Chapter 4

Shared Tributaries of the Tigris River

INVENTORY OF
SHARED WATER RESOURCES IN WESTERN ASIA (ONLINE VERSION)

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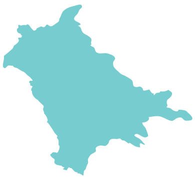


Shared Tributaries of the Tigris River

EXECUTIVE SUMMARY

The Tigris River Basin has several sub-basins that are shared between Iraq and Turkey or between Iran and Iraq. The main shared tributaries are the Feesh Khabour, the Greater Zab, the Lesser Zab and the Diyala.

With more than 27 BCM, the Tigris tributaries significantly contribute to total Tigris river flow. The main contribution to discharge originates from the Greater and Lesser Zab Rivers, which contribute 40-60% of total Tigris flow in Baghdad. In general, the four shared tributaries exhibit similar flow regimes, with normal fluctuations of wet and dry years around the mean annual flow. Although the Lesser Zab and the Diyala have been dammed since the 1960s, there is currently no evidence of a regulated stream-flow regime.

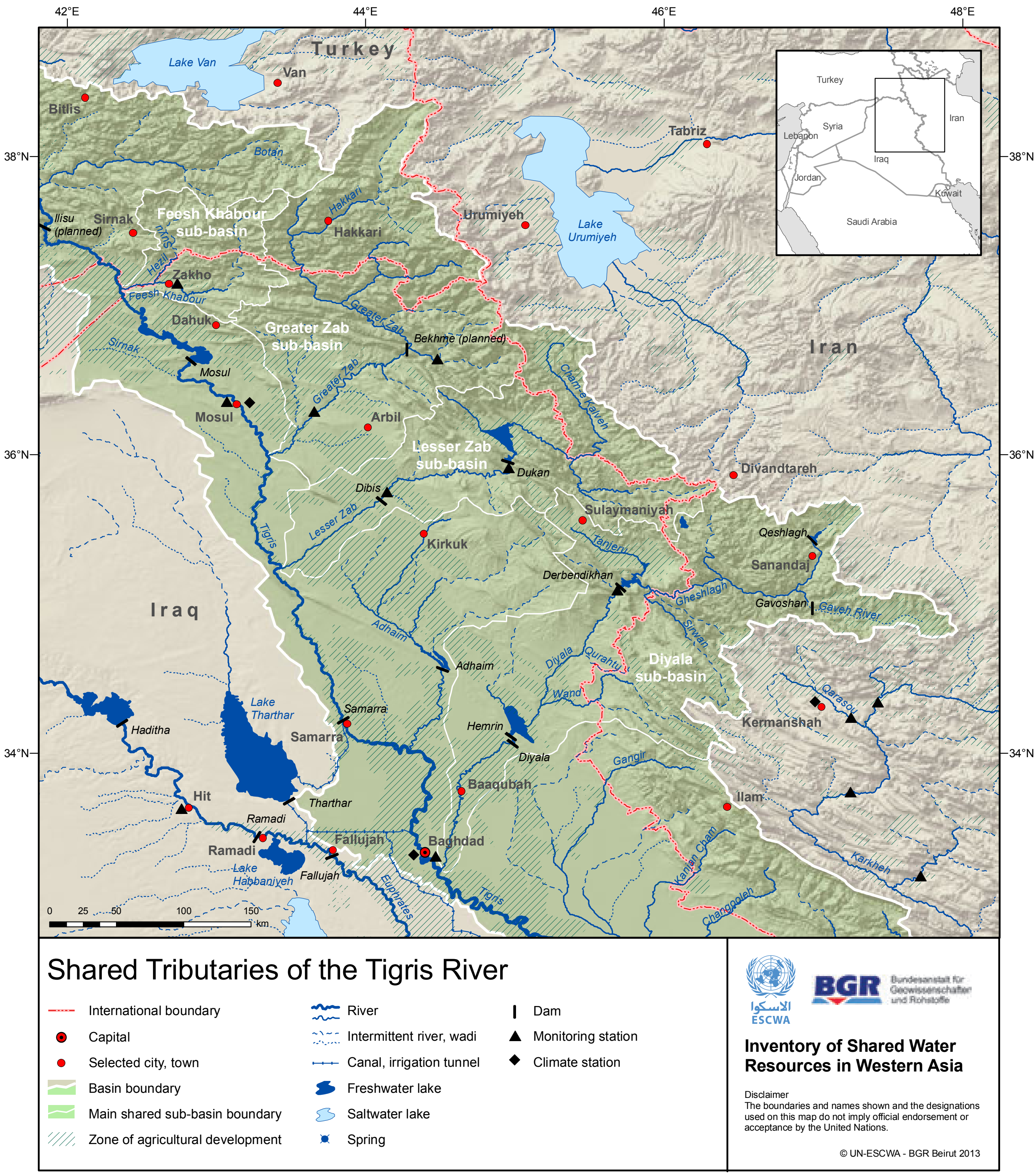
Water resources management differs from one shared basin to another. While the Greater Zab is to date unregulated, several of the dams and regulators on the Lesser Zab and the Diyala support irrigated agriculture projects in the region. No specific water agreements govern any of the four tributaries.

The Greater Zab, Turkey, 2010. Source: Caracas.

SUB-BASIN FACTS

RIVER	FEESH KHABOUR	GREATER ZAB	LESSER ZAB	DIYALA
BASIN AREA SHARES	Iraq 43% Turkey 57%	Iraq 65% Turkey 35%	Iran 24% Iraq 76%	Iran 25% Iraq 75%
BASIN AREA	6,143 km^2	26,310 km^2	19,780 km^2	33,240 km^2
RIVER LENGTH	181 km	462 km	302 km	574 km
MEAN ANNUAL FLOW VOLUME	2 BCM	12.7 BCM	7.8 BCM	4.6 BCM
DAMS	Unregulated to date	Unregulated to date	2 (~7 BCM capacity)	4 (>7 BCM capacity)
PROJECTED IRRIGATED AREA	~37,000 ha	..	..	..

