Chapter 2

Shared Tributaries of the Euphrates River

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

german cooperation
DEUTSCHE ZUSAMMENARBEIT

BGR Bundesanstalt für Geowissenschaften und Rohstoffe

ESCWA
United Nations Economic and Social Commission for Western Asia

How to cite
UN-ESCWA and BGR (United Nations Economic and Social Commission for Western Asia; Bundesanstalt für Geowissenschaften und Rohstoffe). 2013. Inventory of Shared Water Resources in Western Asia. Beirut.

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EXECUTIVE SUMMARY

The Euphrates River has three main shared tributaries: the Sajur and the Balikh/Jallab are shared between Syria and Turkey, while the Khabour sub-basin is shared between Iraq, Syria and Turkey.
With an average annual discharge of 97 MCM, the Sajur is the smallest of the three tributaries. Originally, the Balikh/Jallab was fed primarily by the karstic Ain al Arous Spring, but it increasingly receives irrigation return flows from intensive agricultural projects, mainly in Turkey. The Khabour is the largest of the three shared Euphrates tributaries in terms of length and mean annual discharge. However, annual flow has decreased dramatically over recent decades from 2,120 BCM before 1980 to 924 MCM around 2000, with values constantly decreasing since then. The Khabour river dries up seasonally at several locations as a result of intensive irrigated agriculture in Syria and Turkey.

While the three Euphrates tributaries used to make up around 8% of annual Euphrates flow, today their contribution has dropped to 5% or less due to decreased flow of the Khabour.
In all three sub-basins water is mainly used for irrigation purposes.

In the Balikh/Jallab sub-basin, the Turkish Urfa-Harran Project imports water from the Atatürk Dam reservoir to irrigate large areas of land which have transformed the Jallab River from an intermittent stream into a perennial river. In the Khabour sub-basin both riparians developed extensive irrigation schemes that have transformed land use patterns and the natural flow regime of the river.

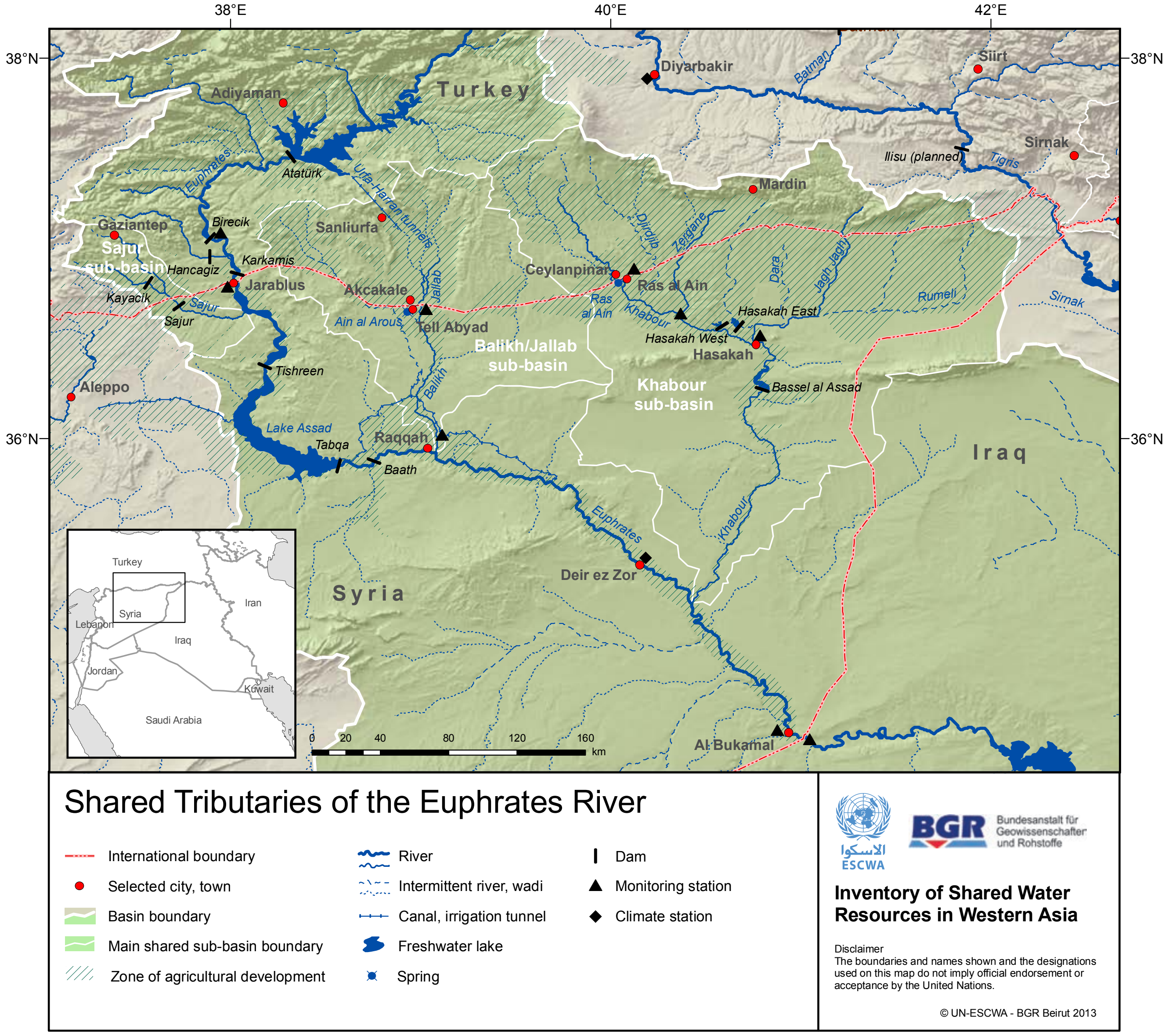
The Sajur River in Syria, 2009. Source: Andreas Renck.

There are no specific water agreements in place for any of the three shared tributaries.

