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Estimated of Runoff Volume in the Basin of Qlatubzan Valley Withen Kalar District, Sulaymaniyah Governorate Using GIS

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Summary:

Purpose:

Study of river basins with their terrestrial area of the riverbed, valleys network, tributaries, and different branches is important in different hydrological and geomorphological studies, the study of the spatial assessment of the surface runoff of the Qalatupzan valley basin using geographic information systems (GIS).

Theoretical framework:

Studying the basin and knowing the changes in the area and the amount of rainfall that have a significant impact on the volume of runoff as well as groundwater that has a significant role in increasing the harvest of valley water and finding the best ways to increase the water share of this basin and to know the natural factors that have formed this basin and study its different morphometric properties and prepare water harvesting models for the basin.

Methodology:

The research relied on several approaches, including the descriptive approach, which is an investigation based on one of the existing phenomena with the aim of diagnosing it, revealing its aspects, and determining the existing

relationships between its elements and the relationships between them and other phenomena, as well as the quantitative analysis method, which is the classification and inclusion of features and the construction of statistical models that attempt to explain what is observed, according to the data of the study, in addtion of the technical approach, which is concerned with using model building as a means of forecasting, and keeping pace with the development in geographic information systems to bring about a qualitative change at the entrances and exits of the geographical search.

Findings:

The importance of studying the basin of the Qalatupzan Valley hydrologically focuses primarily on knowing the volume of surface runoff and estimating the amount of water available in this basin and its importance in water harvesting and knowing the factors affecting the increase or shear of surface runoff in it, depending on the techniques of geographical systems.

Research, Practical & Social implications: The aim of the study is determined by knowing the spatial assessment of the volume of surface runoff for harvesting the water of Qalatupzan Valley using GIS from the source point represented in Sulaymaniyah Governorate until its downstream in the Diyala River.

Originality/value:

Knowing the natural and surface characteristics of the study area Basin of Qlatubzan Valley Withen Kalar District, Sulaymaniyah Governorate, through knowing the seasonal and annual amounts of rainfall. Clarifying the relationship between the spatial assessment of runoff and basin water harvesting and the factors controlling it, and then preparing models for basin water harvesting.

Keywords:

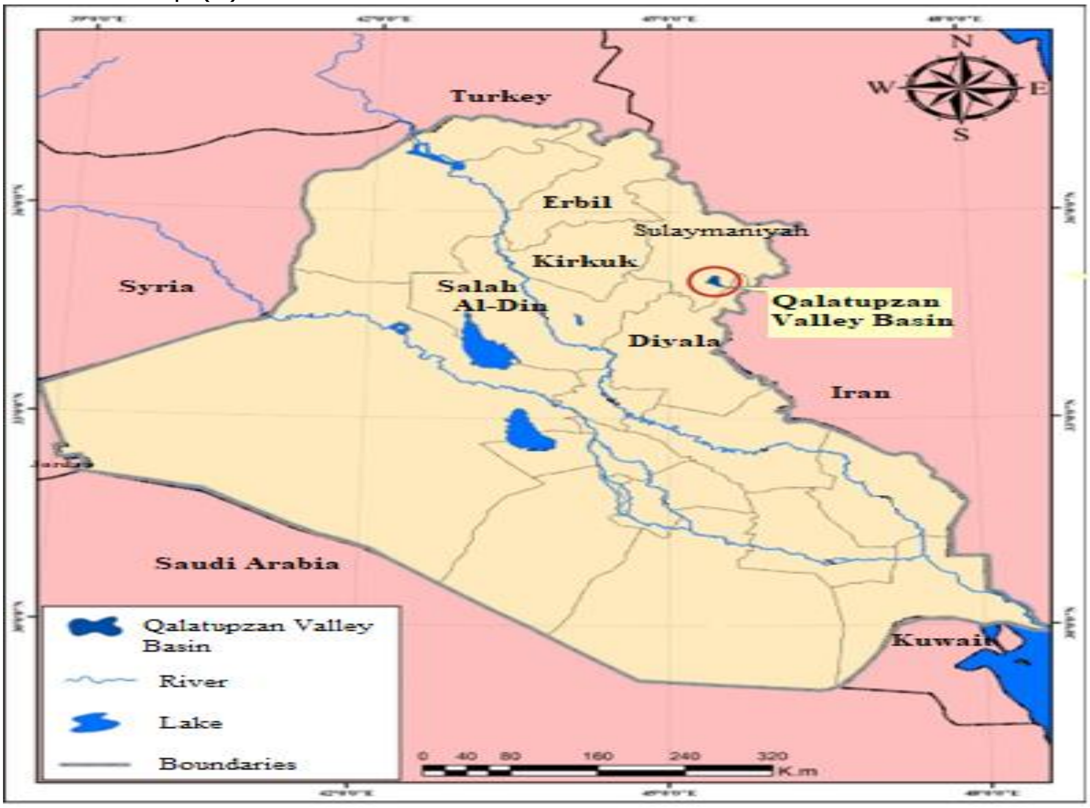
Basin, Valley, Qalatupzan, Water, Kalar District, Sulaymaniyah, Hydrology, Torrential Rain, Rain.

1. Introduction:

The hydrology of seasonal valleys runoff is based on precipitation and surface water runoff, which are the main axis of surface water. Surface runoff is the last stage of rainwater, according to which the hydrological role of the earth's surface is revealed as a precious water resource, and the best means can be determined to invest it on the one hand, as well as reduce its floods and address the risks arising from it on the other hand (Salama, Hassan Ramadan, 1980: 99).

The hydrological studies of the water valleys aim to obtain specific information on the surface runoff, including the volume and depth of runoff for the basin of the study area, so it is based on mathematical methods and equations. These are called (experimental) studies that supply empirical solutions, but many solutions and mathematical equations have been presented by some specialists to estimate hydrological work. The estimation of the volume of flow is based on a small amount of information. The second category is called (medium complex methods), which depends on more comprehensive information than the previous one, especially the influencing factors, while the third category is called (the most complex methods), and the latter is the most complex as it depends on Its study on every element that falls within the transformation of the rain phenomenon into surface runoff, which requires hydrometric stations (Daoud, Jumaa Muhammad, 2012; (Khoma & Vdovychyn, 2021).

The study area is located astronomically between two latitudes (35° 4' 56- 25' 53° 34) north. and between (45° 35' 6" 53' 21° 45) east longitude. Geographically, the area found in the Sulaymaniyah governorate, specifically in the Kalar district. The area of the area is (149,476 km2). The area is administratively decided from the north and northwest, Kalar district, from the east by Darbandikhan district, and from the south by Khanaqin district and Diyala River, as shown in map (1).



Map (1) of the location of the Qalatupzan Valley Basin in Iraq
Source: Republic of Iraq, Ministry of Water Resources, General Authority for Survey, Iraq's administrative map, scale 1:1000000 for the year 2016 and the outputs of the ARC GIS 10.8.

2. The flow characteristics of the Qalatupzan Valley Basin:

As for the number curve method (SCS-CN), it is among the second category, which is one of the most famous methods and methods used in hydrological studies to calculate surface runoff. This model was developed by the Soil Conservation Department of the United States Department of Agriculture in 1970. Its formula was developed in 1986.

