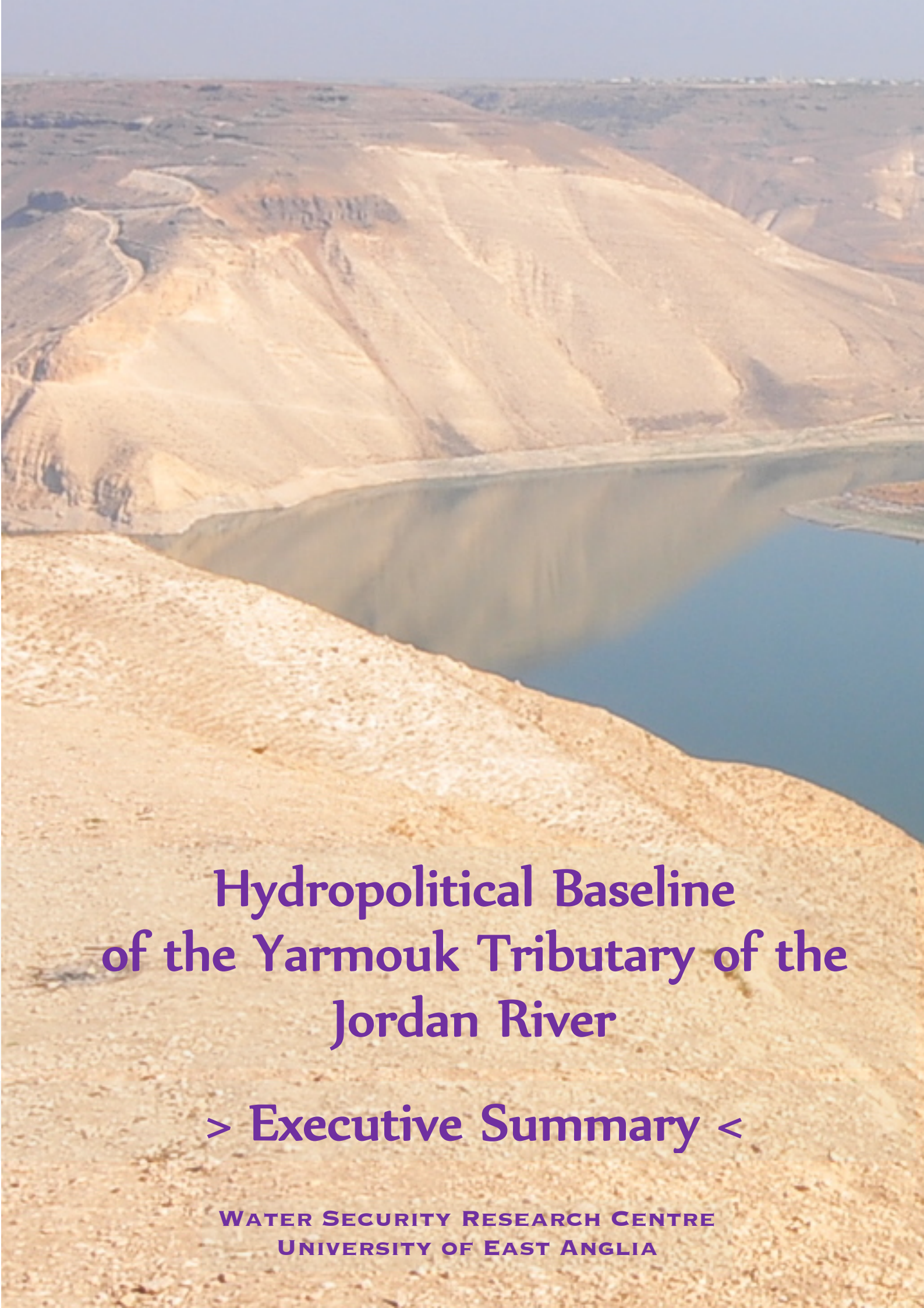

# Hydropolitical Baseline of the Yarmouk Tributary of the Jordan River

## > Executive Summary <

Water Security Research Centre
University of East Anglia

# Hydropolical Baseline Study of the Yarmouk Tributary of the Jordan River

## EXECUTIVE SUMMARY

This study was written by Mark Zeitoun, Muna Dajani, Chadi Abdallah, Sharif Youmans, Sa'eb Khresat and Heather Elaydi of the Water Security Research Centre of the University of East Anglia (UEA). The research was supported financially by the UEA and the Swiss Agency for Development and Cooperation (SDC).

**The contents do not necessarily reflect the views of the SDC or the Swiss Federal Department of Foreign Affairs.**

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*Cover photo*: The al Wehdeh Dam Reservoir on the Yarmouk tributary viewed from Jordan, November 2015. *Source*: Heather Elaydi.

