Journal of Namibian Studies, 33 S3(2023): 2698–2719 ISSN: 2197-5523 (online)

Modeling The Hydrological Hazards Of The Slopes Of Zubaidat, East Of Maysan, Using Modern Technologies

Haneen Riyad Hassoun Muhammad[1], Dr. Mohamed Abdel-Wahhab Hassan[2]

[1,2]Basra University / College of Arts / Department of Geography and Geographic Information Systems

Abstract

The study of the hydrological characteristics is of great importance because it shows the susceptibility of the river basin in the possibility of occurrence of water runoff, and then the occurrence of the risks of torrents and flooding in the region, and the hydrological characteristics of the drainage basins are a reflection of the climatic and topographical conditions of the basins in the region, as the surface formations of varying hardness make them subject to water erosion In addition, it works to accelerate the process of movement of materials on the surface of the earth to form multiple geomorphological forms, with a long dry season that works to prepare sediments ready for transportation, and the study of these properties It helps to know the seriousness of the valleys in which a water flow occurs that has the capacity of force and action, which causes it to cause destruction and devastation that stands as an obstacle to the development of the region, by studying the hydrological characteristics that have a role in its formation, using the (SCS-CN) method.

keywords: Modeling, Hydrological Hazards, Slopes, Zubaidat, Maysan, Modern, Technologies.

Introduction

Hydrological studies are interested in shedding light on water basins because of their great importance in arid and semi-arid regions. It is due to their great need for water resources, as they suffer from the scarcity of these resources. The rainfall within the study area is characterized by fluctuation and irregularity in its fall times, as well as the variation in the amount of precipitation. As the rain is characterized by its abundance and falls within a short period of time, which results in surface runoff and the occurrence of torrents and floods in the study area.

Problem of Study

The study problem is summarized as follows:

1. Do the hydrological characteristics have a role in the occurrence of flood risks in the study area?

2. Is it possible to identify the hydrological risks represented by torrents and floods by relying on remote sensing techniques and geographic information systems?

Hypothesis of Study

The hypothesis is an initial answer to the research problem, which is as follows

1. The hydrological characteristics have a major role in the occurrence of flood risks in the study area, so this study focused on the surface runoff characteristics based on the (SCS-CN) method.

2. By relying on remote sensing techniques and geographic information systems, it is possible to identify the hydrological risks in the study area, as they provide accurate data to determine those risks.

Location and Area of Study

Al-Zubaidat area is located in Al-Jaz', in the southeastern part of Maysan Governorate. It is astronomically located between latitudes (716.16 - 47 39) north and longitudes (824.28 - 8.47) east. It occupies an area of about (742 km 2) from Maysan Governorate. The north is the Tayeb River, the Dourij River to the south, the Islamic Republic of Iran to the east, and the Tigris River to the west. In this location, it is located within the arid and semi-arid regions.

Objectives of Study

The paper study aims at the following:

1. Produce a map of the hydrological hazards in the study area.

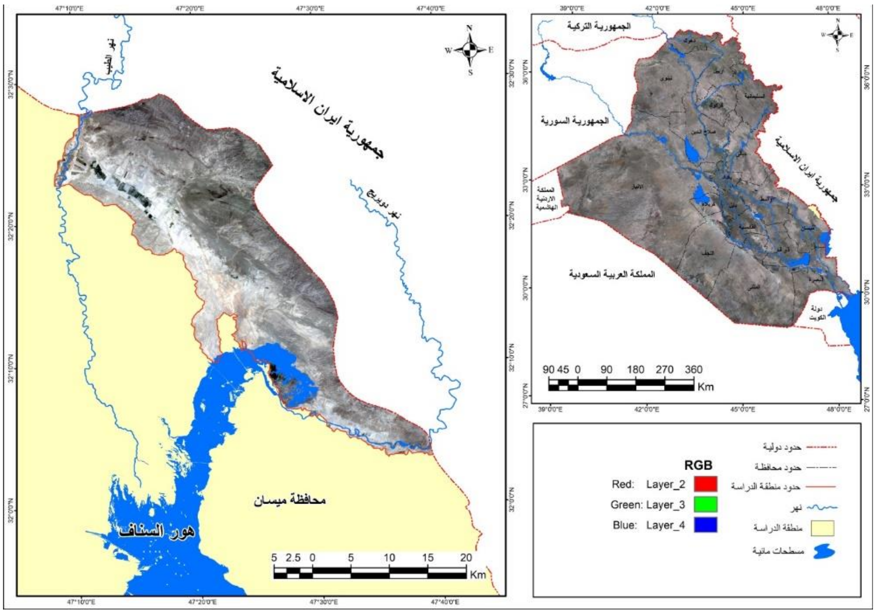
2. Find out the extent to which water flows are capable of causing torrents and floods in the region, and then developing appropriate solutions to treat them.

Methodology of Study

The research relied on the following approaches:

The descriptive approach was adopted to take advantage of the information found in books, theses, dissertations and scientific journals that apply to the study area, and the analytical approach was relied upon to analyze the samples of the soils of the study area, in addition to adopting the quantitative or statistical approach through the use of statistical equations.

Map 1.1 – Study Area



Source: Ministry of Water Resources/ Iraq Admin. Map 2022

Concept of Surface Runoff

Surface runoff is defined as the surface runoff, the amount of rain that exceeds the absorption capacity of the soil as a result of the continuation or increase in the amount of rain over the rates of infiltration and evaporation, that is, after the soil reaches the post-saturation stage, where the water begins to run on the surface of the earth according to the degree of slope of the surface, until it reaches water to one of the watercourses and becomes a part of it (Hassan Abu Samour, 1999), that the daily, monthly, seasonal and annual averages of the volume of surface runoff water and water levels often show large variations due to the variation of water feeding sources and their size, and the processes of determining the volume rates of surface runoff water are of great importance In hydrological studies, because it determines the times of flooding and drought, which enables specialists to store flood waters and invest them in times of drought and to reduce the negative environmental effects of the variation in water volume (Al-Saadi, p. 105).

