

Consequences of Uncontrolled Flash Storm Flooding: A case study from Iraq, December 2025- January 2026

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Abstract

Iraq is one of the most affected countries in the World by climate change. The country has suffered from severe droughts for many years, causing a decrease in the water level in all existing dams' reservoirs and a decrease in the groundwater level, a decrease in the amount of water flow in rivers, and the immigration of thousands of farmers from rural areas to nearby cities and towns. In December 2025 -January 2026, an extraordinary rain and snowfall occurred in almost all parts of Iraq; consequently, floods occurred in all rivers, streams, valleys, and even plains. The maximum recorded precipitation was 126 mm/day for three consecutive days at Cham Chamal town, where two people died, one was missing, and 600 houses collapsed. The main roads between the capital, Baghdad and many cities were blocked due to flooding. Large agricultural lands were flooded. Unfortunately, the enormous amounts of flood water were lost without being stored to be of benefit in the coming months. We constructed a special map and divided the whole area of Iraq into three types of basins: controlled, uncontrolled, and semi-controlled. They form 15.37%, 67.96%, and 16.66% of the total Iraqi coverage area, respectively.

Highlights

- Iraq is witnessing severe drought due to climate change.
- Uncontrolled floods caused a lot of economic losses and life losses too.
- We divided the whole area of Iraq into 3 main types of basins.
- The basins are controlled, uncontrolled, and semi-controlled.
- The three basins form 15.37%, 67.96%, and 16.66% of the total Iraqi coverage area, respectively.

1. Introduction

Iraq is considered to be the fifth-most vulnerable country to climate breakdown, affected by climate change, soaring temperatures, insufficient and diminishing rainfall, intensified droughts and water scarcity, frequent sand and dust storms and flooding (IOM, 2022). The decrease in rainfall amounts and the decrease in water flow in the Tigris and Euphrates rivers and their tributaries have caused severe drought conditions in different parts of Iraq, especially the southern parts. The marshes are almost dry; accordingly, thousands of families are migrating towards nearby towns and cities from the marshlands and other water bodies. The livestock and fisheries are severely affected in marshlands and other rural areas. All these events happened after the droughts, which hit almost all parts of Iraq.

Tens of articles have been published about the impacts of climate change on Iraq; among them are, but are not limited to: Gregory et al. (2005) explained the impact of climate change on food scarcity. Adamo et al. (2018a) studied and discussed the effect of climate change on the environment of Iraq. Adamo et al. (2018b) discussed the future of water resources in the Tigris and Euphrates rivers due to climate change. Al-Ansari et al. (2018) studied the impact of climate change on the water quality of the Tigris and Euphrates rivers. Al-Ansari et al. (2019) discussed the water shortage in the Tigris and Euphrates rivers and the environmental consequences. Abdullah et al. (2020) discussed how floods can be controlled in the Mesopotamian Plain. Adamo et al. (2022) studied climate change in Iraq and the need for future research. They discussed the consequences of climate change and its harsh effects on different sectors in Iraq. Sissakian et al. (2020) explained the role of climate change in the desertification and salinisation of the Mesopotamian Plane in the central part of Iraq. Al-Ansari et al. (2023a) explained the causes of water resources scarcity in Iraq and mentioned many possible solutions to overcome this scarcity. Al-Ansari et al. (2023b) discussed the possible solutions to overcome water shortage in Iraq. Sissakian et al. (2023a) discussed the consequences of climate change in Iraq and showed the harsh effects on different aspects and in different parts of Iraq. Sattar (2023) reported on the construction of dams in the Kurdistan Region of Iraq. He mentioned that "As the clear and present dangers of climate change and global warming become a reality in Iraq and the Middle East, the Kurdistan Regional Government has committed itself to developing strategies to secure the future of its people, the foremost of which is the construction of dams and reservoirs. Alwan et al. (2025) discussed the impact of climate change on population migration and displacement within the southern governorates of Iraq. They focused on drought and desertification of land, specifically in Dhi Qar, Maysan, Muthanna, and Basra governorates. Sissakian et al. (2023b) explained the impact of water scarcity on food security in Iraq. Al-Shakri (2025) argued that climate change is drying rivers, upstream neighbouring countries are diverting and reducing water flows in the Tigris and Euphrates rivers and their tributaries, while at the same time, the responsible authorities have failed to manage this most vital resource in Iraq. He added that "Scarcity of water is not only a national crisis for Iraq, but a growing driver of internal tension".

All the mentioned research and more have dealt with the climate change impacts of the droughts on Iraq. Less research, however, was conducted to overcome these impacts by constructing dams and practising water harvesting. Among these other studies, not limited to, are: Kamel and Suleiman (2012), who performed a hydrologic study for the Iraqi Western Desert to assess possible water harvesting projects. Faqe Ibrahim et al. (2019) conducted site selection of dams intended for water harvesting in Duhok Governorate, NW Iraq. Sadeq and Mohammad (2022) studied the watershed in Kirkuk Governorate, Iraq, for water harvesting projects. Ashraf et al. (2024) discussed the most suitable water harvesting sites in a data-scarce region via an integrated Promethee-II-AHP method in a GIS environment in Iraq. Hajani et al. (2025) performed a GIS study to select relevant locations for the construction of dams for water harvesting in Erbil, Iraq. Mohammed and Abed (2025) discussed the possibility of constructing dams along Wadi Al-Ubaid in the Iraqi Western Desert for water harvesting.

The current study aims to: **1)** point out all water basins along the Tigris and Euphrates rivers and their tributaries in Iraq where rainfall runoff can be stored in existing reservoirs, natural depressions such as, Tharthar Lake, southern and middle marshes, Al-Razzazah, Al-Habbaniyah, and along the longitudinal depressions along the Abu Jir active fault zone (Fig. 1), which runs almost parallel to the Euphrates River, and **2)** show areas where the rainwater runoff during floods will be wasted without storage possibilities, and to; Third: indicate areas where small dams should be constructed to collect flood water runoff for different domestic uses, agriculture and electric power generation.

