



## Spatial Analysis of Dry Valley Floods in Salah Al-Din Governorate and Ramadan Valley

### Ali Mukhlif Sabea

Department of Geography, College of Education for Humanities, Tikrit University, Tikrit, Iraq.  
ORCED: 0000-0001-93500-1522. E-mail: Alimukhl@tu.edu.iq

### Numman Hussain Atea

Department of Geography, College of Education for Humanities, Tikrit University, Tikrit, Iraq.  
ORCED: 0000-0002-17448-6655. E-mail: geographyhigher@gmil.com

### Sedeak Mustafa Jasim

Department of Geography, College of Education for Humanities, Tikrit University, Tikrit, Iraq.  
ORCED: 0000-00002-0106-24479. E-mail: sadekmostafa@tu.edu.iq

### Hussain Abid Ismaiel

Department of Geography, College of Education for Humanities, Tikrit University, Tikrit, Iraq.  
ORCED: 0000-0002-7205-97366. E-mail: dr.hussainabd@tu.edu.iq

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### Abstract

Flash floods are considered to be one the worst kind of hazard. They are characterized by their suddenness, rarity, small scale, heavy rain and peak discharge, unpredictable, fast and violent movement. It has severe effects on human society in the form life losses, damages to property, roads, communication and on natural settings. Advances in hydrology, meteorology, engineering, using of GIS and remote sensing still not able to increase real time forecast. Researchers from

developed countries have stressed to more focus to improve very short time an effective early warning system with collaboration of local communities for flash flood risk supervision. The data were combined with the Geographical Information System to analyze the temporal and spatial distribution of flood events in Salah Al-Din Governorate and Ramadan Valley. The analysis of the spatial distribution of the floods proves that most of the occurrences are recorded in the southern part of the study area. Most of the flooded areas in the study area are mainly pre-classified areas within the areas threatened by the flood due to the low level of its surface and its proximity to the course of the main valley (Wadi Jarnav), which flows into the Tigris River. The proposed method estimates the localization of sites prone to flood, and it may be used for flood hazard assessment mapping and for flood risk management. It was therefore, suggested that government agencies and policy makers should adopt this powerful technique for reliable and well synthesized information which is a vital component of flood risk assessment and planning.

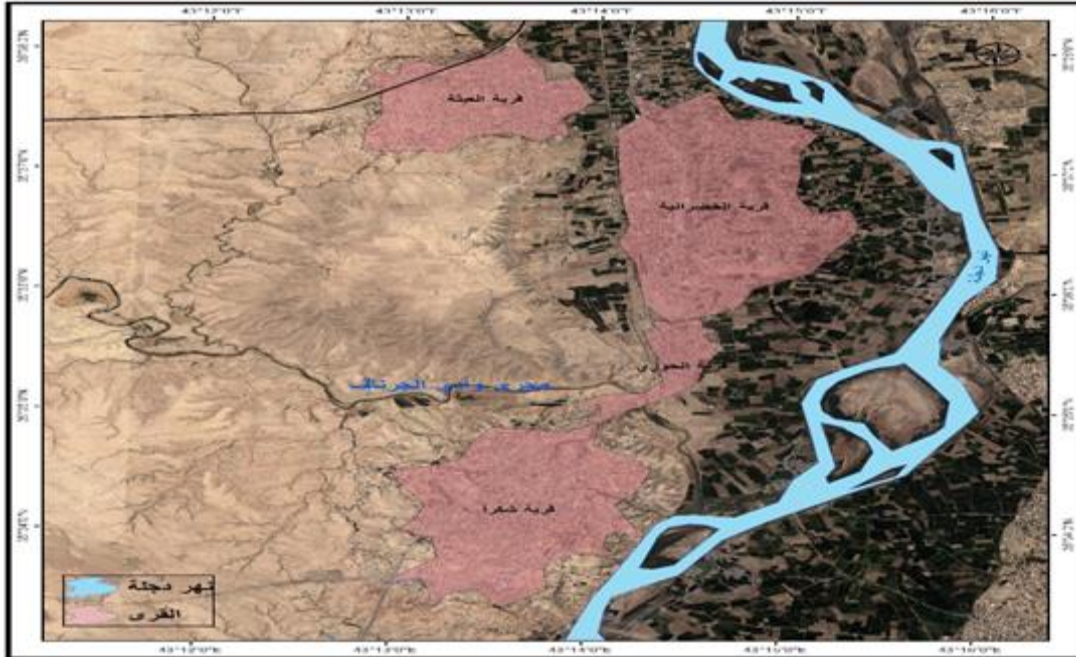
**Keywords:** Dry Valley Floods; Salah Al-Din Governorate; Ramadan Valley.

## **Introduction**

The areas of Shirqat district are located in the transitional area between the semi-mountainous regions of Iraq to the sedimentary plain area, which has a moderate slope that tends to the shoulders of the Tigris River as it allows sudden flooding of the flood valleys adjacent especially with heavy rains following the volatile climate prevailing in Iraq. This happened what was expected to happen to the villages of Houriya and Khodrania affected by the floods coming from the adjacent valley, which is the valley of Ramadan (Jarnav), which led to the sinking of these villages with varying levels of water, especially the village of Houriya, which was affected by the rapid and sudden floods that occurred at night, which flooded Most parts of this village, as well as the village of Khadraniya affected by floods and high levels of the Tigris River. Note that such a kind of flood does not occur annually and this gives reassurance to the inhabitants of the region to live in the forbidden areas and therefore the occurrence of human and material losses, and that the reasons for this annual fluctuation of the flood is due to the prevailing climate fluctuations, but the occurrence of this flood to this degree causing losses due to several reasons Natural and human we will come to mention later.