SUB-BASIN FACTS

RIVER	SAJUR	BALIKH/JALLAB	KHABOUR
BASIN AREA SHARES	Syria 40% Turkey 60%	Syria 38% Turkey 62%	Iraq 6% Syria 66% Turkey 28%
BASIN AREA	2,860 km^2	13,600 km^2	36,200 km^2
RIVER LENGTH	108 km	196 km	388 km
MEAN ANNUAL FLOW VOLUME	98 MCM	~140-210 MCM	924 MCM
MAIN DAMS	2	Unregulated to date	3
PROJECTED IRRIGATED AREA	..	~330,000 ha	~404,000 ha

OVERVIEW MAP



CONTENTS

FIGURES

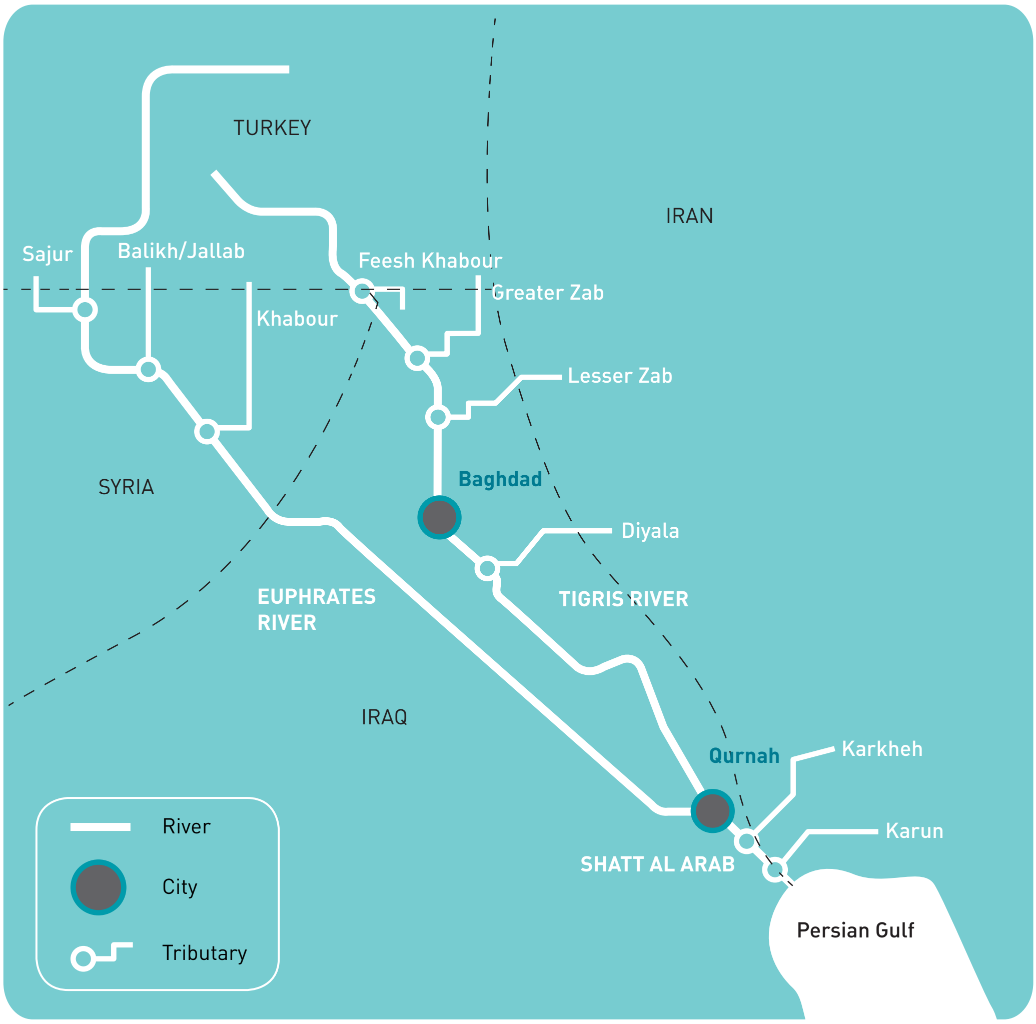
TABLES

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 Euphrates River Basin has three major tributaries: the Sajur, the Balikh/Jallab and the Khabour Rivers (see Overview Map, Fig. 1).

The only right-bank tributary, the Sajur, is the smallest of the three rivers in terms of length and discharge.

The second tributary is the left-bank Balikh/ Jallab River, which can be divided into two parts: the northern, nowadays perennial Jallab River, which originates in the Urfa Heights in Turkey, and the southern Balikh River, which originates at the Ain al Arous Spring in Syria.

The Khabour River originates on the south-facing slopes of the Taurus Mountains in Turkey and is formed by the confluence of the Ipramiye and Güzelyat Rivers. It is the largest of the three tributaries in terms of length and mean annual discharge. All three Euphrates tributaries form shared basins between Syria and Turkey.

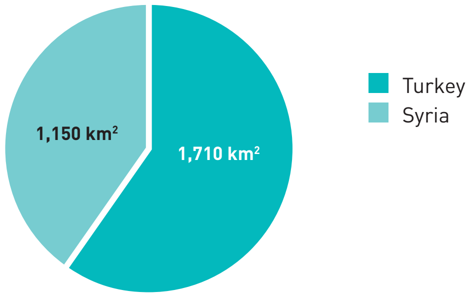
The Sajur River in Syria, 2009. Source: Andreas Renck.

Sajur

The Sajur River stems from the confluence of two streams in Turkey, the Ayfinar Deresi and the Bağırsak Deresi. It flows south-eastwards, entering Syria at Kusek and discharging into the Euphrates about 20 km downstream of the city of Jarablus.[1] This confluence is usually flooded by the Tishreen Dam reservoir (see Overview Map).

The river has a total length of 108 km, of which 48 km lie in Syria and 60 km in Turkey. The Sajur River drainage basin covers 2,860 km², 40% of which lies in Syria and 60% in Turkey (Figure 2).[2]

Figure 2. Distribution of the Sajur Basin area



Source: Compiled by ESCWA-BGR.

HYDROLOGICAL CHARACTERISTICS

Hydrological data for the Sajur sub-basin is limited. Table 1 compiles discharge estimates for different periods in Turkey and Syria. The river's maximum discharge usually occurs in February and March, while the minimum falls between June and October. According to estimates, the mean discharge of the Sajur in Syria usually lies below 3 m^3/s, with maximum discharge values of 25 m^3/s recorded during flood periods in the 1960s and a minimum discharge of 0-0.5 m^3/s during dry periods. According to the Central Bureau of Statistics in Syria, the mean discharge of the Sajur was 3.1 m^3/s between 2002 and 2006, which amounts to an annual mean of about 98 MCM.[3] The Sajur River flow contribution to the Euphrates is almost negligible and represents just 0.39% of annual Euphrates flow.

