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GEOMORPHOLOGY OF SOILS AFFECTED BY FLOODS IN DIYALA GOVERNORATE

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ABSTRACT

The study area, which is estimated at 17,665.00 hectares, was chosen, as it flat sedimentary plain area between longitudes 44 22´) and 45°56 east and latitude (33° 3´ and 35° 6´) north. The applications of geographic information systems and satellite data were used for the study area in two images, the first for 2018, Which represents the period of floods and torrents coming from the eastern mountains extending between Iraq and Iran, and the second for 2019, which represents the period of receding torrential waters, the American Landsat 8 satellite, which carries eleven bands. OLI sensor with resolution of 30 x 30 meters. Where the following was done. The satellite images were processed by integrating bands for the satellite image, removing noise and creating a mosaic for the satellite image. The NDWI values for 2018 and 2019 were calculated for the highest value (0.2415 _ 0.1160) respectively, while TWI ranged between 4.65 indicating semi-steep and sloping terrain, and 19.4 indicating areas that may contain steep slopes. The land area coverage for the index NDWI for the year 2018 was about (40.33)%, and for the year 2019 about (24.59)%, the difference was about (15074)%, the net coverage area. The slope characteristics of the study area were calculated and the level values were calculated as the heights and levels of the study area ranged from 13-1038 m, which are mountain peaks, while the levels of the study reached between 47.91-33.06 m. The degree of slope within the slope class (0-2A), which represents flat and semi-flat slopes, which formed approximately 66-87% of the study area, while the rest of the slope classes were 12.04% from Diyala Governorate. Among the values of flow accumulation, the separation limit of 50000 was used to separate, as it showed the best line for the accumulation of runoff on the map. Where all the values of the cells in the flow accumulation distribution map ranged between zero 1.62 * 106, and each cell in the resulting visual represents a drainage point receiving water Irrigated from the point above it in the value.

***Keywords*:** Geomorphology, soils, floods

Introduction

Soil geomorphology has been defined as an accurate assessment of the genetic relationship of soil and land formations, which are only possible if their interconnectedness is recognized (Gerrard, 1981). One of the sources of spatial variation in soil arises from several different factors, the most important of which are soil formation factors as well as soil management practices, which affect the yield (Mulla and Mc Bratney, 2000). The variation in soil physical properties can be attributed to the conditions of wetting and drying to which it is exposed. Soils seasonally (Dorner *et al*., 2009**)**. There are studies and results that show the problems that occur as a result of torrents in dry areas, to find the relationship between the characteristics, the shapes of the basins and the occurrence of torrents, Including the geomorphological factors of concentrated basins with their natural characteristics such as slope, area, shape, and length of the main watercourse and their effectiveness role in determining the shape of the hydrograph through which time can be determined between the peak of the rainstorm and the peak of the drainage. The area of the basin has a large and important role in determining the accumulated quantities of water from rainstorms, so the relationship between them is considered positive, as the peak drainage increases with the height, which leads to an increase in the amount of rainfall**.** (Al-Baroudi, 2012). Most of the previous studies that shed light on the dangers and damages of flash floods, were not sufficient to clarify the risks facing cities accurately, because it is impossible to avoid or pay the risks of floods, and currently most recent studies have relied on a number of modern applications and technologies, such as Remote sensing, GIS ,and digital elevation models DEM, by working using maps that identify sites threatened by floods, and conducting studies and research that further improve the work of monitoring networks, to determine valley paths and basin characteristics and turn them into digital maps that led to the improvement of hydrological analyzes through mathematical models to represent the process of runoff. In the water basin in a way that simulates the behavior of the hydrological system in the basin, (Al-Fitouri, 2017). One of the objectives of the research is to monitor the change in the distribution of water cover for a period during which the study area is exposed to floods and another that represents the receding of flood waters**.** Determine the dominant and influential geomorphic units in determining watersheds and flood water movement in the study area**.**

