Water management solution pathways under climate change in the Middle East region

RésEAU Brief no. 5
December 2023

RésEAU

Editorial

Dear colleagues,

It is with great pleasure that we present the fifth edition of the RésEAU Brief series, a medium to share SDC's learnings from water related projects and programmes at the global level. This edition addresses **water management solution pathways under climate change in the Middle East region**, with a focus on Jordan, the host country for **the 36th AGUASAN Workshop** which took place in June 2022. It was followed by the official launch of the **Sub-RésEAU MENA**, covering the Middle East and Northern Africa.

Water security and climate change are among the most relevant and urgent issues for the economies and social stability of the countries in the MENA region, and therefore for SDC and its partners. The region is a global hotspot of unsustainable water use: in some countries, more than half of the current water withdrawals exceed sustainable limits (World Bank, 2017). Over 60 percent of the population in the MENA region live in water-stressed areas, further exacerbated by climate change, societal, economic and political fragility and instability, making the management of water scarcity even more difficult (ibid.). Rapidly growing urbanisation and climate change jointly increase water stress, limiting agricultural land and reducing productivity, and finally jeopardising food security and health.

The region will need to intensify its efforts to "increase **water use efficiency** across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity" (SDG 6.4). Improved water use and management across sectors is also the basis for climate change adaptation and mitigation (SDG 13). National and regional policies need to therefore consider water management and use practices through a **climate resilience** lens.

Against the backdrop of these challenges, this RésEAU Brief summarizes some of the strategies currently applied for sustainable water management and climate resilience in the Middle East. And, in line with these strategies, the actionable solutions that were co-created by the participants of the AGUASAN Workshop in Jordan.

We wish you a good read and welcome your feedback and comments!

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1. Water use and management in the Middle East region: challenges and opportunities[1]

1.1 Water scarcity in the Middle East region

Countries in the Middle East are the most water **stressed** in the world, that is, they withdraw the highest proportion of freshwater of the total available resources (de Waal et al., 2023).

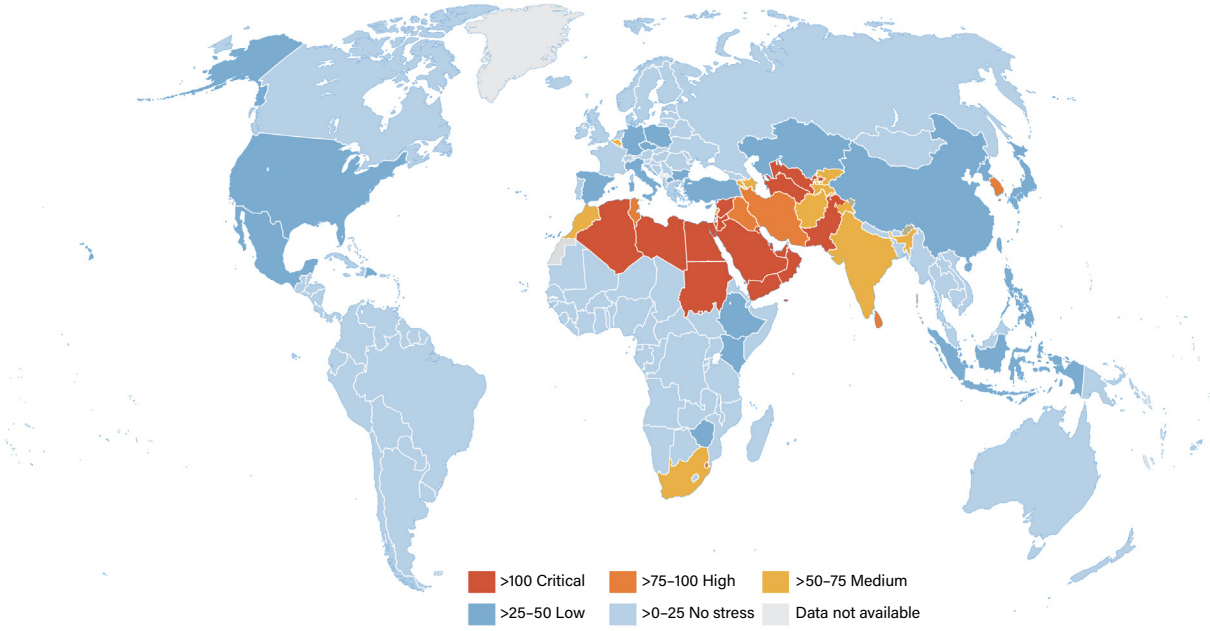


Figure 1: Water stressed countries, following SDG 6.4.2: Level of water stress: freshwater withdrawal as a proportion of available freshwater resources (source: de Waal et al., 2023).