OVERVIEW MAP



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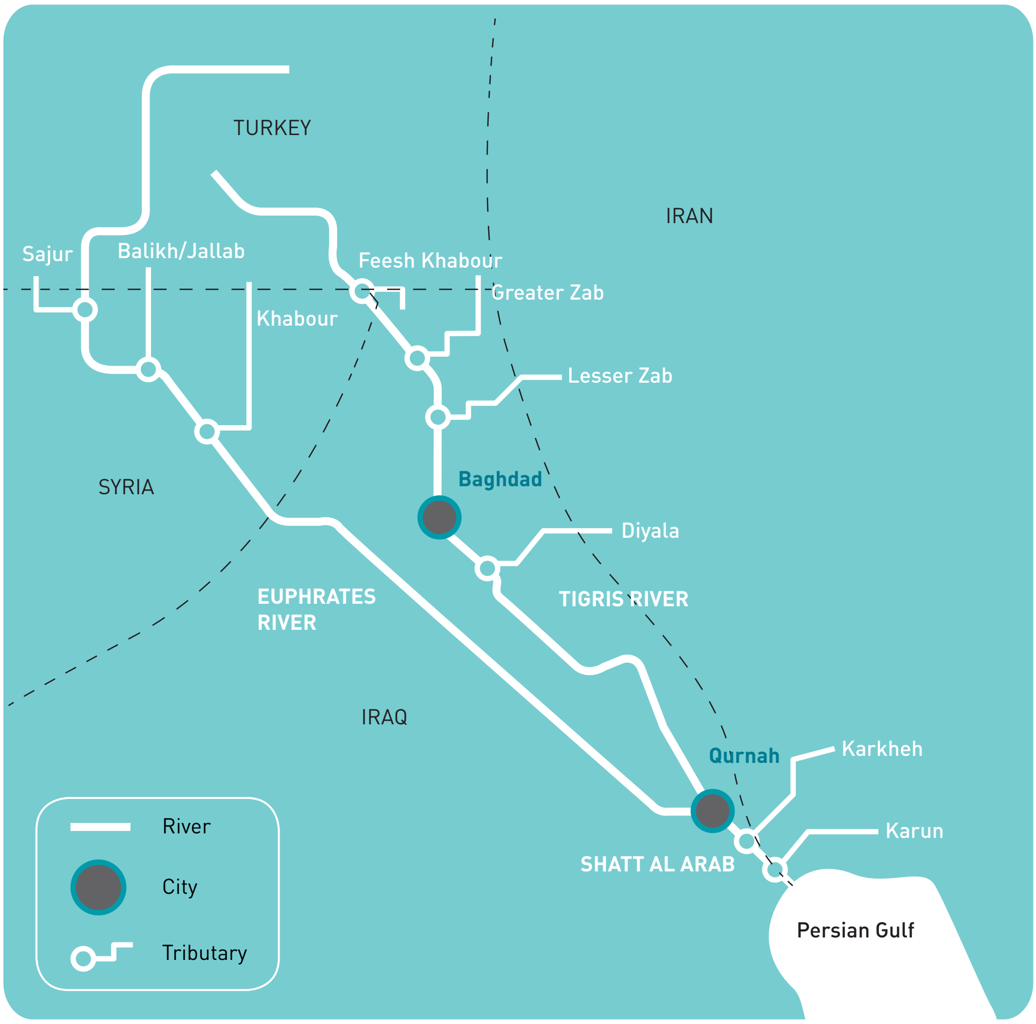
Defining the Euphrates-Tigris-Shatt al Arab Basins

The Euphrates-Tigris-Shatt Al Arab river system constitutes by far the largest surface water resource in the study area. Its combined topographic catchment covers more than 900,000 km^2 from the headwaters in the Taurus-Zagros Mountain Range to the Mesopotamian lowlands and the only outlet to the Persian Gulf, the Shatt Al Arab (Fig. 1). The overall basin is also home to around 54 million people in Iran, Iraq, Syria and Turkey. Given its importance and in order to adequately reflect the specific conditions as well as its complex hydrology, the Inventory dedicates five chapters to this river system.

The Euphrates River Basin (Chap. 1) and Tigris River Basin (Chap. 3) each have a different dynamic and set of characteristics, particularly with regard to their riparian countries, tributaries and contribution to discharge, as well as water use patterns and water quality. The shared tributaries of the Euphrates River (Chap.2) and the major shared tributaries of the Tigris River (Chap. 4) are covered in more detail in two separate chapters in order to highlight the role of these rivers and draw attention to local water issues and transboundary impacts. Chapter 4 also provides information on water use in Iran, which does not share the watercourse of the Tigris River itself but hosts important tributaries within the Tigris Basin. Finally, the Shatt al Arab River is discussed together with two additional major tributaries, the Karkheh and the Karun Rivers, which discharge directly into the Mesopotamian Marshes or the Shatt al Arab itself, and are hence neither part of the Euphrates or Tigris River basins (Chap. 5).

Figure 1. Sketch of the Mesopotamian river system



Source: Compiled by ESCWA-BGR.

Introduction

The Tigris River has a number of tributaries, most of which are shared between Iraq and Turkey, or Iran and Iraq (see Chap.3, Table 1). Their contribution to Tigris river flow is significant. In general, there is limited information on the Tigris tributaries and few in-depth studies exist on these rivers. This Inventory focuses on four of the shared Tigris tributaries. They have been selected on the basis of their size, significance and the availability of information.

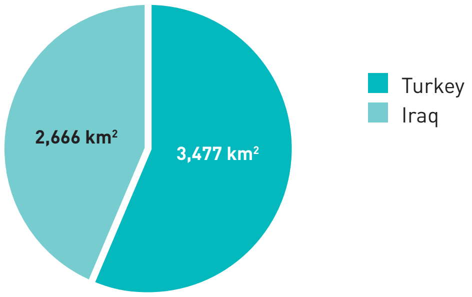
The Feesh Khabour is shared between Iraq and Turkey and forms the smallest of the four tributaries discussed here, both in terms of river length and basin size. The Greater and Lesser Zab are not only the most prominent Tigris tributaries, but also contribute the largest flow volume to the Tigris River. Finally, the Diyala, which is shared between Iran and Iraq, is regulated by four dams.

The Lesser Zab in Bekhme, Iraq, 2005. Source: Ed Kashi/VII.

Feesh Khabour

The Feesh Khabour River (also known as the Little Khabour or Habur in Turkish) originates in Sirnak, in eastern Anatolia in Turkey. The river flows south into Iraq, flowing through Iraqi Kurdistan and then west through the city of Zakho. Downstream from Zakho, the river is joined by its main tributary the Hezil Suyu, which forms the Iraqi-Turkish border for approximately 20 km from here on. The river discharges into the Tigris at the three-country border between Iraq, Syria and Turkey (see Overview Map).

Figure 2. Distribution of the Feesh Khabour Basin area



Source: Compiled by ESCWA-BGR.