Materials and Methods

Location and size

The study area is located in Diyala governorate; it is bounded on the north by Sulaymaniyah governorate and part of Salah al-Din governorate, and on the west by the governorates of Baghdad and Salah al-Din, while from the south by Wasit governorate and from the east by the Iraqi-Iranian borders. It is represented in the central region of Iraq and to the east of the Tigris River basin, it is located in the flat sedimentary plain area between longitudes (44º 22´and 45º 56)east "and latitude (**33**º 3´and **35** º 6´) north. , (Jasim, 1991**)**

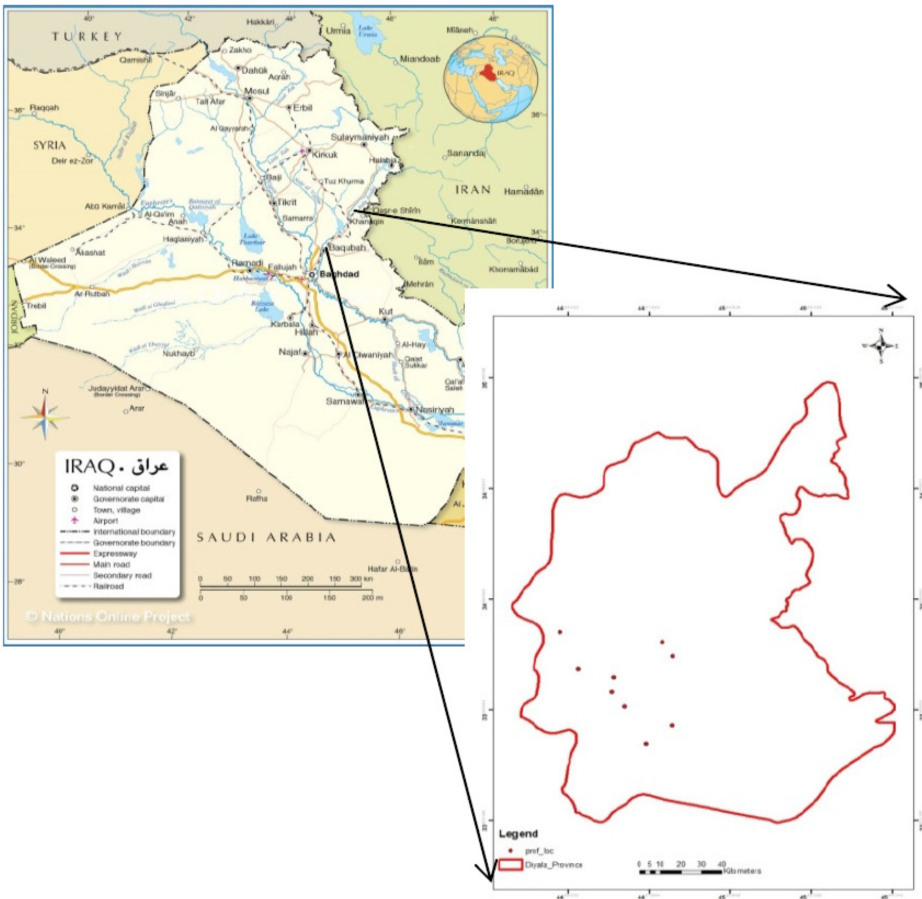


Fig. 1 : A map of Iraq showing the study area

Satellite image

The satellite data for the study area was obtained by two visuals, the first for the year 2018, which represents the period of inundation and torrents coming from the eastern mountains extending between Iraq and Iran, and the second for the year 2019, which represents the period of Water receding of the flood. Eleven bands, resolution ability 30 * 30m, for ranges 1-8, from the USGS site for the same study area processing of the satellite image

The bands (2,3,4,5,6,7) are merged into Layer Stack. The noise removal process was completed, and the mosaic was prepared for the two visual images, after which the study area was subset and then a image interpretation of the two images was made from the satellite. As shown in (Figure 2)

