Tikrit Journal of Pure Science 23 (9) 2018

ISSN: 1813 – 1662 (Print)
E-ISSN: 2415 – 1726 (On Line)

TJPS

TIKRIT JOURNAL OF PURE SCIENCE

Journal Homepage: http://main.tu-jo.com/ojs/index.php/TJPS/index

Estimation of Annual Water Income Using (SCS-CN) Method based RS-GIS for Wadi Abu Khashab Watershed-North of Iraq

Asal Hassan Mahmood Al Jubouri[1], Sabbar Abdullah Saleh Al Qaisy[1], Yassen Ali Saleh Al Qaisy[2]

[1] *Department of Applied Geology, Collage of Science, University of Tikrit, Tikrit, Iraq*

[2] *Department of Civil Engineering, Collage of Engineering, University of Tikrit, Tikrit, Iraq*

ARTICLE INFO.

Article history:

-Received: / / 2017

-Accepted: / / 2017

-Available online: / / 2018

Keywords: Annual Water Income, (SCS-CN) Method, Curve Number (CN), Land Cover, Hydrologic Soil Groups (HSG), Surface runoff.

Corresponding Author:

Name: Sabbar Abdullah Saleh

E-mail: sabbar.saleh@tu.edu.iq

Tel:

Abstract

The Annual Water income for Wadi Abu Khashab watershed estimated as about(47.416 km^2) by employing a set of software (ArcGIS, Erdas Imagine) using the US Soil Conservation Method (SCS-CN) and four different methods resulting in an average annual water flow rate of the four Techniques were (7,049,316 m^3), based on the spatial data of the satellite (Landsat-8) with spatial accuracy (30) meters and for bands (7,5,3) respectively, which is dated (5-2-2016) for two methods, while two methods are based on the geological background based on the geological map, this is the first time that the four methods have been used together in one search to ensure accurate and scientific results, the soil cover was classified and the nature of its uses, the soil hydrology and the identification of its varieties, the quantities of Rainfall, and the determination of the Curve Numbers (CN).

Introduction

Surface Runoff is one of the most important component in the water resources and sources of water for streams, lakes and ponds in arid and semi-arid environments. Estimation of quantity is important for any proposed hydraulic construction in the region. Decision makers must follow mathematical formulas and solutions related to runoff estimation and its other characteristics. It is also important to know and calculate the amount of runoff available for investment and use for water harvesting in our current study, whether this quantity is sufficient for the three proposed reservoirs or a part of it, then estimating the water income is necessary so different techniques and methodologies have been used in this study to estimate the water revenue of the reservoir under study, which will contribute to storage in the proposed dams reservoirs.

The study area is located in the south-eastern part of Salah Al-Din governorate and the south-western part of Kirkuk governorate, about 70 km south-east of Tikrit city. The coordinates of Abu-Khashab dam proposed in UTM are (439395) and (3834251) meters West and (439719) and (3834072) meters East, and extends the study area in addition to the reservoir area of the dam body to include the proposed dam locations and reservoirs and longitudinal sections and cross sections of these reservoirs and covered by the study Within the coordinates of the above-mentioned, the following figure (1) shows Abu-Khashab reservoir dam proposed location.

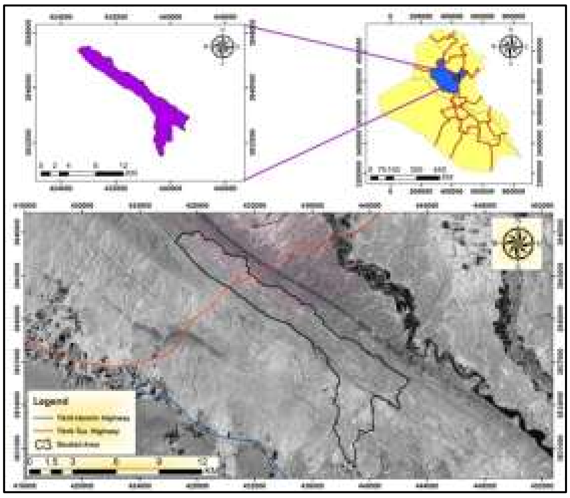

Figure (1) Location of study area

Geology of the Study Area

The geology of the area is characterized with a thick sedimentary cover of Sandstone, Limestone, Claystone, Marl, Siltstone, and Gypsum [1], The exposed formations at the location of the dam and the water reservoir are Mukdadiya, Injana and Fatha, in addition to the Quaternary Deposits of Pleistocene (the deposits of the Alluvial fan) which are from the Middle Miocene to the Recent [2], Figure (2). the formations of the reservoir are described as in the following, from oldest to youngest.

