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Spatial Modeling of Torrential Hazards in the Al-Ratka Valley Basin in the Western Anbar Plateau

Awrad Imad Shehab[1], Dr Ahmed Falih Fayyad[2]

Abstract

Objectives: The study focused on spatial hydrological modeling of the flood hazards in AL-Ratka Valley. In the western region of Iraq, more particularly in the Al-Anbar Governorate, can be found find the Al-Ratka Valley. The valley occupies an area of 7134 km2, forming a natural unit. There are six secondary basins in all, and each one is unique in terms of hydrological features. Geology, elevation, and slope characteristics.

Methods: were taken into account as part of the study's natural features. The digital data obtained from topographic maps, aerial photographs, satellite visuals, and Geographic Information Systems (GIS) programs were relied upon. A set of important coefficients were used when studying water basins using Snyder's model, a number of significant coefficients were employed to examine water basins. This will establish how much of a hazards of flooding the Al-Ratka Valley and its auxiliary basins are.

Results: The Ratka Valley basin has gained an important position due to its large area, which provides the opportunity for its investment and sustainability within the northern desert in the Western Plateau. The valley basin represents a natural unit with an area of (7134) km2. The basin consists of six secondary basins: (Al-Aghri, Al-Ajraman, Akash, Malasi, and Al-Awja). The surface of the study area was characterized by an elevation of (835) meters above sea level, while the lowest elevation reached (257) meters above sea level. It is clear through the use of Young's classification of slope that the region varies in slope between semi-lands. Flat lands (59%) occupied the largest area of the region, and steep lands amounted to (2.5%).

Conclusions: According to the study, torrential torrents are hazards in this area. Between different basins, there are differences in the severity. The (Ajrman) basin was discovered to be at a low- hazard torrential level. The basins (Akash, Al-Awja, and the main basin) are situated in an somewhat hazards area of torrential rain. The Al-Aghari, Malsi, and Al-Ratka secondary basins are situated in an area with a high hazard of torrential rains.

Keywords: *Al-Ratka Valley, modeling, hazards, floods.*

1. Introduction

Therefore hydrological studies are interested in researching, evaluating, and modeling them. In order to overcome the issues the water basins are experiencing, there is a need to make efforts in this area, which is mostly represented by assigning studies and research.

[1] Department of Geography, College of Education for Humanities, University of Anbar, Iraq, Email: Awr20h5003@uoanbar.edu.iq, Orcid ID: 0009-0002-9705-9887
[2] Department of Geography, College of Education for Humanities, University of Anbar, Iraq, Email: . ed.ahmed.flaih@uoanbar.edu.iq,

The flood issue is one of the most significant. It still consumes a significant portion of the attention of researchers doing hydrological studies, in addition to the issue with the surface water runoff that occurs as a result of a rainstorm over a particular basin. This issue becomes more significant in runoff ponds that experience seasonal and irregular runoff, Hydrological models represent attempts to represent hydrological systems from the beginning of rainfall until the occurrence of torrent flow in a mathematical form. These models vary in their complexity according to the user's requirements and the availability of data.

These models range from simple models to three-dimensional physical models. The Snyder model is one of the hydrological models that were developed to estimate the size and strength of torrents, based on the morphometric characteristics of the basins, especially those that are characterized by a scarcity of hydrological data for storms causing torrent flow.

Research Problem:

1- Is it possible to build models that simulate reality with a geoinformation environment that reveals the hazards of torrential rains in the valley Al-Ratka basin and its secondary basins?

2- Is there a direct impact of the torrents on the land cover and its investments in the basin?

The hypothesis of the study:

1- In order to calculate the hazard of flooding, a number of mathematical formulae are used, together with satellite visualizations and geographic information systems programs.

2- For the hazard of flooding, models can be made.

The aim of the study: The research aims to identify the hazards of floods. This is according to the spatial variation of the Ratka Valley basin and its secondary basins. Divide it into categories according to the degree of severity. This is done by analyzing a group of hydrological coefficients (Snyder model). It is directly related to the effluent processes and the occurrence of torrential hazards in the basin. Creating a model for these hazards using modern geographical technologies

Study methodology: The analytical approach and the inductive approach were relied upon, as the data related to each natural characteristic was analyzed, and the barometric-quantitative approach was relied upon, which refers to the use of the language of numbers in expressing spatial phenomena more accurately by using a set of equations and statistical analyzes.

Previous studies

1- The study of Ahmed Falih Fayyad 2020 This study dealt with a spatial modeling of flood hazards in Valley Al-Walj in Al-Anbar Governorate within Al-Rutba district. It concluded that the region suffers from the dangers of torrential flows, as it was found that the middle Al Walaj and Matitah basins are under a high risk torrential level, while the Daya basin is located under a medium risk torrential level, while the Al Buraim and Eastern Al Walaj basins were of low risk.

2-The study of Hind Tariq 2022 This study dealt with the geomorphological risks of erosion and floods in the Valley Al-Maleh basin, which is located in the southeastern part within Wasit Governorate, through the final classification of the severity of the basins.

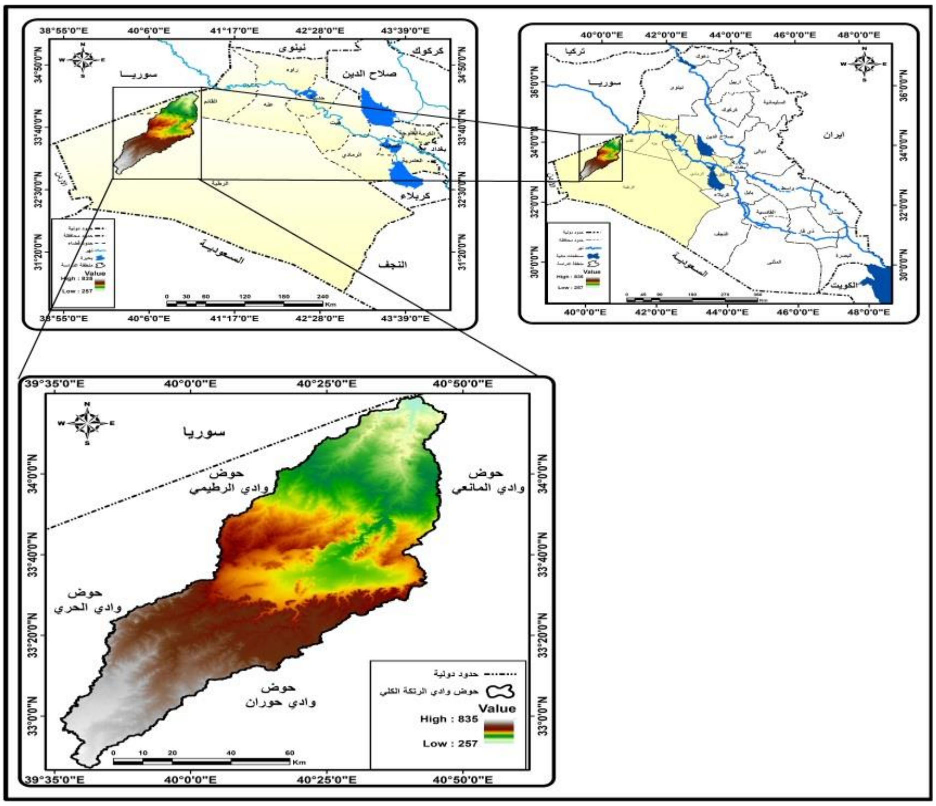
3-The study of Baker Bahgat Thamer This study dealt with the Duilib Valley Basin, which is located within Anbar Governorate, north-east of Haditha Lake. The valley consists of (3) secondary basins. The hydrological characteristics of the basins were studied, but no classification and modeling of the water basins was done.

4-The study of Ahmed Abbas Al- halboosy This study dealt with the Shabala Valley Basin, which is located within the Anbar Governorate. The valley consists of (4) secondary basins. The hydrological characteristics

of the basins were studied, but no classification and modeling of the water basins was done.