Building the hydrological model using (CSC-CN) method

Building a model using the (CSC-CN) method, which is one of the methods used in estimating surface runoff developed by the Soil Conservation Department of the United States Department of Agriculture (Soil Conservation Service) in 1970, and its famous formula was developed in 1986 AD, which deals with several variables, including uses Agricultural land, vegetation cover, and the amount of rainfall, then estimate the surface runoff according to this method within the geographic information systems environment (ARC GIS 10.6) and by adopting remote sensing techniques to obtain accuracy in determining areas with runoff to choose the optimal location for water harvesting and building water stores as they operate The study, with cell units and dimensions (30 x 30) in order to obtain accurate results covering the study area, and the (CSC-CN) method requires many stages and equations to obtain accurate surface runoff estimates and the approved equation for measuring runoff according to (USDA), (Abdul Wahed, 2020, p. 225) and as follows:

$$Q = \frac{(P-Ia)2}{p-Ia+S} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Whereas

Q = runoff depth (in inches)

P = amount of rain falling (in inches)

Ia = Initial interception before the start of surface runoff represented by evaporation, seepage and vegetation

S = surface rain gathering after start of runoff (in inches)

Since (Ia) is one-fifth of the value of (S), then (la) becomes:

La= 0.25 ……………………..(2)

Now, equation has become as follows:

$$Q = \frac{(P-0.2S)2}{P+0.8S} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

It speaks for:

S = maximum surface accumulation after the onset of runoff

CN = curve numbers

As for the layers counter (Q, la, S), the equations were entered through the program (Arc gis 10.6) and through the use of the cellular calculator (SPatil Calculator) within the functions of the spatial analyzer (Analyst Raster). The surface runoff was calculated through the following equation (Mohsen, 2018 , p. 185).

$$Qv = \frac{Q-A}{1000} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Q_v= volume of surface runoff

Q= runoff depth (m)

A= Basin area, and it is expressed in the cell area (900) m2 instead of the basin area, as the flow volume is calculated at the cell level.

1000 = conversion factor so that the final results are in cubic meters.

In order to extract the values of (CN) in the study area and then estimate the volume of surface runoff formed by the torrents during the duration of the rainstorm, the following steps must be followed:

Land Cover Classification (USGS) for the study area:

The term “land cover” refers to the actual nature of the surface in a location, that is, it is related to the characteristics on the surface of the earth. It also provides a description of the prevailing surface conditions such as vegetation, rivers, lakes, and trees (Al-Ghazi, 2010, p. 114), the study area, in addition to Topographic maps and field study, then the satellite data was subjected to several stages of processing through the environment (Arc gis 10.6) and then the classification and analysis of the land cover. It was shown through map (1-2) and table (1-1) that the study area was classified into five varieties of varying size and proportion, as follows:

1. Barren Lands: It represents the unexploited open lands of the Zubaidat area, meaning that it is devoid of vegetation and the presence of this type of land appears in separate parts of the area, while its presence is concentrated in separate places of the study area. (28.80) of the total area of the Zubeidat area. This type of land represents the largest area of the area, as this type is characterized by the speed of surface runoff due to the lack of obstacles in these lands, and the speed of runoff works in turn to prevent water from leaking into the ground.

Categories of Land Covers at Study Area

Class	**Area KM^2**	**%**
Barren lands	28.80	213.8
Agricultural lands	13.84	102.78
Marshes and swamps	23.73	176.18
coarse sediment	22.84	169.55
Sand dunes	10.76	79.89
		TOTAL

Source: Researcher, based on satellite visual, American satellite (Land sat ol 18)

2. Agricultural Lands: This category includes all agricultural lands, which cover a small area of the Zubaidat area, which amounted to (102, 78) and by (13,84) of the total area of the study area, as the availability of rain has a major role in the spread of these lands In the region, among the types of plants found in this region are cultivated plants, riverside plants, and annual plants that grow during the rainy season. This variety

is spread in the northwestern parts and in small parts of the middle and south of the study area.

3. Marshes and Swamps: This type of land cover is found in the western parts, represented by a part of Marsh Al-Sanaf that flows into the Al-Tayeb River, and occupies an area of (176.18) with a ratio of (23.73) of the total area of the study area.

4. Coarse Sediments: - Coarse sediments are spread in the middle of the study area, as this type of land occupies an area of (169.55) and by (22.8) of the total area of the region. This is the slope of the area transferred from it. These deposits contribute to providing some of the raw materials needed for the construction industry, such as gravel and sand. The extraction sites for these materials are spread within the Iraqi borders.

5. Sand Dunes: Sand dunes occupy an area of (79.89) and at a rate of (10.76) of the total area of the study area. This type of land is spread in most parts of the study area, as it spreads in various forms, including crescent dunes, longitudinal dunes, and Al-Nabak dunes.

4. Hydrological Groups of Soils of the Study Area

The characteristics and quality of the soil have an effect on the process of generating surface runoff as a result of rain precipitation, depending on the rate of velocity of infiltration and transmission of water within the soil. It reveals the extent of the influence of the soil texture on the emergence of runoff, and a soil classification has been developed by the US Soil Authority. Table (1-2) (A.B.C.D) differs in its characteristics and characteristics. Table (1-2) represents (A.D) two extreme cases, as group (A) represents low surface runoff, while group (D) brings to light high runoff, while group (B) represents an average case surface runoff, (Al-Hasnawi, 2022, p. 102). By analyzing the texture characteristics of the soils of the study area that were explained above, it was found that there are several soils, and the area and percentage of each type of soil were calculated as follows:

Table (1-2) Soil Hydrological Groups as per SCS-CN Classification

Class	Depth	Type of Soil
A	**Little**	**Deep sandy layer with a small amount of clay and silt**
B	**Medium**	**A sandy layer less deep than the medium infiltration rate after wetting**
C	**Above medium**	**A well-defined clay layer with an infiltration rate below the medium before soil saturation**
D	**High**	**A clay layer with a high swelling rate with a**