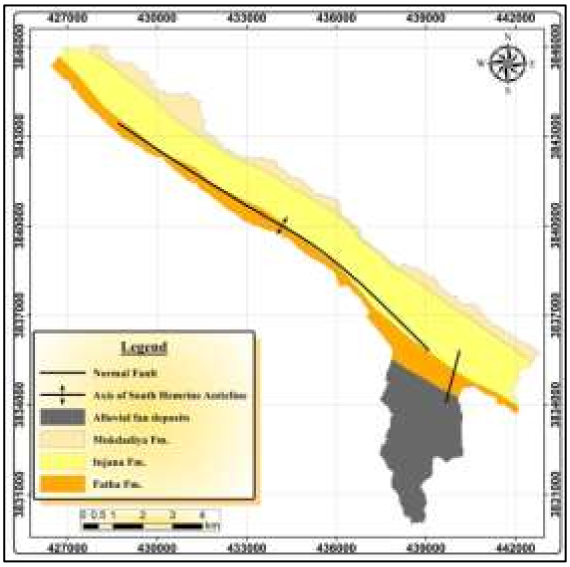

Figure (2) Geological map of study area (modified from Al Barwary and Slaiwa, 1991)

Fatha Formation (Middle Miocene)

This Formation is exposed in the middle part of the reservoir along the longitudinal section of the reservoir.

It is one of the most economically important formations widely outcrop in Iraq. It was renamed in Iraq in the name of the Fatha Formation using an ideal section at Al-Fatha, 10 km north of Baiji city, Within the southeastern plunge of the Makhoul fold [3]. The thickness of this Formation is in the ideal location in the area of Al-Fatha (268) meters, The large changes in the thickness of the composition, the fossilized fossils and the rocky loads indicate that the sedimentary environment of Fatha Formation is shallow marine environment (lagoon) [4].

This configuration is divided into two members:

Upper Fatha

This member is exposed within the study area in the middle part of the reservoir and along the rectangular reservoir section. It consists of Limestone, Red Claystone, Siltstone, Gypsum, Sandstone [1].

Lower Fatha

This member is not exposed within the study area. It consists of the Marl, Limestone and Gypsum rocks and the thickness of these rocks is variable in sedimentary cycles [1].

Injana Formation (Upper Miocene)

This Formation is exposed in the upper part of the reservoir over lained by Mukdadiya Formation under lained by Fatha and along the section of the rectangular reservoir.

This formation consists of Sandstone, Claystone and Gypsum, In the sedimentary cycles, the thickness of the rocks is altered by subsequent erosion on the main folds [1], in addition to containing These rocks on the lenses of Silt and Sand of different thickness, the upper contact limit is conformable with Mukdadiya Fm. while the bottom boundary is conformable with the formation of Fatha [1].The sedimentation environment of this formation is It is a river environment in the upper part, and the lower part of it is a marine environment [3].

Mukdadiya Formation (Late Pliocene)

The Rocky Expositions of this Formation appear at the top of the and along the longitudinal reservoir section. The age of the formation is Late Pliocene and is deposited in a fluvial environment consisting of soft, coarse gravel and gravely sandstone sequential with sandstone, mudstone and siltstone [1].

The formation Characterized by the presence of sedimentary structures, cross-bedded, and clay balls. The lower contact seam is conformable gradational marked by appearance of gravely sandstone with Injana Formation, while the upper border is gradual with Bai-Hassan formation.

Quaternary Deposits (Alluvial fan)

These sediments cover some area from the studied area, deposits of the pleistocene which are composed of gravels, sand, loam [1].

As a result of the sedimentation of the seasonal valleys because of extreme change in the slope and is related to some of them as foot plains around the Hamrin Hills series [5]. These sediments are poorly cemented leading to the creation of an appropriate layer for the percolation of water into groundwater aquifers. The sediment deposits of these clusters were divided into four facies [1], clayey gravel, sandy gravel, clayey sandy gravel, sandy gravel. The thickness of these sediments ranged from a few centimeters to several meters depending on their deposition locations and the geological status of the area fitted and the morphological body comprising them [6].

(SCS-CN) Features

This method is known as the US Soil Conservation Service (SCS), also known as the Curve Number (CN) method, which was designed by the Department of Soil Conservation of the United States Department of Agriculture (1970) and developed in (1986) [7], Medium Complexity method [8]. It is known as SCS-CN.

The steps of this method are a series of mathematical equations that depend on the availability of information on the land cover and the nature of land uses, the soil hydrological conditions and the identification of its varieties, and the quantities of rain falling. All these variables are expressed by a number called curve number (CN) that used for the purpose of estimating runoff.

The main reasons for the success and widespread use of this method are that they represent many factors including soil type, land use and treatment, surface state, and previous moisture state, and their integration

ISSN: 1813 – 1662 (Print)
E-ISSN: 2415 – 1726 (On Line)

into a single curved number (CN). In addition, it is the only methodology that is readily available for well-documented environmental inputs [9].