In SDC's programming, the **Near East** region is composed of Iraq, Israel, Jordan, Lebanon, the Occupied Palestinian territory, and Syria, with the wider **Middle East** including the Arabian Peninsula and Iran (SDC, 2020).

The focus in this brief is on **Jordan**, as a country illustrative for the water, climate, and geo-political challenges in the Middle East, crossing the development and humanitarian spheres in this fragile region. Jordan was therefore the host of the AGUASAN workshop 2022 (AGUASAN, 2022).

This brief refers to the **Middle East and Northern Africa** (MENA) region when mentioning broader regional realities and sources, as this is the region covered by the **Sub RésEAU MENA** (with members from Lebanon, Iraq, Jordan, Syria, occupied Palestinian Territories, Yemen, Tunisia, Egypt, Morocco, and Turkey).

1 This section is based on work on water scarcity in the MENA region by the World Bank in 2017 ("Beyond Scarcity: Water Security in the Middle East and North Africa") and in 2023 ("The Economics of Water Scarcity in the Middle East and North Africa: institutional solutions").

A recent World Bank (2023) study concludes that the MENA region is facing unprecedented **water scarcity**. "By 2030, the **water available per capita** annually in MENA will fall below the absolute water scarcity threshold of 500 m^3 per person per year. Water scarcity will become even more acute as the **population grows**. The region's population grew from just over 100 million people in 1960 to more than 450 million in 2018. It is estimated to reach more than 720 million by 2050". Without adjustments in current water management strategies, water **demand** will rise and shortages will have a detrimental impact on **livelihoods and agricultural output** and may raise **tensions** among users, notably between farmers and cities (de Waal et al., 2023).

Important to highlight in relation to population growth are the **urbanisation** tendencies as well as the additional pressure faced by countries such as Jordan, on water systems and services due to the influx of **displaced** people, putting both host communities and refugees at risk.

Available water resources are **overallocated** across consumptive uses as agriculture, cities, and industry (see the volumetric importance of irrigation water use in the region in Figure 2). This increases tensions over water resources, within countries as well as in transboundary basins.

The key drivers of water scarcity are related to **demographics and economic growth** (see also Droogers et al., 2012). Yet the **cost of climate-related inaction** is much higher in MENA than in other regions of the world. Continuing along the current path of water management and allocation could cost the region much more than elsewhere.

A tomato farmer looks off towards an area where the Dead Sea has receded in Ghor Haditha, Jordan, on April 10, 2021.
© Marcus Yam

1.2 Need for sustainable water use and management

Countries in the MENA region have addressed water scarcity by increasing or stabilizing **water supply** by building more dams, tapping into groundwater, and desalination without adequately addressing critical water demand, efficiency, and governance issues. This is **fiscally and environmentally unsustainable** (de Waal et al., 2023).

The authors flag that there has been little focus on **reducing water losses** and introducing efficiency measures that would conserve water. There is room for optimization across use sectors:

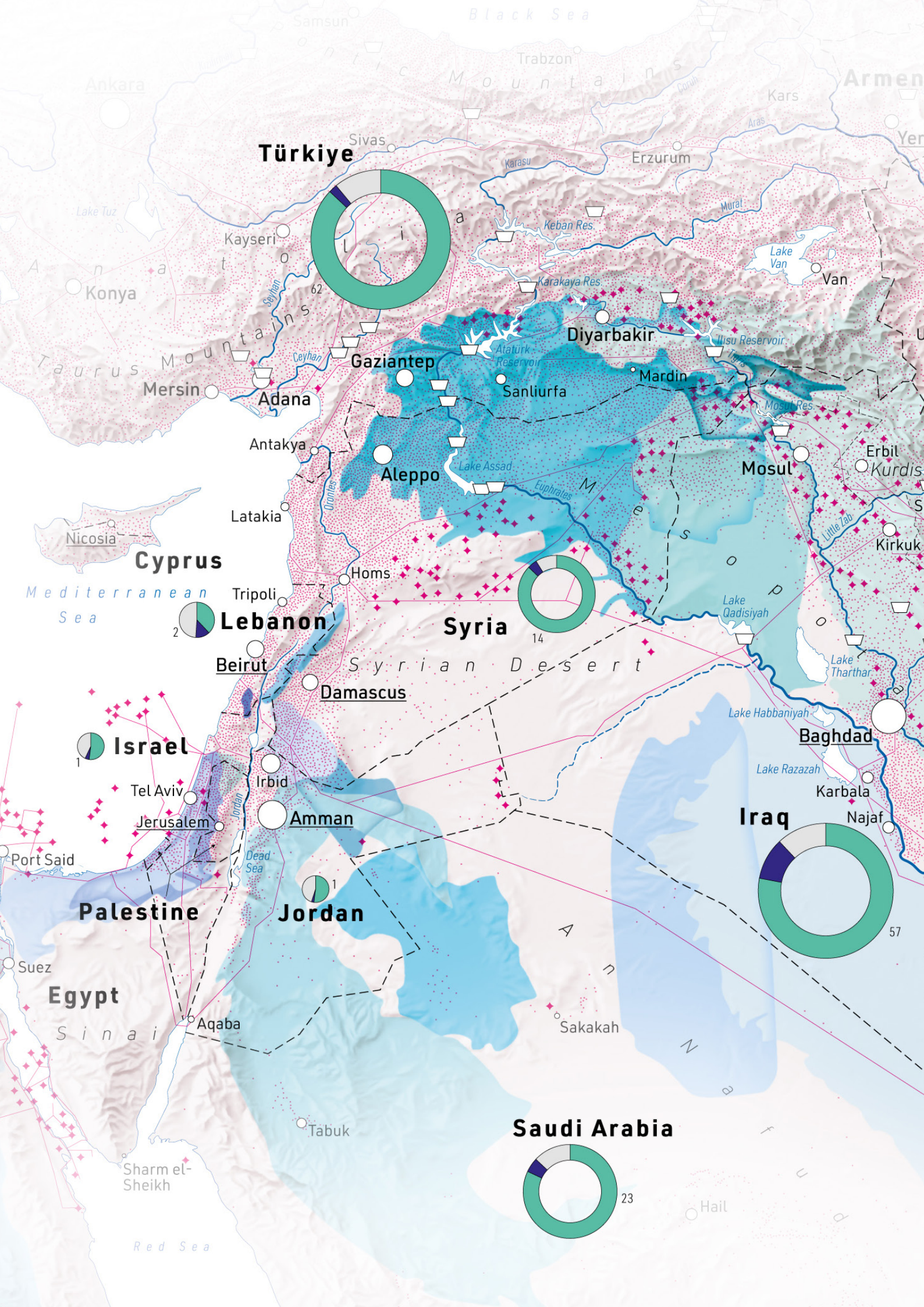
- In water supply: half of the utility service providers reported that more than 30% of the water they produce is not billed to customers due to a combination of physical and administrative losses (ibid.).
- In sanitation: 82% of collected wastewater either goes back into nature untreated or is treated but not reused (World Bank, 2017).
- In agriculture: agriculture uses nearly 80% of the region's water. Total water productivity (the economic output per volume of water used by an economy) is for many MENA countries well below that of high-income countries' average of 50 USD/m^3. The region has the highest per capita freshwater resources losses in the food supply chain in the world (ibid.).
- Across these sectors, the region has the world's lowest water tariffs and the highest proportion of GDP (2%) spent on public water subsidies (ibid.).

The unsustainable withdrawal of **groundwater** has enabled policy makers to delay tackling water management and services reforms. MENA has relied increasingly on **imports of virtual water** — water used to produce commodities — which doubled between 1998 and 2010. Reliance on virtual water imports exposes countries to supply shocks.

Existing **institutions** that manage the allocation of water across competing needs — particularly between agriculture and cities — are highly centralized and technocratic. This limits their ability to **resolve trade-offs** in water use at the local level. Reforms are needed to **decentralize decisions** about water management and service delivery (de Waal et al., 2023).

