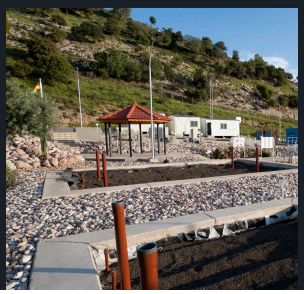
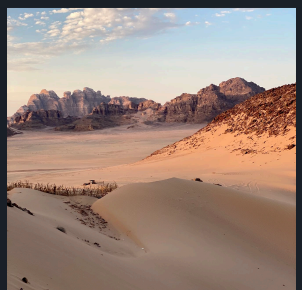
Influx of Syrian Refugees in Jordan | Effects on the Water Sector

February, 2021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Influx of Syrian Refugees in Jordan | Effects on the Water Sector

Helmholtz Centre for Environmental Research – UFZ

Ministry of Water and Irrigation

Influx of Syrian Refugees in Jordan |

Effects on the Water Sector

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NICE
National Implementation Committee for Effective Integrated Wastewater Management

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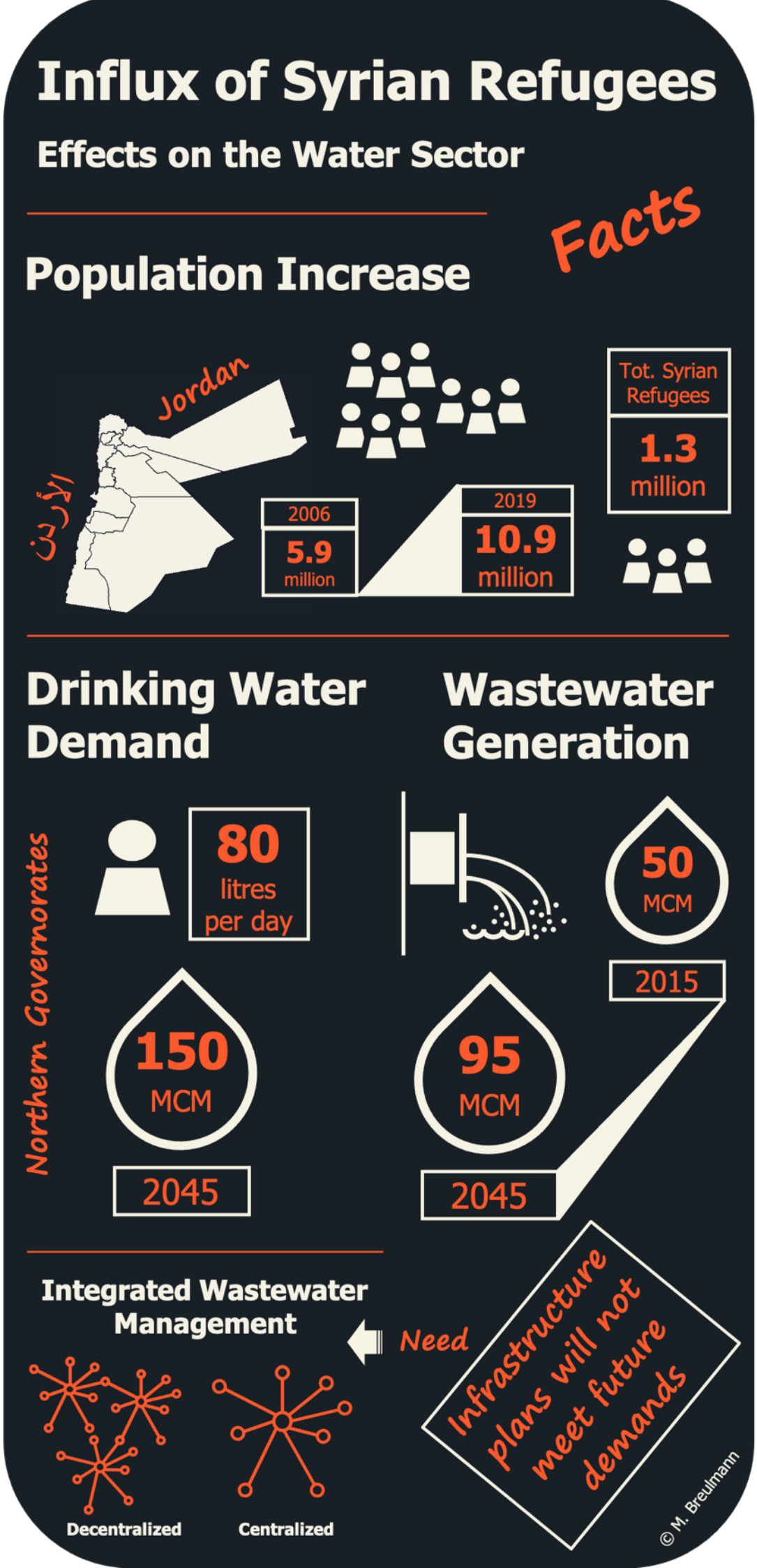
List of Acronyms

Abbreviation	Specification
AFD	Agence Française de Développement,
CU5	Children Under 5
CWWTP	Centralized Wastewater Treatment Plant
GPS	Global Positioning System
JRP	Jordan Response Plan
JS	Jordanian Standard
JVA	Jordan Valley Authority
KAC	King Abdullah Canal
NICE	National Implementation Committee for Effective Integrated Wastewater Management
NRW	Non-Revenue Water
MCM	Million Cubic Meter
MEAN	Middle East and North Africa
MoEnv	Ministry of Environment
MoH	Ministry of Health
MoPIC	Ministry of Planning and International Cooperation
MWI	Ministry of Water and Irrigation
SDG	Sustainable Development Goal
TWW	Treated Wastewater
UN	United Nations
UNHCR	United Nations High Commissioner for Refugees
USD	Unites States Dollar
WAJ	Water Authority of Jordan
WFP	World Food Programme
WUA	Water User Association
WWTP	Wastewater Treatment Plant
YWC	Yarmouk Water Company



Box 1 General facts about the influx of Syrian refugees on the water sector of the Hashemite Kingdom of Jordan.

Summary

Jordan is burdened by an extreme scarcity of water and the challenges related to this have been aggravated by an influx of refugees since the year 2013. The total number of registered and unregistered Syrian refugees is estimated to be around 1.3 million. The majority of Syrian refugees in Jordan, about 84%, live in urban areas and it's highly likely that the majority will remain in Jordan. The Syrian refugees were, and still are, highly vulnerable and they continue to struggle - especially with: high housing rental prices; sourcing income-generating activities; overcrowding of public sector services such as education and health; and competition over resources, such as water.

The tense water situation in Jordan was already apparent long before the influx of Syrian refugees. The population growth due to refugees from Palestine, Lebanon and Iraq, as well as droughts, trans-boundary tensions over water resources, water mismanagement and an inefficient agricultural sector, have all been identified as the main issues affecting the water sector (Hussein et al., 2020).

Today, however, the effects are even more apparent than ever before. In particular, the Northern Governorates Irbid and Mafraq have been affected by the influx of Syrian refugees where the population increase has caused a significant additional demand for water, resulting in local water shortages and, ultimately, enormous pressures on the sewage network and wastewater treatment plants.

The old distribution networks were not built to support the vast increase of the population. Additional stresses on the existing water infrastructure require urgent repairs and maintenance of water pumping stations, and renovation of wastewater treatment plants in order to prevent further contamination of the water supply.

The overall demand for water has increased by 40% in the Northern Governorates in the last few years as a direct result of hosting Syrian refugees. However, the frequency of water supply in some locations has decreased from once a week to once every four weeks. It has been calculated that the expected water demand and wastewater generation will almost double by the year 2045, if all the Syrian refugees stay in Jordan.

Apart from that the presence of the Syrian refugees is directly related to the securing of large amounts of humanitarian aid and infrastructure investments.

Water is often considered a public good rather than a commodity, and water theft is one of the main issues being addressed by the Jordanian Government (Baylouny and Klingseis, 2018). Groundwater is the main source of freshwater. However, more than 50% of the total groundwater abstraction is considered

unsustainable due to overexploitation or abstraction from nonrenewable fossil aquifers (Breulmann et al., 2020b). Furthermore, the indirect disposal of untreated wastewater through cesspools or leaking sewer systems has further threatened the quality of Jordan's scarce groundwater resources. Moreover, competition among the domestic, agricultural and industrial sectors seriously jeopardizes water sustainability.

Another controversial point is that although the agricultural sector's water requirements accounts for around 52% of national water needs, it contributes only 3% – 4% to gross domestic production (Breulmann et al., 2020b). Moreover, aside from the fresh water supply, the issues of wastewater and sewage treatment are one of the most prominent issues in the water sector in general. Complaints against local water companies have significantly increased due to clogged sewage systems which led to a public outcry in 2013 (Baylouny and Klingseis, 2018).

Overall, we can say that the Syrian refugees did not create the water scarcity in Jordan; however, it has clearly been exacerbated by their presence. Indeed, it could be said that the influx of Syrian refugees has exposed the inherent deficits of the Jordanian water infrastructure and its mismanagement.

The Jordanian Ministry of Water and Irrigation (MWI) has therefore conducted various large and costly studies during recent years in order to secure water supplies and wastewater treatment for the future. It has focused principally on sub-urban and urban areas of the Irbid Governorate, which has had the highest influx of Syrian refugees. However, little has been achieved so far.

The Jordanian government is in a dilemma. The potential costs are enormous. It's already obvious that the intended investments will not meet future demands and solutions need to be implemented immediately. If current water management practices continue without change, many aquifers will soon be lost: they will either dry out, become too saline, or become polluted. With this clear investment backlog, traditional decision pathways of conservative planning must be left behind and regionally adapted concepts for the future need to be implemented. For example, an integrated wastewater and water management approach and the implementation of semi- and decentralized wastewater treatment systems will assist in mitigating extreme water scarcity and protect groundwater resources in Jordan.

Technological changes are clearly needed for the long-term in order to mitigate the problems within the water sector. However, these will only result in positive outcomes if institutional changes are initiated through the political will of the Jordanian government.

الملخص

إن الأردن يعاني من مشكلة شح المياه الشديدة، و بسبب تدفق اللاجئين منذ عام 2013 ازدادت التحديات المتعلقة بمشاكل ندرة المياه.بحيث يقدر إجمالي عدد اللاجئين السوريين المسجلين وغير المسجلين بحوالي 1.3 مليون لاجيء حيث أن ما يعادل 84٪ من اللاجئين السوريين في الأردن يعيشون في المناطق الحضرية ومن المرجح أن تبقى الأغلبية منهم في الأردن. لقد عانى اللاجئون السوريون ولا يزالون مستضعفين للغاية وذلك بسبب ارتفاع أسعار إيجارات المسكن؛ و تحديد مصادر للدخل؛ و اكتظاظ خدمات القطاع العام مثل التعليم والصحة؛ والتنافس على الموارد، مثل المياه.

إن أزمة الوضع المائي الراهن موجودة من قبل قدوم اللاجئين السوريين بفترة طويلة. حيث سبقها العديد من الأزمات والتي كان لها دور كبير في التأثير على قطاع المياه مثل النمو السكاني الناتج عن اعداد اللاجئين من فلسطين ولبنان والعراق، فضلاً عن مواسم الجفاف والنزاعات على الموارد المائية العابرة للحدود وسوء إدارة المياه والقطاع الزراعي غير الفعال (Hussein et al., 2020).