Figure 1: Map showing the main dams, reservoirs and valleys. Dams: 1 = Mosul, 2 = Haditha,

3 = Dukan, 4 = Derbendi Khan, 5 = Duhok, 6 = Gom Ispan, 7 = Al-Adhaim, 8 = Hemren, and 9 = Samarra. Natural depressions: 10 = Al-Tharthar, 11 = Al-Habbaniyah, 12 = Al-Razzazah, and 13 = Depressions along Abu Jir Active Fault Zone. Marshes: 14 = Al-Shbicha, 15 = Al-Hammar, and 16 = Al-Hwaizah.

The current study area covers the whole of Iraq (Fig. 1). Figures (1) shows existing large dams and small dams on rivers and streams, together with the natural depressions, marshes, and wadies in the country. It also shows the recommended locations for the construction of dams to store flood water runoff, which cannot be stored in the existing dams and should not be wasted, and flows to the Arabian Gulf through the Shat Al-Arab.

2. Materials and Methods

In performing the current research, we have reviewed tens of relevant published papers, hydrological maps, drainage maps, and interpreted satellite images. Accordingly, we have managed to construct a special map, which elucidates the delineation of basins in Iraq along the Tigris and Euphrates rivers and their tributaries. We have used ArcGIS Pro / Desktop to calculate the coverage areas of the basins shown on the mentioned map. As the scales of the used satellite images are small, the calculated areas are approximate. This is because the drawn delineation limits of the basins cannot be fixed to such highly refined accuracy. Nevertheless, the obtained results are considered to be enough for this research. Moreover, we have also discussed the possibilities of storing the extra rainfall runoff downstream of the existing dams and how to store the large volume of runoff, which is currently transferred to Al-Tharthar Depression, with the subsequent loss of quality due to the high salt content of water stored in this depression, through a special channel from downstream of the Samarra dam. Finally, we have presented some suitable sites for the possible construction of dams after being studied and evaluated scientifically.

3. Results

After three years of continuous decrease in the amounts of rainfall and water inflow in the main rivers and streams in Iraq from Turkey, Iran and Syria, extremely high amounts of rainfall and snowfall have been witnessed from December 2025 and still in January 2026 in Iraq. Accordingly, large amounts of water are stored in the reservoirs of existing dams, Al-Tharthar Depression, and the marshes. However, large amounts of runoff (more than those stored) flowed out of Iraq to the Arabian Gulf through the Shat Al-Arab.

Recorded rainfall amounts ranged from (33–126) mm/ day, the maximum being on the 10th of December 2025 in Cham Chamal town in the Iraqi Kurdistan Region, causing inundation of 500 homes and the central library of the town, which included historical books, maps and historical manuscripts (Fig. 2). Other cities and towns witnessed extraordinary rainfall, which caused damage to infrastructure, blockage of the main roads (Fig. 3), and even loss of lives.

Figure 2: Cham Chamal inundated library (10/12/2025), a) inside, and b) outside.

Figure 3: Damage to infrastructure (10/12/2025), a and b) Damage to the Tuz Khurmatu bridge, c) Accumulated trucks on a damaged road near the Daqooq town, and d) Inundated main road between Baghdad and Kirkuk city.

The uncontrolled rainwater runoff during floods resulting from heavy rainfall in different parts of Iraq also caused life losses; two in Sulaimaniyah city, three in Nasiriyah city, and eight injuries in different towns and cities in different parts of Iraq. These events were accompanied by large evacuation efforts by volunteers in different cities and towns (Fig. 4).

Figure 4: Evacuation attempts by volunteers: a) A child from an inundated car, b) Guiding trucks' drivers to the position of the road, c) Guiding a flock of sheep to cross a flooded stream, d) Officers evacuating isolated people by ropes, e) Pulling a car in a snow-covered road, and f) Two persons waiting for evacuation.

Moreover, huge floods were initiated from the western part of Iran and flowed into the eastern parts of Iraq through streams and wadies caused severe damage to infrastructure and inundation of large agricultural lands. Moreover, large amounts of water flowed towards the Tigris River, then to the Shat Al-Arab and finally to the Arabian Gulf. It is noteworthy to mention that although the rainfall is decreasing, there are periods when the precipitation is relatively high for a short period of time, causing floods. Several examples can be recognised in this context (Al-Ansari et al., 2014a,b,c, 2015, and 2025; Osman et al., 2014, and 2019) (Fig. 5).

Figure 5: Flood scenes in different parts of Iraq at different times.

Besides the extraordinary rainfall, extreme snowfall was witnessed in different cities and towns of the Kurdistan Region (North and northeast of Iraq). The height of the snowfall ranged between (0.3–3) m (Fig. 6), the maximum being in Choman town, in the extreme northeast of Iraq. The melting of the snow caused more runoff in valleys and streams, which increased the amount of flooded water.

Figure 6: Dense snowfall, a) Near Hassan Beg Mountain (10/12/25), and b) Near Choman town (15/01/2026), both in the northeastern part of Iraq

According to the Deputy of the General Directorate of the National Centre for Water Resources Management, the amount of rainfall outflow originating from the northern and north-eastern parts of Iraq on 10/12/2025 was $500^{10 \times 6} \text{ m}^3$; out of this volume, $200^{10 \times 6} \text{ m}^3$ was diverted to Al-Tharthar Depression by the Samarra Barrage through the Samara- Tharthar flood control channel. He added that the amount of water released from all Iraqi dams decreased from $300 \text{ m}^3/\text{sec}$ to $150 \text{ m}^3/\text{sec}$. Moreover, these amounts of water will recharge the groundwater and increase the grazing areas in the next spring.

Although the amounts of rainfall in December 2025 and January 2026 were more than the normal rainfall rates, in February 2026, people, especially in rural areas, in Al-Diwaniyah, Al-Nasiriya and Al-Amara governorates (middle and south of Iraq), especially rural areas, are suffering from water scarcity. Affected farmers are suffering and have declared that they will eventually abandon their agricultural lands due to water shortage, which has caused severe economic losses, including the loss of thousands of cattle, especially water buffaloes, and livestock. The water crisis extended to include drinking water and other daily uses.