WATER RESOURCES MANAGEMENT

Both riparian countries have over the past century increased their water use for irrigation along the Sajur. As a result, flow volumes have diminished along the river's course and in summer the Sajur periodically runs dry due to intensive irrigation abstractions. Syria and Turkey have also constructed dams on the river. The Kayacik Dam was built on the Ayfinar Deresi as part of the Southeastern Anatolia Project (GAP) in Turkey. It has a reservoir capacity of 117 MCM. The Sajur Dam in Syria was inaugurated in 2005 and has a capacity of 14.5 MCM. It is used for the irrigation of approximately 10,000 ha, mainly along the river's downstream banks.

WATER QUALITY & ENVIRONMENTAL ISSUES

The Sajur River's water quality is good compared to that of the two other tributaries. According to the Syrian Ministry of Irrigation, the water is suitable for agricultural use, with Electrical Conductivity (EC) values ranging between 661 μS/cm and 823 μS/cm in 2010.

Table 1. Mean annual flows of the Sajur River

COUNTRY	LENGTH (km)	PERIOD	FLOW (m^3/s)			FLOW (MCM/yr)	SOURCE
			MEAN	MINIMUM	MAXIMUM		
Turkey	60	1980	4.4	..	..	138.6	GAP in Kolars and Mitchell, 1991, p. 109.
Syria	48	1966	3.0	0.5	25.0	94.5	FAO in Kolars and Mitchell, 1991, p. 109.
Syria	48	1980	1.9	—	13.6	59.9	SAR in Kolars and Mitchell, 1991, p. 109.
Syria	..	1980	2.8	..	..	88.0	USAID in Kolars and Mitchell, 1991, p. 109.
Syria	..	2002-2006	3.1	..	..	97.7	Central Bureau of Statistics in the Syrian Arab Republic, 2010.
..	108	..	4.2	0.5	15-20	132.5	ACSAD and UNEP-ROWA, 2001, p. 22.

Source: Compiled by ESCWA-BGR.

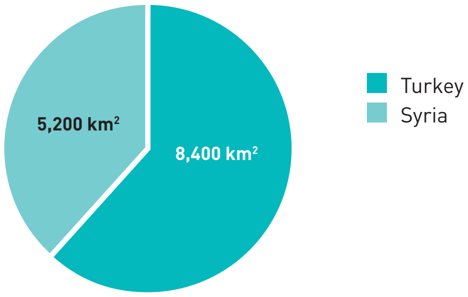
Balikh/Jallab

Covering a total surface area of 13,600 km², the Balikh/Jallab sub-basin is shared between Syria (38%) and Turkey (62%) (Figure 3).[4] The Jallab originates in the Urfa Heights in Turkey[5] and flows south for 15 km[6] before joining the Balikh River which originates in Syria.[7] The two rivers form a tributary to the Euphrates with a total length of about 196 km, of which 107 km lie in Syria and 89 km in Turkey.[8]

The primary source of the Balikh is the karstic Ain al Arous Spring near the Syrian border town of Tell Abyad. The river also receives water from a number of intermittent streams and ephemeral wadis, including the Wadi Qaramogh and the Wadi al-Kheder. The Jallab River also contributes to Balikh flow and has over recent decades become perennial due to the inflow of agricultural drainage water from the Urfa-Harran region in Turkey. The Balikh discharges into the Euphrates downstream of Lake Assad near the city of Raqqah, around 80 km south of the Turkish border.

Precipitation levels in the basin decrease from north to south, with an annual average of more than 450 mm in the north and less than 150 mm in the south-east.

Figure 3. Distribution of the Balikh/Jallab Basin area



Source: Compiled by ESCWA-BGR.

HYDROLOGICAL CHARACTERISTICS

The Jallab used to be an intermittent stream with an annual discharge of around 111 MCM (Table 2). Today it has become a perennial river that carries irrigation return flows from intensive agricultural projects in the Urfa-Harran Plain in Turkey. While no official data is available, it is likely that the discharge has increased significantly since the projects were established in the late 1980s, with mean discharges of around 10-20 m³/s.[9] The flow regime of the Jallab varies strongly throughout the year, depending on precipitation and irrigation in Turkey.

In the 1980s, the Ain al Arous Spring near the Syrian town of Tell Abyad was the primary source of water for the Balikh, with an average discharge of 6 m³/s or about 189 MCM/yr, which is equivalent to twice the mean annual flow volume of the entire Sajur River (Table 2). However, extensive groundwater abstraction for irrigated agriculture in the upper basin has had a far-reaching impact on spring and river flow. The Ain al Arous Spring currently falls dry for most of the year, while the upper Balikh River[10] no longer flows year round.[11] It is not clear whether the recent and projected diversion of irrigation water from the Euphrates River (through the Urfa tunnels in Turkey and from Lake Assad in Syria) will alter the water balance again. Today, the flow of the upper Balikh River mainly consists of untreated wastewater from Tell Abyad.

In general, the lower Balikh has a wide riverbed. The import of irrigation water from Lake Assad to the Balikh sub-basin also impacts the river's hydrology. The Balikh essentially acts as a drain for the return flows from the Balikh Irrigation Projects (see below). According to official figures, the Balikh has an average discharge of 6.8 m³/s (214 MCM/yr), with a maximum discharge of up to 35 m³/s during floods (1,104 MCM/yr).[12] However, values in the lower basin could well be higher as the measurement location was not specified. The Balikh River flow contribution to the Euphrates is estimated at

Ain al Arous Spring, Syria, 2009. Source: Andreas Renck.

Table 2. Mean annual flows of the Balikh River

COUNTRY	RIVER	PERIOD	FLOW (m³/s)			FLOW (MCM/yr)	SOURCE
			MEAN	MINIMUM	MAXIMUM		
Turkey	Jallab	1980s	3.5	..	..	111	GAP 1980 in Kolars and Mitchell, 1991, p. 112.
Syria	Ain al Arous Spring		6.0	..	..	189	USAID 1980 in Kolars and Mitchell, 1991, p. 112.
	Total Balikh		..	..	..	300	Kolars and Mitchell, 1991, p. 112; Beaumont, 1996, p. 142.
Syria, Turkey	Balikh/Jallab	2001	4.4	0.5	20.0	139	ACSAD and UNEP-ROWA, 2001, p. 22.
Syria	Balikh	2002-2006	6.8	—	35.2	214	Central Bureau of Statistics in the Syrian Arab Republic, 2010.