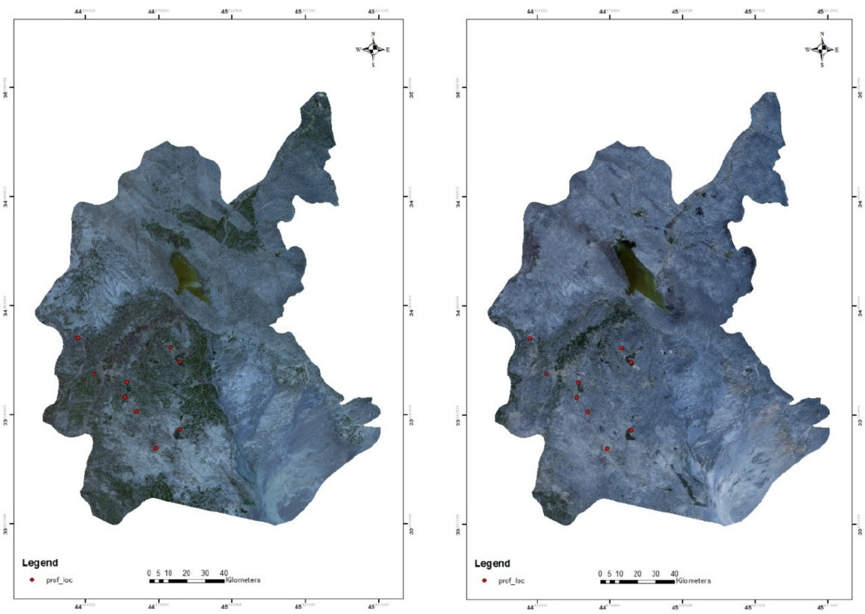


Fig. 2 : Mosaic for the satellite image in study area for 2018 and 2019

Earth coverings Index

The NDWI and TWI index units were identified on the 2018 satellite image, which represent the period of torrential flooding. And marking the location of the pedons and their coordinates using the GPS device and the tracking process, and the of index NDWI were calculated according to Equation No. (1**)**

NDWI = NIR _ Mid lR / NIR + Mid lR ...(1)

NDWI = Normalized Difference Water Index

Near - infrared spectroscopy = NIR The near – infrared spectroscopy used in band 5

Mid IR = Mid infrared electromagnetic spectrum of medium infrared used in band6

The spectral beams can be substituted in Equation No. (1) as follows:

NDWI = (Band5 – Band6) / (Band5 + Band6)

The values of TWI topographic wetness index which in its calculation are based on flow accumulation and slope were calculated according to equation (2**)**.

TWI =ln("Flow Acc"*900/Tan" slope_in_radians")..(2)

TWI=Topographic Wetness Index

Ln =inverse of logarithm

900=resolution**30 * 30**m

Tan"slope_in_radians= degree of slope angle

Calculation of slope characteristics and digital elevations model

The model of the digital heights of the surface of Iraq has been deducted from Diyala governorate with a spatial resolution of (25 * 25) m 2 obtained from the official website of the USGS, as in Figure (5). Also in determining the characteristics of the slope characteristics by following the protocols for extracting these characteristics in an environment. Arc GIS 10.3 for desktop and according to its toolbox. Where the watershed was determined first, and then the slope and its varieties were determined for the study area and the length, direction flow in it was calculated.

Slope

The slope values were extracted by following the protocol of extracting the slope from the digital elevations model mentioned in the Arc GIS desktop user index. Figure (6) shows a map of the slope distribution in the study area.

Determine Watershed

The watersheds were determined by following the protocol for calculating the watershed in the study area by adopting the digital elevations model DEM, and by using the fill feature in determining the basic water sheds in the area, and figure (7) shows the watersheds in the study area**.**

Flow accumulation

Calculated from the flow direction values by following the protocol in the program index. Figure (8) shows a map of the flow basin in the study area.