This model is concerned with studying the details of land uses for calculating surface runoff, as it depends on the land classification and its uses, determining the prior moisture of the soil, and the amount of water permeation to it based on four hydrological groups, and thus it compensates for other solutions that do not include the above-mentioned elements in its calculation of runoff the surface (Al-Nafi'i, Haifa Muhammad, 2010; Krysiński & Szczepański, 2020).

The technology of geographic information systems and remote sensing (RS & GIS) has been used in order to obtain the accurate details in calculating the surface runoff because it deals based on the cell unit (pixel unit) (30 * 30). It supplied integrated data management, as follows: -

2.1. Stages of extracting flow characteristics:

The mathematical model (SCS-CN) is a series of equations that depends on a set of variables that are included in its calculation of the runoff, which are the type of vegetation cover, soil hydrology, land cover types, patterns of use and the amount of rainfall. As for (CN) it depends on three Variables (pre-condition of soil moisture - soil hydrology - land cover) The CN-SCS method can be expressed mathematically as follows:

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

while:

Q = depth of runoff (inches).

P = rainfall (inches).

Ia = Primary extracts before runoff as soil, plant reception and evaporation (in).

S = the maximum surface pool after the start of the runoff (inches) and it was found that Ia is equal to one-fifth of the value of S and Ia is calculated as follows:

Is = 0.2S .... Equation 2)) S is calculated by the following mathematical formula:

$S = \frac{1000}{CN} - 10$ ....*Equation (*3)

Through algebra of the value of S, the mathematical equation for the depth of runoff was transformed and became as follows:

Q= $\frac{(p-Ia)2}{(p+0.8S)}$ *.......... Equation (4)*

It is noted that the inputs to the model are in inches, so the equation was reformulated to conform to the metric scales, as the fixed numbers in the previous equation were multiplied by (25.4) to convert them from inches to (mm), so the formula of the equation became as follows (Maidment, David R.1993: 77-78.).

$S = \frac{25400}{CN} - 254$ *........ Equation (5)*

To estimate the volume of runoff by CN-SCS method), it can be calculated through the following equation.

$QV = (Q * A/1000)$......... *Equation (6)*
while: -
QV-: the volume of runoff.
Q: the depth of runoff.
A: The area of the drain basin.
1000: the conversion factor.

2.2. Extract values (CN):

The Curve Number (CN) values are confined between (zero-100), and they express the dimension of the water susceptibility of the components of the land cover in the drainage basins. This method is based on a set of mathematical equations, which in turn depends on the data and information available on land cover and usage patterns., the amount of rainfall and soil hydrology (Hameed, Hasan Mohammed, 2013; Mazur & Kuć, 2020).

As the value of (CN) approaches (100) this indicates that the soil surface is more capable of preserving water and has low permeability. The process of extracting the value of the (CN) is by merging the hydrological groups with the layer of land cover and by making a code) for each layer so that it differs from the values that exist in the other layer, so that there are no errors by the program and the layers with the same values are merged And then merge the two layers that we mentioned through the tool (combine) in the program (ArcGIS 10.8) and thus show the values of (CN) for the basin of the study area. To obtain the values of CN, this depends on three variables, namely (pre-moisture of the soil / land cover / soil hydrology) we follow the following:

A. Determination of Soil Moisture State (AMC): There are three types of soil moisture, the first, second and third cases. The first represents dry soil, the second is normal soil, and the third is with controls and conditions, which are light to heavy rain with low temperatures during the first five days before calculating the surface runoff (Soil Conservation Service. 1986: 3-6). The soil surface is saturated with water, and in our current study we will rely on the second soil condition, which is the usual case.

B. Classification of ground covers: This is represented in determining the types of land cover and the resulting activities practiced by humans and representing these types in detailed classified maps and statistical tables representing the area of each type of land cover. Some land uses affect surface runoff, for example, vegetation works to impede the flow of running water, which leads to its infiltration into the soil, and this naturally affects the volume of runoff. Detailed for any area whatsoever. The land cover of the study area classified through the satellite imagery (Land Sat/8) captured on 22/4/2021. The data and information were obtained through the wave classification in the ArcGis10.8. The types of land uses can be classified and identified as follows:

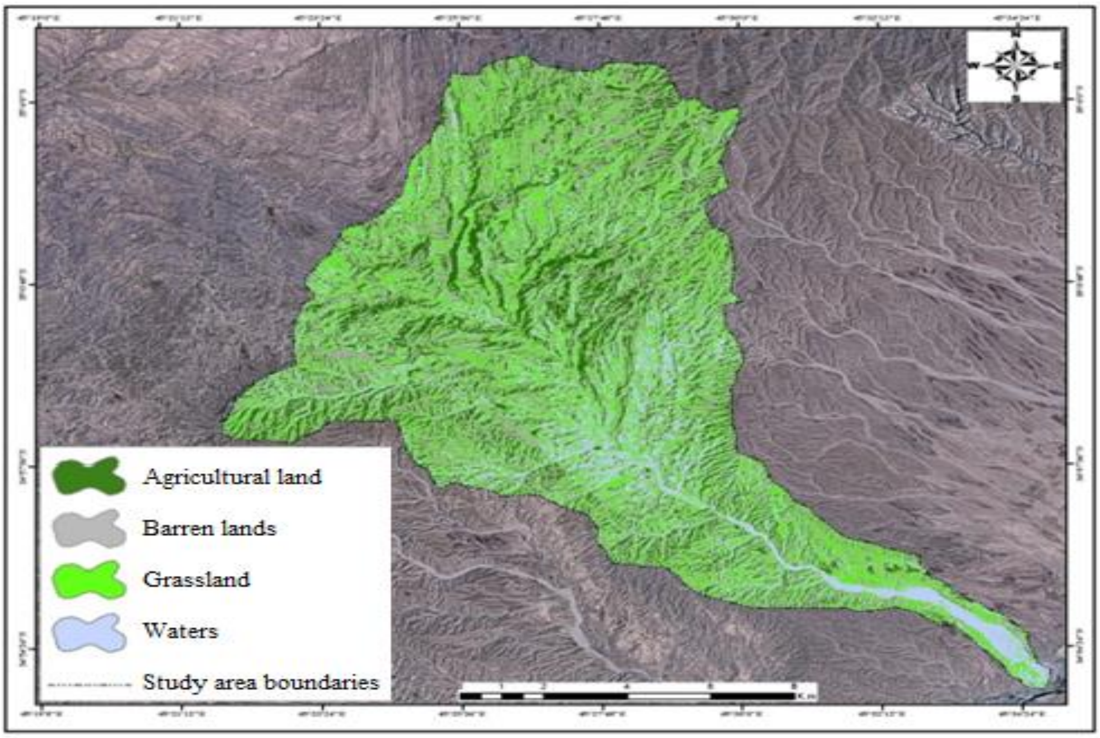
- Classification of agricultural crops:

This category is represented in the lands that are widely used in agricultural production, which include foodstuffs in their production, such as wheat and barley as shown in Photo (1), as well as vegetables, orchards, and uncultivated and abandoned lands. It was found that the area of this category, which stands for the third area It reached (23.5 km2) of the area of the basin area, which constitutes (15.7%), the total area of the basin. The hydrological impact of agricultural crops is highlighted by impeding the velocity of water flow, which in turn leads to the penetration of water into the depth of the soil,

which translates into a decrease in the volume of water flow in this category, considering that most plants are winter plants and depend mainly on rain for their growth, that is, in winter and early spring, as shown in Table (1), Map (2).