Source: Compiled by ESCWA-BGR.

around 0.86% of annual Euphrates flow. Flooding is an issue in many parts of this relatively flat sub-basin, and flood protection dams have been built along the whole river course, even across the Syrian-Turkish border.

WATER RESOURCES MANAGEMENT

Land use patterns in the Syrian and Turkish parts of the Balikh/Jallab sub-basin were traditionally centred on rain-fed agriculture and livestock grazing with limited irrigation in the major floodplains. However, the development of large-scale irrigation projects in the late 1980s has led to widespread development of irrigated agriculture.[13]

The Urfa-Harran Project is the largest irrigation project in the Turkish part of the Balikh/Jallab sub-basin. As one of the first projects within GAP, it imports irrigation water through the Urfa-Harran tunnels from the Atatürk Dam reservoir, and irrigates 140,000 ha of land, with a further 8,000 ha under construction.[14] The project currently encompasses about half of the established irrigated areas (277,123 ha) in GAP irrigation projects on the Euphrates.[15] A project of this size requires an estimated water import of 1,481 MCM/yr into the Balikh/Jallab sub-basin.[16] Consequently, and as mentioned above, the Jallab has been transformed from an intermittent stream into a perennial river, carrying irrigation return flows from GAP.

Irrigated agriculture is also practiced in the Syrian part of the basin, though satellite imagery suggests it appears to be less intensive and more scattered. Syria has been pursuing an irrigation development strategy in the Euphrates Basin since the 1980s. One of the largest projects is the Balikh Irrigation Project, which imports irrigation water from Lake Assad on the Euphrates River.[17] Original plans aimed to irrigate a total of 185,000 ha of land, requiring the annual import of 1,850 MCM from the Euphrates.[18] So far about 90,000 ha are irrigated, of which 57,000 ha drain towards the Balikh River.[19] This results in an annual import of 570 MCM from the Euphrates.[20] Together with the Turkish import of approximately 1,481 MCM/yr, the total amount of water imported into the Balikh/Jallab sub-basin is almost seven times as high as the total natural flow of the Balikh/Jallab. This obviously has an increasingly significant impact on the basin.

WATER QUALITY & ENVIRONMENTAL ISSUES

While water flow is increasing as a result of agricultural developments in the upper catchment of the Jallab, water quality is deteriorating due to saline drainage waters from Syrian and Turkish irrigation activities. Data from 1996-1999 shows that the salinity level of the Jallab was already high when it entered Syria, with a mean EC value of 1,528 μS/cm (Table 3).[21] Recent information indicates that the salinity of the Jallab is at least double that of the Ain al Arous Spring, the source of the Balikh in Syria. Downstream salinity increases further with the return waters from the Balikh Irrigation Project and other agricultural activities along the river. The discharge of sewage water from urban areas such as Akcakale and Harran in Turkey, and Tell Abyad in the upper Balikh further contribute to the river's salinization and pollution. While detailed long-term information on water quality is not available, predictions from the 1990s concerning the increase in nutrients in the river are probably accurate.[22]

The increased salinity does not necessarily affect agricultural activities in the lower Balikh Basin, as the large irrigation schemes do not use water from the Balikh, and receive relatively clean water from the Euphrates. Nevertheless, in the long term salts and other pollutants in the Balikh will impact Euphrates water quality after the confluence of the two rivers just downstream from Raqqah. At this stage, however, it is difficult to determine the extent of this problem. The absolute volume of Balikh irrigation return flow is small compared to the total Euphrates river flow and thus unlikely to affect water quality considerably. However, irrigation return flows may have significant impact during periods of maximum irrigation (i.e. late spring and early summer) when the Euphrates flow is reduced.

Table 3. **Mean Electrical Conductivity (EC) values for Ain al Arous Spring, Jallab and Balikh Rivers for different years**

PERIOD	STATION	EC (μS/cm)	SOURCE
2010	Ain al Arous Spring	760	BGR, 2010.
1996-1999	Jallab[a]	1,528 (680-2,830)	ACSAD and UNEP-ROWA, 2001.
2010		1,800	BGR, 2010.
		1,729	Ministry of Irrigation in the Syrian Arab Republic, 2012.
2010	Balikh	2,750 (1,486-3,100)	BGR, 2010; Ministry of Irrigation in the Syrian Arab Republic, 2012.

Source: Compiled by ESCWA-BGR.
Notes:
- The mean values from BGR, 2010 refer to measurements taken in October 2010, whereas the value from the Ministry of Irrigation in the Syrian Arab Republic, 2012, is the yearly average.
- The values in brackets refer to the range.
(a) Measured at Tell Abyad.

The Jallab River on the Syrian-Turkish border, Syria, 2010. Source: Andreas Renck.

Khabour

The Khabour River is the largest of the three shared Euphrates tributaries in terms of length and mean annual discharge. The Khabour Basin is often described as the most complicated element of the Euphrates system as the river's different branches originate both in Syria and in Turkey (see Overview Map).[23]

The Khabour Basin is shared by Syria and Turkey, with a small part of the basin in Iraq. The drainage basin covers a surface area of almost 36,200 km², of which 28% lies in Turkey and 66% in Syria (Figure 4).[24] To the south-east, around 6% of the basin falls within Iraqi territory.[25]

The Khabour River has a total length of 388 km of which 308 km lie in Syria.[26] The river discharges into the Euphrates near Deir ez Zor.[27] Several wadis contribute to the Khabour, creating the upper Khabour or Khabour Triangle. They include the Djirdjib, the Zergane and the Jagh Jagh – permanent streams which are important for irrigation during the summer months. Others streams such as Breibitch, Jarrah, Khneizir and Rumeli are intermittent and only flow during the rainy season.

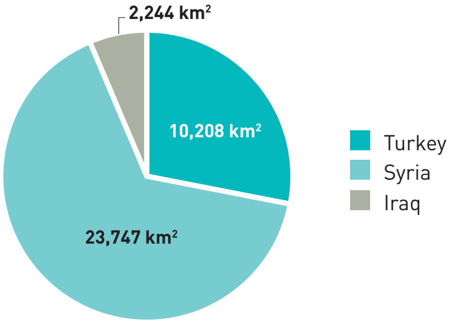
The Khabour sub-basin is characterized by a Mediterranean climate with dry, hot summers and wet, cool winters. From north to south, yearly precipitation decreases from more than 400 mm to less than 200 mm.

