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The Yarmouk Tributary to the Jordan River II: Infrastructure Impeding the Transformation of Equitable Transboundary Water Arrangements

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ABSTRACT: This article explores the ways in which key components of infrastructure built on the Yarmouk tributary to the Jordan River induce or impede the transformation of existing transboundary water arrangements. Focussing on the Jordanian-Israeli Adassiyeh Weir and on the Jordanian-Syrian Wehdeh Dam, the article interprets archival documents, official river-gauging data, and interviews through a frame that highlights depoliticisation by hydrocracies within the politics of international infrastructure. The weir is found to be operated in a manner that prioritises Jordan's commitment to Israel when flows are low, and to be designed to bound the volume that Jordan can make use of during low or very high flows. The dam appears oversized but regulates the flow to the downstream weir when its reservoir does not lie empty. The design and operation of the infrastructure is found to partially and selectively depoliticise contentious transboundary water issues in a manner that privileges the more powerful actors. Transformation of the arrangements is impeded as the distribution and use of the flows is not questioned by the water authorities or the international diplomatic community, and alternative arrangements are not considered.

KEYWORDS: Jordan River, Yarmouk, transboundary water, treaties, agreements, international infrastructure, power, Jordan, Syria, Israel

INTRODUCTION

> *When the engineer of the 20th century erects his power plant on the very spot that previously supported a textile mill, he actualizes new forces in the old setting. Nature acquires a new function; and gradually it also assumes a new appearance (Karl Wittfogel, Oriental Despotism, 1957).*

> *What we call Man's power over Nature turns out to be a power exercised by some men over other men, with Nature as its instrument (C.S. Lewis, The Abolition of Man, 1943).*

No less than 20 papers in 4 special issues[1] of *Water Alternatives* have positioned themselves in relation to the very different perspectives offered by the two famous authors that are quoted above. The first view is utilitarian and positivist, with an apparent lack of awareness of any negative consequences on society that human conquest of the environment may bring about. The second view is critically realist and, by foregrounding the politics, is focussed on what the first ignores.

This article weighs in on the debate from the perspective of international infrastructure built on transboundary watercourses. More specifically, it explores the way in which the main elements of water infrastructure built on the Yarmouk tributary of the Jordan River induce or impede the transformation of the existing transboundary water arrangements. It does this by investigating how the politics of international infrastructure plays out between Jordan and Syria, and between Jordan and Israel. The international infrastructure scrutinised is the Adassiyeh Weir, which was completed five years after being called for in the 1994 Israel-Jordan peace treaty, and the Wehdeh Dam, which was completed 19 years after being called for in the 1987 Syria-Jordan water agreement.

This article complements the investigation started in Zeitoun et al. (2019a), which focussed on the influence of the international agreements that the states have signed. That article argues that the water agreements lock in and perpetuate inequitable arrangements by being 'blind' to the asymmetry of existing water use between the states, and lacking clauses that would govern groundwater use or would build in the flexibility required to manage the many issues currently faced by transboundary water resource managers. This article supplements that analysis by applying a frame of the politics of international infrastructure to explore the extent to which, and the way in which, the projects of hydraulic bureaucracies address the contentious issues and consider alternatives.

The data comes from the published literature, archives (French, British, Zionist), interviews with Jordanian water resource managers, field observation, satellite imagery, and Jordanian river- and canal-gauging records. While gauging records are presented with some degree of accuracy, the quality of the data (as noted in the relevant sections) limits the findings to being indicative only. A further challenge to the analysis is its focus on a tributary of a wider basin. An analysis of the Yarmouk tributary in isolation from the rest of the Jordan River Basin would be possible if only flows and water use were being considered, but is not possible for a study that also investigates international institutions and politics.[2]

The article first reviews the politics of international infrastructure, asserting that the technocratic development paradigms favoured by hydrocracies (and, to a lesser extent, by mainstream hydro-diplomacy) can depoliticise and displace rather than resolve the related contentious issues. It then reviews the development of infrastructure in the Yarmouk tributary basin before taking a deeper look at the design and operation of the Adassiyeh Weir and the Wehdeh Dam. The Jordanian-Israeli Adassiyeh Weir is found to be operated in such a way as to meet Jordan's agreed commitments to Israel, and to be designed to ensure that excess flows pass it by. The weir also obligates Jordan to a variable and bounded share: low when the river flows are low and capped when the flows are very strong. The upstream Jordanian-Syrian Wehdeh Dam is found to be designed on flow rates that have long since dropped, and thus to be oversized. When partly full, the dam is nonetheless operated in a way that generates a more

[1] These include: F. Molle et al. (2009). Hydraulic Bureaucracies and the Hydraulic Mission: Flows of Water, Flows of Power, Water Alternatives 2(3): 328-349; D. Moore et al. (2010). The World Commission on Dams +10: Revisiting the Large Dam Controversy, Water Alternatives 2(3): 3-13; J. Obertreis et al. (2016). Water, Infrastructure and Political Rule, Water Alternatives 9(2): 168-181; and B. Crow-Miller et al. (2017). The (Re)turn to Infrastructure for Water Management? Water Alternatives 10(2): 195-207.

[2] The Yarmouk is in any case not considered independently of the Jordan River by water resource managers (whether Syrian, Jordanian or Israeli), by International Water Law (which uses the wider basin as a unit of analysis), or by Annex II of the 1994 Jordan–Israel peace treaty which discusses both together.

stable flow downstream, though not to the extent that it can provide the insecurity of supply resulting from the very concrete constraints: commitments to provide downstream flows with no certainty of or control over the flows received from upstream. The article concludes that while the arrangement could be made much more efficient through redesign of the weir and the shifts in the operating regime of the dam and weir, the depoliticising technocratic approaches favoured by both the water bureaucracies and the international diplomatic community prevent alternatives to the status quo from being considered.

HYDROCRACIES AND DIPLOMATS STRIPPING INTERNATIONAL INFRASTRUCTURE OF ITS POLITICS

A transboundary water 'arrangement' comprises all the agreements, protocols, infrastructure, river basin commissions and other institutional structures that shape policy and use of transboundary waters (primarily) between states. This paper's primary object of study is the most material of structures of a transboundary water arrangement; that is, the international infrastructure. The 'transformation' of a transboundary water arrangement is understood to be underway when the elements that maintain it are altered, and this requires an alternative vision to guide the knowledge and action that are required to fuel the alteration (Zeitoun et al., 2016). The focus of study must thus turn to the interaction of that vision and the infrastructure.

Governments have long developed elaborate systems of water infrastructure to build their states under very different visions of 'development', as detailed for the Euphrates River in *Oriental Despotism* (Wittfogel, 1963), in the reports of the US Tennessee Valley Authority (Creighton et al., 1998; Delli-Priscoli, 1998a), or in accounts of the actions of the government of Sudan (Verhoeven, 2012; Mohamud and Verhoeven, 2016). Referred to as 'hydrocracies' (Gyawali, 2001; Molle et al., 2009), the water bureaucracies overwhelmingly tend to follow a technocratic (and 'positivist' or traditional engineering) approach to the development of water resources. In some cases, hydrocracies have acquired a life, purpose and logic of their own (see Menga and Swyngedouw, 2018; Pyla and Phokaides, 2018; Blake, 2019). Occasionally at arm's length from central government and with several successful projects under their belts, the hydrocracies perpetuate themselves to the point where their very existence (in service to the state) and the infrastructure they build becomes the reason for their existence.[3] (Molle et al., 2009).

The service that hydrocracies provide to their state will often align with the political vision and interests of the latter. The interests can vary from satisfaction of the water 'needs' of a state's own citizens (Mollinga, 2008), to control of others within a state's territory (Swyngedouw, 1999; Tvedt, 2004; Oestigaard, 2009), to control of others in territory that they the state has taken over (Headrick, 1988; Phare, 2009; Selby, 2013a; Dajani and Mason, 2018). The water bureaucracies can be considered in this way to be implementing a state's 'hydraulic mission' (Allan, 2001), with 'mission' referring to the zealousness that can develop in water-related state-building and nation-making processes, such that the process of building infrastructure predominates and the original goal is no longer questioned (Allouche, 2019). Molle et al. (2009: 336) elaborate on the process, explaining that the power wielded by hydrocracies is a function of "fuelling and sustaining the *cycle that goes from planning to the construction* of infrastructure" (emphasis added). Violence and political contestation of the wielding of power may furthermore be hidden as a result, because after infrastructure is built it can fall out of the public limelight and be taken for granted by many (Dajani, 2018: 74).

It is when national hydrocracies seek to build infrastructure along their borders that the politics of infrastructure confronts the politics of states (see, for example, Sneddon and Fox, 2006; Thomas, 2016), and the process takes on an international – and sometimes less public – dimension. Critical research

[3] This may be the case with the American Bureau of Reclamation and Army Corps of Engineers (Reisner, 1986), the Dams Implementation Unit and the Merowe Dam in Sudan (Dirar et al., 2015; Mohamud and Verhoeven, 2016; Ali et al., 2019), or the Turkish General Directorate of State Hydraulic Works (known as DSI) and the multi-dam GAP project in Turkey (Kramer and Kibaroglu, 2011; Scheumann et al., 2011; Kibaroglu, 2015).

warns of the stifling of public debate on related issues due in part to the 'securitisation' of the resource by governments that seek to move it beyond the realm of politics by framing it as a matter of national existence. Public debate is also not pursed when political issues are treated as being nonpolitical or 'technical', which is referred to here as 'depoliticisation' (Fox and Sneddon, 2007; Allouche et al., 2014; Weinthal et al., 2015). Attention is drawn, for example, to the prevailing technocratic approach of international diplomacy and peacebuilding efforts, whether or not they are related to water and environment (see, for example, Pugh, 2005). The technocratic (or 'liberal') peacebuilding approach aligns epistemologically with the water supply infrastructure drive preferred by the hydrocracies, making it more likely to be taken up by policy makers.

Such depoliticisation can serve to build trust between key players in the hydrocracies on different sides of the border (for Jordan River examples, see Abitbol, 2013; Aggestam and Sundell-Eklund, 2013), if not with all the communities affected by the decisions. However, stripping profoundly political issues of their politics incurs risks, not the least of which is stifling rather than addressing the interstate tensions that international infrastructure can generate. Furthermore, because the technocratic approach understates asymmetries in power, it may not consider all the aspects of the issue in question that are relevant to its resolution, for example its rights-based aspects or the ethics of sustainable development (Selby, 2013b; Aggestam and Sundell, 2015). Not only is the size of the 'basket of policy options' reduced as a result, but the policy that is implemented is likely to be that which is preferred by the more powerful actor (Ferguson, 1993). In extreme cases of power asymmetry, a 'culture of silence' can develop among the less-powerful actors (Freire, 1972: 2), and consent to the arrangement can be established – even if it is not openly acknowledged – whether among workers in the Appalachian Valley (Gaventa, 2005: 18) or among the marginalised water users along the Jordan River (Zeitoun et al., 2019).

In this view, the boreholes, dams, and weirs that hydrocracies build under a technocratic paradigm can also be read as (literally) concrete manifestations of hard power plays. Once the infrastructure is in place, the reputation of the hydrocracy becomes tied to its success, a new pattern of use is established, and a new relation develops between the users and the resource. The new relationships are *not* typically challenged by technocratic diplomatic initiatives, and can be expected to fall out of the awareness of the general public. Related expressions of soft power include the narratives created around the watercourse, and setting the agenda for what is and what is not up for discussion (see, for example, Daoudy, 2009). As a result, the alternative vision, knowledge or action that is required for the transformation of a transboundary water arrangement must confront the existing set of institutions which, in some cases, may be very well established.

The assertion is, then, that technocratic and depoliticising approaches to diplomacy can re-enforce the paradigm that drives the state hydrocracies, thereby foreclosing public debate about the relationships established through the international infrastructure. In turn, the infrastructure tends to operate out of the public limelight and towards the interests of the more powerful party. Alternatives to the arrangement will either challenge what has been established or will fail to develop in the first place. As will be discussed, it is the latter situation that appears to emerge from the design and operation of the Adassiyeh Weir and Wehdeh Dam.