Study area location:-

According to the Map (1), the basin is located in Anbar Governorate, in the western region of Iraq. The basin, which has a surface size of 7134 km2, is a natural entity. Accordingly, the region is limited to two latitudes (32°55'1"N 34°17'38.4"N) to the north, and two arcs of longitude (39°36'18"E 40°46'44"E) to the east.



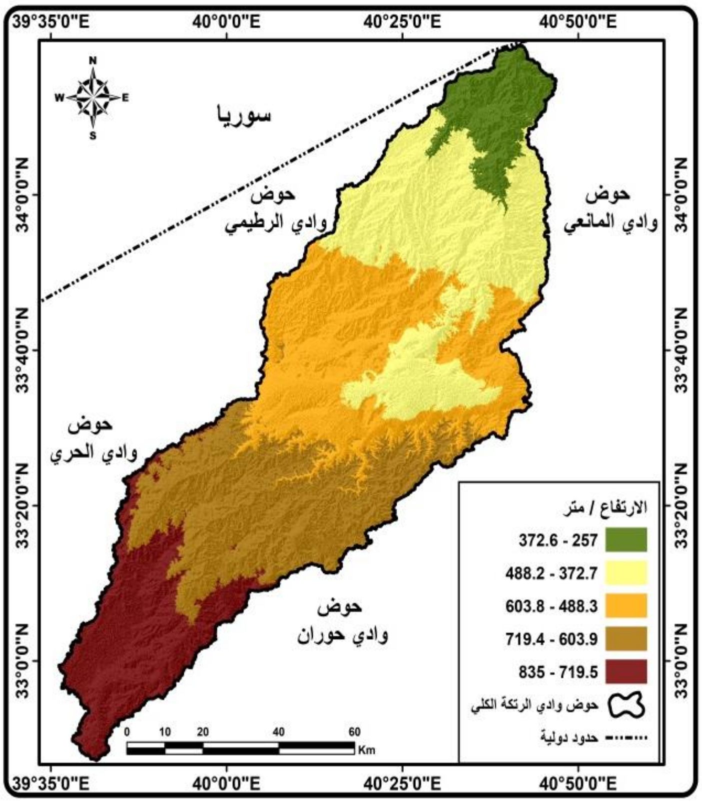
Map (1): Study area location in Iraq's Anbar Governorate

Source: Based on the Republic of Iraq, Ministry of Industry and Minerals, General Establishment for Geological Survey and Mineral Investigation, Administrative Map of Iraq, year 2000, scale 1:250000, and Arc Gis 10.8 program.

First: Natural characteristics of the study area:

A-Molarization: Indentation is defined as the vertical and horizontal dimension of the Earth's surface. Its study is of importance in geographical studies, especially the natural ones. This concept has a role in determining the nature of the activity that a person can practice on any part of the earth’s surface. From this standpoint, the study of indentation includes the following data:

- Height: The hydrological characteristics of the water basin are emphasized by height characteristics, which play a significant and essential influence. It by fixing the water dividing line. which can indicate the area of the pelvis. As well as knowing the slope and height of the basin. It was possible to analyze the heights of the area according to the data that was derived from the digital elevation model (DEM) with a spatial resolution of 30 x 30 m and by adopting a contour period of (25) meters, The basin is divided into five categories of elevations, see map (2) and table (1).



Map (2) Elevations of the study area basin

Source: Worked by the researcher based on the digital elevation model (DEM) with a discriminatory accuracy of (30x30) m and processed using the program (8.Arc GIS 10).

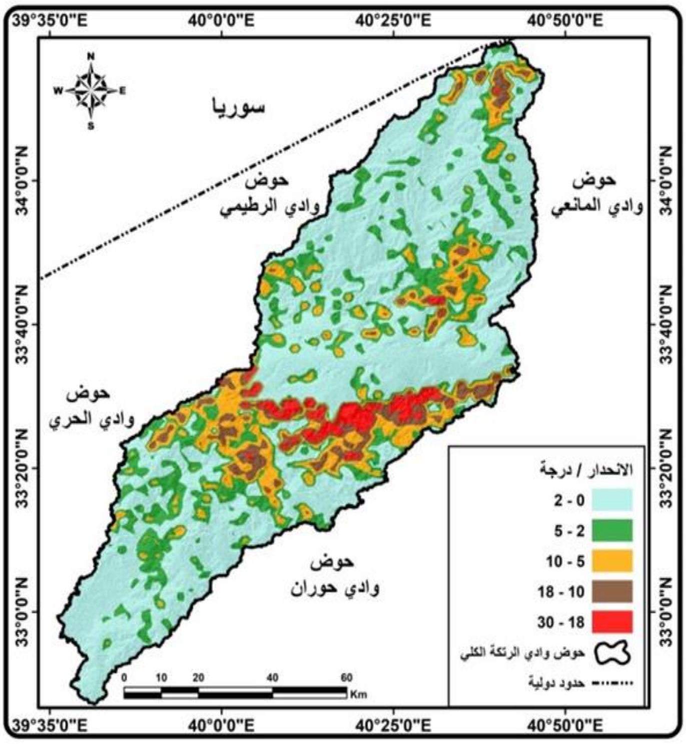
Table 1 Height levels, their areas (km^2) and percentages of the area (%)

categories	Height above sea level/m	Area (km²)	Percentage of area (%)
First	257 -37206	504	7.1
second	372.7 - 488.2	1813	25.4
Third	488.3 - 603.8	1911	26.8
Fourth	603.9 - 719.4	1801	25.2
Fifth	719.5 - 835	1105	15.5
Total	-	7134	100

- Regression: In geographical studies in general and geomorphology in particular, regression is crucial. This is due to its function in examining the features of the earth's surface and how they relate to various forms of human activity, such as urbanization, highways, agriculture, and so on. Since every important project must be established, it is necessary to research the nature of the earth's surface, including the decline. Through its influence on the horizontal water circulation of the surface and subsurface, decline plays a part in hydrological research as well. As well as its role in the movement of water inside the soil through seepage and seepage. For the purpose of measuring the degrees of slope, a digital elevation model (DEM) and a topographical map of the area were adopted using (Arc GIS10.8) software. According to the classification (Young1975), the study area was classified into (5) regressive categories. Each category expresses the amount of change in height between each cell and its neighboring cell, as follows: see map (3), table (2).

Table 2 Classification of regressions in the study area according to the Young classification

degree of regression	Land slope type	Area km^2	Percentage
0-2	Semi flat lands	4250	59.6
2-5	Simple sloping lands	1487	20.9
5-10	Slightly sloping lands	814	11.4
10-18	Moderately sloping lands	402	5.6
180-30	steep lands	181	2.5
Total		7134	100



Map (3) Regression levels for the study area according to the Unit classification Young

Source: From the researcher’s work, relying on a digital elevation model (DEM) with a discriminatory accuracy of (30x30) m, and a surface map of Anbar Governorate, scale 1:100,000, and processed using the program (8.Arc GIS 10).

Second: Estimating Pond Runoff Hazards

The hydrological characteristics are one of the variables that clearly affect the volume of runoff, as surface runoff is affected by many natural and human factors, including precipitation. As for surface runoff studies, they are numerous, represented by the use of mathematical models and technical tools, and accordingly, the Snyder model was relied upon to study the Ratka Valley basin, This model was developed by Snyder in 1938 AD to study the water basins in dry lands for which no water data or rain data are available. This model is the most popular in estimating runoff for dry area basins, although there are several models by other scientists, This model aims to develop a water flow chart for water basins in desert areas to estimate the risks of floods by knowing the quantities and sizes of flow and estimating its time. ,(Hanan, 2008,242)

It is one of the oldest models that were presented to calculate the hydrograph unit for a specific basin, depending on the characteristics and dimensions of the drainage basin itself, in lands where it is difficult to measure rain storms. Runoff is rather dependent on the morphometric characteristics of the basins,(Hanan, 2008,242) which are as follows:

1- Concentration time

This variable represents the amount of time needed for the rainwater to flow from the drainage basin's highest point to the area downstream (Muhammad Musa, 2015, 123). As a result, it aids the planner in making wise choices when faced with torrents. The concentration time depends on three main variables: the slope of the stream, the length of the basin, and the vertical difference, and it can be calculated according to the following equation: (Nasser, 2008, 85)

$$TC = (0.00013)*(L1.15)*(H0.38)$$

It represents:

TC = concentration time (hour)

L = the length of the main stream

H = average height of the basin (m)

When applying the above equation to the basins of the study area, the results shown in Table (3) appeared. The concentration time of the main estate basin was (7.87) hours, which is equivalent to (472.2) minutes. The average concentration time for all secondary basins was (12.06) hours, which is equivalent to (723.6) minutes. With a discrepancy in that from one basin to another. The lowest concentration time was (0.5) an hour, which is equivalent to (30) a minute in a basin The (Ajrman). While the highest concentration time was recorded in basin (Al-Awja). The concentration time was (3) an hour, which is equivalent to (180) a minute. As shown in the table (3), while the rest of the basins recorded values between those limits.

