

On the Need for Including Groundwater Allocation in Future Negotiations on the Orontes

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Abstract

A series of treaties between Lebanon and Syria on the use of the Orontes ('Assi) River's flows emerged in the mid-1990s, being reformed twice to result in a finalized 2002 agreement allocating Lebanon 96 million cubic meters (MCM) out of 403 MCM as measured at the Hermel Bridge gauge. Focusing on the area south of Ar-Rastan, Syria, this article seeks to explore these treaties' treatment of groundwater, ultimately demonstrating that it is not sufficiently accounted for. This allows for intensive groundwater abstractions—which may be beyond the aquifer's recharge rate—to be undertaken in Syria. The paper concludes with recommendations to better manage the basin's groundwater resources, which include improving groundwater data, using these data to calibrate improved hydrologic models, and a renegotiation of the treaty to better account for groundwater use.

Keywords

Orontes River, Assi River, Groundwater, Transboundary Watercourses, Transboundary Groundwater, Lebanon-Syria Relations

1. Introduction

In the age of the Anthropocene,¹ humanity's access to and use of vital water resources have increasingly become objects of concern. Indeed, Earth's water resources which are so vital to humankind are increasingly being put under pres-

¹With some citing the detonation of the first atomic bomb as the event that heralded its arrival, the Anthropocene can be understood as the age in which humans have made a permanent mark on the Earth; we have effectively changed the "nature of nature." See Richard Monastersky, "First Atomic Blast Proposed as Start of Anthropocene," *Nature*, January 16, 2015,

<https://www.nature.com/news/first-atomic-blast-proposed-as-start-of-anthropocene-1.16739>.

sure by rising global temperatures; unless efforts are made to ensure that water is used efficiently and responsibly, this pressure will be compounded. One factor that adds another layer of complexity to the quest for the sustainable use of water resources is when they flow across borders. Making up over 250 bodies of water and covering almost fifty percent of Earth's surface [1], transboundary water resources are river basins, aquifers, and lakes shared by two or more countries [2]. Owing to one of the fundamental characteristics of water—it flows—it is a difficult resource for countries to manage in a way that ensures equitable access while simultaneously respecting one of the key tenants of the international order: sovereignty. Groundwater resources are a complicating factor, as they are often unmeasured and ungoverned. The importance of groundwater ranges from minor to major depending on the geology of the watershed in question. The inclusion of groundwater in transboundary agreements is often neglected, with the focus being placed primarily on surface water.

One country characterized by the heavy presence of groundwater is Lebanon—indeed, some researchers have noted that if Egypt is to be deemed the “gift of the Nile,” then this small Eastern Mediterranean nation is the “gift of karst” [3]. Lebanon is also home to a major transboundary watercourse characterized by the extensive presence of groundwater: the Orontes River. Known in Arabic as Nahr al-Assi—the rebellious river—the Orontes springs from Lebanese territory and flows in a northerly direction through Syria and Turkey before discharging into the Mediterranean Sea. In 1994, Syria and Lebanon adopted the “Agreement on the Distribution of the Water of the Orontes River Originating from Lebanese Territory between the Lebanese Republic and the Syrian Arab Republic,”² [4] which was amended in 1997 [5] and 2002 [6].

It may be argued that the agreements started off as coercive (1994), with Syria establishing a hegemonic position. It has been noted that the original 1994 Agreement was not in concordance with many of the principles espoused by the 1997 United Nations Convention on the Law of the Non-navigational Uses of International Watercourses, including Articles 5 and 6 (Equitable and reasonable utilization and participation, and related factors) [6]. The 1994 Agreement was revised in response to these criticisms, with many authors arguing that the final 2002 Agreement can be considered to be “fair and equitable” to both Syria and Lebanon [7]. However, Kaissi (2014) calls into question the legitimacy of all three treaties, arguing that they ought to be nullified on the basis that they were signed when Lebanon was under Syrian occupation [8]. Furthermore, these treaties fall short in one crucial aspect of the governance of transboundary water resources—they do not sufficiently account for groundwater [9]. This article seeks to explore these treaties’ (lack of) attention to groundwater, placing itself within the growing literature on the governance of transboundary water resources generally and transboundary groundwater resources specifically. It will focus on the area south of Ar-Rastan, Syria, as it can be argued that the three treaties focus on

²Hereinafter “The 1994 Agreement.”

this portion of the basin as it is fed almost exclusively by water originating in Lebanon. This area is shown on the following page in **Figure 1**.