Table (1) Land cover and land uses in the basin of the study area

Source: Researcher based on the program (Arc GIS10.8).



Map (2) of the land uses and ground cover in the basin of the study area
Source: Researched based on (Satellite Visual) and (ArcGIS 10.8).

Land uses	Area / km2	%
Agricultural crops	23.5	15.7
Graslands	45.9	30.7
Barren lands	74.8	50.1
water	5.2	3.5
Total	149.4	100

-Range lands category:

It is represented in the areas covered by short seasonal weeds, which are generally widespread in the study area, where this type provides natural pastures for livestock and constitutes an area (45.9 km2) of the area of other uses, and its percentage is (30.7%) than the rest of the other percentages. The vegetation cover affects the volume of runoff, as the higher the density of the vegetation cover, the less amount of running water. As in Table (1), Map (2), Photo (2)..

- **Bare ground class:**

This type appears in rocky areas, areas with steep slopes, and areas of soft soil or sandy gravel, where there is almost no vegetation cover, and this type of soil lacks everything necessary for life. From the hydrological point of view, it is positively reflected on the volume of the flow by not impeding the speed of the flow, except for soils of rocky or gravel formation, and its area reached (74.8 km2) and a percentage of (50.1%) over the rest of the other ratios. As in Table (1), Map (2), and Photo (3).

- **Class of water**: This category includes running water and ponds located in the main and secondary valleys within the water basins, and they constitute an area of (5.2 km2) and a percentage of (3.5%), as shown in Table (1) and Map (2).

- **3. Preparation of hydrological soil groups for the Qalatupzan Valley Basin:**

Soil hydrological characteristics affect the volume of runoff resulting from rainfall, so these characteristics must be considered when estimating the volume of runoff, as classified by the Department of Soil Conservation (SCS). These four groups are the extent of the soil texture's role in the occurrence of surface runoff, and the groups are (A-B-C-D), as each type has its own characteristics that differ from the other type in terms of the appearance of the surface runoff and the movement of surface water, and that the two types (A - D) represent two extremes of separating and Where the emergence of runoff, while (B-C) they represent an intermediate case for the emergence of runoff (Hameed, Hasan Mohammed. 2013: 89). As shown in Table (2).

Table (2) Soil Hydrological Groups According to (SCS) Method

Soli hydrological complexes	Soli characteristics
A	Deep sandy layer with a small amount of clay and silt
B	sandy-sandy mixture or sandy-mixed
C	A sandy layer of less depth than Class A with an average infiltration rate after wetting the soil, silty or mixture
D	Clay layer of definite depth with sub-median infiltration rate before soil reaches saturation, sandy-clay mixture

Source: Soil Conservation Service. (1986). Urban Hydrology for Small Watershed. Technical releases 55,2nd, U.S. Dept of Agriculture, Washington D.C.

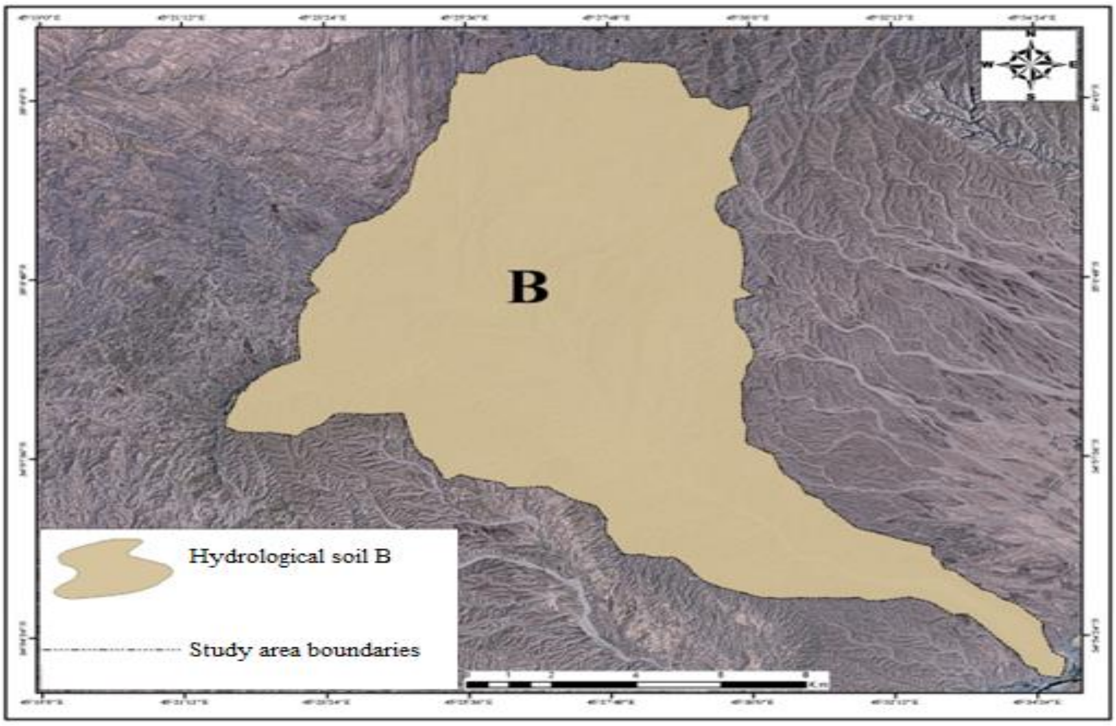
Work was done to determine the hydrological groups of the soil in the Qalatupzan valley basin based on the data of the soil map prepared by the American (USDA), as well as based on the map of the Food Organization for the year 2006 AD, as well as the soil texture and based on them, as layers (map) were created for the basin of the study area and within Software environment (ARC GIS 10.8).

It was found that the hydrological categories of the soil prevalent in the Qalatupzan Valley Basin were two types of those types, the hydrological group (B), which is prevalent in the Qalatupzan Valley Basin, as shown in Table (3) and Map (3), and it is one of the most important categories The soil in the basin of the study area, as it is responsible for the surface water runoff.

Table (3) Distribution of hydrological soil classes in the basin of the study area

Soil Hydrological Group	Area / km2	%
B	149.4	100
Total	149.4	100

Source: Researcher, based on the program (Arc GIS 10.8).



Map (3) of soil hydrology in the study area
Source: Researcher based on map (3).

This category consists of hard rocks, which are dominant in the study area, and are of immense importance from the hydrological point of view, being the least hydrologic group and the least capable of absorbing water, which leads to the production of a large amount of runoff.