4. Discussion

Although the current year (2026) seems to be a rainy year with a lot of rainfall, just the opposite of the previous three years, people in the Al-Diwaniyah, Al-Nasiriyah, and Al-Amarah governorates (Fig. 7), however, are suffering from water scarcity and claiming the abandonment of their agricultural lands and the loss of their animal wealth. This can only be seen as one of the consequences of the uncontrolled wasting of rainwater during floods resulting from heavy rainfall.

Table 1
Characteristics of the drainage basins

Basin		Description
No.	Name	
T1	Mosul Dam	Runoff flows directly into the Mosul Dam reservoir through the Tigris River, which originates from Turkey and Syria.
T2	Tigris River (1)	Runoff flows released from the Mosul Dam, plus Dokan Dam releases, together with natural runoff from the catchment area downstream of the Dokan Dam (through the Lesser Zab River) towards the Tigris River until the Samarra Barrage.
T3	Greater Zab River	Runoff flows through the Greater Zab River and all its tributaries, flowing from Turkey and Iran towards the Tigris River.
T4	Dokan Dam	Runoff flows directly into the dam's reservoir through the Lesser Zab River, flowing from Iran.
T5	Darbandikhan Dam	Runoff flows directly into the dam's reservoir through the Sirwan (Diyala) River, flowing from Iran and the Tanjero tributary in Iraq.
T6	Al-Adhaim Dam	Runoff flows directly into the dam's reservoir through Al-Adhaim River and its three tributaries, which originate from inside Iraq.
T7	Himreen Dam	Runoff flows directly into the dam's reservoir through the Diyala River, between Derbendi Khan and Hemren dams, partly flowing from Iran.
T8	Tigris River (2)	Runoff flows directly towards the Tigris River from Samarra, Al-Adhaim and Hemren dams through Al-Adhaim and Diyala rivers and partly from Iran.
E1	Haditha Dam	Runoff flows directly into the dam's reservoir through the Euphrates River, flowing from Iraq and Syria.
E2	Rutbah-Ramadi	Runoff flows directly towards the Euphrates River from Haditha Dam, Wadi Horan and other wadies (valleys).
E3	Al-Nukhaib	Runoff flows directly towards Al-Habbaniyah and Al-Razzazah depressions and partly to the Euphrates River through tens of wadies.
E4	Al-Salman	Runoff flows directly towards many depressions along the Abu Jir Fault and Al-Hammar marsh through tens of valleys.
E5	Euphrates River	Runoff flows directly to the Euphrates River and, in turn, to Al-Hammar Marsh.
S1	Shat Al-Arab	Runoff flows directly towards the Shat Al-Arab, mainly from Iran.
S2	Al-Basrah	The water flows directly towards Shat Al-Arab, mainly from inside Iraq and partly from Kuwait.
Th	Al-Tharthar	Runoff flows from parts of Sinjar Mountain and Al-Jazira through Al-Tharthar valley and its tributaries.
1	Zakho	A small basin in the NW of Iraq; the water flows towards Turkey.
2	Shlair	A small basin in the extreme NE of Iraq; the water flows towards Iran.
3	Sinjar	The long basin in the extreme West of Iraq; the water flows towards Syria.
4	Traibeel	The long basin in the extreme West of Iraq; the water flows towards Jordan and Syria.

Figure 7: Map of drainage basins imposed over a satellite image. For the letters and numbers indication, refer to Table 1.

To elucidate the areas where there is no control on the runoff in Iraq, we constructed a special map, which shows the main drainage basins of the Tigris and Euphrates rivers with their tributaries, the main wadies, especially in the Iraqi Western and Southern deserts, and Al-Tharthar Wadi and Depression (Fig. 7). The map shows the existing main dams, reservoirs, and drainage basins. Each drainage basin has a number indicating which river, reservoir, depression, or marsh it drains. The details of the drainage basins are given in Table 1.

Table 1: Characteristics of the drainage basins

From the map of the drainage basins in Iraq (Fig. 7), it is clear that only a small part of the rainwater runoff in Iraq is controlled by means of dams, while runoff, which flows from the remaining part of Iraq, is uncontrolled. Accordingly, it flows in the rivers towards the marshes and Shat Al-Arab and ultimately to the Arabian Gulf (Fig. 7). However, some basins are semi-controlled, such as T2 and T3 (Table 2); these types are discussed in detail in the following.

Table 2
Coverage areas and percentages of the basins in Iraq

Basin		Coverage	Percentage of the total coverage area of Iraq (%)	Percentage of the total coverage area of Iraq (%)						Basin		
No.	Name	Area (km ²)		Tigris River	Euphrates River	Shat Al-Arab	Al-Tharthar	Flowing out of Iraq		Controlled	Uncontrolled	Semi controlled
T1	Mosul Dam	11298.49	2.57	34.57						2.57		
T2	Tigris River (1)	20863.91	4.75									4.75
T3	Greater Zab River	19030.83	4.33									4.33
T4	Dokan Dam	5696.03	1.29							1.29		
T5	Darbandikhan Dam	7232.33	1.65							1.65		
T6	Al-Adhaim Dam	18330.83	4.17							4.17		
T7	Hemren Dam	6912.33	1.57							1.57		
T8	Tigris River (2)	62537.89	14.24								14.24	
E1	Haditha Dam	17147.75	3.90		47.34					3.90		
E2	Rutbah-Ramadi	36661.65	8.35								8.35	
E3	Al-Nukhaib	78655.63	17.91								17.91	
E4	Al-Salman	59224.81	13.48								13.48	
E5	Euphrates	16264.66	3.70								3.70	
S1	Shat Al-Arab	3666.17	0.83			4.08					0.83	
S2	Al-Basrah	14264.66	3.25								3.25	
Th	Al-Tharthar	33295.49	7.58				7.58					7.85
1	Zakho	1683.09	0.38					6.42			0.38	
2	Shlair	3466.17	0.79								0.79	
3	Sinjar	11098.50	2.53								2.53	
4	Traibeel	11940.04	2.72								2.72	
Total		439271.26	99.99							15.15	68.18	16.93
Controlled basins			Uncontrolled basins				Semi-controlled basins					

4.1. Controlled Basins

These basins are controlled by means of different types of dams (Table 2, Fig. 7). The total coverage area of these basins is 99913.25 km², forming 22.74% (Tables 2 and 3) of the total coverage area of Iraq. These basins store the flowing rainwater runoff by means of the Mosul Dam (basin T1), Haditha Dam (basin E1), Dokan Dam (basin T4), Darbandikhan Dam (basin T5), Al-Adhaim Dam (basin T6), and Hemren Dam (basin T7).