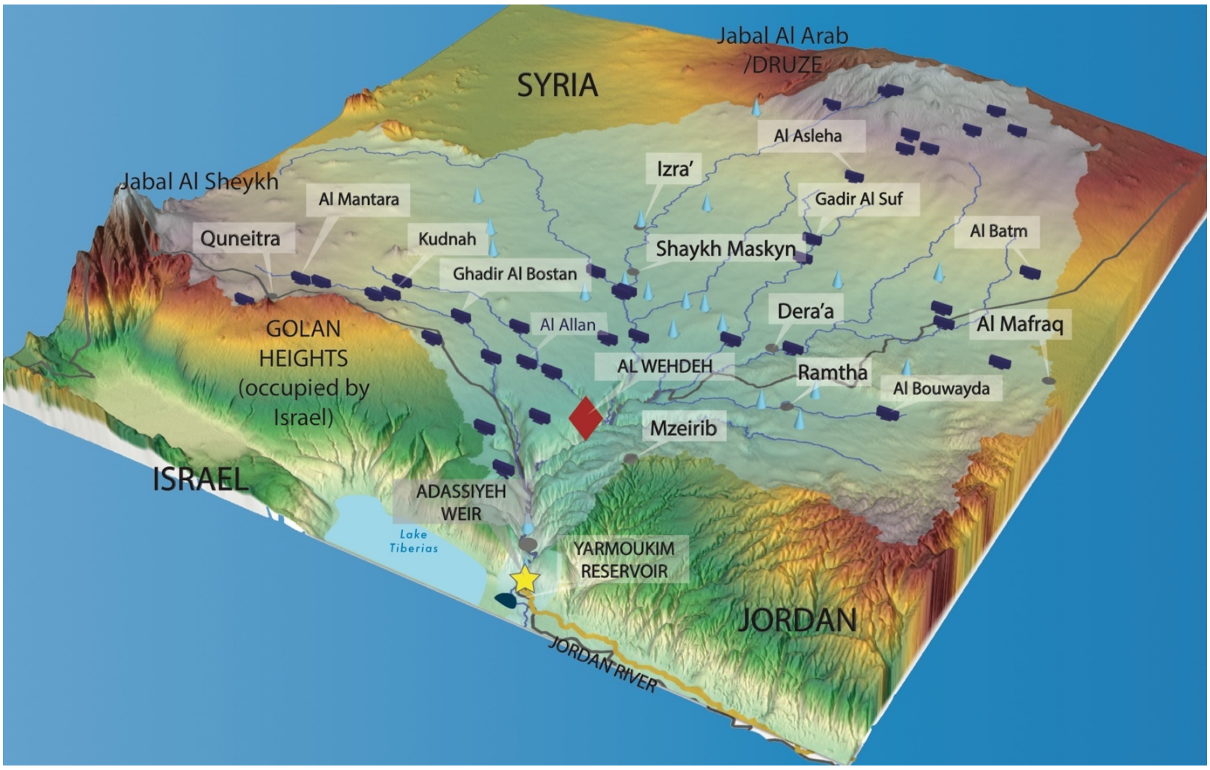
A CENTURY OF UNCOORDINATED INFRASTRUCTURE ON THE YARMOUK TRIBUTARY BASIN

This section reviews the political context from which the hydrocracies and international infrastructure on the Yarmouk emerged. As shown in Figures 1 and 2, dozens of dams have been built along the six sub-tributaries,[4] and thousands of wells have been drilled into the basalt and limestone aquifers that underlie the basin. The infrastructure has been built in a wholly uncoordinated manner, which is an expected

[4] The tributaries are (in Syria), the Raqqad, al ‘Allan, Hareer/Arram, Thahab, and (in Jordan) the Zeidi and the Shallala.

result when three hydrocracies are operating at different periods and speeds from within a constantly changing political context.[5]

Figure 1. Topographic perspective (looking northeast) of the basin of the Yarmouk tributary to the Jordan River, indicating the Wehdeh Dam, Adassiyeh Weir, and smaller dams on the tributaries.



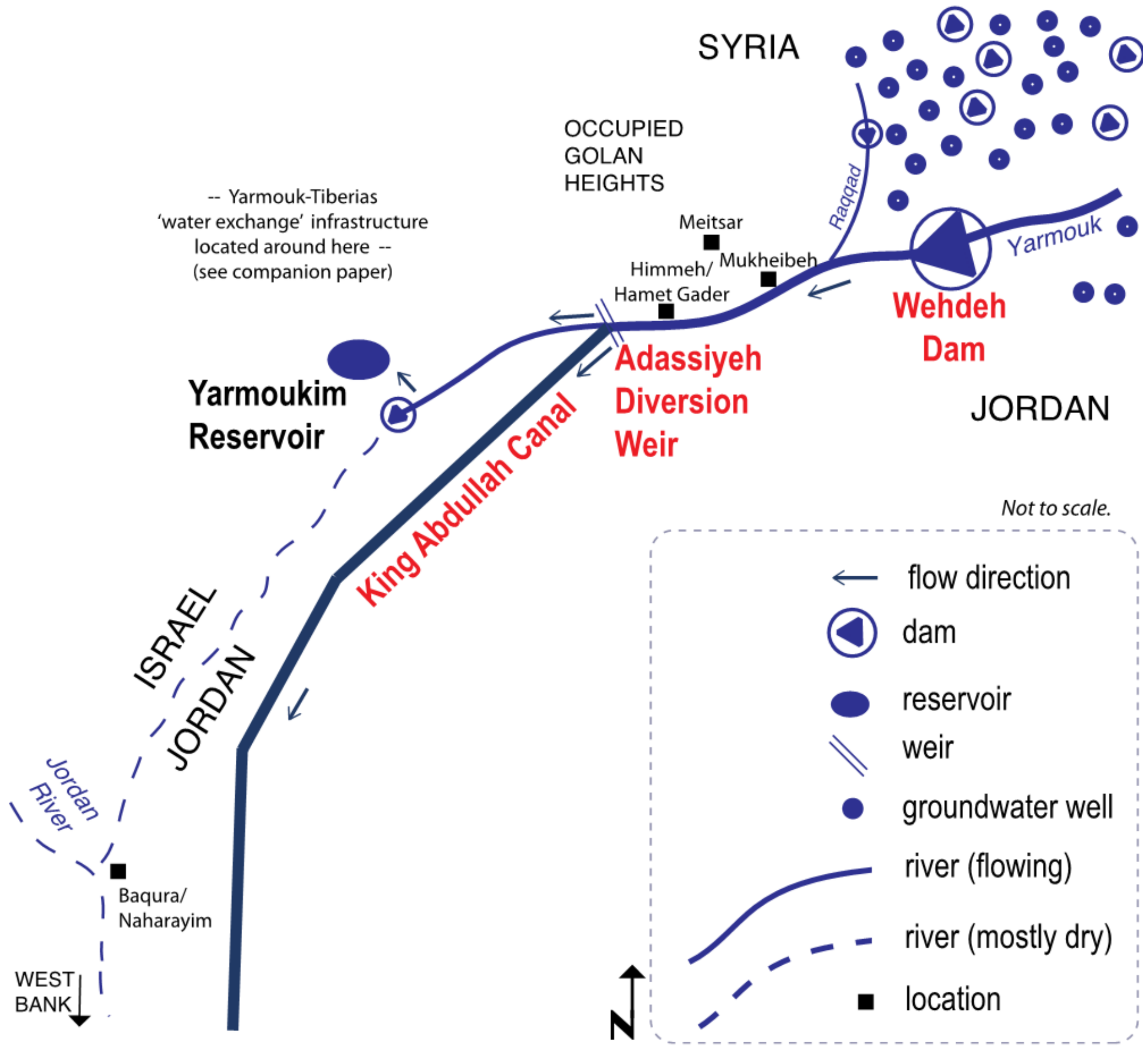
Source: Prepared by Marin Stefani based on analysis led by Chadi Abdallah.

Note: The map shows the location of the Adassiyeh Weir (yellow star), the Wehdeh Dam (red diamond), and 31 smaller dams.

All political entities that have controlled the territory – whether they be Ottoman, British, French, Arab, Zionist, Syrian, Jordanian or Israeli – have built infrastructure to exploit the waters (see top line of Figure 3). Following the defeat of the Ottoman Empire at the end of World War I, the mainstream of the Yarmouk tributary served as the border between French Syria, British Transjordan, and (for about eight miles back from the confluence of the Yarmouk tributary with the Jordan River) British Mandate Palestine. By 1948, following Syrian and Jordanian independence from France and Britain, and the Palestinian *Nakba*, the Yarmouk marked the border of Syria, Jordan, and (for about eight miles) Israel. Israel's occupation of the Golan in 1967 expanded its direct territorial control a further two miles up the river (Daoudy, 2008), to the confluence of the Raqqad tributary with the Yarmouk mainstream – the site of the Ibn al Khaldun's 'Battle of the Yarmouk' over 1300 years earlier and near today's Israeli colony of Kibbutz Meitsar.

[5] In the sense that the hydrocracies do not coordinate their claims on the river, Smith's biblical observation of cooperation on the river made in 1966 still holds: "[T]he rival Jordan diversion schemes now being carried out by Israel and the Arab states can be likened to a *limb from limb rending of the infant by irreconcilable and importunate parents*" (Smith, 1966: 111) (emphasis added).

Figure 2. Sketch of infrastructure in Yarmouk tributary basin, showing location of the Wehdeh Dam, the Adassiyeh Weir, and the King Abdullah Canal (not to scale).



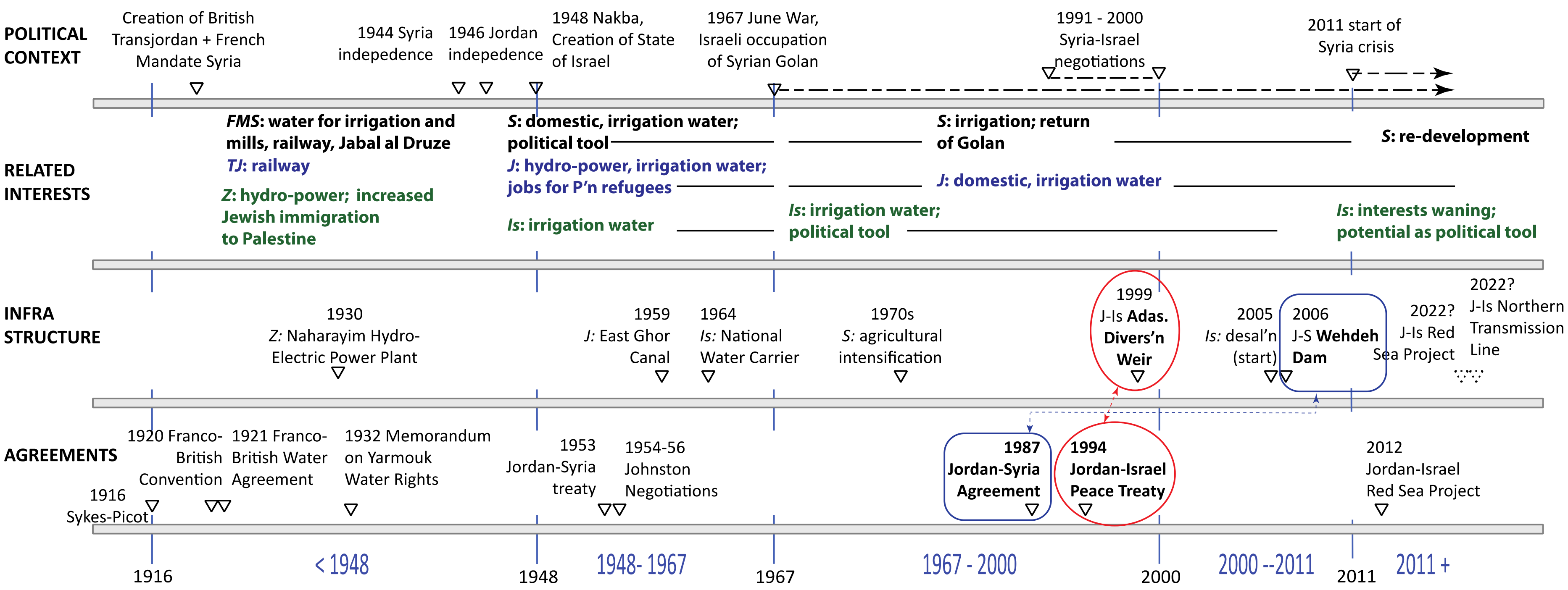
Source: authors.

Technocratic development of the Yarmouk and Jordan

Throughout the basin, plans for water infrastructure have been more prevalent than the infrastructure itself. One of first major plans to develop the Yarmouk flows is found in the 1913 Ottoman 'Franjieh' concession, which proposed the transfer of 100 million cubic metres per year (Mm^3/y) of the Yarmouk flow to the Lake of Tiberias in order to generate electricity and irrigate the Jordan Valley (Haddadin, 2002). The Ottoman authorities also conceded the use of parts of the Jordan and Yarmouk to Greek citizen Euripides Mavrommatis in 1914 for hydroelectric and other purposes (CO, 1926, 1927). The plans were revived in 1926 when the British granted a concession to Russian businessman and Zionist leader Pinhas Rutenberg to use the Yarmouk and Jordan flows to operate a power plant at their confluence – the then Jordanian territory of Baqura (referred to as Naharayim, or 'two rivers', in Israel).[6]

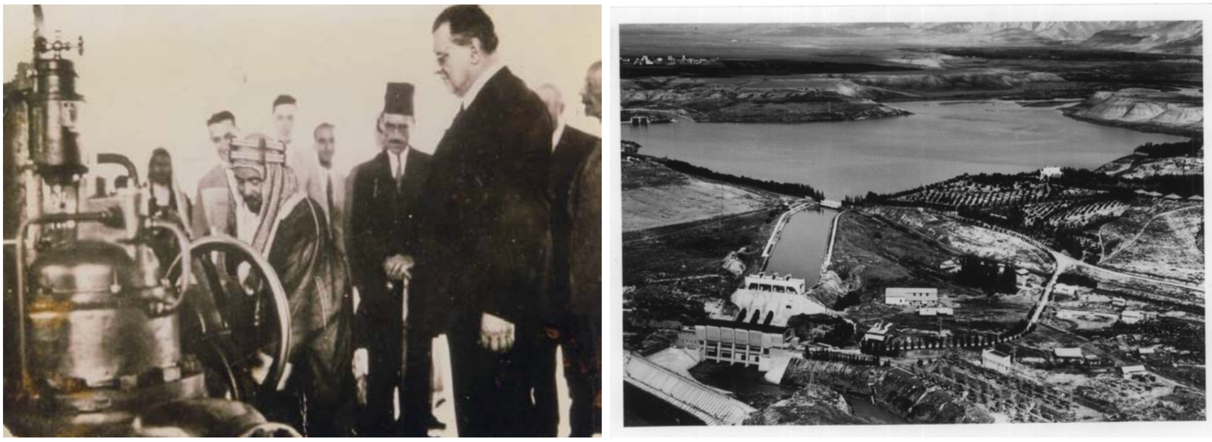
[6] Farming by Israelis in the Jordanian territory of Baqura continues until the time of writing, having been assured until October 2019 under the terms of Annex I of the 1994 Israel-Jordan peace treaty (the specified period of 25 years). In October 2018, the Jordanian side indicated its desire to enter into consultations with Israel about the terms of this arrangement.

