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Future Freshwater Deficits in Palestine and Jordan

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KEY FINDINGS

Baseline Scenarios were developed in Palestine and Jordan based on realistic assumptions for population growth, economic and agricultural development, and future water supply until 2050.

Freshwater deficits between 2020 and 2050 were estimated in both countries. To get insight into the spatial distribution of the deficits, the national territories were divided in 17 demand areas.

Palestine and Jordan will need 605 and 712 Mio.m^3 of water per year to cover their respective domestic and industrial water demand in 2050.

Domestic and industrial water deficits will be especially high in Gaza and in the urban centers of Northern and Central Jordan.

MOTIVATION

Jordan and Palestine are witnessing a significant population growth, especially in the urban centers. Both countries are developing quickly, intensifying their use of natural resources. Large-scale projects to expand the irrigated agriculture area and create new industrial hubs are underway (Ministry of Water and Irrigation, 2016; Palestinian Water Authority, 2013). All these factors exert a significant pressure on the available freshwater resources. Today, 58% of the water consumed in the region is extracted from the aquifers by both countries. Overexploitation of the aquifers put a strain on the groundwater resources. Climate change is also predicted to have an impact on both surface water and groundwater resources. The SALAM Initiative aims at finding solutions to cover the future water demand of all economic sectors in each region of Palestine and Jordan. Given the importance of the task, long-term planning until 2050 is essential. The extent of the problem should be clearly defined before decision-makers can start planning and implementing solutions. The first step of the assessment is to calculate the current water budget and agree on realistic assumptions to compute all components of the water demand and supply by 2050. In this policy brief, the future water budget is estimated in the main economic sectors for each region in Palestine and Jordan.

METHODOLOGY

The study follows a two-step process: compute the current freshwater budget gathering water demand and supply data, and estimate the future water deficits or surpluses in each demand area. Palestine and Jordan are divided in demand areas (clusters), defined taking administrative divisions but also topography and the existing water infrastructure into consideration. Local water supply and demand data from 2020 is aggregated by demand cluster. Supply includes freshwater supply (fresh groundwater and surface water, desalinated water), which is based on a detailed assessment of the availability of renewable freshwater resources for each cluster, and reclaimed water (reused wastewater, brackish groundwater). Demand in the agricultural sector is partially covered by reused wastewater.

Projecting future water demand and supply until 2050 implies making assumptions on the socio-economic development of the region and on the future state of freshwater resources. The set of assumptions for each country defines the baseline development scenario. The baseline scenario follows a Business-As-Usual approach, assuming that no major interventions in the regional water resources system, such as water transfer projects, are implemented during the planning horizon. The strategic master plans of both countries were used as basis to assess future freshwater budgets (Ministry of Water and Irrigation, 2016; Palestinian Water Authority, 2013). Projections for freshwater supply in Jordan were based