A. Determination of the pre-moisture of the soil:

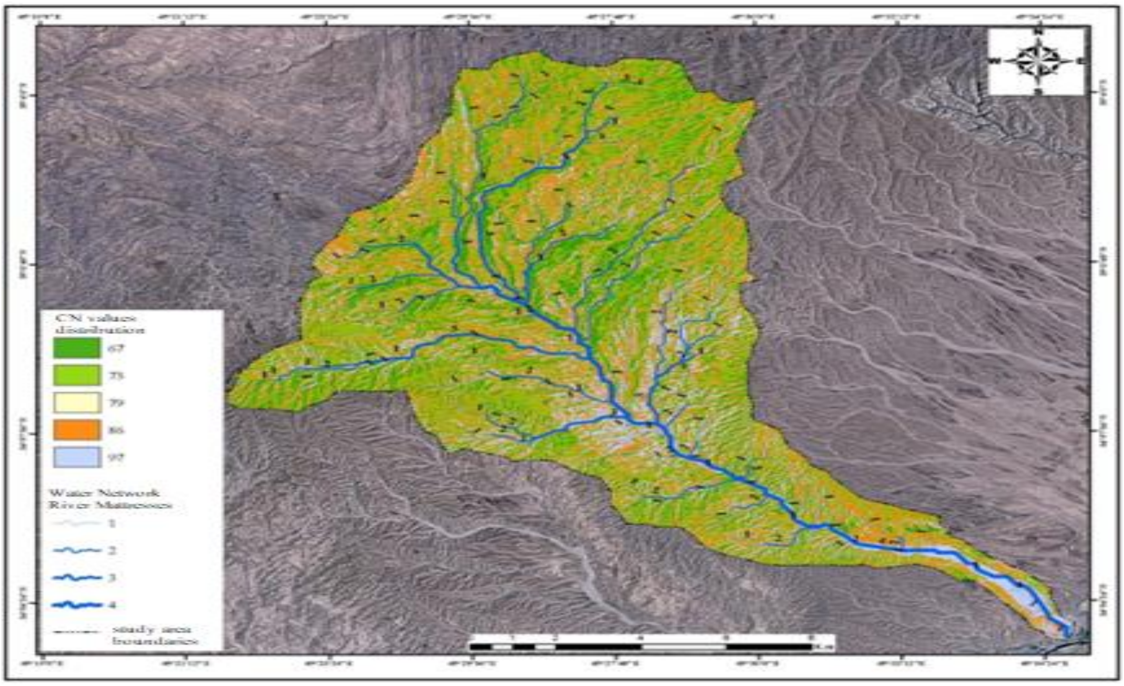
Soil moisture is defined as the normal condition (AMS II) in the study area, and similarly, through the use of the land classification and the hydrological group of the soil, the value of the curve (numerical runoff) (CN), by integrating (combine) for each From the land cover layer (Land use) and Group Hydrologic Soil in (Arc gis10.8) and through the (Union) where (cn) values are given in the form of a numeric column. As shown in Table (4) and Map (3). It is clear from Table (4) that the results are obtained, which are the expressive values of (CN) in the basin of the study area, which are (5) values, ranging between the value (67) for the most water-permeable areas, and the lowest ability to produce surface water runoff and between (97) For areas less permeable to water and with a large capacity to produce surface water runoff, and this in turn has a significant impact on the hydrological side in terms of the ability to generate runoff and the permeability of the soil to water, and therefore there is a great possibility of harvesting the basin water well, and all the values we obtained It is higher than the median value of (50), and this is evidence that reinforces that the surface of the basin generates surface water runoff, as the total rate of the basin reached (80.4) as in the map (4).

Table (4) Distribution of CLACH values (CN) extracted in the study area basins

	Tab curve values / (CN)	Area / km2	%
1	67	15.6	10
2	73	18.8	13
3	79	43.1	29
4	86	63.3	42
5	97	8.6	6
Average	80.4	149.4	100

Source: Researcher based on the output of Arc Gis 10. 8).

B. Coefficient Calculation (S):



Map (4) Distribution of (CN) values in the basin of the study area
Source: the researcher based on the program (Arc GIS10.8).

It shows the values of the coefficient (S) about the ability of the soil to retain water after the start of the surface runoff process, and also describes the condition of the soil saturated with water also after the runoff process, that is, after the process of water infiltration into the soil, and that the thickness of the soil layer that is saturated with water varies according to the type of soil and the extent of its absorption of water during rain fall and therefore the coefficient (S) is closely related to the quality of the soil and its ground cover, which reflects from the values of (CN) (Al-Matiouti, Issa Saleh Abd, 2015: 103).

As the approach of the values of the coefficient (S) to zero reflects the low potential of the soil to retain water on the surface of the stream after the run-off process, which increases the amount of running water. Soils retain water on the surface and therefore the amount of running water is reduced (Soil Conservation Service: 1,2).

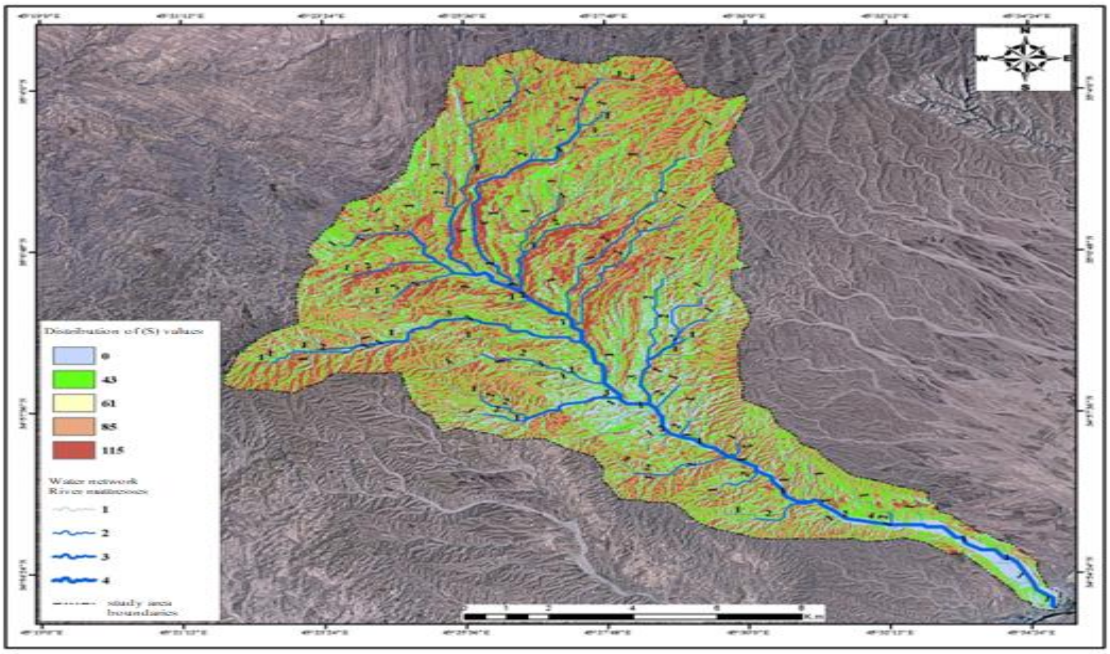
The value of (S) is calculated in the mathematical formula according to the equations (Maidment, David R, 1993: 77), and the value of the parameter (S) was calculated to calculate the flow characteristics in the study area by doing the algebra of maps through the cellular calculator in Spatial analysis tools in Arc Gis10.8, as this process is done by entering the formula of all mathematical equations, and thus we will get the layers (maps) that represent the (S) parameter of the Qalatupzan valley basin and through the observation, table (5) and map (5) It turns out that the values expressing the parameter (S) in the study basin, it reached (5) values, its values ranged between (115-0) mm.