2. Relevant Agreements

Flowing from south to north, the Orontes River is primarily used for irrigation by the three riparian states. Depending on the source, the Orontes is either the second or third largest river in Lebanon in terms of annual flow.³ Lebanon's Zarqa spring is the largest in the Orontes Basin, contributing an average flow of approximately 347 - 429 MCM/year [10]. In spite of this significant contribution, Lebanon has been allocated a relatively small share of the river's flows, with

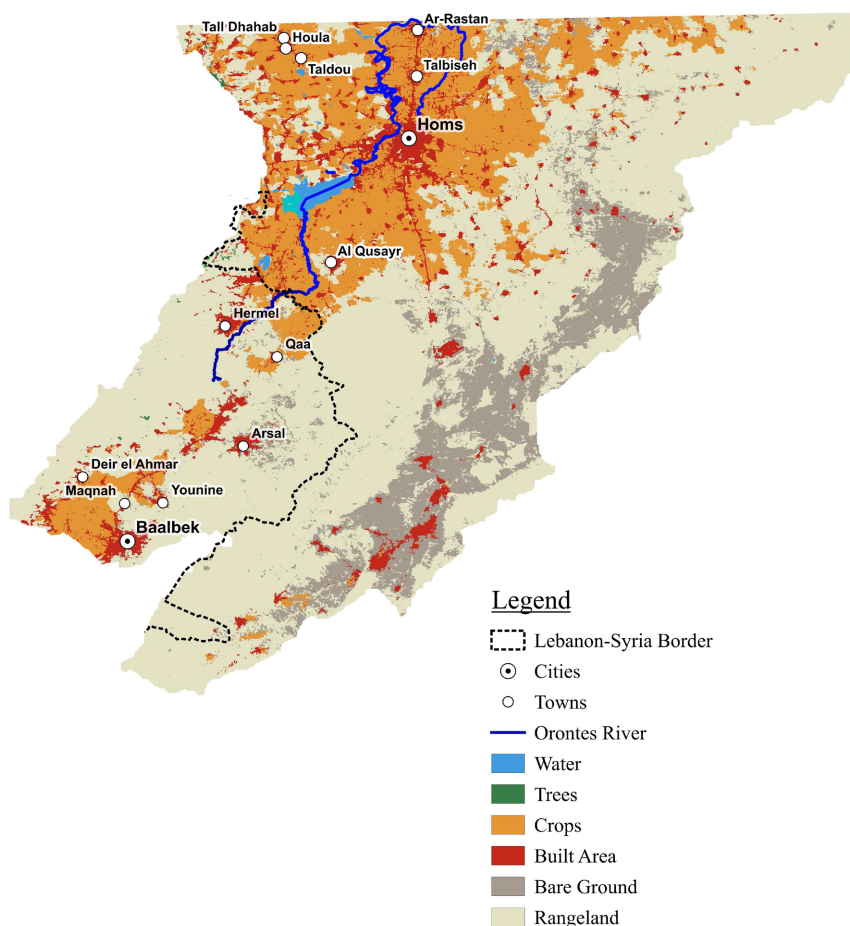


Figure 1. Orontes Basin land use detail—Lebanon and Syria south of Ar-Rastan [map]. Note that this figure contains total crop coverage—both rainfed and irrigated. Data layers: Esri, Microsoft, and Impact Observatory: Sentinel-2 10 m Land Use; OpenStreetMap QuickOSM [computer files]. Salt Lake City, UT, USA: Generated by Christopher Peterson, October 16, 2022. Using: QGIS—64 Bit [GIS]. 3.16.16-Hannover.