HYDROLOGICAL CHARACTERISTICS

The Khabour River is fed by rainfall and snow-melt from the Armenian Highlands. Precipitation and groundwater are the main sources of runoff in the basin.[28] After the river crosses the Syrian-Turkish border, the stream receives substantial input from several major karstic springs[29] near the town of Ras al Ain.

With regards to flow rates, the earliest period covered in the literature refers to a location on the Khabour near the confluence with the Euphrates: for the period 1943-1961, the mean discharge was 50.7 m³/s (1,599 MCM/yr)[30] (Table 4). A detailed analysis of 1966 data concluded that the natural discharge of the Khabour River and its tributaries was 57.5 m³/s (1,813 MCM/yr), of which 47.7 m³/s (83%) were attributable to Turkey and 9.8 m³/s (17%) to Syria.[31] Similar values were maintained during the period 1961-1980, with mean annual discharge values ranging from 46.9 m³/s (1,477 MCM) at Ras al Ain near the Syrian-Turkish border, to 67.2 m³/s (2,117 MCM) at Hasakah after the confluence of all Khabour tributaries.

Figure 4. Distribution of the Khabour Basin area



Source: Compiled by ESCWA-BGR.

In the following period 1981-2000, mean annual discharge volumes at Ras al Ain, Tal Tamer and Hasakah declined by 55%, 52.4% and 44% respectively compared to pre-1980 periods. Discharge at the Ras al Ain Spring – once the single-most important source of the Khabour and one of the largest karst springs in the world – declined from a mean annual discharge of 40 m³/s in the 1980s[32] to only 14 m³/s in 1998 and 7.38 m³/s in 2003.[33] This decline has been widely attributed to the overexploitation of groundwater for irrigation purposes in the Turkish part of the Khabour catchment area.[34] A three-year regional drought between 1998 and 2001 could also explain the reduction in flows during this period. Since 1999, the lower Khabour reportedly runs dry in July and August.[35] According to recent data from the Syrian Central Bureau of Statistics, the mean annual discharge of the Khabour River in Syria at Ras al Ain between 2008 and 2010 was

The Khabour near Tell Halaf, Ras al Ain, Syria, 2009. Source: Bertramz.

Table 4. Mean annual flows of the Khabour River in Syria

STATION	PERIOD	FLOW (m^3/s)	FLOW (MCM/yr)	SOURCE
Calculated total	1966	57.5	1,813	Kolars and Mitchell, 1991, p. 191.
Near Euphrates confluence	1943-1961	50.7	1,600	ACSAD and UNEP-ROWA, 2001.[b]
Ras al Ain Spring	1961-1980	46.9	1,477	Oresic and Bahnan, 2005.
	1981-2000	25.8	813	
Tal Tamer	1961-1980	53.2	1,675	
	1981-2000	27.9	878	
Hasakah	1961-1980	67.2	2,117	
	1981-2000	29.3	924	
Ras al Ain Spring	2008	3.6	113.5	Central Bureau of Statistics in the Syrian Arab Republic, 2010.
	2009	4.3	135.6	
	2010	2.09	65.9	

Source: Compiled by ESCWA-BGR.
(a) Kolars and Mitchell, 1991, p. 191, states that 47.7 m^3/s or 1,504 MCM is attributed to Turkey and 9.8 m^3/s or 309 MCM to Syria.
(b) ACSAD and UNEP-ROWA, 2001, p. 22 indicates that the average values refer to the Souar station. Maximum and minimum values were given for Tal Tamer and Shadadah locations, respectively.

between 2.09 and 4.3 m^3/s[36] – less than 5-10% of the near-natural pre-1980 values (Table 4).

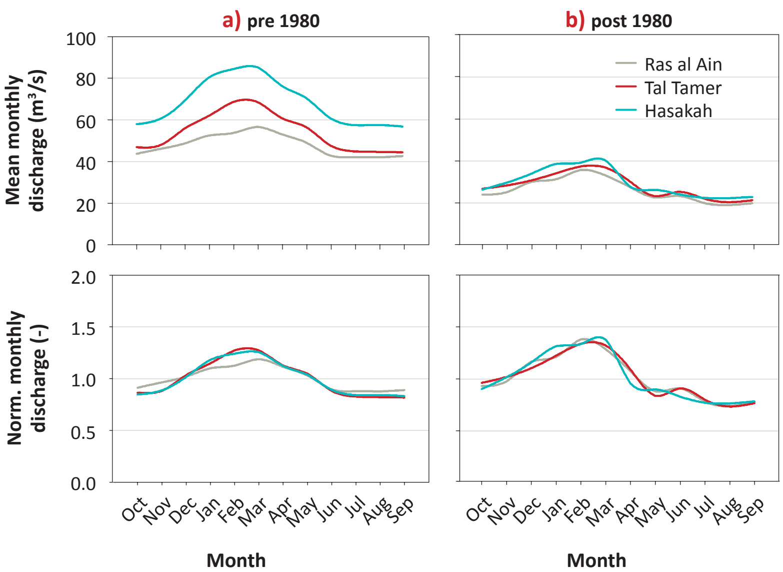
The Khabour River and its tributaries once played a significant role in determining the quantity and quality of Euphrates water, contributing up to 12% of annual Euphrates flow.[37] However, other calculations suggest that the Khabour only contributed a 7% share, if one assumes that the natural annual flow of the Euphrates River at the Syrian-Turkish border was 30 BCM before 1973 (see Chap. 1), and that the near-natural flow of the Khabour was around 2.1 BCM (see pre-1980 value at Hasakah, Table 4). Current values and shares are probably far lower, suggesting a flow contribution to the Euphrates River of 3.7% for the period 1980-2000. This contribution may have dropped further since 2000 (see 2008-2010 discharge values for Ras al Ain, Table 4).

Parts of the upper Khabour Basin in Turkey (Mardin-Ceylanpinar Plains) receive increasing amounts of Euphrates water that is imported from Lake Atatürk more than 260 km away. It is not clear how return flows and changes in abstraction patterns will affect local hydrology and water quality in Syria and Turkey in the long term.