Figure 3. Infrastructure, interests and agreements in the Yarmouk tributary to the Jordan Basin, in relation to the volatile political context. Note the context within which the Yarmouk agreements develop, and the building of the Adassiyeh Weir and Wehdeh Dam occur.



Notes: FMS = French Mandate Syria; TJ = Transjordan; Z = pre-1948 Zionist; S = Syria; J = Jordan; Is = Israel.

Figure 4. Left: The inauguration of the Palestine Electric Corporation's Naharayim power plant in 1933 by Emir Abdullah of Jordan. Its owner, Pinhas Rutenberg, looks on. Right: aerial photograph of the Naharayim power plant.



Source: Avitzur, 2003.

The plant was completed in 1930, and was the first major piece of infrastructure on the river. As seen in Figure 4, it was formally inaugurated in 1933 by Emir Abdullah, then ruler of Transjordan (Avitzur, 2003). The plant was initially seen as crucial to expanding the 'carrying capacity' of the land of Palestine, which was the argument made by Zionists to the British authorities in response to a policy to limit Jewish immigration to Palestine[7] (Reguer, 1995: 704). The plant was productive until 1948, at which point the Iraqi armed forces took control of it in the course of the fighting that led to the Palestinian *Nakba* and the creation of the State of Israel.

While water development plans stalled during the 1940s, Jordan, Israel and Syria planned their individual hydraulic missions, each of which had their international diplomatic backers. The British-led 'TVA on the Jordan' plan (a.k.a. 'Hays Plan' or 'Hays-Lowdermilk Plan)[8] sought to emulate the American colonising development plan (Alatout, 2009). It proposed diverting the mainstream of the Jordan River and half of the Yarmouk tributary to the Lake of Tiberias for use in British Mandate Palestine, with the other half of the Yarmouk flows to be for use by Jordan (Hays, 1948). Very critical of the predicted effects that the 'TVA on the Jordan' plan would have on Jordan, British engineer R.H. MacDonald developed, in response, the 1951 'MacDonald Plan' (FO, 1949). This plan proposed the Lake of Tiberias as a storage reservoir to feed irrigation canals on the *ghors* (flood plains) of the Jordan River (MacDonald & Partners, 1951), the eastern one of which would be built by Jordan as the 'East Ghor Canal' in 1959. The East Ghor Canal, later renamed the King Abdullah Canal (KAC), is the oldest Yarmouk infrastructure still in operation and is a vital conveyor of water to the farms of the Jordan River Valley (and, later, supplied drinking water for cities) (Venot et al., 2007).

[7] By the time the plant was occupied by Iraqi forces in 1948, its importance had dropped relative to other sources of electricity, supplying just a quarter of the British Mandate's electricity demand (Avitzur, 2003).

[8] Hays was the American project manager of the original TVA; in 1944, he was requested by the British Commission on Palestine to review the water plans for Palestine. The report he published in 1948 – called 'TVA on the Jordan' – hosts an introduction from American engineer Walter C. Lowdermilk. Lowdermilk, in this introduction, invokes the mindset of man's dominion over nature when he writes that "there are few places in the world where mankind has a more favourable opportunity to adopt a constructive approach towards the problems of the common man", citing the plan's potential for providing "an example of the backward Middle East" (Hays, 1948). Following the 1948 *Nakba*, the plan was never implemented for Palestine, but was later developed by Israel as the Lowdermilk-Hays Plan.

The most concerted Jordan River Basin-wide diplomatic effort during this period was the US-led 'Johnston Mission', which resulted in the 'Johnston Plan' that allocated the flows among the four riparian states of the time. The 1952 'Bunger Plan' may have been the first to propose a dam at Maqarin. As seen in Figure 1, Maqarin is the remarkable confluence point of five out of six of the Yarmouk's main tributaries (Sevette, 1953). The idea was re-proposed in the 1953 'Main Plan' (Main, 1953), and written into both the 1953 and the 1987 Syria-Jordan water agreements (as discussed at length in the companion 'Yarmouk' article). The Bunger Plan also proposed a diversion weir at Adassiyeh, downstream of Maqarin and thus able to also capture the flows of the fifth tributary, the Raqqad; it also proposed a smaller dam at al Himmeh/Hamat Gader just upstream of it, which was to regulate flows into the weir and operate in concert with releases from the Maqarin Dam. As will be discussed later, only the former was built.

Soon afterwards, during a period of high visibility and very public hydropolitics, contestation over the infrastructure took much more overt forms. The fledgling Israeli water bureaucracy attempted to implement the 'TVA on the Jordan' plan in 1953, though the effort was bombed by the Syrian army. In 1962, due to Israeli lobbying of British authorities, the plans of the (Jordanian) Jordan Valley Authority to build the Khalid Dam near Maqarin were thwarted, which went against the expressed will of the US diplomats (Baker-Harza, 1953; FO, 1962: EJ 1422/5,9). In 1964, Israeli forces bombed the projects of the Syrian-Egyptian Arab plan that were intended to divert the headwaters of the Jordan. In 1966 and 1967, the Israeli army bombed the JVA construction sites of the Khalid Ibn al Waleed Dam at Mukheibeh (Suleiman, 2003; Ibrahim, 2013), and bombed its East Ghor Canal on eight occasions between 1969 and 1970 (Sosland, 2007).

Israel eventually implemented elements of the 'TVA on the Jordan' plan in 1964, notably the National Water Carrier that drew water from the Lake of Tiberias, in a step considered crucial to the "political construction of the nation-state" of Israel and to the establishment of Mekoroth (Alatout, 2009: 379). The bureaucracies of each of the Yarmouk states meanwhile embarked on separate hydraulic missions by drilling hundreds of wells to abstract the groundwater and dozens of dams to utilise almost every source of surface water, including in the Hauran Plain by the Syrian Ministry of Water Resources (Etana, 2015; Cafiero, 2016; Dana, 2016). In contrast, the artesian wells that bubbled up to the surface near the Yarmouk mainstream at Mukheibeh were developed during this period by local Jordanian farmers, and thousands more wells were drilled without licenses by individuals on the Syrian and Jordanian parts of the Hauran Plain. However, the plan to use the Lake of Tiberias to store the winter flood flows of the Yarmouk was not to materialise until the Jordan-Israel peace treaty was agreed to in 1994.

Current and future use of water

More current estimates of the use of Yarmouk flows differ considerably from the Johnston Plan allocations, and come from numerous secondary sources processed in UEA (2019). Those documents assess that water users in Syria withdraw approximately 335 Mm^3/y from the Yarmouk tributary basin, of which approximately 170 Mm^3/y is groundwater pumped from thousands of licensed and unlicensed wells, and roughly 165 Mm^3/y[9] is surface water stored behind 32 dams. Estimates by Jordanian JVA and the Ministry of Water and Irrigation are: approximately 98 Mm^3/y drawn directly from the Yarmouk – about 32 Mm^3/y of which is groundwater pumped from over 200 wells – and the flows that are diverted into the King Abdullah Canal (as will be discussed). The (Israeli) Jordan Valley Water Authority (a local institution that is distinct from the much larger national water provider, Mekoroth) is estimated to use approximately 56 Mm^3/y of Yarmouk flows, counting the 35 Mm^3/y used directly from the Yarmouk

[9] Ministry of Water and Irrigation (2014), cited in UN-ESCWA/BGR (2013: 197), states that Syrian use of water in the Yarmouk tributary basin is 453 Mm^3/y, but this figure applies to the administrative boundary of the Yarmouk (i.e. including all of Al-Suwayda Governorate). Of this, 327 Mm^3/y (60% of which is groundwater) is used for agriculture, 92 Mm^3/y is for domestic use (assumed to be all from groundwater), and 34 Mm^3/y is for industry (assumed to be all from surface water). The figure 165 Mm^3/y is derived from these figures and is accurate within the margins of error deriving from the above assumptions. The figure also matches closely with the 180 Mm^3/y given in Al Qusaym (2016) and Hoff (n.d.).

tributary via the Yarmoukim Reservoir (as will be discussed), a roughly estimated 4 or 5 Mm^3/y from the four dams (with 10 Mm^3/y retention capacity) in the Occupied Syrian Golan Heights, about 2 Mm^3/y from the wells on the Golan at Meitsar (HSI, 2016a: 352), and 14 Mm^3/y of spring discharge at al Himmeh/Hamat Gader (HSI, 2016a: 353).

With water resources in the Jordan River Basin more or less fully exploited, no state is particularly well equipped for further expected changes in water availability. The flow into the Yarmouk mainstream is expected to drop further when Syrian farmers return to their livelihoods on the Hauran Plain (Muller et al., 2016) or when climate change causes a drop in precipitation rates (Al Raggad et al., 2018; Shentsis et al., 2018) or river flows (Rajsekhar and Gorelick, 2017). The hydraulic mission of each state has since evolved away from dams and boreholes. Most of the infrastructure built since the 1970s is related to what are considered more efficient irrigation systems (Margane et al., 1996; Al-Husein, 2007), and – in Israel – wastewater reuse (Feitelson, 2004) and desalination (Aviram et al., 2014). Some of the very last of the 'classic' types of infrastructure built in the Jordan River Basin were completed on the Yarmouk tributary: the Adassiyeh Weir in 1999, and the Wehdeh Dam in 2006.

THE JORDANIAN-ISRAELI ADASSIYEH WEIR

From sand and rocks to concrete

From a hydraulic perspective, the optimum spot to divert Yarmouk flows to irrigate the eastern flood plain of the Jordan River Valley is at Adassiyeh, because of its relatively high elevation at a point near the valley. As the 1952 Bunger Plan noted, a diversion weir built at Adassiyeh would benefit from a small flow-regulating dam (with a proposed storage capacity of about 8 Mm^3) built at the relatively flat area at al Himmeh just upstream (FCO, 1979). The sovereignty of al Himmeh was contested between Syria and British Mandate Palestine, however, and the territory was occupied and renamed Hamet Gader by Israel in 1967 (Neff, 1994; Al Majdoub, 1998; Ishtayyeh, 2011; see also UEA, 2019: Box 2).

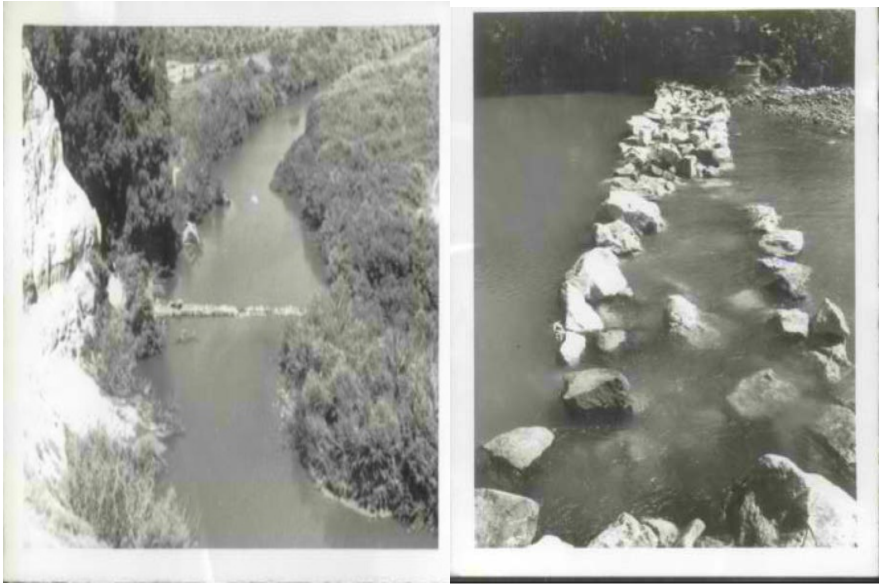
The Jordanian water bureaucracy had been benefitting from the supply of some Yarmouk flows to the East Ghor Canal through a sandbar at Adassiyeh that diverted the flows southwards, and which was created as sediment was deposited in the river bed (Haddadin, 2002: 221). Against the expressed will of the Jordanian government, Israeli farmers of the 'Yarmouk triangle'[10] extended a rudimentary rock weir (Figure 5) across the entire river in 1976, in order to ensure a stable flow for their use downstream (Haddadin, 2006; Kinnarty, in Sosland, 2007). Jordanian attempts to build a more solid weir were thwarted by the Israeli government's lobbying of British authorities; Israel put forward its concern that the flows be reserved for use by Palestinians in further downstream on the West Bank of the Jordan River (Sosland, 2007: 104, 112). The concern was also to extend to Israeli Yarmouk triangle famers, who had been lobbying to secure a flow of 40 Mm^3/y since 1948 (Haddadin, 2000).[11]

Following the well-documented US-facilitated Jordanian-Israeli 'picnic table' talks held at Baqura (see Haddadin, 2002; Shamir, 2003), the decision to build the concrete Adassiyeh Weir that stands today was specified in the 1994 Jordan-Israel peace treaty. Annex II, Article II, Paragraph I of the treaty states that:

[10] This is the land between the southern end of the Lake of Tiberias, the foot of the Golan Heights, and the confluence of the Yarmouk and Jordan (Baqura/Naharayim).