Table 3
Coverage areas and percentages of the main basins

Basin Name/ Symbol	Coverage Area (km ²)	Percentage of the total coverage area of Iraq (%)	Type of the basin		
			Controlled	Un- controlled	Semi controlled
			(km ²)	(km ²)	(km ²)
			% *	% *	% *
Tigris River	151902.64	34.58	50370.10	61637.80	39894.74
T1-T8			33.16	40.58	26.26
Euphrates River	207954.50	47.34	17147.75	190806.75	
E1-E5			8.25	91.75	
Al-Tharthar	33295.49	7.58			33295.49
Th					100
Shat Al-Arab	3666.17	0.83		3666.17	
S1				100	
Al-Basra	14264.66	3.25		14264.66	
S2				100	
Outside of Iraq	28187.80	6.42		28187.80	
1-4				100	
Total	439271.26	99.99	67517.85	298563.18	73190.23
			** 41.41	** 68.18	** 16.93
* From the total area of the basin, ** from the total area of Iraq					

Table 2: Coverage areas and percentages of the basins in Iraq

4.2. Uncontrolled Basins

These are the basins in which there is no control on the rainfall runoff (Fig. 7). This means that the rainfall runoff in these basins flows towards three groups: **1)** Shat Al-Arab, through the Tigris River; (basin T8), **2)** To the Euphrates River directly; (basin E2), depression, which are developed along the Euphrates-Abu Jir Active Fault ;(basins E3 and E4), and the marshes; through the Euphrates River; (basin E5), and **3)** Flowing Towards outside of Iraq; (basins 1, 2, 3, and 4). The total coverage area of these basins is 299463.27 km², forming 68.18% of the total coverage area of Iraq (Tables 2 and 3). The locations of these basins are shown in Figure (7).

Table 3. Coverage areas and percentages of the main basins

4.3. Semi-controlled Basins

These are the basins in which the rainfall runoff is not fully controlled. This means that part of the runoff is controlled, including: **1)** the water released from the Mosul Dam through the Tigris River (basin T2), **2)** the rainfall runoff flowing through the Greater Zab River and its tributaries (basin T3), and **3)** the rainfall runoff flowing towards Al-Tharthar Depression (basin Th). We considered these three basins as semi-controlled because part of the runoff water is diverted through the Samarra Barrage (Fig. 1) towards Al-Tharthar Depression, while the remaining part flows out of the Samarra Barrage towards Shat Al-Arab through the Tigris River (Fig. 7). Although there is one barrage on the Tigris River at Al-Kut city, this barrage is only for regulation and has no capacity for water storage; therefore, part of the flow is diverted to various irrigation projects while the remaining part is released towards Shat Al-Arab. The total coverage area of these basins is 39894.71 km², forming 9.08% of the total coverage area of Iraq (Tables 2 and 3). The locations of these basins are shown in Figure (7).

4.4. Coverage Areas and Percentages

Apart from the basins of the Tigris (basins T1, T4 - T8) and Euphrates (basin E1) rivers, all other basins are uncontrolled or semi-controlled (Tables 2 and 3). We have distinguished the basins of the Tigris River (basins T1 – T8) and those of the Euphrates River (basins E1 – E5) to elucidate the coverage areas and their percentages of the total coverage area of Iraq (Table 4).

The total coverage area of the Tigris River is 151902.64 km² (Table 4), forming 34.58% of the total coverage area of Iraq. Among this total area, 50370.10 km, 61637.80 km, and 39894.74 km form controlled, uncontrolled and semi-controlled basins, respectively, representing 33.16%, 40.58%, and 26.26% percentages of the total coverage area of the basins of the Tigris River (T1 – T8) (Fig. 6 and Table 4). The total coverage area of the Euphrates River is 207954.50 km² (Table 4), forming 47.34% of the total coverage area of Iraq. Among this total area, 17147.75 km² and 190806.75 km² form controlled and uncontrolled basins, respectively, representing 8.25% and 91.75% percentages of the total coverage area of the basins of the Euphrates River (E1 – E5) (Fig. 7 and Table 3).

For the remaining basins, i.e. Shat Al-Arab, Al-Basra, and those which flow out of Iraq, they are all completely uncontrolled. Whereas Al-Tharthar Depression forms a semi-controlled basin by 100%, apart from the diverted water from the Samarra Barrage.

From Table (3), it is clear that the total areas of the controlled, uncontrolled, and semi-controlled basins in Iraq are 67517.85 km², 298563.18 km², and 73190.23 km², whereas their percentages are 15.37%, 67.97%, and 16.66%, respectively.

4.5. Increasing the Coverage Areas of Controlled Basins

The total coverage area of Iraq is a matter of debate; different sources mention different data. The textbook of Geography in the sixties of the last century gave an area of 444433 km². The country profile of Iraq (2008) mentioned 438320 km²; the Iraqi Embassy in Washington (2026) mentioned 437072 km², whereas Instagram data (2025) mentioned 438317 km². These discrepancy figures may be attributed to: **1)** Revising and formalising the Jordan- Iraq border line at Al-Risha area in 1984, **2)** Revising and formalising the total border of Iraq-Saudi Arabia during the seventies of the last century, and **3)** Fixing the land border line between Kuwait and Iraq by the United Nations in 1993. However, we have measured the area using the ArcGIS Pro / Desktop program and found that the total area is 439271.26 km², based on a Google Earth Pro satellite image dated on 01/01/ 2021. Discrepancies in the total coverage area may also be due to using different maps or images, which show slight variations in the international boundaries of Iraq with neighbouring countries. These discrepancies are, however, so slight that they do not result in any significant errors in the calculated results. Moreover, the calculated coverage areas and percentages of the different drainage basins (Tables 2 and 3) depend on the accuracy of the constructed basins, which cannot be done so accurately on the satellite image (Fig. 7).