### **The location of the study area**

The study area is determined by the area of flood occurrence, which is determined between the longitudes ( $57^{\circ} 25' 43''$   $43^{\circ} 20' 43''$  E) and two latitudes ( $20^{\circ} 55' 35''$   $63^{\circ} 50' 35''$ ) north which consist of the villages Al-Khadraniya, Al-Houriya and Shukran villages are the villages that surround the estuary of Wadi Al-Jarnaf, map No. (1).



**Map 1. Wadi Al - Ramadanyat (Jarnaf) and the distribution of villages in the study area**

(Source: The work of the researcher based on satellite visual data and digital model)

### Justification for the study

1. The area was hit by floods and devastating flash floods that led to huge human and material losses in several villages of Shirqat, including the village of Hourri and Khadraniya.
2. The study area suffers from the decline of the agricultural area for several reasons, the most important of which are: the successive years of drought and desert encroachment; Ramadani (Jarnav), which is characterized by fluctuation of discharge, depending on the rainfall.
3. The presence of huge amounts of water that takes place during the rainy season, especially in the spring in the valley of Jarnav and go without taking advantage of them.
4. Persuade decision-makers that the construction of small dams on the valley of Jarnav for the purpose of harvesting water is necessary and is of great economic, social and environmental feasibility.
5. Improving the living conditions of the residents of the Shirqat area and working to settle the population of the area and prevent their migration towards urban centers.

### Objectives of the study

The study aims to determine the impact and area of flooding in the study area and to calculate the environmental and physical effects of the flood by showing its impact on human settlements, in addition to the factors that led to this flood through the study of the valley through the analysis of the water network of the basin in this The area to identify the most important hydrological

characteristics of the basin depending on the analysis of land cover capacity Controlling its variations and variations represented (depth of runoff - runoff volume - volume of discharge), as well as determining the most important reasons that led to the devastating floods in the region, in addition to determining the appropriate site for the construction of a dam and the application of water harvesting techniques and using modern geographic techniques. And the ways in which this water wealth can be invested because of its long-term strategic dimensions

### **The importance of the study**

The importance of the study was highlighted through the application of GIS techniques and RS data in building a geographic database to calculate the environmental damage caused by the flood and determine its results and causes by providing an advanced technical method of measurement and morphometric analysis to reach accurate results that support the environmental rehabilitation project of this valley. Provide advice to decision-makers in the establishment of small dams for water retention, harvesting and development, treatment, storage and use of water drainage for various purposes related to human activities. The importance of the study is also to reveal the nature of hydrological processes Which is practiced in the basin and the resulting effects which lead to an imbalance in the ecological balance of the basin, as well as the water scarcity experienced by the region in the summer, and management of rainfall and rainfall Studies of spatial analysis using modern techniques.

### **Spatial Analysis of Human Settlements Flooded in the Study Area**

Spread of human settlements (villages) along the valley and the basin (53.5 km) and an area (894) km<sup>2</sup> of 32 villages, has varied in size in terms of population and the number of housing units and in general villages tend to increase the population Whenever I went to the mouth of the valley in the Tigris River, a number of residents of these villages made earthworks on some of the waterways in this valley to benefit from storing water in the rainy period after the fifth month of the year for the purpose of watering some crops and Breeding of livestock, these repayments were among the many reasons that caused the flooding of this valley, because of the collapse of these repayment after filling the depressions in front of the dams in one go.

The studied human settlements belong to the district of Shirqat within Salah al-Din governorate within four villages threatened by flooding, Qura Al-Houriya, Al-Khadraniya, Al-Eitha and Shukran villages. 500 to 1000 meters downstream.



**Map 2. Human settlements in the study area**

Source: Bariq, Unpublished Master Thesis, Tikrit University, College of Education for Humanities, Department of Geography, 2018

### **The emergence of human settlements in the study area**

The period of stay in the residential units in the two villages that were drowned by the torrential torrents that swept through the valley of Jarnav, and the facts that can be noted in these villages, have varied over the past 10 to 60 years. Fixed building materials (block, bricks and concrete) reverse the predominant characteristic of residential units in the countryside of Iraq until the nineties of the last century, which is mud construction and wood roofing and methods simulated from reeds, and to show a detailed picture of the length of stay we will address as follows:

#### **The village of Al-Khadraniya**

Table 1 revealed that the number of housing units in the village amounted to (165) housing units. The period of construction varied over (47%) of the housing units have been established since (10-60) years. The previous period, despite the fall of the rain and in quantities not different from what fell in this period, which indicates the existence of a reason for this large flooding of the inhabitants of this village is not the amount of rain, as the table revealed that (36%) of the

housing units hard to exist between (4-10) (17 years) of which have been present in their current places between (1-2) years, and it should be noted that the modern population units are T was inundated (high water level) because of the proximity of these units to the base of the valley and high water levels in it.

**Table 1. Duration of Residence in Residential Units**

The village name	Year	Two years	Proportion of housing units	3-6 years	Proportion of housing units	7-9 years	Percentage	More Than 10 years	Percentage
Al-Khadrania	14	15	165	33	22.4%	25	15.1%	8	47.3%
Al-Hurria	02	2	1.9%	12	5.7%	5	2.4%	191	90.0%

Source: Field study and questionnaire

### The village of Houriya

Table 1 revealed that the number of housing units in this village amounted to (212) housing units. Of the total number of housing units in the village, the number of housing units that have been established between (2-10) years is about (17) housing units (8%) of the total while the modern houses number (4) housing units It is worth mentioning that the damage caused to the residential units of this village is more than that of the residential units in Al-Khadrania village due to the low level of the lands of these villages. So we found from the field visit that all the housing units in this village were damaged with varying severity of damage according to the proximity of the valley stream.