[11] During the 1950 Johnston negotiations, Israeli officials had advocated for an assured 25 Mm^3/y of the flow, and this was secured in the Johnston Plan (Phillips et al., 2007). Interestingly, the Memorandum of Understanding (MoU) between Israel and the US Government stated that Israel's share is 40 Mm^3/y, while the MoU with the Arab countries stated that it was 25 Mm^3/y. The issue was raised again in 1976 by then Deputy Water Commissioner Shaul Arlosoroff (US NESAA, 1976), and in 1978 by the acting US Deputy Chief of Mission Samuel Hart in a letter to Israeli Deputy Director General of the Ministry of Foreign Affairs Moshe Alon (Hart, 1978).

Figure 5. The rock weir built by Israeli farmers in 1962, to allow more flow downstream to the Yarmouk triangle.



Source: ISA (1939).

> Israel and Jordan shall cooperate to build a diversion/storage dam on the Yarmouk River directly downstream of the point 121/Adassiyeh Diversion. The purpose is to *improve the diversion efficiency into the King Abdullah Canal* of the water allocation of the Hashemite Kingdom of Jordan, and *possibly for the diversion of Israel's allocation* of the river water (emphasis added).

In refusing to build on the territory of al Himmeh that Israel contests with Syria (Haddadin, 2002), Jordan effectively consented to the construction of the concrete weir *without* the related storage dam upstream. The concrete weir was also designed as a crucial component of the Yarmouk-Tiberias 'water exchange' arrangement between Jordan and Israel, which is reviewed critically in Zeitoun et al. (2019a). In effect, then, the completion of the Adassiyeh Diversion Weir in 1999 was one of the final steps taken towards implementation of the 'TVA on the Jordan' plan to store Yarmouk flood flows in the Lake of Tiberias that was once so contested, and signalled the end of the Bunger or other plans initiated by Jordan.

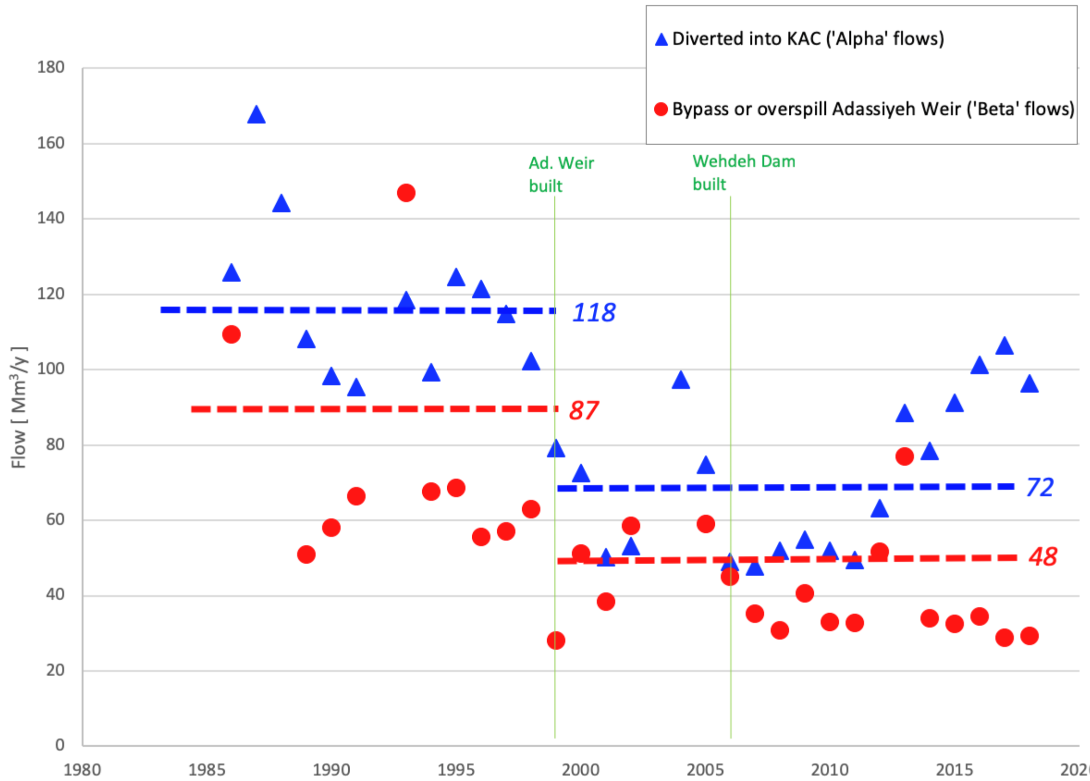
Planning, construction, design and operation of the Adassiyeh Weir

The successful construction of the weir also indicated that Jordan and Israel managed to skirt the disagreements over both the sovereignty of al Himmeh and the distribution of Yarmouk flows, and has apparently resulted in a period of low contestation between the two hydrocracies – for which US diplomacy can take some credit. The extent to which it has improved the "diversion efficiency into the King Abdullah Canal" warrants further investigation, however.

As shown in Table A.1 in the annex, the (Jordanian) Jordan Valley Authority has been gauging the river flow at Adassiyeh since 1962, though distributing and accounting for the flows in different ways as the Adassiyeh Weir and Wehdeh Dam have been brought online. Column b of Table A.1 suggests a steadily declining trend in the volumes being diverted into the King Abdullah Canal by the sandbar or rock weir, possibly related to the decline in river flow due to climatic factors and increased abstractions upstream (Haddadin, 2002: 261; HSI, 2016b; Muller et al., 2016). There also appears to be a marked drop in the flows from 1999 onwards – the year that the Adassiyeh Weir was completed. The drop cannot be wholly attributed to the weir, however, because of the manner by which the Jordan Valley Authority recorded data from 1999 onwards. According to JVA staff members responsible for collection and recording of the data, and as shown in Column (e), the JVA-recorded flow gauged as entering into the KAC at Adassiyeh from 1995 onwards included all of the flows diverted by the weir *as well as* the flows from the previously mentioned Mukheibeh wells, which had been diverted away from the farmers of the area by the Jordanian authorities and canalised into the river as agreed in the 1994 Water Annex (Ghureir, 2018; Shattat, 2018, UEA, 2019). From 2006, the flows gauged by the JVA as entering the KAC at Adassiyeh (still Column e) *further* include the flows released from the Wehdeh Dam, which was completed the same year (as discussed further in the next section). The 'total flows' going into the KAC from 2006 onwards are thus gauged from three separate sources (i.e. river flow (gauged downstream of the Wehdeh Dam but upstream of the Mukheibeh wells (thus capturing the flow of Raqqad tributary), the Mukheibeh wells themselves, and releases from Wehdeh releases) (Ghureir, 2018; Shattat, 2018), even if they flow physically together by the time they reach Adassiyeh.

Even with this understanding of the way the flows have been gauged and are accounted for, there remains an apparent marked decline in the flows diverted into the KAC. As shown in Figure 6, the drop in flows into the KAC before and after the construction of the Adassiyeh Weir affects the flows diverted into, or bypassing, the weir to different degrees. The figure shows that the KAC had on average 72 Mm^3/y diverted into it in the 19 years since the weir was built, with exceptionally heavy (flood) flow years excluded (Table A.1, Column e). This is about 47 Mm^3/y less than the 118 Mm^3/y diverted into it from 1986 to 1999 (1986 being the first year for which data on the bypass flows is available, and the exceptionally heavy (flood) flow years of 1999 and 2003 excluded).

Figure 6. Flows diverted to, bypassing or overspilling the KAC, from 1986 to 2018.



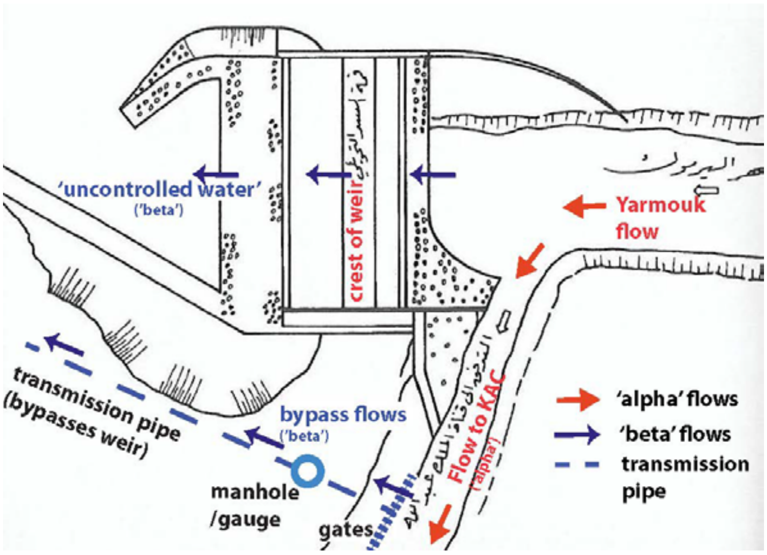
Notes: The average flow is interpreted for the years on either side of the year of completion of the Adassiyeh Diversion Weir (1999), within data limitations discussed in the text; heavy flood years are excluded. When flood years are included, the average flows bypassing the KAC are 125 Mm^3/y (before 1999) and 69 Mm^3/y (after 1999). Data from JVA (2016a) has been checked against JVA (2006) and JVA (2018), with minor irregularities due to different labels and periods, and as detailed in Table A.1.

The rough average of 87 Mm^3/y that overspilled the KAC from 1986 to 1999 dropped to an amount of 48 Mm^3/y bypassing or overspilling the weir from 1999 to 2018 (Table A.1, Column f). Put another way, flows diverted into the KAC dropped by about 47 Mm^3 per year on average after the weir was built, while the flows that bypassed the KAC dropped by 39 Mm^3 per year/ A visual assessment of the flows bypassing the weir (the red dots of Figure 6) suggests that the flows bypassing the weir are generally much more regular than the flows that get diverted (the blue triangles), especially if other high-flow years are not included.

While the flow gauged at Adassiyeh reflects the flow of the river, the flow into the KAC at the same point is also determined by the design and operation of the weir. As shown in Figure 7, the concrete weir spans the width of the Yarmouk mainstream, arresting the flow so that it is diverted southwards into the KAC channel. The JVA gauging records refer to the flows entering the canal at this point as 'Alpha' flows (Column € of Table A.1). The flows that the weir operators allow to bypass the weir do so through two gates that can be opened to allow transmission via a gauged pipe back to the riverbed several dozen metres downstream. These flows are referred to by the JVA as 'beta' flows (and found in Column f). During heavy floods (for example, in 1992 and 2003), the mainstream flows spill over the crest of the weir and continue into the river channel; they are referred to by the JVA as 'uncontrolled water' (Column g), and are subsumed in the JVA records as 'beta' flows (Column f).

Figure 7. The Jordanian-Israeli Adassiyeh Diversion Weir from several perspectives.

(a) Sketch adapted from Haddadin (2002: 289), indicating 'alpha' or 'beta' flows



(b) The Adassiyeh Diversion Weir looking northeast.

(c) The Adassiyeh Diversion Weir looking north.

(d) Looking west: gates

Source: a) Sketch adapted from Haddadin (2002: 289); b) Photo taken in situ on February 2002, source unknown; c) Photo taken by the authors, in situ on September 2018; d) Photo taken by the authors, in situ on September 2018.

Notes: (a) Sketch indicating flows JVA records as 'alpha' (diverted to KAC) or 'beta' (bypassing or overspilling the crest of the weir); (b) Looking northeast – showing the crest of the weir spanning from Israel on the left to Jordan on the right, the channel towards the KAC on the right, and the flushing channel aligned with the river direction in between; (c) Looking north – flows diverted to the KAC through the channel, which the JVA records as a compilation of flows from the river, from Mukheibeh wells, and water released from the Wehdeh Dam (note remote gauge on top right); (d) Looking west – two gates, one of which is open, on the west side of the diversion structure (circled) through which some of the flows counted as 'beta' by the JVA bypass the weir, in accordance with the 1994 Jordan-Israel peace treaty.

The maximum limit of flow diverted into the KAC is set by the Water Authority of Jordan at 10 to 14 m^3/s (upper limit equivalent to about 440 Mm^3/y),[12] out of concern for the excess turbidity that it would have to remove before passing it on to consumers (Ghureir, 2018; Ghantous, 2018). The regulation is enforced physically by an additional set of gates roughly 50 metres downstream along the KAC (not shown in Figure 6), though is of an order of magnitude greater than the current inflows into the KAC, and therefore not likely to actually limit the possibly increased diversions in any way.