In order to clarify this discrepancy, whether in the case of decline or rise, the drainage basins in the study area were classified into three categories as in the table (4) and map (4) according to the time of concentration as follows:

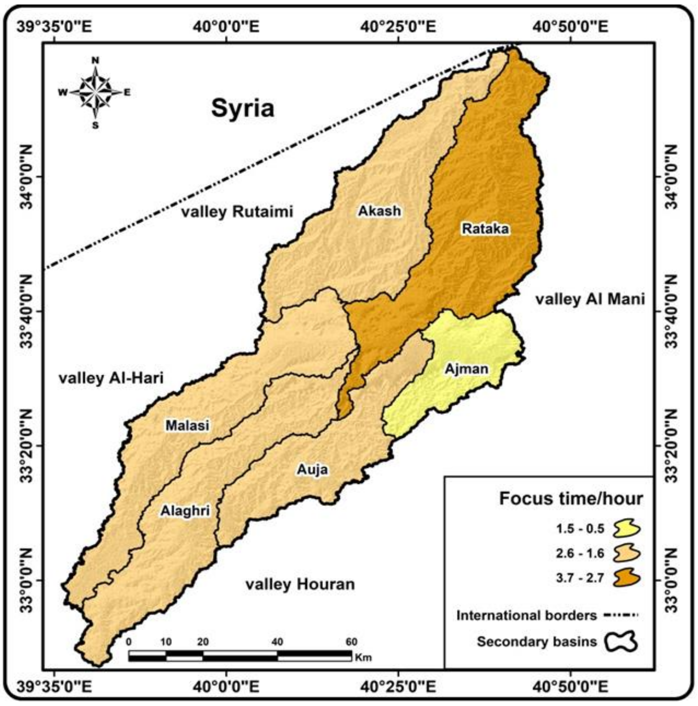
Table 3 Concentration time / hour, minute for the estate pond and its secondary ponds

Basin	L	H	TC / hour	Tc / minute
Al-Aghari	150.3	357	2.65	159
Malsi	135.6	339	2.27	136.2
The Ajrman	43.2	232	0.5	30
Akash	110.3	367	2	120
The secondary Al-	147.4	412	1.64	98.4

Ratka				
Al-Awja	104.9	317	3	180
the main basin	275.5	578	7.87	472.2

Table 4 Basin categories according to concentration time / min

categories	Repetition	the basins they represent
0.5-1.5	1	3
1.6-2.6	4	5,4,2,1
2.7-3.7	1	6
Total	6	6



Map (4) categories of basins according to concentration time / hour.

Source: Based on Table (4), Arc Map (10.8) program, and Digital Elevation Model (DEM).

2- Deceleration time

It is the time between the onset of rain and the onset of runoff. Deceleration time can be used to identify the time required for the onset of surface runoff for each basin. As well as calculating the leakage losses during this time (Wilburl, 1964 p.3), and the following equation was relied upon to extract the deceleration time: (Mujib, 2008,89).

$Tp\ (hr) = ct(Lb\ Lca)^{0.3}$

It represents:

Lb = main stream length (km).

Lca = the distance from the mouth of the basin to its center of gravity (km).

Ct = peak flow time coefficient, which is specific to the nature of the basin and its slope, and its value ranges between (2.0-2.2).

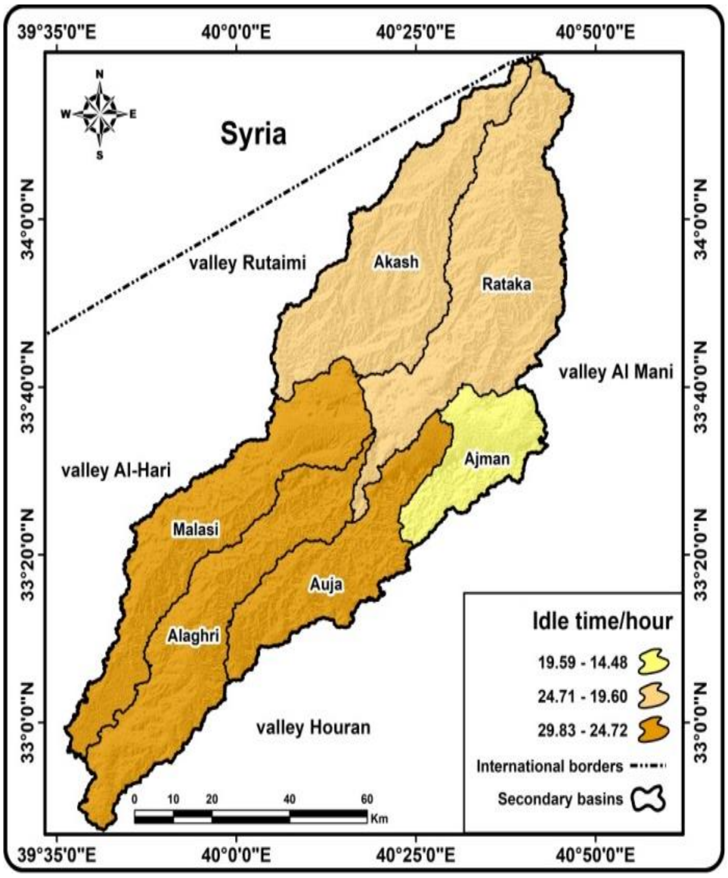
By applying the above equation, it is noted that the average deceleration time for the main estate basin was (37.09) hours, as in the table (5). As for the secondary basins, the highest rate was reached in the (Al-Aghri) basin, as it reached (29.82) hours. As for the lowest rate, it was recorded in the (Ajman) basin, as it reached (14.48) an hour. As for the rest of the basins, their rates ranged between those limits. From the foregoing, it appears that there is an inverse relationship between the idle time and the degree of severity. That is, the lower the deceleration time value, the higher the hazard. The reason for this is due to the short period of time required for surface runoff to occur. Consequently, this leads to a decrease in the amount of leaking water, thus increasing the amount of running water and increasing the volume of water discharge. Based on the table (5), the basins of the region were classified into three categories, as shown in the table (6) and the figure (5).

Table 5 Deceleration time for the estate basin and its secondary basins.

Basin	L	the distance from the mouth of the basin to its center of gravity (km).	Deceleration time / hour
Al-Aghari	150.3	54.3	29.82
Malsi	135.6	51.8	28.51
The Ajrman	43.2	20.2	14.48
Akash	110.3	45.5	23.19
The secondary Al-Ratka	147.4	53.2	29.46
Al-Awja	104.9	36.0	23.66
the main basin	275.5	96.6	37.09

Table 6 categories of basins according to deceleration time / hour.

categories	Repetition	the basins they represent
14.48-19.59	1	3
19.60-24.71	2	4,6
24.72-29.83	3	1,2,5
total	6	6



Map (5) classes of docks by deceleration time.

Source: Based on Table (6), Arc Map (10.8) program, and Digital Elevation Model (DEM).