### Human Damage Caused by the Flood

**1. Deaths:** The human damage varied between the two villages. The field study conducted by the study team indicated that 83% of the deceased due to their drowning are from the village of Houriya, with 15 people distributed among (9) males and (6) females. The number of deceased in the village of Khadraniya (3) females 17 percent of the total number of deceased in the two villages and it should be noted that most of the deaths in the villages were those who live close to the course of the valley and who completed the construction of their role before a short time, see Table 2.

**Table 2. Casualties caused by the flood of Wadi Al-Jarnaf in the villages**

The Village name	Male	Female	Percentage
Al-Kadraniya	2	1	17%
Al-Hurriya	9	6	83%

Source: Field study and questionnaire

**2. Livestock damage:** The field study and Table 3 revealed that the damage of livestock was more than that of Al-Houriya village, where the number of livestock that drowned in the

village of Al-Khadraniya reached (798) head between (cows, sheep, goats) and poultry (chicken) (72%), while the village of Houriyeh, despite the increase in the number of housing units in comparison with the village of Khadraniya, but the losses of livestock did not exceed (30%) by (299) head between animals and birds, which indicates that the number of housing units that were Breeding livestock in the vegetable is more than In addition, there are more than (8) poultry fields in Al-Khadraniya that have been submerged due to the valley water; on this side.

**Table 3. Damage of livestock caused by the flood of Jarnaf Valley in the villages**

The Village name	Birds Chickens	Cows\goats\sheeps
Al-Khadraniya	750	48
Al-Huriya	260	39
Total	1010	78

Source: Field study and questionnaire

- 3. Crop damage:** The field study revealed that there are large areas of agricultural land, which were planted with wheat, barley and vegetables, amounting to (318) dunums in the two villages. 281 dunums and barley crop area (29) dunums while the area of agricultural land affected in the village of Houriya (8) dunums only distributed between wheat crop (5) dunums and barley crop (2) dunums and vegetables area (1) dunums.
- 4. Damage to services:** The field study revealed that two schools were damaged, one in the village of Houriyeh and the other in Khadraniya. Al-Khadraniya school was less water rise, which caused less damage in terms of the spread of moisture throughout the classrooms and the management rooms, but the fence, heavy water tank and furniture were not damaged as in the school of the nymph.

### **The approximate costs of renovating the housing units**

Due to the varying spatial location of the valley stream of the residential units, it was reflected on the amount of damage caused to them. The approximate costs for the reconstruction of housing units:

- 1. Al-Khodrania Village:** Table 4 revealed that the number of housing units requiring high costs of restoration, which is limited to (6-10) million dinars, amounted to (21) housing units, which constitute only (12.7%) of the cost of reconstruction of housing units in the village, while the number of units was The housing units whose reconstruction costs are limited to between (2 million - 6 million) (73) housing units constituting up to (50.4%) of the cost of reconstruction of housing units in the village, while the number of housing units that do not need large amounts, which is limited between (1) -2) million dinars (61) housing units, which constitute (37%) of the total cost of reconstruction of housing units in the village, which number(165) housing units.

**Table 4. Approximate Costs for the Reconstruction of the Village**

The Village name	Approximate reconstruction costs (million)									
	1-2 million	%	2.1-4 million	%	4.1-6 million	%	6.1-8	%	8.1-10	%
Al-Khudraniya	61	37%	36	21.9%	47	28.5%	7	4.2%	14	8.5%
Al-Hurriya	23	10.9%	55	25.9%	73	34.5%	25	11.8%	36	17%
Total for the two Villages	22.3%		24.1%		31.8%		8.5%		13.3%	

Source: Field study and questionnaire

**Village nymph:** We also mentioned that the damage caused to the housing units in this village is more and reported in terms of the impact. The number of housing units that do not need large amounts is because the damage is less than the number of (23) housing units, the amounts of reconstruction (10.9%) of the total cost of units Housing units in the village, while the number of housing units, whose reconstruction costs are limited between (2 - 6) million (28) housing units costed reconstruction (60.3%) of the total cost of housing units throughout the village, while the number of housing units, which hit thousands Which need high costs for reconstruction, which is between (6-10) million about (61) units the nickname of the percentage of the amounts required for building them (28.8%) of the total amount needed for the reconstruction of housing units in the village, the (212) housing units.

### The numerical distribution of housing units and their spatial distance from the valley

The distribution of housing units on both sides of the valley of Jarnaf varies in number and distance from the valley:

**1. Al-Khodrania Village:** The number of housing units hit by the flood is about 165 housing units. Table 6 revealed that (48%) of the total housing units are far from the valley between (100-300) m (79) units. The closer the distance between the housing unit and the valley course prevails, the percentage of losses prevails and the doubling of reconstruction amounts, while the percentage of housing units in this village, which is far from the valley between 400-600 m, about (30.9%) of the total housing units Approximately (51) housing units, while the proportion of housing units away from the valley by more than (700) m was (21.1%), which is equivalent to (34) housing units.

