	2220585	437460	370890	366135
75	2420228	476790	404235	399052.5
100	2560328	504390	427635	422152.5

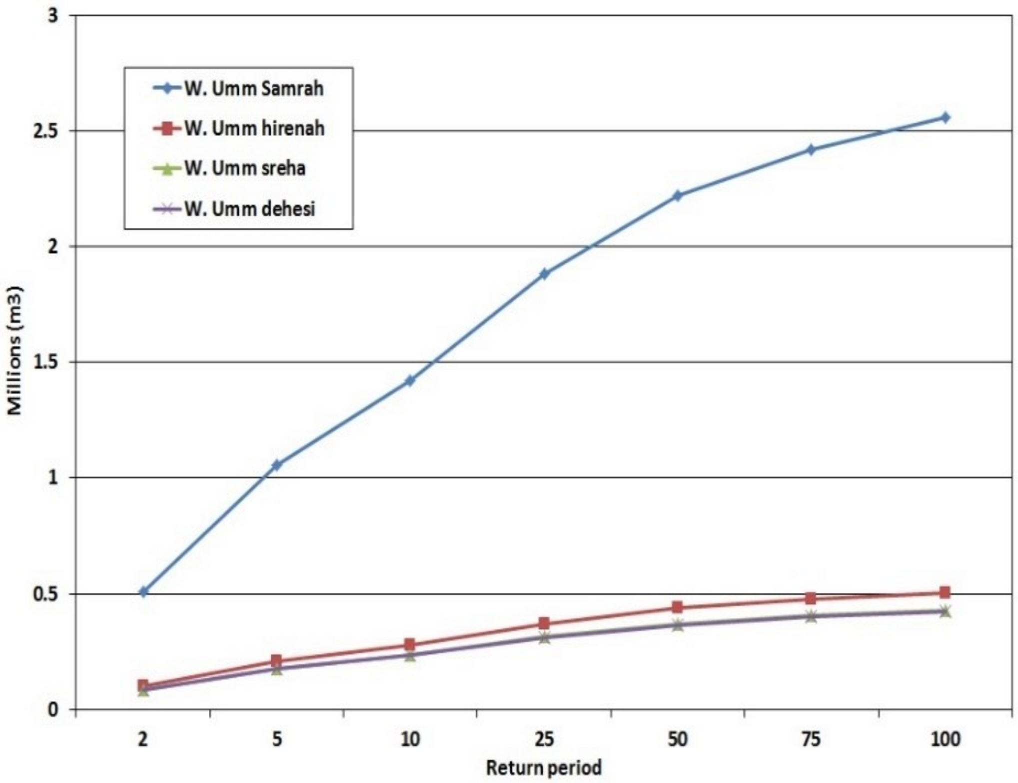

Fig. (13) Estimating the volume of water expected in the study area's basins at different periods.

Recommendations

Although there have been some dams recently constructed on the basins of the study area, the area is still at risk of run-off, which occurred on 14 November 2021, when parts of the village of Shaik El-Shazly were drowned because of the run-off of the study area basins. By showing the design capacity and storage capacity of the dams built on the study area basins:

- There are five protective dams on the study area basins, including two on Wadi Umm Samrah and one on each of the other three valleys.
- The storage capacity of dams on the study area basins was approximately 1.3 million cubic meters for the Umm Samrah basin and 0.47 million cubic meters for the Umm Hirenah, 0.44 million cubic meters for the Umm Sreha, and 0.33 million cubic meters for the Umm Dehesi basin (Ministry of Water Resources, 2019, P.37).

It is clear from the presentation of the design storms expected to occur at intervals (2- 5- 10- 50- 75- 100 years) that the ability of these dams to reserve and prevent the basin flash floods and its impact on the areas of human activity in Shaik El-Shazly village stops at 25 years' time period. The dams may collapse in the event of design storms lasting over 50 years, exposing the village to severe run-off. On November 14, 2021, flash floods exceeded dam design capacity, causing significant damage to the village urban area.

Based on the above, the study recommends that:

1. Upgrading the design capacity and storage capacity of the five dams constructed on the study area basins to absorb the largest amount of water from the floods.

2. Dig a bunch of storage lakes in front of dams to absorb any amounts of water beyond their design capacity after modification.
3. Construction of water drainage channels behind dams to drain any amounts of water beyond their design capacity, avoiding the village urban to the mainstream of Al-Sheikh basin.
4. Cleaning and maintenance of the village's old water wells and drilling of new water storage and utilization wells for various purposes.

Conclusion

The study examines the risks of flash floods in the Sheikh Shazly region in the Eastern Desert. The region is characterized by igneous rocks and low water losses due to seepage. The study uses topographical maps and digital elevation files to extract water drainage basins and networks. Mathematical equations are applied to calculate risk factors in these basins. The Wadi Umm Dehesi basin ranks first in flash flood danger, followed by Wadi Umm Samrah. The Umm Hirenah and Umm Sreha basins have low potential for torrefaction. The study also calculates the time of return of floods, which ranges from one to 25 years. The study also estimates design storms based on climate data over intervals of (2-5-10-25-50-75-100 years. The study concludes that dam efficiency needs to be increased proportionally to designed storms over 50 years or more to avoid flash flood dangers.