Flow regime

Generally, the flow regime of the Khabour River at different gauging stations (Ras al Ain, Tal Tamer, Hasakah) shows a subtle high-flow season coinciding with winter rainfall from January to March and a prolonged but stable low-flow season from April to December. This limited seasonal variation compared to the main stem of the Euphrates or Tigris River can be ascribed to the strong groundwater influence[38] with relatively steady flow contributions throughout the year. The pre-1980 (1961-1980) and post-1980 (1981-2000) river flow regimes presented in Figure 5 show subtle changes with increased peak values in winter (February) and decreased low flows starting in April, possibly as a result of intensified irrigation in the catchment. However, engineering works in the catchment date back to the early 1960s and therefore the pre-1980 flow regimes may already reflect the effect of regulation to some extent. Changes to the snowfall and snow-melt regime as a result of climate variability and higher

Figure 5. Mean monthly flow regimes of the Ras al Ain Spring and Khabour River at different gauging stations (pre- and post-1980)



Source: Compiled by ESCWA-BGR based on data published in Oresic and Bahnan, 2005.

temperatures may have triggered an early snow-melt contribution to stream-flow. However, this phenomenon requires more in-depth research.

WATER RESOURCES MANAGEMENT

For millennia, rain-fed agriculture was prevalent in the upper Khabour Basin. Along the lower Khabour, nomadic tribes and small settled communities practised a limited amount of gravity irrigation for cultivation. In the 1940s this began to change and extensive irrigation schemes in both Syria and Turkey reshaped land use, the natural water regime and the basin's character. Today intensive irrigated agriculture dominates the landscape, dams have been built to support those initiatives and the Khabour steppe no longer exists in its original form.[39]

Turkey

Turkey developed dams and extensive irrigation schemes in the Turkish part of the Khabour Basin as part of GAP (see Chap.1). The main schemes in the Khabour Basin are the Mardin-Ceylanpınar Projects, which are designed to irrigate 302,000 ha.[40] Another planned irrigation project will import water from the Tigris River into the Khabour Basin and irrigate 89,000 ha upon completion.[41] Euphrates water from the Atatürk Dam is also being used for irrigation purposes in the Turkish part of the Khabour Basin.[42]

As Turkish irrigation water imports will increase with every completed scheme, high quantities of irrigation return water will continue to alter the river's flow regime, in addition to reducing water quality due to agro-chemicals and higher salinity.[43]

Syria

When Syria began to invest in irrigated agriculture in the 1950s and 1960s, heavy emphasis was laid on the development of the lower Khabour region and parts of the upper Khabour. In the following decades, large parts of Hasakah Governorate that lie in the Khabour Basin were equipped with dams and canals. Three dams were built as part of the Khabour River Basin Irrigation Project: the Hasakah East and Hasakah West Dams were built on tributaries of the Khabour between the Ras al Ain Spring and Hasakah. The Bassel al Assad Dam was built on the Khabour River, 25 km south of Hasakah (Table 5). These diversion and storage structures supply comprehensive irrigation systems such as the Hasakah East and West Irrigation Projects. As a result, land irrigated by surface water gravitation in Hasakah Governorate increased eightfold from 7,400 ha to 65,000 ha between 1990 and 2000.[44] Over this period, Hasakah became the most important agricultural region in Syria, producing around 40% of the country's wheat and cotton supply, two of the main irrigated crops in Syria.[45] Agricultural land use in the Khabour Basin has undergone significant change in recent years, with major developments between 1990 and 2000. According to a remote sensing study that covers this period, changes in the distribution of irrigation projects in the Khabour Basin have led to significant social shifts.[46] Rain-fed agriculture in the upper Khabour and floodplain irrigation by gravity along the lower Khabour were replaced by groundwater irrigation and/or canal networks in scattered areas in the steppe. This drastic change is linked to the introduction of diesel pumps, which tapped deep groundwater reservoirs, as well as the subsequent establishment of dams and canals.

Total irrigated land area in Hasakah Governorate in 2010 was officially estimated at 358,000 ha, of which about 45,000 ha were irrigated by rivers and springs, while 313,000 ha were irrigated by wells.[47] Irrigated land from surface water resources in Hasakah seems to have diminished slightly from 65,000 ha in 2000[48] to 45,000 ha in 2010. Lands irrigated by the Khabour were estimated at 55,550 ha in 2010, in addition to 4,000 ha irrigated by the Jagh Jagh River, a Khabour tributary.[49] This amounts to nearly 60,000 ha of surface-irrigated land, in Hasakah Governorate but probably also beyond.

As groundwater is the main source of irrigation water in the basin, it is important to note that more water is being used from underground sources than is naturally replenished.[50] This is reflected in pumping from wells that are more than 100 m deep, in addition to greater differences between water levels before and after the irrigation season.[51] Summer cultivation using groundwater has reportedly been banned in Syria but not details are available and full

Table 5. Main dams in the Khabour Basin in Syria

NAME	COMPLETION YEAR	CAPACITY (MCM)	PURPOSE[a]	BACKGROUND INFORMATION
Bassel al Assad (Hasakah South or Khabour)	..	605	I	On the Khabour River. Projected irrigated area: 50,000 ha
Hasakah East (8 March)	1990	233	I	On a Khabour tributary.
Hasakah West (7 April)	1990	91	I	On a Khabour tributary. Projected irrigated area: 48,000 ha

Source: Compiled by ESCWA-BGR based on Ministry of Irrigation in the Syrian Arab Republic, 2010; Ministry of Irrigation in the Syrian Arab Republic, 2006.
(a) Irrigation (I).

The Khabour near Tell Sheikh Hamad, Syria, 2009. Source: Bertramz.

implementation remains rather unlikely.[52]
In 2009, Syria launched the Al Khabour River Basin Irrigation Development Project to further enhance agricultural productivity and create jobs in one of the country's poorest areas, the region around Hasakah, Deir ez Zor and Raqqah.[53]

The new development project plans to bring water from the Tigris River into the Khabour Basin by means of an integrated inter-basin transfer system. The water will irrigate about 150,000 ha of land in the Hasakah region, in addition to generating electricity.[54] No details are known regarding the state of implementation of this project in view of the current events.

Iraq

Iraq has no significant projects in the Khabour Basin as it has limited possibility to develop water resources in this area. However, discharge from the Euphrates tributaries affects water quantity and quality in Iraq.