The SCS-CN method requires several steps, procedures and mathematical equations to obtain accurate estimates of the surface water flow of the study area. The mathematical equations adopted are (USDA, 1986) [7] as follows:

$$S = 25400/CN - 254 \quad \dots\; 1$$

S= Potential Maximum Retention After Runoff (mm)

$$Ia = 0.2\, S \quad \dots\; 2$$

Ia= Initial abstraction Before Surface Runoff by Soils Reception by plant and evaporation (mm)

$$D = (P-Ia)^2 / ((P-Ia)+S) \quad \dots\; 3$$

D = The depth of the surface flow (mm), which is symbolized in many literature with the symbol (Q) and was replaced in this study to distinguish between the depth of runoff and discharge, which is also symbolized by the symbol (Q).

P = Rainfall (mm), there is no a rain gauge in the watershed, rain data were adopted from the nearby stations around (Tikrit, Baiji, Tuz and Kirkuk) for the period (1975-2011) were based on equipotential line map [10] the depth of rain = (222 mm).

$$V = (D*A)/1000 \quad \dots\; 4$$

V= Surface runoff volume (m^3)

A= Area (m^2)

Before applying the SCS-CN method, the following paragraphs should be created and identified:

Land Cover Classification

This class deals with identifying and clarifying the types of land cover within the study area. satellite data (Landsat-8) was processed and used (30) meters and the bands (3,5,7) respectively, which are dated at (5-2-2016). In the current study, the Unsupervised Classification was adopted for two of the methods used to calculate water revenues using remote sensing techniques, while two methods were adopted on the geological background based on the geological map. This classification is not based on prior information on spectral groups field studies are needed in advance but are done select the number of items based on the type of spectral characteristics which are common in the visual, which is different depending on the digital data of the visual, and then identify the identity of each type of land cover based on comparison with land cover maps or land use maps or through the subsequent field calibration and using the program (ERDAS IMAGINE 2014). Five types of ground cover by remote sensing methods were observed and marked as follows:

Desert Shrubs (Clastic Mukdadiya)

This taxonomic category represents the land containing the shrubs, plants and desert plants of seasonal and seasonal species, which depend on their growth on the low rainfall due to the difficult environmental conditions, and their spread was observed mostly in the study area within the outcrops of the formation of Mukdadiya in the north-east. Area of this category according to the modern classification (1.68 km^2) which represents (3.55%) from the total study area. The total area according to the traditional classification is (8.68 km^2) which represents (18.32%) of the total area.

Vegetated Lands

This category includes seasonal and seasonal species grasses, which include weeds and short and low-growth plants that grow under poor hydrological conditions. Their spread has been widely observed in the areas of Alluvial fans, especially with the extension of waterways and lowlands. Area of this category According to the modern classification (7.45 km^2) or (15.71%) from the total study area, while the total area according to the traditional classification was (14.4 km^2) it represents (30.35%) of the total area.

Exposed Lands (Out Crops of Fatha Fm.)

Including the rocky and hard rock and unused land because it is not fit for agricultural use because of its hardness, which includes rock reservoirs of the anticline folds and convex highlands that are exposed to erosion, so it was observed high rate with the extension of the area surveyed and high within the study area, which corresponds to the formation of Fatha, The new classification was (2.22 km^2) it represents (4.68%) of the total study area, while its area was according to the traditional classification (7.59 km^2) it represents (16.1%) of the total area.

Bare Lands (Fallow)

This classification category represents the land covered by the remains of plants and crops after the end of the season of growth or cultivation and harvest, and is concentrated in most areas of the study area in conjunction with other varieties, the area according to the modern classification (15.78 km^2) or (33.28%) from the study area, while its area was according to the traditional classification (10.18 km^2) it represents (21.46%) of the total study area.

Others

This category includes a herbaceous mix of low-growth grass brush and short grasses that different from the other four varieties and are interfere with each other. Therefore, it is observed that it spread in a scattered and random manner within the study area. The area of this variety was according to the modern classification (20.29 km^2) or (42.78%) from the study area, while according to the traditional classification (6.57 km^2) it represents (13.86%) of the total area.

ISSN: 1813 – 1662 (Print)
E-ISSN: 2415 – 1726 (On Line)

Table (1) Land Cover Classification

Class	Modern classification		Traditional Classification	
	Area (km^2)	Percentage (%)	Area (km^2)	Percentage (%)
Desert Shrubs (Clastic Mukdadiya)	1.68	3.55	8.69	18.32
Vegetated Lands	7.45	15.71	14.4	30.35
Exposed Lands (Out Crops of Fatha Fm.)	2.22	4.68	7.59	16.1
Bare Lands (Fallow)	15.78	33.28	10.18	21.46
Others	20.29	42.78	6.58	13.86

Hydrologic Soil Groups (HSG)

The soil was classified by the US Soil Conservation Administration (SCS) into four Hydrological Soil Groups (HSG) based on the rate at which water is transferred and filtered, thus detecting the impact of soil texture on the formation of water flow [11], all the types of hydrological soils are distributed within the study area, and the soil groups (A, B, C, D) each have special characteristics of surface runoff [12], The geological background has been considered in this classification, Table (2), (3):-

Table (2) Soil according to their hydrological characteristics according to (SCS) method

Hydrologic Soil Groups	Soil type
A	A deep sand layer with a high filtering ratio with very little clay and silt
B	Sand layer deep to medium depth with average filtration rate after soil saturation
C	Mud layer with depth of submerged filtration rate before soil reaches saturation state
D	Mud layer with a high swelling rate with a shallow layer of soft silt soil near the surface

Table (3) Area and Percentage of Hydrologic Soil Groups for the study area.