1.3 Challenges and opportunities to improve water management

In all, even without the effects of climate change on water availability and demand, tendencies such as increasing demand, water pollution and weak water governance make the **water security outlook** in the region bleak. Nevertheless, the region has examples of more optimal water use and management practices and policies. Favorable contextual factors such as a young, generally educated population; ample renewable energy supply options (wind and solar); and the use of digital technologies in water resource data, provide opportunities to improve water management.


Black Sea
Samsun
Trabzon
Pontic Mountains
Ankara
Kars
Armen
Sivas
Türkiye
Erzurum
Karasu
Aras
Lake Tuz
Kayseri
Keban Res.
Murat
Lake Van
Van
Anatolia
Konya
Seyhan
62
Karakaya Res.
Taurus Mountains
Diyarbakir
Ilisu Reservoir
Tigris
Ceyhan
Gaziantep
Atatürk Reservoir
Mardin
Mersin
Adana
Sanliurfa
Mosul Res.
Antakya
Erbil
Kurdis
Aleppo
Lake Assad
Mosul
Euphrates
Mesopo
Orontes
Latakia
Little Zab
Kirkuk
Nicosia
Cyprus
Homs
Mediterranean Sea
Tripoli
Lake Qadisiyah
2
Lebanon
Syria
14
Beirut
Syrian Desert
Lake Tharthar
Damascus
Lake Habbaniyah
Baghdad
Israel
1
Irbid
Lake Razazah
Tel Aviv
Karbala
Jordan
Jerusalem
Amman
Iraq
Najaf
Port Said
Dead Sea
1
57
Palestine
Jordan
Suez
Egypt
Sinai
Aqaba
Sakakah
Tabuk
Saudi Arabia
Sharm el-Sheikh
23
Hail
Red Sea