		shallow layer of fine soils close to the surface

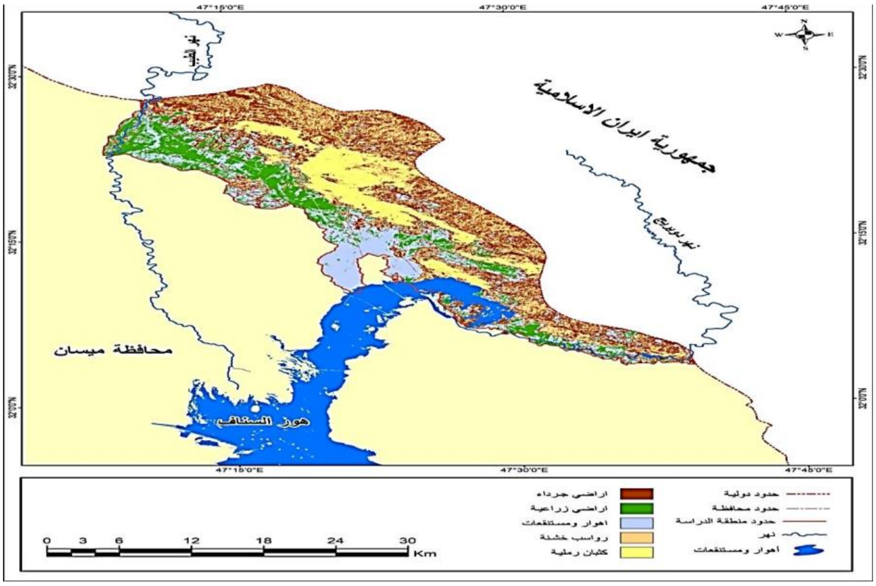
Hydrological Group A: - This group of soils includes the sediments of the floodplains, which are sandy soils with a coarse texture consisting of a deep sandy layer with high permeability and has a high ability to absorb water with a small amount of clay and silt, so the surface runoff is small. The northern and northwestern parts of the study area amounted to (319.42) square meters, with a percentage of (43.03) of the total area of the study area. As shown in table (1-3).

Table (1-3) Classes of hydrological soils for the study area

Class	Area KM^2	%	Type of Soil
A	**319.42**	**43.03**	**Deep sandy layer with a small amount of clay and silt**
B	**328.05**	**44.19**	**A sandy layer less deep than the medium infiltration rate after wetting**
D	**94.73**	**12.76**	**A clay layer with a high swelling rate with a shallow layer of fine soils close to the surface**

Created by researcher relying on table (2.1)

Map (1-2) land uses in the study area



Source: Created by researcher, based on the satellite image of the American satellite (Land sat oL18), Al-Hazm (4,5), 2018.

2. Hydrological Group B

This group consists of mixed, clayey, silty soils of shallow depth, with little porosity. This category is concentrated in the northern and northeastern parts of the study area, as shown in map (1-3), as the area of this type reached (328.05), with a percentage of (44.19) of the total area. for the study area.

3. Hydrological Group D

This group occupies the largest area of the study area, as it has an area of (9.73) and by (12.76) of the total area of the study area. The emergence of a high surface runoff when compared to other hydrological groups, this type of soil is concentrated in the northeastern parts of the study area.

Extract the values of (CN) in Study Area

The value of (CN) expresses the amount of surface permeability and the extent of the water response to the components of the land cover and soil hydrology in terms of its ability to permeate water. They are estimated numbers starting from (0-100), the closer the value is to (0), the more permeable the roofs to water and the lower their ability to generate surface runoff, while if the value is close to (100), the roof is impermeable and turns all that falls on it from rain into runoff surface (Students, 2022, p. 119). After completing the basic requirements for extracting (CN) values for the study area by combining the two layers of the cover, the soil and hydrological soils of the region through (Combine) in the program (Arc gis 10.6), the results made clear that the values (CN) of the region ranged between (39-91). Such hose values were classified according to the outputs of the program (Arc gis 10.6) into three categories that express the susceptibility of the soil and its response to surface runoff. Ass shown in the map (4-1) and table (4-1), if these categories show a clear discrepancy in terms of area and percentages occupied by my agencies:

Table (1-4) CN curve values for the study area

Categories	Area KM^2	%
39-49	292.1	39.35
50-72	346.6	46.69
73-91	103.5	13.94
TOTAL	742.20	100

Source: Created by researcher, based on the outputs of the Arc Gis 10.6 program.

1. First Category: This category includes values between (39-49), which came in the second place in terms of area, as it occupied an area of (292.1) and at a rate of (39.35) of the total area of the study area. It is the least of the categories in response to surface runoff. Due to the increased permeability of the soil and the high percentage of sediment in it. This category is spread in the northwestern parts of the study area.

2. Second Category: This category occupied values between (50-72), which ranked first in terms of the area it occupied, as it occupied an area of (346.6) and at a rate of (46.69) of the total area of the study area. It is a category with a medium response surface runoff. It is concentrated in separate parts of the study area.

3.Third Category: - This category occupied the values between (73-91) came in the third rank in terms of the values it occupies, as it occupied an area of (103.5) with a ratio of (13.94) of the total area of the study area. It has a response to surface runoff due to the lack of soil permeability. This category is distributed in most parts of the study area.

Calculation of Coefficient of Maximum Possibility After Runoff (S)

The coefficient (S) refers to the maximum possibility of retaining or confining water in the soil after the start of surface runoff. Rainfall and its seepage into the soil, and through that it can be confirmed that this coefficient is directly related to the type of land use and soil quality. As the closer the (S) values are to zero, this indicates a decrease in the soil's ability to retain water during the start of the run-off process. This leads to a rise in the amount of Surface runoff on the surface of the earth. On the contrary, when the value of the coefficient (S) increases, the ability of the soil to retain water on the surface of the earth increases, which causes a decrease in the generation of surface runoff of water, (Al-Atabi, 2021, p. 153). The coefficient (S) was extracted according to The following equation:

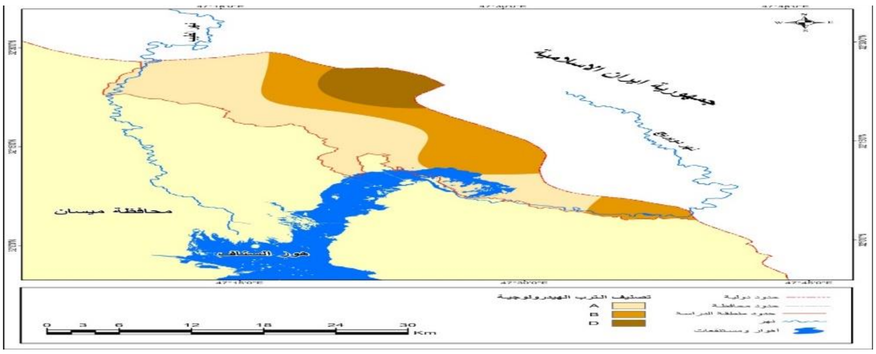
$$S = \frac{1000}{CN} - 10$$

It speaks for:

S = maximum surface accumulation after the onset of runoff

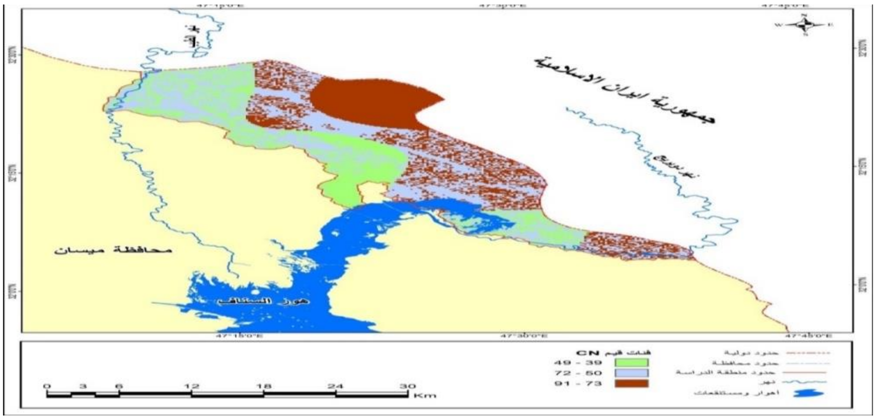
CN = curve numbers.