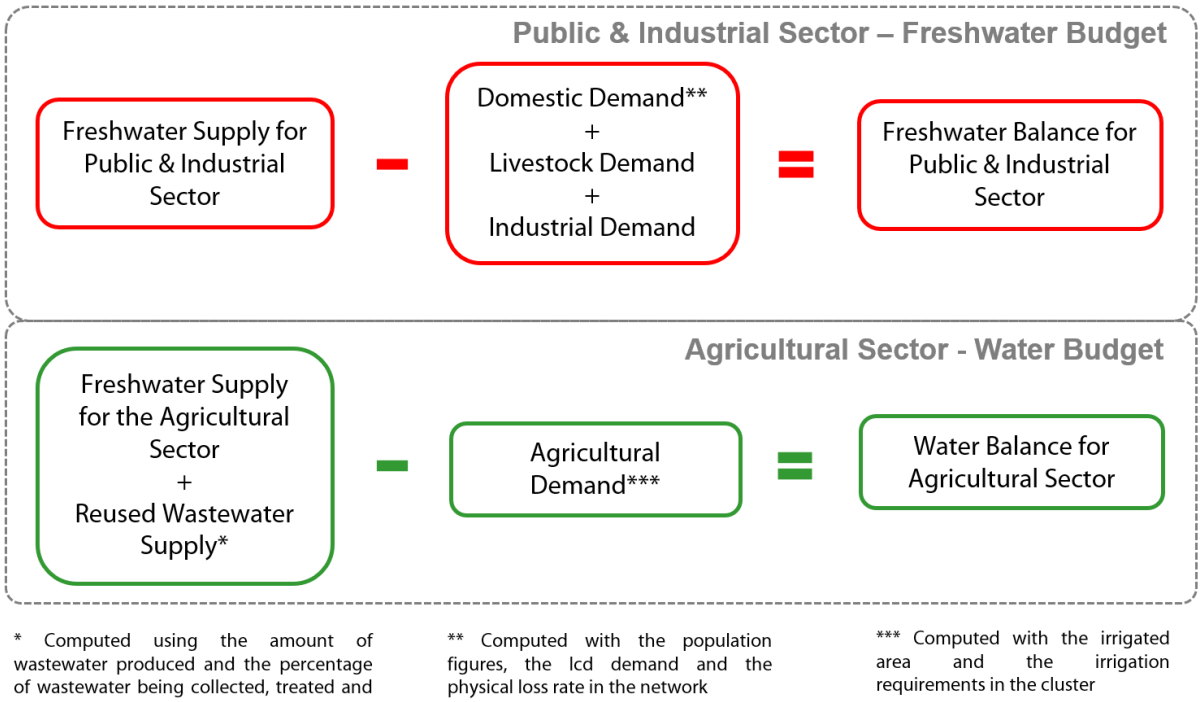

Figure 1: Assessing the future water budgets

on the findings of Margane & Al-Dweiri (2010). The underlying assumptions were refined in close cooperation between German and regional partners. Figure 1 shows how freshwater budgets are computed for domestic and industrial water uses as well as for agricultural water use.

RESULTS

The freshwater budget was assessed between 2020 and 2050 for all demand clusters. The main underlying assumptions for the baseline scenarios are summed up in Table 1. The population should increase significantly in both countries, which will induce a dramatic increase in domestic water demand. The water authorities of both countries plan to increase the daily water supply per capita up to 120 L by 2030, which will contribute to a further rise in water demand. In the baseline scenarios, no reduction of physical losses is considered for the following decades. Both countries expect significant industrial developments, that will increase pressure on water resources. However, industrial water demand in Jordan and Palestine will remain comparatively much lower than the domestic demand, respectively 10 and 5 times lower. Irrigated area should be extended, especially in the Jordanian highlands, the Northern Cluster in the West Bank and the Palestinian section of the Jordan Valley. Both countries plan to intensify the wastewater reuse program to reduce the share of freshwater being used in the agricultural water balance. While freshwater supply should decrease in Jordan due to groundwater overexploitation and climate change, it is planned to increase in Palestine.

Figure 2 shows the expected freshwater deficits for domestic and industrial water uses. If the assumptions defined in the baseline scenarios turn out to be valid, both countries will face steadily increasing freshwater deficits in the following decades. Palestine and Jordan will need 605 and 712 Mio.m^3 of water per year to cover their respective domestic and industrial water demand in 2050. The geographical repartition of these deficits is shown in Figure 3. Gaza, the Northern and Southern clusters in the West Bank and Northern and Central Jordan will be especially impacted. The agricultural sector will also face water shortages: 447 Mio.m^3/a in Palestine and 479 Mio. m^3/a in Jordan.

DISCUSSION AND CONCLUSIONS

The projected water budgets in Palestine and Jordan are considerable. The situation should be first addressed by improving water use efficiency and reducing losses in the network. Eliminating losses in the public water network by 2050 would allow to save up to 120 Mio.m^3/a in Palestine and 80 Mio.m^3/a in Jordan. Further studies are required to consolidate these numbers and to estimate the related cost. This would however only cover a small fraction of the expected deficits. Desalinating seawater, therefore, is the only solution to cover the increasing water needs of the region. [Water Production and Transfer Strategies, p. 22] were designed during the SALAM-Initiative to develop water resources system planning solutions to the freshwater deficit problem of the region. Because of these water imports to the region, public

	PALESTINE	JORDAN
Population Growth	Annual growth rate estimated at national level 2020-2025: 2.5% / 2025-2050: 3.5% Population *2.7 between 2020 and 2050	Annual growth rate estimated at cluster level National average: gradual decrease between 2020 (2.20%) and 2050 (1.70%) Population *1.8 between 2020 and 2050
Public	Public = Domestic + Tourism + Commercial Domestic: Gradual increase of the minimum water supply per capita from 80 lcd (2020) to 120 lcd (2030); 2030-2050: 120 lcd	Public = Domestic + Tourism + Livestock + Commercial + Small Industries Domestic: Gradual Increase of the minimum water supply per capita from 95 lcd (2020) to 120 lcd (2030); 2030-2050: 120 lcd
Public Network Losses	Physical loss rate estimated at national level Fixed at 28% Economic losses (non-billed) 15%, not considered	Physical loss rate estimated at cluster level Physical Loss Rate fixed. National average: 18% Economic losses (non-billed) 26%, not considered
Industry	Small and large industries Computed at national scale based on public demand: 7% of the public demand in 2020, 20% in 2050 *11 between 2020 and 2050	Large industries Annual growth rate estimated at cluster level *2.5 between 2020 and 2050
Irrigated Area	*3 between 2020 and 2050, large increases in the Northern Cluster and in the Lower Jordan Valley (*5)	*1.4 between 2020 and 2050, large increases in Ma'an (*2) and Northern Cluster (*1.7)
Wastewater Reuse	Goal at Cluster Level National Average: Volume recovered after collection, treatment and reuse amounts in 2050 to 75% of the produced wastewater (vs 9% in 2020)	National Goal: Volume recovered after collection, treatment and reuse amounts in 2050 to 64% of the produced wastewater (vs 38% in 2020)
Freshwater Supply	*2.2 between 2020 and 2050: new wells in the West Bank, desalination plant in Gaza (55 Mio. m^3/a), additional purchase agreements from Israel	20% decrease in surface water and groundwater resources between 2020 and 2050 due to groundwater overexploitation and climate change

Table 1: Main underlying assumptions used to compute freshwater budgets

water consumption and hence wastewater production will increase. This creates a huge potential for wastewater reuse, which will lower water deficits in the agricultural sector.