WATER QUALITY & ENVIRONMENTAL ISSUES

Very little information is available regarding water quality of the Khabour. At its source in Syria, the river water is considered suitable for drinking according to Syrian standards. However farther downstream, it is threatened by pollution from untreated wastewater that is directly discharged into the river from surrounding urban settlements.[55] Water samples from the Bassel al Assad Dam reservoir have revealed extremely high Biochemical Oxygen Demand (BOD) values reaching 490 mg/L.[56]

Groundwater in the Euphrates Sub-Basins

The two main tributaries of the Euphrates River in Syria, the Balikh and Khabour, are fed by two large springs, the Ain al Arous and the Ras al Ain, which originate along Syria's northern border from the Jezira Limestone Aquifer (Midyat Aquifer) of mainly Eocene age (see Figure 6 below and Chap. 24). The aquifer's main recharge areas are located in south-eastern Anatolia in Turkish territory. The Ain al Arous and Ras al Ain Springs previously had an average discharge of 6 m^3/s and 40 m^3/s respectively,[57] but spring discharge has been significantly reduced due to groundwater extraction from a large number of wells in Syria and Turkey. Recent estimates cited a discharge of 3 m^3/s for the Ras al Ain Spring area.[58]

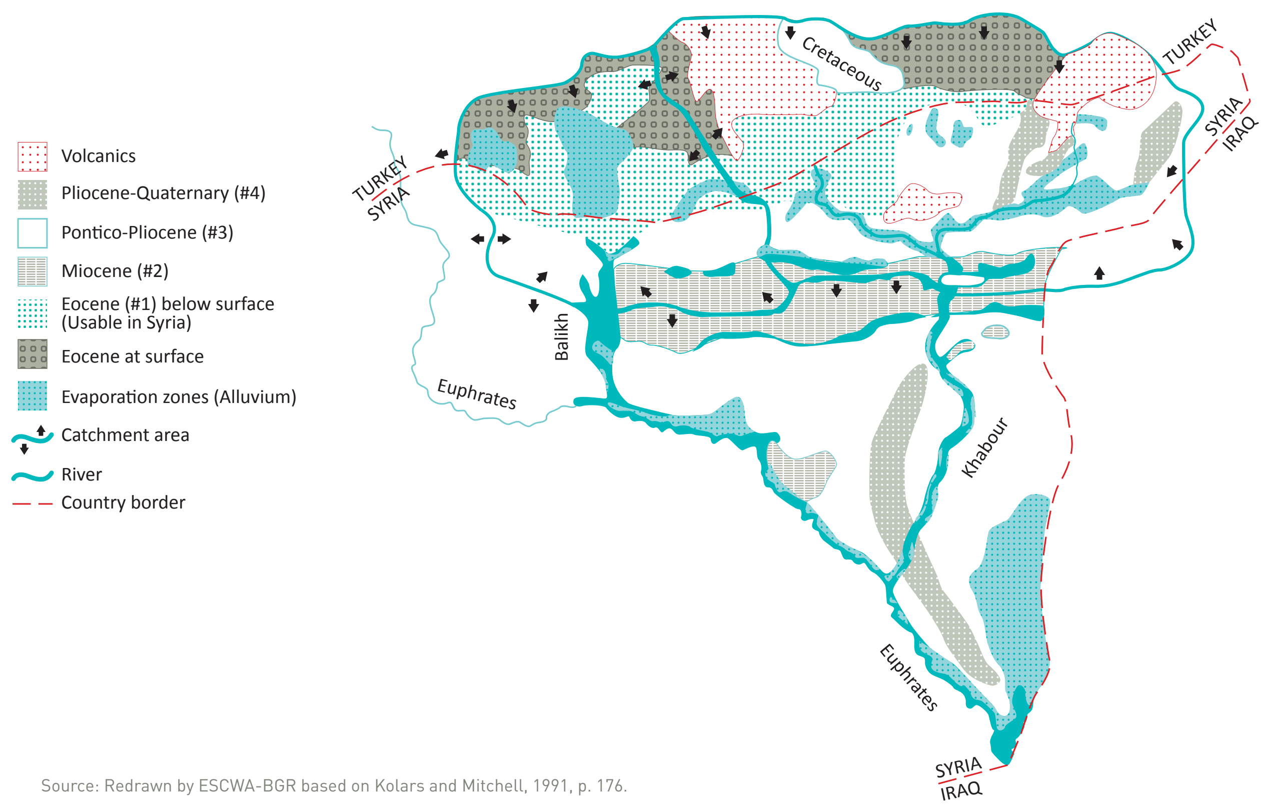
The Jagh Jagh River, a tributary of the Khabour, is fed by springs in the Miocene Limestone aquifer in Turkey and flows into the Syrian Jezira[59] with a mean flow volume of 2-3 m^3/s. The water of the Jagh Jagh River is consumed by irrigation and lost to evaporation in swamps in the area of the Quaternary Radd Aquifer in the northern Syrian Jezira. The Ar Rad Aquifer dominates the north-eastern part of the Khabour Basin. Aquifer productivity decreases to the south as water salinity increases.[60]

Estimates by FAO assess renewable groundwater resources in the Khabour Basin at 650 MCM/yr, though more recent estimates are much higher.[61]

Groundwater flow southward across the Syrian-Turkish border is significant and has been estimated at 1,200 MCM/yr.[62] It can be assumed, however, that flow dynamics have changed significantly as a consequence of large-scale groundwater abstractions in both countries over recent decades.

Base flow in the Sajur River is fed by Paleogene carbonate aquifers in the Gaziantep area in south-eastern Turkey.

Figure 6. Aquifers in the Jezira catchment area



Source: Redrawn by ESCWA-BGR based on Kolars and Mitchell, 1991, p. 176.

Agreements, Cooperation & Outlook

AGREEMENTS

There are no agreements in place between the riparian countries that specifically refer to the tributary rivers discussed in this chapter.

COOPERATION

There is no information on cooperation between the riparian countries regarding the three tributaries discussed in this chapter.

OUTLOOK

Over the last four decades both the Balikh/Jallab and Khabour sub-basins have experienced far-reaching changes that impacted flow trends and water quality. As irrigation return water from large agricultural development projects in Syria and Turkey continues to increase, the sub-basins are likely to be affected in the future as well.