Map (1-3) Hydrological soils of the study area



Source: 1) Created by researcher based on the soil classification map issued by the Food and Agriculture Organization (FAO). 2) Field study and results of the laboratory analysis of the physical and chemical properties of the soil samples in the study area and the outputs of the program (Arc Gic 10.6)

Map (1-4) Distribution of curve values (CN) in the study area



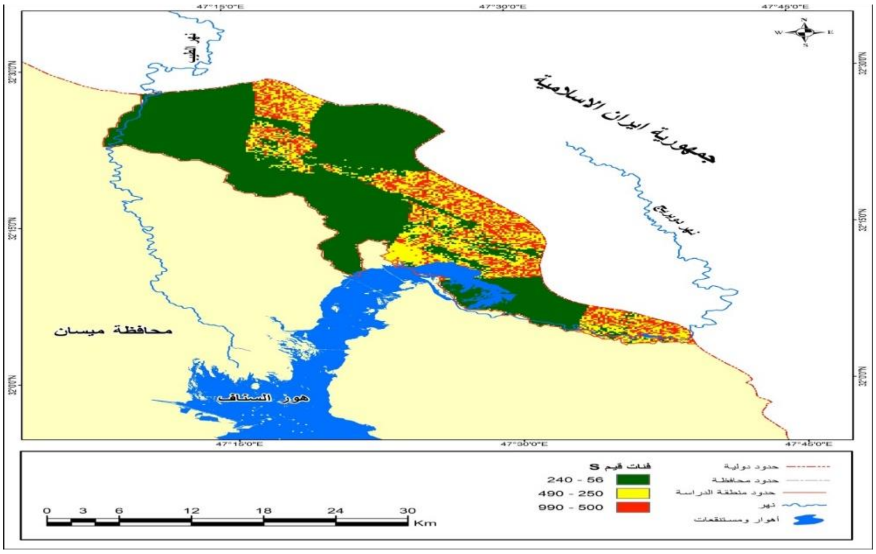
Source: Created by researcher based on the merger of the two layers of land use maps and hydrological soils, and the outputs of the (Arc Gis 10.6) program.

By applying the above equation using (Raster caiculator) within the program (Arc gis 10.6) to obtain values and results through which a map was extracted to determine these values, their area and percentage divided into three categories, As indicated in the map (1.5) and table (1.5), the values of the coefficient (S) ranged between (56-990) as follows:

First Category: It includes values between (56-240), as most parts of the study area fall within this category for coefficient (S). These values indicate the low potential of the soil in preserving and storing water, which leads to the occurrence of surface runoff, as the soil is deaf. It contains a high percentage of clay and silt and a small percentage of sand, which reduces its porosity and permeability.

Second Category: This category includes coefficient values (S) that range between (250-490). This parameter indicates an increase in the soil's ability to store and preserve water and its leakage into the interior, which reduces the surface runoff process. This category occupied an area of (146.34) with a percentage of (19.71) of the total area of the study area as it is located on the slopes that include rocky soils with large porosity as a result of the large number of faults and cracks.

Map (1.5) Coefficient (S) in the study area



Source: Created by researcher based on the coefficient (S) and the outputs of the program (6Arc Gis 10.)

Coefficient S	Area KM^2	%
56-240	492.4	66.34
250-490	146.34	19.71
500-990	103.46	13.93
TOTAL	742.20	100

Source: Created by researcher based on the equation (S) and the outputs of the program (Arc Gis 10.6).

Third Category: This category occupied the values of the coefficient (S), whose value ranges between (500-990), where the surface runoff decreases within this category for the coefficient (S). Also, the ability of the soil to retain water increases, as it spreads over fragile rock formations that have a high capacity on water retention. The area of this category reached (103.46), with a percentage of (13.93) of the total area of the study area.

Calculation of the initial extraction coefficient (La)

The coefficient (La) indicates the amount of rainwater lost before the start of surface runoff through evaporation, and through what plants intercept from rainwater or through leakage, Therefore, it has a strong correlation with the type of soil, its porosity, and the density of vegetation cover. It is also directly related to the coefficient (La). It represents one-fifth of the value of (La), and the low values of this coefficient, which are close to zero, indicate a decrease in the amount of water loss before the start of surface runoff (Al-Nafaei, 2010, p. 109).

The values of (La) coefficient were obtained through the (Arc) program gis 10.6) and the Raster (Calculator) tool within the Spatial Analyst list to produce map (1-6) and table (1-6) in which it is clear that the values of (La) coefficient ranged between (11-200) divided into three categories as follows:

Table (1-6) Categories of coefficient values (La / mm) for the study area

Values of La Coefficient	Area KM^2	%
11-48	454.18	61.19
49-98	93.61	12.61
99-200	194.41	26.19
TOTAL	742.20	100

Source: Created by researcher based on the (La) equation and the outputs of the (ARC Gic 10.6) program.

1. First Category: This category includes values that range between (11-48), and it represents the largest area, which reached (454.18) and at a rate of (61.19) of the total area of the study area. The values of this area are close to zero, and they indicate a decrease in the amount of rain lost. Before the start of surface runoff, which leads to the generation of high surface runoff, which is compatible with the coefficient equation (La). This category included most parts of the study area, where the soil is coherent and clayey, which reduces the amount of rainwater loss.