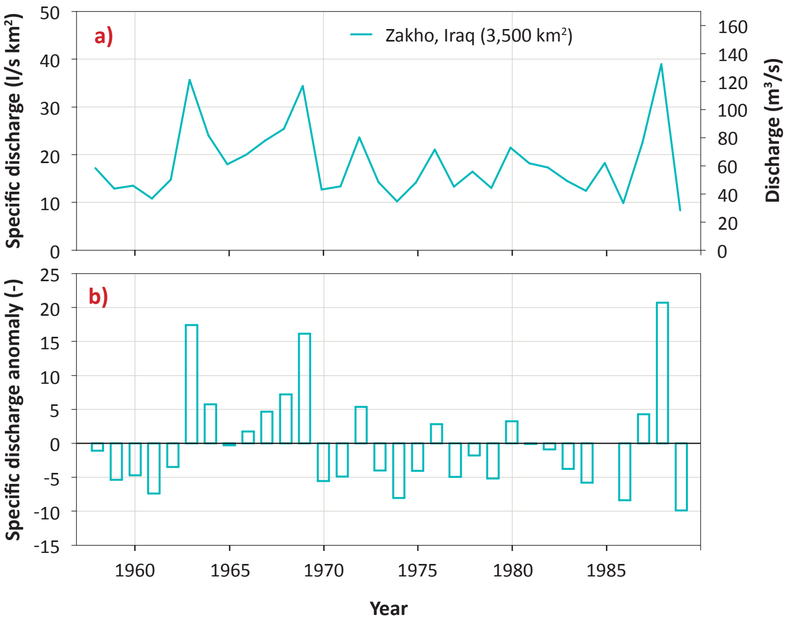
HYDROLOGICAL CHARACTERISTICS

With a length of about 181 km, the Feesh Khabour River has a catchment area of 6,143 km^2, of which 57% are located in Turkey and 43% in Iraq (Figure 2).[1]

The mean annual flow volume at Zakho is around 2 BCM (Table 1). However, total flow contribution to the Tigris is probably higher as the Zakho gauging station is situated upstream from the Hezil Suyu, a tributary to the Feesh Khabour. Measurements of the Feesh Khabour at the Zakho gauging station for the period of record 1958-1989 show three major wet years (1963, 1969 and 1988) and one extremely dry year in 1989 (Figure 3). The annual river flow time series shows a normal fluctuation of wet and dry years around the mean annual flow, with no statistically significant trend.[2]

The flow regime of the Feesh Khabour shows a distinct high-flow season with a peak in May and a low-flow season from July to December. This can be considered a typical near-natural nival regime dominated by winter precipitation in the form of snow, and snow-melt in the spring months (Figure 4).

Figure 3. a) Mean annual discharge and b) discharge anomaly time series of the Feesh Khabour (1958-1989)



Source: Compiled by ESCWA-BGR based on data provided by USGS, 2012; Ministry of Water Resources in Iraq, 2012.

Table 1. Summary of annual flow volume statistics for the main Tigris River tributaries in Iraq

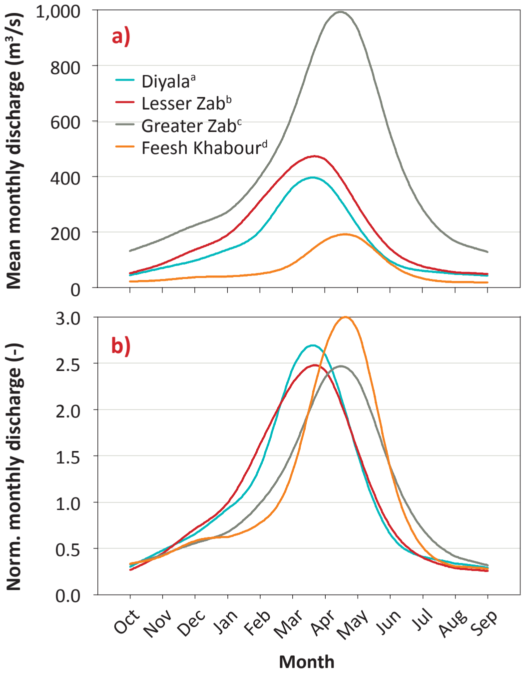
RIVER (DRAINAGE AREA, km^2)	STATION (DRAINAGE AREA, km^2)	PERIOD	MEAN (BCM)	MINIMUM (BCM)	MAXIMUM (BCM)	CV[a] (-)
Feesh Khabour (6,143)	Zakho (3,500)	1958-1989	2.0	0.9	4.3	0.41
Greater Zab (26,310)	Eski Kalak (20,500)	1931-2011	12.7	3.7	23.6	0.31
Lesser Zab (19,780)	Dukan (11,500)	1931-2011	6.0	1.7	15.1	0.42
Diyala (33,240)	Derbendikhan (17,800)	1931-2011	4.6	1.2	14.4	0.48

Source: Compiled by ESCWA-BGR based on data provided by USGS, 2012; Ministry of Water Resources in Iraq, 2012.
(a) Coefficient of Variation. For information on the definition and calculation of the CV see 'Overview & Methodology: Surface Water' chapter.

WATER RESOURCES MANAGEMENT

No dams or regulators have to date been built on the Feesh Khabour River or its tributaries. Information on water use in the basin is scarce and no water resources management studies are available for the sub-basin. However, satellite images show that agriculture, and particularly irrigation, play a major role in the basin with a projected irrigated surface of about 37,000 ha (see Overview Map). Intensive irrigated agriculture is practised along the entire course of the river in both Iraq and Turkey. The irrigated areas stretch roughly from the city of Zakho to the east to the tri-border point in the west, with a slightly larger irrigated area in the Turkish part of the basin.

Figure 4. **Mean monthly flow regimes of the main Tigris River tributaries at different gauging stations (1931-2011)**



Source: Compiled by ESCWA-BGR based on USGS, 2012; Ministry of Water Resources in Iraq, 2012.
(a) At Derbendikhan.
(b) At Dukan.
(c) At Eski Kalak.
(d) At Zakho.