The location of the village of Sheikh Al-Shazly in the middle of Wadi Al-Sheikh, at the meeting point of the four valleys

One of the ancient Roman wells in the village of Sheikh Al-Shazly, which can be used to store and benefit from flood water

The walls of the storeroom of Sheikh Al-Shazly Mosque were affected by flood waters

Part of the wall of Sheikh Al-Shazly Mosque collapsed due to floods

Reference

Akaad, M, K, and Abu Ela, A, M, (2002): Geology of the Basement rock in the eastern half of belt between latitudes 25 30 and 26 30 N central eastern desert, Egypt., the geological survey of Egypt, paper. No. 78 Cairo.

Arthur, L, B (1978): Geomorphology a systematic analysis of late Cenozoic land form, prentice Hall, Inc. Englewood cliffs, New Jersey (U.S.A).

Ashour, M.M., (2002): Flash Floods in Egypt: A Case Study of Durunka Village- Upper Egypt.

Beadnall, H, J, (1924): Report on the geology of the red sea coast between Qoseir and Wadi Ringa, Ministry of Finance, Bulletin. No13.

Crichley,W. and Siegret,K. (1991) : Water harvesting. FAO corporation Document Repository, Available at: http://www.fao.org/3/U3160E/u3160e05.htm#3.4%20probability%20analysis.

El Gaby, S, and Habib, M, S (1982): Geology of the area south west port Safaga, eastern desert, annals of geological survey of Egypt Vol. XII.

El Shamy, I, Z, et al (1999): Flash flooding threat to the red sea costal townies of Safaga, sensing and space sciences, Vol 2.

El Sherbini, M, I, et al (1992): geological and geochemical studies on the Cretaceous tertiary succession along Qena – Safaga roads eastern desert, Egypt.

El-Akaad, S., & Dardir,A.A.,(1966): Geology of The Red Sea Coast between Ras Shagra and Mersa Alam with Short Note on Results of Exploratory work at Gebel El-Rusas Lead Zinc deposits, Paper No.35,Geological Survey, Cairo.

Gheith,H. , Sultan,M. (2002) : Constrution of hydrologic model for estimating wadi runoff and ground water recharge in the Eastern Desert, Egypt, Journal of Hydrology, 263.

Gregorgy, K. J. & Walling, D. E. (1973): Drainage Basins - Form and Process, Edward Arnold, London.

Horton, R. E., (1945): Erosional Development of streams and their Drainage Basin Hydrophysical Approach to Quantitative Morphology, Bull. Geol. Soc. America, Vol. 56.

Horton, R., (1932): Drainage Basin Characteristics, Transactions of The American Geophysical Union, Vol.13.

King, C., (1966): Techniques in Geomorphology, Edward Arnold, London.

Melton, M, A, (1958): Geometric Properties of Mature Drainage systems and their Representation any phase space, Jour. Geo1.

Miller, V., (1953): Aquantitative Geomorphic Study of Drainage Basin Characteristics in the Clinch Mountain Area, project NR 389 – 042, Tech. Rept.3., Columbia Univ.

Milton, V, C, (1952): A Quantitative Study of Drainage Basin Characteristics in Clinch Mountain Area, Virginia, Ras, Proj, NR 384-042.

Ministry of Water Resources and Irrigation, National Water Research Center, Water Resources Research Institute (2019): Protecting the village of Sheikh Al-Shazly from the dangers of floods, Red Sea.

Muller, E., (1974): Origins of Drumlins in Glacial Geomorphology, D.R.Cates (Ed.),Binghamton,New York , State Univ.

Patrick, L, A, (2002): Natural disasters, San Diego.

Salloum, G, M, et al (1989): Tectonics of the Idfu- Marsa Alam area. First conf. geochemist., Alex Univ.

Schumm, S. A., (1956): Evolution of Drainage System and Slopes in Badlands at Perth Amboy New Jersy, Bull. Geol. Soc. America, Vol, 67.

Schumm, S. A., (1956): Evolution of Drainage System and Slopes in Badlands at Perth Amboy New Jersy, Bull. Geol. Soc. America, Vol, 67.

Smith, K. G., (1958): Erosional Processes and Landforms in Badlands, National Monument South Dakota, Bull. Geol. Soc. America, Vol. 69.

Smith,K, (1996): Environmental Hazards, Assessing Risk Reduction Disaster, London Routledge.

Strahler, A., (1958): Dimensional Analysis Applied to Fluvial Eroded Landforms, Geol. Soc. America Bull., Vol.69.

Strahler, A., (1964): Quantitative Geomorphology of Drainage Basin and Channel Net Work, in Chow, V. T (Editor), Handbook of Applied Hydrology, New York.

Strahler, A., (1985): Dimensional Analysis Applied to Fluvially Eroded landforms, Bull. Geol. Soc. America, Vol. 63.

U, S, Conservation Service, (1972): Hydrology, Section4, Natural Engineering hand book, Washington N.D.C.

Young, A., (1972): Slopes, Oliver & Boyd, Edinburgh.