Prior to the Syrian crisis that erupted in March 2011, transboundary issues such as the water quality of the Balikh were put aside in the interest of continued good relations between the two countries. The relationship between Syria and Turkey has seriously deteriorated since then, and it is not clear how the two countries will handle cross-border water issues in the future, particularly as the two sub-basins are important for the socio-economic development of both riparians.

The Sajur River, Syria, 2009. Source: Andreas Renck.

Notes

1. Medzini and Wolf, 2005.
2. Basin area was estimated from a digital elevation model (HydroSHEDS) similar to Lehner et al., 2008.
3. Central Bureau of Statistics in the Syrian Arab Republic, 2010.
4. Basin area was estimated from a digital elevation model (HydroSHEDS) similar to Lehner et al., 2008.
5. ACSAD and UNEP-ROWA, 2001. Urfa is also referred to as Sanliurfa (Yesilnacar and Gulluoglu, 2007).
6. Syrian Geographical Society, 2010.
7. For Syria, the Balikh River starts at the point where the Ain al Arous Spring feeds the river.
8. Kolars and Mitchell, 1991, p. 112; Central Bureau of Statistics in the Syrian Arab Republic, 2010.
9. Kolars and Mitchell, 1991, p. 111 predicted that return flows from the Sanliurfa-Harran region would increase the flow of the Balikh to 368-928 MCM. Interviews in Syria (UN-ESCWA and BGR, 2010) have confirmed this trend, and mean discharge in the Jallab was estimated at 10-20 m^3/s (315-630 MCM/yr) with maximum discharge of about 100 m^3/s after heavy rains in the upper catchment.
10. The upper Balikh River consists of the 12 km stretch from Ain al Arous to the confluence with the Jallab.
11. According to ACSAD and UNEP-ROWA, 2001, Ain al Arous has completely dried up since 1985.
12. ACSAD and UNEP-ROWA, 2001; Central Bureau of Statistics in the Syrian Arab Republic, 2010.
13. Hole, 2009; Beeley in Beaumont, 1996, p. 140: agricultural activities in the Turkish part of the Balikh focused mainly on the cultivation of rain-fed cereals.
14. Ministry of Environment and Forestry in Turkey, 2009, p. 61.
15. The total planned irrigated areas within the entire GAP region adds up to 1.2 million ha.
16. According to Turkish Government estimates in Beaumont, 1996, p. 142. In 2002, the water conveyed to the plain for irrigation amounted to 1,048 MCM. See Yesilnacar and Gulluoglu, 2007, p. 208.
17. Hole, 2009, p. 145.
18. According to an assumed water application rate of approx. 10,000 m^3/ha/yr. Beaumont, 1996, p. 143, 144.
19. According to internal report by UN-ESCWA and BGR, 2010.
20. Applying the same rate of water requirements for land as Beaumont, 1996, p. 144.
21. The recommended EC limit value for irrigation water is set at 700 μS/cm by FAO, 1994.
22. Beaumont, 1996; Kolars and Mitchell, 1991 had predicted that the salt and nutrient loads of the river would increase substantially if both the Syrian and Turkish irrigation projects in the Balikh Basin were implemented as planned.
23. Kibaroglu et al., 2005, p. 163.
24. Basin area was estimated from a digital elevation model (HydroSHEDS) similar to Lehner et al., 2008.
25. Kolars and Mitchell, 1991, p. 168. According to Daoudy, 2005, p. 65 and a report issued by the Ministry of Environment in Iraq et al., 2006, p. 71 the Khabour Basin covers 36,900 km^2.
26. For Kolars and Mitchell, 1991, p. 168 the river extends 120 km in Turkey and flows for 486 km in Syria. According to the Central Bureau of Statistics in the Syrian Arab Republic, 2010, the Khabour has a total length of 477 km of which 402 km lie in Syria.
27. Zaitchik et al., 2002, p. 4.
28. Kolars and Mitchell, 1991, p. 179.
29. Burdon and Safadi, 1963.
30. ACSAD and UNEP-ROWA, 2001.
31. Calculations by Kolars and Mitchell, 1991, p. 191 were based on data from 1966.
32. Hole, 2009, p. 6; a similar value is given by Burdon and Safadi, 1963 for the Ras al Ain Spring.
33. FAO, 2005 in Hole, 2009, p. 6.
34. ACSAD and UNEP-ROWA, 2001.
35. Zaitchik et al., 2002.
36. Central Bureau of Statistics in the Syrian Arab Republic, 2010.
37. Kolars and Mitchell, 1991, p. 81.
38. Kolars and Mitchell, 1991.
39. Hole, 2009; Zaitchik et al., 2002.
40. Ministry of Development in Turkey, 2011.
41. Beaumont, 1996, p. 142 refers in this context to the Nusaybin-Cizre-Idil Project.
42. Hole, 2009, p. 10.
43. Beaumont, 1996, p. 142.
44. Oresic and Bahnan, 2005.
45. Ibid.
46. Zaitchik et al., 2002.
47. Central Bureau of Statistics in the Syrian Arab Republic, 2011.
48. Oresic and Bahnan, 2006.
49. Ministry of Irrigation in the Syrian Arab Republic, 2012.
50. Oresic and Bahnan, 2006.
51. Ibid. Barnes, 2009 reports that during the 1990s, the lower reaches of the Khabour ran dry completely as a result of an expansion in the number of wells in the region. Groundwater pumping close to rivers can induce seepage from the riverbed with an increased hydraulic gradient towards groundwater aquifers.
52. Hole, 2009, p. 8.
53. IFAD, 2009, p. 7.
54. Ministry of Irrigation in the Syrian Arab Republic, 2010.
55. Ministry of Irrigation in the Syrian Arab Republic, 2012.
56. Ibid.
57. FAO and UNDP, 1966.
58. Al-Charideh and Abou-Zakhem, 2009. See Chap. 24.
59. The Khabour Basin in Syria is known as the Jezira. It is divided into the Lower Jezira which stretches north from the city of Deir ez Zor on the Euphrates to Jebel Abdel Aziz in the west and the Sinjar Mountains to the east of the Khabour. The Upper Jezira is located north of these mountains, extending from the city of Hasakah in Syria at the confluence of the Khabour and Jagh Jagh Rivers to the Anti-Taurus Mountains in Turkey (Kolars and Mitchell, 1991, p. 168).
60. Wakil, 1993.
61. Ibid.
62. FAO, 2009.

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