Greater Zab

The Greater Zab River is the largest Tigris tributary in terms of water yield. Its headwaters originate in the Ararat Mountains in Turkey at an altitude of 4,636 m asl.[3] The headwater topography is characterized by steep slopes, with several tributaries and wadis (Khazir, Rubar-i-Shin, Rukuchuk and Rubat Mawaran Rivers) flowing into the Greater Zab. This perennial stream has a total length of 462 km and flows mainly in Iraq before discharging into the Tigris River 49 km south of Mosul.[4]

HYDROLOGICAL CHARACTERISTICS

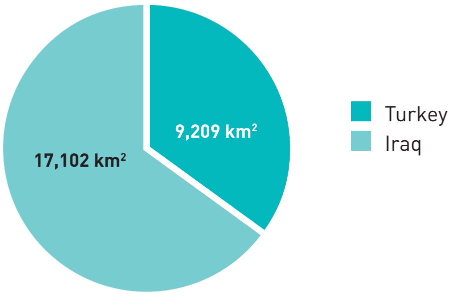
The Greater Zab and its tributaries cover a basin area of around 26,310 km² of which 35% is located in Turkey and the remainder in Iraq (Figure 5).[5] Annual precipitation ranges between 350 and 1,000 mm.[6] Rainfall and snow-melt result in a typical flow regime similar to that of the Feesh Khabour, with a high-flow season in spring (Figure 4). Peak flows of the Greater Zab occur in May. The Greater Zab supplies the Tigris River with an average annual flow volume of 12.7 BCM measured at Eski Kalak and 12 BCM farther upstream at the Bekhme Dam. However, total Tigris flow contribution is probably higher as another tributary joins the river downstream of the Eski Kalak gauging station. According to some estimates, 33% of the Tigris flow at Baghdad originates from the Greater Zab.[7]

Measurements of the Greater Zab at Eski Kalak and at the upstream Bekhme Dam station for the period of record 1931-2011 are similar to those of the Feesh Khabour, with three major wet years (1963, 1969 and 1988) and one extremely dry year in 1989 (Figure 6). The annual river flow time series shows a normal fluctuation with no discernible trend of wet and dry years around the mean annual flow.

WATER RESOURCES MANAGEMENT

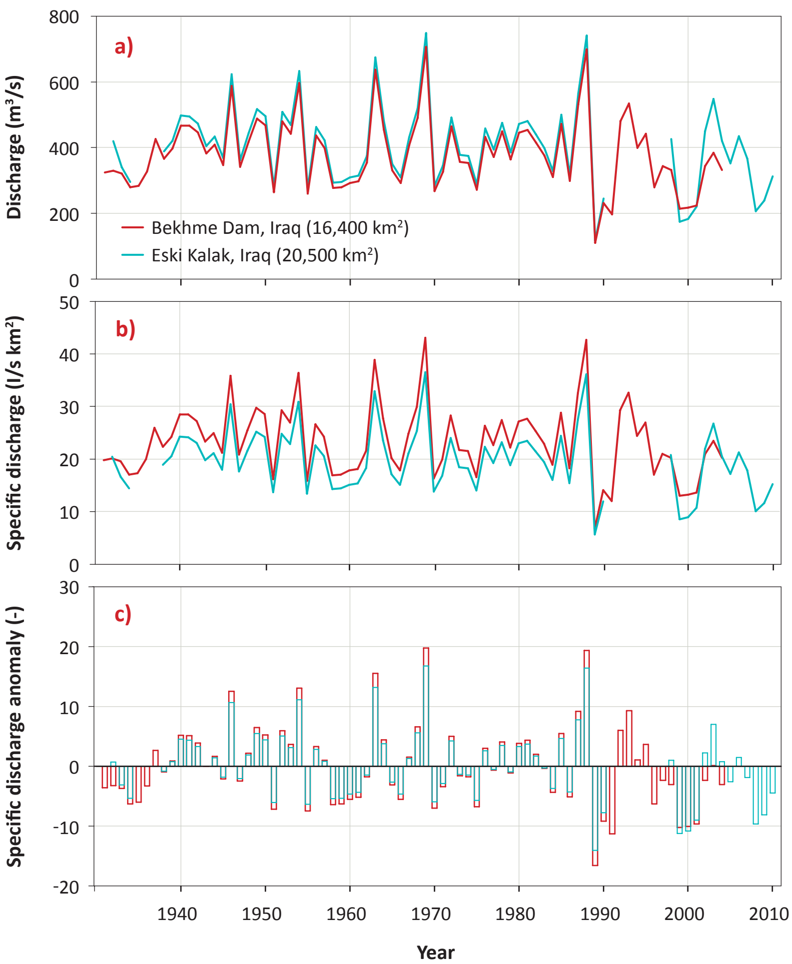
The Greater Zab is one of the few unregulated rivers in the region as no dams have been built on the river to date. However, both riparian countries have plans to exploit the Greater Zab (Table 2). Iraq has planned two dams in the basin: the Bekhme and Mandawa Dams.[8]

Figure 5. Distribution of the Greater Zab Basin area



Source: Compiled by ESCWA-BGR.

Figure 6. a) Mean annual discharge, b) specific mean annual discharge and c) discharge anomaly time series of the Greater Zab (1931-2011)



Source: Compiled by ESCWA-BGR based on data provided by USGS, 2012; Ministry of Water Resources in Iraq, 2012.

The Bekhme Dam was originally designed for flood control and irrigation in the 1940s, and later evolved to include a storage facility that could replace the storage system at Lake Tharthar (see Chap. 3). The dam was redesigned several times over the years until construction finally started in 1988.[9] The aim of the project was to create a large reservoir that would be used to supply irrigation water and hydropower to the mainly Kurdish population in northern Iraq. However construction was suspended in 1990 due to the outbreak of the Gulf War. Today the Bekhme Dam is once again being considered as a potential source of electricity for 1.5 million homes in Iraqi Kurdistan.[10] According to the Iraqi National Development Plan 2010-2014, construction will take three years and the dam will have a hydropower generation capacity of 1,500 MW.[11]

The Greater Zab River, at Zahko, Iraq, 2012. Source: James Gordon.

Lesser Zab

Located to the south of the Greater Zab, the Lesser Zab River (also Little Zab or Lower Zab) originates in the north-eastern Zagros Mountains in Iran, near the Iraqi border. In the upper basin, the river flows through deep canyons where a number of tributaries such as the Banah and Qazlaga contribute to discharge.[12] With a total length of around 302 km,[13] the Lesser Zab joins the Tigris near the city of Fatha, 220 km north of Baghdad (see Overview Map).

HYDROLOGICAL CHARACTERISTICS

The Lesser Zab covers a basin area of 19,780 km², of which about 76% lie in Iraq and 24% in Iran (Figure 7).[14]

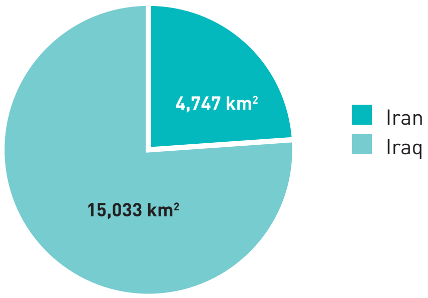
The average annual flow volume of the Lesser Zab at Dukan and at the downstream gauging station of Altun Kupri-Goma is about 6 BCM and 7.8 BCM respectively, with an average discharge contribution to the Tigris of around 191 m³/s and 249 m³/s for the two stations.