As is the case with most weirs, the actual volume of the flow diverted varies with changes in the depth and velocity of the streamflow, and the flows spilling over the crest can be substantial (Column g of Table A.1). Following the terms of the Water Annex of the 1994 Israel-Jordan Peace Treaty that was agreed to five years before the weir was built, the Jordanian JVA operator of the weir ensures that a minimum of 1m^3/s flows through the two bypass gates used to channel the flows around the weir (Ghureir, 2018; Ghantous, 2018). This is equivalent to roughly 32 Mm^3/y, or nearly one-quarter more than the 25 Mm^3/y that Jordan agreed to provide to Israel in the 1994 treaty. The extra is added to make up for evaporation or seepage losses, in order to ensure that 25 Mm^3/y is delivered at the Israeli border (Ghureir, 2018).

When considered alongside the 'uncontrolled water' (flood flows of Column g) that overspills the weir, roughly 69 Mm^3/y on average was *not* diverted into the King Abdullah Canal from 1999 to 2018 (see Column f and Figure 6). As scrutinised in Zeitoun et al. (2019a), all of these flows are dammed and diverted to the Israeli Yarmoukim Reservoir (see Figure 2). Israeli JVWA data accounts for the 35 Mm^3/y

[12] In contrast, the 1979 Harza Jordan River Stage II project had suggested controlled releases and a maximum diversion of 20 m^3/s (630 Mm^3/y) (Harza, 1979: 11; Haddadin, 2017).

used by Israeli farmers and kibbutzim in the Yarmouk triangle – which is close to the previously mentioned amount (40 Mm^3/y) that had been lobbied for by the farmers in the 1970s.[13]

Taken together, the Adassiyeh Weir and the water exchange infrastructure provide a reliable flow to Israel and an intermittent flow to Jordan. In dry years (where the flow at Adassiyeh is, say, less than 100 Mm^3/y – though more thorough investigation is required to give a reliable figure), the flow to Israel and to Jordan are roughly equal. In exceptionally wet years (where the flow at Adassiyeh is very roughly greater than 200 Mm^3/y (though, again, more thorough investigation is wanting), the flow to Israel may be greater than the flow into the KAC. During years that where the flow is considered neither very low or high, Israel is secured a steady share, while Jordan's share varies.

Given the asymmetric distribution of control and use of Jordan River Basin water between the two states, the finding begs the question why modifications to the design or operation of the weir is not considered. Letting a greater share of the Yarmouk tributary flow by gravity into the KAC would be more efficient, for instance, and arguably more equitable. The role of the Wehdeh Dam upstream must be considered beforehand, however, before conclusions can be drawn.

THE JORDANIAN-SYRIAN WEHDEH DAM

The decision to build a dam near Maqarin was based on its location as the international border meeting point of five of the six most important tributaries to the Yarmouk (see Figures 1 and 8). The site of the dam was agreed upon by both Jordan and Syria in the water agreement they signed in 1953, shortly after Bunger's proposal. Two of the goals of the dam stated in the document were to produce hydroelectricity and to regulate the river flow for the Adassiyeh Weir downstream (and, in doing so, regulating the diversion to the eastern shore eastern shore of the Jordan River through the East Ghor – later King Abdullah – Canal). With these goals in mind, the Maqarin Dam was originally designed to be 160 metres high and to have a storage capacity of 500 Mm^3.

After originally ruling out the Maqarin Dam at the start of its negotiations, the Johnston Plan later called for an 85-metre-high dam with a capacity of 73 Mm^3, with the possibility of extending the height to 95 metres (Johnston, 1955). Following decades of Israeli obstruction of the building of the dam (Sosland, 2007), in the 1970s the Jordanian hydrocracy and government engaged in assertive diplomacy, including it in the *Jordan Valley Development Plan, 1975-1982*, and in the amendment of the 1953 Yarmouk water agreement (Haddadin, 2007: 102).

Increased Syrian use of the tributary flows in the Hauran Plain and the increasing domestic pressure on the Government of Jordan to secure more water resulted in an expansion of the objectives of the dam to also providing municipal and industrial water for northern Jordan (Haddadin, 2002: 227). In this way, a dual-purpose dam at Maqarin was re-stipulated in the 1987 Jordan-Syrian water agreement, but with the design height reduced from the 1953 figure of 160 metres to 100 metres. The opportunity to build the dam finally came about after Israeli concerns were offset by the 1994 Jordan-Israel peace treaty, and during a period of good relations between Jordan and Syria, in 2006.

[13] The JVWA data and the companion paper also detail how Israel pumps back an average of 47 Mm^3/y from the Lake of Tiberias to the King Abdullah Canal (which is more than double the amount it committed to under the Water Annex).

Figure 8. The Jordanian-Syrian Wehdeh Dam, September 2018, looking north, with Syria in the background and Jordan in the foreground.

Source: Authors (2018).

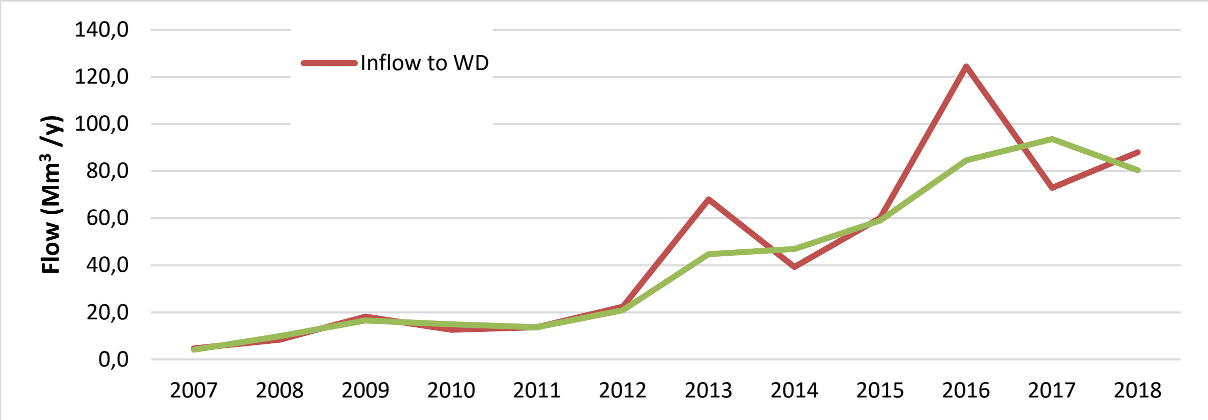
Design and operation of the Wehdeh Dam

As the Jordanian-sponsored report referred to as the *Orient Study* indicates, the design parameters for the dam were based on river flows and water use from the 1970s (Orient, 2011). Yet, by the time the dam was constructed in 2006, i) the 1994 Jordanian-Israeli Water Annex had been signed; ii) the Adassiyeh Weir had been constructed; iii) Jordan had hosted its second and third large wave of people fleeing war (from the Iraqi invasion of Kuwait in the US/UK invasion of Iraq in 2003); iv) the Syrian (and to a much lesser degree Jordanian) governments and farmers had drilled thousands of wells within the basin; and v) the long-term average flow at Maqarin (the site of the dam) was much lower than it had been in the 1950s, possibly due to the ever-expanding Syrian and Jordanian hydraulic missions.

As shown in Figures 9 and 10, one result of using outdated design parameters was that the dam lay empty for several years after its completion. This sparked new tensions over use of the Yarmouk, with formal and informal Jordanian voices blaming exploitation by Syria for the lack of water, and members of the Jordanian hydrocracy loudly proclaiming 'violations' of the 1987 Jordan-Syria water agreement[14] (Hussein, 2017). Figure 9 shows that the inflow into the reservoir began increasing from 2011 onwards, with an inflow of about 70 Mm^3 in 2012 and 124 Mm^3 in 2016. The increase has been attributed to the hundreds of thousands of people displaced by the conflict in Syria, which has allegedly resulted in a reduction of groundwater pumping for irrigation, particularly in the Syrian part of the Hauran Plain (Muller et al., 2016; Avisse et al., 2017). The increased inflow has also been attributed to the absence of coordinated dam management in Syria, and possibly has also been caused by altered rainfall and recharge patterns (UEA, 2019).

[14] The analysis of the companion Yarmouk article reveals that the accusations are not founded, pointing out that deficiencies in the water agreement are blocking progress towards a more equitable and sustainable transboundary water arrangement.

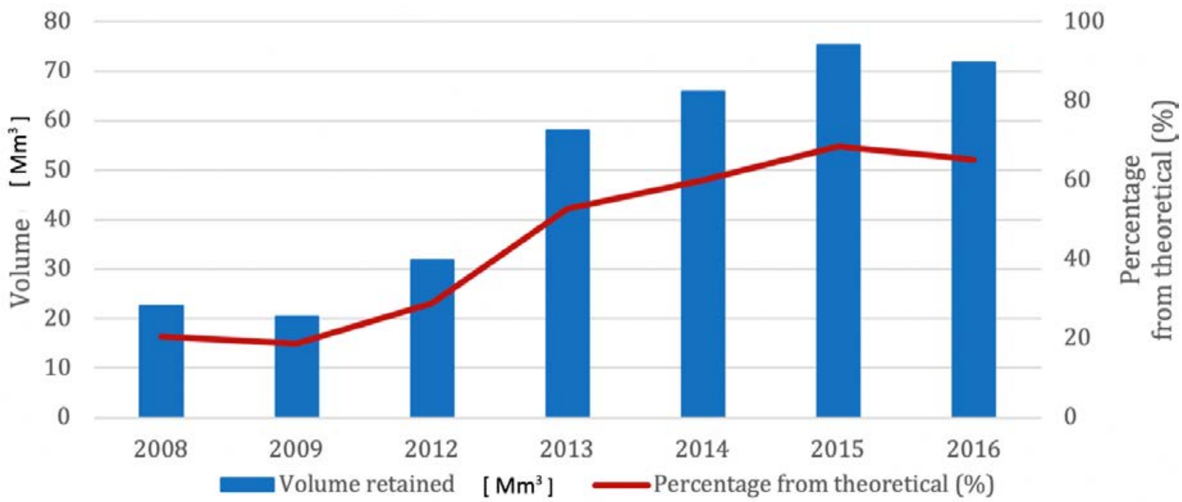
Figure 9. Flows in and out of the Wehdeh Dam reservoir (not storage), 2008-2018.



Sources: For 2007 to 2015, the data comes from a second JVA dataset referred to as JVA (2016b), which records daily flows into, and releases from, the Wehdeh Dam. It does not exactly match the release data of JVA (2016a), and so also does not match the data of Table A.1, Column d. Data for the years 2016 to 2018 (inclusive) comes from updated dataset JVA (2019).

Notes: The outflow of the Wehdeh Dam for 2007 to 2011 (< 20 Mm^3/y) appears low, in relation to the longer-term (1999 to 2018) and previously-discussed average flows diverted into the KAC (69 Mm^3/y) or bypassing it (72 Mm^3/y, for a total of 141 Mm^3/y). The discrepancy may be explained by considering the additional flows into the river downstream of the Wehdeh Dam: from the Raqqad tributary (no data from the Syrian gauging station is available, but the JVA gauge (data shown in Table A.2 column b) is just further downstream so can act as reasonable proxy) and from the Mukheibeh wells (Table A.1, Column c). According to the JVA, the average and highly variable flow of the river upstream of Mukheibeh Wells from 1999 to 2008 (year Wehdeh Dam was built) is 38 Mm^3/y. The average gauged flow of the Mukheibeh Wells for 2008 (first year of gauging) to 2018 is a much more steady 36 Mm^3/y. To the extent that the comparison is valid, the total flow of the river and the Mukheibeh (not including releases from the dam) is an indicative 74 Mm^3/y (and this is comparable to the 77 Mm^3/y from 1990 to 2010 (dates for which data is available) gauged by the Hydrological Survey of Israel data at Adassiyeh ('Gate 121' gauging station), further downstream (HSI , 2016b)). The rest of the discrepancy may be attributed to the great influence of flood flows and the many issues with reliability of the data (uncalibrated datasets, measurement and reporting errors, etc.). Reminder: the numerical findings of this analysis should be considered 'indicative'.

Figure 10. Volume retained by the Wehdeh Dam during the spring season. Note that this is different from the gauged inflow into the dam presented in Figure 8, as it is based on a different method.