The value of 50,000 was set for the purpose of separating and isolating cells or the receiving of pixels from surrounding cells**.**

NDWI index

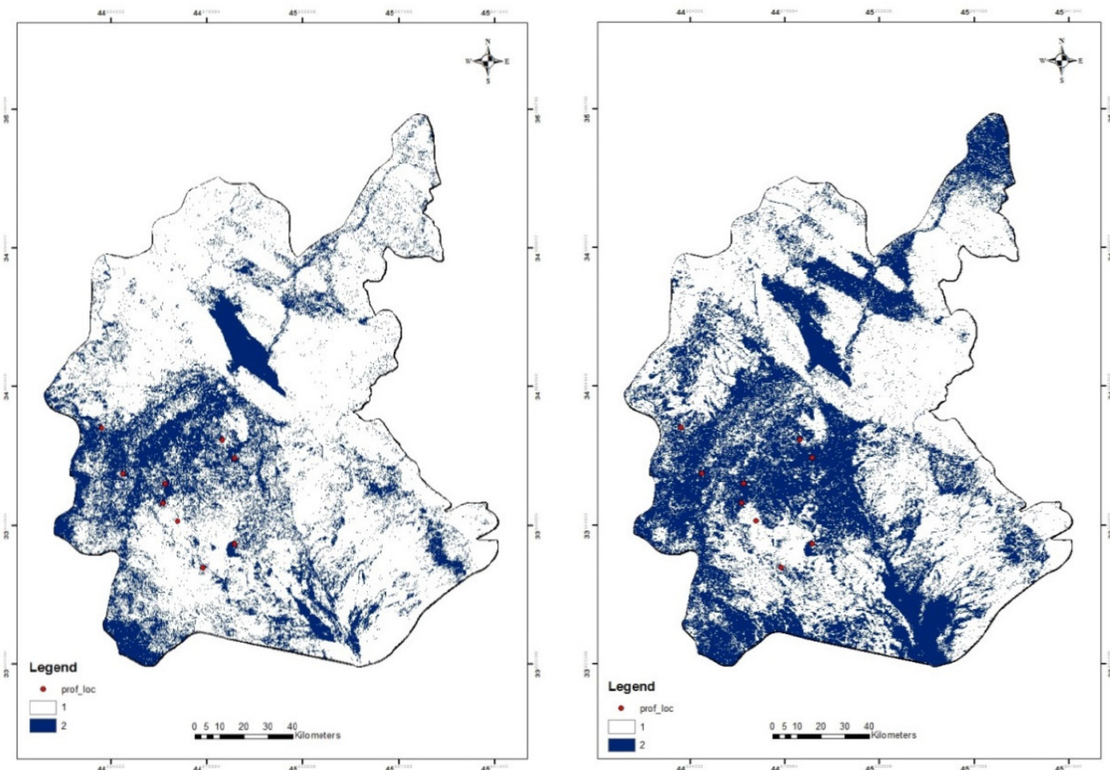
A reclassification of the NDWI was performed and two new classes were given. Class A, areas with NDWI index values 0 (less or equal to zero) were related to non-water affected areas. Class B with NDWI index values > 0 (greater than zero), a view representing affected areas. Where figure (A) for the year 2018 indicates the NDWI values greater than zero and the blue model refers to the soils affected by water with a high percentage, flooded with flood water ,As for figure (B) for the year 2019, which indicates the values of NDWI less than zero, shown in blue in a few percentages, where the white color, which represents dry lands and unaffected lands, is shown in a greater proportion, and this indicates the decline of torrential water in 2019 by a difference from 2018, and it is due to for 2018, there was higher humidity and more water than the following year, as a result of the floods and torrents that flooded that area compared to 2019, and Figure (3) illustrates that.

The flooding of the soil as a result of floods leads to making its surface work as a mirror for the sensors that capture the image in those flooded areas.