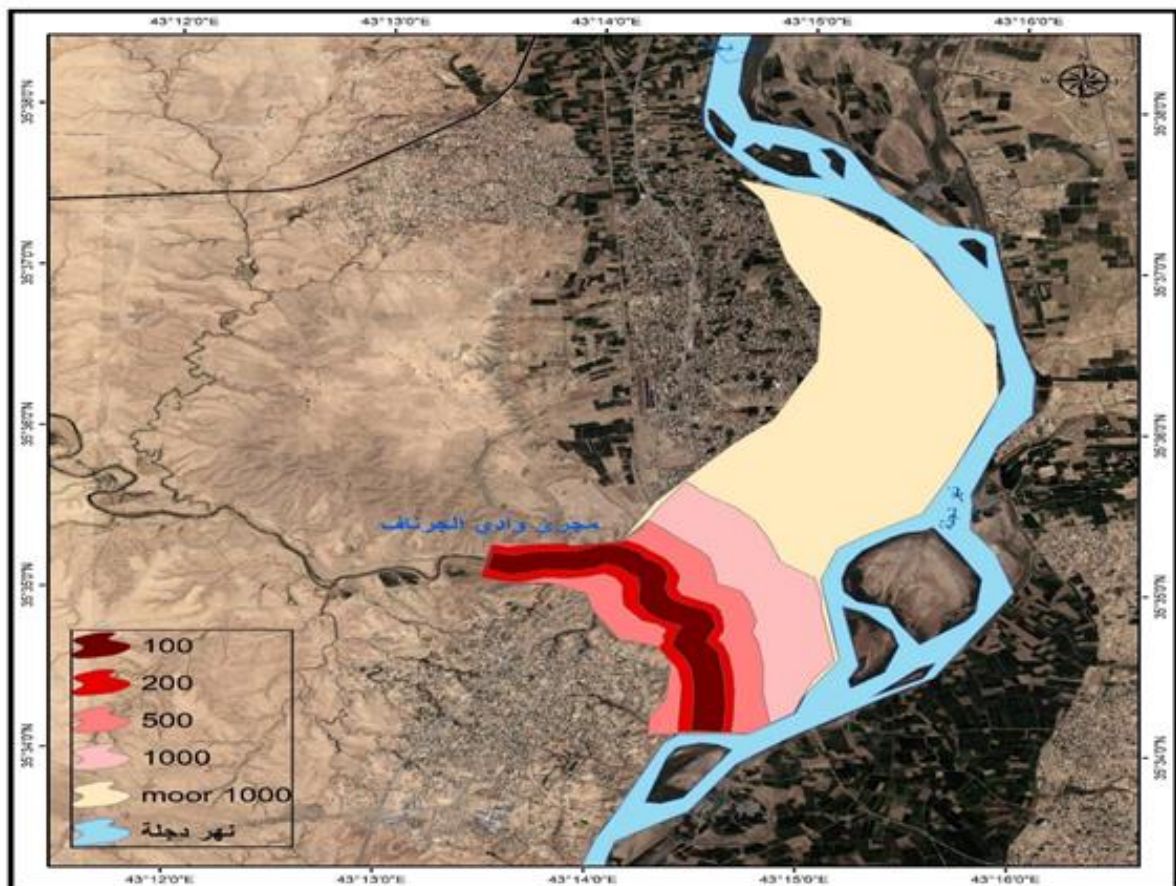
**Table 5. The spatial dimension of the residential units from the flood of Wadi Al Jarnaf in the villages of Al – Khadraniya and Al-Huria**

The Village name	The spatial dimension in meters										
	100 million	200 million	300 million	%	400 million	500 million	600 million	%	700 million	800 million	%
Al-Khudraniya	36	19	24	47.8%	19	22	11	30.9%	30	4	21%
Al-Hurriya	46	24	25	35.4%	28	48	23	34.4%	18	-	8.5%
Total	46%				39%				15		

Source: Field study and questionnaire



**2. The village of Houriya:** The number of housing units that have been flooded and submerged in varying proportions (212) housing units, and Table 5 based on the field study revealed that (95) housing units away from the valley with a distance of (100-300) m, by (44.8%). It is these units that have been flooded at higher levels than the rest of the housing units being closer to the valley stream, while The number of housing units that are far from the course between (400-600) m and (46%) of the total number of housing units, and it should be noted that these units, despite the spatial distance from the valley, but it was affected by the high moisture content of the soil A large scale in these housing units with the collapse of some reservoirs of heavy water and external fences of these units, while the housing units that are more than (700) m from the valley has reached (18) housing units formed (8.5%) of the total housing units. The damage was less compared to other units, and in general the proportion of housing units that was damaged Adults in both villages, which are (100-600) meters (85.1%).



**Map 3. Spatial Dimensions of Residential Units from Wadi Ramadanyat Stream**

(Source: The work of the researcher based on satellite visual data and field study)

## **The qualitative distribution of damage to the housing units in the villages of Al-Khadraniya and Houriya**

The field study carried out by the research team revealed that the damage caused to the housing units inside the village and between the two housing units of the two villages was found to be greater. The rise in Al-Khadraniya, which caused water levels to inundate a large number of housing units in the nymph and a higher elevation than in Al-Khadraniya.

**Damage to residential units in Al-Khadraniya village:** Table 6 revealed that the housing units that were partially damaged (ie, humidity, demolition of heavy water tank) or any other damage were (85) housing units (51.5%) of the total number of housing units in Al-Khadraniya which were damaged. (165) housing units, while the number of housing units that were totally damaged (the humidity of the collapse of the external fence, water tank (heavy, external utilities) due to high water levels flooded by about (80) housing units (48.5%). Of the total, if we separated the damage to the housing units, we found that the largest number of housing units hit by moisture and spread in nearly (162) housing units (98%), while the damage to the collapse of external facilities ranked second numerically by about (132) housing units by The collapse of the heavy water tank reached the third rank with about (126) housing units (76.3%).

**Damage to residential units in the village of Houriya:** We have pointed out in more than one place in this study that the damage to housing units in this field is the most numerous and reported the kind of high water levels that flooded this village, the field study and Table 7 revealed that the partially damaged housing units amounted to (41) housing units (19.3% of the total housing units that were damaged) (212) housing units in the village, while 85 housing units (400%) were totally damaged of the total number of damaged housing units in the village, it shows the qualitative and quantitative variation of the damages that hit the residential units if the qualitative vocabulary of the damages is detailed as the humidity came with the largest number of housing units as it reached (122) housing units, or (57.5%) of the total housing units. Second: The demolition of the external fence with (96) housing units (45.3%). The number of housing units affected by the collapse of the heavy water tank and the collapse of the external utilities in this village and the number of (92.93) respectively and (43.8 and 43.4%), respectively.