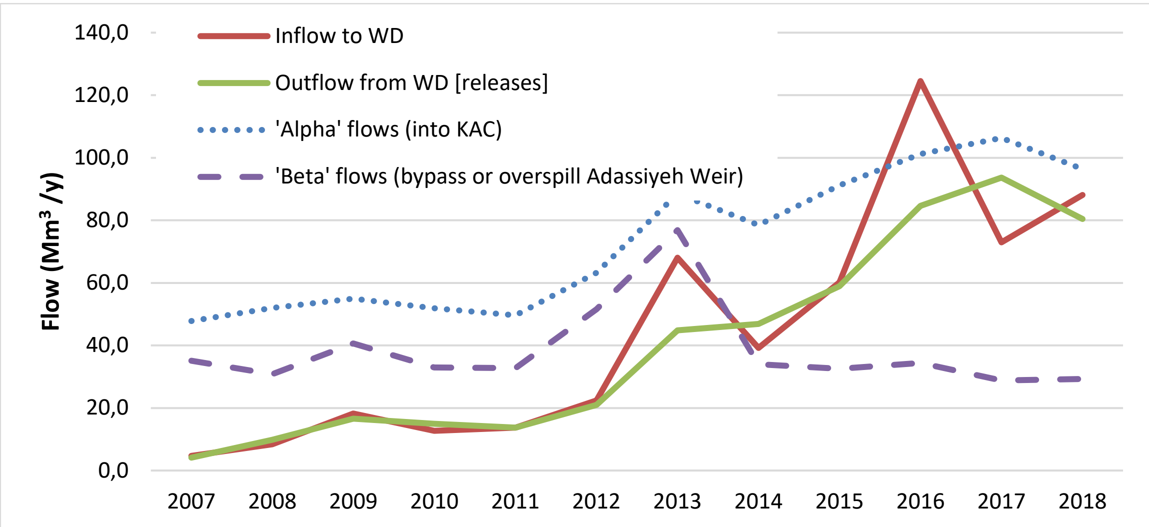
Source: UEA (2019), based on analysis of satellite imagery.

Based on analysis of satellite imagery from UEA (2019) (and roughly concurrent with the satellite imagery analysis undertaken through a different method, in Avisse et al., 2017), Figure 10 shows that the volume of water retained behind the Wehdeh Dam increased from about 32 Mm^3 in 2012 to 58 Mm^3 in 2013, and reached a maximum of 75 Mm^3 in 2015.

The dam's objective of regulating the supply to the Adassiyeh Weir (and thus to the KAC) became doubly important once construction of the smaller regulating dam for the Adassiyeh Weir, at al Himmeh, was no longer a viable option because (as discussed) of contested sovereignty. The data that informs Figure 9 shows that the Wehdeh Dam performs this function, in the sense that more water is released during the dry (summer) months and retained during the wet (winter) months. But the volatility of the inflows (Figure 9) and storage (Figure 10) suggest that a more thorough assessment is warranted.

Figure 11 considers the Wehdeh Dam and Adassiyeh Weir in concert, by comparing the inflows and releases from the dam with the flows diverted into, or bypassing, the King Abdullah Canal. Within the noted limitations in data, Figure 11 reveals several significant features. The first is the general synchronicity between the amount of water released from the Wehdeh Dam and the flows that enter or bypass the KAC. In other words, as more water enters the Wehdeh Dam, more water is released and more water both enters and bypasses the KAC. Considering the inconsistent amount of water entering the dam, the figures suggest that the dam is fulfilling its river-regulation role (as previously noted). A second point is that there is a rapid 'response' between dam releases and flows entering or bypassing the KAC. This would suggest that the original plan to have a second, smaller dam just for regulating flows for the Adassiyeh Weir remains a good idea from a hydraulic perspective. Third, noting the increased flow into the KAC, Jordan appears to be benefitting to a certain degree from the infrastructure whose construction it has negotiated upstream (the dam) and downstream (the weir) on the Yarmouk, even if it was built out of sequence. The assessment must be put in the context of the findings of Figure 5, however, which show that Jordan has been able to use less water from the Yarmouk since the year the Adassiyeh Weir was built.

Figure 11. Indicative comparison of Yarmouk inflows into, and releases from, the Wehdeh Dam.



Notes: Solid lines are from JVA, 2016a; dashed lines (the flows diverted by, or bypassing, the Adassiyeh Weir) are from JVA, 2016b and JVA, 2019. The two datasets from which the data are taken have not been calibrated, meaning the findings are indicative only; this explains discrepancies with the data of Table A.1.

WD = Wehdeh Dam; KAC = King Abdullah Canal.

Source: Please refer to Figures 6 and 9.

A related point is that the flows bypassing the weir and KAC remain consistently above 30 Mm^3/y even when the flows to the KAC are very low. Because Israel has sole use of these flows, this means that Jordan maintains its commitment from the 1994 Water Annex to supply Israel a net 25 Mm^3/y. Reading Figures 6 and 11 together reveals that Israel benefits proportionately *more* than Jordan does from increased storage in the Wehdeh Dam, both in dry years and in heavy flood years. In other words, by virtue of the 1994 Israel-Jordan treaty, the Israeli share is secured first even when the dam lies empty and the river runs at low flow. Due to the design of the Adassiyeh Weir, the Israeli share is increased in heavy flood years. As noted earlier, the Jordanian share is in effect 'bounded'; it is relatively low when the dam releases are low and relatively high when the flows are strong (as they have been since 2012).

THE DESIGN AND OPERATION OF THE INFRASTRUCTURE IMPEDES TRANSFORMATION

Considering the Adassiyeh Weir and Wehdeh Dam together, the short answer to the main question of this article is that the design and operation of the international infrastructure maintain the Yarmouk water arrangements in the state that they were when the infrastructure was built. This section seeks to explain that stability by considering the extent to which the design and operation reflects the technocratic processes of development and diplomacy, reinforces power asymmetries, and impedes the resolution of contentious issues.

Design and operation of the infrastructure reflecting and re-enforcing asymmetries in power

The influence of power asymmetry may be gauged crudely through a rapid assessment of the relative benefits that the infrastructure has had for each of the states involved. Though the task has not been completed fully for Syria, the operation of the Wehdeh Dam appears currently to be of very little significance to the water authorities in the north part of the basin. The main purpose of the 1987 Jordan-Syria water agreement was to build the dam, but it placed no restrictions on groundwater development and use inside Syrian territory (see Zeitoun et al., 2019a). Though Syrian members of the hydrocracy have explained in detail how the dams they have built do not violate the terms of the agreement (Enas and Shallalah, 2018), no such claims have been made in relation to the Wehdeh Dam. Informal discussions with water resource managers and the monitoring of Syrian and Jordanian media have demonstrated that the construction of the Wehdeh Dam and the Adassiyeh Weir have not significantly influenced the transboundary water policy of the Syrian hydrocracy. Further investigation into the effect on shared water management of the absence of a hydropower component of the Wehdeh Dam (of which 75% of the power was to be distributed to Syria) would yield interesting insights in this direction.

The infrastructure appears somewhat more relevant to the water bureaucracy in Israel. Muller et. al. (2016) point out the association between assumed reduced groundwater pumping in Syria and the post-2012 filling of the Wehdeh Dam; they suggest that in that sense Jordan has benefitted indirectly from the outbreak of war in Syria in 2011. The more surprising finding of this paper's tracking of the flows through the infrastructure is that the Israeli farmers and Israeli government have – at least in 2012 and 2013 – also benefitted from the filling of the dam, and largely 'immune' to the amount of water the dam has stored or released since that time. Figure 6 shows how an average of 69 Mm^3/y (48 Mm^3/y if flood years are excluded) has bypassed or spilled over the weir since its construction in 1999. As all of the bypass and overspill flows are captured and used by Israel (see Zeitoun et al., 2019a), the Israeli Yarmouk triangle farmers have secured on average *more* than the 40 Mm^3/y share of Yarmouk flows that they had sought since the 1950s, and the Israeli state has secured more than the 25 Mm^3/y that it is due according to the terms of the 1994 peace treaty. Moreover, this minimal Israeli share fixed by the terms of the treaty is secured even if the dam reservoir levels drop and the flows in the river decrease. The assurance has been accomplished through different methods over the decades: by the Yarmouk triangle farmers' manipulation of the rock weirs, by the government's international treaty, and through the design and operation of the Adassiyeh Weir.

The extent to which the international infrastructure favours Jordan is less clear. The dam had been proposed as beneficial to Jordanians originally in the Franjieh Plan over a century ago and was again called for in two agreements that Jordan signed with Syria. The flows that make it into the dam are highly responsive to upstream water use (primarily in Syria, but also in Jordan) and precipitation rates (as determined within the limits of the inadequate data that is available). Though future flows into the dam reservoir are anticipated to drop if groundwater withdrawals in the Hauran Plain resume, the reservoir continues to fill (Figure 11). The Wehdeh Dam thus continues to meet at least one of its primary purposes, the regulation of the flow downstream for more steady inflow into the King Abdullah Canal via the Adassiyeh Weir. However, the design of the Adassiyeh Weir means that the assertion holds only when the flows are neither too low nor too strong. Considering that the dam was completed seven years after the weir and decades after pumping patterns in Syria had been established, the dam appears decidedly overdesigned. Even though the capacity of its reservoir was scaled down from 500 to 110 Mm^3, a dam with half of this volume would appear to be better suited for its designated purpose. The opposite may hold for the Adassiyeh Weir, which appears undersized without the originally planned reservoir at al Himmeh/Hamat Gader, particularly given the generally acknowledged greater need for water in Jordan than in Syria or Israel.

In summary, the Wehdeh Dam is crucial to Jordan's water supply and a key asset of its hydrocracy, but is largely irrelevant in Syria. The design and operation of the Adassiyeh Weir meanwhile suggests that it is as much an uncertain source of water for Jordan as it is a secure one for Israel. Considered alongside the Yarmoukim Reservoir discussed in Zeitoun et al., 2019a the dam and the weir can be read as components of a suite of discriminating international infrastructure. Israel's share is fixed in absolute terms by the treaty, while the hydrologic variability imposed by the climate and upstream pumping is passed on to Jordan. From a Jordanian perspective, the situation is akin to the two decades of water 'cooperation' on the terms of its more powerful neighbours (see, for example, Thomas, 2017). Here, the less-powerful actor will have to confront clear and considerable obstacles in any attempt to effect any change in the current transboundary water arrangement.

An alternative arrangement can be derived by questioning the effect that heightening the crest of the weir would have. Raising the crest would result in more flood flows being diverted to the KAC, which could readily double the Yarmouk flows used by Jordan (and still be well within the turbidity-limiting flow limit imposed by the Water Authority of Jordan). In the extreme, this would mean the diversion of all the Yarmouk flows at Adassiyeh into the King Abdullah Canal (though this would of course be subject to negotiation with Israel). The modified infrastructure would obviate the need for the 'water exchange' infrastructure and for the energy required to pump water to the Lake of Tiberias and back again. The modified infrastructure would also update the outdated (1950s) idea in a way that would meet current and future Jordanian water demand in the Jordan River Valley, and beyond. The volume and salinity-reducing role of Yarmouk flows that benefit Israel and the Lake of Tiberias would be made up through the excess supply in the national system (plans for which are already in place (Wine, 2019)).

Reflection on the enduring effect of the forgotten infrastructure

Neither of these transboundary water arrangements have attracted much public debate or international diplomacy for some time and the alternative vision required for transformation is not expected to emerge under the current political context. Though they were planned out-of-sync, the dam and the weir both work together not only to impede but to stifle any transformation of the transboundary water arrangement between Jordan and Syria, and between Jordan and Israel.

The assertion can be substantiated in part by the interplay between the infrastructure and the agreements that enabled them. The 1987 and 1994 water agreements may be considered the institutional foundation upon which infrastructure was built. It is striking to consider how the diplomacy that led to the agreements, which in turn led to the infrastructure, continues to shape the transboundary water arrangements several decades on. Once they had been built, the weir and the dam committed the parties in a very concrete and lasting manner indeed; they continue to operate round the clock, through periods of extreme wet and dry, peace and war. They will likely continue to do so for the rest of their design lives, unquestioned as they are by the public or international diplomatic community.

There is no reason to believe that the concrete must outlive the technocratic 'development' and diplomatic paradigms under which it was poured. Reducing the flow through the gates of the Adassiyeh Weir is a matter of turning the valves; reducing the overspill of the weir requires raising its crest or rebuilding the weir, neither of which is technically difficult. Likewise, while the Wehdeh Dam may have the capacity to store more water than it currently does, storage and release levels can be managed as if it were a dam half its size simply by opening or closing the gates. Thus, in the sense that the infrastructure can be modified or operated according to a different regime, it is no less reversible than is the text of the agreement. Both are static, in direct contrast to the ever-changing use and availability of the water. Changing the text, or the design or operation of the infrastructure obliges the consent of all the actors, however, and this appears to be yet another factor that shapes the static status quo.

Beyond concluding generically that 'the political context' is all-determining, the findings suggest a selective depoliticising effect that may be altogether more enduring. Given the asymmetry in benefits and costs, the concrete structures on the mainstream of the Yarmouk can be seen in very many ways as expressions of the power of some people over others (to return to the observation of C. S. Lewis). Though the authors have not carried out specific investigation into the contentious narratives put forward by the hydrocracy, press and public online presence in Jordan about dams in Syria, use of the narratives appear to have peaked around 2011, or soon after the reservoir of the Wehdeh Dam started filling. Should renewed groundwater use in Syria or the effects of climate change result in the reservoir lying empty again, the narratives are likely to resume, and the issue will be readily *re*politicised, if not also quickly securitised.