أصبح لهذه التأثيرات اليوم اثرا واضحًا أكثر من أي وقت مضى. فعلى وجه الخصوص، تأثرت المحافظات الشمالية إربد والمفرق بتدفق اللاجئين السوريين حيث تسببت الزيادة السكانية في زيادة الطلب على المياه بشكل كبير، مما أدى إلى نقص المياه المحلية، وبالتالي احدثت ضغوطات هائلة على شبكة الصرف الصحي ومحطات معالجة مياه الصرف الصحي.

لم تستوعب شبكات التوزيع القديمة الزيادة الهائلة في أعداد السكان والتي بدورها شكلت ضغوطات اضافية على البنية التحتية الحالية للمياه ومما دفع القطاع الى إصلاحات عاجلة وصيانة لمحطات ضخ المياه، والعمل على إعادة تأهيل محطات معالجة مياه الصرف الصحي من أجل منع المزيد من تلوث إمدادات المياه.

زاد الطلب الإجمالي على المياه بنسبة 40٪ في المحافظات الشمالية في السنوات القليلة الماضية كنتيجة مباشرة لاستضافة اللاجئين السوريين. مما ادى الى انخفاض معدل تزويد المياه في بعض المواقع من مرة واحدة في الأسبوع إلى مرة كل أربعة أسابيع. وتشير التقديرات أنه في حال بقاء اللجوء السوري بالنسب الحالية فإن كميات الطلب المتوقع على المياه وإنتاج مياه الصرف الصحي سوف يتضاعف بحلول عام 2045.

كان ذلك دافعا الى العديد من الدول الصديقة والمجاورة لمد يد العون للشعب الاردني من خلال المساعدات الانسانية والقيام ببعض الاستثمارات المتعلقة بالبنية التحية بسبب تجاوز القدرات المالية للأردن.

وتعتبرقضية الاعتداء على مصادر المياه إحدى القضايا الرئيسية التي تعالجها الحكومة الأردنية والتي كان لها الأثر الكبير على مصادر المياه وأثمانها (Baylouny et al., 2018). وتعتبرالمياه الجوفية المصدر الرئيسي للمياه العذبة. ولكن، أكثر من 50٪ من إجمالي استخراج المياه الجوفية يعتبرغير مستدام بسبب الإفراط في الاستغلال أوالاستخراج من طبقات المياه الجوفية الأحفورية غير المتجددة (Breulmann et al., 2020a).

علاوة على ذلك، فإن التخلص غير المباشر لمياه الصرف الصحي غير المعالجة من خلال الحفر الامتصاصية أو أنظمة الصرف الصحي المنفذة قد زاد من خطورة تعرض نوعية موارد المياه الجوفية الشحيحة في الأردن لخطرالتلوث. عدا، عن استخدامها بين القطاعات المنزلية والزراعية والصناعية الذي بدوره يشكل تهديدا بشكل خطيرعلى استدامة المياه. نقطة أخرى مثيرة للجدل هي أنه على الرغم من أن متطلبات المياه للقطاع الزراعي تمثل حوالي 52٪ من الاحتياجات المائية الوطنية، إلا أنها تساهم بنسبة 3٪ - 4٪ فقط في إجمالي الإنتاج المحلي (Breulmann et al., 2020a) بغض النظر عن إمدادات المياه العذبة، فانه و بشكل عام تعد قضايا الصرف الصحي ومعالجة مياه الصرف الصحي من أبرز القضايا في قطاع المياه.ولقد زادت الشكاوى ضد شركة المياه المحلية (شركة مياه اليرموك) بشكل كبير بسبب انسداد أنظمة الصرف الصحي مما أدى إلى احتجاج شعبي عام 2013 (Baylouny et al., 2018).

لم يكن اللجوء السوري السبب الرئيسي في مشكلة ندرة المياه في الأردن. ولكن، تفاقمت بسبب وجودهم بشكل واضح. حيث يمكننا القول إن تدفق اللاجئين السوريين كان سببا في زيادة الحمل والعبء على شبكات المياه والصرف الصحي مما أدى الى ظهور عيوبها بسبب تجاوز السعات التصميمية للشبكات كشف عن النقص والعيوب في البنية التحتية للمياه وسوء إدارتها. لذلك أجرت وزارة المياه والري العديد من الدراسات الكبيرة والمكلفة خلال السنوات الأخيرة من أجل تأمين إمدادات المياه ومعالجة مياه الصرف الصحي في المستقبل. وقد ركزت بشكل أساسي على المناطق الحضرية وشبه الحضرية في محافظة إربد، والتي شهدت أكبر نسب تواجد للاجئين السوريين. ولكن، لم يتحقق الكثير حتى الآن.

إن الحكومة الأردنية في مأزق. حيث أن التكاليف المحتملة هائلة ومن الواضح ايضا أن الاستثمارات المقصودة لن تلبي المتطلبات المستقبلية ويجب تنفيذ الحلول على الفور. إذا استمرت ممارسات إدارة المياه الحالية دون تغيير، فسيتم خسارة العديد من طبقات المياه الجوفية قريبًا: إما أن تجف أو تصبح شديدة الملوحة أو تصبح ملوثة. مع هذا التراكم الاستثماري الواضح، يجب ترك مسارات القرار التقليدية للتخطيط المحافظ وراء الركب وتنفيذ المفاهيم المتكيفة إقليمياً للمستقبل. على سبيل المثال، سيساعد نهج الإدارة المتكاملة للمياه العادمة والمياه وتنفيذ أنظمة معالجة مياه الصرف شبه المركزية واللامركزية في التخفيف من ندرة المياه الشديدة وحماية موارد المياه الجوفية في الأردن.

من الواضح أن التغييرات التكنولوجية ضرورية على المدى الطويل من أجل التخفيف من المشاكل داخل قطاع المياه. لكن، لن يؤدي ذلك إلى نتائج إيجابية إلا إذا تم إحداث تغييرات مؤسسية من خلال الإرادة السياسية للحكومة الأردنية.

1. Introduction

According to a report published in 2019 by the World Resource Institute currently 17 countries face "*extremely high*" levels of water stress, where agriculture, industries and municipalities withdraw more than 80% of available water resource every year[1].

The country Jordan ranks fifth in the nations that face the greatest water stress (**Figure 1**[2]).

Jordan has one of the lowest levels of water availability per capita in the world (100 m^3), which is far below the global threshold for severe water scarcity (500 m^3) and, as such, is constantly being challenged by water shortages (Breulmann et al., 2020b; Halalsheh et al., 2018). The country burdened by extreme water scarcity, a factor which has always been one of the biggest barriers to the country's economic growth and development.

Challenges related to water scarcity have been aggravated by an influx of refugees, which is related to ongoing political unrest in the region. Water scarcity challenges are furthermore exacerbated by worsening drought conditions associated with climate change.

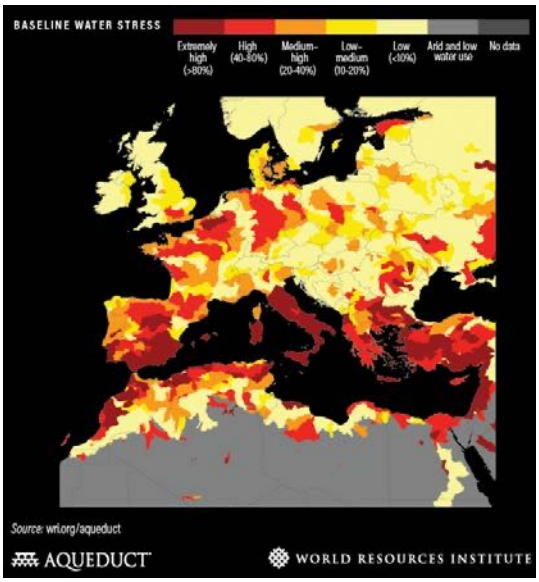


Figure 1 Water stress in Europe and the MENA Region. Adopted from: The World Resource Institute[3].

1.1 Hosting Syrian Refugees

Largely since 2013, Jordan has experienced a massive influx of Syrians who have fled civil war. According to UNHCR[4] about 324,000 Syrian refugees registered in 2013, which had increased to 744,721 registrations by the end of 2019 (**Figure 2**). Estimates of the total

[1] *www.wri.org/blog/2019/08/17-countries-home-one-quarter-world-population-face-extremely-high-water-stress*
[2]
[3] *www.wri.org/blog/2019/08/17-countries-home-one-quarter-world-population-face-extremely-high-water-stress*
[4] *ttps://data2.unhcr.org/en/situations/syria/location/36*

number of refugees vary between different reports (UNHCR, 2018a; b), however, the overall total number (registered and unregistered) is estimated to be around 1,330,000 (UNHCR, 2019). This makes Jordan second only to Lebanon as being the world's highest per capita refugee hosting country (UNHCR, 2018a). In Lebanon, one out of five, while in Jordan one out of 15 is a refugee (UNHCR, 2019). Over recent years the number of refugees has remained constant due to stricter entry criteria, since Syrians need to register with the Ministry of Interior and UNHCR (JIF, 2018). In general, the majority of Syrian refugees in Jordan, about 84%, live below the poverty line in urban areas where they contribute to significant population increases and add pressure to the various service sectors (UNHCR, 2018a; 2019).

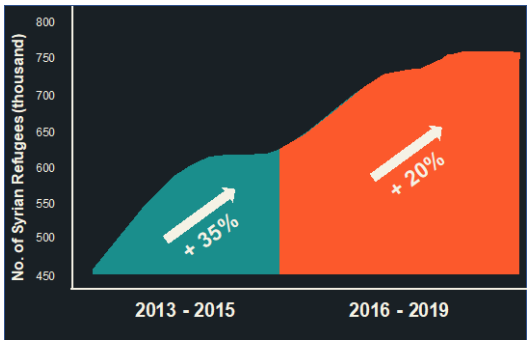


Figure 2 Registered Syrian refugees in Jordan from 2013 – 2019 (Source: UNHCR).

A 'Host Community' is defined as follows: "[…] A host community in this context refers to the country of asylum and the local, regional and national governmental, social and economic structures within which refugees live. Urban refugees live within host communities with or without legal status and

Box 2 Definition of the term '*Host Communities*'. Source: UNHCR[5].

Although in October 2018 the '*Jaber-Nasib*' border crossing between Jordan and Syria reopened, only a small number returned to Syria and it is highly likely that the majority will remain in Jordan (UNHCR, 2018b).

A survey conducted by NAMA Strategic Intelligence Solutions, in partnership with the Konrad Adenauer Stiftung, suggested that only a small proportion (approximately 14%) of the population is committed to return to Syria, while more than 50% are planning to remain in Jordan (Rosshandler, 2019). The living situation for Syrian refugees is still challenging although many of them have now been in the host country for four or more years. The vast majority of

[5]www.unhcr.org/protection/resettlement/4cd7d1509/unhcr-ngo-toolkit-practical-cooperation-resettlement-community-outreach.html

Syrian refugees have been integrated within host communities (see **Box 1**) in urban, peri-urban and rural areas. However, they continue to suffer increasing vulnerability and face high rates of poverty (UNHCR, 2019).