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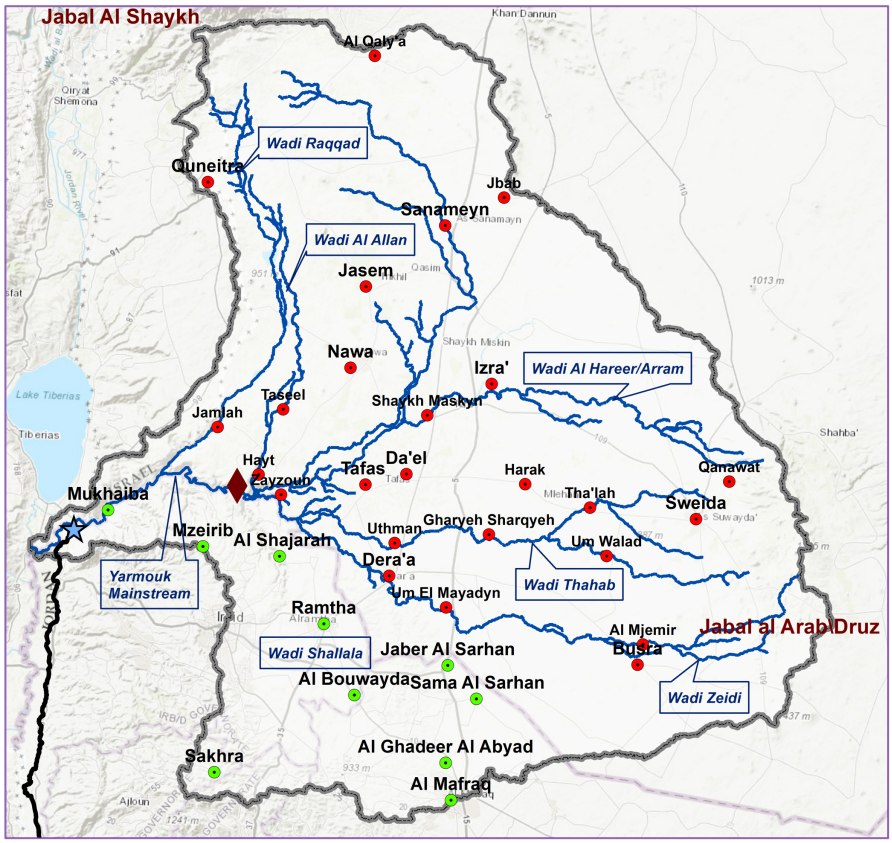
# Executive Summary

**Towards an equitable and sustainable arrangement on the Yarmouk tributary of the Jordan River.**

This study provides the comprehensive biophysical and political analysis of the Yarmouk tributary of the Jordan River required by diplomacy that seeks a more equitable and sustainable arrangement. It was designed and implemented by researchers from Jordan, Syria, Lebanon, Switzerland, Germany and the United Kingdom, with funding from the Swiss Agency for Development and Cooperation, and the University of East Anglia.

The Yarmouk tributary basin in relation to the Jordan River Basin.

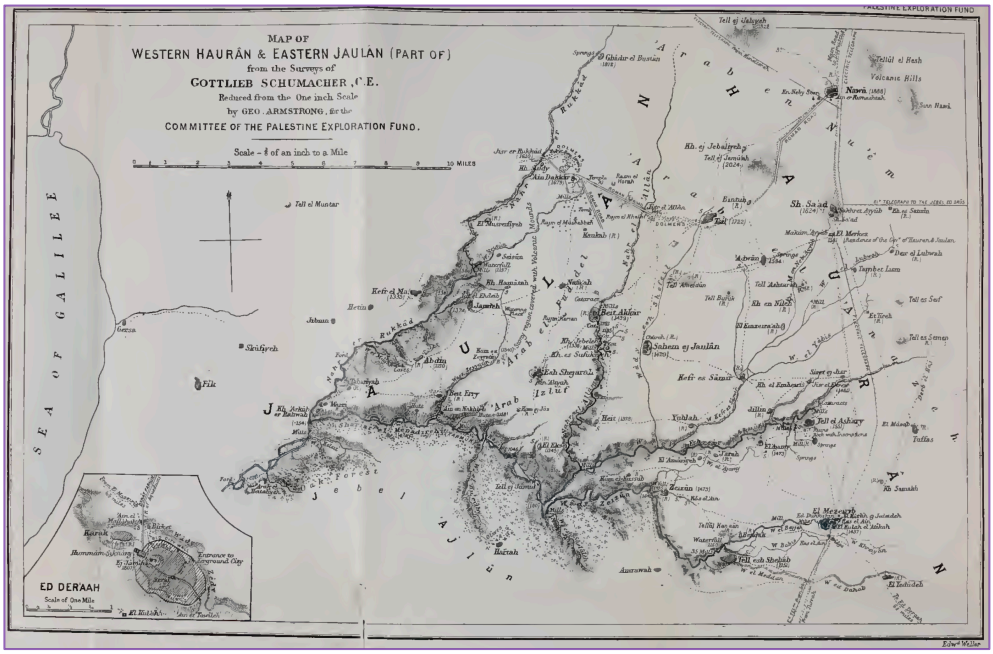



An equitable and sustainable arrangement on the Yarmouk tributary is expected to greatly reduce social and political tensions for the roughly 1.6 million people living in the basin in Jordan and Syria. It could also enable more effective transboundary water management across the entire Jordan River Basin. However, reaching that point requires diplomacy that can cut through the patchy knowledge and misperceptions that characterise our common understanding of the Yarmouk.