Similarly, the silence that followed the construction of the Adassiyeh Weir in 1999 contrasts dramatically with the attention given to hydropolitics in the overtly violent decades that led up to its construction. The difference may be explained by the fact that the weir and the 1994 treaty did succeed in managing many of the contentious water issues between Jordan and Israel. In this scenario, the infrastructure and agreements would have rendered the transboundary water arrangements more resilient. However, considering the asymmetric benefits resulting from the design and operation of the weir, as demonstrated here, and the asymmetry in water distribution throughout the broader Jordan River Basin (in Zeitoun et al., 2019a), the silence may just as well be suggesting that the role that the infrastructure plays is simply no longer questioned by the hydrocracies or by the general public. If this is the more accurate scenario, the hydrocracies' technocratic process of planning, design and operation of the infrastructure matches the international diplomatic processes, stripping the politics out of the use and distribution of the water. The theory reviewed suggests that this could be the result of the consent given by the less-powerful state authorities. In the process, asymmetries in power are played down and there is no consideration of alternative designs (such as a heightened weir) or operating regimes (such as keeping the bypass gates closed for longer). The local impact of the arrangement – on Jordan's share within the wider Jordan River Basin or local control over the Mukheibeh Wells – is ignored, and tensions are stifled, at least for a while. In either scenario, Wittfogel's 'nature' has acquired a wholly utilitarian function, and the international infrastructure works with the agreements to perpetuate rather than transform the arrangement.

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ANNEX. JORDANIAN AND ISRAELI FLOW DATA IN AND AROUND THE ADASSIYEH WEIR

Table A1. Distribution of Yarmouk flows at Adassiyeh.

a	b	c	d	e	f	G
Year	Flows originating from Yarmouk River recorded as diverted into the KAC at Adassiyeh, by sandbar or by the AW (JVA 2016a, 2019)*	Discharge from Mukheibeh wells used locally (after 1995) or diverted into the KAC (JVA 2016a, 2018)*	Flows originating from WD, recorded as diverted into the KAC by the AW (JVA 2016a, 2019)*	^Total flows diverted into the KAC, via sandbar/rock weir/AW (including Mukheibeh wells discharge and Wehdeh releases) ('Alpha' flows) (JVA 2016a, 2019)*	^^ Flows not diverted into the KAC, because they i) (before 1999) overspill the sandbar or rock weir; or ii) (after 1999) overspill or bypass the AW, ('beta' flows) (JVA 2016a, 2019)*	Flows over-spilling the AW ('uncontrol-led water') (JVA 2016a, 2019)*
1962	77.50	nd	nd	nd	nd	Nd
1963	93.44	nd	nd	93.44	nd	Nd
1964	109.08	nd	nd	109.08	nd	nd
1965	138.94	nd	nd	138.94	nd	nd
1966	133.93	nd	nd	133.93	nd	nd
1967	136.15	nd	nd	136.15	nd	nd
1968	150.54	nd	nd	150.54	nd	nd
1969	97.73	nd	nd	97.73	nd	nd
1970	63.22	nd	nd	63.22	nd	nd
1971	115.86	nd	nd	115.86	nd	nd
1972	149.64	nd	nd	149.64	nd	nd
1973	112.01	nd	nd	112.01	nd	nd
1974	124.57	nd	nd	124.57	nd	nd
1975	125.60	nd	nd	125.60	nd	nd
1976	126.10	nd	nd	126.10	nd	nd
1977	126.78	nd	nd	126.78	nd	nd
1978	128.64	nd	nd	128.64	nd	nd
1979	113.75	nd	nd	113.75	nd	nd
1980	124.23	nd	nd	124.23	nd	nd
1981	128.26	nd	nd	128.26	nd	nd
1982	144.02	nd	nd	144.02	nd	nd
1983	128.56	nd	nd	128.56	nd	nd
1984	145.12	nd	nd	145.12	nd	nd
1985	126.39	nd	nd	126.39	nd	nd
1986	125.92	nd	nd	125.92	109.4	nd
1987	167.90	nd	nd	167.90	179.9	nd

1988	144.35	nd	nd	144.35	184.7	nd
1989	108.12	22.1	nd	108.12	50.8	nd
1990	98.4	23.6	nd	98.4	58.2	nd
1991	95.5	16.9	nd	95.5	66.4	nd
1992	164.9	9.2	nd	164.9	613.3	nd
1993	118.5	16.2	nd	118.5	146.9	nd
1994	99.2	20.6	nd	99.2	67.7	nd
1995	108.0	16.6	nd	124.6	68.7	nd
1996	100.8	20.6	nd	121.4	55.6	nd
1997	99.7	15.0	nd	114.7	57.0	nd
1998	87.3	15.0	nd	102.3	62.9	nd
1999	62.9	16.3	nd	79.2	28.1	nd
2000	54.6	17.9	nd	72.5	51.3	nd
2001	30.4	19.9	nd	50.3	38.4	nd
2002	23.0	30.1	nd	53.1	58.6	nd
2003	54.7	24.4	nd	79.1	465.4	418.5
2004	68.6	28.8	nd	97.4	172.8	136.2
2005	42.6	32.1	nd	74.7	59.1	18.1
2006	14.25	34.8	nd	49.1	45.1	2.3
2007	15.99	31.8	nd	47.8	35.1	1.6
2008	14.90	30.2	6.9	52.0	30.8	2.5
2009	10.59	29.1	15.3	55.0	40.6	6.6
2010	12.67	27.7	11.5	51.9	33.0	0.2
2011	13.65	25.8	10.1	49.6	32.7	0.6
2012	18.52	27.9	16.8	63.2	51.6	10.2
2013	28.32	25.9	34.3	88.5	76.9	31.7
2014	16.04	23.8	38.7	78.5	33.9	0.0
2015	19.00	23.3	48.9	91.2	32.5	0.1
2016	7.52	23.3	70.4	115.3	34.4	0.2
2017	3.9	23.2	79.3	120.8	28.8	0
2018	5.7	23.0	67.7	109.3	29.9	nd
Avg. for series	87	23	40	105	94 / 65 (if 1992 and 2003 removed)	37
Avg. from:	*1999-2018:* **26**	n/a	n/a	1986-1999: **121 / 118** (if 1992 removed) 1999-2018: **72 / 71.5** (if 2003 removed)	1986-1999: **125 / 87** (if 1992 removed) 1999-2018: **69** / **48** (if 2003 removed)	n/a

Sources: JVA and JVWA, and as noted.

Notes: As discussed in the text, discrepancies are due to measurement error and poor reliability of the reported data; nd = no data; AW = Adassiyeh Weir; WD = Wehdeh Dam.

* Main databases used are listed. All are checked against JVA (2006), JVA (2016b), JVA (2018), and JVA (2019), with minor irregularities due to different labels and periods;

^ Column e calculated as follows: from 1962 to 1995 equal to Column b; from 1995 to 2006 sum of Columns b and c; from 2006 to 2018: sum of Columns b, c, and d.

^^ Column f includes 'uncontrolled water' (from Column g) from 2003 onwards.

References

Abitbol, E. 2013. Hydropolitical peacebuilding: Israeli-Palestinian water relations and the transformation of asymmetric conflict in the Middle East. PhD thesis, Department of Peace Studies, School of Social and International Studies. University of Bradford, Bradford.

Aggestam, K. and Sundell, A. 2015. Depoliticising water conflict: functional peacebuilding in the Red Sea-Dead Sea water conveyance project. *Hydrological Sciences Journal*.

Aggestam, K. and Sundell-Eklund, A. 2013. Situating water in peacebuilding: revisiting the Middle East peace process. *Water International* 39(1): 10-22.

Al Majdoub, T. 1998. *La Ahada Yashrab: Mashare' Al Miya fi Istratijiyat Israel [Not a Drop to Drink: Israeli water strategy*. Beirut: Riad El-Rayyas Books.

Al Qusaym, M. 2016. (اليرموك حوض) الجنوبية المنطقة في المياه واقع عن أولي تقرير.

Al Raggad, M.; Salameh, E.; Alqadi, M.; Magri, F. and Ciogna, G. 2018. Implication of projected climate change for groundwater recharge in North Jordan. *Geophysical Research Abstracts, EGU General Assembly 2018* 20(EGU2018-12359).

Al-Husein, A.B. 2007. اليرموك حوض في التلوث. *Syrian Cosmological Society*.

Alatout, S. 2009a. Bringing abundance into environmental politics : Constructing a Zionist network of water abundace, immigration and colonization. *Social studies of Science* 39(3): 363-394.

Ali, N.; Willis, R.; Hashim, M.J. and el Moghraby, A. submitted 2019. Norms, mobilization and conflict: The Merowe Dam as a case study. *Transnational Environmental Law*.

Allan, J.A. 2001. *The Middle East water question: Hydropolitics and the global economy*. London, UK: I.B. Tauris.

Allouche, J. 2019. State building, nation making and post-colonial hydropolitics in India and Israel: Visible nd hidden forms of violence at multiple scales. *Political Geography*.

Allouche, J.; Nicol, A. and Mehta, L. 2014. Water security: Towards the human securitization of water? *The Whitehead Journal of Diplomacy and International Relations* XII(1): 153-172.

Aviram, R.; Katz, D. and Shmueli, D. 2014. Desalination as a game-changer in transboundary hydro-politics. *Water Policy* 16: 609-624.

Avisse, N.; Tilmant, A.; Müller, M.F. and Zhang, H. 2017. Monitoring small reservoirs storage from satellite remote sensing in inaccessible areas. *Hydrology and Earth System Sciences Discussions*: 1-23.

Avitzur, S. 2003. The power plant on two rivers. Tel Aviv: The Israel Review of Arts and Letters. website hosted by Ministry of Foreign Affairs (Israel) http://mfa.gov.il/MFA/MFA-Archive/2003/Pages/The%20Power%20Plant%20on%20Two%20Rivers.aspx

Baker-Harza. 1953. Yarmouk-Jordan Valley Project Appraisal Report, prepared by Michael Baker Jr.; Inc.; Rochester Pennsylvania and Harza Engineering Company, Chicago, Illinois, USA. Jordan: Cooperative Department, Water Resources Development, Ministry of Finance, Government of the Hashemite Kingdom of Jordan. December 1953.

Blake, D.J.H. 2019. Recalling hydraulic despotism: Hun Sen's Cambodia and the return of strict authoritarianism. *Austrian Journal of South-East Asian Studies* 12(1): 69-89.

Cafiero, C. 2016. Supply and demand prospects for the major syrian agricultural products. FAO. 2016.

CO. 1926. Agreement as to Water Concession at Jerusalem, between the Crown Agents for the Colonies and Euripides Mavrommatis. Westminister, London: UK National Archives Commonwealth Office record CAOG 14/124.

CO. 1927. Case concerning the re-adaptation of the Mavrommatis Concessions – Opinion of the Attorney General and Mr. Fachiri. UK National Archives Commonwealth Office record CO 733/131/1-3.

Creighton, J.L.; Delli-Priscoli, J. and Dunning, C.M. 1998. *Public involvement techniques: A reader of ten years experience at the Institute for Water Resources*. Institute for Water Resources, US Army Corps of Engineers.

Dajani, M. 2018. Water struggles as struggles for recognition: The lived geographices of farming communities in Sahl al-Battuf and the occupied Golan Heights. PhD thesis from the Department of Geography and Environmnent. London School of Economics and Political Science, London.

Dajani, M. and Mason, M. 2018. Counter-infrastructure as resistance in the hydrosocial territory of the occupied Golan Heights. In Menga, F. and Swyngedouw, E. (Eds), *Water, technology, and the nation-state,* pp. 131-146 London: Routledge.

Dana, O. 2016. Personal communication with Syrian academic, via Skype 25 November 2016. Anonymised.

Daoudy, M. 2008. A missed chance for peace: Israel and Syria's negotiations over the Golan Heights. *Journal of International Affairs* 61(2): 215-234.

Daoudy, M. 2009. Asymmetric power: Negotiating water in the Euphrates and Tigris. *International Negotiation* 14(2): 361-391.

Delli-Priscoli, J. 1998 Public involvement; Conflict management; and dispute resolution in water resources and environmental decision making. In Creightion, J.L.; Dunning, C.M.; Delli-Priscoli, J. and Ayres, D.B. (Eds), *Public Involvement and dispute resolution: A reader on the second decade of experience at the Institute for Water Resources,* pp. Alexandria, USA: Institute for Water Resources, US Army Corps of Engineers.

Dirar, A.; El Moghraby, A.; Hashim, M.J. and Zeitoun, M. 2015. Displacement and resistance induced by the Merowe Dam: The influence of international norms and justice. Norwich: University of East Anglia.

Enas (pers. comm.) and Shallalah (pers.comm). 2018. Personal communication at the offices of the Ministry of Water Resources in Damascus, May 2018 and December 2018. Anonymised.

Etana. 2015. The Yarmouk Basin: Between conflict and development. ETANA Syria Publishing and Documentation.

FCO. 1979. Jordan Waters. UK National Archives Commonwealth Office record FCO93-1988, RRM040/1.

Feitelson, E. 2004. The new water geography. Paper read at Lecture given at the IPCRI 'Water for Life' Conference 12-14 October 2004, 12-14 October 2004, at Antalya, Turkey.

Ferguson, J. 1993. *The anti-politics machine: "Development", depoliticization, and bureaucratic power in Lesotho*. Cambridge: Cambridge University Press.

FO. 1949. Jordan Irrigation Plan: Report on Hays-Lowdermilk Scheme (by R.H. MacDonald). UK Foreign Office record FO 957/95.

FO. 1962. Gauging the extent of British involvement in the "Jordan Waters problem". UK Foreign Office record FO 371/164137.

Fox, C.; A. and Sneddon, C. 2007. Transboundary river basin agreements in the Mekong and Zambezi basins: Enhancing environmental security or securitizing the environment? *International Environmental Agreements: Politics, Law and Economics* 7(3): 237-261.