Looking at Table 7 shows that the humidity in both villages accounted for 75.3% of the housing units, while the collapse of the external utilities and the heavy water tank constituted 59.5 and 58% respectively, then the collapse of the external fence 53% of the total housing units in the two villages (377) housing units.

## **Spatial analysis of the flood and its causes in the study area**

One of the first requirements to know the effects of floods and human, physical and environmental losses of any area is to know the area of flooding and spatial coverage of flood water. The area covered by water flooded by floods during the hours of more than 13 km 2,

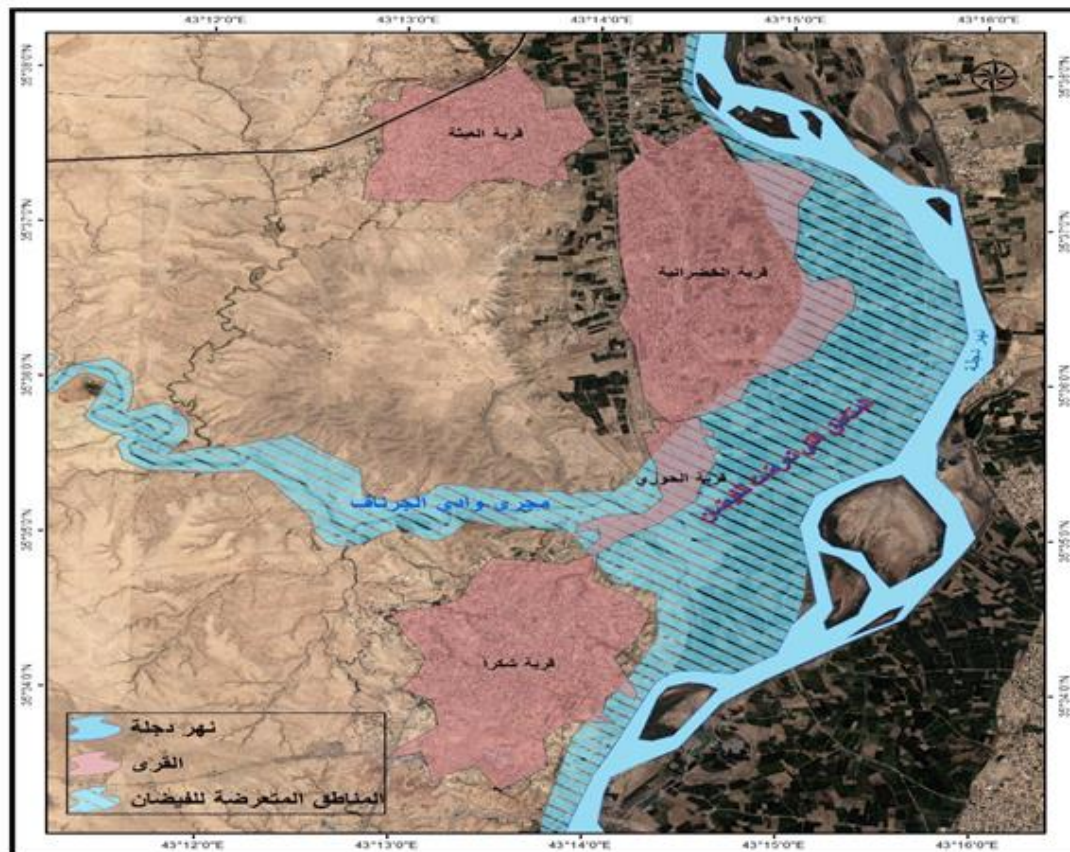
which led to the sinking of the village of Houriya and parts of the village of Al-Khadraniya and Al-Aaitha, thanks to the sinking of a large number of residential units as in Table 6.

**Table 6. The area of flooding and the number of submerged buildings in the villages of the study area**

No.	The village name	The area of flooding is 2 km	Number of submerged buildings
1	Al- Hurry	2.161	212
2	Al-Khadraniya	1.734	165
3	Shukran	0.14	11
4	Al-A'etha	0.06	6
	total	4.095	373

Source: Work of the researcher accreditation on map 2 and field study

The area covered by flooding, which starts from the north-west side of the villages, which unites at the end of the valley of the Jarnaf estuary to expand fan to cover most of the Tigris River Basin and thus covers most parts of the village of Houriya and Khadraniya map (2), and also varied the area that was flooded with water Among the villages that reached the flood map No. (3), where the village of Houriya suffered the most losses, where flooded 212 housing units and 165 housing units, while the losses in the village of Shukra and Al-Aaitha are the lowest and did not cause losses to prevent residents from staying in their housing units.



**Map 4. Villages that have been flooded and flooded (Source: The work of the researcher based on satellite visual data and digital modeling)**



**Picture 1. Shows houses flooded**



**Picture 2. Water immersion level for homes**

On 23/11/2018

**Factors causing flooding in the study area:** The reconstruction of the villages of Khadraniya and Houriya requires that we look at the reasons that led to the flooding of this valley at this particular time, although more than 80% of its housing units have been established for more than 50 years and throughout this period their role has not been exposed to the flood. Or partial flooding, however close to the residential units of the valley, indicating the existence of the reasons that led to this flood and through the field study and questionnaire distributed to the inhabitants of these villages shows that the reasons for the flood of this valley due to several factors:

### **Natural factors**

1. Climatic factors represented in the increase of rainfall, which amounted to more than 125 mm in hours, while the annual revenue of this region in previous years is approximately 200 mm, Table 7, Figure 1.