Diplomacy that ignores the politics and hydrology of the area risks perpetuating the mistakes of the past into the future, resulting in evermore uncoordinated and inefficient infrastructure, skewed and ambiguous treaties, and confrontational narratives. Indeed, if the pattern of basin development that this study has identified persists for a few more decades, the basin will be riddled with unnecessary water swaps, out-of-basin transfers, and desalination projects through treaties and institutions that

lost their relevance more than half a century earlier and no longer meet the needs of the people. Informed diplomacy, on the other hand, can help equip residents of the Yarmouk tributary basin to better face the challenges caused by political upheavals, massive demographic shifts and long-term changes in climate – not to mention the recurrent possibility of punctual or protracted war.

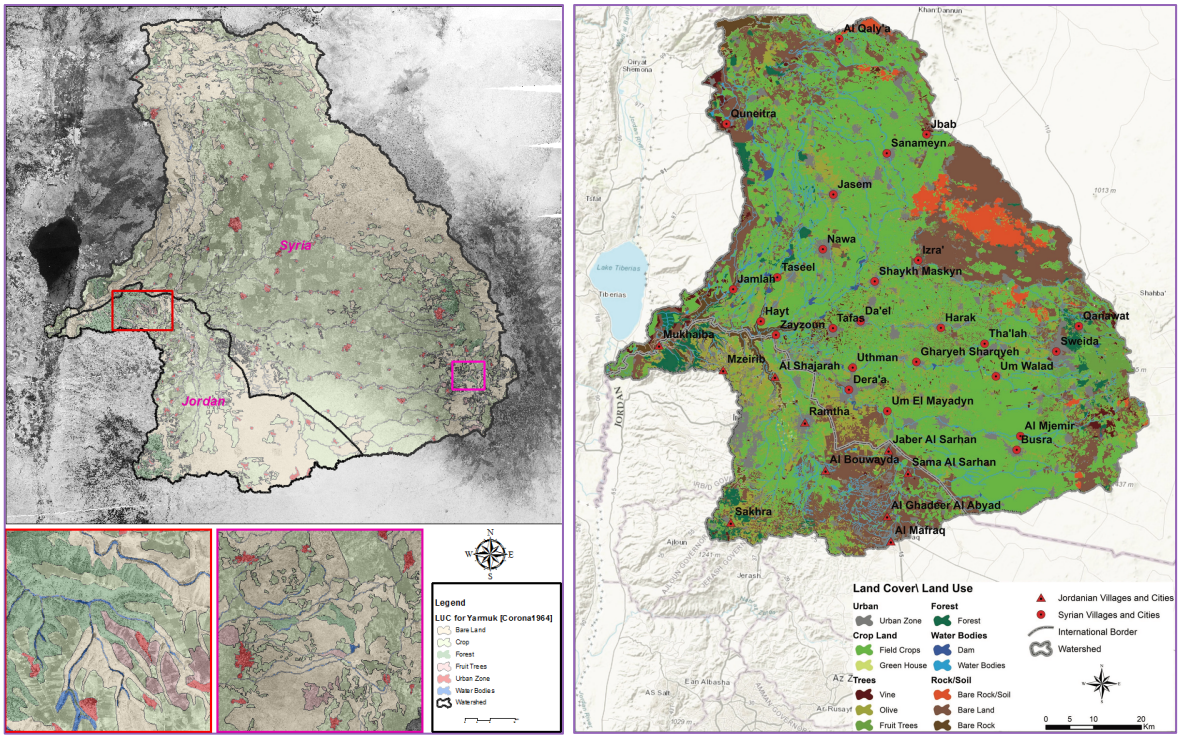
The *Sharia't el Menadireh* (Yarmouk), between the Jaulan (Golan) and Hauran Plain. Source: Schumacher 1889.




**How the study examines the past to illuminate the present.** The report draws on several hundred sources and multiple lenses to scrutinise how water has been used throughout the tributary basin. Examination of archives in Jordan, Lebanon, Israel, France and the United Kingdom has revealed, for instance, the extent of the shift in importance of the Yarmouk Valley as a path for the Hejaz Railway (under Ottoman rule) to a source of water for state-building efforts (under British and French rule). The colonial authorities negotiated water-sharing arrangements from 1920 onwards, whether out of concern of rebellion amongst their new subjects (as the French authorities with the Druze communities around Jabal al Druze in Syria), or to respond to regional crises (as the British with Transjordan and Palestinians displaced by the *Nakba*/creation of the State of Israel in 1948). The archives also reveal the extent to which international law was used to guide American diplomacy in the Jordan Basin – but only until the late 1970s.

The Yarmouk tributary's more recent past is explored through extensive analysis of satellite images. The method proves very useful to track the considerable conversion of bare land in the 1960s to the current widespread level of cultivation, and to identify dams and patterns of agricultural water use. The result is the most accurate estimate to date of the area of the basin (7,387 km$^2$), length of the river (154 km, from the heights of Jabal al Arab / Druze to the confluence with the Jordan River), and elevation profiles of the main wadis that contribute to the Yarmouk mainstream. One particularly useful outcome is the highly detailed land use and cover map (1:20,000 scale) that will serve water resource managers in their respective States, and – eventually – across the borders.