Table (5) Distribution values of (CN) - (La) mm in the basin of the study area

	Maximum retention values (S) mm	**Initial stripping modulus (la) mm**	**The Area is km2**	**%**
1	115	23,8	47.8	32
2	85	17,8	23.8	16
3	61	12,8	15.5	10
4	43	9,2	43.8	29
5	0	0	18.5	12
Total			149.4	100

Source: Researcher based on map (4).

From the hydrological point of view, it indicates that the surface of the soil in the study area is normal, by keeping water on its surface with the presence of weakness, causing a significant rise in the water flows in the surface of the basin.) km 2 of the area of the study basin and a percentage (32%) of the area of the basin, which expresses the value of (67) in the values of (CN), which is followed by the value of (85) at a rate of (16%) of the area of the basin and expressing the value of (72) of the values of (CN), while the rest of the values constitute the remaining percentages (51%).



Map (5) Distribution of (S) values in the study area
Source: Researcher based on (8Arc GIS10.).

C. Calculation of the initial extraction factor (LA) in the aquarium:

It is indicated in this parameter (LA) to determine the amount of water lost before the start of the runoff process by evaporation or by plants intercepting running water or depressions. As well as through the internal leakage of water, which is closely related to the quality of the soil and ground cover, and represents one fifth of the maximum potential value of water retention in the soil after the beginning of the surface runoff of the parameter (S), and the closer its value is to zero, this indicates the low percentage of rain losses before it begins the process of runoff, which increases the speed of generation of surface runoff, but if its value reaches (50.8) mm. It is the median of the coefficient (La), as the initial extraction rate becomes equal to the rate of running surface water, while the amount of rain losses increases, and the volume of surface runoff decreases if the value of (La) rises from (50.8) mm.

The value of the parameter (La) can be calculated through the process of (maps algebra) using the cellular calculator (Raster Calculator) within the tools of spatial analysis (Spatial analyst. Rainfall constituted 32% of the basin area, expressing the values (65-115) for each of (S-CN), respectively, and between the value (zero) and (12%) of the basin area, expressing the values (0.98) , for each of (S-CN) respectively for the areas with the least loss of rainwater before the start of the runoff process, and that all coefficient values are less than the median value of (79) mm and all go towards (0) and this plays a major role from the hydrological point of view in the study basin Because the surface of the basin can generate the highest amounts of runoff.

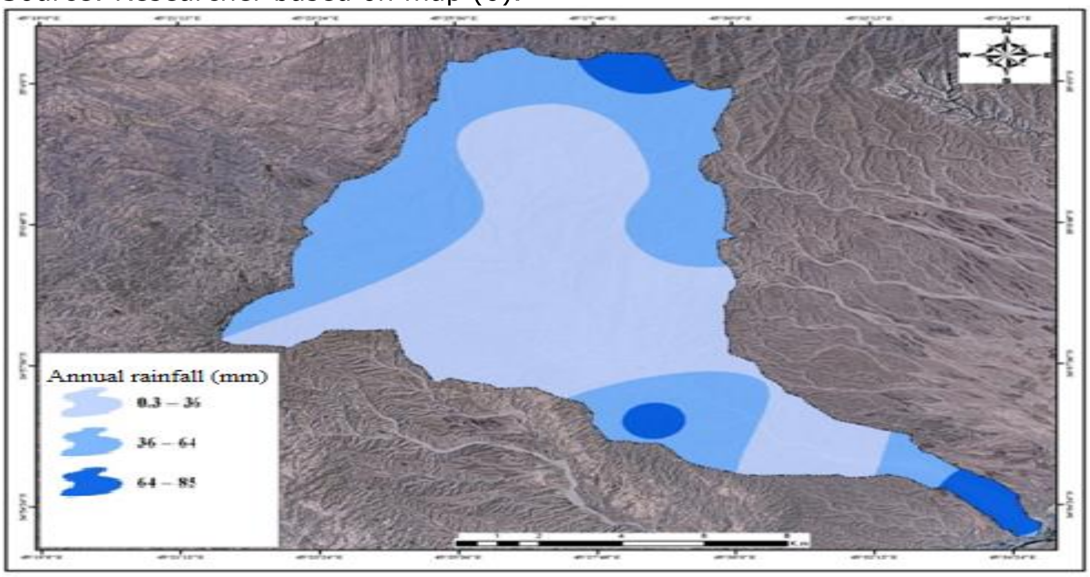
3.1. Layers of depths equal to precipitation in the Qalatupzan valley basin:

Falling rain is the main source of water flow, and its quantity and intensity depend on the extent and scarcity of heavy rainfall. Certainly, the greater the amount of rainfall, the greater the volume of water flow and vice versa when the amount of rain falling. Precipitation is expressed in the standard (P), which is one of the basic elements in the equation that is used to estimate the depth of surface runoff and is symbolized by it (Q). Rain data was used in Khanaqin and Sulaymaniyah stations, as stations adjacent to the study area, as the basin of the study area was covered with equal rain lines. (mm), and the Inverse Distance Weight method was used, which is one of the estimation methods for the rain peak in the unmeasured areas, and spatial statistical analysis was used within the integrated environment of the (ARC GIS 10.8) program to reach the depths of equal rain in the study area. A map of the isotropic lines was obtained, which ranged between (262-300) mm, and at an average of (250) mm, as shown in Table (7) and Map (6), and these values are hydrologically reflected in an important and positive way, as these values indicate that Qalatupzan Valley Basin receives annually large amounts of falling rain, which increases the ability of the basin to generate surface water runoff coinciding with low temperatures, evaporation and winds in the winter season, and this increases the volume of water runoff, and due to the absence of surface runoff losses district, which encourages investment and the development of various sectors.

Table (6) equal depths of rain in the basin of the study area

Minimum depth equal to rain	Max depth equal to rain	Rain equal depth rate
0.3	85	42.7

Source: Researcher based on map (6).



Map (6) Equal Depths of Rain in The Basin of The Study Area
Source: Based on Arc GIS 10.8.