We note that the coverage area of the lands affected by the water in 2018 was 40.47% of the total area, as it decreased to 24.7% in 2019, and this is index that the lands of Diyala Governorate and its soil were affected by flood water to about multiple the area between the two years. As for the values of this index, it was calculated for the pedons sites in the study area by using the ERDAS 2014 program for the years 2018-2019, and finding the difference between the two years, as shown in Table(1), The highest values for the year 2018 were (0.2415), and this value indicates a decrease in the pedons of the study area and its exposure to floods due to flood water, and the lowest value for 2018 was (0.0551). This indicates the high level of the study area, and the index values were (0.1044). The high level of that area where the torrents were not affected. As for the NDWI values for the year 2019, the highest calculated value was (0.1160), and the lowest value (0.0551), while we note the presence of two negative values for the water index, indicating the water recession and the dryness of the region due to climate change, lack of rain, higher temperatures and evaporation.

Table 1 : Shows the deference NDWI values for the years 2018 and 2019,

P	NDWI 2018	NDWI 2019	Difference 2018_2019
1	0.0617	0.0559	0.0057
1	0.0553	-0.0034	0.0587
2	0.1567	0.0827	0.0739
4	0.1490	0.0819	0.0671
5	-0.0283	-0.0341	0.0058
6	0.1278	0.0566	0.0712
7	0.1172	0.0853	0.0319
8	0.0591	0.1160	-0.0568
9	0.2415	0.0551	0.1864
Range	0.1044	0.0551	0.0493



2018 2019

Fig. 3 : Shows the spatial variance of the NDWI For the years 2018-2019

Topographic Wetness Index (TWI)

From the results of Table (2) and Fig. (4), it is index that there is a wide range of this index that reflects the topographical condition, as the minimum value of this index is 4.65 indicating semi-flat and low-slope, while the value 19.4 indicates higher areas with steep slopes that may be highest. With pedons the study, it showed a range confined to close values (8.82_12.4). These values may be related to values of slope or difference in heights that are not dominant, but not insignificant.

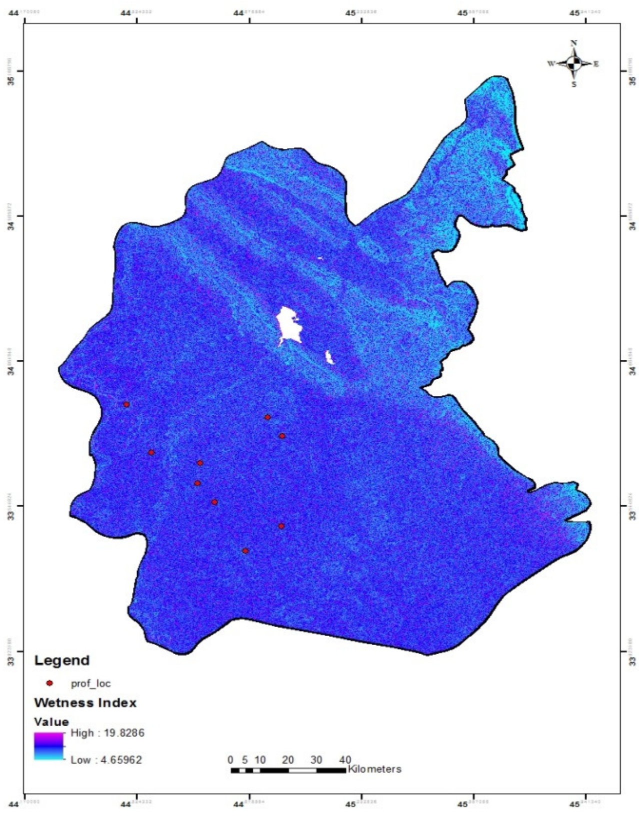


Fig. 4 : Topographic wetness index (TWI), upper and lower levels

Table 2 : Values TWI, Slope, Flow Direction, Flow Accum, Elevation

Flow Accum	Flow Direction	Slope	Elevation	TWI
3.1843	40.1661	0.5270	33.0654	10.4047
23.3497	3.7119	0.2439	43.3603	12.4015
0.0000	27.3877	0.9211	33.8400	8.8220
27.5816	8.0000	0.2959	41.3386	10.9713
0.7426	1.8704	0.5737	42.1399	9.4202
4.6929	16.0000	0.3143	39.5821	9.9278
0.0376	21.9162	0.5411	47.9194	9.2228
41.4454	14.0000	0.4599	41.7381	10.4073
5.5260	3.9665	0.2460	39.2191	10.1668