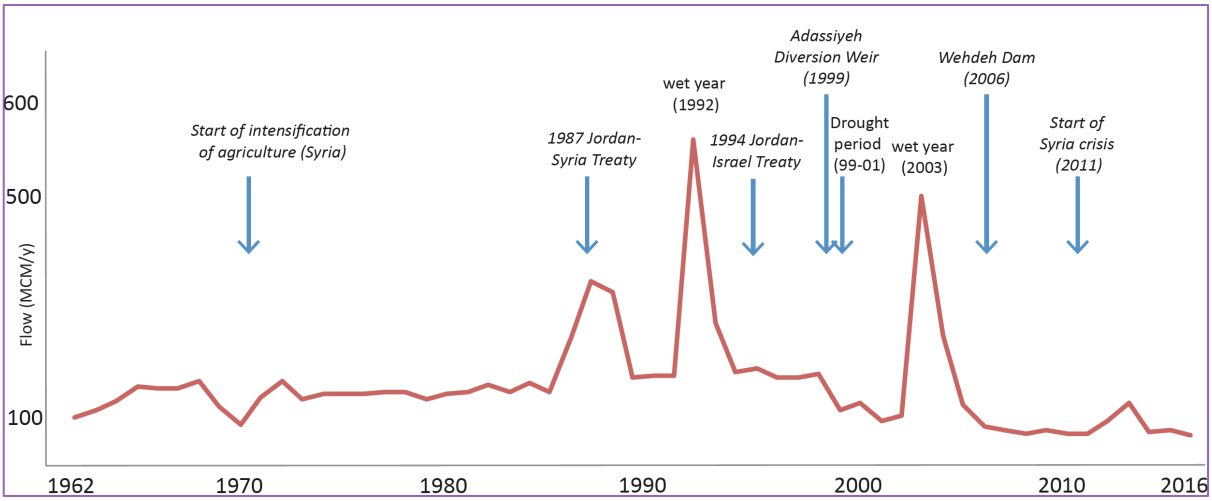
Changes in land use and cover between 1966 (left) and 2011 (right). Refer to main document for sources.




The study employs all available sources of information, including pumping and availability data publically available from or provided by the Jordanian Ministry of Water and Irrigation, the Jordan Valley Authority (in Jordan), the Jordan Valley Water Authority (in Israel), and the Hydrological Service of Israel. It draws upon the widest possible range of hydrological and hydrogeological studies, whether published in peer-reviewed scientific journals, donor reports, local media or PhD theses (and whether in Arabic, Hebrew, French or English). The quantitative data has been verified by field-level observation in Jordan and Israel (although not in Syria, because of the ongoing crisis), and supplemented by more than 30 interviews conducted with Syrian, Jordanian and Israeli scientists, water resource managers, farmers and policymakers.

The body of knowledge holds that the long-term average total 'availability' of water in the basin is very roughly 450 MCM/y measured at Adassiyeh, of which roughly 200 MCM/y is counted as surface water and 250 MCM/y as groundwater. The river flow is highly sensitive to changes in precipitation and abstraction, with the average annual flow varying within the same decade from 50 to 250 MCM/y, and flood flows that can exceed 500 MCM/y (in e.g. 1992).

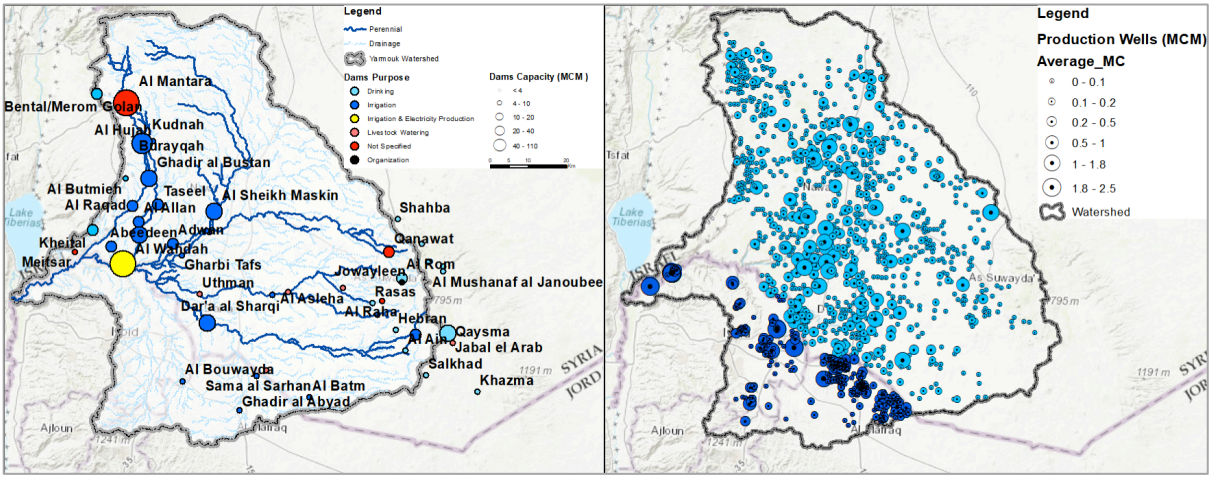
The flow of the Yarmouk measured at Adassiyeh (1962-2016). Source: Compiled based on yearly reporting by JVA.