Figure 8 shows the mean annual discharge variability and anomalies of the Lesser Zab, which is characterized by regular oscillation of wet and dry periods at both gauging stations. While lower-than-average water yield since 1999 may indicate intensified stream regulation, no significant long-term trend can be detected. Compared to the Greater Zab, peak flows generally occur earlier in spring (April), mainly as a result of lower snowfall levels and earlier snow-melt. Generally, the Lesser Zab flow regime shows the same dynamics and seasonality as other Tigris tributaries. While dams have been in operation on the river since the 1960s, a comparison of pre-1960 and post-1960 mean monthly discharge shows no evidence of a regulated stream-flow regime to date.

WATER RESOURCES MANAGEMENT

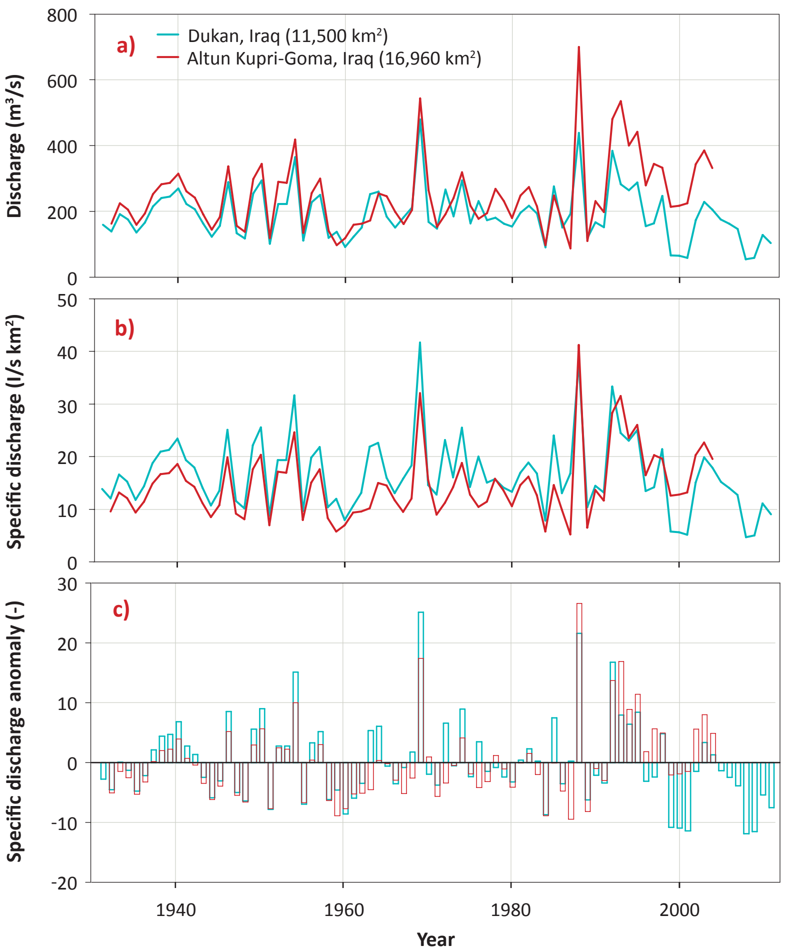
Two dams have been built in the Iraqi part of the Lesser Zab sub-basin: the Dukan and the Dibis (Table 2). The former was built in 1961 as an arch dam upstream of the city of Dukan and has a maximum storage capacity of 6,970 MCM.[15] It is used to regulate Tigris flow and also provides water for irrigation and hydropower generation. The Dibis Dam regulates discharge to the Kirkuk Irrigation Project. Built between 1960 and 1965, it is located about 130 km upstream from the confluence of the Lesser Zab with the Tigris. The Kirkuk Irrigation Project is one of the most important irrigation projects in the region. It was developed in the late 1960s and uses water from the Lesser Zab and Lake Dukan to irrigate 300,000 ha of land. Around 87,500 ha had been implemented by 1983.[16]

Figure 7. **Distribution of the Lesser Zab Basin area**



Source: Compiled by ESCWA-BGR.

Figure 8. **a) Mean annual discharge, b) specific mean annual discharge and c) discharge anomaly time series of the Lesser Zab (1931-2011)**

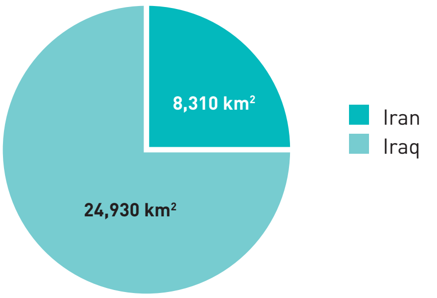


Source: Compiled by ESCWA-BGR based on data provided by USGS, 2012; Ministry of Water Resources in Iraq, 2012.

Diyala

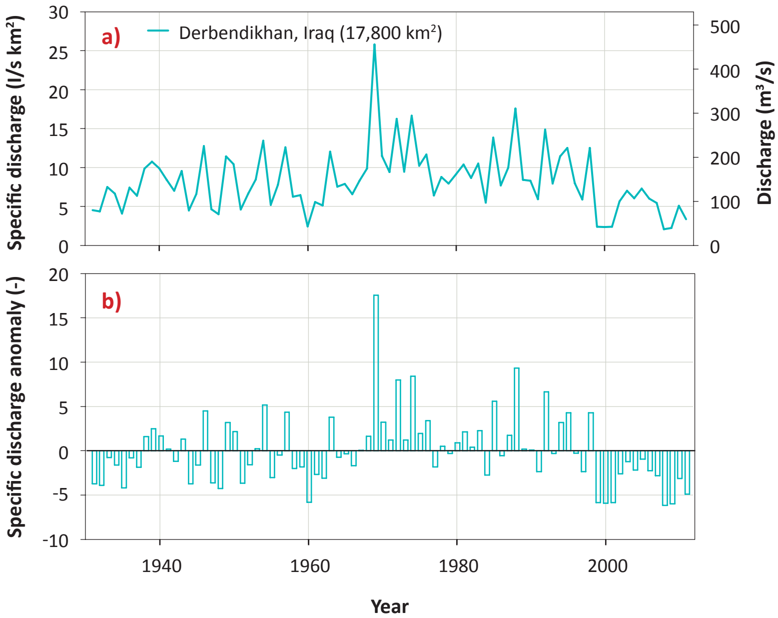
The Diyala River originates near Sanandaj in the Zagros Mountains in Iran, forming the Iran-Iraq border for over 30 km. With a total length of 574 km,[17] the river has a drainage area of 33,240 km², of which 25% are located in Iran and 75% in Iraq (Figure 9).[18] The Diyala joins the Tigris 15 km south of Baghdad (see Overview Map). Its principal tributaries are the Tanjeru, Sirwan and Wand Rivers.[19] Many of the Diyala's smaller tributaries are shared between Iran and Iraq.