3- Base time for torrents

The base time represents the period of time that the torrent stays in the water basin from the source to the downstream. The base time for torrents (day) is calculated using the following equation:- (Intdhar, 2018 p.16)

Tb (days) = 3 + tb (hr) /8

It represents:

Tb (days) = torrent base time (day)

Tb (hr) = Basin response time to precipitation/hours (the Deceleration time)

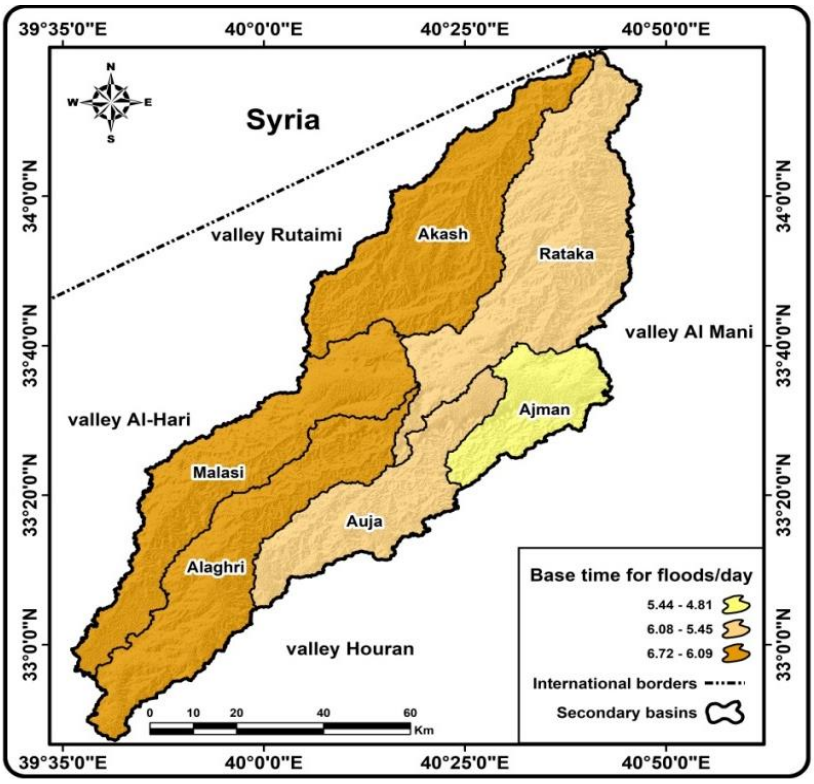
By applying the above equation, it was found that the average for the main estate basin was (6.19) days. As in table (7). As for the secondary basins, the highest average base time was reached in (Al-Aghri) basin. It recorded an average of (5.24) days. As for the lowest rate, it reached (4.15) days, recorded by the (Ajman) Basin. As for the rest of the basins, their rates ranged between those limits. It is evident from the foregoing that there is a direct relationship between the deceleration time and the base time. The higher the deceleration time coefficient, the greater the torrent base time. Accordingly, the basins of the region were classified into three categories, as shown in the table (8) and the map (6).

Table 7 The base time of the runoff / day for the estate basin and its secondary basins

Basin	Deceleration time / hour	Base time for torrents (day)
Al-Aghari	29.82	6.72
Malsi	28.51	6.56
The Ajrman	14.48	4.81
Akash	23.19	5.89
The secondary Al-Ratka	29.46	6.68
Al-Awja	23.66	5.95
the main basin	37.09	7.63

Table 8 Categories of basins according to the base time of floods / day

categories	Repetition	the basins they represent
4.81-5.44	1	3
5.45-6.08	2	4,6
6.09-6.72	3	1,2,5
total	6	6



Map (6) categories of basins according to the base time of the flood / day

Source: Based on Table (8), Arc Map (10.8) program, and Digital Elevation Model (DEM).

4- Duration of progressive rise

It is the time taken from the beginning of the torrent flow, after the occurrence of surface saturation, taking into account the continuation of rain, until the torrents flow from the upper and middle valleys to the downstream (Najah 2020, p.52). The time period extends from the beginning of the runoff to its peak on the hydrograph (Mohamed, 2012 p.5). This period is calculated according to the following equation:

Tm(hr) 1/3 Tb (hr)

It represents:

Tm = the period of gradual rise of the torrent flow (hours).

Tb (hr) = Base time torrent computed (hours).

By applying the above equation, it was found that the duration of the gradual rise of the main estate basin was (99.54) hours As in the table (9). As for the secondary basins, the highest mean for the duration of the gradual rise was (84.26) hours. It was recorded by Basin (Al-Aghri). As for the lowest rate, it was recorded in the (Ajman) basin, which reached (66.73) hours. As for the rest of the basins, their rates ranged between those limits.

There are several factors affecting the determination of the duration of the gradual rise of the torrential flow in the basins, including the nature of the surface formations in the upper and middle headwaters of the basins. The less porous and permeable it is, the more it leads to fast flow despite the lack of precipitation. It was also found that there is a direct relationship between the time of slowdown, the time of the base and the duration of the gradual rise of the torrential flow. Accordingly, the basins of the region were classified into three categories, as shown in the table (10) and the map (8)

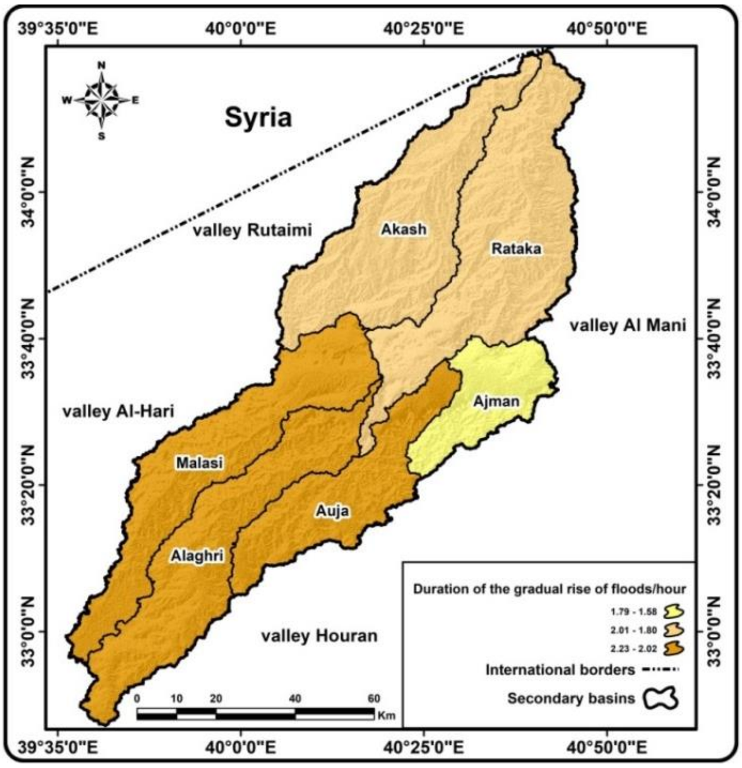
Table 9 The duration of the gradual rise of the floods / hour for the Ratka basin and its secondary basins

Basin	Base time for torrents (day)	Duration of progressive rise
Al-Aghari	6.72	2.21
Malsi	6.56	2.16
The Ajrman	4.81	1.58
Akash	5.89	1.94
The secondary Al-Ratka	6.68	2.20
Al-Awja	5.95	1.96
the main basin	7.63	2.45

Table 10 The duration of the gradual rise of the floods / hour for Al-Ratka basin and its secondary basins

categories	Repetition	the basins they represent
1.58-1.79	1	3
1.80-2.01	2	4,6
2.02-2.23	3	1,2 ,5

Total	6	6



Map (7) categories of basins according to the duration of the gradual rise of torrents / hour

Source: Based on Table (10), Arc Map (10.8) program, and Digital Elevation Model (DEM).

5-The duration of the gradual decrease in torrential flow

It is the time taken by the torrent for the water to return to its normal state. That is, the period for the level of the torrent to drop and return to its normal state (Mohammed, 2012 p.5). The duration of the gradual decrease in the torrential flow was extracted by the following equation (Mujib, 2008 p.89):

Td(hr) 2/3Tb(hr)

It represents:

Td(hr) = the period of gradual decrease in the flow in hours

Tb (hr) = the base time of the stream in hours.