The groundwater flowing through the three major aquifer systems is more stable than the surface flows, and more significant as a useable source – particularly for agricultural water use from the 1970s onwards. More recently, the Shallow Basalt Aquifer is exploited through thousands of licensed and unlicensed wells in Syria, providing approximately 170 MCM/y for drinking and irrigation water, while more than 32 MCM/y is pumped in Jordan from over 200 wells that exploit the A7/B2 – $Cr_2cn$ cp/$Cr_2m$-d (Wadi as Sir/Amman-Al Hissa) Aquifer, primarily for irrigation in the Jordan River Valley and drinking water in Amman.

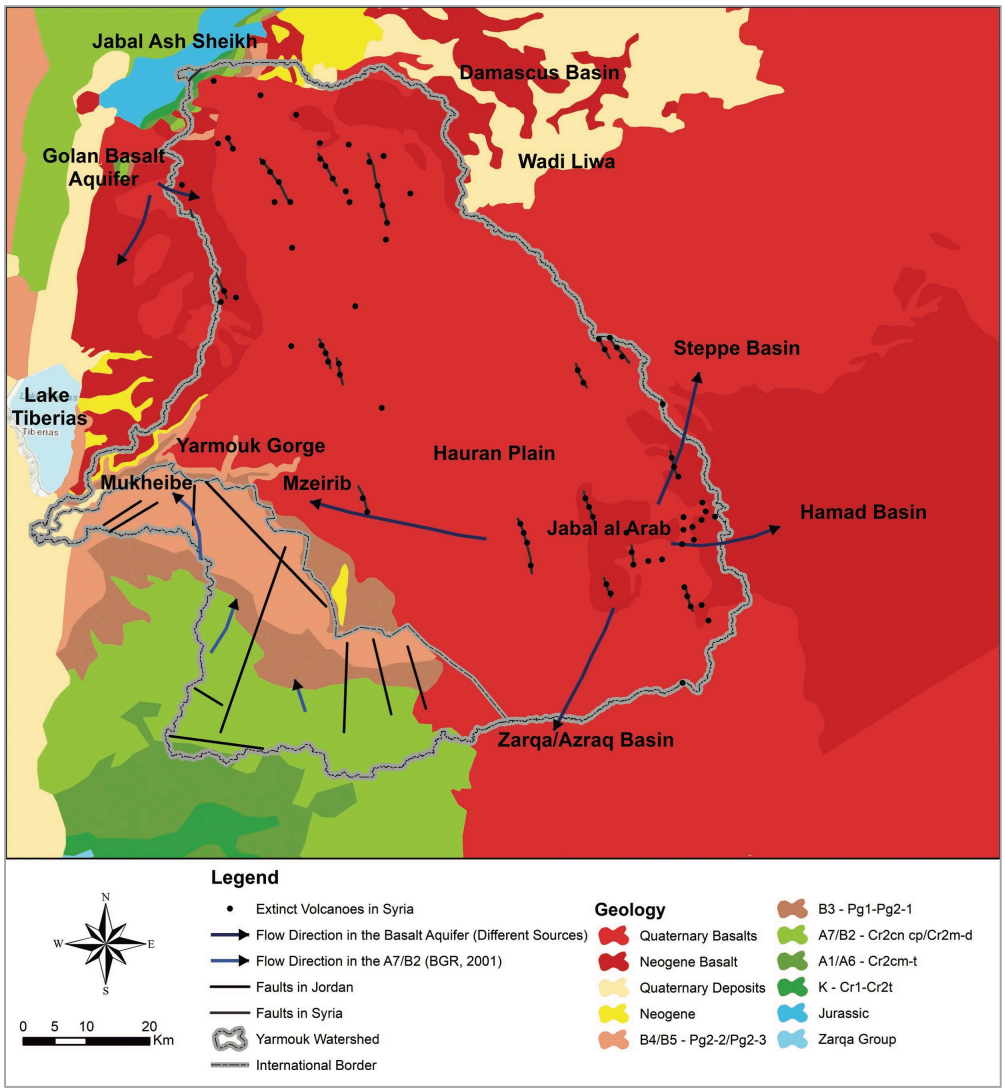
**Diplomacy for the future.** Diplomacy may best be served by the study's identification of patterns arising from the constant interplay of *interests, infrastructure, treaties* and *narratives*. The findings corroborate commonly held knowledge about the steady decline of flow in the Yarmouk mainstream (from 450 MCM/y measured at Adassiyeh prior to development in the basin to roughly 40 MCM/y gauged at the same location between 2008 and 2015). This is likely due to upstream surface water and groundwater abstractions, via the many wells or 40 dams on Yarmouk wadis. The 32 dams found in Syria are calculated to have a theoretical total storage capacity of approximately 205 MCM, though actual volumes stored are estimated at very roughly half that amount. The flow of the river is further affected by the variable precipitation, by the Adassiyeh Diversion Weir completed in 1999, and by the Wehdeh Dam completed in 2006, as discussed below.

Dams and wells in the Yarmouk tributary basin (2017). Refer to main document for sources.



Interestingly, the flow of the Yarmouk mainstream has been increasing since 2011, due at least in part to reduced agricultural activity in Syria following the start of the crisis there. Expecting that water use will eventually revert to pre-crisis patterns, the recent increase in mainstream flow should be seen less as encouraging news than as a clarion call for renewed efforts to improve the water-sharing arrangements. Experience with agricultural pumping suggests that the groundwater in the aquifers is being abstracted at rates beyond their sustainable limits, though accurate volumes of lateral flows from neighbouring hydraulically connected aquifers remain very difficult to estimate.