Figure 9. Distribution of the Diyala Basin area



Source: Compiled by ESCWA-BGR.

Figure 10. a) Mean annual discharge and b) discharge anomaly time series of the Diyala (1931-2011)



Source: Compiled by ESCWA-BGR based on data provided by USGS, 2012; Ministry of Water Resources in Iraq, 2012.

HYDROLOGICAL CHARACTERISTICS

Measured at the Derbendikhan gauging station for the period of record 1931-2011, the Diyala River has a mean annual flow volume of 4.6 BCM. However, the river's total flow contribution to the Tigris is probably significantly larger as various tributaries are not taken into account at this upstream gauging station. Despite the construction of a major reservoir in the upper Diyala catchment in 1962, no significant impact on flow volumes and flow regime can be detected. As with the other Tigris tributaries, 1963 is one of the wettest years within the period of record. Since 1999 below-average flow volumes mark a dry period in the catchment, which potentially indicates intensified stream regulation (Figure 10). However, no long-term trend is detectable over the whole period of record from 1931 to 2011. The Diyala stream-flow is very similar to that of the Lesser Zab. It is characterized by peak flows in April and a low-flow season from July until November.

WATER RESOURCES MANAGEMENT

The Diyala River and its tributaries have more dams along their course than any other Tigris tributary, with three dams in the Iraqi part of the basin and two in Iran (Table 2).

The Derbendikhan Dam was constructed in 1962 as a multi-purpose dam on the upper course of the Diyala in Iraq. Besides flood protection and power generation, the dam secures domestic water supply and irrigation water.[20] The 17,850 km² catchment area lies mainly in Iran.[21] Iraq built the Hemrin Dam in the early 1980s, creating Lake Hemrin with a storage capacity of over 2 BCM. Inflows originate primarily from the Wand River in Iran and runoff from Iraq is only generated during the rainy season.[22]

Irrigation canal near the town of Taweela in the Diyala Basin, Iraq, 1992. Source: Ed Kashi/VII.

In recent years, the Wand River has been at the centre of disputes between Iran and Iraq. In 2008, news agencies reported that Lake Hemrin lost about 80% of its capacity due to the damming of the Wand River in Iran,[23] sparking protests and demonstrations at the Iranian-Iraqi border. In 2011, the Iraqi parliament addressed the issue and subsequently Iraqi officials discussed solutions to the problem with their Iranian counterparts.[24]

Built in the late 1960s, the Diyala Weir is located about 10 km downstream of the Hemrin Dam and about 130 km from the confluence of the Diyala with the Tigris. The main purpose of this dam is to divert the outflow of the Hemrin Dam to irrigation canals.[25]

In Iran, two dams are located in the headwaters of the Diyala: the Qeshlagh (or Vahdat) Dam is located on the Gheshlagh River, while the Gavoshan Dam lies on the Gaveh River. The Qeshlagh Dam was completed in 1979 with a potential reservoir volume of 224 MCM.[26] The Gavoshan Dam was built between 1992 and 2004, primarily for irrigation purposes (Table 2). In addition to supporting a hydroelectric power station, the dam also provides drinking water for the city of Kermanshah. Water is diverted through a tunnel from the Gavoshan Dam reservoir to the Razavar River basin.[27]

Table 2. **Constructed and planned dams on the main shared Tigris River tributaries in chronological order of construction**

COUNTRY	NAME	RIVER	COMPLETION YEAR	CAPACITY (MCM)	PURPOSE[a]	BACKGROUND INFORMATION
Iraq	Dukan	Lesser Zab	1961	6,970	I, FC, HP	The dam is part of the Kirkuk Irrigation Project.
Iraq	Derbendikhan	Diyala	1962	3,000	I, FC, HP, WS	Most of the dam's 17,850 km^2 catchment area lies in Iran.
Iraq	Dibis	Lesser Zab	1965	..	FD	A regulator dam that diverts water from the Lesser Zab to the Kirkuk Irrigation Project. The dam's spillway capacity is 4,000 m^3/s.
Iraq	Diyala Weir	Diyala	1969	..	FD	This regulating structure is located downstream of the Hemrin reservoir and distributes water into the lower Diyala River and irrigation canals.
Iran	Qeshlagh (Vahdat)	Gheshlagh (headwater of the Diyala)	1979	224	I, HP, WS	-
Iraq	Hemrin	Diyala	1981	4,000	..	In 2008, Lake Hemrin lost 80% of its capacity following Iran's damming of the Wand River.
Iran	Gavoshan	Diyala	2004	550	I, HP, WS	The dam was constructed to supply 395 MCM to irrigate 31,000 ha of land, generate 11 MW of hydropower and supply 63 MCM of potable water to the city of Kermanshah.
Iraq	Taq Taq	Lesser Zab	Completion scheduled: 2015	..	..	-
Iraq	Bekhme	Greater Zab	Completion scheduled: 2015	..	I	Partially constructed.
Iraq	Mandawa	Greater Zab	Completion scheduled: 2015	..	..	-
Turkey	Cukurca	Greater Zab	Planned	..	HP	Planned hydropower capacity: 245 MW
Turkey	Doganli	Greater Zab	Planned	..	HP	Planned hydropower capacity: 462 MW
Turkey	Hakkari	Greater Zab	Planned	..	HP	The dam is in its final design phase. Planned hydropower capacity: 245 MW

Source: Compiled by ESCWA-BGR based on General Directorate of State Hydraulic Works in Turkey, 2009; Ministry of Environment in Iraq et al., 2006; FAO, 2009; IRIN, 2008; UNESCO, 2009.
(a) Irrigation (I), Flood Control (FC), Hydropower (HP), Flow diversion (FD), Water Supply (WS).