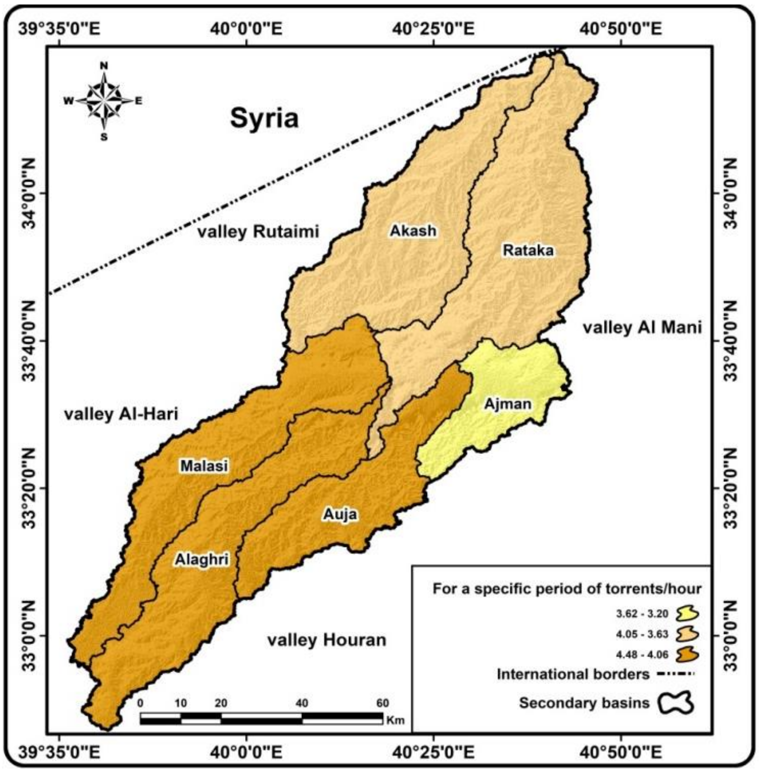
By applying the above equation, we find that the duration of the gradual decline of the main estate basin was (5) hours As in the table(11). As for the secondary basins, the highest rate was reached for the period of gradual decline (4.48). It was recorded by Basin (Al-Aghri). As for the lowest rate, it was recorded in the (Ajman) basin, which reached (3.20) an hour. As for the rest of the basins, their rates ranged between those limits. Accordingly, the region's basins were classified into three categories, as shown in the table (12).

Table 11 the duration of the gradual decline of Al-Ratka valley and its secondary basins.

Basin	Base time for torrents (day)	The duration of the gradual decrease in torrential flow
Al-Aghari	6.72	4.48
Malsi	6.56	4.37
The Ajrman	4.81	3.20
Akash	5.89	3.92
The secondary Al-Ratka	6.68	4.45
Al-Awja	5.95	3.96
the main basin	7.63	5

Table 12 Categories of basins by duration of the gradual decline

categories	Repetition	the basins they represent
3.20-3.62	1	3
3.63-4.05	2	4,6
4.06-4.48	3	1,2 ,5
Total	6	6



Map (8) Categories of basins by duration of the gradual decline

Source: Based on Table (12), Arc Map (10.8) program, and Digital Elevation Model (DEM).

6- Estimating the duration of torrential runoff

It is defined as the time taken by the water through the streams of the basins and their tributaries to reach the estuary .The duration of torrential flow can be calculated by relying on the following equation: (H.M, 2006 p.11).

T=N*hr

It represents:

T = the time it takes to complete the run-off to the end (hours).

N = a constant value of (5).

Hr = deceleration time (hr).

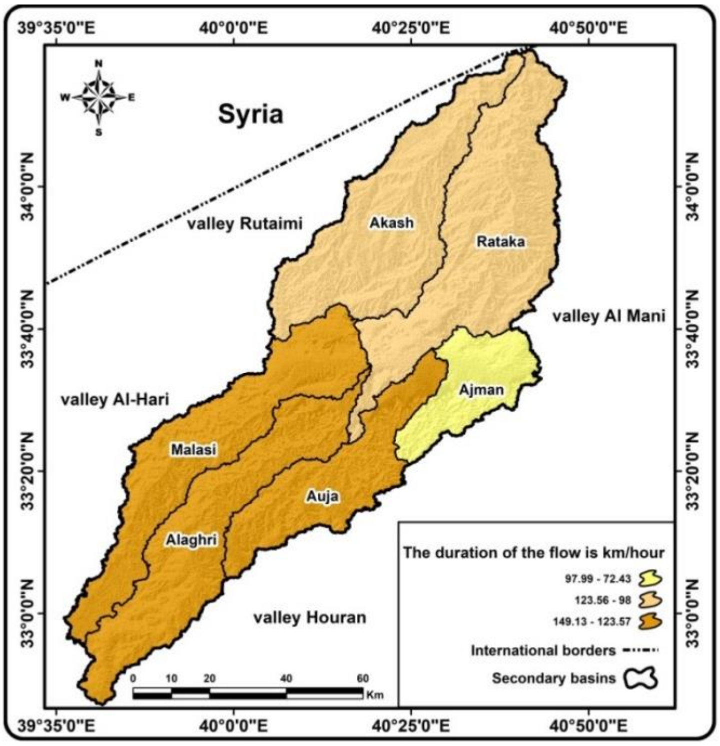
By applying the above equation, it was found that the duration of the torrential runoff for the main Al-Ratka basin was (185.47) (km / hour), as in the table (13). As for the secondary basins, the highest rate was (89.5) km / hour. It was recorded in the (Al-Aghri) basin. As for the lowest rate, it reached (89.5) km / hour. (46.0) km/h was recorded by the (Ajman) basin, while the rest of the basins vary between those limits. It is clear from the foregoing that the area and length of the basins have an effect on the rainwater they receive and the volume of water that is disposed of in these basins. Accordingly, the basins of the region were classified into three categories, as shown in the table (14) and the map (9).

Table 13 Duration of runoff km/h for Al-Ratka basin and its secondary basins

Basin	Deceleration time / hour	Estimating the duration of torrential runoff
Al-Aghari	29.82	149.11
Malsi	28.51	142.55
The Ajrman	14.48	72.43
Akash	23.19	115.98
The secondary Al-Ratka	29.46	147.34
Al-Awja	23.66	118.33
the main basin	37.09	185.47

Table 14 Categories of basins according to the duration of torrential runoff km / h

Categories	Repetition	the basins they represent
72.43-97.99	1	3
98-123.56	2	4,6
123.57-149.13	3	1,2,5
total	6	6



Map (9) Basin categories according to the duration of the runoff

Source: Based on Table (14), Arc Map (10.8) program, and Digital Elevation Model (DEM).

7- Torrential velocity

It is considered one of the most important hydrological parameters for drainage basins, as it determines the severity of valleys. As well as its ability to sculpt and transport sediment. It is defined as the volume of water across a river section per unit time. (Esraa, 2018 p.300). The flow velocity of the area basins can be calculated by relying on the following equation:

V=L/tc

It represents:

V = flow velocity

L = length of drain pan (km)

tc = concentration time (hours)

By applying the above equation, it was found that the flow velocity of the main estate basin was (24.7) km / h, as shown in the table (15). As for the secondary basins, the highest rate of runoff velocity was recorded in (Akash) basin. It reached (45.7) km/h. As for the lowest rate, it was recorded in (The secondary Al-Ratka) basin, which reached (36.7) km/h. As for the rest of the basins, their rates ranged between those limits.