Hydrologic Soil Groups	Area (km^2)	Percentage (%)
A	6.23	13.14
B	23.37	49.29
C	9.13	19.25
D	8.69	18.32

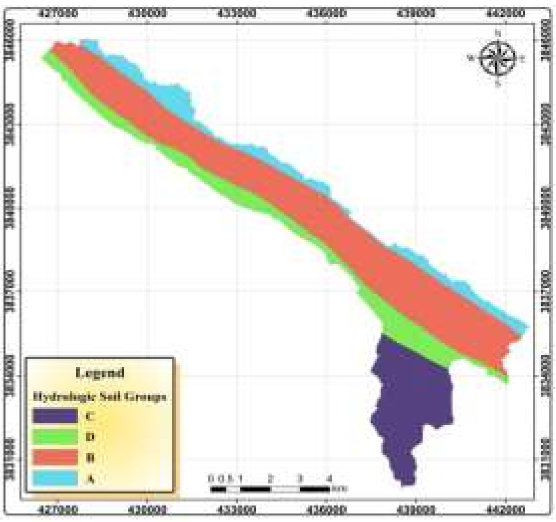

Figure (3) Hydrologic Soil Groups for the study area according to the stratigraphic background.

Curve Numbers (CN)

They are values that Reflect the extent to which the surfaces can absorb and penetrate the water or Surface Runoff, depending on the state of the soil cover and hydrological soil and their conditions, The high (CN) values indicate the high- impermeable surfaces that have the potential to generate high surface runoff, while the low (CN) values indicate the low-impact or non-solid surfaces that have a low surface-flow potential.

According to the AMC-II (SCS), the values of (CN) were found to be in the range of (0-100) [7], as shown Table (4), and the high and close values of (100) indicate the most solid surfaces, while values close to (0) indicates the non-solid surfaces that allow the passage of high amounts of water through the soil, and between the two is the average value (50) Which reflect the medium permeability surfaces and impermeable surfaces so that the Surface runoff rates are equal with filtration rates.

Table (4) The values of Curve Numbers (CN) corresponding to the soil cover and the Hydrologic Soil Groups according to the (SCS) method, which appeared in the study area.

Cover Description		Curve Numbers for Hydrologic Soil Groups			
Cover type	Hydrologic condition	A	B	C	D
Herbaceous-mixture of grass, weeds, and low-growing brush, with brush the minor element (Exposed, Vegetated, Others)	Poor	–	80	87	93
	Fair	–	71	81	89
	Good	–	62	74	85
Desert shrub	Fair	55	72	81	86
Bare Lands (Fallow)	Poor	76	85	90	93

Calculation of coefficient (S)

Coefficient (S) refers to the maximum potential for soil to hold or hold water after surface runoff [13]. It describes the condition of the fully saturated soil with water after the start of surface runoff after the leakage or filtration process has stopped. The thickness of the layer of soil saturated with water varies depending on the type of soil and its ability to absorb water during the period of rainfall, and it can be emphasized that this coefficient is directly related to the soil type and type of land use.

The high value of the coefficient (S) reflects the high soil ability to retain water and thus the decrease in the amount of surface water runoff, while the low and close value of zero reflects the low soil capacity to retain water resulting in an increase in the amount of surface water runoff. Calculate (S) value in all the techniques used to calculate surface runoff according to the mathematical equation No. (1) according to [7] that mentioned above.

Calculation of coefficient (Ia)

The initial abstraction coefficient reflects the amount of rainwater loss before surface runoff by evaporation, rainwater contamination by plants, water collected in surface depressions, or through leakage and filtration, representing 1/5 of the (S) value [7]. The value of (Ia) was calculated using all the techniques used to calculate surface runoff according to the mathematical equation (2) according to [7] that mentioned above.

The low value of (Ia) factor indicates the decrease of rainwater loss before start surface runoff which helps to accelerate surface runoff, while the high value of (Ia) factor indicates the loss of high amounts of rain resulting in a decrease in the amount of flow water on the surface, while (Ia) and the average of surface runoff are equal if the mean value of the coefficient (Ia) was (50.8 mm) [7].