The acquired data on the coverage areas of the controlled basins showed that these areas are very small; 67517.85 km², forming 15.37% of the total area of Iraq (Table 3), as compared to the areas of uncontrolled basins (298563.18 km²; forming 67.97% of the total area of Iraq, Table 3). These data obviously show that the majority of the rainfall runoff amounts in Iraq are uncontrolled, which means they cannot be stored for use in deficiency months.

To increase the areas of controlled basins at the expense of the uncontrolled and semi-controlled basins, the following steps should be considered:

- 1. Construction of Dams:** Construction of large dams like Mosul, Haditha, Dikan, and Darbandikhan is not relevant because of: a) the high cost, b) the long duration needed, c) the low volume of inflows in the rivers, and d) the effect of the large dams on the quality of the stored water is not relevant (Adamo et al., 2020). Therefore, the construction of small dams on the large streams and wadies is the best choice. We have suggested some locations for the construction of such dams (Fig. 1). However, detailed site investigations and studies should be performed before site selection and starting construction.
- 2. Water Management:** Enhancement of the water management performed by the Ministry of Water Resources of Iraq, as the present situation is poor and has bad consequences on the amounts of available water, flows in the Tigris and Euphrates rivers, and their distributaries in the middle and southern parts of Iraq. In particular, the fresh water is diverted to Al-Tharthar Depression, which is polluted due to the presence of gypsum beds in the depression. Consequently, the dissolution of the gypsum beds will increase the salinity of this fresh water and change it to brackish water. Moreover, the released amounts of water from all existing dams and barrages are not well planned during the whole year; accordingly, people living in the southern governorates suffer from water shortage starting from May and even April.
- 3. Water Harvesting:** The strategy of water harvesting should be considered by the concerned authorities and even encourage the private sector and farmers' cooperatives to help in this effort. The Iraqi Kurdistan Government is performing such a strategy by the construction of small earth dams on the large streams and wadies (valleys).
- 4. Termination of Flood Water Diversion and Storage in Al-Tharthar Depression:** Al-Tharthar Depression (Figs. 1 and 7) is the largest natural depression in Iraq; it has developed as a result of the dissolution of the gypsum beds (Sissakian, 2011). Therefore, its stored water quality is highly brackish to saline (more than 10000 ppm) (Al-Jiburi and Al-Basrawi, 2015). Accordingly, the diversion of fresh rainwater runoff from Samarra Barrage to the depression means polluting it and increasing the salinity of the Mesopotamian Plain when the stored water is diverted back to the Tigris and Euphrates rivers for irrigation purposes. Similarly, all the rainfall runoff drained from the basin (Th) (Fig. 7) by Wadi Al-Tharthar into Al-Tharthar Depression will be wasted in the same way if it is allowed to flow into the depression. This can be avoided only if small dams on this wadi are constructed as a rainfall harvesting project; at the same time, stopping the diversions of flood flows from Samarra Barrage to Al-Tharthar Depression through the Samarra-Tharthar flood channel.

5. Conclusions

From the presented data, we can conclude that most of the rainwater and snowmelt runoff cannot be controlled, as there is not a sufficient number of dams with sufficient storage capacities on the rivers, streams or main wadies. In this work, we have divided the whole coverage area of Iraq into the natural drainage basins along the main rivers, streams and wadies, which in turn may be classified into three main types: 1) Controlled drainage basins,

2) Uncontrolled drainage basins, and 3) Semi-controlled drainage basins. The total coverage areas of these three types are: 67517.85 km², 298563.18 km², and 73190.23 km², respectively. These coverage areas form 15.37%, 67.97%, and 16.66%, respectively, of the total area of Iraq. To increase the areas of the controlled basins by changing the types of the uncontrolled and semi-controlled basins, we have given many preliminary and general suggestions in this respect. Further detailed studies supported by field inspections are needed to reach concrete solutions. Needless to say, such work is very important and urgently needed. This is due to the intensification of turbulent climate change impacts culminating in intensive localised storms. So, such storms continue to pose threats to lives and properties, while their resulting runoff mostly goes to waste, despite Iraq's present need for each drop of water due to the present water scarcity and persistent drought conditions.

Declarations

Conflict of Interest

All authors declare that there is no conflict of interest in the current research.

Author Contribution

Conceptualization, Nadhir Al-Ansari, Varoujan K. Sissakian, Salah A. Saeed and Nasrat Adamo; methodology, formal analysis, investigation: Nadhir Al-Ansari and Varoujan K. Sissakian; Validation and visualization, Nadhir Al-Ansari and Varoujan K. Sissakian; data curation, Nadhir Al-Ansari, Varoujan K. Sissakian, Salah A. Saeed and Nasrat Adamo; writing, Nadhir Al-Ansari, Varoujan K. Sissakian, Salah A. Saeed and Nasrat Adamo. All authors have read and agreed to the published version of the manuscript

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Data Availability

Data can be obtained from the corresponding author.