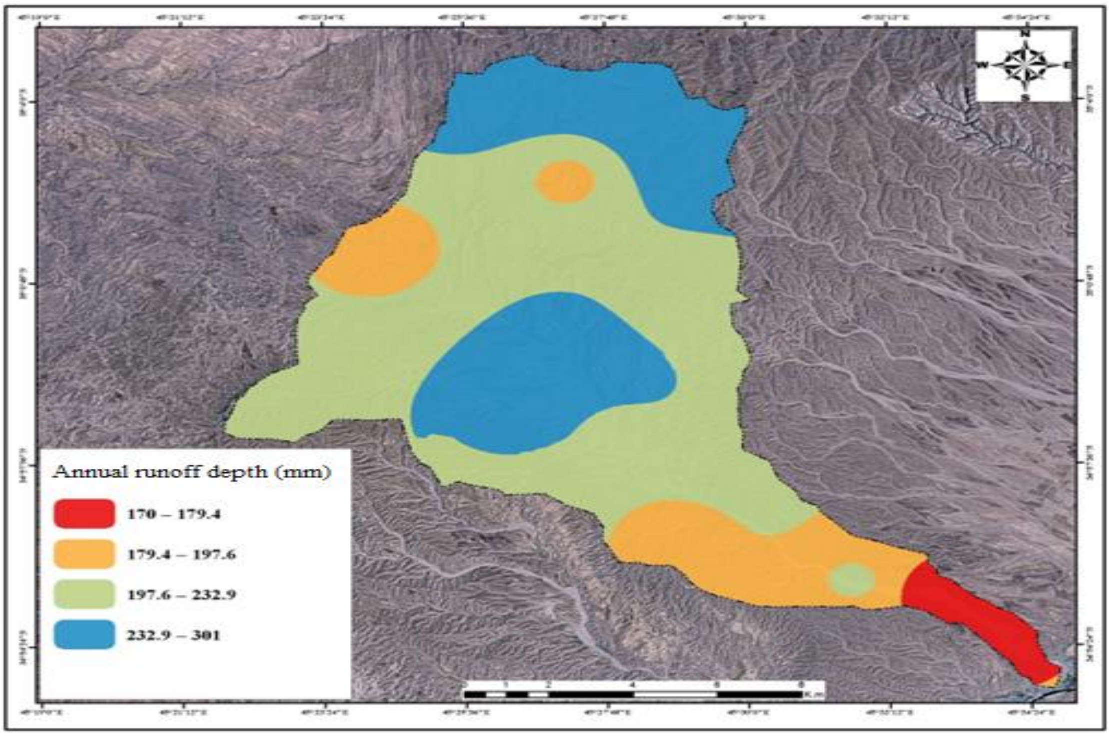
3.2. Estimation of the annual runoff depth (Q) mm in the Qalatupzan valley basin

Runoff Depth expresses the relationship of a particular rain wave with the components of the characteristics of the drainage basin. The depth of runoff varies according to the type of land cover and its permeability.

The depths of the runoff are determined by a period that begins with the rainfall on the surface of the earth and ends when the water pours into the watercourse. The depth of runoff (Q) mm was calculated in the current study of the basin of the study area, depending on the natural data of the basin, including the type of hydrological soil and the type of the land cover, which was expressed in the values of (la-s-cn).

By calculating the annual rate of rainfall in the basin of the study area, we find that the depth of runoff expresses the amount of water that is going on the surface of the earth during the rainstorm away from the area of the collecting basin (Hameed, H.M. 2013: 23). Which made its depth coefficient different from the coefficient of runoff volume (QV), and through what is shown in Table (7) and Map (7) that the values of the depth of surface run-off range between values (170-301) mm.

The average surface runoff in the study basin reached (272.5) mm, and this indicates that most of the rain that falls becomes surface runoff in the basin, and this is reflected positively from the hydrological point of view, as it indicates that the basin has a large capacity and a high potential for the generation of surface runoff. On the surface of the earth, due to rainfall, and therefore, there are enormous collection areas in the study basin that increase the volume of water flow.



Map (7) Depths of annual runoff (mm) in the Qalatupzan Valley Basin
Source: the researcher based on the program (Arc GIS10.8).

Table (7) Annual runoff depths in the Qalatupzan Valley Basin

Annual run-off depth (mm)	**Area / km2**	**%**
170 – 179.4	15.8	11
179.4 – 197.6	36.8	25
197.6 – 232.9	86.4	58
232.9 – 301	10.4	7
Total	149.4	100

Source: Researcher based on map (7).

3.3. Estimation of annual runoff volume (QV) for the Qalatupzan Valley Basin

The annual runoff volume (QV) is about the total runoff of the basin area, which is one of the most important calculations used in many hydrological studies (Hameed, H.M. 2013: 26-27).

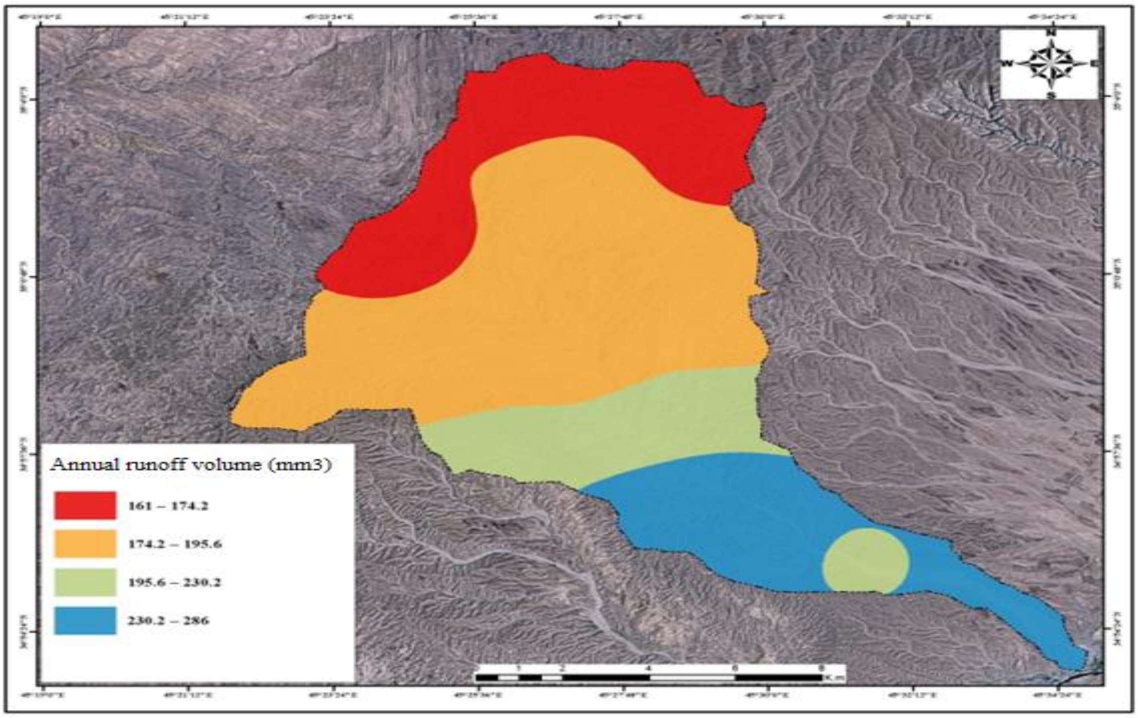
In order to calculate the surface runoff of the basin of the study area, which was calculated within the modern geographical techniques (Gis) in the program (Arc Gis 10.8) using a formula of equations, a map was obtained, which shows the annual runoff volume of the Qalatupzan Valley Basin as shown in Table (8) and map (8).

Table (8) volume of annual runoff (mm3) in the Qalatupzan Basin

Categories	**Volume (m3)**	**%**
161 – 174.2	145563	19
174.2 – 195.6	248858	32
195.6 – 230.2	163665	21
230.2 – 286	209362	27
the total	767448	100

Source: Researcher based on map (7).

The study showed that the total volume of annual runoff amounted to (767448) cubic metres. This indicates that the basin surface has a large productive capacity for runoff. We note the results of calculating the hydrological characteristics that accurately enhance the presence of very large amounts of runoff water in times of rain. This topic has an important role from the hydrological point of view of the study basin, as the results confirm that the basin has a water resource that can be used and invested for various purposes in the study area, including agricultural development and water harvesting.