³The Litani is the largest river in Lebanon. According to the Lebanese Ministry of the Environment (2001), the Nahr Ibrahim's annual flow is 508 MCM, and the Orontes' is 480 MCM; Bakalowicz (2009) gives a figure for the annual flow of the Ibrahim of 319 MCM and 656 MCM for the Orontes. See "Lebanon's Second National Communication to the United Nations Framework Convention on Climate Change" (Republic of Lebanon—Ministry of Environment, February 2011), 9, https://unfccc.int/sites/default/files/resource/lebanon_snc.pdf.

the 1994 Agreement allocating the former 80 MCM of the 403 MCM as measured at the Hermel Bridge gauge. If the flow at this gauge is measured to be below 403 MCM, Lebanon's share is to be reduced by a percentage equal to the percentage decrease in flow at the Hermel Bridge gauge. As noted by Comair and Scoullas (2015), the 1994 contains several weaknesses as it was signed when Lebanon was under Syrian occupation [6]. In 1997, the "Annex to the Agreement on the Distribution of the Assi River Springing from Lebanese Territory"⁴ was added to the 1994 Agreement, allowing for the exclusion of several subbasins in Lebanon from the agreement: Labweh, Yammoune, Orgosh, Joubab al Homr, and Marjhine. A further amendment was made in 2002,⁵ resulting in Lebanon being allocated an additional 16 MCM of groundwater (for a total allocation of 96 MCM) and Syria blessing the construction of two dams on the Lebanese portion of the watercourse [6].

In spite of these adjustments, it is questionable if the agreements signed between Lebanon and Syria during this era can be considered equitable. Indeed, according to Makdisi (2001), "Syria... essentially dictated the terms within which Lebanon agreed" to the 1994 Agreement and 1997 Annex [11], and the reality remains that the final amendment in 2002 was made when Lebanon was still under Syrian occupation.⁶ The contrast in the amounts allocated to the two riparians can quite literally be seen from space: **Figure 2** on the following page

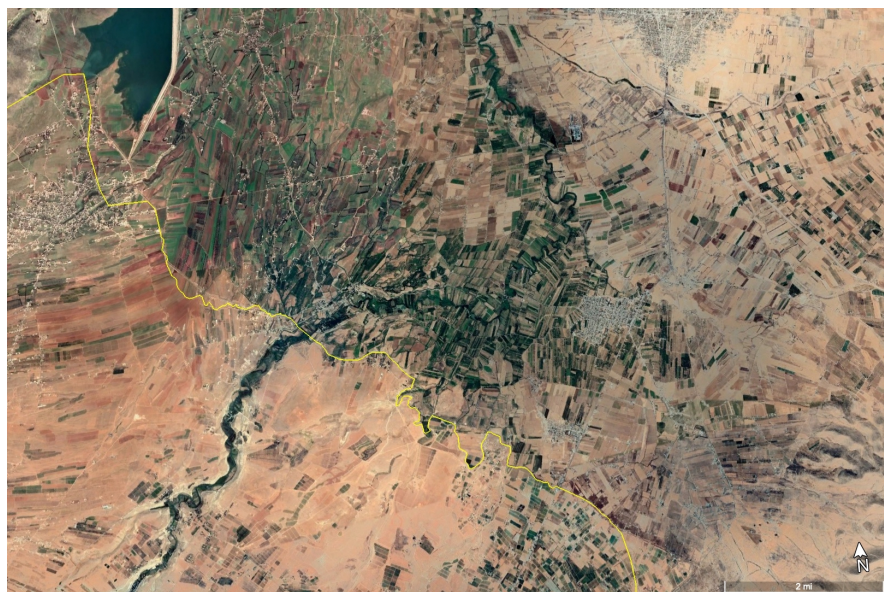


Figure 2. Google Earth Pro 7.3.4.8642. (May 2021). Lebanon-Syria border detail. 34°27'11.43"N, 36°29'30.34"E, Eye alt 11.56 mi. Maxar Technologies, CNES/Airbus 2022. < <https://www.google.com/earth/versions/> > (Accessed October 16 2022).

⁴Hereinafter, "The 1997 Annex."

⁵Hereinafter, "The 2002 Agreement."

⁶This article uses the term "occupation" in a broad sense, acknowledging that various elements within Lebanon welcomed the Syrian presence. Furthermore, the 1991 "Treaty of Brotherhood, Cooperation, and Coordination" signed between the two countries legitimized Syria's presence in Lebanon. In spite of this, other elements of Lebanese society strongly decried Syria's activities.

shows a sharp increase in the number of irrigated areas immediately after the Orontes crosses the border from Lebanon into Syria. If both countries are to consider the flows of the Orontes to be of “mutual benefit,” as stipulated by Article 1 of the 1994 Agreement,⁷ how might such a clear disparity in usage patterns be explained?