Surface characteristics of the study area

Figure (5) shows that the levels of the study area start from a height of (13 m) and end to (1038 m), and these heights are semi-gradient in the ranks as the elevations are between north to, north-east and southeast, and they represent the mountain peaks and heights of the edges of the study area, while they reached The studied pedon levels were the highest level of 47.91 m above sea level, and the lowest level of the study pedons was 33.06 m. This area is considered the most affected by humidity, and the flood water collects in it due to its low level. It is also considered one of the flat sedimentary plain areas with almost flat grades.

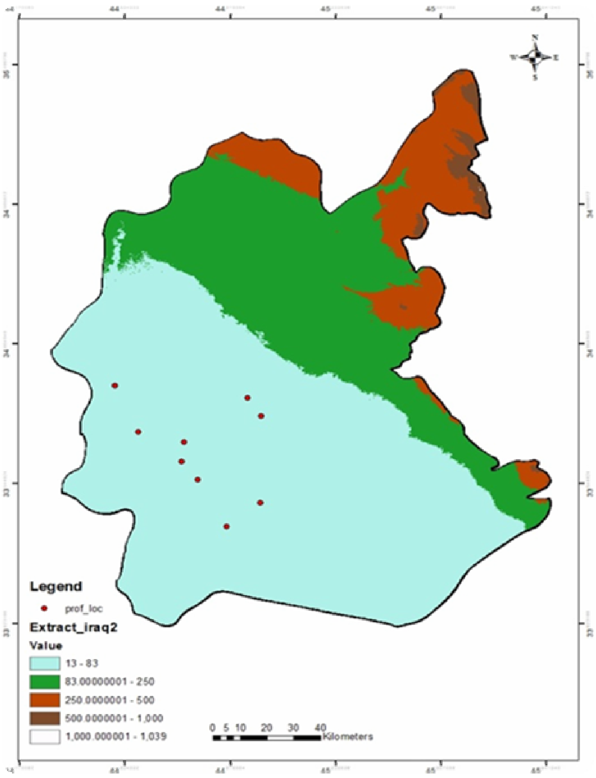


Fig. 5 : A map showing the levels of the studied area

Slope

Figure (6) shows a map of the spatial distribution of the slope in the study area, that the degree of slope was limited to simple slope, as the slope class (0-2A), which represents flat and semi-level slopes, is approximately 66-87% of the study area while the rest of the slope classes were 12.04% of the Diyala Province region. The reason is that the lands of Diyala Province region have a geomorphic nature that differs from the mountainous and rugged areas where the length of the slope is large. the study areas is of a gradual type that shows its effect in long distances and not in short distances as it is in the northern regions. According to Young's 1972 classification, Table (3). The predominant B and A grades appeared, followed by the slopes.