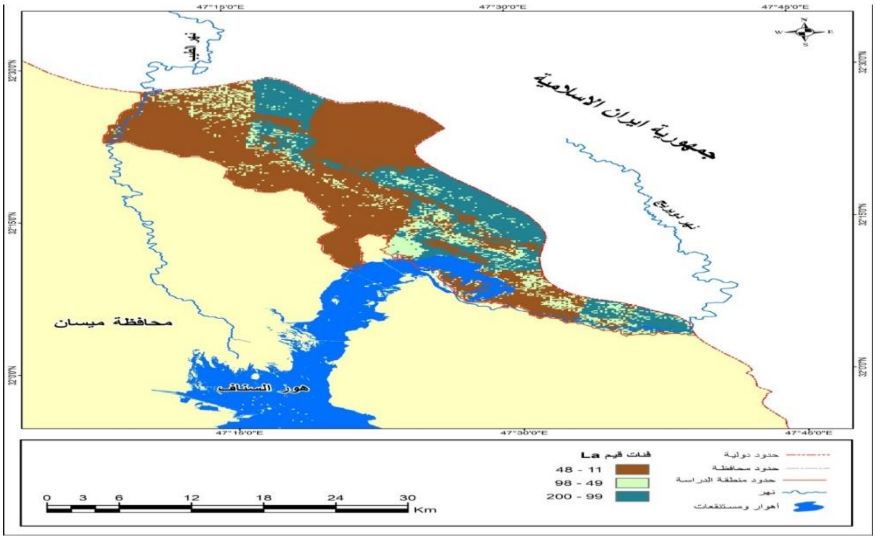
2. Second Category: The values of this category range between (49-98), and they also refer to the lack of rainwater losses before the start of surface runoff, but in a lesser way than the first category. It occupied an area of (93.61) and at a rate of (12.61) from the total area of the region. It is spread among the steep areas and unevenly throughout the region.

3. Third Category: This category included values that ranged between (99-200), this category ranked second in terms of area, which amounted to (194.41) and at a rate of (26.19) of the total of the study area, which indicates a high amount of rainwater loss due to its soil. It is characterized by high infiltration, and then the lack of surface runoff. This category is spread within the formations of Bay Hasan and Muqdadiya.

Calculation of Rainfall Group According to Rain Intensity Scale (mm) for the Rainy Season (2018-2019)

The region is vulnerable to rainy storms varying in terms of intensity and recurrence system. The importance of daily precipitation lies in being the main source of water in the region, with emphasis on the intensity of rainstorms occurring suddenly and unevenly and affecting human activities with the torrential rains they cause (Al-Zubaidi, 2018,143), Thus, it is exposed to precipitation with varying amounts of quantity and time as a result of the influence of the frontal middle depressions of the Red Sea, and the depressions of the Red Sea. Therefore, the focus here will be on the intensity of precipitation. As for the hydro geomorphological risks, the rainfall intensity is linked to the entry of depressions coming from the north and northwest, which are compatible with the direction of the waterways at the headwaters in the north of the region. It is characterized by a steep slope of more than (30 degrees), and the surface formations vary in hardness, which makes them subject to water erosion, as we notice in Tayyat Al-Tayyib area in the southern part, which is eroded due to the rain stresses that work on activating severe groove water erosion, as it works on the creeping and slipping of fragile soil with a small thickness due to the shape of these risks, in addition to that it works to accelerate the process of movement of earth surface materials to form multiple geomorphological forms, with a long dry season that works to prepare sediments ready for transportation. The lack of data for daily precipitation, in addition to that, most of the previous studies do not rely on daily rainfall data, but rather monthly equations, where reliance was made on the American satellite stations (http.ll.www.chrsdata.uci.edu.com), to obtain precipitation data. The rainy season for the season (2018-2019), and these stations contain points, each point includes daily data covering an area of (25) km 2, since the rainy season started for the period (1/9/2018) until (31/5/2019), and six points were assigned To cover the study area, (Abdul Wahed, previous source, 246), look at map (1-8).

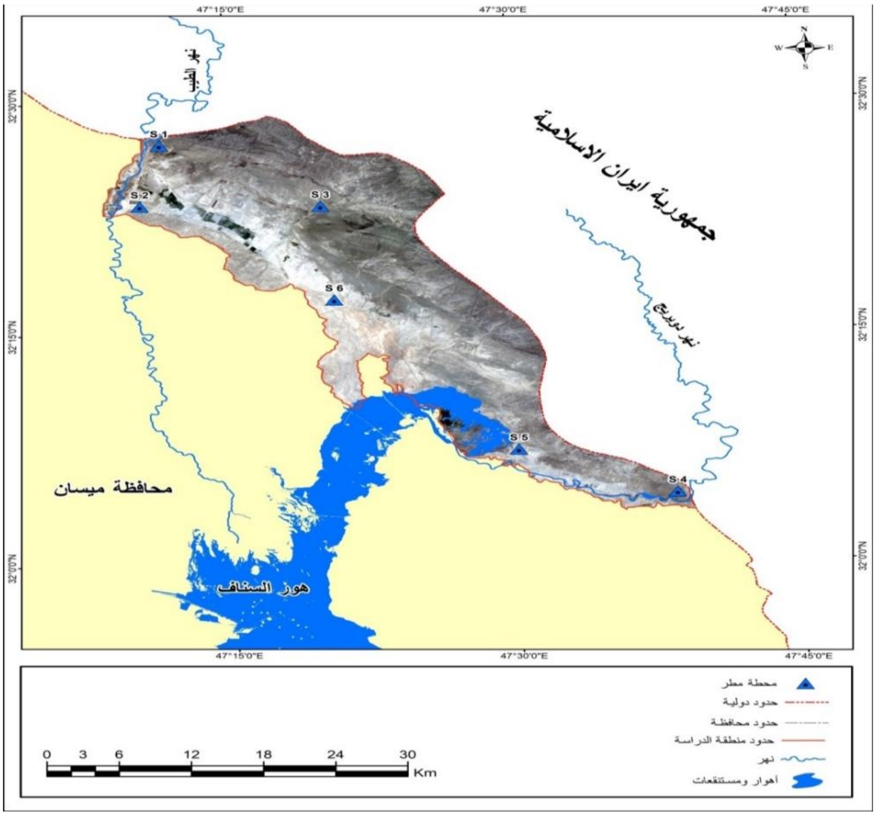
Map (1-6) Categories of primary extraction coefficient (La) values in the study area



Source: Created by the researcher based on the coefficient equation (La) and the outputs of the program (Arc Gic 10.6).