Geology of the Yarmouk tributary basin and general flow direction of groundwater in the main aquifers. Based on Hobler et al., 2001; Margane, 2015; Orient, 2011; Ponikarov and Mikhailov, 1964; UN-ESCWA/BGR, 2013).

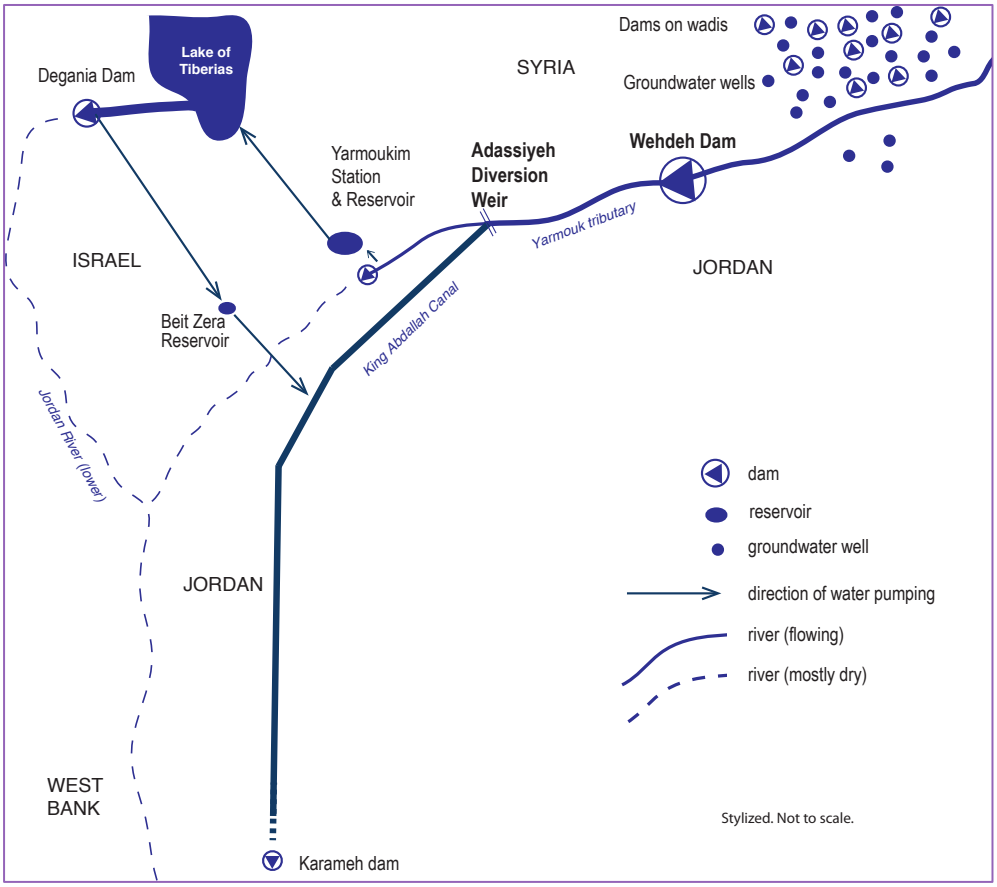



The diplomatic response can come through any admixture of three main conclusions that stem from the interplay of interests-infrastructure-treaties-narratives: i) an equitable and sustainable distribution is feasible; ii) the infrastructure should be much more efficient; and iii) revised treaties can be part of the solution.

**i) An equitable and sustainable arrangement is feasible.** The study's mapping of Jordanian-Syrian water relations tracks their dramatic variation over the decades, as they reflect changes at the broader political level (e.g. 1950s pan-Arabism, the 2003 US/UK Invasion of Iraq, current Syria crisis). Jordanian-

Israeli relations were most intense from the 1950s to the 1970s, with repeated Israeli attacks on the East Ghor Canal and kidnapping of soldiers protecting the temporary weir at Adassiyeh. Relations improved through the now well-known secret political dialogue (much of which was facilitated by talks related to Yarmouk flows), which culminated in the 1994 Peace Treaty.