Map (8) The volume of annual runoff (mm3) in the Qalatubzan Valley Basin
Source: the researcher based on the program (Arc GIS10.8).

Thus, the annual flow of water in the valley is, in the first place, the volume of water that the valley sheds when it falls into its mouth, depending on the amount of precipitation and evaporation, as well as many other factors, which play the period in which the largest amount of precipitation falls. Rain plays a significant role. If the weather is warmer, this will reduce annual runoff and vice versa.

4. Calculation of the estimation of peak flow rate:

1- **Concentration time**: it means the concentration time, which is the time it takes for a drop of water to reach the exit of the furthest part of the basin. The time of concentration in the basin of the study area has reached (8.5 hours).

2- **Calculation of the peak flow time**: the peak time is understood as the period from the beginning of the rain until reaching the peak of the discharge (Rasheed, Anas Mahmoud and Qilimus, Youssef Francis. 2004: 45, 58), as the peak time in the study basin was 0.094 hour).

3- **Peak runoff calculation**: It means the peak runoff, which is the largest amount of drainage expected from the basin during a rainstorm. The peak of the peak often occurs before the middle of the storm's time period (Khalifa Abd al-Hafiz. 2006: 121). There is a relationship between the volume of drainage and the area of the basin, as well as the length of the stream and its slope, and the height of the peak of the drainage is related to these factors and is affected by them in terms of its height and low. The value of surface runoff expresses the volume of water that is discharged at the end of the basin. The maximum surface runoff flow of the basin of the study area was (193) m 3 seconds, and the peak runoff flow was obtained by applying statistical equations and it has great hydrological importance in harvesting water from the basin and using it in the various development areas in the region.

A. Increased risk of floods and floods:

Floods and heavy rains occur when the land is unable to absorb heavy rainwater, or the ability of rivers and waterways to drain it, and this is related, and this is related to, among other things, most notably (Al-Wadai, Idris Ali Salman, 2014: 2) and as follows:

1. Precipitation amounts, intensity and continuity of precipitation.
2. Soil type, texture and porosity, which vary according to the soil type.
3. Feeding area and shape of water troughs.
4. The degree of surface slope and the nature of the vegetation cover.
5. Density and quality of vegetation cover.
6. Human activities and their effects in the region.

The dangers of flash floods are related to the occurrence of very severe rainstorms that lead to the flow of large amounts of running water on the surface, and that the water moves according to the gradient factor from one place to another.

It can reach large quantities to places whose natural features may not contribute to generating large surface runoff, leaving behind unexpected damage and great loss of life and property, especially in the absence of means to control floods, as happened in the flood of Qalatupzan Valley (2020).

It is difficult to predict the phenomenon of heavy rain or floods in dry and semi-arid areas because it is linked to the interruption of precipitation and the size of its depth, given that heavy rains are a phenomenon that humans cannot control when they occur. And the extent of its intensity should not be a reason to deepen its effect by changing its natural characteristics in the environment (Al-Nafi'i, Haifa Muhammad, 2010: 1421). A limited time, but most floods usually occur in the second half of winter or in the spring months. These periods are characterized by the concentration of rain, as well as soil saturation during the first period of winter, as well as surface runoff that contributes to soil erosion and the transfer of rock and stone fragments, which increases Erosion of rocks, as well as precipitation in the northern region of the study area, where most of them fell within months (January, February, March), and the largest floods occurred in Qalatupzan Valley, which led to a large flood with great material losses.

The topographical variation of the surface of the study area reaches a minimum of (304) meters above sea level and (1150) meters above sea level, and it reflects the asymmetry in the role and effectiveness of floods in the region. The hills, depressions, and between Qalatupzan Valley and its low course, and these manifestations were reflected in the dangers of torrential rains and torrential rains that were reflected on agricultural lands, which led to the transfer of some sand, soil and gravel from their sites due to water erosion, in the valley of Qalatupzan, and at its natural levels, the water flooded large areas of agricultural land. The rainwater transfers soil and gravel from one place to another, as well as eroding the rocks and dissolving part of them. They are as follows (walling, D. E. 2008: 21):

1. Soil erosion: As it descends, rainwater sweeps away gravel, sand and dust from high areas and carries them to low areas, which causes a change in the shape of the land.
2. Fragmentation of rocks: When rainwater runs into cracks in the rocks and its temperature drops to zero or less, it freezes and increases in size, and puts pressure on the rocks, causing the rocks to break and crumble.
3. Stalactites and stalagmites: They are beautiful rock forms that occur in wet caves as a result of calcium carbonate deposition. The stalagmites are formed when calcium carbonate is deposited in the floor of the cave forming the rising columns, and stalactites are formed when calcium carbonate is deposited in the ceiling of the cave.
4. Caves and fissures: When rain falls, part of the rainwater seeps into the groundwater, and during its leakage, it dissolves part of these rocks, creating gaps, caves and cracks in it.

The variation of vegetation cover on the surface of the earth with the wrong cultivation and overgrazing led to the discovery of large areas of the land and became subject to water and wind erosion, as in the study area.

It is clear from the above that there are risks of soil erosion and erosion as a result of the seriousness of this matter, as well as the effectiveness of natural factors in the basin of the study area, the occurrence of large material losses in agricultural lands, the deterioration of large areas of agricultural land, cutting and removing trees and overgrazing, for example, that leads to the decline of vegetation cover and soil survival. Bare in front of direct sunlight and rain, making the soil of the lands vulnerable to erosion and erosion factors because of the intensity of the runoff and the slope of the surface of the region, and its role in decreasing the fertility of the soil and its production. Rich in nutrients for plant growth, which is negatively reflected in the fertility of the soil, and these factors prepare the surface of the earth to absorb the analysis of rain water or obstruct it or multiply the frictional force of rain when it collides with the ground, which leads to an increase in the intensity of rainwater drainage, and thus the occurrence of sudden floods in Qalatupzan Valley, therefore, necessary measures and scientific measures must be taken to prevent the aggravation of this phenomenon in the region.

B. Hydrological Hazards:

In order to highlight the environmental risks in the Qalatupzan Valley Basin and to clarify their degrees, a map of these risks has been drawn according to the following steps:

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1. A matching process was carried out for the map producing the sensitive environmental elements, then their weights were collected and recorded within the squares into which the base map of each basin was divided. That is, all the weight degrees of the symmetrical squares separately and for all parts of the basin. And as in Table (9).

Table (9) Area and percentage of hydrological hazards in study area

Hydrological Hazard	**Area km2**	**%**
very dangerous	40.9	27
moderate risk	56.7	38
low risk	51.8	35
the total	149.4	100

Source: Researcher based on the map (9).

2. Surrounding the squares with totals confined within one taxonomic category in order to sort the categories from each other to prepare a map equal to the special values of the degrees of environmental risks in the basin.
3. Removing the boxes and inserting the final map into the calculator for engineering improvements to obtain the final design of the environmental hazards map in the basin.

a) To show the hydrological hazards in the basin of the Qalatupzan valley and to clarify their degrees, a map of the hydrological hazards was designed according to the following steps:

b) A classification of the values of the natural variables that greatly affect the hydrological risks, their identification, conformity and distribution over the study area, and limiting their values to totals based on the value of their presence or absence.