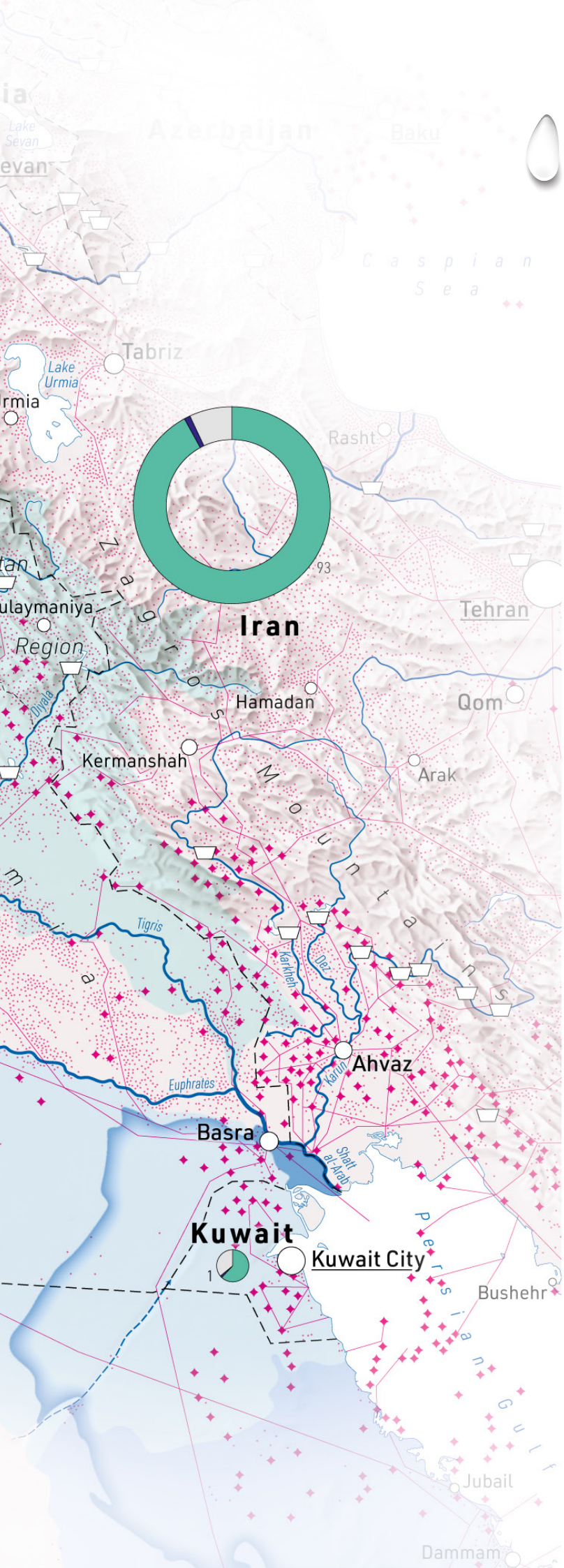


Figure 2. Water consumption per sector in countries in the Middle East region

Transboundary aquifers

Rivers

Other elements

Major hydropower plant

Gas or oil production and exploration area

Gas or oil pipeline

State borders

Regional borders

Population density

Water consumption by sector 2020, billion m³

Agriculture

Industry

Domestic

50
20
10
5
2
1

City population in million, latest available data

5 2 1 0.5 0.2 0.1

Country population in million, latest available data

Turkey 85

Iraq 38

Jordan 11

Israel 9

Saudi Arabia 33

Lebanon 5

Palestine 5

Iran 84

Syria 21

Kuwait 5

0 100 km

Map produced by Zoi Environment Network, December 2023

2. Climate change impacts on water resources and their use in MENA

The MENA region is not only the most water-scarce region in the world, it is also one of the regions most affected by climate change (Waha et al., 2017). The expected economic losses from climate-related water scarcity in this region are the most significant: estimated at 6 to 14% of GDP by 2050, as compared to a global average reduction of less than 1% (de Waal et al., 2023).

2.1 Observed climate change impacts on water resources

Climate change already has a considerable impact on water resources quantity, quality, and predictability in the region. MENA countries are already experiencing heat extremes and water shortages (Waha et al., 2017). Observations indicate large increases in temperature extremes, in evapotranspiration, and decreased precipitation in the region, contributing to drought conditions, decreased surface runoff and dust storms (Shaw et al., 2022). Heat waves have increased in intensity, number, and length during recent decades, especially in summer for the coastal Mediterranean region (Ali et al., 2022). The observed increase in meteorological droughts since the 1960s confirms the overall drying trend in the region (Waha et al., 2017). This drying trend goes hand in hand with the risk of floods, the most frequent natural disaster in the MENA region. Between 1981 and 2011, about 300 floods hit the region, killing 19,000 people and affecting more than 8.6 million people (World Bank, 2014).

2.2 Projected climate change impacts on water resources

Climate change is likely to further increase pressure on water resources. MENA countries are expected to experience future drying and temperatures increasing at a faster rate than the global land average, with increasing risks of heat waves (Borghesi and Ticci, 2019). Climate models project regional **warming** at rates about 20% above global means and **reduced rainfall** (12% less for global warming of 3°C) for MENA countries in the Mediterranean region (Ali et al., 2022).

With 2°C global warming, annual **water discharge** is expected to decrease by 15-45% (Waha et al., 2017). With 4°C global warming, the mean summer temperatures could increase by up to 8°C, while water runoff could decrease by 75%, and land aridity could increase by more than 60% in many parts of the MENA region (ibid.).

For Jordan, for example, the projections for 2070-2100 include the climate will become drier, with 16 - 47% less precipitation, more, longer and more severe droughts and 15% higher potential evapotranspiration (Jordan's 4th National Communication on Climate Change, 2023).

The low-lying areas in this region are the most exposed to coastal **climate-related risks** (e.g., sea level rise, floods, erosion) and other consequent risks (e.g., saltwater intrusion and agriculture damage). Climate change threatens water availability, reducing river low flows and annual runoff by 5 to 70% across the Mediterranean region, reducing hydropower capacity (Ali et al., 2022). By 2100, the two largest reservoirs in Jordan are projected to have a reduction in annual inflow of 31% and 65% (Rajsekhar and Gorelick, 2017).

A 16% decrease in **groundwater recharge** is projected in Jordan by 2100 due to reduced precipitation (Jordan's 4th National Communication on Climate Change, 2023). Consequently, groundwater quality is expected to decrease, with higher salinity levels (Ministry of Water and Irrigation, 2023). Lastly, climate change is likely to further increase the frequency and intensity of existing hazards, such as **flash floods** (World Bank, 2017).