Freire, P. 1972. *Cultural action for freedom*. Middlesex: Penguin Books.

Gaventa, J. 2005. *Power and powerlessness: Quiescence and rebellion in the Appalachian Valley*. Chicago, USA: University of Illinois Press.

Ghantous, R. pers. comm. 2018. Personal communication, Beirut, 17 July 2018. Anonymised.

Ghureir (pers. comm.), M. 2018. Personal communication at Adassiyeh, Sept 2018. Anonymised.

Gyawali, D. 2001. *Rivers, technology and society; Learning the lessons of water management in Nepal*. London, UK: Zed Books.

Haddadin, M. 2017. Personal communication, Amman, 9 June 2017.

Haddadin, M. 2000. Negotiated resolution of the Jordan-Israel water conflict. *International Negotiation* 5(2): 263-288.

Haddadin, M. 2002. *Diplomacy on the Jordan: International conflict and negotiated resolution*. New York: Springer Science and Business Media, LLC.

Haddadin, M. 2006. *Water resources in Jordan: Evolving policies for development, the environment, and conflict resolution*. Washington: Resources for the Future.

Haddadin, M. 2007. *Salaam ala al Yarmouk Al Muwajahat w al Mufawadat (1967-2000) [Peace on the Yarmouk: Confrontation and Negotiation (1967-2000)]*. Amman.

Hart, S.F. 1978. Correspondence to Mr Moshe Alon, Deputy Director General of the Ministry of Foreign Affairs. Tel Aviv, October 4, 1978: Embassy of the United States of America, Tel Aviv.

Harza. 1979. Jordan Valley Irrigation Project Stage II: Project Overview. Harza Overseas Engineering Company.

Hays, J.B. 1948. T.V.A. on the Jordan – Proposals for Irrigation and Hydro-Electric Development in Palestine. Washington, DC, USA: A Report Prepared Under the Auspices of the Commission on Palestine Surveys, Public Affairs Press, assisted by A.E. Barrekette, with an introduction by Walter C. Lowdermilk.

Headrick, D.R. 1988. *The tentacles of progress: Technology transfer in the age of imperialism, 1850-1940*. Oxford, UK: Oxford University Press.

Hoff, H. n.d. Climate change, impacts and adaptation in the MENA region, with focus on Syria.

HSI. 2016a. Development and utilization of water resources in Israel until Autumn 2014 [in Hebrew]. Jerusalem: Hydrological Service of Israel.

HSI. 2016b. State of water sources in Israel 2016 (Hebrew). Jerusalem: Hydrological Service of Israel. http://water.gov.il/Hebrew/ProfessionalInfoAndData/Data-Hidrologeime/Pages/water-resources-2014.aspx

Hussein, H. 2017. Whose 'reality'? Discourses and hydropolitics along the Yarmouk River. *Contemporary Levant*.

Ibrahim, H. 2013. *The red minaret – Memoirs of Ibrahim Ghusheh: Ex-spokesman of Hamas*. Al-Zaytouna Centre.

ISA. 1939. Zoltan Kluger Photos, dated 11/06/1939. Israel State Archives.

ISA. 1962. Letter from Israeli Ministry of Foreign Affairs (Chet Tzad) to Israel envoy to Washington (Mr Gazit), 29 August 1962. Israel State Archives.

Ishtayyeh, M. 2011. *The encycloaedia of Palestinian terminology and concepts*. Amman: Dar al Jaleel.

Johnston, E. 1955. Johnston Allocation of Jordan River Waters 9/30/55 ('The Johnston Plan'). U.S. National Archives and Records Administration, College Park Maryland. NND927340, declassified 9/30/04.

JVA. 2006. Index for Surface water, dams, and King Abdallah Canal, 1990-2006. Amman: Spreadsheet of the Jordan Valley Authority (Jordan).

JVA. 2016a. JVA Historical Data 1962-2016. Amman: Spreadsheet of the Jordan Valley Authority (Jordan), provided Nov 2017. Shows Yarmouk River Discharge from 1962 to 2016, monthly totals.

JVA. 2016b. Water level at Al Wehdah Dam 2007-2016. Amman: Spreadsheet of the Jordan Valley Authority (Jordan), provided December 2016. Shows daily gauging records of 'In Flow Data' and 'Out Flow Data', in m3.

JVA. 2018. Inflows to KACn & Con & Alloc & JR 2008-2017. Amman: Spreadsheet of the Jordan Valley Authority (Jordan), provided September 2017. Shows sources of flows to northern parts of King Abdallah Canal, plus Concessions to Israel.

JVA. 2019. والوحدة وطبريا اليرموك Yarmouk Tiberias and Unity Dam 2016-2019 Amman: Spreadsheet of the Jordan Valley Authority (Jordan), provided December July 2019. Shows monthly gauging records for Wehdeh Dam (in and out), KAC (alpha and beta flows) and returns from Tiberias (via Beit Zera), 2016 to half of 2019.

Kibaroglu, A. 2015. An analysis of Turkey's water diplomacy and its evolving position vis-à-vis international water law. *Water International* 40(1): 153-167.

Kramer, A. and Kibaroglu, A. 2011. Turkey's position towards inernational water law. In Kibaroglu, A.; Scheumann, W. and Kramer, A. (Eds), *Turkey's water policy: National frameworks and international cooperation,* pp. Heidelberg: Springer-Verlag.

MacDonald & Partners. 1951. Report on the Proposed Extension of Irrigation in the Jordan Valley. London, UK: Sir M. MacDonald & Partners, Chartered Civil Engineers, prepared for the Hashemite Kingdom of Jordan. March 1951.

Main, C.T.; Inc. 1953. The unified development of the water resources of the Jordan Valley Region, prepared at the request of the United Nations under direction of the Tennessee Valley Authority by Chas. T. Main, Inc. Boston, Massachussets, USA (a.k.a. "The Main Plan" or "The Unified Development Plan").

Margane, A.; Zuhdy, Z. and Saffarini, I. 1996. Volume 1 – Part 2 – Spring discharge in northern Jordan. Amman, Jordan: Federal Institute for Geosciences and Natural Resources and Water Authority of Jordan. 1996.

Menga, F. and Swyngedouw, E. (Eds). 2018. *Water, technology, and the nation-state*. London: Routledge.

Mohamud, M. and Verhoeven, H. 2016. Re-engineering the state, awakening the nation: Dams, islamist modernity and nationalist politics in Sudan. *Water Alternatives* 9(2): 182-202.

Molle, F.; Mollinga, P.P. and Wester, P. 2009. Hydraulic bureaucracies and the hydraulic mission: Flows of water, flows of power. *Water Alternatives* 2(3): 328-349.

Mollinga, P.P. 2008. Water, politics and development: Framing a political sociology of water resources management. *Water Alternatives* 1(1): 7-23.

Muller, M.F.; Yoon, J.; Gorelick, S.M.; Avisse, N. and Tilmant, A. 2016. Impact of the Syrian refugee crisis on land use and transboundary freshwater resources. *Proceedings of the National Academy of Sciences* 113(52): 14932-14937.

Neff, D. 1994. Israel-Syria: Conflict at the Jordan River, 1949-1967. *Journal of Palestine Studies* 23(4): 26-40.

Oestigaard, T. (Ed). 2009. *Water, culture and identity: Comparing past and present traditions in the Nile Basin Region*. University of Bergen, Bergen: BRIC Press.

Orient. 2011. Yarmouk River Basin water resources assessment and use – Final report. The Hashemite Kingdom of Jordan, Ministry of water and irrigation, Jordan Valley Authority. 2011.

Phare, M.-A.S. 2009. *Denying the source: The crisis of First Nations water rights*. Vancouver: Rocky Mountain Books.

Phillips, D.; Attili, S.; McCaffrey, S. and Murray, J. 2007. The Jordan River Basin: 1. Clarification of the Allocations in the Johnston Plan. *Water International* 31(5): 16-38.

Pugh, M. 2005. The political economy of peacebuilding: A critical theory perspective. *International Journal of Peace Studies* 10(2): 23-42.

Pyla, P. and Phokaides, P. 2018. An island of dams: Ethnic conflict and the contradictions of statehood in Cyprus. In Menga, F. and Swyngedouw, E. (Eds), *Water, technology, and the nation-state,* pp. 115-130. London: Routledge.

Rajsekhar, D. and Gorelick, S.M. 2017. Increasing drought in Jordan: Climate change and cascading Syrian land-use impacts on reducing transboundary flow. *Science Advances* 3(e1700581 30 August 2017).

Reguer, S. 1995. Rutenberg and the Jordan river: A revolution in hydro-electricity. *Middle Eastern Studies* 31(4): 691-729.

Reisner, M. 1986. *Cadillac desert – The American West and its disappearing water*. New York, USA: Penguin Books.

Scheumann, W.; Baumann, V.; Mueller, A.L.; Mutschler, D.; Steiner, S. and Walenta, T. 2011. Environmental impact assessment in Turkish dam planning. In Kibaroglu, A.; Scheumann, W. and Kramer, A. (Eds), *Turkey's water policy: National frameworks and international cooperation,* pp.139-160. Heidelberg: Springer-Verlag.

Selby, J. 2013a. Cooperation, domination and colonisation: The Israeli-Palestinian joint water committee. *Water Alternatives* 6(1): 1-24.

Selby, J. 2013b. The myth of liberabl peace-building. *Conflict, Security & Development* 13(1): 57-86.

Sevette, P. 1953. Legal aspects of the Jordan Valley Development. Geneva, 8 October 1953: Memorandum by P. Sevette, Head of the Electric Power Section, Idustry Division, Economic Commission for Europe. Prepared at the request of the United Nations Relief and Works Agency for Palestine Refugees.

Shamir, U. 2003. *The negotiations and water agreement between the Hashemite Kingdom of Jordan and the State of Israel*. UNESCO.

Shattat, O. 2018. Personal communication in Amman, December 2018 and May 2019. Anonymised.

Shentsis, I.; Inbar, N.; Rosenthal, E. and Magri, F. 2018. Numerical representation of rainfall field in basins of the Upper Jordan River and of the Yarmouk River. *Environmental Earth Sciences* 77(24).

Smith, C.G. 1966. The disputed waters of the Jordan. *Transactions of the Institute of British Geographers* 40: 111-128.

Sneddon, C. and Fox, C. 2006. Rethinking transboundary waters: A critical hydropolitics of the Mekong basin. *Political Geography* 25: 181-202.

Sosland, J.K. 2007. *Cooperating rivals: The riparian politics of the Jordan River Basin*. New York, USA: State University of New York Press.

Suleiman, R. 2003. The historical evolution of the water resources development in the Jordan River Basin in Jordan. IWMI, MREA. 2003.

Swyngedouw, E. 1999. Modernity and hybridity: Nature, regeneracionismo, and the production of the Spanish waterscape, 1890-1930. *Annals of the Association of American Geographers* 89(3): 443-465.

Thomas, K.A. 2016. The river-border complex: An border-integrated approach to transboundary river governance illustrated by the Ganges River and Indo-Bangladeshi border. *Water International* 42(1): 34-53.

Thomas, K.A. 2017. The Ganges water treaty: 20 years of cooperation, on India's terms. *Water Policy* 19: 724-740.

Tvedt, T. 2004. *The River Nile in the age of the British: Political ecology and the quest for economic power*. London: IB Tauris.

UEA. 2019. Hydro-political baseline of the Yarmouk Tributary of the Jordan River. Norwich: Water Security Research Centre of the University of East Anglia.

UN-ESCWA/BGR. 2013. *Inventory of shared water resources in Western Asia*. Beirut: UN Economic and Social Commission for Western Asia (ESCWA), and the German Federal Institute for Geosciences and Natural Resources (BGR).

US NESAA. 1976. Israeli use of Yarmuk River water. Cable from US Bureau of Near Eastern and South Asian Affairs in Tel Aviv to Secretary of State in Amman. https://wikileaks.org/plusd/cables/1976TELAV08483_b.html

Venot, J.-P.; Molle, F. and Hassan, Y. 2007. *Irrigated agriculture, water pricing and water savings in the Lower Jordan Basin (in Jordan)*. Colombo: International Water Management Institute.

Verhoeven, H. 2012. Water, civilisation and power: Sudan's hydropolitical economy and the Al-Ingaz Revolution. Department of Politics & International Relations. Oxford University, Oxford.

Weinthal, E.; Zawahri, N. and Sowers, J. 2015. Securitizing water, climate, and migration in Israel, Jordan, and Syria. *International Environmental Agreements* 15: 293-307.

Wine, M.L. 2019. Under non-stationarity securitization contributes to uncertainty and Tragedy of the Commons. *Journal of Hydrology* 568: 716-721.

Wittfogel, K. 1963. *Oriental despotisms: A comparative study of total power*. New Haven: Yale University Press.

Zeitoun, M.; Cascão, A.; Warner, J.; Mirumachi, N.; Matthews, N.; Farnum, R. and Menga, F. 2016. Transboundary water interaction III: Contesting hegemonic arrangements. *International Environmental Agreements*: 271-294.

Zeitoun, M.; Mirumachi, N.; Warner, J.; Kirkegaard, M. and Cascão, A. 2019. Analysis for water conflict transformation. *Water International*.