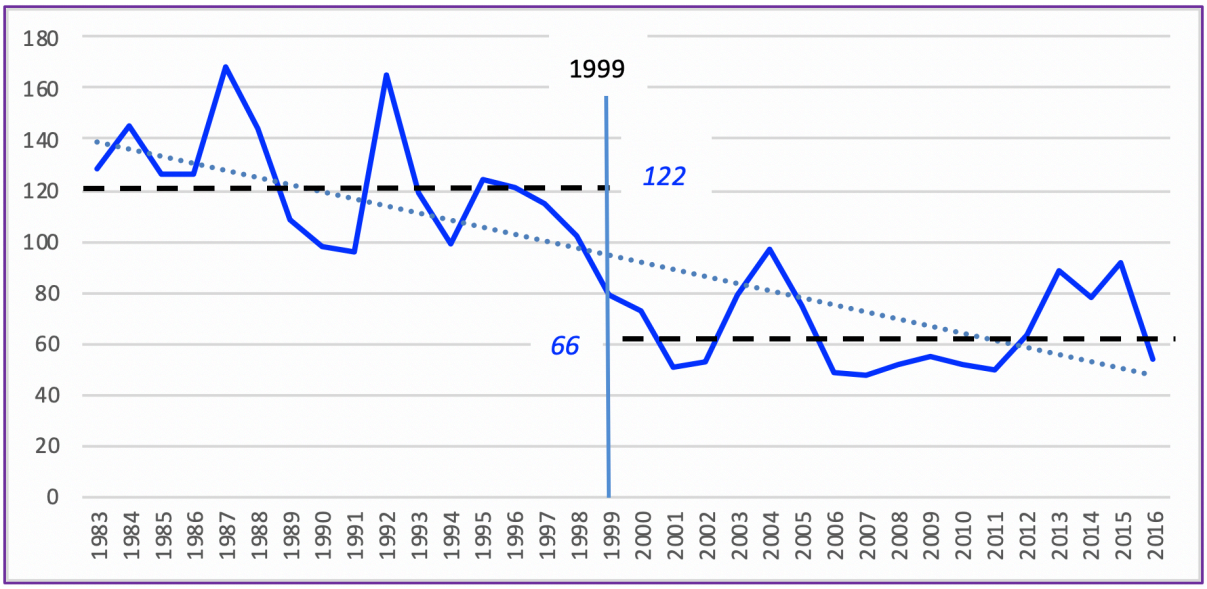
Sketch of infrastructure on the Yarmouk tributary and Lower Jordan River (2017).




The study further evaluates the current distribution of control and use of Yarmouk flows, vis-à-vis the principles of International Water Law applied to the wider Jordan River Basin (notably the 1997 UN Watercourses Convention, which the governments of Syria and Jordan have ratified). Secondary sources show that Syria uses on average roughly 335 MCM/y of Yarmouk flows; Jordan roughly 98 MCM/y (not including an average of 47 MCM/y of non-Yarmouk flows supplied by Israel from the Lake of Tiberias in partial accordance with the terms of the 1994 Jordan-Israel Peace Treaty); and Israel roughly 56 MCM/y (not counting the 47 MCM/y supplied to Jordan, but including water used in the Occupied Syrian Golan Heights and Meitsar settlement). Israel currently uses significantly more than the maximum range of its legal entitlement from the Jordan River Basin; both Syria and Jordan currently use less.

**ii) The infrastructure could be much more efficient.** The post-2011 increase in Yarmouk tributary flows is reflected in the flows entering into and released from the Wehdeh Dam. Though it remained nearly empty in the first years following its completion in 2006, the average flow into the dam from 2008 to October 2016 was 33 MCM/y (while the average release was 35 MCM/y). In 2015, the dam was filled to 75% of its 110 MCM/y capacity. Importantly, the flows into the King Abdallah Canal (KAC) have not increased accordingly, as explained below.

Drop in the diversion of Yarmouk flows to the King Abdallah Canal, from 1986-2016 (MCM/y). JVA 2016.




The analysis of Section 6 shows that the average annual flows diverted from the Yarmouk to the KAC for the 18 years prior to construction of the Adassiyeh Weir in 1999 was 122 MCM; the average since then has been 66 MCM. The average annual flow *bypassing* the KAC during the same period were 87 MCM and 50 MCM, respectively. In other words, Yarmouk flows to the KAC dropped by about half following the construction of the Adassiyeh Weir, while the flows bypassing the KAC dropped by considerably less, and (when flood flows are counted) are cu§rrently greater on average than the flows diverted into it. The Yarmouk flows that bypass (or overspill) the Adassiyeh Weir flow downstream until they are pumped entirely into the Yarmoukim Reservoir in Israel.

The relative increase in flows bypassing the KAC is explained in part by the Yarmouk-Tiberias 'water swap' arrangement detailed in the 1994 Jordan-Israel Peace Treaty. The flows are then pumped for use for drinking and agriculture of Israeli kibbutzim, and to the Lake of Tiberias. The transmission to the Lake of Tiberias is based on an idea originally proposed in the 1950s, prior to the intensification of agriculture in the Jordan River Valley and when it was logical to store the excess winter floodwater in the lake. While that arrangement is now cemented in the 1994 Peace Treaty, its logic has broken down given the rise in agricultural water demand in the Jordan River Valley.

**iii) Revised agreements can be part of the solution.** The temporary conclusion of negotiations (which resulted in the 1987 Jordan-Syria Water Agreement and the Water Annex of the 1994 Jordan-Israel Peace Treaty) may have led to cautious optimism that water use throughout the Jordan River Basin could be coordinated in a sustainable manner. More than a quarter of a century on, however, the agreements are proving to be part of the problem. When evaluated against the clauses of a model treaty, both fall well short of their potential.

The 1987 Jordan-Syria Treaty is considered unsustainable for a number of reasons, including: i) it does not account for the impact on downstream users; ii) it is no longer 'fit for purpose' (which was to build the Wehdeh Dam); iii) it fails to reflect the actual availability and use of water (particularly the connected surface water and groundwater flows, increased demand driven by population influxes, and projected effects of climate

change); and iv) it is inequitable in its allocation of use and control over the flows when evaluated against the principles of International Water Law. The omissions, contradictions, specificity and ambiguity are found to work in Syria's favour, in the narrow sense of the term. Syrian violations of the treaty are debatable, even if the number of dams currently constructed (32) is greater than the number stipulated in the treaty (26).