2.3 Climate change impacts on water use

Higher temperatures will lead to a greater requirement for **human water consumption**, further straining the limited water supply. Increased water scarcity and variability due to climate change are furthermore expected to increase the exposure to contaminated waters, reduce water availability for sanitation and expand disease burden (ibid.; Ministry of Water and Irrigation, 2023).

Increasing water demand from irrigated **agriculture** due to higher temperatures puts the water resources under enormous pressure in the MENA region. The lack of surface flows and reliance on non-renewable groundwater reserves for irrigation makes agriculture particularly vulnerable to global warming (World Bank, 2016). Yields of rainfed crops may decrease by 64% in some locations (Ali et al.,2022).

Given the growing water demand from agriculture and other users and the increasing competition over water resources, water management needs to be improved and adaptation efforts need to be enhanced (ibid.). The **three basic management and adaptation options** are: 1) increasing the supply and storage of water, 2) decreasing demand, and 3) reducing water-related risks, i.e. the impact of precipitation extremes and variability (World Bank, 2016).

The next section will take a closer look at current water management strategies and options to take them further towards climate resilience.

A farm worker checks sprinklers, pressurized by solar energy in Mosul, Iraq, February 2022.
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3. Current water management strategies for climate resilience and future pathways

Jordan currently implements several **strategies** to reduce water scarcity and adapt to climate change related risks. The most important strategies are presented here (see for a more exhaustive list: Ministry of Water and Irrigation, 2023 and Ali et al., 2022). In line with these strategies, potential **actionable solutions** were co-created by five expert groups at the AGUASAN Workshop from the MENA region and are presented in the boxes. The solutions were shared with SDC's regional water network, the Sub-RésEAU MENA, and will serve as a thematic and strategic foundation for efforts in the region in the following years.

- **Improve the water use efficiency** in all sectors, especially in **agriculture** where on-farm water use efficiency is currently around 60%, leaving room for improvement (Ministry of Water and Irrigation, 2023). For instance, adopting pitcher irrigation to supply water to plants at specific rate, but also using drought-resistant crops (Abu-Zreig, 2022).

Box 1:
Establishing a Predictive Food Security Platform

A dynamic and coherent water-climate-crop modelling platform to enable seasonal scenario planning and the selection of high-nutritional, water-saving value crops at country and regional scale in Jordan and Lebanon.

There is a lack of understanding of how water scarcity affects food security. This is necessary to strategically reallocate water budgets for critical crops that sustain national food security. The expert group suggests creating a predictive tool looking at food security holistically. The tool is a modelling platform where water, climate, and crop data are integrated to enable scenario planning and inform crop selection for each season on country and/or regional scale. Its use could allow promoting high-nutritional value crops for national consumption and minimize the virtual water exported to other countries. For more information read the factsheet.

- **Reduce non-revenue water** (NRW) is another top priority for Jordan's water sector, to reduce water demand. In recent years, several programs and plans have been developed to address the problem. The authorities aim to reduce NRW from its current level of around 50% nationally to 25% of water supplied to urban systems by 2040. Reducing NRW is focus of a specific strategy, along four mayor pillars: 1) Strengthening institutional capacity of water utilities; 2) Effective measurement, monitoring and controlling of water supply; 3) Reducing commercial losses; and 4) Minimizing physical losses. (Ministry of Water and Irrigation, 2022).

- **Increase the contribution of non-conventional water resources to the national water budget.** Currently, there are 31 wastewater treatment plants across the country which produce 186 million m^3 of high-quality treated wastewater, with 90% already being reused in irrigation and industry (Ministry of Water and Irrigation, 2023). Future water supplies are expected to mainly rely on the sea water desalination (ibid.). The National Water Carrier Project is expected to deliver annually 300 million m^3 of desalinated water by 2027. This strategic project will take water from the Red Sea, desalinate it, and channel it 450 kilometers north to Amman and its surrounding area (Ministry of Water and Irrigation, 2022).

Box 2:
Promote decentralized, cost-effective, and valued wastewater treatment in rural areas of Jordan and Lebanon, through pilot-scale demonstration plants.