In this study, only one baseline scenario, based on commonly agreed realistic assumptions, was considered for each country. Nevertheless, other development scenarios can be investigated in the Water Budget Tool (see box).

This helps to reflect on the uncertainties related to the projections of the baseline scenario. It could be argued that assumptions for population growth in Palestine are a bit optimistic. Likewise, predictions for the evolution of the irrigated area and extension of the wastewater reuse program in Palestine might be overestimated. Further studies should refine the assumptions for the agricultural sector. Non-revenue losses are included now in the domestic and industrial water consumption and aren't

THE WATER BUDGET TOOL

Several decision-support tools were designed in the SALAM Initiative and are compiled in the [SALAM Information and Expert System, p. 86]. The Water Budget Tool (WBT) allows the user to compute future freshwater deficits at cluster and national level and visualize the results in graphs. New development scenarios can be created by the system user, just by modifying the underlying assumptions. The numerous functionalities and user-friendly interface of the WBT make it a great planning tool for regional decision-makers.

deducted from the water supply unlike physical losses. However, these amounts are mostly used for irrigation purposes and should be added to the water supply for agriculture instead of the domestic and industrial supply. Furthermore, the impacts of climate change on freshwater supply and demand should be assessed in depth in both countries.

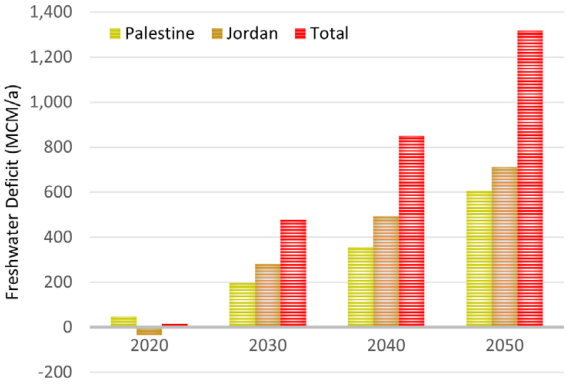

Figure 2: Freshwater deficits for public and industrial water (2020-2050)

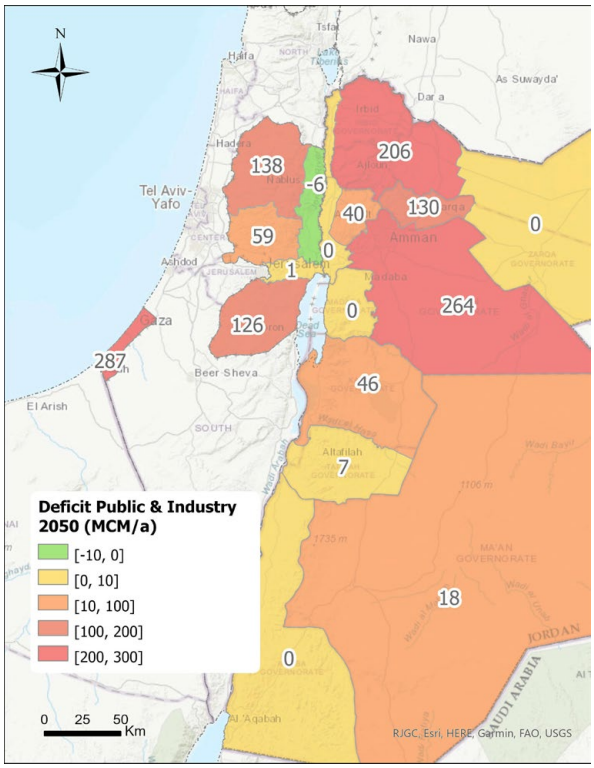

Figure 3: Freshwater deficits in 2050 for public and industrial water. In Jordan, it is assumed that water transfers will occur using the current hydro-infrastructure between the demand clusters with surpluses in 2050 (Aqaba, Jordan Valley, Madaba, Eastern Cluster) and other clusters with large deficits. Given that there is currently no centralized water transfer infrastructure in Palestine, water transfers between clusters are not considered.

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References

Margane, A. & Al Dweiri, M. (2020). Rapid Assessment of the Consequences of Declining Resources Availability and Exploitability for the Existing Water Supply Infrastructure. The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH in Cooperation of the Ministry of Water and Irrigation (MWI): Amman, Jordan.

Ministry of Water and Irrigation (MWI): Amman, Jordan. (2016). National Water Strategy 2016-2025.

Palestinian Water Authority (PWA). (2013). National Water and Wastewater Strategy for Palestine: Towards Building a Palestinian State from Water Perspective.