These high numbers of Syrian refugees have put an enormous burden on Jordan. The direct cost of the Syrian Crisis to Jordan since 2011 has been calculated to be about 11 billion USD, which covers the costs of providing education, health, water, energy, sanitation and other services (MoPIC, 2019; Rosshandler, 2019).

In 2018 the Regional Refugee and Resilience Plan presented an integrated humanitarian and resilience response to the situation facing refugees and host communities with clear strategic directions guiding the coordination of overall regional responses, and responses at the country level (UNHCR, 2019). The Response Strategies in various sectors addressed such areas as protection, food security, education, health and nutrition, basic needs, shelter, WASH, livelihoods, and social cohesion (UNHCR, 2019). The Northern Governorates in particular, such as Irbid and Mafraq, have received large numbers of Syrian refugees accounting for up to 19% of the entire governorates' populations in Irbid and 38% in Mafraq **(Table 1**, **Figure 3**).

Most of the Syrian refugees in the north originated from Dar'a (47%), Homs (32%) and Rural Damascus (8%) (MercyCorps, 2013).

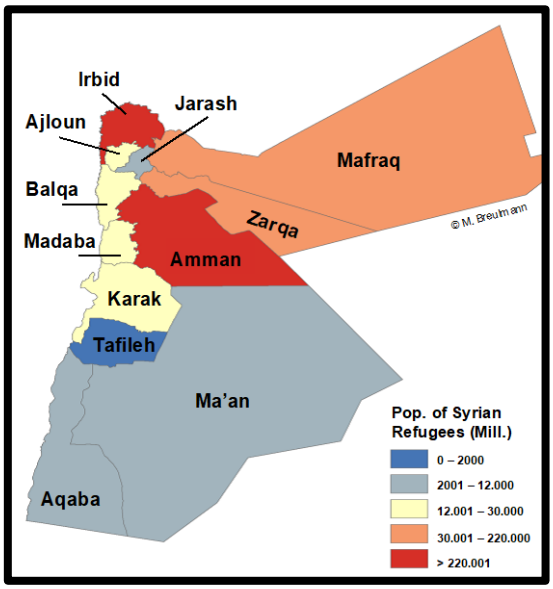


Figure 3 Distribution of the numbers of registered Syrian refugees in Jordan for the year 2017.

This population increase has affected public services for all, particularly the quality and availability of education, and the decline of healthcare through an overburdening of facilities (Carrion, 2015; Muller et al., 2016). It has furthermore caused a significant increase in the demand for water, associated with increased local water shortages, thus putting enormous pressures on the sewage network and wastewater treatment plants (Alshoubaki and Harris, 2018; Carrion, 2015). For example, in both Mafraq and Ramtha, water, education and health services emerged as

increasingly urgent needs for the residents (MercyCorps, 2013).

Table 1 Distribution of Syrians in Jordan for the year 2017 (Source: Department of Statistics).

Gov.	Jordanian	Syrians	Others	Total without Syrians	Total	Jordanian (%)	% of Syrians	Others (%)
Amman	2,626,310	459,400	1,072,647	3,767,300	4,226,700	62.1%	**10.9%**	25.4%
Zarqa	949,450	184,863	280,486	1,254,637	1,439,500	66.0%	**12.8%**	19.5%
Balqa	407,991	29,512	70,441	489,088	518,600	78.7%	**5.7%**	13.6%
Madaba	161,186	15,468	18,702	184,032	199,500	80.8%	**7.8%**	9.4%
Irbid	1,353,392	362,270	116,082	1,504,730	1,867,000	72.5%	**19.4%**	6.2%
Mafraq	322,934	219,264	29,405	360,736	580,000	55.7%	**37.8%**	5.1%
Ajloun	161,553	15,288	4,664	170,412	185,700	87.0%	**8.2%**	2.5%
Jarash	172,450	11,461	61,630	238,539	250,000	69.0%	**4.6%**	24.7%
Karak	280,082	18,008	28,581	315,892	333,900	83.9%	**5.4%**	8.6%
Tafilah	92,643	2,040	4,484	99,560	101,600	91.2%	**2.0%**	4.4%
Maan	131,558	8,914	8,063	143,086	152,000	86.6%	**5.9%**	5.3%
Aqaba	138,806	8,228	47,806	190,272	198,500	69.9%	**4.1%**	24.1%
Jordan	**6,798,357**	**1,334,717**	**1,742,991**	**8,718,283**	**10,053,000**	**67.6%**	**13.3%**	**17.3%**

Overall, housing, education, health and water emerged as the leading areas that municipal authorities need to manage in order to provide for the influx of refugees (MercyCorps, 2013).

In northern Jordan, four key macro-level drivers of tension between refugees and host communities have been identified (REACH, 2014a):

- Increase in housing rent prices.
- Competition for income-generating activities.
- Overcrowding of public sector services like education and health.
- Competition for resources, such as water.

— Housing

It has been shown that host communities, like Jordan, clearly benefit from the presence of refugees and the associated international aid they receive (Carrion, 2015).

For example, the increased housing demand has allowed owners to set higher rents (Carrion, 2015). Business owners have benefited from higher consumer demand and the availability of informal Syrian labour prepared to work for wages that would not be accepted by Jordanians.

When the influx of Syrian refugees to Jordan started, the MercyCorps had

already highlighted the increased cost of housing, competition over jobs, and the uneven distribution of aid as key sources of tension; however, although tensions were rising they had not erupted into violence (MercyCorps, 2013).

In particular, the tension over housing occurred since rental prices increased by up to six times the original rates, which has priced Jordanians out of their own housing and has taken advantage of the Syrians' circumstances (MercyCorps, 2013).

Due to these exorbitant prices, Syrians were often forced to accommodate as many as 20 people in one flat (MercyCorps, 2013). However, other sources report that the mean household size is 5.3 persons, which is the same as the average size found for Syrians in Jordan's 2015 population census, where only 4% of the households have 10 persons or more, and the median number of people sharing a single bedroom is 3.7 (Tiltnes et al., 2019).

The presence of many vulnerable Syrians struggling to afford their rent and other basic living costs presents a real challenge for Jordan. The support given is often not perceived as being distributed to those most in need, which creates confusion and tension among host and refugee communities alike because many people do not understand the decision-making framework being employed (Rosshandler, 2019).

The Government of Jordan has estimated that poverty rates range from 15% – 25% in the Northern Governorates and that essential services and resources - in particular that of access to adequate housing as one of the basic needs (JIF, 2018) – and others as mentioned above such as municipal services, education, prospects for income-generating opportunities, and access to water, all emerge as key drivers of tension at the macro-level (REACH, 2014a).

In general, it can be assumed that the majority of Syrian refugees in Jordan live in 'proper' houses. Apartments are far more common than traditional houses (so called dars), since they are more readily available and affordable in urban areas (Tiltnes et al., 2019).

Thus, about 96% of the Syrian refugees in Amman live in apartments, compared to only 45% in Mafraq, which has a more rural character, and where makeshift housing, often in the form of tents and huts, is not uncommon (Tiltnes et al., 2019).

Due to the considerable proportion of Syrian refugees in Mafraq who live in tents or huts, it is quite common for them to improvised forms of outside toilets, and/or that toilets are shared

among a number of households. By comparison, most apartments have their own sanitary facilities of a certain standard (Tiltnes et al., 2019). WFP and REACH (2016) described Syrian refugees residing in such informal housing as being in a particularly vulnerable position in the labour market, and experience food security levels that are below those of other refugees.

— Income and expenditures

Most Syrian refugee households are living below the Jordanian poverty line (Abu Hamad et al., 2017). The mean monthly household expenditures are approximately: rent 135 JD; energy 21 JD; food 120 JD; tap water 5 JD; bottled water 3 JD; transportation 10 JD; phone/mobile 10 JD; medical treatment 17 JD (Tiltnes et al., 2019).

The median yearly household income is also significantly lower in Mafraq at around 1,000 JD, and in other governorates, while it is around 3,000 JD in Amman, Irbid and Zarqa (Tiltnes et al., 2019).

It has been suggested that the partial economic inclusion of Syrian refugees could provide thousands of jobs for Jordanians and Syrian refugees over the coming years, especially in sectors where Jordanian participation is low and where we find a high ratio of foreign workers (e.g. construction, agriculture, service, industry, cleaning) (UNHCR, 2019).

According to MoPIC, 39,344 work permits had already been issued, between 1st January and 23rd November 2017 (UNHCR, 2019).

— Education

Since the beginning of 2017, the Ministry of Education in Jordan has successfully accommodated the double shift system in response to overcrowding in public schools (UNHCR, 2017a). Only about 54% of Syrian children below the age of 18 attend school, compared to 85% of Jordanian children, due to financial obstacles including the costs of school fees and transportation (CARE, 2018).

A third of Syrian refugee children are not in the correct grade for their age and Syrian schoolchildren also face verbal and physical harassment at school (CARE, 2018).

Core components within the educational sector, as identified by UNHCR (2017c), were (i) completion of formal education and missed schooling; (ii) children who are at risk of not completing their education (i.e. early ‘drop out’) and (iii) access to education.

— Health

The lack of free health care services for Syrian refugees outside of camps has widened the health inequalities between the two populations, and has affected Jordan's health and development indicators. Increasing the co-payments made by Syrian refugees has further increased their lack of access to proper health care since 41% of their income already goes towards medical expenses (UNHCR, 2017b).

Although the mortality rate among children under 5 (CU5) in Jordan is within Sustainable Development Goal (SDG) targets, the CU5 mortality rate among Syrian refugees is much higher which affects the country's overall indicator rate. Reproductive health indicators are also affected as the maternal mortality rate has also increased over recent years. Family planning statistics are poor, partly due to a lack of awareness within the refugee population, of services available in Jordan; this is compounded by their lack of financial stability and access to transportation. Displacement coping mechanisms within the refugee population have included early forced marriages, having more children, and having them earlier, which has also affected gender equality and women's and children's health indicators. This has retarded the recent progress made by Jordan in lowering birth rates, and improving nutrition and access to health (Okour et al., 2012).

The Syrian refugee population is also faced with higher rates of communicable diseases due to poor living conditions and gaps in immunisations, and as such, their communities have been placed at risk, as well as adding further pressure to the Jordanian health care system. This has had repercussions in immunisation coverage, where the percentage of children receiving all basic immunisations has decreased, and the percentage receiving no vaccinations at all has increased.

Jordan must move towards providing universal health care to all populations within the country in order to improve its health and development indicators against the SDGs.

— SARS-CoV-2 crisis

Another example highlights the dramatic situation of the Syrian refugees in Jordan, who are increasingly vulnerable, facing high rates of poverty (UNHCR, 2019) and are now additionally affected by the SARS-CoV-2/ Covid-19 crisis.

Low-income and marginalized communities are those most vulnerable

to the crisis. The strong measures (e.g. lockdown) implemented by the Jordanian government, as they declared a state of emergency in March 2020, have received praise domestically. However, although they might be necessary in light of the global health crisis, there is also a risk of significant collateral damage (Dhingra, 2020).