Table 15 Flow velocity km/h for Al-Ratka basin and its secondary basins

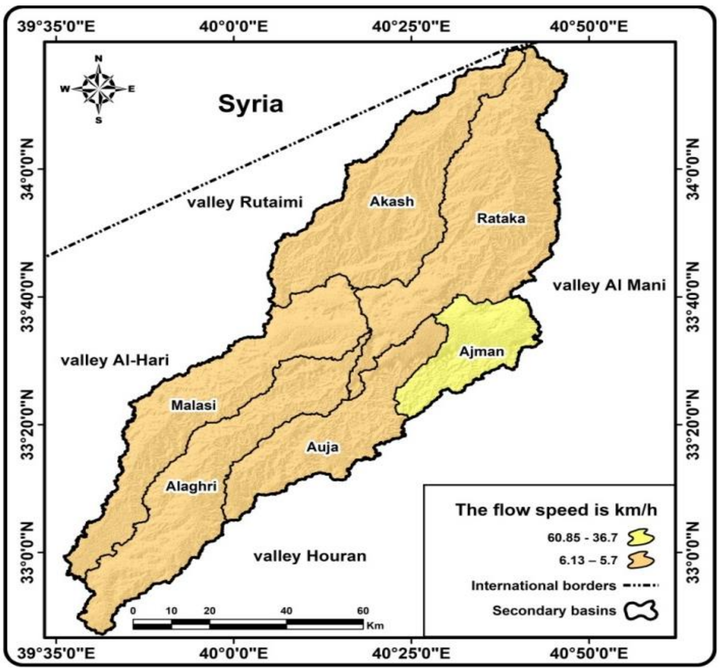
Basin	L	TC / hour	Torrential velocity
Al-Aghari	106.7	2.65	40.26
Malsi	105.6	2.27	46.51
The Ajrman	42.5	0.5	85

Akash	91.6	2	45.8
The secondary Al-Ratka	110.1	1.64	36.7
Al-Awja	75.0	3	45.7
the main basin	194.8	7.87	24.7

The severity of floods on the surface of basins can be determined by flow velocity. That the faster the torrential run-off, the more hazards the basin, and vice versa. The reason for this is due to the large area of the basins in addition to the low slope of the surface. Accordingly, the basins of the region were classified into three categories, as shown in the table (16) and the figure (10)

Table 16 Categories of basins according to the Torrential velocity

Categories	Repetition	the basins they represent
36.7-60.85	5	1,2,4,5,6
5.7 – 6.13	1	3
Total	6	6



Map (10) categories of basins according to the speed of flow torrents km / h

Source: Based on Table (16), Arc Map (10.8) program, and Digital Elevation Model (DEM).

8-The ideal time for rain to fall on drainage basins

When the duration of rainfall does not exceed the concentration time of the water basin, this equation is used. This is to know the ideal time for rainfall that allows runoff in the main valleys after losses, whether by leakage or evaporation. (H.M, 2006 p.150) The ideal time for rainfall in the basins of the study area is obtained through the following equation (Mujib, 2018):

$$tr(hr)= (tp(hr))/(5.5)$$

It represents:

Tr(hr) = ideal time of rain in hours.

Tp (hr) = the response period of the watershed to rainfall, calculated in hours.

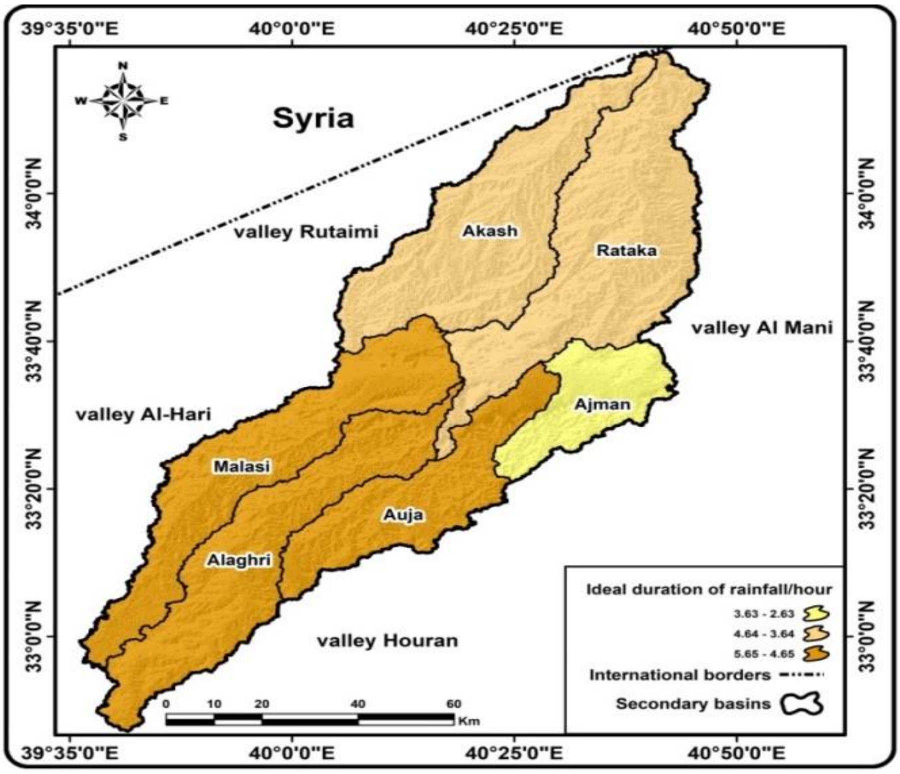
From the application of the above equation, we find that the ideal time for rainfall in the main Al-Ratka basin was (4.64/hour).

Table 17 Categories of basins according to the ideal duration of rainfall / hour.

Basin	Deceleration time / hour	The ideal time for rain to fall on drainage basins
Al-Aghari	29.82	5.42
Malsi	28.51	5.18
The Ajrman	14.48	2.63
Akash	23.19	4.21
The secondary Al-Ratka	29.46	5.35
Al-Awja	23.66	4.30
the main basin	37.09	6.74

Table 18 Categories of basins according to the ideal duration of rainfall / hour

Categories	Repetition	the basins they represent
2.63-3.63	1	3
3.64-4.64	2	4,6
4.65-5.65	3	1,2,5
total	6	6



Map (11) Basin categories for the ideal duration of rainfall/hour

Source: Based on Table (18), Arc Map (10.8) program, and Digital Elevation Model (DEM).

9-Runoff volume

The runoff volume represents the total water flowing into the dry basin drainage network. This occurs when the intensity of the rain exceeds the capacity of the water basin to absorb it. As this leads to the occurrence of floods and torrents as a result of the accumulation of large amounts of rain. Thus, the water velocity becomes high, that is, when the amount of rain increases, the leakage process in the ground decreases. which increases its hazard (Khalifa, 2006 p.110). The flow volume values can be obtained through the following equation: - (Ishaq, 2016 p.1540)

$Qt(m^3/s)=\Sigma(km)^{0.85}$

$Qt(m^3/s)$ = Runoff volume (1000 m^3)

$\Sigma(km)$ = Total lengths of basin sewers (km)

0.85 = fixed foundations

By applying the above equation, it was found that the average runoff volume of the main estate basin amounted to (4267.00) thousand m 3, as shown in the table (19). The secondary basins varied in the volume of runoff. It reached the highest rate in the (secondary Al-Ratka) basin. As it recorded (1017.45) thousand m^3. The lowest rate was recorded by the (Ajman) basin. It reached (345..40) thousand m^3. As for the rest of the basins, their values varied between those limits.