A cursory reading of these treaties would imply that Syria's allocation would be 403 MCM minus Lebanon's 96 MCM allocation—*i.e.*, 307 MCM. However, as will be shown in this article's subsequent section, Syria may be making ground-water abstractions significantly beyond this figure. Importantly, the treaties only rely upon surface water measured at the Hermel Bridge gauge to determine allocation; however, groundwater is mentioned in the treaties and allocation is intermixed with surface water. As will be shown, this is a major flaw found within all three treaties.

3. Consumption Estimate

The exchange of accurate and quality data is crucial for any transboundary agreement to function properly. As noted by Lins (2008), “...what may be the most critical burgeoning challenge associated with water resources has received relatively minor attention, *i.e.*, ensuring the adequacy, consistency and long-term maintenance of high-quality hydrological observations” [12]. However, previous research has shown that there is an acute lack of data on the Orontes Basin. For the years that data are available, many are not consecutive and rarely overlap [10]. In addition, groundwater data are almost non-existent. Finally, even if data exists, consistent measuring techniques may not have been used. As a result of the lack of accurate and consistent data, a simple consumptive use technique will be used to determine water use within the two countries. Two statistics are necessary for this technique: irrigated hectares and water demand.

A 2016 study by Jaafar *et al.* surveyed cropland in Lebanon's Litani and Orontes River Basins. The most recent of its kind in the Lebanese portion of the Orontes Basin, the study surveyed approximately 1500 fields within these two neighboring river basins. The authors of the study analyzed Landsat and Sentinel-2 scene files of the Bekaa Valley with GIS software, classifying them by type, and ultimately concluding that the Lebanese portion of the Orontes Basin contains approximately 13,800 hectares of irrigated cropland [13]. This figure, however, includes the areas that are exempt from counting towards Lebanon's allocation as per the terms of the 1997 Annex. Peterson (2022) estimated the sizes of the four areas' respective irrigated areas to be 3713 hectares. When subtracted from the abovementioned 13,800-hectare figure, this results in a figure of 10,087 [9]. For Syria, Peterson (2022) used a land use map based on 2010 data from Jaubert (2014) [14], concluding that the area south of Ar-Rastan has approximately 84,460 hectares of irrigated areas [9].

Finally, an estimate of water usage is made following the techniques described

⁷“يعتبر [لبنان وسوريا] ان مياه نهر العاصي...هي ذات منفعة مشتركة”.

by Pica (1997) [15]:

$$CU_L = I_L * D/E - R \quad (1)$$

$$CU_S = I_S * D/E - R \quad (2)$$

where: CU_L is Lebanon's consumptive use; CU_S is Syria's consumptive use; I_L is Lebanon's irrigated hectares; I_S is Syria's irrigated hectares; D is demand; E is efficiency; and R is return. Following Jaafar, D is 0.655 meters, E is 0.6, and R is $0.2 * I * D/E$.⁸ Obviously, demand, efficiency, and return will likely vary significantly depending on crop type irrigation schedule, soil types, etc. However, it is likely that in the aggregate, errors will be relatively small since both countries grow similar crops, have similar irrigation techniques, and have a similar climate. The calculation yielded 88 MCM for Lebanon and 739 MCM for Syria south of Ar-Rastan. The relevant information is displayed below in **Table 1**.

As can be seen, Syria's estimated consumption is vastly larger than the implied 307 MCM from the finalized 2002 Agreement, suggesting that the country is making intensive groundwater abstractions. Further proof of these abstractions is given by Saadé-Sbeih *et al.* (2018), who show a vast increase in the number of wells in the Syrian portion of the Orontes Basin south of Ar-Rastan (>10 wells/100 hectares) compared with the Lebanese portion of the basin (approx. 1 - 5 wells/100 hectares) [16]. In addition, using NASA GRACE (gravity recovery and climate experiment)⁹ data, Lezzaik (2016) provides further confirmation of intensive abstractions in the Syrian portion of the Orontes Basin in the period between 2003-2014 [17].