The expert group suggests shifting toward a decentralized sanitation strategy which offers agility and relatively swift sanitation improvements that communities and Small to Medium Enterprises can manage themselves. A stepwise approach is proposed to overcome resistance and to mobilize support for decentralized wastewater treatment and reuse, based on 1) Assess the state-of-the-art on decentralized/rural Wastewater Treatment (WWT) in MENA, including performance, obstacles, and opportunities; 2) Upgrade selected pilot treatment plants in Lebanon as demonstration site for stakeholders from Jordan, Lebanon, and Iraq; 3) Develop a refined concept approach to decentralized/rural wastewater treatment in MENA. For more information read the factsheet. See also Box 6 for the field visit to the South Amman Wastewater Treatment Plant and the reuse in agriculture.

- **Reduce groundwater over-abstraction and improve groundwater recharge.** This strategy has three components: 1) Control the number and expansion of wells; 2) Control the abstraction by existing wells; 3) Manage the supply, that is, increasing availability by e.g. artificial recharge (Molle et al., 2017). Groundwater resources continue to be overexploited and urgently require rehabilitation. Some of them have been totally depleted and rehabilitation may have become technically impossible (Radaideh, 2022). The outlook is bleak: current policies are unlikely to suffice for balancing supply and actual uses, and water tables will continue to fall, even though at lower rates (Molle et al., 2017).

Box 3:
Improved water information systems for evidence-based decision-making in groundwater management.

Despite its key role as central water source in the MENA region, information and data on groundwater is insufficient for evidence-based decision-making and sustainable use.

The expert group suggests developing an improved information and management system for groundwater and to enhance stakeholder awareness and involvement in the development and implementation of solutions to manage and reduce water demand. These solutions include enlarging groundwater storage and regulating water demand at large scale. For more information read the factsheet.

- **Increase water storage capacity** through:
1) Rainwater harvesting by households. At the household level, rooftop rainwater harvesting is promoted as a viable option, but its implementation rate is still limited due to its high initial cost and maintenance requirements (Al-Houri & Al-Omar, 2022). The volume of rainfall collected on rooftops could increase water supply by about 30 million m^3/year or 8% of the domestic national water supply in 2015 (Abdulla, 2020). 2) Rainwater harvesting at farm level, through measures to increase soil water retention capacity, infiltration ditches and small earthen structures (Abu-Zreig, 2022). 3) Dam construction and operation at watershed level. The scarcity of rainwater in recent years combined with sedimentation building up considerably reduced their potential to bridge water shortages (Ministry of Water and Irrigation, 2023). In 2021, six out of a total of 17 mayor surface water reservoirs have dried up (Abu-Zreig, 2022).

Box 4:
Generalised rainwater harvesting and storage at household level.

The expert group suggests fostering the willingness of public and private owners to implement rainwater harvesting and water-saving infrastructures in buildings. Rainwater harvesting can increase the self-reliance and resilience in case of temporary suspension of centralized water supply services. It can reduce tensions of refugees and host communities during drought or water supply interruptions.

High-level communication is needed to mobilize the population to become the actor of the solution by increasing the portion of rainwater harvested in urban areas. This will complement the already existing Jordanian water-saving culture. For more information read the factsheet.

- **Understanding synergies and trade-offs along the Water-Energy-Food-Ecosystems (WEFE) Nexus**. The need to understand water challenges as interrelated with food, energy and ecosystems (the WEFE nexus) is clearly emphasized in the National Water Strategy 2023-2040. Examples include using nature-based solutions for treating wastewater then reused for irrigation or using solar energy to reduce water production and transport costs and its carbon footprint. Or the importance of reducing food waste, thereby indirectly reducing the water required for its production (A&FS Network, 2023). This requires holistic, cross-sector planning and coordination of water-related policies and investments (Ministry of Water and Irrigation, 2023).

Box 5:
Recognise the value of ecosystems in the WEFE domains.

To counter the idea that protection or improvement of ecosystems has no value or added benefit in development in the water-energy-food domains, a simple step for attracting investment interest is to demonstrate the socio-economic value of the second 'E' for Ecosystems. The expert group proposes to select existing projects in the water/energy or water/agriculture sectors and identify the true monetary value of the ecosystems they support, e.g. in avoided health costs, in comparing replacement versus restoration costs or enhanced productivity and income through improved environmental quality. Demonstrating the socio-economic value of ecosystems could attract investment in the WEFE Nexus and encourage cross-sectoral project thinking that gives priority to the WEFE Nexus rather than specific sectors or resources. For more information read the factsheet.