The strong measures, like travel restrictions within Jordan and across the border, have disrupted aid activities, threatened livelihoods and failed to consider the needs not only of the refugees but also of vulnerable Jordanians (Dhingra, 2020).

These travel restrictions have threatened the flow of international assistance that is critical for many refugees' daily lives.

Because the majority of Syrian refugees in Jordan live below the poverty line (UNHCR, 2018a; 2019) they do not have the economic means to stock up on supplies. Without any income the majority will be unable to purchase any necessities or pay rent during the lockdown.

Labor restrictions and disruptions to the flow of international aid for refugees and vulnerable host communities will have dramatic consequences which are only likely to worsen (Dhingra, 2020).

2. Water and Sanitation

At the beginning of the influx of Syrian refugees, Jordanians complained that the Syrians were not attentive to Jordan's water shortage problem – "*Syrians' cavalier attitude to water usage is partially responsible for the lack of water in the North*" (MercyCorps, 2013).

The insufficient water supply has led to frustration amongst the indigenous population since there exists a widespread belief among Jordanians that Syrians are not accustomed to rationing water (Hussein et al., 2020; REACH, 2014b) and that the quality of available water is likely to be degraded by Syrian refugees (Baylouny and Klingseis, 2018); however, this perceived threat has not been confirmed at all.

About 44% of Syrian refugee households consume bottled drinking water, and about 34% are connected to the public water network. It has also been reported that about 12% of households run out of water, at least once in a while, due to inadequate storage tanks or because either the landlord or water authority cut the supply (Tiltnes et al., 2019), however, the local Jordanian community is facing the same issues.

Most Syrian refugee households therefore rely on piped water or buy it from tanker trucks, as is the case in Mafraq, whereas only a few rely on other sources of water such as rainwater, wells and groundwater (Tiltnes et al., 2019).

A survey has assessed that 60% of Syrians are likely to be severely vulnerable in terms of water, sanitation and hygiene (WASH) services, which often remain unavailable or command exorbitant rates (Tiltnes et al., 2019; UNHCR, 2017c).

Concerning sanitation, 77 out of 88 sub-districts were categorized as 'highly to severely vulnerable' according to the sanitation vulnerability criteria of: poverty, coverage, wastewater treatment plant condition, network age, and Syrian vs. Jordanian population (MoPIC, 2019).

Nearly 90% of Syrian refugees have access to national water and sewage networks, including a regular water supply, with 20% experiencing wastewater overflows more than once during the previous year. The most vulnerable may not have safe (or sufficient) water storage (Tiltnes et al., 2019), and a number of challenges remain concerning the efficiency and

effectiveness of water and wastewater systems (MoPIC, 2019).

Water and sanitation vulnerabilities have clearly increased because of the refugee crisis, particularly in Jordan's Northern and Central Governorates.

The overall demand for water has increased by 40% in the Northern Governorates in the last few years as a direct result of hosting Syrian refugees, while the frequency of water supply in some locations has decreased from once a week to once every four weeks (MoPIC, 2019; REACH, 2014b). This has forced residents to resort to water rationing and the adoption of other coping mechanisms such as rainwater collection, purchasing water from private tankers, and digging wells.

The availability of water in Irbid, for instance, has not only fallen from 65 L to 50 L per person per day, which is well below the national objective of 100 L, but there has also been a marked increase in the number of households residing in unsafe housing which is not connected to the water network and is therefore dependent on water tankers (AFD, 2018).

The overall water infrastructure and piping networks are generally out-dated: often more than 50% of water is Non-Revenue Water (NRW) that is lost as a result of leakages, weak infrastructure, illegal consumption, and theft (Hussein, 2018; Hussein et al., 2020; MoPIC, 2019; REACH, 2014b).

The old but extant distribution networks were not built to support the vast increase of the population currently being experienced. Additional stress on existing water infrastructure requires the urgent repair and maintenance of water pumping stations and renovation of wastewater treatment plants to prevent further water supply contamination (Breulmann et al., 2020b; REACH, 2014b).

Water shortages, as mentioned earlier, are putting sewerage networks under stress, and compounding existing problems with solid waste management, so causing levels of sanitation to deteriorate (REACH, 2014b)

The quantity of water supplied per capita has been reduced, and the quality of water has also been perceived to have decreased, with concerns being raised over the contamination of water sources due to the presence and construction of more cesspits and septic tanks (Breulmann et al., 2020a; REACH, 2014b).

Finally, the Yarmouk and the Jordan rivers are shared with neighbouring countries, binding Jordanian usage to obligations under bilateral agreements, which must be fulfilled.

— Jordan Response Plan

In 2014 the Jordanian Government developed the first response plan (JRP) to the Syrian crisis in partnership with the United Nations (MoPIC, 2015). It represented a three-year program (2016-2018) of high priority interventions to enable the Kingdom of Jordan to respond to the effects of the Syrian crisis without jeopardizing its own development trajectory. The total cost of response interventions in the JRP over the period 2016-18 is about 8.0 Billion USD for refugee interventions, resilience-strengthening, and specific budget support needs (MoPIC, 2015). The JRP: 2016-18 aimed to meet the humanitarian needs of Syrian refugees and the Jordanian population. It also fostered the resilience and effectiveness of education, energy, health, justice, municipal services, social protection, and water and sanitation (MoPIC, 2015). About 750 Million USD were budgeted to ensure the provision of essential and sustainable WASH services such as: ensuring safe and equitable access to water services in camps while maintaining standards in host communities; upgrading and maintaining existing structures and where necessary developing new facilities; and developing technical capacity to ensure adequate numbers of staff are in place and receive appropriate training (MoPIC, 2015).

The second JRP to the Syrian crisis was developed for the years 2018-2020 (MoPIC, 2017) since there was a growing acknowledgment that the humanitarian funding and programming were neither sufficient nor sustainable, thereby requiring a more development-oriented approach to build resilience and reduce Jordan's dependency on humanitarian assistance over time (MoPIC, 2017). The aims of this resilience-oriented approach were to ensure that the impact of the crisis does not lead to lasting negative effects on the well-being of individuals, households, communities, institutions and systems, and to build national capacity in order to absorb future external shocks (MoPIC, 2017). The JRP: 2018-2020 was budgeted with a total of 7.3 Billion USD including 653 Million USD for the WASH sector.

However, the needs and requirements of Syrian refugees and Jordanian host communities have vastly outpaced the financial support received by the JRP: 2016-18 and JRP: 2018-20. The 2019 JRP was therefore developed as a one-year plan and the programmatic response and the subsequent budgetary requirements have been captured only for the year 2019 and allocated at 2.4 Billion USD including 229 Million USD for the WASH sector

(MoPIC, 2019). The strategic objectives remain similar to the JRP 2018-2020 given that the number and distribution of Syrian refugees in Jordan has not changed significantly over the past year and that international aid has fallen short of needs.

Because of this, a third JRP to the Syrian crisis was developed for the years 2020-22 (MoPIC, 2020). Due to the decreased funding in the past year, and although the situation in Syria might seem stable, neighboring countries are still suffering and the JRP 2020-22 should include more flexible, resilient and responsive structures. It aims to reduce pressure on Jordan as a host country and improve living conditions and self-reliance that will help to eliminate vulnerabilities and support Jordan in maintaining the quality of services provided for Syrian refugees.

The JRP: 2020-22 was budgeted with a total of 6.6 Billion USD including 483 Million USD for the WASH sector.

— The tanker business

One further form of water supply beside the public network is the transport and sale of bulk water from groundwater wells or surface bodies via tanker trucks.

Within the kingdom of Jordan four color-coded water tankers operate: green, blue, orange and black, each restricted to carry a specific designated grade of water.

- **Green** Tanker ➜ Drinking water.
- **Orange** Tanker ➜ Wastewater.
- **Blue** Tanker ➜ Non-Potable water.
- **Black** Tanker ➜ Industrial Water.

In general, either private businesses employ drivers of these tankers or they are operated by individual owner-drivers.

For example, the national body responsible for controlling drinking water and its Green Tankers is the Ministry of Health (MoH) which implements, in this respect, the 2017 Law of '*Control and Inspection of Economic Activities'* No. 33. To gain a licence for such a tanker one must apply to and receive an official approval (stamp / signature) from the Environmental Health Department within the district in which one lives. The Public Security Directorate (e.g. traffic department) will then provide the final license for the tanker.

In order to be approved, the 1953 "*Regulation for the Tanker for Drinking Water*"; Article (12) Industrial Law No. 16 has to be followed. This clearly

states that drinking water must only be received from private wells, which are certified by MWI and MoH; agricultural and governmental wells are not certified for selling drinking water.

The amount of water that may be taken by the tanker is not specified by the Government, nor is the price per cubic meter, which can therefore vary between districts.

The tankers are controlled and monitored by the MoH, but this does not follow a regular scheme. Nevertheless, under this ministerial control, the condition of the tankers can be tested and the level of chlorination checked, which must return a chloride concentration between 0.2 – 1.5 mg/L according to (JS 286, 2005). Due to security reasons and various violent incidents in the past, all MoH staff members conducting inspections are accompanied by the Royal Department for Environmental Protection (Rangers).

Should a tanker fail its MoH tests the Public Security Directorate is informed, who keep the tanker for about 1 – 2 weeks until it has satisfied inspection criteria and a fee of 200–250 JD has to be paid. Results of the monitoring are internally reviewed by the MoH and are not published.

Orange tankers for wastewater fall under the responsibility of the Ministry of Environment (MoEnv). The procedure of getting a licence for an orange tanker is similar to the one described above, the only difference being that the application has to be submitted to the MoEnv.

Photo 1 Orange tankers releasing their collected wastewater to a discharge point at a centralized wastewater treatment plant in Jordan (© Marc Breulmann).

Uncontrolled wastewater dumping by private tankers is threatening groundwater resources in Jordan (Breulmann et al., 2020a) and needs to be addressed by mapping such events (Melloni et al., 2013). Stricter control mechanisms were therefore implemented by installing GPS modules in orange tankers in order to track them and to make sure that the wastewater reaches the proper treatment plants.

For blue and black tankers no monitoring and control mechanisms exist. Blue tankers, for example, can receive their water from any well in Jordan, even from unlicensed ones. However, this also means that during the summer, when water is scarce and rationed in some rural areas, blue tankers often sell un-potable water to the green tankers who will then sell it on as drinking water. To receive a blue tanker-licence the same procedure as for a private car has to be followed.

— Ministry of Water and Irrigation

The official institutions in Jordan involved in the water sector are the Ministry of Water and Irrigation (MWI), the Water Authority (WAJ) and the Jordan Valley Authority (JVA).

The MWI was established in 1988 in response to Jordan's recognition of the need for a more integrated approach to national water management.

The MWI is responsible for overall national leadership on policy, strategic direction and planning of Jordan's water sector, in coordination with WAJ and JVA. Under By-law No. 14 of 2014, the MWI assumes full responsibility for water and public sewage and all related projects in Jordan. The MWI aims to upgrade, develop and regulate the water sector and enhance the quality of water services. It has a mandate to do the following: develop sectoral policies and strategies; endorse plans and programs related to water resources protection; implement international agreements; develop laws, by-laws, regulations and normative and technical standards; develop private sector partnerships; supervise the implementation of strategic plans and programs; and follow up on the performance of water companies and utilities. Since its establishment, the MWI has been supported by several donor organization projects that have assisted in the development of water policy and water master-planning as well as a restructuring of the water sector.