Calculation depth of the surface flow (D)

Depth of the surface flow refers to the summary of the interaction between a particular rain wave with the components and characteristics of the discharge basin, the difference in the type of ground cover and the amount of permeability of soil results in a difference in the depth of the surface flow formed on its surface. In such cases, Curve Numbers (CN) are the variable and controllable element of the depth variation of surface runoff between the basin parts. The depth of the surface flow (D) is calculated according to the mathematical equation (3) according to [7] that mentioned above.

Calculation of surface runoff volume (V)

Surface runoff volume is the total flow of the runoff to the basin area, it is considered an important hydrological calculation for many hydrological studies, specially dam locations, their optimum location and effectiveness, and identification of the most vulnerable locations. The surface runoff volume (V) is calculated according to the mathematical equation (4) according to [7] that mentioned above.

Techniques used to apply (SCS-CN) method to calculation of annual water revenues

The Techniques, methods and methodologies Multiple and varied which was used to calculate the annual water revenues by applying the US Soil Conservation Service (SCS). Five methods were studied and analyzed, one of these methods was ignored, in which the study area was considered to be homogenous and the results showed high abnormalities from the other four methods, which were convergent results because they don't take the quantities of water vaporized and filtered in the soil into account within the equations and therefore neglected and not included in the practical products, while using four methods resulted convergent values, as explained statement results in detail: -

Assuming (CN) values depending on the stratigraphic background

This method was considered each formation of the four geological formations (Mukdadiya, Injana, Fatha, Quaternary Deposits) which constitute the study area is a homogeneous formation in terms of hydrological conditions, soil cover and type of hydrological soil, the values of the curve numbers (CN) were determined for each geological formation by dependence and deriving from the scale table (4) (SCS-CN) [7] as shown in Table (5):

Table (5) (CN) values stratigraphic background for (SCS-CN) method.

Geological formation	(CN) values	Area (m^2)	Percentage (%)
Mukdadiya Fm.	55	6,228,908	13.14
Injana Fm.	71	23,370,416	49.29
Fatha Fm.	93	8,687,725	18.32
Alluvial fan	81	9,128,951	19.25

After the determination of (CN) values for each geological formation, the mathematical equations of the (SCS-CN) method were then applied in a sequential and gradual manner to calculate the volume of water surface runoff (V) for each geological formation, after calculated the coefficients of (S), (Ia), (D), and (V) for each geological formation based on equations (1), (2), (3), (4) according to [7], as shown in Table (6).

Table (6) the coefficients of (S), (Ia), (D), and (V) of geological formations were evaluated by (USDA, 1986).

Geological formation	Coefficient of (S)	Coefficient of (Ia)	Coefficient of (D)	surface runoff Volume (V)
Mukdadiya Fm.	208	41.6	84	523,228
Injana Fm.	104	21	132	3,084895
Fatha Fm.	19	4	201	1,746233
Alluvial fan	60	12	163	1,488019

Thus, the total surface runoff volume in (m^3) of the four Geological Formations in this method is equal to (6,842,375 m^3).

Weighted Curve Number (CN_w)

The value of the weighted curve number expresses the mean rate of all the constituent parts of the total basin [14]. In this method, we find the value of the weighted curve number (CNw) of the water basin consisting of four geological formations each of which has a predetermined curve number (CN), depending on the following equation:

$$CNw = \frac{\sum CNi \times AREAi}{\sum Area}$$

Where (i) = 1,2,3,4….

$$CNw = \frac{CN1 \times Area1 + CN2 \times Area2 + CN3 \times Area3 + CN4 \times Area4}{Total\ Area}$$

After compensation (CN) values for each geological formation with the area occupied in the previous equation and make the calculations, we find the value of the weighted curve number (CNw) is (75), then we found and calculated coefficients of (S, Ia, D) and then calculate the surface runoff volume in (m^3) as follows:

$S = 25400/75 - 254$ …..…. 1

$S = 84.7$ mm

$Ia = 0.2 \times 84.7$ …..……. 2

$Ia = 16.94$ mm

$D = (222-16.94)^2/((222-16.94)+84.7)$ …. 3

$D = 145.12$ mm

$V= (145.12*47416000)/1000$

Surface runoff volume (V) according to this method = (6,881,010 m^3).

The Unsupervised Classification method mentioned in (Goetz, 1990)

This method is based on the computer in the classification of the visual and the identification of its varieties, as it was determined (5) categories based on the visual classification within the region and the processing and use of data satellite for (Landsat-8) accurately spatial resolution (30) meters and bands (7,5,3) respectively and captured on (5-2-2016) According to the classification rule (number of class × 2 + 1) [15], since the higher number of class according to the above rule is due to the fear of the presence of interstitial categories that do not appear if they were give fewer categories and then manually merge them later.

The resulting varieties were distinguished in different colors, Vegetated Lands with green, Clastic Mukdadiya in gray, Exposed Lands in red, Bare Lands in blue, Others in yellow, as shown in Figure (4).