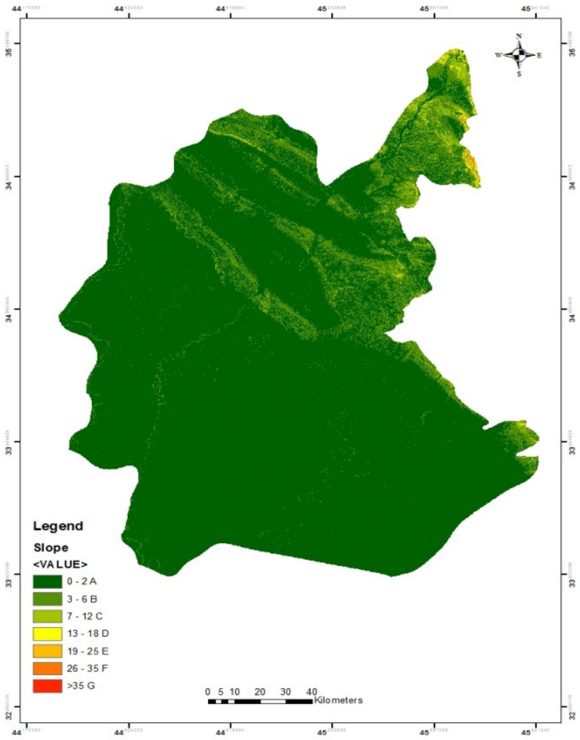


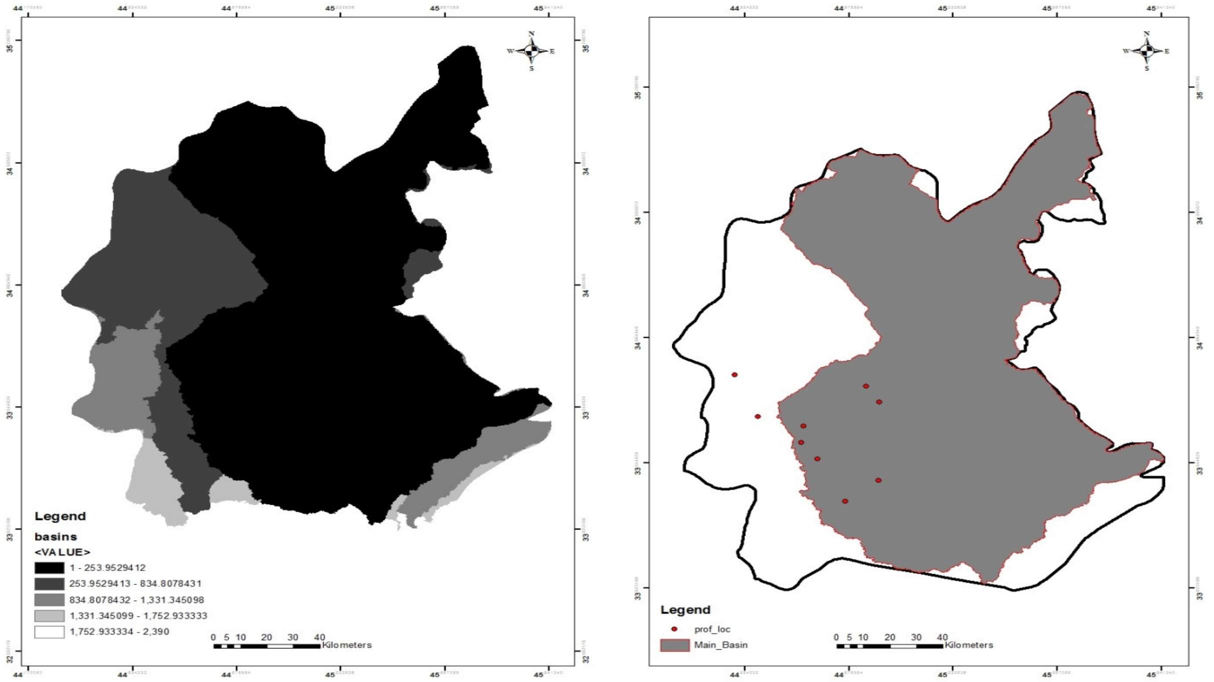
Fig. 6 : Slope of the study area

Table 3 : Slope levels according to Young's classification (1972)

Percent slope	Slope class	Description
0-2	A	Nearly level
3-6	B	Gently sloping
7-12	C	Moderately sloping
13-18	D	Strongly sloping
19-25	E	Moderately steep
26-35	F	Steep
>35	G	Very steep

Watershed

As Figure (7) (A) shows, the existence of a group of Watersheds, and with different areas covering most of the study area, the largest Watersheds was 67.73% of the study area. And that there are other Watershed basins that appeared in significant areas, but they are ineffective as was the main and discontinuous Watershed shown in Figure (B**)**