The Ministry of Water and Irrigation embraces the two most important entities dealing with water in Jordan:

- WAJ*:* is responsible for the operational management of the water sector, which includes bulk water supply and retail distribution where commercialization of distribution services has not occurred. WAJ is mandated for all operational functions of the water sector including: managing water and wastewater services; regulating construction and quality of service provision projects, operations and maintenance; monitoring all levels of sector services; and supervising the water utilities and water companies. WAJ continues to manage all contracts with the water companies, and both, WAJ and JVA recommend water service cost changes and capital projects, but the Cabinet has ultimate regulatory authority, especially for tariffs.

- JVA: is responsible for the socioeconomic development of the Jordan Valley. It primarily manages bulk water supply for irrigation, domestic and industrial purposes and promotes land development in the Valley. The JVA is also responsible for the following: water resources development; improving the environment, hydroelectric power, tourism, industry and other beneficial uses in the Valley; setting all necessary regulations to control the use of water in farm units, oversight of irrigation networks and agricultural roads networks; and the implementation of master and detailed plans for lands outside the planning authority of municipalities. The JVA has organized Water Users Associations (WUAs) in the Jordan Valley to encourage community and private sector participation in managing public resources and to provide services for its customers.

2.1 The Northern Governorates

Jordan has managed to provide approximately 67% of its population with a sewerage network (MWI, 2018). The rest of the population is served by onsite management systems, principally cesspools, from which unwanted infiltration of unpurified wastewater can lead to serious contamination of the groundwater (Breulmann et al., 2020a; Breulmann et al., 2020b).

The severe water scarcity effectively renders wastewater treatment and re-use an important option for preserving and extending available water supplies. The reuse of properly treated wastewater into national water resources management has clear benefits for public health, groundwater, the environment and economic development (Breulmann et al., 2020b). Treated wastewater (TWW) may provide a significant renewable and reliable water resource, and will help conserve existing sources of freshwater.

Furthermore, because TWW constitutes a valuable source of water and nutrients in agricultural schemes, it also has value in terms of reduced chemical fertilizer use and increased agricultural productivity. However, such benefits can only be realized if the Jordanian government takes appropriate and timely action to improve the current situation and overcome existing obstacles (Breulmann et al., 2020b).

— Wastewater treatment and reuse

As mentioned earlier, the Northern Governorates like Irbid and Mafraq have received large numbers of Syrian refugees whose presence has put severe strains on the infrastructure and its already scarce water resources.

A study by Muller et al. (2016) showed that the irrigated land area within the Yarmouk basin in southern Syria decreased by approximately 50% after the civil war. At the same time the reservoir storage in the Al-Wheda dam in the North of Jordan decreased by almost 50%. The immediate benefit of a reduced need for irrigation water was offset by the freshwater needs of thousands of Syrian refugees (Muller et al., 2016).

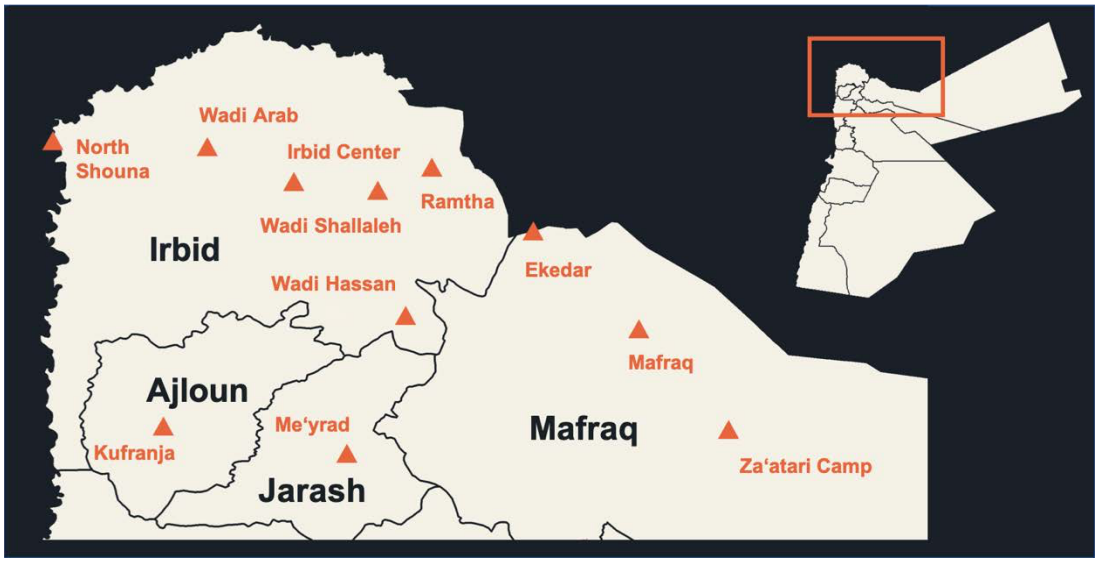


Figure 4 Locations of the centralized wastewater treatment plants in the Northern Governorates Irbid, Mafraq, Jarash and Ajloun.

There are currently 11 centralized wastewater treatment plants (CWWTPs) in the Northern Governorates with an overall design capacity of about 31.8 MCM/year (**Figure 4**).

The CWWTPs in the Northern Governorates actually treat 18.6 MCM wastewater per year, with only about 6.1 MCM/year being directly reused (Breulmann et al., 2020b) (**Table 2**). The remaining TWW, which corresponds to 11.6 MCM, is indirectly reused and discharged to wadis leading to the Jordan river (Breulmann et al., 2020b) (**Table 2**).

Table 2 Data on centralized wastewater treatments plants in the Northern Governorates of Jordan (Breulmann et al., 2020b; MWI, 2018). MCM: Million Cubic Meter.

Gov.	WWTP	Design capacity	Influent quantity	Effluent quantity	Reuse of Reclaimed Water		
					Irrigation	Forestry	Discharge to wadis
		MCM/ year					
Ajlun	Kufranja	3.1	1.3	1.2	1.0	0.2	0
Irbid	North Shouna	0.4	0.2	0.2	0	0	0.2
Irbid	Wadi Arab	7.7	4.6	4.5	0	0	4.5
Irbid	Irbid Center	4.0	3.0	2.9	0	0	2.9
Irbid	Ramtha	2.7	1.6	1.4	1.4	0	0
Irbid	Wadi Shallaleh	5.0	3.1	2.9	0	0	2.9
Irbid	Wadi Hassan	0.6	0.5	0.4	0.4	0	0
Jarash	Me'yrad	3.3	1.6	1.6	0.5	0	1.1
Mafraq	Za'atari Camp	1.3	0.5	0.5	0.5	0	0
Mafraq	Ekedar	1.5	0.8	0.7	0.7	0	0
Mafraq	Mafraq	2.2	1.4	1.4	1.4	0	0

MCM: Million cubic meter.

The CWWTPs seem to have been able to cope with the population increase and the associated increase in wastewater generation and are apparently functioning well within their design capacity. However, this is a misconception since large areas of the Northern Governorate are not connected to a main sewer-network and most wastewater is stored in cesspits which are not properly sealed.

Furthermore, most CWWTPs currently do not meet the respective irrigation/ discharge limits of the Jordanian standard JS 893 (2006) and show a lack of performance (Al-Assa'd and Sauer, 2010). *E. coli* concentrations are generally higher than the permissible limits for discharge to streams, wadis and water bodies (JS 893, 2006) at locations in the Northern Governorates where indirect use occurs at the Irbid Center, Wadi Shallaleh, North Shouna and Wadi Arab facilities (Breulmann et al., 2020b).

An optimization of CWWTPs in Jordan is urgently needed. The responsible ministries should plan further investigations to evaluate the performance of certain WWTPs that are producing effluent that does not comply with JS 893 (2006). Increasing the quality and the secure delivery of TWW will also create high quality reuse options in the Northern Governorates (Breulmann et al., 2020b).

Furthermore, and as mentioned earlier, the overall water infrastructure and piping networks are generally out-dated. Often more than 50% of water is NRW that is lost as a result of leakages, weak infrastructure and illegal consumption (theft) (Hussein, 2018; MoPIC, 2019; REACH, 2014b). In rural areas especially, which are generally not connected to the main sewer network, the population has increased markedly over recent years and has contributed to the contamination of groundwater resources (Breulmann et al., 2020a). In a study by Breulmann et al. (2020a) so called *Hot Spots* in Jordan were identified. Hot Spots are defined as areas where groundwater resources have been, or are expected to be, contaminated, through leakage of domestic wastewater from cesspools, septic tanks, or through inappropriate handling of wastewater from sewage networks. Based on multi-dimensional criteria i.e. people served, level of pollution, frequency of pollution and the presence of on-site treatment, 16 Hot Spots were identified in Jordan of which six are located in the Northern Governorates (**Figure 5**) namely: the Hareema, Kufr Asad and Pella well fields in Irbid, and the El-Beida, El-Qantara and Tannur/Rasun springs in Ajloun (Breulmann et al., 2020a), which clearly illustrates the severity of the problem of water contamination**.**

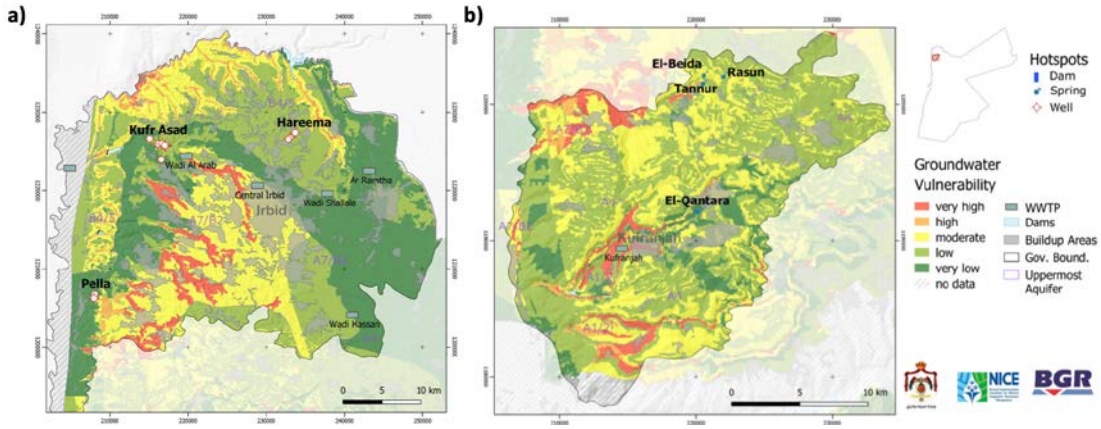


Figure 5 Groundwater vulnerability map and Hot Spots of a) the Irbid and b) the Ajloun Governorate. Adopted from (Breulmann et al., 2020a).