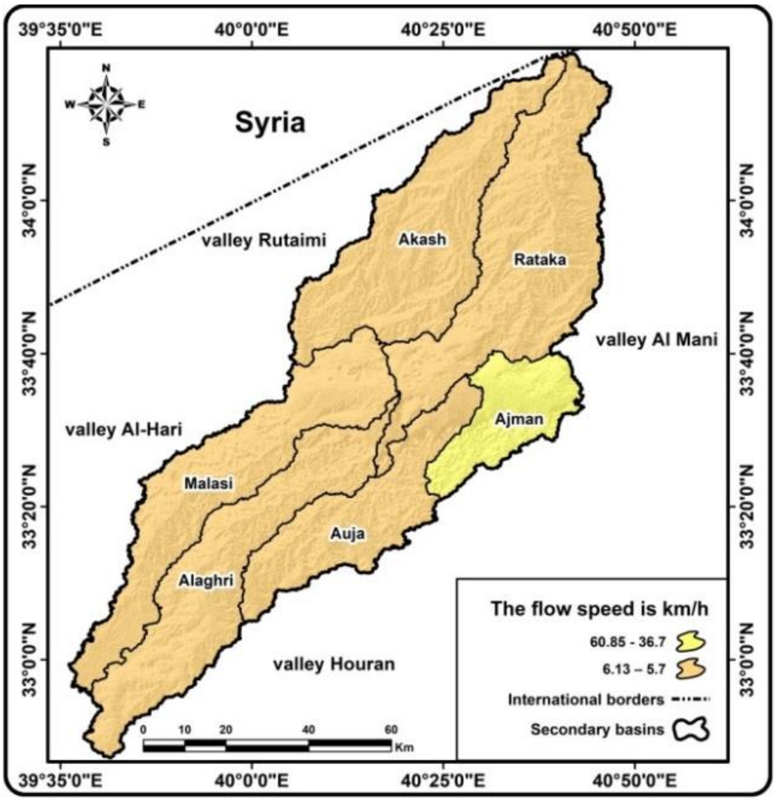
From the foregoing, it is clear that there is a direct relationship between the areas and lengths of waterways with the volume of runoff. It increases with the area unit of the water basin. As the large areas of water basins are increasing watercourses. Their lengths increase, and vice versa. Accordingly, the basins of the region were classified into three categories, as shown in the table (20) and the map (12).

Table 19 The runoff volume of the estate basin and its secondary basins

Basin	basin area (km2)	Total lengths of basin	Runoff volume (1000 m3(
Al-Aghari	1280	874	316
Malsi	1305	955	341
The Ajrman	544	407	165.2
Akash	1420	954	340.8
The secondary Al-Ratka	1718	1197	413.4
Al-Awja	867	624	237.6
the main basin	7134	5020	1398

Table 20 Basin categories according to the flow volume, thousand m3

Categories	Repetition	the basins they represent
165-247.9	2	3,5
248-330.7	1	1
330.8-413.5	3	2,4,6
Total	6	6



Map (12) the volume of runoff for the basins of the area thousand m3.

Source: Based on Table (20), Arc Map (10.8) program, and Digital Elevation Model (DEM).

10- Maximum flow value of torrents

The value of the maximum flow of torrents is used to determine the maximum flow of torrential water that can reach the streams of the valleys in the event of a strong torrential activity. This value can be calculated in the basins of the study area through the following equation:- (Mujib, 2018 p.97)

$$Qp(m^3/s)= \frac{CPA}{tp(hr)}$$

It represents:

$Qp(m^3/s)$ = the maximum flow quantity of torrents in the drainage basin

A = basin area (km^2)

Tp (hr) = the response period of the watershed to rainfall, calculated in hours.

CP = coefficient related to the capacity of the water drainage basin to store water, and its value ranges between (2-6.5).

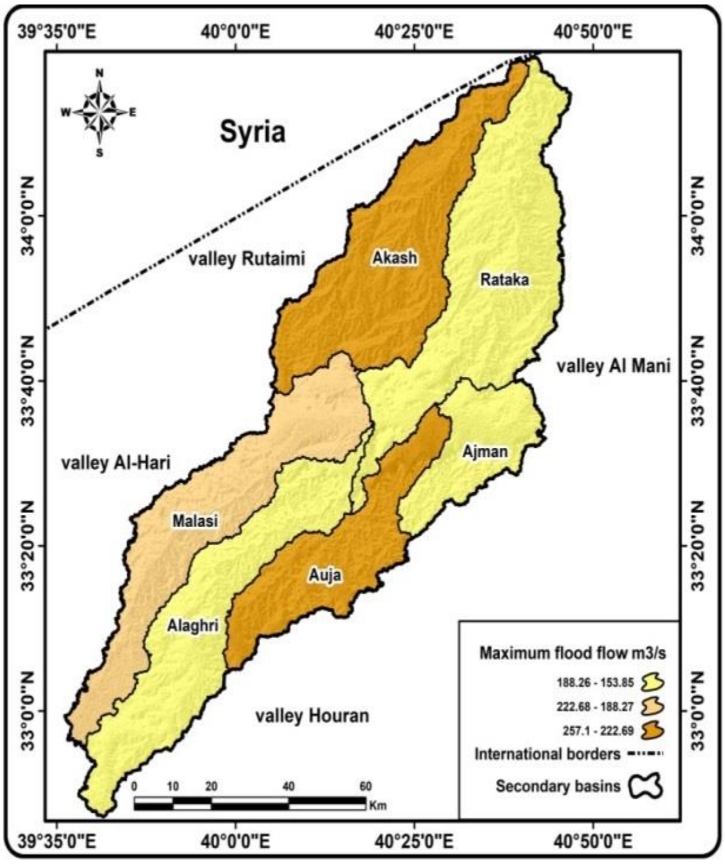
From the above equation, it was found that the average maximum flow rate for the Al-Ratka basin was (1189) m3/sec. As for the secondary basins, the highest rate was recorded in the (secondary Al-Ratka) basin. It reached (412) m3/sec. The lowest rate was (251.3) m3/s in the (Ajman) basin. As for the rest of the basins, their values ranged between those limits, as shown in the table (21). Accordingly, the basins of the region were classified into three categories, as shown in the table (22) and the figure (13).

Table 21 The value of the maximum flow of torrents for the basins of the region, m3/sec.

Basin	basin area (km2)	Deceleration time / hour	Qp
Al-Aghari	1280	17.9	180.26
Malsi	1305	17.1	192.24
The Ajrman	544	9.2	157.70
Akash	1420	15.5	257.09
The secondary Al-Ratka	1718	17.7	244.86
Al-Awja	867	14.2	153.85
the main basin	7134	25.5	807.75

Table 22 Basin categories according to the value of the maximum flow of torrents m3 / sec

Categories	Repetition	the basins they represent
153.85-188.26	3	1,3,6
188.27-222.68	1	2
222.69-257.1	2	4,5
Total	6	6



Map (13) Basin categories according to the value of the maximum flow of torrents m3 / sec

Source: Based on Table (22), Arc Map (10.8) program, and Digital Elevation Model (DEM)

11-Flood coefficient

It is one of the important hydrological variables, its role is highlighted by the fact that it works on the flow of water towards the waterways, and then the arrival of the peak of the flood to the end of the basin. Or it works to impede that movement and prevent the peak of the flood from reaching the end of the basin. The flood coefficient was calculated according to (Jaton 1980 p.41) as follows:

Flood coefficient = longitudinal discharge density of the basin (km/km^2) X frequency of first-order sewers ($stream/km^2$)

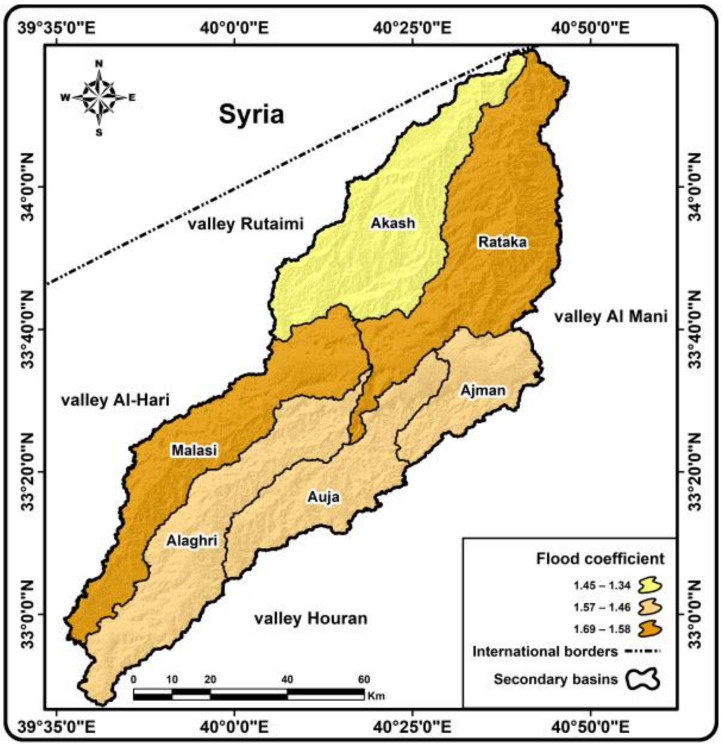
When applying the above equation to the estate basin, it was noted that the flood coefficient was (1.54). The basins of the region vary in the value of the flood coefficient from one basin to another. As in table (23). It reached its maximum in (Mallasi) basin, which recorded a value of (1.68). While the least of them appeared in the (Akash) basin, with a value of (1.34). The rest of the values ranged between these limits. To show the variation in the flood coefficient, the region's basins were classified into three categories. This is according to the flood coefficient, as in the table (24) and the map (14).