Water Quality & Environmental Issues

Except for data on salinity levels, limited information is available about the water quality of the Tigris tributaries. Available data on this parameter indicates that water quality in the tributaries in Iraq is acceptable. Variations in Total Dissolved Solids (TDS) values for the Feesh Khabour (Table 3), Greater Zab and Lesser Zab Rivers (Figure 11) show that no significant change in salinity has occurred over the shown time period, and that the water was suitable for agricultural use. However no recent data is available for the Greater and Lesser Zab and changes may have occurred (see also Diyala River).

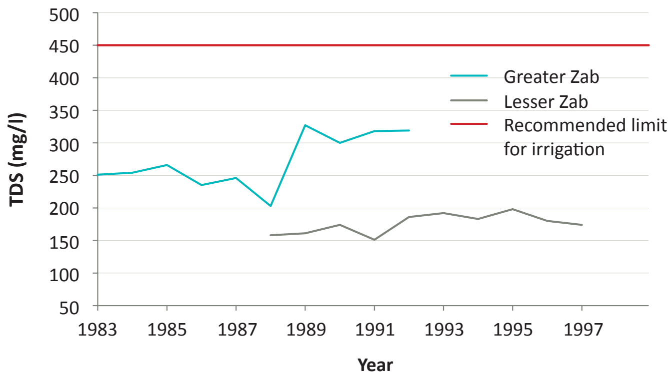
The Diyala River (Figure 12), also showed an average TDS value of 233 mg/L in 1989-1998.[28] However, higher salinity values were measured in 2009 in Lake Hemrin,[29] possibly as a result of the reduction in the lake's capacity since 2008 following Iran's damming of the Wand River.

Table 3. **Mean Total Dissolved Solids (TDS) values of the Feesh Khabour in Iraq for different years**

YEAR	TDS (ppm)	SOURCE
1982	275	Al-Layla and Fathalla, 1989.
2009	139	Ministry of Water Resources in Iraq, 2012.
2010	125	
2011	125	

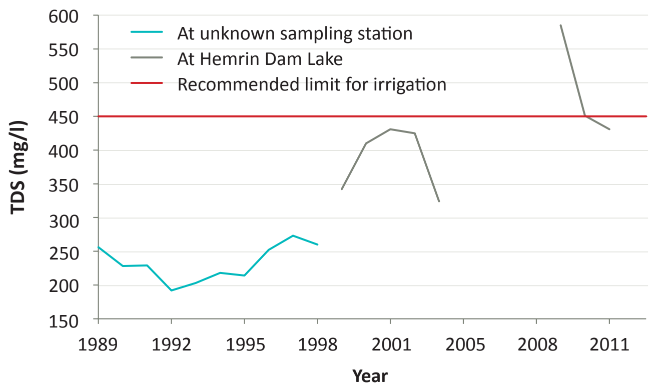
Source: Compiled by ESCWA-BGR.

Figure 11. **Mean Total Dissolved Solids (TDS) values of the Greater Zab and Lesser Zab in Iraq (1983-1997)**

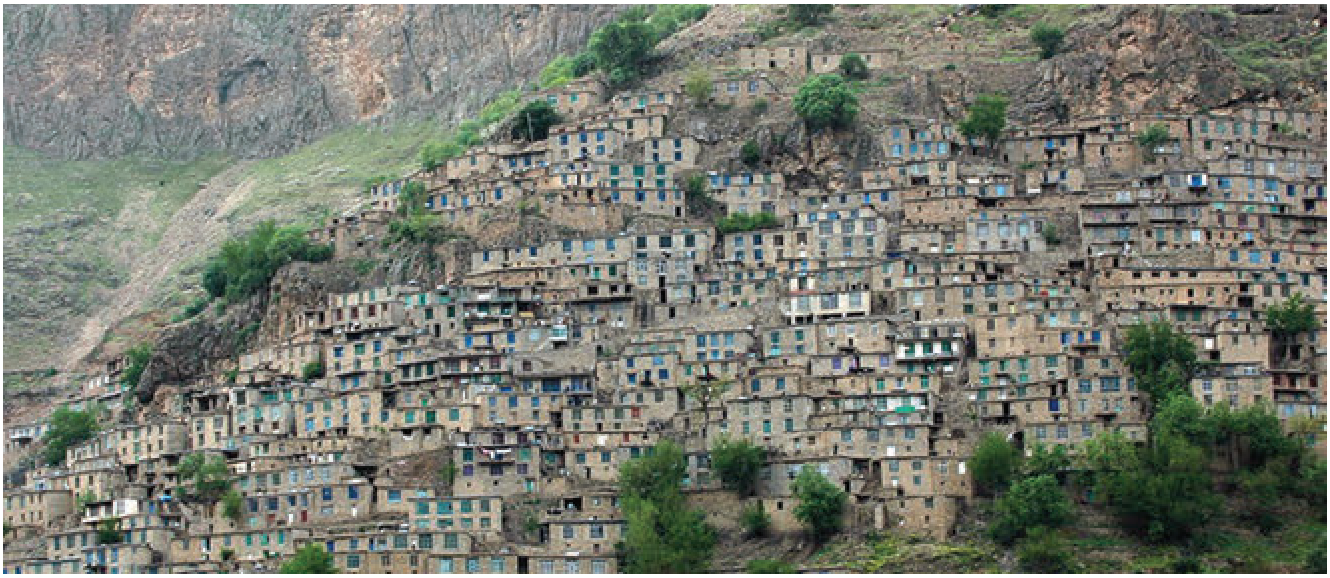


Source: Compiled by ESCWA-BGR based on UNESCO, 2009.

Figure 12. **Mean Total Dissolved Solids (TDS) values of the Diyala River in Iraq (1989-2011)**



Source: Compiled by ESCWA-BGR based on UNESCO, 2009; Ministry of Water Resources in Iraq, 2012.



The village of Firuzan, Zakho, Iraq, 2012. Source: James Gordon.

Groundwater in the Tigris Sub-Basins

The four major tributaries of the Tigris River, the Feesh Khabour, Greater Zab, Lesser Zab and Diyala, originate in the Taurus-Zagros Mountains in Iran and Turkey. In the higher mountain area, groundwater is discharged from the main karstic aquifers (Bekhme and Pila Spi Aquifers) into springs. In the inter-mountain basins, groundwater also enters stream-beds through overlying unconsolidated deposits (see Chap. 23). Most of this spring-water is probably diverted upstream for irrigation and water supply purposes.

In the Taurus-Zagros foothill area, groundwater from the Bai Hassan-Mukdadia Aquifers (see Chap. 23) discharges prevailingly into the main Tigris tributaries.