References

1. Al-Ansari N, Al-Jawad S, Adamo N, Sissakian VK, Laue J, Knutsson S Water Quality within the Tigris and Euphrates Catchments. Journal of Earth Sciences and Geotechnical Engineering 8 (3): 95–121. http://www.scienpress.com/journal_focus.asp?Main_Id=59
2. Al-Ansari N, Adamo N, Sissakian VK Water shortages and their environmental consequences within the Tigris and Euphrates Rivers. Journal of Earth Sciences and Geotechnical Engineering 9 (4): 27–56. http://www.scienpress.com/journal_focus.asp?main_id=59&_id=IV&Issue=1389407
3. Al-Ansari N, Adamo N, Hachem AH, Sissakian VK, Laue J, Abed SA Causes of Water Resources Scarcity in Iraq and Possible Solutions. Engineering 15: 467–496. <https://www.scrip.org/journal/eng>
4. Al-Ansari N, Adamo N, Sissakian V, Laue J Possible solutions to water shortage problem in Iraq. Engineering 6:205–223. <https://www.scrip.org/journal/paperinformation?paperid=135612>
5. A-Jiburi H, Al-Basrawi NH Hydrogeological Map of Iraq, scale 1:1000000, 2nd edition. Iraqi Bulletin of Geology and Mining 11(1): 17–26
6. Abdullah A, Al-Ansari N, Adamo N, Sissakian VK, Laue J Floods and Flood Protection in Mesopotamia. J Earth Sci Geotech Eng 10 (4): 155–173. <file:///C:/Users/Varoujan/Desktop/>
7. Adamo N, Al-Ansari N, Sissakian VK, Knutsson S, Laue J Climate Change: Consequences on Iraq's Environment. J Earth Sci Geotech Eng 8 (3): 43–58
8. <https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=http://www.diva->
9. Adamo N, Al-Ansari N, Sissakian VK, Laue J The Future of the Tigris and Euphrates Water Resources in View of Climate Change. J Earth Sci Geotech Eng 8: 59–74
10. https://www.researchgate.net/publication/324680990_The_Future_of_the_Tigris_and_Euphrates_Water_Resources_in_view_of_Climate_Change
11. Adamo N, Al-Ansari N, Sissakian VK How Dams Can Affect Freshwater Issues in the Euphrates-Tigris Basins. J Earth Sci Geotech Eng 10 (1): 43–76
12. http://www.scienpress.com/journal_focus.asp?main_id=59&_id=IV&Issue=1556687
13. Adamo N, Al-Ansari N, Sissakian VK (2022) Climate Change and the Need for Future Research. Earth Environ Sci 1120:012029. <https://iopscience.iop.org/article/10.1088/1755-1315/1120/1/012029>
14. Al-Shakri H (2025) Iraq's water crisis: Dammed by neighbours, failed by leaders. CHATHAM HOUSE publications. <https://www.chathamhouse.org/2025/08/iraqs-water-crisis-dammed-neighbours-failed-leaders>

15. Alwan KH, Al-Jawari SM, Mohammed AM, Obaid YH The Impact of Climate Change on Population Migration and Displacement Within the Southern Governorates of Iraq. *Int J Environ Impacts* 8 (6): 1266–1277. <https://www.acadlore.com/journals/IJE>
16. Ashraf MU, Masood M, Iqbal M, Ahsan MF, Mustafa AU Ascertainment of the most suitable water harvesting sites in a data-scarce region via an integrated Promethee-II–AHP method in a GIS environment. *Water Pract Technol* 19(3): 796–811. <https://doi.org/10.2166/wpt.2024.052>
17. Country, Profile (2008) Internet data, last retrieved on 26/ 02/ 2026. <https://openknowledge.fao.org/server/api/core/bitstreams/ecd5b0d0-7e80-4b5f-90f8-0b8db75fa>
18. Faqe Ibrahim GR, Rasul A, Hamid AA, Ali ZF, Dewana AA Suitable site selection for rainwater harvesting and storage case study using Dohuk Governorate. *Water* 11(4): 864. <https://doi.org/10.3390/w11040864>
19. Hajani E, Sissakian VK, Musa I, Atrooshi SA, Douven W, Masih I Water harvesting in Erbil Watershed, Kurdistan Region of Iraq. *J Earth Syst Sci* 134:68. <https://doi.org/10.1007/s12040-025-02530-4>
20. Holthaus E Is Climate Change destabilising Iraq? *Slate, Future Tense*.
http://www.slate.com/articles/technology/future_tense/2014/06/isis_water_scarcity_is_climate_change_destabilizing_iraq.html
21. Instagram (2025) Histo-Geography of Iraq. Internet data, last retrieved on 26/02/2026. <https://www.instagram.com/p/DSC1DgriCCK/>
22. IOM (2022) Migration, Environment, and Climate Change in Iraq. Internet data, last retrieved on 19 January 2026. <https://iraq.un.org/en/194355-migration-environment-and-climate-change-iraq>
23. Iraqi Embassy in Washington (2026) Internet data, last retrieved on 26/02/2026. <https://www.iraqiembassy.us/page/geography>
24. Gregory PJ, Ingram JSI, Brklacich M Climate Change and Food Security. *Philosophical Trans Royal Soc B: Biol Sci* 360: 2139–2148.
<https://pubmed.ncbi.nlm.nih.gov/16433099/>
25. Kamel AH, Suleiman SA Hydrologic study for Iraqi western desert to assessment of water harvesting projects. *Iraqi J Civil Eng* 7(2): 16–27.
<https://doi.org/10.37650/ijce.2012.68988>
26. Mohammed H, Abed B The Feasibility of Constructing Rainwater Harvesting Dams and Their Storage Capacity in Al-Abyadh Valley West of Iraq. *J Eng* 31(3):96–112. <https://joe.uobaghdad.edu.iq/index.php/main/article/view/3505>
27. Sadeq SN, Mohammad JK The application of watershed delineation technique and water harvesting analysis to select and design small dams: a case study in Qara-Hanjeer Subbasin, Kirkuk-NE Iraq. *Iraqi Geol J* 55(1B): 57–70. <https://doi.org/10.46717/igj.55.1B.6Ms-2022-02-22>
28. Sissakian VK Origin of the Tharthar Depression, Central part of Iraq. *Iraqi Bull Geol Min* 7(3): 47–62
29. Sissakian VK, Adamo N, AlAnsari N, Abdullah M, Laue J Desertification and Salinization of the Mesopotamian Plain. A Critical Review. *J Earth Sci Geotech Eng* 10, 125–142. https://www.scienpress.com/Upload/GEO/Vol%2010_4_6.pdf
30. Sissakian VK, Adamo N, Al-Ansari N The Severe Consequences of Climate Change in Iraq: A Case Study. *Engineering* 15 (4): 242–260
31. <https://www.scirp.org/journal/paperinformation?paperid=124494>
32. Sissakian VK, Al-Ansari N, Adamo N, Laue L The Impact of water scarcity on food security in Iraq. *Eng Archit* 17: 441–457.
<https://www.davidpublisher.com/index.php/Home/Article/index?id=49698.html>