— Water demand and wastewater generation

The rapid population increase, which exceeded the expected annual increase of 2.1% (2013 – 2017) resulted in the severe problems in the water sector becoming more apparent very early. An estimated annual 2.1% population increase till the year 2045 will result in a demand for freshwater of almost 150 MCM and wastewater being generated at a rate of approximately 95 MCM the Northern Governorates (**Table 3**). Since the Northern Governorates in particular were affected by the influx of Syrian refugees the expected water demand and wastewater generation will almost double by 2045. The MWI must therefore consider initiatives to improve the water situation specifically in this area (Farishta, 2014). If water management continues as it does at present, many aquifers will soon be lost: they will either dry out or they'll become too saline to use (Whitman, 2019).

For example, it can be expected that already for the year 2015 about 32 MCM/year of raw wastewater was not treated in one of the eleven CWWTPs. This figure has been estimated by subtracting the actual treated wastewater at the CWWTP in the North from the estimated WW-generation in 2015; **Table 3**. It is not clear where this high amount ended up, but it can be assumed that most of it might be infiltrated into the soil through leaking cesspits, impacting groundwater resources. However, the actual number is probably much higher since NRW was not included in the calculation.

Table 3 Calculated population increase, drinking water demand and wastewater generation in the Northern Governorates Irbid, Mafraq, Ajloun and Jarash for the years 2015 – 2045. It was considered that all refugees will remain in the Governorates (Scenario 1). Assumptions: annual population increase of 2.1% and water demand of 80L/p/d (Source: Department of Statistics).

a)

	2015			2020			2025		
		Water demand	WW Generation		Water demand	WW Generation		Water demand	WW Generation
Gov.	Population	MCM/year		Population	MCM/year		Population	MCM/year	
Irbid	1,770,158	51,688,614	33,080,713	1,963,997	57,348,702	36,703,169	2,179,061	63,628,591	40,722,298
Mafraq	549,948	16,058,482	10,277,428	610,169	17,816,943	11,402,843	676,985	19,767,962	12,651,496
Ajloun	176,080	5,141,536	3,290,583	195,361	5,704,553	3,650,914	216,754	6,329,222	4,050,702
Jarash	237,059	6,922,123	4,430,159	263,018	7,680,120	4,915,277	291,819	8,521,121	5,453,517
Total	**2,733,245**	**79,810,754**	**51,078,883**	**3,032,545**	**88,550,318**	**56,672,203**	**3,364,620**	**98,246,895**	**62,878,013**

b)

	2030			2035			2040		
		Water demand	WW Generation		Water demand	WW Generation		Water demand	WW Generation
Gov.	Population	MCM/year		Population	MCM/year		Population	MCM/year	
Irbid	2,417,676	70,596,150	45,181,536	2,682,421	78,326,681	50,129,076	2,976,155	86,903,734	55,618,390
Mafraq	751,117	21,932,625	14,036,880	833,367	24,334,326	15,573,969	924,624	26,999,022	17,279,374
Ajloun	240,490	7,022,294	4,494,268	266,824	7,791,260	4,986,407	296,042	8,644,431	5,532,436
Jarash	323,774	9,454,214	6,050,697	359,229	10,489,484	6,713,270	398,566	11,638,121	7,448,397
Total	**3,733,058**	**109,005,283**	**69,763,381**	**4,141,841**	**120,941,752**	**77,402,721**	**4,595,387**	**134,185,308**	**85,878,597**

c)

	2045		
		Water demand	WW Generation
Gov.	Population	MCM/year	
Irbid	3,302,055	96,420,004	61,708,803
Mafraq	1,025,874	29,955,512	19,171,527
Ajloun	328,460	9,591,028	6,138,258
Jarash	442,210	12,912,536	8,264,023
Total	**5,098,599**	**148,879,080**	**95,282,611**

— Current investment projects

The Jordanian Ministry of Water and Irrigation has conducted various feasibility studies during recent years in order to secure the water supply and wastewater treatment for the future (Whitman, 2019). However, these studies have focused predominantly on sub-urban and urban areas of the Irbid Governorate, which have been most affected by the influx of Syrian refugees (**Figure 6**).

Some of the studies are listed below:

- A study from 2015 on '*Water Sector for the host communities of Syrian refugees in Northern Governorates in the Hashemite Kingdom of Jordan: Sewerage and Water Supply*' describes two Master Plans for sewerage systems in order to identify the required improvements for the sewerage services as well to mitigate the existing poor water supply services in the urban areas of Irbid, Ramtha, and Mafraq. The Master Plans meet the projected demand of a 2035 Jordanian population,

considering the current level of Syrian refugees. The total amount of water available for the Northern Governorates is expected to increase to 91 MCM/year from current levels of 72 MCM/year, however it was already clear that even this would not satisfy the demand by 2017. The overall investment costs were calculated as approximately 140 Million USD for the water supply and 300 Million USD for the sewerage systems.

- A 2016 study entitled: '*Wastewater collection, treatment and reuse project for Liwa'a Al-Wasatia and East Irbid villiages'* includes the design of wastewater collection networks, the treatment and effluent reuse from communities of Liwa'a Al Wasatia and East Irbid Villages, Mughaier and Hakama, Kufur Youba and unserved areas in Soum Villages of the Irbid Governorate. The overall investment costs were calculated as approximately 77 Million USD.
- A Study from 2018, entitled: '*Operations Concept of Wastewater Treatment Plants & Wastewater Reuse System (WWTRE) Wadi Arab in YWC: Private Sector Operation & Management of WWTP's Wadi Shallala, Irbid Central & Wadi Arab, Transmission pipeline to Jordan Valley and the Hydro Power Plant'*.
- A project from 2019: 'Investment Support to the '*Wadi Al Arab Water System II" Project'* aims at treating and conveying 30 MCM/year of freshwater from the King Abdullah Canal (KAC) to the Zabda Reservoir, serving mainly the city of Irbid. Additional water will supplement the limited potable water resources available in the Irbid Governorate where the population continues to grow. The Project includes: (i) a raw water intake from the KAC and low-lift pump station located adjacent to the KAC, (ii) a new conventional water treatment plant and pumping station; (iii) a 25.6 km transmission pipeline to convey the treated wastewater to the Zabda Reservoir, (iv) three booster pumping stations (at altitudes of +26 m, +240 m and +435 m) along the transmission pipeline, and (v) external assistance to the Promoter for construction

works supervision together with communication activities. The overall investment costs were estimated at approximately 14 Million USD.

- A 2019 study entitled: '*Improved access to water, water distribution performance and related sewerage disposal in Irbid Governorate for host communities and Syrian refugees'* aims at tackling challenges by promoting an innovative and inclusive approach combining the development of infrastructures and humanitarian activities for water access by the most vulnerable households of refugees and host communities. The main objective is to develop infrastructures and capacities for the adequate delivery of water and sanitation in the area of Irbid and Ramtha, where the Syrian refugees and host communities are facing the growing quantitative and qualitative deterioration of services. The overall investment costs were estimated at approximately 40 Million USD.

  The specific objectives of the Action are: (i) Expanding and improving the performance of the water networks in greater Irbid and Ramtha, where water could be distributed to fulfill the expected needs in terms of volume and timeliness, with reduced leakage and energy consumption; (ii) Connecting to sewerage networks and yet unserved areas of Irbid that will receive the new water resources; (iii) Capacity strengthening of YWC staff for operations and maintenance of the expanded and restructured networks and (iv) Improving access to water for the vulnerable communities, both Syrian and Jordanian, thus contributing to lowering the water-service-related tensions, and hence the resilience of communities.
- The project '*Providing Lebanese and Jordanian communities hosting Syrian refugees with improved WASH infrastructure and facilities at community, institution, and household level*' aims to build the resilience of refugees and host communities through a participatory approach that increases access to effective water and sanitation services and improves health outcomes through improved hygienic environments and practices.

The action will target both Syrian refugees living in the targeted communities and the communities hosting them who have faced significant challenges with increased populations. The overall investment costs were estimated at approximately 6 Million USD.

- A feasibility study from 2018, titled: '*West Irbid Wastewater*' aims to upgrade and construct a wastewater infrastructure system in 15 villages, located in West Irbid, by laying public sewer infrastructure that would serve a catchment area of approximately 21.9 km^2 including, where necessary, the installation of wastewater pumping stations enabling the towns to connect effectively to the wastewater network and to the existing Wadi Al-Arab wastewater treatment plant. The overall investment costs were estimated at approximately 53 Million USD.
- A 2019 feasibility study entitled: '*Feasibility Study for Bani Kenaneh Water Supply and Sanitation Projec*t' shows scenarios, which aim to upgrade the existing water supply network and to provide for the first time a wastewater collection system and wastewater treatment infrastructure in the Bani Kenaneh District, meeting the expected demand of a 2045 Jordanian population. The overall investment costs, depending on the described scenarios, were estimated at approximately 71 – 124 Million USD

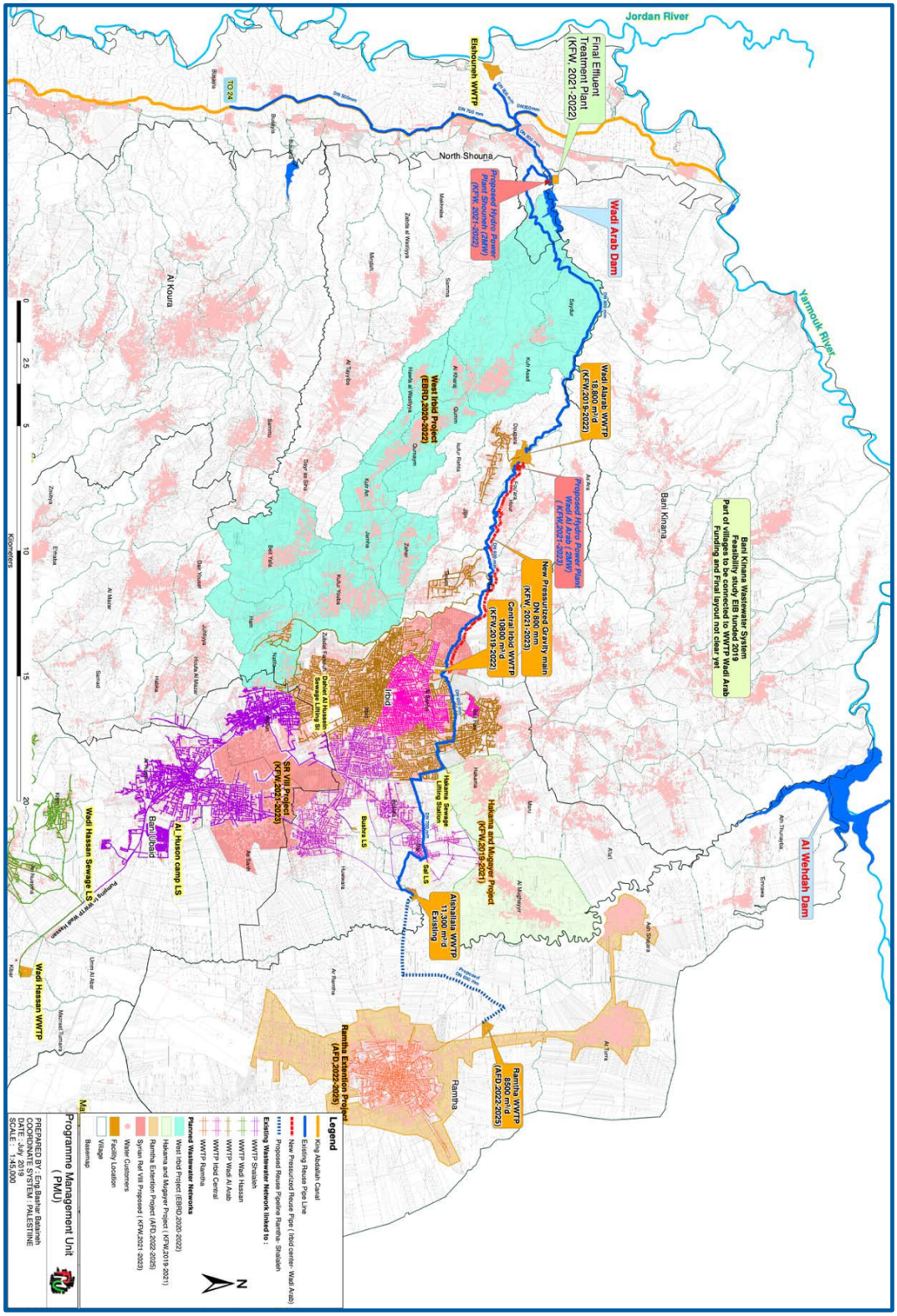


Figure 6 Overview of planned water and wastewater projects in the Irbid Governorate. Source: Project Management Unit of the Jordanian Water Authority.