**Table 7. Rainfall in Makhmour Station (1988-2013)**

Months	Jun.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Rain\ml	99.2	61.5	43.7	48.7	9.6	0.7	0	0	7.3	11.1	27.1	37.6	346.5

Source: The work of the researcher based on the data of the Meteorological Authority of Makhmour station for the period (1988-2013) (unpublished data).

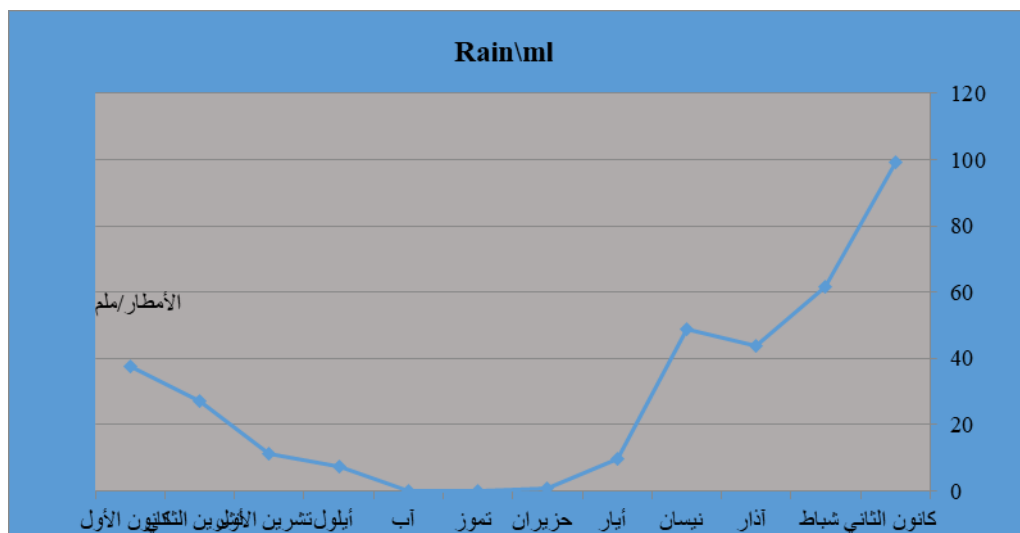


Figure 1. Rainfall Rates for Makhmour Station (1988-2013)

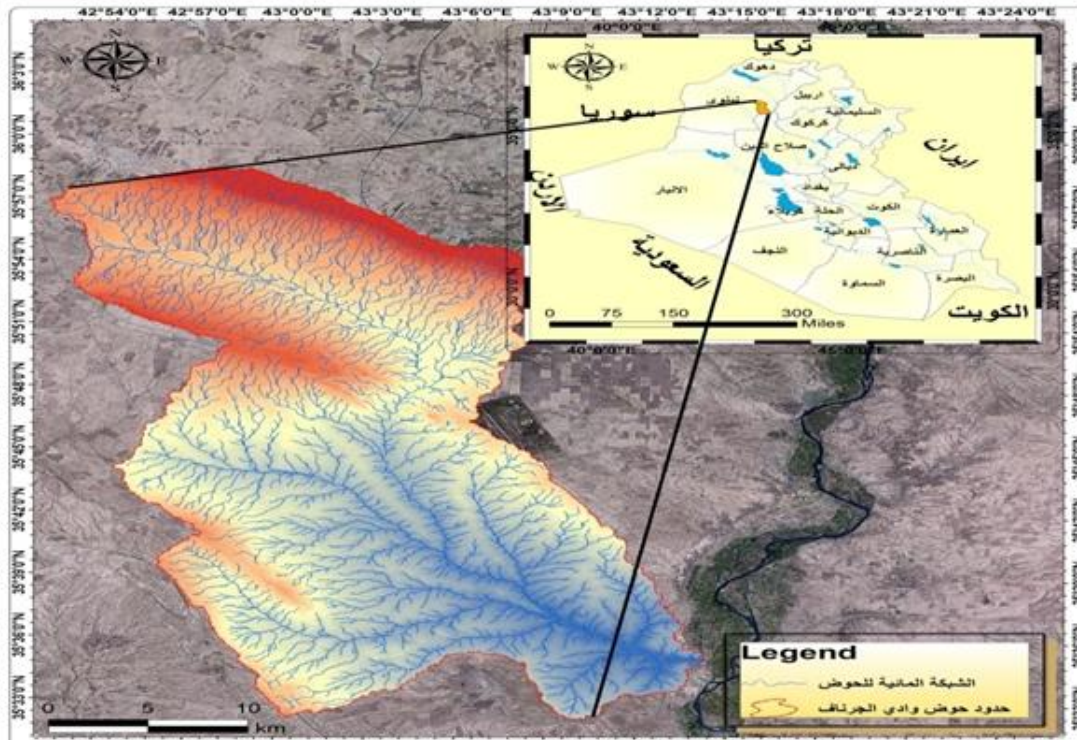
Al-Khaderaniya village pointed to an increase in the amount of rainfall this year, while 85% of the residents of Al-Houriya village, whose housing units were damaged, said that the increase in rainfall is one of the main reasons for this flood. (28 It is noteworthy that this year is one of the wet years in Iraq in general, where the periods of rainfall continued continuously without the presence of long time intervals between periods of rainfall, and that the amounts were more than compared to previous years, as indicated by the field study and Table 8. More than 81% of the respondents from.4%) in the two villages causes the flood to Ze Dah amounts of rain falling.