Figures



Figure 1

Map showing the main dams, reservoirs and valleys. Dams: 1= Mosul, 2= Haditha,

3= Doka, 4= Derbendi Khan, 5= Duhok, 6= Gom Ispan, 7= Al-Adhaim, 8= Hemren, and 9= Samarra. Natural depressions: 10= Al-Tharthar, 11= Al-Habbaniyah, 12= Al-Razzazah, and 13= Depressions along Abu Jir Active Fault Zone. Marshes: 14 = Al-Shbicha, 15= Al-Hammar, and 16= Al-Hwaizah.



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Figure 2

Cham Chamal inundated library (10/12/2025), a) inside, and b) outside.



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Figure 3

Damage to infrastructure (10/12/2025), a and b) Damage to the Tuz Khurmatu bridge, c) Accumulated trucks on a damaged road near the Daqooq town, and d) Inundated main road between Baghdad and Kirkuk city.



Figure 3

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Figure 4

Evacuation attempts by volunteers: a) A child from an inundated car, b) Guiding trucks' drivers to the position of the road, c) Guiding a flock of sheep to cross a flooded stream, d) Officers evacuating isolated people by ropes, e) Pulling a car in a snow-covered road, and f) Two persons waiting for evacuation.



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Figure 5

Flood scenes in different parts of Iraq at different times.



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Flood scenes in different parts of Iraq at different times.



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Figure 6

Dense snowfall, a) Near Hassan Beg Mountain (10/12/25), and b) Near Choman town (15/01/2026), both in the northeastern part of Iraq



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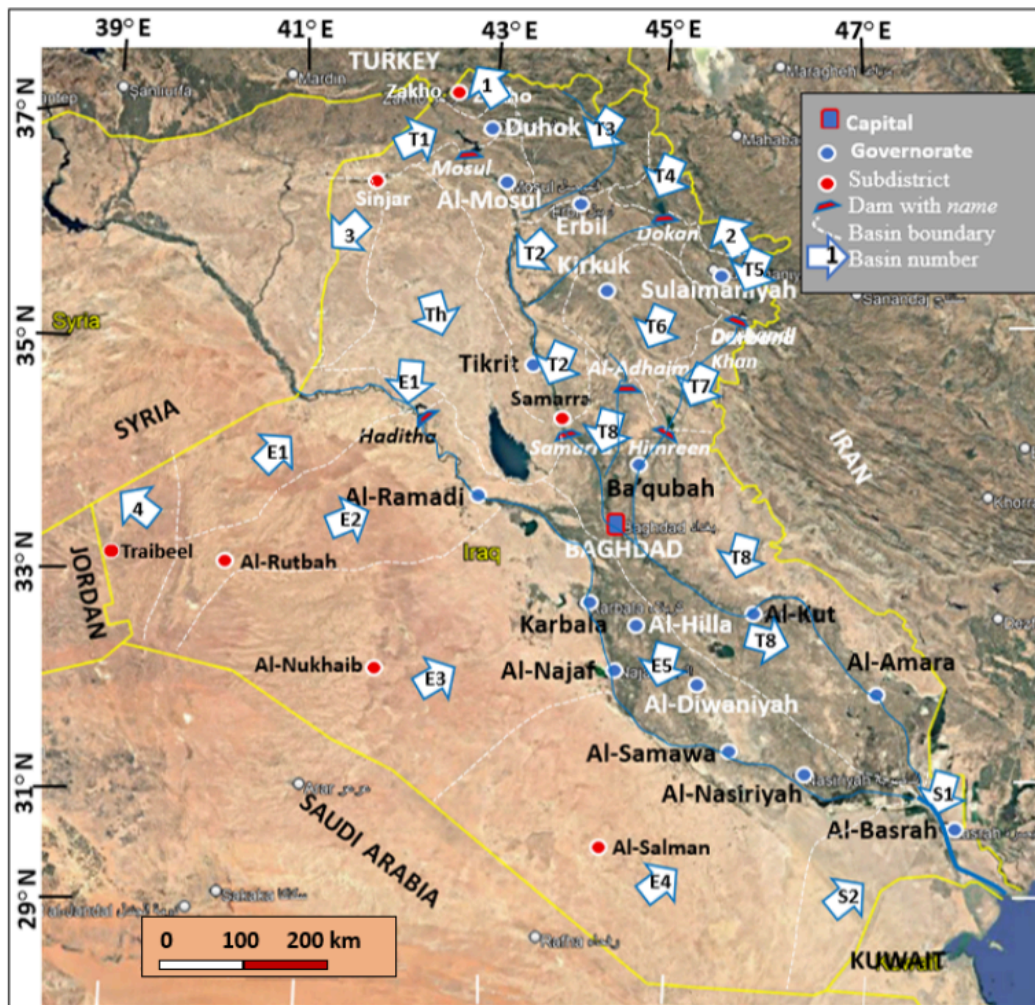


Figure 7

Map of drainage basins imposed over a satellite image. For the letters and numbers indication, refer to Table 1.