For analysis of the reasons for the occurrence of rain intensities, the strongest model of rain intensity that occurred on (13-14/01/2019) was taken. As the rain intensity values ranged between (37/59 / mm), and the lowest limit in Station No. (6) located in the center of the study area. Also, the number of hours of rain intensity reached (13 hours / day) in station No. (6), and Station No. (1), which is located in the southwestern parts of the study area. The number of hours of rain intensity reached (17 hours / day) and the date Same, noting that the amount of water.

Map (1-7) Distribution of selected points of the American satellite stations (Chrsdata) in the study area



Source: Created by researcher, based on http.ll.www.chrsdata.uci.edu.com and the outputs of the program (Arc Gis 10.6).

The amount of falling water begins to increase gradually from its inception and then decreases at the end of the rain intensity. For completion of the process of calculating the volume of runoff, a spatial modeling of the total rainfall intensity was carried out. It was come out from the map (1-8) and table (1-7) that the highest total rainy intensity was for the central parts of the region, while the second category included (39.5-41.3) The area covered by that category was (212.47) and its percentage was (28.62) of the total area of the study area. It turned out that the largest area within the region was the category (39.4-73.6) and, its area is (254.41) and by (34.27) of the total area of the study area, in the central parts of the region.

Table (1-7) Categories of rain intensities / mm during the rainy season on (13/14/01/2019) at the stations of the study area

Categories of rain intensity	Area KM^2	%
39.4-73.6	254.41	34.27
39.5-41.3	212.47	28.62
41.4-34.2	169.18	22.79
43.3-45	58.42	7.87
45.1-46.9	26.8	3.61
TOTAL	742.20	2.81

Source: Created by researcher based on http.ll.www.chrsdata.uci.edu.com, and the outputs of the program (Arc GIS 10.6).

Table (1-8) Locations of rain intensities

Name	Intensities	X	Y
S1	46.87	47 11’ 30 .651 E	32 27 19.093 ’ N
S2	40.47	47 10 ’23.311’ E	32 23 22 .409 ‘ N
S3	39.72	47 19 58.558’ E	32 23 14.928’ N
S4	39.59	47 38’ 22 961 ‘E	32 4’ 24 348 ‘ N
S5	39.59	47 30 3.450’ E	32 7’ 17 . 991 ‘ N
S6	37.59	47 20 ‘ 33.124’ E	32 17 9. 804’ N

Source: Created by researcher based on map (1-7) and the outputs of the program (Arc GIS 10.6).

1.9 Runoff Depth Measurement (Q)

The depth of the surface runoff is that part resulting from rainwater and exceeds the absorbent capacity of the soil after saturation. Therefore, it moves according to the geomorphology of the surface and the slope until it reaches the waterways to pour into them, and becomes a part of them. Running water to the watercourse, and the Runoff Depth reflect the summary of the interaction between a specific rain wave with the components and characteristics of the drainage basin (Al-Darrat, 2020, p. 61). It is one of the inputs to the basic equation, and then the Map Algebra process was used using the Raster Calculator within the Spatial

Analyst list in the program (Arc gis 10.6). The surface runoff depth was calculated according to the following equation:

$$Q = \frac{(P - la)2}{p - la + s}$$

Whereas:

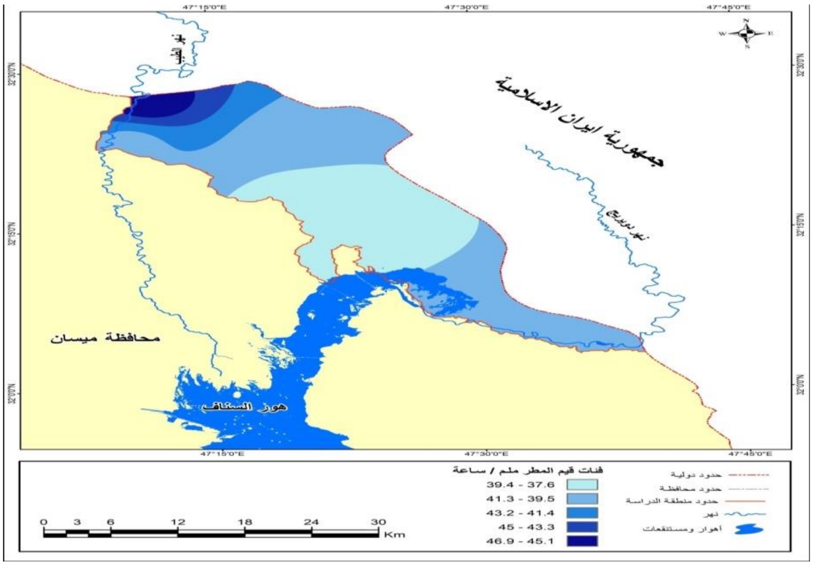
Q = runoff depth (in inches)

P = amount of water falling (in mm)

La = initial interception before runoff

S = surface runoff after runoff

Map (1-8) Categories of rain intensities / mm during the rainy season on 13/14/1/2019 for the stations of the study area



Source: Created by researcher, based on http.ll.www.chrsdata.uci.edu.com, and the outputs of the program (Arc Gis 10.6).

Through the application of the above equation, the surface runoff depth values for the area ranged between (110-780) as shown in the map (1-9). Table (1-9) is divided into three categories. The first category amounted to (444.72) with a percentage of (59.91) of the total area of the study area included separate parts of the study area. While the area of the second category amounted to (188.74) at a rate of (25.42) of the total area of the study area. As for the third and last category, it occupied an area of (108.74) at a rate of (14.65) of the total area of the region. It included the northern and northeastern parts, and a small part to the south of the study area.

Table (1-9) Categories of coefficient (Q) values for the study area

Values of coefficient (Q)	Area KM^2	%
0.39-110	444.72	59.91
120-240	188.74	25.42
250-780	108.74	14.65
TOTAL	742.20	100

Source: Created by researcher, based on the (Q) equation and the outputs of the (ArcGis 10.6) program

Measurement of Runoff Depth (QV)