Table 8. Causes of flooding in Al-Jarfaf Valley

The village	Rains		Blockage of the Crimean bridge openings		Bridge collapse		Dirt repayment collapse		Near housing from the valley	
	No.	%	No.	%	No.	%	No.	%	No.	%
Al-khudraniya	135	81%	128	77%	99	60%	73	44%	22	135%
Al-huriya	181	855 %	171	80.6%	149	70%	140	66%	8	3.7%
Total		83%		78.5%		65%		55%		8.3%

Source: Field study and questionnaire

**2. Topographic factors:** It is a factor that follows the main valley influencing the occurrence of the flood, which is the valley of Ramadaniyat (Jarnaf). 00- 58 ° 35' N, as in Figure 1-1, the study area extends northwest of Shirqat, from the village of Miran (northwest) to the village of Houriya (southeast), and runs in the Tigris River in the southern border of this village It covers an area of about 894 km<sup>2</sup>, the length of the main valley is about 53.5 km, and the height of the valley at the source is about 320 m above sea level. The end of the valley is 155 meters above sea level.



**Map 5. Wadi Al-Ramadanyat Basin**

(Source: Sabbar Abdullah Saleh and others, Morphological analysis and calculation of water revenue at the section of the proposed dam on the valley of Jernav / Sharqat / northern Iraq, Journal of the Faculty of Science, No.)

## Human factors

- 1. Blockage of old bridge openings:** There are two bridges on the valley of Al-Jirnan, one of them is more than 70 years old and the last one is next to the old bridge. In addition to the function of draining the running water in Wadi Jarnaf towards the Tigris River through the openings in the two bridges, the field study and questionnaire indicated that (77%) Some of the respondents in Al-Khadraniya indicated that the cause of the flooding of this valley is the blockage of water drainage holes in the two bridges due to the collapse of the surface of the old bridge, which lies north of the new bridge and the closure of the drainage holes in the second bridge. This led to a rise in the water levels in the valley and the exit of water to the residential units and submerged them, whether partially or completely. While (80.6%) of the respondents in the village of Houriya said that the cause of the flood in addition to the high amounts of rain falling is the blockage of the bridges and no drainage of running water in the valley.
- 2. The collapse of the old bridge:** We also pointed out that the surface of the old bridge has slipped towards the new bridge, which is only 7 m away from it. This slide led to the closure of the drainage holes of the water. Distances of up to 70 km, which led to the closure of the water drainage holes in the new bridge. These quantities led to the inundation of large

numbers of units Residential Diachlorus nymph, has revealed that the field study (21.4%) Some of the respondents in al-Khadraniya village indicated that the collapse of the bridge is one of the causes of flooding and the outflow of water from the waterway to the neighboring housing units, while (23.5%) of al-Houriya village pointed to this reason.

**3. The collapse of the sand repayment in the top of the valley:** It is well known that the residents who are away from the permanently flowing watercourses resort to storing or harvesting water in different ways, especially those who are practicing grazing mainly as well as agriculture, through the establishment of dirt on the valleys to store water during periods of rain, for use in periods of interruption, The field study and spatial monitoring of the valley showed that the population groups make a dirt repayment on the course of this valley over a distance of (23) km from the sites of these villages are strengthening these repayment in the period of rain of each year, and because this repayment does not have drainage holes for excess water About the ability of these To repay to endure, the dam has collapsed The first one, including the water behind it, and the flow of water to the second dam, the second dam collapsed because of its inability to bear such quantities. To the west and to the fall of large amounts of rain in the southern and southwestern sections of Mosul. That (16.8%) Al-Khadraniya residents attributed the cause of the flood to this reason, while (21.6%) of the inhabitants of al-Houriyya blamed the cause of the flood to this reason. The study team believes that the cause of this flood is the reimbursement which did not have drainage holes for the surplus water. The answer does not weaken this reason because a large proportion of the inhabitants who were questioned do not know anything about these dirt repayments which were placed in the top of the valley.



**Figure 1. Shows the earth dams built on the valley basin**

(Source: Bariq, Unpublished Master Thesis, Tikrit University, College of Education for Humanities, Department of Geography, 2018)

**Spatial Proximity:** The approach of the people to the course and settlement through the establishment of housing units is one of the reasons for the flood on the lack of impact, because we have already shown that more than (80%) of the housing units in the villages of Khadraniya and Hurriyah have been in these places near the valley more For 50 years, there was no flood threatening the existence of these housing units, in addition to the competent authorities (Department of Water Resources) There are no taboos for this valley to prevent residents from exceeding them by building. Khadraniya was the cause of drowning because of its proximity to the valley and that 3.7% of the housing units in the nymph is due to the sinking of the proximity of the valley of the Jarnav.

Delayed government agencies in the completion of the proposed dam projects on this valley, which would have significantly reduced the occurrence of floods and turn the forbidden areas in the valley to safe areas. The construction of dams and reservoirs on the streams of small valleys, rather than the construction of large dams that are expensive time, effort and money is the best way to do so, as small valleys have a small storage capacity compared to large dams in addition to be low cost to set up, taking into account the importance Water harvesting through reducing the risks of flooding as well as the possibility of investing this water in the development of the region in terms of agricultural, recreational and livestock development, where two sites were elected to construct dams taking into account the previously mentioned aspects