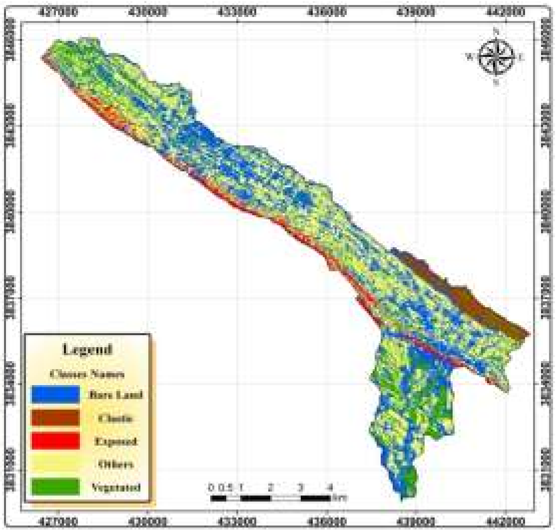

Figure (4) Unsupervised Classification of the Land Cover for the study basin

The values of Curve Numbers (CN) for each of the five categories were then determined and derived from Table (4) of the (SCS-CN) as shown in Table (7):

Table (7) (CN) values of land cover class by (SCS-CN)

Class	(CN) values	Area (m^2)	Percentage (%)
Clastic Mukdadiya	55	1,680,948	3.55
Exposed Lands	93	2,218,107	4.68
Vegetated Lands	74	7,451,394	15.71
Bare Lands	90	15,779,972	33.28
Others	71	20,286,112	42.78

The mathematical equations of (SCS-CN) were applied in a sequential and gradual manner to calculate the volume of water surface runoff using the (Raster Calculator) in the Spatial Analyst menu in the (Arc Map 10.4) program. the layer maps were prepared for the Potential Maximum Retention After Runoff (S), the Initial abstraction Before Surface Runoff by Soils Reception by plant and evaporation (Ia), The depth of the surface flow values (D), and map of Surface runoff volume (V), As shown in the following Figures (5), (6):-

ISSN: 1813 – 1662 (Print)
E-ISSN: 2415 – 1726 (On Line)

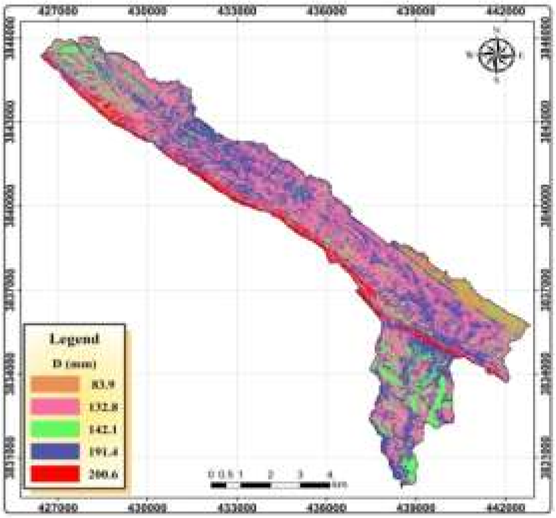

Figure (5) Distribution of surface flow values (D) for the study basin

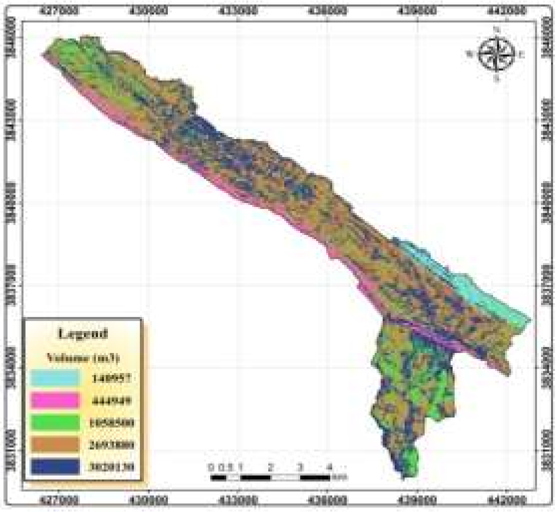

Figure (6) Distribution of Surface runoff volume (V) for the study basin

Thus, the total surface runoff volume in (m^3) in this method is equal to (7,358,416 m^3).

The Traditional Unsupervised Classification method

This method is the most widely used and popular by researchers since it depends on the computer in the visual classification and identification of its varieties. The (5) categories were selected based on the visual classification within the region to process and use satellite data for (Landsat-8) accurately spatial resolution (30) meters and bands (7,5,3) respectively, and it is different from the modern method of taking the number of major class without applying the rule of the world (Goetz).

The resulting varieties were distinguished in different colors, Vegetated Lands with green, Clastic Mukdadiya in gray, Out Crops of Fatha Fm. in red, Bare Lands in blue, Others in yellow, as shown in Figure (7).