(A) **(B)**

Fig. 7 : The main Watersheds in the study area

Flow Accumulation

Figure (8) shows the flow accumulation map for the study area, where the separation limit of 50000 was used to separate the values of the runoff accumulation as all the values of the cells in the flow accumulation distribution map are between zero and 1.62 * 106 and that each cell in the resulting image represents a drainage point receiving drained water. From the point above it in the value, so choosing this value of 50,000 showed the best line for the accumulation of runoff on the map, which represents the course in which you can receive the cells represented by the points of water removed from locations higher than in the value, so after determining this value and comparing it with other values which are 10,000, 100,000, we found that the best expression of flow accumulation was at this value. It is also worth noting that the flow accumulation line was identical to the Deyala River and its valley, the natural matter that leads to the operation of this river as drainage also for the soil of the surrounding area, although most of its water sources are from outside the study area, neighboring countries.

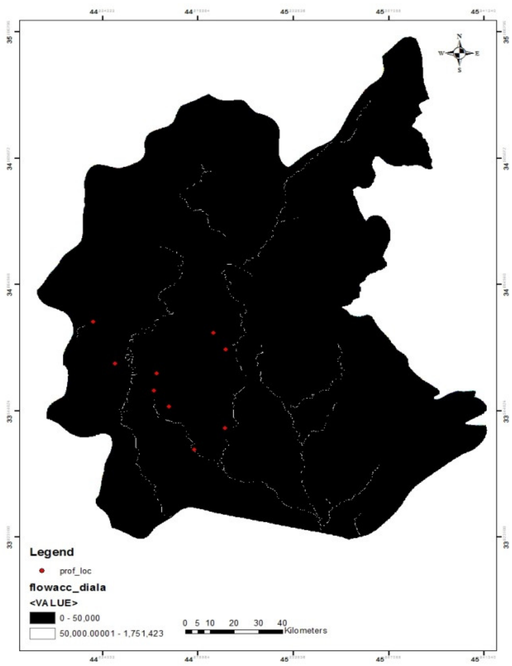


Fig. 8 : Shows the accumulation of flow Changes Detection

Figure (9) shows the change in the NDWI index for the years 2018 and 2019, as the NDWI index showed a coverage area of 40.33% for the year 2018, which is indicated in red, where the areas of decrease represent the proportions of the NDWI values for the two-year difference, while the coverage area reached 24.59% for the year 2019, which represents the areas indicated in green. In other words, there is a difference of approximately 15.74% of the net coverage area affected by flood water in 2018 compared to 2019. This is evidence that flood waters flooded areas of approximately 15.74% in 2018, more than the areas in 2019. In other words, there is an area of approximately 278, 361.9 hectares of Diyala governorate's land affected by the flood water. The same figure also shows that the flood waters submerse many areas of the governorate, concentrated in the eastern regions of the governorate in addition to the center, and this corresponds to the main watershed shown in the study area

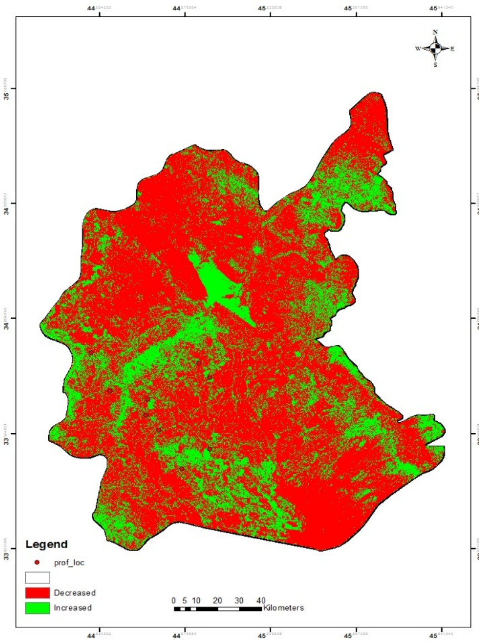


Fig. 9: Variation in the two-year NDWI index 2019-2018

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