Evaluation of the Yarmouk treaties against the clauses of a model treaty. Refer to main document for sources.

| Features of a Model Transboundary Water Agreement | 1987 Jordan-Syria | 1994 Jordan-Israel | 1995 PLO-Israel[27] |
|---|---|---|---|
| *Allocative mechanisms* | | | |
| Based on 'equitable and reasonable use' | No | No | No |
| Specific, rather than ambiguous | Yes | No | Yes |
| Flexible, rather than rigid | No | No | No |
| *Technical mechanisms* (related to e.g. conjunctive groundwater and surface water) | | | |
| Acknowledgement of surface water and groundwater as part of the same transboundary watercourse | No | No | No |
| Adequate accounting for use, amount and quality of groundwater in reserve, and rate of its replenishment | No | No | No |
| Common identification, delineation and characterisation of transboundary groundwater | No | No | No |
| Appropriate measures to prevent, control and reduce the pollution of transboundary groundwater | No | No | No |
| Comprehensive water accounting (including for use, amount and quality of soil water, and gains made through improvements in irrigation efficiency/in the 'paracommons') | No | No | No |
| *Uncertainty Mechanisms* (related to changes in needs, climate, etc.) | | | |
| Revisiting clauses | No | No | No |
| Escape clauses | No | No | No |
| *Institutional mechanisms* | | | |
| 'prior notification' | No | Yes | No |
| 'no significant harm' | No | No | No |
| Enforcement clauses | No | No | No |
| Monitoring provisions | No | No | No |
| Dispute resolution mechanisms | No | No | No |
| Self-enforcement mechanisms | No | No | No |
| Multilateral bodies for information exchange or management | Yes | Yes | Yes |
| *Environmental and health concerns* | | | |
| Water-quality provisions | No | Yes | No |
| Biodiversity, river base flows, etc. | No | No | No |

The Water Annex of the 1994 Jordan-Israel Peace Treaty is likewise considered unsuitable for several reasons, including: i) it does not account for the impact on downstream users; ii) it fails to account for groundwater flows; iii) it does not account for Israeli water use in the Occupied Syrian Golan; and iv) it is inequitable, when the very ambiguous allocation mechanism is seen in the light of established water use, International Water Law, and significant asymmetries in power.

Both water agreements are also problematic in that they disregard environmental and water-quality concerns, are inflexible in a constantly

changing context, and legitimise the water use that has been established. For instance, the Jordan-Syria Treaty sanctions uncontrolled and inefficient irrigated agriculture in Syria, at the expense of inflows into the Wehdeh Dam. The Jordan-Israel treaty locks in the use of floodwater solely for Israel, a 'water swap' that diverts flows *away* from the KAC for use in Israel (even if some of the flows are returned to the KAC), and continued Israeli water use in the Occupied Syrian Golan.

**Recommendations for an equitable and sustainable future.** The future can look bleak, or better. Any conception of the basin 50 years from now under a 'business-as-usual' scenario sees ever-more infrastructure pushing the basin's water resources beyond their sustainable limits, while obstructing state development (particularly in Jordan), and contributing to political tensions. A more equitable and sustainable arrangement is simple to envision, if challenging to implement: one where the flows are used efficiently within their sustainable limits, and shared equitably amongst all riparian States and residents.

Opportunities for diplomacy to improve the Yarmouk arrangements include fairly widespread recognition that the 1987 Water Agreement is no longer fit for purpose; a shared history of water users in the Hauran Plain; and a heightened importance of the flows for the rebuilding of a stable Syria. Opportunities for Jordan and Israel include the relative ease with which Jordan may exploit more of the Yarmouk flows through minor modifications to existing infrastructure; the game-changing current level of desalinated flows in Israel, which could relieve pressure on the competition for the freshwater flows; and the 2019 Al Baqura and al Ghamr negotiations.

Finally, the study recommends that parties interested in pursuing the path towards an equitable and sustainable arrangement:

i) **Develop a common and more complete knowledge base**. The first gaps to fill relate to surface water and groundwater quality, and groundwater availability in light of projected changes in use and climate. The improved understanding of the biophysical features of the basin – through a joint groundwater monitoring programme, for instance – should be extended to all users, to address current disagreements over data;

ii) **Support 'transboundary community' projects**, between the States and/or between communities on both sides of the border in the Hauran Plain. These include participatory mapping, twinning of water operators, water users associations, farming knowledge exchange and joint research into the benefits of coordinated transboundary water management;

iii) **Optimise the infrastructure**. Consider a more optimal infrastructural arrangement, by initiating a pre-feasibility study. This would investigate the benefits of greater use of gravity and in-basin use, and the accompanying great potential savings in energy costs and evaporation losses;

iv) **Be guided by International Water Law**, including identification of the opportunities that may arise from using the UN Watercourses Convention as a guide to negotiations or ratifying of the UNECE Water Convention; and

v) **Revisit the agreements**, to make them more effective, drawing on advances in the collective understanding of treaty resilience, environmental concerns and expected changes in climate and water demand.

The extensive Qualitative and Technical annexes detail one path to implement the recommendations, and provide substantial supporting documentation.