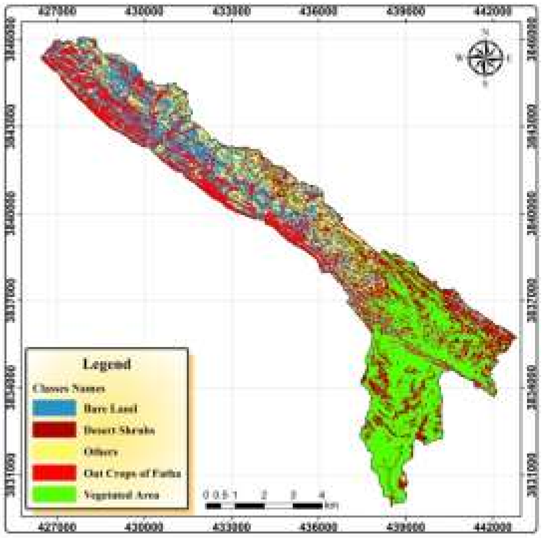

Figure (7) Traditional Unsupervised Classification of the Land Cover for the study basin

The values of Curve Numbers (CN) for each of the five categories were then determined and derived from Table (4) of the (SCS-CN) as shown in Table (8):

Table (8) (CN) values of land cover class by (SCS-CN)

Class	(CN) values	Area (m^2)	Percentage (%)
Mukdadiya Fm.	55	8,688,794	18.32
Out Crops of Fatha Fm.	93	7,588,849	16.1
Vegetated Lands	74	14,399,344	30.35
Bare Lands	90	10,175,281	21.46
Others	71	6,573,265	13.86

The mathematical equations of (SCS-CN) were applied in a sequential and gradual manner to calculate the volume of water surface runoff using the (Raster Calculator) in the Spatial Analyst menu in the (Arc Map 10.4) program. the layer maps were prepared for the Potential Maximum Retention After Runoff (S), the Initial abstraction Before Surface Runoff by Soils Reception by plant and evaporation (Ia), The depth of the surface flow values (D), and map of Surface runoff volume (V), As shown in the following Figures (8), (9):-

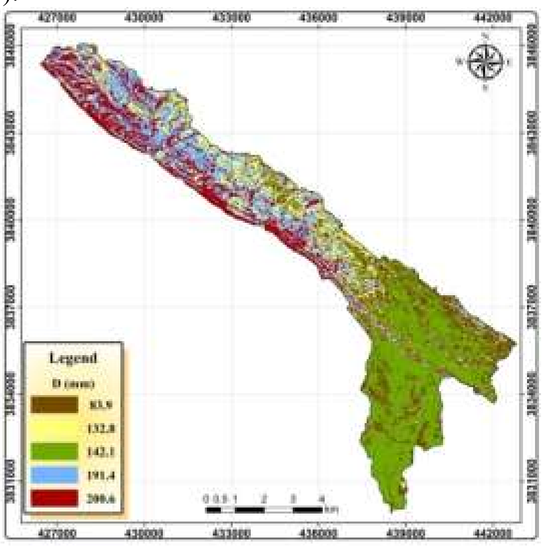

Figure (8) Distribution of surface flow values (D) for the study basin

ISSN: 1813 – 1662 (Print)
E-ISSN: 2415 – 1726 (On Line)

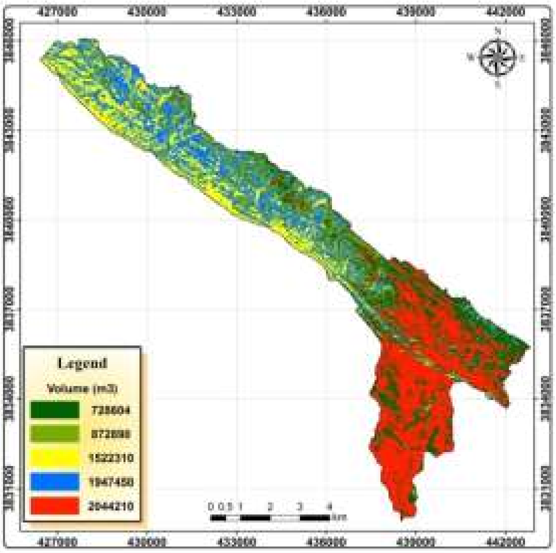

Figure (9) Distribution of Surface runoff volume (V) for the study basin

Thus, the total surface runoff volume in (m^3) in this method is equal to (7,115,464 m^3).

Conclusion

1. Area of Wadi Abu Khashab Basin was (47.416 km^2).
2. Five types of Land Cover Classification by remote sensing methods were observed and marked.
3. Hydrologic Soil Groups (HSG) (A,B,C,D) are distributed within the study area.
4. The surface runoff values produced by the four methods used to apply (SCS-CN) method to calculate Annual Water Income were very close, giving priority to the adoption of these values, rate of this four Techniques were (7,049,316 m^3).
5. Annual Water Income depending on the geological background are equal to (6,842,375 m^3).
6. Annual Water Income depending on Weighted Curve Number (CNw) method are equal to (6,881,010 m^3).
7. Annual Water Income depending on the Modern Unsupervised Classification method mentioned in (Goetz) are equal to (7,358,416 m^3).
8. Annual Water Income depending on The Traditional Unsupervised Classification method are equal to (7,115,464 m^3).
9. Weighted Curve Number (CNw) was (75), this gives the impression that the surface of the Basin tends to produce water surface runoff.