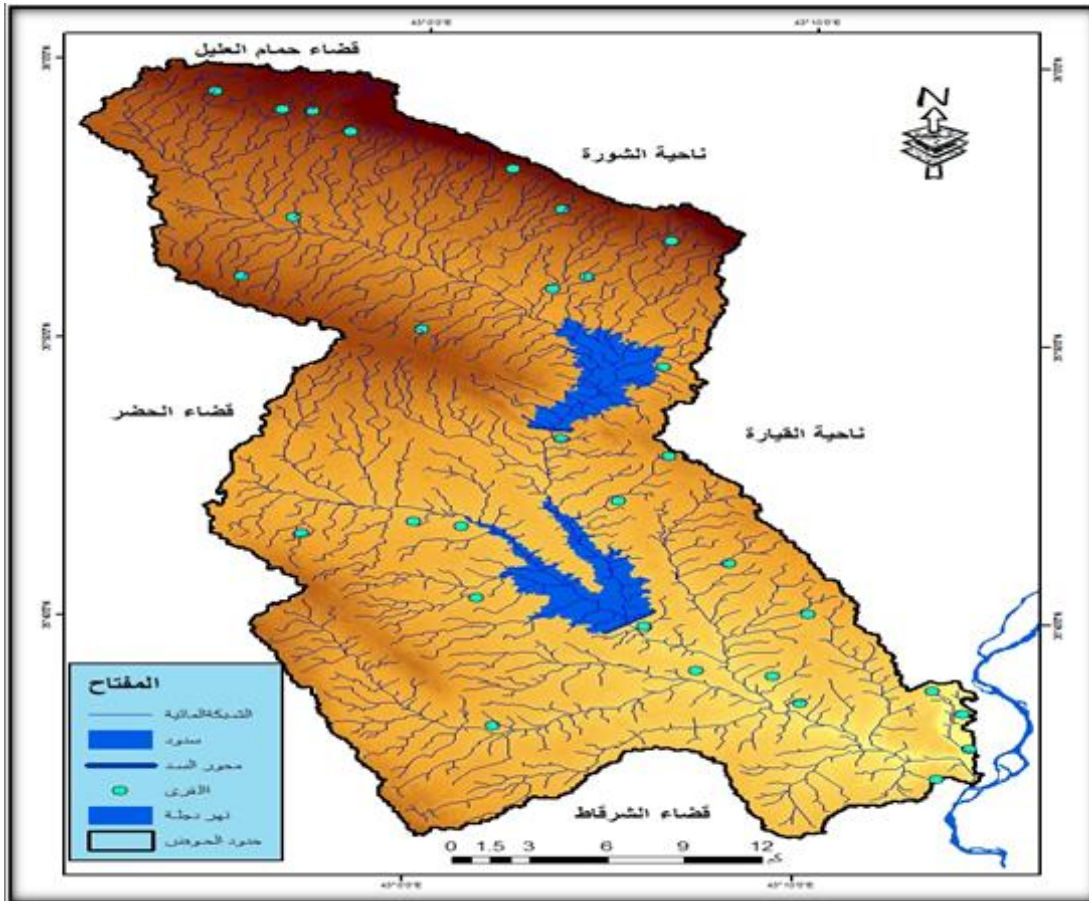
In summary, (97%) of the reasons for the flood are due to four reasons are frequent rain, clogged drainage holes for the old bridge, and the collapse of the old bridge and the collapse of the dirt repayment at the top of the river valley, and does not constitute near the housing units of the course of a significant impact, and may be due to a small percentage To the fear of the respondents not to compensate them for the damage if they have given the impact of this factor.

### **Solutions and remedies to prevent future floods**

1. The need for the relevant government authorities to establish dams to prevent floods in the valley of Jarnav, as it can be proposed more than one dam in several sites that can be used to reduce the floods in the future in addition to investing in the harvesting of rainwater to be used in the reclamation of vast land in the region and can be used as means of transport As bridges as well as for tourist purposes, map (5).
2. The need to alert the population of these areas not to settle near the main stream of the valley and stay away from the forbidden and threatened by the flood
3. Directing the population not to set up informal, irregular earth repayments because of its effect in increasing the risk of flooding.
4. The need for the concerned authorities to conduct periodic maintenance on the old bridge to avoid the recurrence of disasters caused by the neglect of this bridge.



5. The need to dig waterways from the end of the basin to the Tigris River to facilitate the flow of flood water to the Tigris and not to climb to neighboring villages.



**Map 6. Proposed Dam Locations in the Study Area**

(Source: Bariq, Unpublished Master Thesis, Tikrit University, College of Education for Humanities, Department of Geography, 2018)

## Conclusions

The most important conclusions reached by this study, which can be summarized in the following points:

1. Most of the flooded areas in the study area are mainly pre-classified areas within the areas threatened by the flood due to the low level of its surface and its proximity to the course of the main valley (Wadi Jarnav), which flows into the Tigris River.
2. This year is an abnormal year from previous years in terms of the amount of annual rainfall, if the estimated daily rainfall on the day the flood occurred is equivalent to annual revenue for a full year.
3. There are a number of causes that increased the risk of this flood, the most important of which is the establishment of random dirt repayment, and the lack of implementation of the

proposed storage projects in the region, as well as the collapse of the old bridge and clogged openings, which increased the accumulation of water and inundated residential areas in a short period accelerated rapidly to increase human losses And physical in this region.

4. As a result of this flood many losses in the region, including loss of lives in addition to significant material losses as a result of the flooding of agricultural land and flooding of houses, property and animals.

## Recommendations

This study recommends a set of recommendations:

1. The study recommends the need for government agencies to implement the relentless projects for the construction of reservoirs dams within the valley network to take advantage of them in the prevention of floods as well as benefit from water storage in addition to considering tourist areas.
2. The study recommends the need to educate the population in order to stay away from the areas threatened by the flood in order to prevent the occurrence of human and material losses, in addition to the need not to establish random earthen dams subject to demolition at any moment, which increases the risk of flooding.
3. The study recommends the need for government agencies to compensate the people of these areas, because the state bears part of the responsibility because it did not implement irrigation projects, such as dams and reservoirs, which would protect these areas from floods.

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