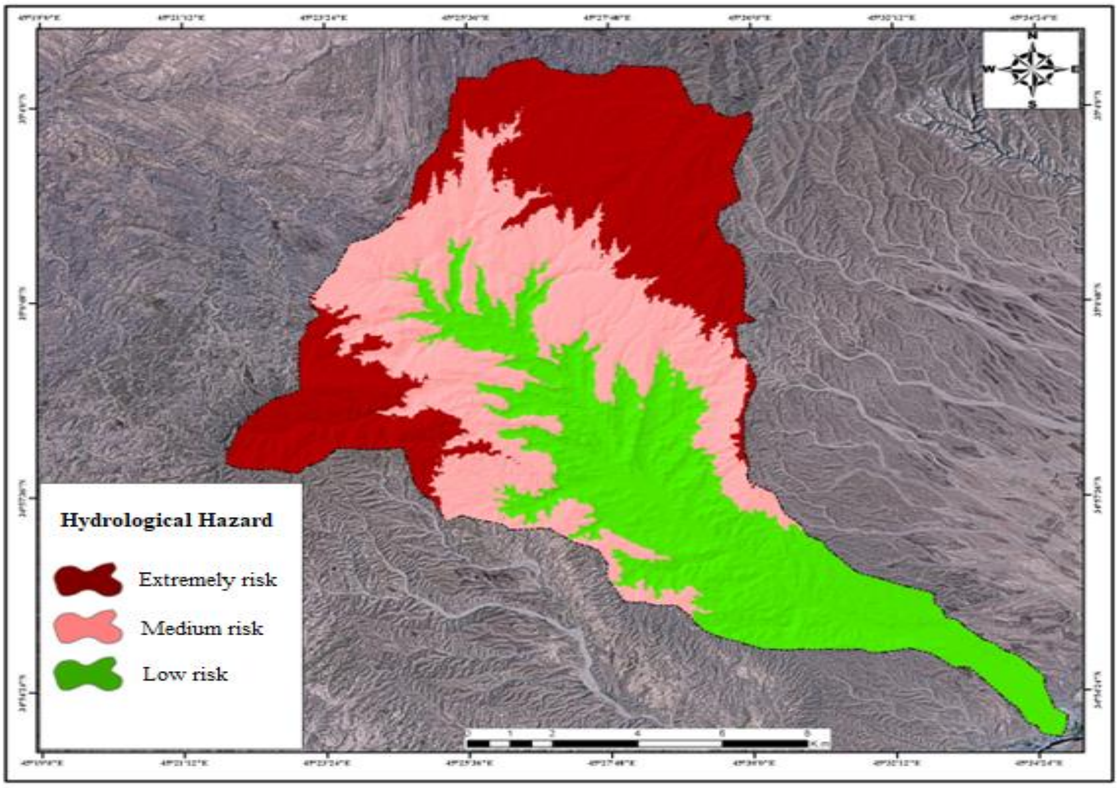
c) A classification of the values of human variables affecting hydrological hazards, their identification, matching and distribution over the study area, and limiting their values to totals based on the value of their presence or absence.

d) After determining the impact of the variables on the degrees of risk, we work to match the totals of the variables in a layered manner to identify the places most affected by these variables and count the high-risk places, and so on for the rest of the risk degrees.

1. A set of maps representing the types of hydrological risks were compiled, and a final map was produced, which included the levels of risks in the region, as it came with three levels of risk:
2. Low-risk areas, which include lands in the areas of ancient accumulating plains and floodplains, with flat lands.
3. Medium-risk areas, represented by the lands of the river flood plain, and the medium-sloping areas.
4. High-risk areas, including hills, highlands, and Badlands.

C. Interpretation of the Hydrological Hazard Map:

It turns out that the numbers of this map are a set of layers, and each layer represents an influential danger in the erosion of agricultural or non-agricultural soils in the study area. As for the hydrological risks that result from unplanned land use patterns that lead to stopping future development due to the operations practiced by farmers, farmers and government agencies that do not follow well-studied development programs, this leads to pressure on the soil (Al-Mawla, Muhammad Fathi Muhammad, 2008: 132-133). The analysis focuses on studying the negative effects of the expected hydrological risks in the region to address and reduce them to the maximum extent possible, in determining the lands that are being developed in the future.



Map (9) of hydrologic hazards in the Qalatubzan valley basin
Source: Based on the water network, slope, and soil map (DEM).

It is clear through the map (9) many layers (layers) of the study area, which were merged and analysed, and included (water network, surface elevation, vegetation cover deterioration, soil) to obtain a final model, showing the hydrological risks, as follows:

High-risk lands: It formed an area of (40.9) km2, out of the area of the study area amounting to (149.4) km2, with a percentage of (27%) and it is located at the mountainous heights, and at the slopes of the steep heights, and the elevation factor appears on it clearly because of its surface and its steep slopes, and among the most important variables that It identified this type of risk as (water erosion, steep slope, floods and their severity and torrential rain), and its soil is subject to continuous erosion, which leads to shallow thickness and lack of organic matter, which causes the emergence of grooves and edges, making it difficult to invest in the field of agriculture, in addition to its low density of vegetation cover, so These lands are not suitable for agricultural use, as they are suitable as grazing areas, as they are grazing lands that have the ability to support a good load of livestock, especially sheep and goats.

Medium-risk lands: It formed an area of (56.7) km2, or 38%, and occupied the largest area in the Qalatupzan Valley Basin, and this means that it acquired the lands of the slopes and the fronts of the mountains. The abundance of its groundwater and moderate salinity, and the soil of these lands is formed from slopes, and most of the time the soil of these lands is exposed to floods in wet years, which leads to the continuous renewal of its soil, which is characterized by good drainage and deep thickness and consists of (mud and alluvial deposits) and of large thickness Because it developed from original soil, adding to its soil transferred from the surrounding heights and due to the acceleration of erosion processes and its activity, and it contains good organic matter in its soil.

Low-risk lands: It formed an area of (51.8) km2, i.e. (35%) of the basin area, and it includes the old agglomeration and flood plains unit, as these lands are characterized by their suitability for agricultural use, in addition to their flat surface and medium slope, and their soil with good drainage and deep thickness and consisting of (sediments). Clay, alluvial and sandy) and with a large thickness because it developed from original soils with the addition of soil transferred from the surrounding heights and due to the acceleration and activity of water erosion processes.

5. Conclusions:

1. The topographical characteristics were reflected in the formation of the valley's streams, which was reflected in the agricultural lands and their development.
2. Most of the valleys start from the northern and north-eastern slopes, following the general slope of the area towards the Diyala River, south of the study area basin.
3. According to (Zink) classification, about (52.4 km2) of the basin area is (35.1%), with a slope of more than (8) degrees, and this poses a risk of exacerbating the occurrence of floods and torrential rains.
4. There is a close and reciprocal relationship between soil and water resources, as the soil works to nourish the basins of water resources in the study area, and the fact that the study area is characterized by the diversity of the soil that it consists of, which has an impact on irrigation projects.
5. Relying on empirical methods, especially the model (SCS-CN) and formal equations, to arrive at calculating the hydrological characteristics of watersheds in the absence of hydrometric measurement stations because of their hydrological repercussions associated with the movement of surface waters.

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