2.2 Scenarios for future water demand and wastewater generation

The prioritization of integrated wastewater management concepts in rural and suburban settlement areas in the Northern Governorates will depend on a potential return of the Syrian refugees to their home country in the near future. However, a large proportion of the population is expected to remain in Jordan.

In the following we have therefore set out four potential scenarios (S1-S4) based on different patterns of the return of Syrian refugees to their home country in order to determine the consequences of the different ways in which the population might behave, on the water sector (drinking water demand and wastewater generation). We analyzed the extent to which the planned investments by MWI are also designed for a population in 30 years' time and whether these plans may be subject to any uncertainties.

We have based our calculations on the following assumptions:

- Calculated annual population increases by 2.1%.
- Projected water demand per person per day: 80 L.
- It was assumed that about 20% does not end up as wastewater (EIB, 2019; USAID, 2018).
- The Syrian refugees (based on **Table 1**) will return by the year 2025.

The scenarios are:

- *Scenario 1:* All Syrian refugees will remain in Jordan (S1).
- *Scenario 2*: All Syrian refugees will leave Jordan (S2).
- *Scenario 3:* 50% of the Syrian refugees will leave Jordan (S3).
- *Scenario 4:* 25% of the Syrian refugees will leave Jordan (S4).

The analyses of the four scenarios show that if all Syrian refugees return to their home country this will have the biggest impact on the water sector in the Irbid and Mafraq Governorate, since the overall share of Syrian refugees on the population was the highest in Jordan: Irbid: 20% and Mafraq: 38%, see **Table 1**. It must be added here, however, that the majority of the Syrian refugees in the Mafraq Governorate are living in camps. This means that the water and wastewater treatment is carried out directly in the camps.

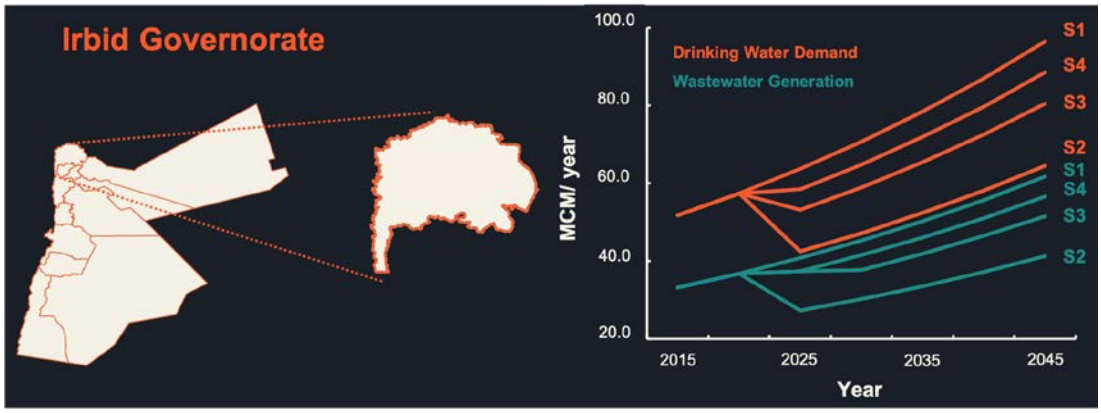


Figure 7 Consequences of scenarios (S1-S4) on the demand for drinking water and wastewater generation in the Irbid Governorate till 2045. Assumptions: annual population increase of 2.1%; water demand of 80L/p/d; Syrian refugees will start to return by 2025; S1: All Syrian refugees remain; S2: All Syrian refugees leave; S3: 50% of the Syrian refugees leave, and S4: 25% of the Syrian refugees leave.

An annual population increase of 2.1% till the year 2045 will result in a water demand calculated to be about 96 MCM/year in the Irbid Governorate, 30 MCM/year in the Mafraq Governorate and a calculated wastewater generation of about 62 MCM/year in the Irbid Governorate and 19 MCM/year in the Mafraq Governorate if all Syrian refugees remain in the two Governorates (S1; **Table 3**; **Figure 7**; **Figure 8**).

If all Syrian refugees were to leave by the year 2025 (S2) wastewater generation will be massively reduced up to the year 2045 by about 33% in the Irbid Governorate and by about 66% in the Mafraq Governorate; the water demand will be reduced by about 33% in the Irbid Governorate and by about 65% in the Mafraq Governorate (**Table 4**).

If fewer refugees return (50%), as calculated in scenario three (S3: **Table 5**) there will still be a clear relaxation of stress on the water sector. The wastewater generation would still be reduced till the year 2045 by about 17% in the Irbid Governorate and by about 34% in the Mafraq Governorate; similarly, the water demand will also be reduced by about 17% in the Irbid Governorate and by about 34% in the Mafraq Governorate (**Table 5**).

However, if an even smaller proportion (25%) return, as shown in scenario four (S4: **Table 6**), the effect on the wastewater generation and overall water demand will only be minor.

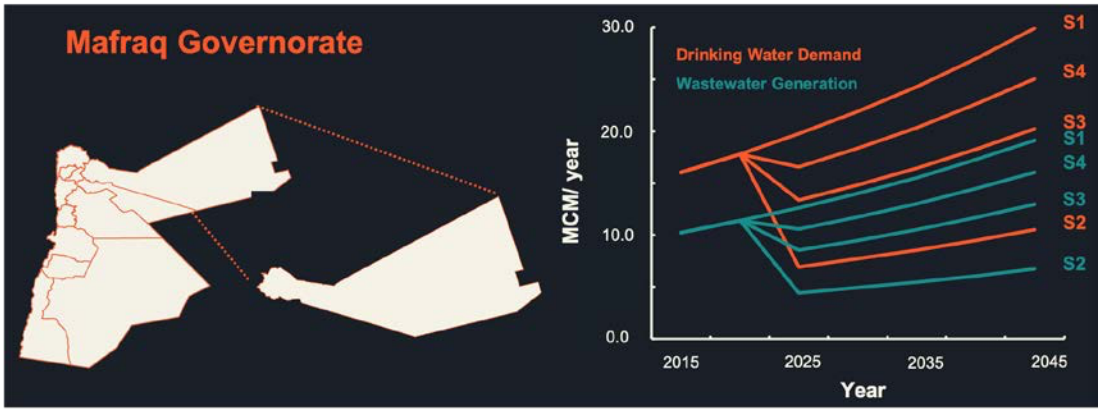


Figure 8 Consequences of scenarios (S1-S4) on the demand for drinking water and wastewater generation in the Mafraq Governorate till 2045. Assumptions: as for Figure 7.

For the Ajloun (**Figure 9**) and Jarash (**Figure 10**) Governorate the return of the Syrian refugees has only a marginal influence on the water sector, since the overall share of Syrian refugees on the population is low with Ajloun at 8% and Jarash at 5%, see **Table 1**. However, even with this low share an effect can still be seen if all Syrian refugees leave by the year 2025 (S2). In that case, till the year 2045 wastewater generation will be reduced by about 20% in the Ajloun Governorate and 8% in the Jarash Governorate, and water demand will be reduced by about 14% in the Ajloun Governorate and about 8% in the Jarash Governorate compared to S1 where all Syrian refugees will remain in the Governorate (**Table 4**).

If only a small proportion return as shown in the two scenarios 3 and 4 (S3: **Table 5**; S4: **Table 6**) there will be no significant effect on wastewater generation and overall water demand.

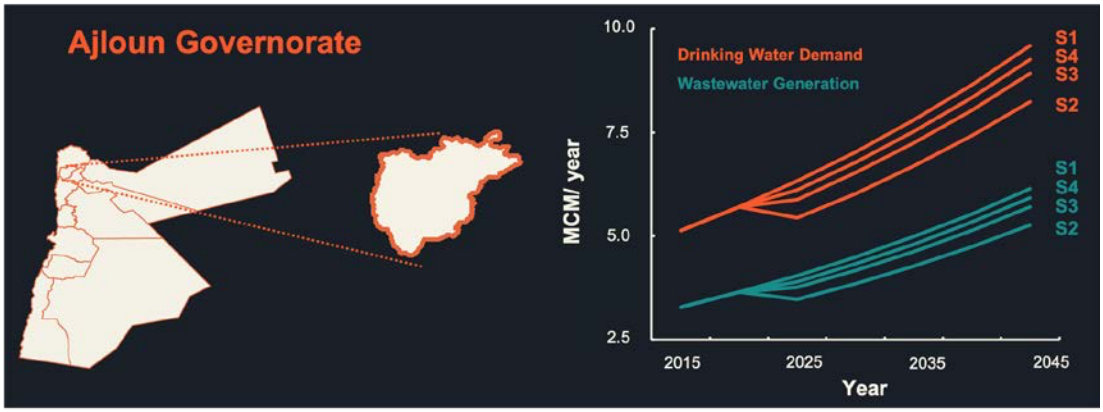


Figure 9 Consequences of scenarios (S1-S4) on the demand for drinking water and wastewater generation in the Ajloun Governorate till 2045. Assumptions: as for Figure 7.

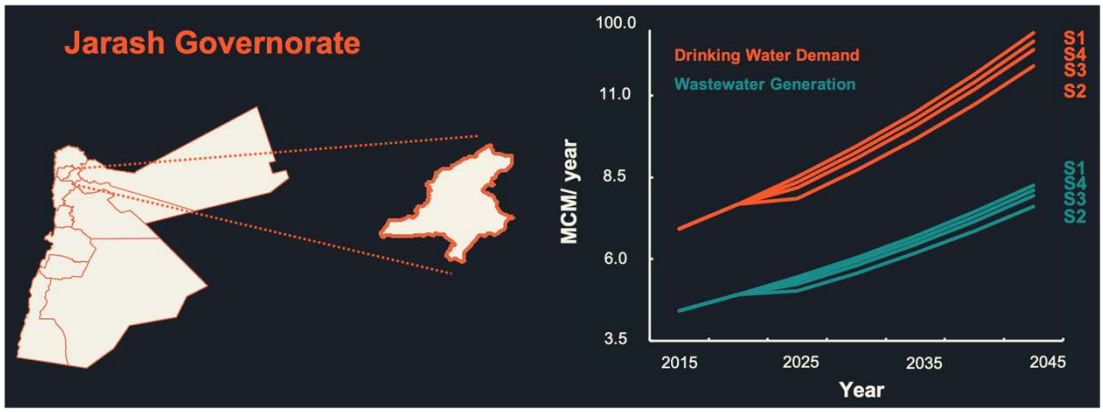


Figure 10 Consequences of scenarios (S1-S4) on the demand for drinking water and wastewater generation in the Jarash Governorate till 2045. Assumptions as for Figure 7.