4. Discussion

This article suggests that these intensive groundwater abstractions in the Syrian portion of the Orontes Basin are evidence of two inherent and interrelated flaws contained within these three treaties: first, that none make mention of an explicit allocation of water to Syria, and second, that there were no limits placed on the number of wells constructed prior to the September 1994 cutoff date, nor how much water can be abstracted from these wells. Two phenomena can be seen here: first, Syria is likely extracting significantly more groundwater than the basin

Table 1. Irrigated hectares and annual consumption estimates.

Country	Irrigated Hectares	Annual Consumption Estimate (MCM)
Lebanon (ex. subbasins mentioned in 1997 Annex)	10,087	88
Syria (south of Ar-Rastan)	84,460	739
Total	94,547	827

⁸See Jaafar *et al.*, *Water Resources within the Upper Orontes*, 21.

⁹See "About the Product," NASA Grace, accessed September 19, 2022, <https://nasagrace.unl.edu/About.aspx>.

can recharge; and second, the basin yields significantly more water than the 403 MCM accounted for in the treaty, implying that Lebanon's share should be larger. It is likely that both of these are occurring at the same time—*i.e.*, they are not mutually exclusive.

It is critical that the groundwater abstractions do not occur beyond the aquifer's recharge rate. This will mean ensuring the quality and availability of groundwater data and ensuring the sharing of data amongst riparians. High-quality, long-term data are needed to ensure groundwater modeling is accurate and calibrated correctly and therefore has the ability to predict future groundwater levels. If these intensive Syrian groundwater abstractions occur at a rate beyond the aquifer's recharge rate, they will negatively affect the ability of Syrians and Lebanese to make use of the Orontes Basin's water, a development that would be undoubtedly inequitable to future generations within the two countries.

An additional layer of complexity is found when we consider where the primary recharge areas of the aquifer are located. As shown by Saadé-Sbeih *et al.* (2018), the vast majority of the groundwater south of Ar-Rastan is "generated" in recharge areas falling within Lebanese territory [17]. The Syrian party can be seen as excessively consuming groundwater that is primarily flowing from Lebanon. It is therefore posited that in order for these treaties to be considered fair and equitable, an explicit allocation of groundwater needs to be added to the treaty.

In the early 1990s, a joint committee for the management of the Orontes was formed between Syria and Lebanon, under which two subcommittees operate: the Subcommittee for River Protection and Environmental Preservation, and the Subcommittee for the Expropriation of Lands in the Vicinity of the Zeita Canals [18]. Three subcommittees operate under the former; while it is beyond the scope of this article to discuss all of them, one is particularly relevant—the Committee on River Hydrology. This committee is tasked with exchanging river data, as well as the supervision of infrastructure and wells. These committees are supposed to meet every month in Syria or Lebanon to discuss the issues in their jurisdiction [18]. It is unclear if this is the true frequency upon which they meet, as this has likely been affected by the ongoing Syrian civil war and Lebanese economic crisis; however, this article suggests two courses of action be taken. First, that these committees focus on the area south of Ar-Rastan, due to the reasons previously mentioned. Second, that they determine whether the intensive groundwater abstractions ongoing in Syria are occurring beyond the aquifer's recharge rate. This could be accomplished by establishing continuous groundwater data in the area south of Ar-Rastan as well as focusing on hydrological modeling in this area.

5. Conclusion

This article has shown the 1994, 1997, and 2002 Agreements between Lebanon and Syria do not sufficiently account for groundwater use. As a result, it suggests that there is something of a "loophole" in the treaties that is being exploited by

Syria, resulting in intensive groundwater abstractions. Such withdrawals are liable to lead to a steady depletion of groundwater in the Orontes Basin. In order to mitigate this, the following steps are necessary: 1) it is critical that groundwater data be increased in both quality and quantity, and that these data be shared evenly amongst the basins' riparians; 2) the aquifer's recharge rate must be determined; and 3) groundwater must be accounted for in an agreement between both nations. This will undoubtedly lead to an atmosphere of greater equity across the basin by ensuring that future generations in Lebanon and Syria alike do not suffer future consequences from the current abstractions of groundwater.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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