Table 23 Flood coefficient of the estate basin and its secondary basins.

Basin	Longitudinal discharge density of the basin	Frequency of first-order streams	Flood coefficient
Al-Aghari	0.68	2.2	1.50
Malsi	0.73	2.3	1.68
The Ajrman	0.74	2.1	1.55
Akash	0.67	2	1.34
The secondary Al-Ratka	0.71	2.3	1.63
Al-Awja	0.69	2.2	1.52
the main basin	0.70	2.2	1.54

Table 24 Basin categories according to the flood coefficient

categories	Repetition	the basins they represent
1.34 – 1.45	1	4
1.46 – 1.57	3	1,3,6
1.58 – 1.69	2	2,5
Total	6	6



Map (14) Basin categories according to the flood coefficient

Source: Based on Table (24), Arc Map (10.8) program, and Digital Elevation Model (DEM).

Results and discussion:

A spatial modeling of the flood risks was carried out based on the geographic information systems and remote sensing program, by integrating the group of hydrological parameters of the Ratka Valley basin and its secondary basins to determine the severity of the floods in the study area, These transactions are (F, QP, Qt, Tr, V, T, td, Tm, Tb, Tp, Tc) And then drawing the layers entered into the program individually and then merging them with a final layer to represent the final weight of the total layers, as a certain weight was given to each layer according to its importance and the degree of its impact, For each basin (3) degrees of severity were given, as the number (3) was given a high degree of risk, number (2) a medium severity degree, and number (1) a low severity degree, and the number of transactions became (30), and then the severity degrees were collected for the transactions of each basin Through research, it becomes clear what follows:-

1. The study region is distinguished by its desert-like climate This is similar to the study of Ahmed Falih Fayyad (spatial modeling of torrential hazards in the Al-Walj basin in Al-Anbar Governorate), as this study dealt with a spatial modeling of torrential hazards in Al-Walj Valley in Al-Anbar Governorate within the Rutba district. .

2- The surface runoff qualities in the research region are significantly influenced by the local geographic features.

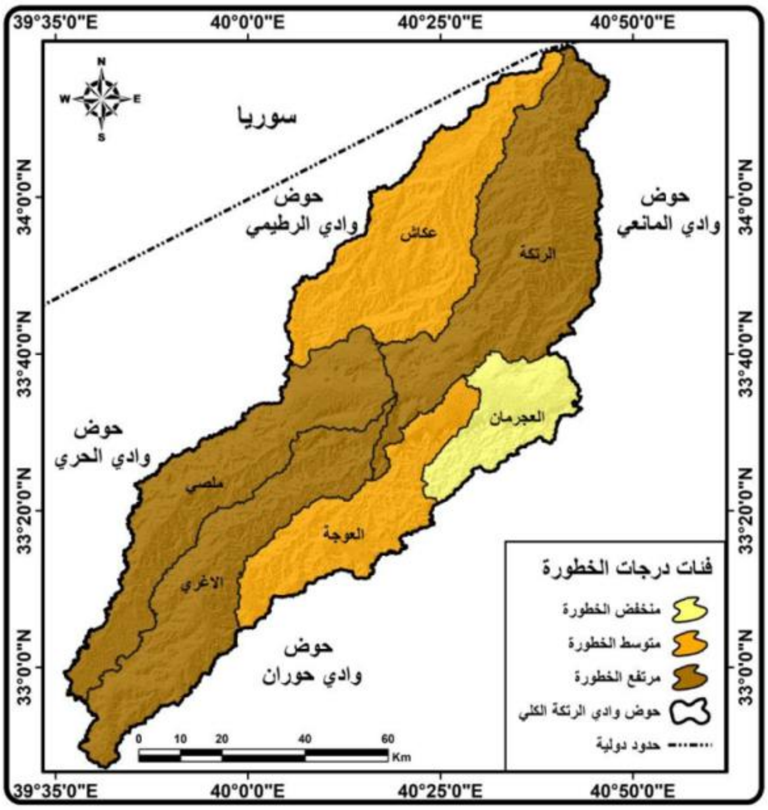
3- The degree of threat that torrents provide to valleys may be calculated using hydrological data associated to torrents.

4- The study showed that the hazard of torrential flows in the region varies in severity from one basin to another, with the Ajman basin being located under a low- hazard level, the Akash and Al-Auja basins being located under a medium- hazard level, Which means that it is suitable for human settlement and carrying out development projects, whether in the tourism aspect or in agricultural activity and industrial projects and the Al-Aghri, Malsi, and Al-Ratka secondary basins being located under a high hazard of torrential flows, This result is similar to the study of Hind Tariq Majeed (geomorphological risks of erosion and torrential rains in the Valley Al-Maleh basin). The main basin is classified as high risk, while the Valley al-Shamasher basin is of medium hazard, while the Valley al-Amaya basin is classified as low hazard. The study of Ahmed Falih Fayyad 2020 This study dealt with a spatial modeling of flood hazards in Valley Al-Walj in Al-Anbar Governorate within Al-Rutba district. It concluded that the region suffers from the dangers of torrential flows, as it was found that the middle Al Walaj and Matitah basins are under a high risk torrential level, while the Daya basin is located under a medium risk torrential level, while the Al Buraim and Eastern Al Walaj basins were of low hazard, As for the study of Bakr Bahjat Thamer (Estimating the volume of surface runoff of the Duilib Valley Basin in the Al-Jazeera region - Anbar Governorate using geographic information systems), this study dealt with the Duilib Valley Basin, which is located within the Anbar Governorate, north-east of Haditha Lake. The valley consists of (3) secondary basins. The hydrological characteristics of the basins, but their difference from the subject of our study is the lack of classification and modeling of the water basins.

Table 25 The results of the final classification of flood hazards in the basins

Basin	Tc	Tp	Tb	Tm	td	T	V	Tr	Qt	Qp	F	Total	degree of severity
Al-Aghari	1	3	3	2	3	2	3	3	3	2	1	26	High hazard
Malsi	1	3	3	2	3	1	3	3	3	2	2	26	High hazard
The Ajrman	2	2	2	2	2	1	2	2	2	1	1	19	Low hazard

Akash	1	2	3	2	3	1	2	3	3	2	2	24	Medium hazard
The secondary Al-Ratka	1	3	3	2	3	1	3	3	3	2	3	30	Medium hazard
Al-Awja	1	3	3	2	1	2	2	3	2	1	2	22	Medium hazard
the main basin	1	2	2	2	3	2	3	3	1	1	2	25	High hazard



map (15) Classification of flood hazards for basins of the study area

Recommendations

1- Establishing stations to measure water discharges to know the real quantities of these discharges. Then its investment in the development of the region can be determined. With the need to carry out a feasibility study and preliminary studies for the projects to be developed in the region.

2- The area is exposed to torrential rains during intermittent periods. It is important to shed light on these torrents and study them extensively to reduce their damage first. Then make use of it as much as possible in the development of projects and their sustainability, such as water harvesting, building dams, land uses, and others.

3- Establishing a database within the geographic information systems for the hazards of floods on the water basins in the study area. Where it is possible to predict the floods and the hazards resulting from them in order to reduce their damage and benefit from them more.

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