The surface runoff volume (QV) expresses the total surface runoff to the area of the basin. This coefficient is of great importance in hydrological studies, especially in determining the sites of dams and water harvesting sites. Estimating the runoff volume helps a lot in identifying the sites most vulnerable to water inundation during heavy rains and the occurrence of Al-Seoul (Al-Saeedi, p. 182). The surface runoff depth (QV) was calculated using the Raster Caiculator within the Spatial Analyst list in the program (Arc gis 10.6) after obtaining the value (Q) for each existing pixel with a fixed area. For each pixel, there is an area of about (30 30) square meters per pixel cell, which gave a fixed area for all pixels about (900) square meters, (Mohsen, previous source, p. 186), and by applying the equation that was mentioned earlier, it turns out:

$$Qv = \frac{Q-A}{1000}$$

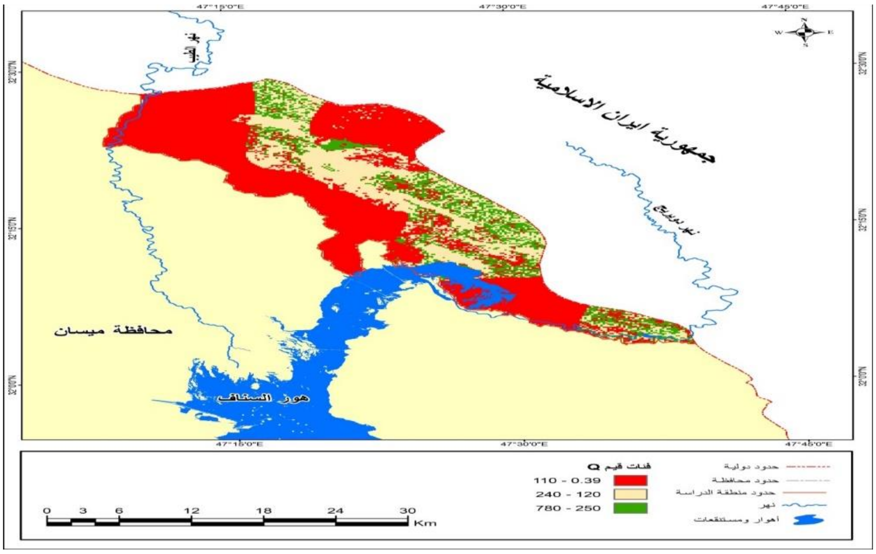
QV = runoff volume

Q = runoff depth (m)

A = the area of the basin. It is expressed in the area of the cell (900) m 2 instead of the area of the basin, as the flow volume is calculated at the level of the cell.

1000 = conversion factor.

Map (1-9) of (Q) values for the study area



Source: Created by researcher based on the (Q) equation and the outputs of (ArcGis 10.6).

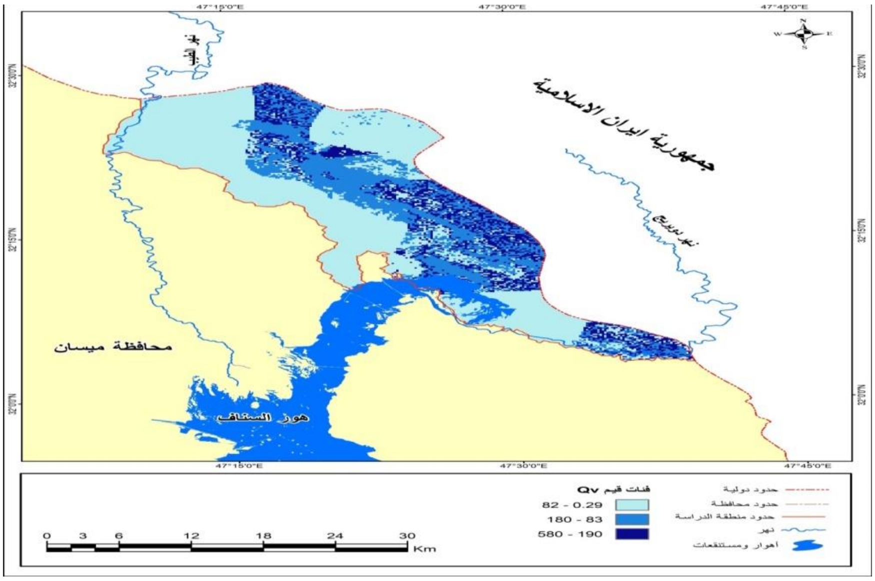
By applying the above equation, the surface runoff volume values (QV) / m3 for the region ranged between (0.29-580) billion / m3 divided into three categories as shown in map (1-10). Through table (1-10), the value of the coefficient (QV) was the largest area of (444.72) with a ratio of (59.91). The values of the coefficient (QV) constituted the smallest area by (108.74) and by (14.65) of the total area of the study area. Also, this volume varies according to the variation in the quality of the land cover and the degree of its permeability and then its ability to generate water runoff. The variation in total rainfall over the study area has a major impact on the variation in the volume of water runoff in relation to the characteristics of the areal basins and their total lengths and streams. Geological factors took part in determining the amount of runoff through the linear structures and the surface. This will increase the risk of floods that pass the area during and after the rainstorm.

Table (1-10) Volume of surface runoff according to coefficient values (QV) / m3 in the study area

Values of coefficient (QV)/M^3	Area KM^2	%
0.29 – 82	444.72	59.91
83- 180	188.74	25.42
190-580	108.74	14.65
TOTAL	742.20	100

Source: Created by researcher based on the (Q) equation and the outputs of the (Arc Gis 10.6) program

Map (1-10) Surface runoff volume according to coefficient values (QV) / m3 in study area



Categories of Hydrological Hazards in the Study Area

The river basins in the study area, available at the study area, are seasonal rivers, the largest part of which is located in the Iranian lands, which bring large amounts of torrential rains from the Iranian lands after a large amount of rain falls in the rainy seasons. Heavy rains, which have significant effects on various human activities, and on this basis, some layers were identified through which a model of hydrological hazards could be determined in the Zubeidat area, where these layers were linked through reclassification based on the selected values (Reclassfy) from the (Spatial) toolbox) Analy tool…. Overlay…. Weighted....