Reference

[1] Jassim, S.Z. and J.C. Goff, Geology of Iraq, Dolin, Prague and Moravian Museum Brno, 2006.

[2] Fouad, S.F., Detailed Geological Mapping of Khanoogah Area, Iraq, GEOSURV, 2002.

[3] Buday, T. and S.Z. Jassim, The regional Geology of Iraq, Vol.2 Tectonism, Magmatism and Metamorphism, Baghdad, 1987.

[4] Buday, T., The Regional Geological of Iraq, Stratigraphy and Paleo Geography, Dar Al-Kuttib publishing House, university of Mosul, 1980.

[5] Al-Tikriti, Kamila Kareem Yassin, Applied geomorphology for the area between Al-Fatha & Al-Door East Tigris, PhD Thesis, university of Baghdad, 2002.

[6] Al-Jawadi, Zaid Yassin, Morphotectonic study of the modern tectonic framework of part of the unstable pavement in northwestern Iraq using remote sensing techniques, PhD Thesis, university of Mosul, 1988.

[7] USDA-TR55, Urban Hydrology for Small Watersheds, USA, Department of Agriculture, 1986.

[8] Richard C. and P.E., Sorrell, Computing Flood Discharges For Small Ungaged Watersheds, USA, Michigan Department of Natural Resources and Environment Land and Water Management Division, 2010.

[9] Mishra, S.K. and V. P., Singh, A relook at NEH-4 curve number data and antecedent moisture condition criteria, Hydrol. Process., 2006.

[10] Al-Doury, Ehab Mohammad Amen, Hydrogeology of West Zightoon Valley Basin, NE Tikrit, Ms.c Thesis, university of Tikrit, 2012.

[11] Chow, V.T. and D.R., Maidment and L.W., Mays, Applied Hydrology, McGraw-Hill, New York, USA.1988.

[12] USDA-SCS, Natural Engineering Handbook, USA, section Department of Agriculture, 1985.

[13] Al-Nofaeey, Haifa Mohammad, Estimation of surface runoff and its risks in the upper basin of Wadi Arafa east of Makkah by means of remote sensing and geographic information systems, Ms.c Thesis, university of Um Al-Kura, 2010.

[14] Richard H. McCuen, Hydrologic Analysis and Design: Second edition, Library of Congress Cataloging-in-Publication Data, Prentice Hall, 1998.

[15] Goetz, A. F., ʻColumn atmospheric water vapor and vegetation liquid water netrievals from airborne imaging spectrometer data' Journal of Geophysical Research, Vol.95, 1990, 3549-3564.

ISSN: 1813 – 1662 (Print)
E-ISSN: 2415 – 1726 (On Line)

تخمين الايراد المائي السنوي باستخدام طريقة (SCS-CN) المعتمدة على تطبيقات الاستشعار عن بعد– نظم المعلومات المكانية لجابية وادي ابو خشب– شمال العراق

عسل حسان محمود الجبوري[1] ، صبار عبدالله صالح القيسي[1] ، ياسين علي صالح القيسي[2]

[1]*قسم علوم الارض التطبيقية ، كلية العلوم ، جامعة تكريت ، تكريت ، العراق*

[2]*قسم الهندسة المدنية ، كلية الهندسة ، جامعة تكريت ، تكريت ، العراق*

الملخص

تم حساب الايراد المائي السنوي لحوض وادي ابو خشب والبالغة مساحته (47.416) كم^2 من خلال توظيف مجموعة من البرامجيات (ArcGIS, Erdas Imagine) بتطبيق طريقة صيانة التربة الامريكية (SCS-CN) وبأربعة اساليب مختلفة نتج عنها معدل ايراد مائي سنوي للطرق الاربعة بمقدار (7,049,316 m^3)، بالاعتماد على بيانات المرئية الفضائية للقمر الصناعي (Landsat-8) بدقة تمييز مكانية (30) متر وللباندات (3,5,7) على التوالي والملتقطة بتاريخ (5-2-2016) لطريقتين، في حين تم الاعتماد في طريقتين على الخلفية الجيولوجية بالاعتماد على الخارطة الجيولوجية، وهي المرة الاولى التي تستخدم فيها الطرق الاربعة سويا في بحث واحد لغرض ضمان نتيجة دقيقة وعلمية، حيث تم تصنيف الغطاء الارضي وطبيعة استخداماته، وهيدرولوجية التربة وتحديد اصنافها، وكميات الامطار الساقطة، و تحديد قيم ارقام المنحنى.