The **Feesh Khabour** rises from a catchment in the eastern Taurus Mountains west of Hakkari, in an area with peaks above 3,000 m asl. The relatively small catchment area on Turkish territory is covered mainly by flysch deposits of the Hakkari complex and the upper Feesh Khabour probably carries no significant base flow from groundwater discharge on its course into the neighbouring area in northern Iraq. In the Zakho Basin in north-western Iraq, the Feesh Khabour River is generally effluent, receiving an inflow of groundwater from Tertiary to Quaternary aquifers. At the lower end of the Zakho Basin, in the border area between Iraq, Syria and Turkey, groundwater in shallow aquifers possibly flows toward the Tigris River in the area of the Hezil Suyu. This river's catchment is mainly covered in limestones and marls of the Upper Cretaceous-Paleogene Kermav Formation. No details on groundwater/surface water relationships are available for the area.

The source of the **Greater Zab** lies at an altitude of approximately 3,000 m asl in the Zagros Mountains east of Lake Van in Turkey. No information is available on the contribution of transboundary flow to the discharge of the Greater Zab, nor on proportions of seasonal runoff and base flow from aquifer discharges in the upper catchments of the river system. Extensive groundwater drainage into the Greater Zab riverbed occurs in the Arbil Basin in the foothills of the Zagros Mountains.

The main source of the **Lesser Zab** lies at an altitude of around 3,000 m asl on the eastern margin of the Zagros Mountains in Iran. Interrelations between groundwater and surface water may be expected, particularly in the upper catchment area through discharge of groundwater from aquiferous carbonate formations and in shallow aquifers of the Ranya Plain, which is partly inundated by Lake Dukan.

In addition to the transboundary flow of the **Diyala**, subsurface inflow appears to reach the Halabja Plain from the mountains of Iran, discharging into the large Zulum Spring. The groundwater/surface water regime within the plain is probably influenced by interconnections between shallow aquifers, stream-beds and other sources. Interaction between groundwater flow in shallow aquifers and surface water possibly occurs in the middle Diyala Basin in the border area between Iran and Iraq.

Agreements, Cooperation & Outlook

AGREEMENTS

There is no comprehensive water agreement in place for the Tigris tributaries discussed in this chapter. However in the 1976 'Agreement between Iran and Iraq Concerning the Use of Frontier Watercourses', the two countries agreed to divide certain shared water resources (including headwaters of tributaries discussed in this chapter). For instance, the agreement states that the Wand River (referred to as Alvend) is to be divided between Iran and Iraq on the basis of the reports of the 1914 Commission on the Delimitation of the Iranian-Ottoman frontier and in accordance with customs.[30] The agreement also foresees the establishment of a permanent joint technical commission composed of an equal number of experts from both countries. However, Iraq has recently expressed reservations regarding the 1976 Agreement.[31]

COOPERATION

There is no information on cooperative measures between Iran and Iraq regarding the four tributaries discussed in this chapter.

OUTLOOK

In periods of drought, rising tension between the riparian countries and local protests cannot be ruled out, as witnessed in 2011 and 2012 along the Iran-Iraq border.[32]

The Greater Zab in Bekhme, Iraq, 2005. Source: Ed Kashi/VII.

Notes

1. Based on estimates from a digital elevation model (HydroSHEDS) similar to Lehner et al., 2008.
2. A Student T-test was performed to assess whether the mean values of the two sampling periods are significantly (at significance level p<0.01) different.
3. ACSAD and UNEP-ROWA, 2001, p. 26.
4. Shahin, 2007, p. 249; FAO, 2009, p. 65; Kliot, 1994, p. 109. By contrast, ACSAD and UNEP-ROWA, 2001, p. 26; Isaev and Mikhailova, 2009, p. 386 state a river length of 473 km.
5. Based on estimates from a digital elevation model (HydroSHEDS) similar to Lehner et al., 2008.
6. Abdulla and Al-Badranih, 2000, p. 15; ACSAD and UNEP-ROWA, 2001, p. 26.
7. Kehreman, 2006, p. 2.
8. Kolars, 1994.
9. Kehreman, 2006, p. 2.
10. Ibid. p. 4.
11. Ministry of Planning in Iraq, 2010.
12. ACSAD and UNEP-ROWA, 2001, p. 27.
13. Based on estimates from a digital elevation model (HydroSHEDS) similar to Lehner et al., 2008. By contrast, Isaev and Mikhailova, 2009, p. 386; ACSAD and UNEP-ROWA, 2001, p. 26 refer to a river length of 456 km. UN-ESCWA, 1981, p. 79; Shahin, 2007, p. 249 state a length of 400 km.
14. Based on estimates from a digital elevation model (HydroSHEDS) similar to Lehner et al., 2008. Other estimates are slightly higher: 21,475 km^2 in FAO, 2009, p. 65; and 22,250 km^2 UN-ESCWA, 1981, p. 79. ACSAD and UNEP-ROWA, 2001, p. 26.
15. Ministry of Environment in Iraq et al., 2006, pp. 15-16.
16. FAO Aquastat, 2008.
17. Based on estimates from a digital elevation model (HydroSHEDS) similar to Lehner et al., 2008. According to UN-ESCWA, 1998, p. 18; ACSAD and UNEP-ROWA, 2001, p. 27 the length of the river is 386 km.
18. Based on estimates from a digital elevation model (HydroSHEDS) similar to Lehner et al., 2008. According to UN-ESCWA, 1998, p. 18; ACSAD and UNEP-ROWA, 2001, p. 27; FAO, 2009, the basin size is slightly smaller at 31,896 km^2. According to Shahin, 2007, p. 249 basin size is no more than 29,700 km^2.
19. Also called Alwind or Al Wand.
20. ACSAD and UNEP-ROWA, 2001, p. 27.
21. Ministry of Environment in Iraq et al., 2006, p. 13.
22. Ibid., p. 22.
23. IRIN, 2008.
24. Iraqi News, 2011; Iraq Energy, 2011.
25. Ministry of Environment in Iraq et al., 2006, pp. 33-34.
26. Motiei et al., 2000.
27. Iran Ministry of Energy News Agency, 2011.
28. UNESCO, 2009.
29. Ministry of Water Resources in Iraq, 2012.
30. The Imperial Government of Iran and the Government of the Republic of Iraq, 1975.
31. Ministry of Water Resources in Iraq, 2012.
32. AINA, 2011; Iraq Business News, 2012; ORSAM, 2012.

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