The Sub-RésEAU MENA organised a webinar in September 2023 as a follow-up of the AGUASAN Workshop to share current thinking, draw lessons from regions where WEFE nexus thinking has already been applied and outline possible approaches for the Middle East.

- **Improve transboundary water sharing agreements with neighbouring countries** through participation in regional dialogue mechanisms, negotiation, and cooperation on water. In this regard, the Blue Peace Middle East initiative supported by SDC, launched the Yarmouk Future Programme, which in 2019 led to the creation of the Water Diplomacy Center at the Jordan University of Science and Technology. The programme generated the knowledge and capacity required to facilitate the emergence of law-based, equitable and sustainable transboundary water arrangements, with a focus on the Yarmouk tributary to the Jordan River (Abu-Zreig, 2022).

- **Improve the adaptive capacity of water utilities** to protect them from adverse impacts of climate change and reduce their environmental impacts, is one among seven central water-related objectives in the National Climate Change Adaptation Plan (NAP) of Jordan. This includes measures such as: 1) Conducting climate-proofing studies for existing water utilities and integration of climate proofing tools for planned water utilities; 2) Applying the Climate Resilience Water Safety and Security Planning tool to identify adaptation measures at utility level.

- **Improve early warning systems for rainfall, flash floods and droughts and reduce flood risk** is another key priority in Jordan's NAP. Key measures include: 1) Improving meteorological capacities in forecasting weather conditions to enhance decision making; 2) Developing flood risk maps for all urban and rural areas and identification of hotspots. In this regard, Swiss Humanitarian Aid (SHA) is supporting Jordan's authorities to strengthen their capacity to manage flash floods with the national flood mapping programme. The Aqaba Flash Flood early warning system is another example (Lechner et al., 2021).

Box 6. Field visit to the South Amman Wastewater Treatment Plant

Participants of the AGUASAN workshop visited the **South Amman Wastewater Treatment Plant**. Treated wastewater is an integral component of Jordan's water resources. The South Amman Wastewater Treatment Plant consists of bioreactor tanks, settling tanks, thickener grit chambers, grease removal installations, splitter boxes and chambers, a chlorination system, and sludge pumping stations. The wastewater is used for the irrigation of crops and for industrial uses.

Impressions from the visit at the South Amman Wastewater Treatment Plant

Also, a **local farmer** situated nearby was visited who **uses the treated wastewater**. The farmer explained the functioning of the irrigation system using wastewater, the payment for water and the financial viability. The choice of irrigation techniques is based on water efficiency and initial investment and maintenance costs. As the use of treated wastewater for crops for human consumption is not accepted, the farmer produces fodder for animal use only, a choice based on the nutritional value and potential revenue (AGUASAN, 2022:16-17).

Impressions from the visit to the local farm which uses treated wastewater for fodder crops

4. Lessons in a nutshell

The people and governments of the Middle East and the MENA region at large, face an increasing number of challenges in **managing water scarcity**: covering dry periods and droughts, feeding a growing population and sharing resources in peace with neighbours. The implications of **climate change** make the underlying water governance changes needed, more evident and more urgent. Climate extremes like droughts and floods intensify the pressure on water resources, related infrastructure, and livelihoods in all countries of the region, leaving the most vulnerable as the poor, the displaced and small farmers, most affected.

The basic strategies at hand are increasing the supply and storage of water, decreasing water demand, and reducing water-related risks. Countries as Jordan, host of the **AGUASAN Workshop 2022**, have developed water management **strategies** that consider climate-related risks along these lines.

Participants of the workshop have identified **five potential solutions** that contribute to pathways towards more resilient water management:

1) establish a platform to plan for food security, based on climate-water data and scenario thinking;

2) demonstrate the value of decentralized wastewater treatment;

3) establish water information systems for evidence-based groundwater management;

4) involve households towards generalised rainwater harvesting and storage; and

5) recognize the value of safeguarding ecosystems in projects in the WEFE domains.

The co-creation of context-specific, practical solutions has sparked collaboration among sector specialists and their organizations. SDC's newly established regional water network, the **Sub-RésEAU MENA**, is trying to take on these ideas as part of its emerging agenda for the following years.

Aljabali Hydroponic farm, UM Al amad-Amman, Jordan.
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Imprint

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Section Water

Cover photo
Extremely low water level in the Mujib dam due to drought, Jordan, June 2022
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