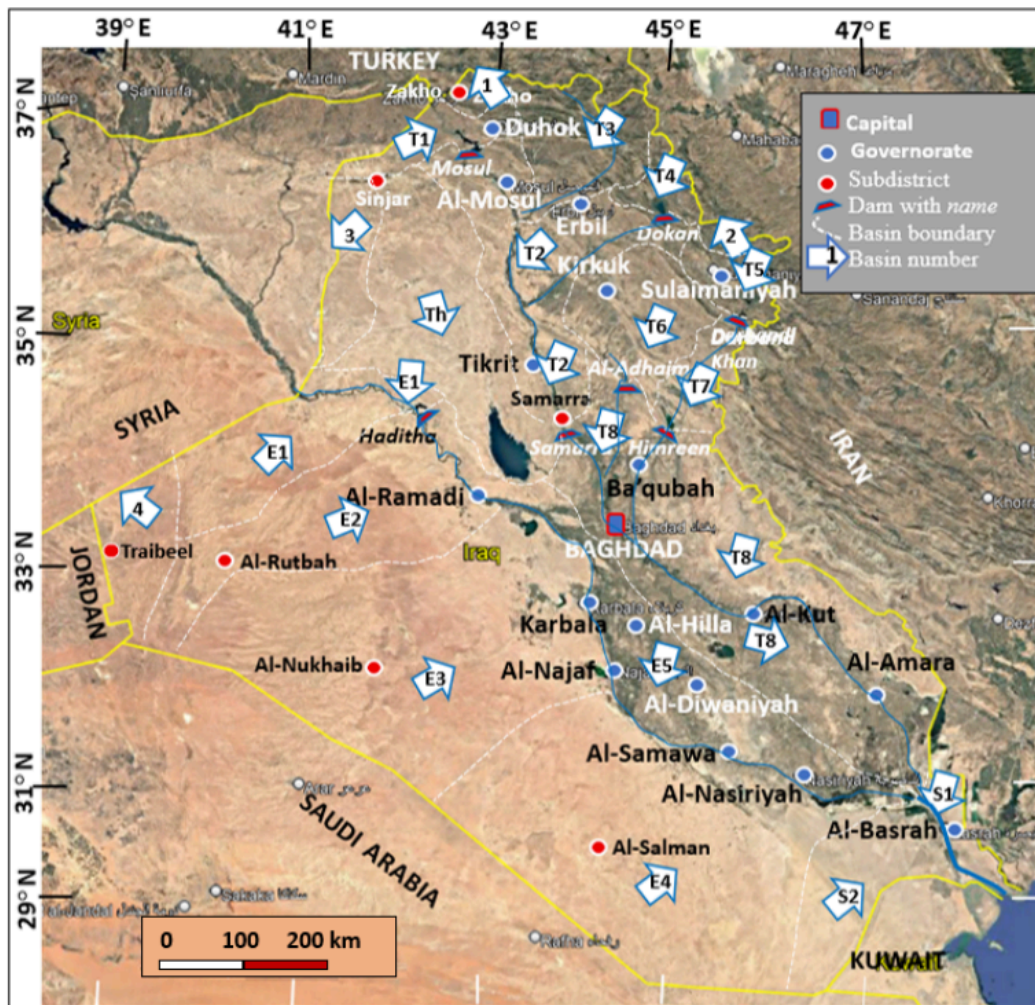


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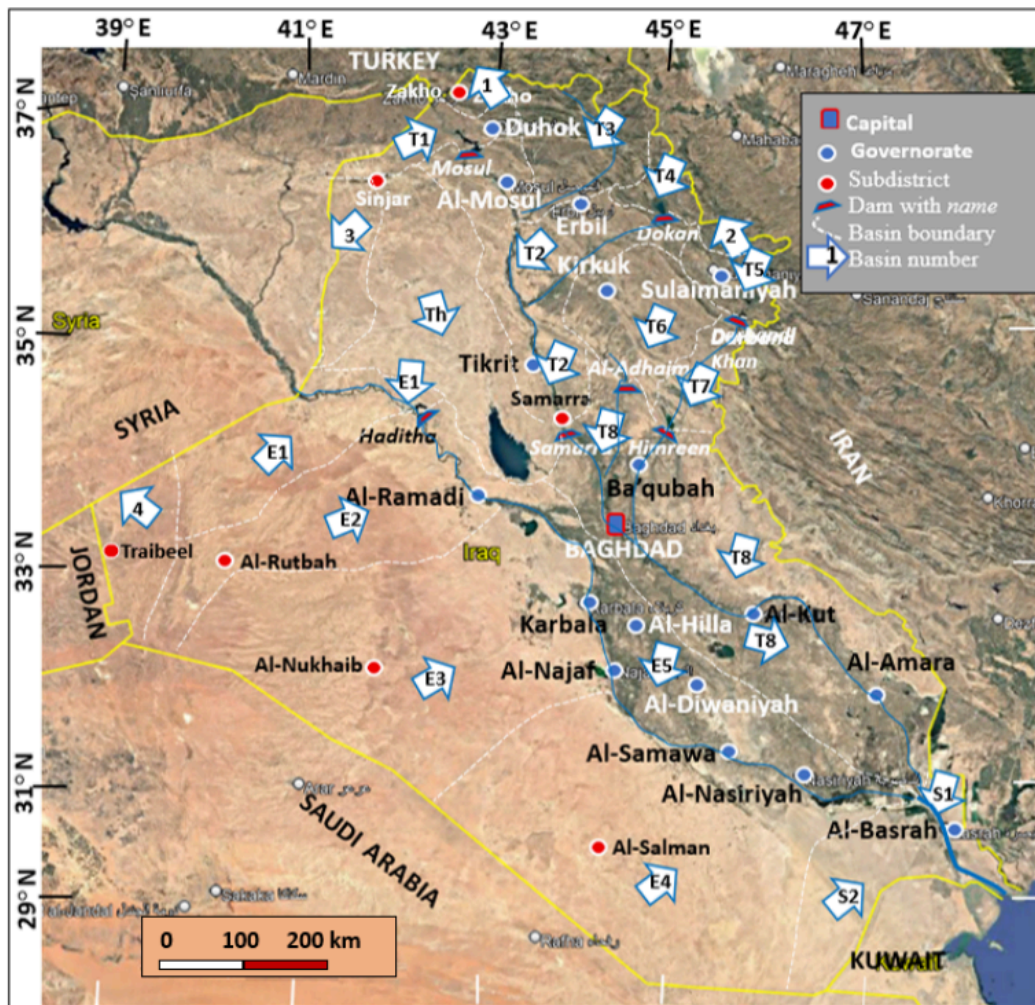


Figure 7

Map of drainage basins imposed over a satellite image. For the letters and numbers indication, refer to Table 1.