A special weight was given to each layer according to its relationship to the quality of the hydrological risks. A weight of (0.2) was given to the ground covers, and a weight of (0.3) was given to the volume of surface runoff / m3, while a weight was given to the last layer (0.5) to the rain intensities. These weights were given to determine the most dangerous areas in the Zubeidat region, by relying on the (ArcGis 10.6) program, as shown in the map (1-11) and table (1-11), as follows:

Table (1.11) Categories of hydrological hazards for the study area basins

Categories	Area KM^2	%
Zero hazard	89.89	12.11
Little hazard	290.94	39.19

Medium hazard	360.89	48.62
High hazard	0.48	0.06
TOTAL	742.20	100

Source: Created by researcher based on integrating the layers (land cover, runoff volume, rain intensity) and based on the outputs of the (Arc Gis 10.6) program

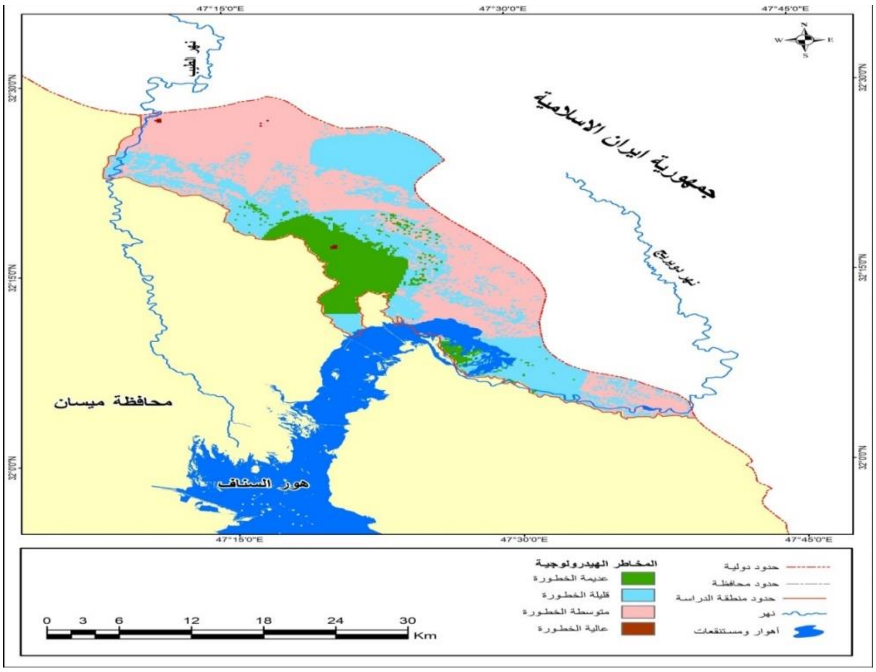
1. Areas of zero risk: This area occupies an area of (89.89) with a percentage of (12.11) of the total area of the study area. This type appears in the western parts of the study area.

2. Areas of low risk: The low-risk areas reached an area of (290.94), with a rate of (39.19) of the total area of the study area.

3. Medium risk areas: It reached an area of (360.89), with a rate of (48.62) of the total area of the study area in terms of space.

4. Areas of high risk: High-risk areas occupied an area of (0.48) at a rate of (0.06) out of the total area of the study area, and they appear in the areas that receive the largest amounts of precipitation through the intensity of rain that appeared in history (13/ 14/01/2019) at the Iraqi-Iranian border from the study area, and it spreads in the northern and northwestern parts of the Zubaidat region.

Map (1.11) Classes of hydrological risks for the study area basins



Source: Created by researcher, based on the outputs of the program (Arc G IS 10.6)

Conclusions

1. Relying on remote sensing techniques and geographic information systems is of great importance in identifying and predicting hydrological risks in the study area.

2. The study area is considered one of the arid and semi-arid areas, which are characterized by abundant rainfall and fluctuations for a short period, which results in the occurrence of floods and torrential rains in the study area.

3. Most of the torrents that occur in the study area are ones coming from the Iranian highlands.

Recommendations

1. Construct dams and soil dams in the study area to reduce or curb the effects of torrential rains coming from the Iranian highlands.

2. Establish hydro-morphometric stations on the streams of the valleys through which hydrological information can be obtained, such as measuring the volume, depth and speed of surface runoff.

3. Make use of flood water for various human activities by relying on water harvesting technology in the study area.

Bibliography

Books

1. Hassan Abu Samour, Hamed Al-Khatib, Geography of Water Resources, first edition, Dar Al-Safaa, Amman, Jordan, 1999.
2. Al-Saadi, Safaa Abdul-Amir Reshim, Geography of Water Resources, first edition, College of Education for Human Sciences, University of Basra, 2014.

Dissertations & Theses

1. Abdel Wahed, Dalia Hassan, The Geomorphological Risks of the Tayeb River Basin and Their Environmental Impacts, Master Thesis, unpublished, College of Arts, Dhi Qar University, 2020.
2. Thamer, Bakr Bahjat, Estimating the volume of surface runoff for the Duilib Valley Basin in the Al-Jazeera region - Anbar Governorate using geographic information systems, master's thesis, unpublished, College of Arts, Iraqi University, 2021.
3. Mohsen, Siri Hassan, Geomorphology of the Neidush Valley Basin, unpublished doctoral thesis, College of Education for Girls, University of Baghdad, 2018.
4. Al-Ghazi, Hassan Sawadi Najiban, Land cover changes in the Hammar marsh region for the period (1973-2008) using remote sensing techniques, unpublished doctoral thesis, College of Education, Basra University, 2010.
5. Al-Husseinawi, Alia Abdullah Abd, Hydrology of Rainfall for the Abu Hudair Basin in the Southern Plateau of Iraq, Study of Water Resources

Development, unpublished doctoral thesis, College of Arts, Dhi Qar University, 2022.

6. Students, Ali Kazem, Estimating the volume of surface runoff in the Chanchal Valley basin, master's thesis, unpublished, College of Education, Al-Mustansiriya University, 2022.
7. Al-Atabi, Ali Radhi Muhaisen, Hydrology of the Kani Sheikh Valley Basin, eastern Diyala Governorate, using Geographic Information Systems (GIS), unpublished master's thesis, College of Education for Human Sciences, University of Wasit, 2021.
8. Al-Nafi'i, Haifa Muhammad, Estimation of surface runoff and its sedimentary risks in the upper basin of Wadi Arna, east of Makkah Al-Mukarramah, by means of remote sensing and geographic information systems, master's thesis, unpublished, College of Social Sciences, Umm Al-Qura University, 2010.
9. Al-Zubaidi, Mujeeb Razouqi Farih, Hydro-geomorphological Evaluation of the Basins of Southeast Mount Pierce and its Effects on Sustainable Development, PhD thesis, unpublished, College of Education, Al-Mustansiriya University, 2018.

Journals and periodicals

1. Al-Darrat, Alaa Jaber, Quantitative Evaluation of Surface Runoff in the Leek Valley Tobruk, Northeastern Libya, Sabratha University Practical Journal, Volume 4, Issue 2, 2020.
2. Al-Saeedi, Abdul-Hassan Jabr Maleh, Al-Ajili, Abdullah Sabbar, Hydrology of the Wadi Jada Basin in the Samawa Desert using Geographical Technologies, Journal of Arts, Appendix 2, Issue 131,

Websites

1. http.ll.www.chrsdata.uci.edu.com