As described above, the MWI has conducted various large and costly studies during recent years in order to secure the water supply and the wastewater treatment for the future in Jordan. It is understandable that the MWI focused predominantly on sub-urban and urban areas of the Irbid Governorate, which were most affected by the influx of Syrian refugees. However, although the Jordanian Government developed three phases of a Jordan Response Plan to the Syrian Crisis (MoPIC, 2015; 2017; 2019) little has been achieved so far. No projects have been prioritized, the planned investments are subject to a high degree of uncertainty and rural areas were not considered.

A large proportion of Syrian refugees might be expected to remain in Jordan and therefore it can be assumed that the situation will develop approximately in accordance with scenarios S1 or S4 and that the pressure on the water sector will consequently continue to intensify.

The costs of the investments already planned are enormous. It's already obvious that the intended investments will not meet the future demands and solutions need to be implemented now. If the present water management practices were to continue without change, many aquifers will be lost forever. It is clear that the investment backlog and traditional decision paths of conservative planning must be left behind, and that regionally adapted concepts for the future need to be implemented.

Technological changes are urgently needed in order to mitigate the long-term problems within the water sector. One solution could be an integrated wastewater and water management approach and the implementation of

semi- and decentralized wastewater treatment systems. This would both help to mitigate the extreme water scarcity and protect groundwater resources. Such approaches can be used with great flexibility and can be adapted to particular local conditions as either a temporary or permanent solution.

Within the framework of the planned investment projects of the MWI, the implementation of semi- and decentralized systems, especially in northern Jordan, seems to be target-oriented.

Due to their special location, individual villages in West-Irbid will not be connected to a channel-bound network in the future; communities and districts in rural areas like Bani Kenaneh will not be given priority in infrastructure planning in the future due to high costs and therefore alternative concepts are necessary and need to be implemented immediately.

2.3 Challenges in the Northern Governorates

The main challenges identified in the Northern Governorates can be summarized as follows:

- Governorates like Irbid and Mafraq, have received the highest numbers of Syrian refugees compared to the governorate's overall population.

  This population increase has affected public services. There has been a -

  - significant increase in water demand, associated with -
  - increased local water shortages, -
  - putting an enormous pressure on the sewage network and -
  - wastewater treatment plants.
- Benefits from reduced needs for irrigation water were offset by the freshwater needs of thousands of Syrian refugees.
- Large areas of the Northern Governorate are not connected to a main sewer-network and most wastewater is stored in cesspits which are not sealed properly and so contaminate groundwater resources.
- Water infrastructure and piping networks are out-dated, leading to more than 50% of water often being lost as a result of leakages, weak infrastructure and illegal consumption.
- Groundwater consumption clearly exceeds replacement.
- Most CWWTPs do not meet the respective irrigation / discharge limits and so contribute to the contamination of water resources.
- Existing wastewater treatment plants cannot meet actual and future demands.
- Planned investments try to secure the water supply and the wastewater treatment, mainly in urban areas.
- Planned investments will not meet future demands.
- Most treated wastewater is discharged from the region and is not used locally.
- Concepts for rural areas are absent.

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4. Annexes

Table 4 Consequences of scenario two (S2): '*All Syrian refugees leave*' on the drinking water demand and wastewater generation in the Northern Governorates Irbid, Mafraq, Ajloun and Jarash for the years 2015 – 2045. Assumptions: as for Table 3.

	2015			2020			2025		
		Water demand	WW Generation		Water demand	WW Generation		Water demand	WW Generation
Gov.	Population	MCM/year		Population	MCM/year		Population	MCM/year	
Irbid	1.770.158	51.688.614	33.080.713	1.963.997	57.348.702	36.703.169	1.454.521	42.472.018	27.182.091
Mafraq	549.948	16.058.482	10.277.428	610.169	17.816.943	11.402.843	238.457	6.962.951	4.456.288
Ajloun	176.080	5.141.536	3.290.583	195.361	5.704.553	3.650.914	186.178	5.436.404	3.479.298
Jarash	237.059	6.922.123	4.430.159	263.018	7.680.120	4.915.277	268.897	7.851.782	5.025.140
Total	**2.733.245**	**79.810.754**	**51.078.883**	**3.032.545**	**88.550.318**	**56.672.203**	**2.148.053**	**62.723.154**	**40.142.818**

	2030			2035			2040		
		Water demand	WW Generation		Water demand	WW Generation		Water demand	WW Generation
Gov.	Population	MCM/year		Population	MCM/year		Population	MCM/year	
Irbid	1.613.796	47.122.856	30.158.628	1.790.513	52.282.978	33.461.106	1.986.581	58.008.151	37.125.217
Mafraq	264.569	7.725.419	4.944.268	293.540	8.571.380	5.485.683	325.684	9.509.977	6.086.385
Ajloun	206.565	6.031.709	3.860.294	229.185	6.692.203	4.283.010	254.282	7.425.023	4.752.015
Jarash	298.342	8.711.580	5.575.411	331.011	9.665.529	6.185.939	367.258	10.723.940	6.863.321
Total	**2.383.273**	**69.591.564**	**44.538.601**	**2.644.250**	**77.212.090**	**49.415.738**	**2.933.804**	**85.667.091**	**54.826.938**

	2045		
		Water demand	WW Generation
Gov.	Population	MCM/year	
Irbid	2.204.118	64.360.252	41.190.561
Mafraq	361.348	10.551.353	6.752.866
Ajloun	282.126	8.238.090	5.272.378
Jarash	407.474	11.898.249	7.614.880
Total	**3.255.067**	**95.047.945**	**60.830.685**

Table 5 Consequences of scenario three (S3): *'50% of the Syrian refugees leave* on the drinking water demand and wastewater generation in the Northern Governorates Irbid, Mafraq, Ajloun and Jarash for the years 2015 – 2045. Assumptions: as for Table 3.

	2015			2020			2025		
		Water demand	WW Generation		Water demand	WW Generation		Water demand	WW Generation
Gov.	Population	MCM/year		Population	MCM/year		Population	MCM/year	
Irbid	1.770.158	51.688.614	33.080.713	1.963.997	57.348.702	36.703.169	1.816.791	53.050.304	33.952.195
Mafraq	549.948	16.058.482	10.277.428	610.169	17.816.943	11.402.843	457.721	13.365.456	8.553.892
Ajloun	176.080	5.141.536	3.290.583	195.361	5.704.553	3.650.914	201.466	5.882.813	3.765.000
Jarash	237.059	6.922.123	4.430.159	263.018	7.680.120	4.915.277	280.358	8.186.451	5.239.329
Total	**2.733.245**	**79.810.754**	**51.078.883**	**3.032.545**	**88.550.318**	**56.672.203**	**2.756.336**	**80.485.025**	**51.510.416**

	2030			2035			2040		
		Water demand	WW Generation		Water demand	WW Generation		Water demand	WW Generation
Gov.	Population	MCM/year		Population	MCM/year		Population	MCM/year	
Irbid	2.015.736	58.859.503	37.670.082	2.236.467	65.304.829	41.795.091	2.481.368	72.455.942	46.371.803
Mafraq	507.843	14.829.022	9.490.574	563.454	16.452.853	10.529.826	625.154	18.254.499	11.682.880
Ajloun	223.527	6.527.002	4.177.281	248.005	7.241.732	4.634.708	275.162	8.034.727	5.142.226
Jarash	311.058	9.082.897	5.813.054	345.120	10.077.507	6.449.604	382.912	11.181.030	7.155.859
Total	**3.058.165**	**89.298.423**	**57.150.991**	**3.393.045**	**99.076.921**	**63.409.229**	**3.764.596**	**109.926.199**	**70.352.767**

	2045		
		Water demand	WW Generation
Gov.	Population	MCM/year	
Irbid	2.753.087	80.390.128	51.449.682
Mafraq	693.611	20.253.432	12.962.197
Ajloun	305.293	8.914.559	5.705.318
Jarash	424.842	12.405.393	7.939.452
Total	**4.176.833**	**121.963.512**	**78.056.648**

Table 6 Consequences of scenario four (S4): *'25% of the Syrian refugees leave'*. on the drinking water demand and wastewater generation in the Northern Governorates Irbid, Mafraq, Ajloun and Jarash for the years 2015 – 2045. Assumptions: as for Table 3.

	2015			2020			2025		
		Water demand	WW Generation		Water demand	WW Generation		Water demand	WW Generation
Gov.	Population	MCM/year		Population	MCM/year		Population	MCM/year	
Irbid	1.770.158	51.688.614	33.080.713	1.963.997	57.348.702	36.703.169	1.997.926	58.339.447	37.337.246
Mafraq	549.948	16.058.482	10.277.428	610.169	17.816.943	11.402.843	567.353	16.566.709	10.602.694
Ajloun	176.080	5.141.536	3.290.583	195.361	5.704.553	3.650.914	209.110	6.106.017	3.907.851
Jarash	237.059	6.922.123	4.430.159	263.018	7.680.120	4.915.277	286.089	8.353.786	5.346.423
Total	**2.733.245**	**79.810.754**	**51.078.883**	**3.032.545**	**88.550.318**	**56.672.203**	**3.060.478**	**89.365.960**	**57.194.214**

	2030			2035			2040		
		Water demand	WW Generation		Water demand	WW Generation		Water demand	WW Generation
Gov.	Population	MCM/year		Population	MCM/year		Population	MCM/year	
Irbid	2.216.706	64.727.826	41.425.809	2.459.444	71.815.755	45.962.083	2.728.762	79.679.838	50.995.096
Mafraq	629.480	18.380.823	11.763.727	698.411	20.393.589	13.051.897	774.889	22.626.761	14.481.127
Ajloun	232.008	6.774.648	4.335.775	257.414	7.516.496	4.810.558	285.602	8.339.579	5.337.331
Jarash	317.416	9.268.556	5.931.876	352.175	10.283.496	6.581.437	390.739	11.409.575	7.302.128
Total	**3.395.611**	**99.151.853**	**63.457.186**	**3.767.443**	**110.009.336**	**70.405.975**	**4.179.992**	**122.055.753**	**78.115.682**

	2045		
		Water demand	WW Generation
Gov.	Population	MCM/year	
Irbid	3.027.571	88.405.066	56.579.242
Mafraq	859.742	25.104.472	16.066.862
Ajloun	316.876	9.252.793	5.921.788
Jarash	433.526	12.658.965	8.101.737
Total	**4.637.716**	**135.421.296**	**86.669.630**

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