NSDS HUB

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WATER SCARCITY IN THE MIDDLE EAST

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Executive Summary

Water scarcity poses a global threat, but its effects are more visible in arid or semi-arid regions like the Middle East, which is one of the most water scarce regions in the world. Factors like climate change and persistent conflict, as witnessed in the Middle East, significantly exacerbate water scarcity and provoke security risks such as socio-economic instability and migration. Given the impact of limited water supplies across social, political and economic domains, water scarcity is better understood within the framework of water security. Indeed, it has the potential to significantly degrade regional security from both the human and governance perspective.

Water scarcity is already a serious problem in the Middle East, especially during periodic droughts. Climate change may exacerbate the problem, functioning as a Damocles' sword, by limiting the time available to preserve scarce water resources. Not only is water in the Middle East scarce, but it is largely sub-optimized. This means there is substantial room for mitigation measures to augment the efficiency of resource use. These measures are not limited to technology and investment, but also include governance reforms with an overarching strategy of synergy and optimization.

The potential impact of water scarcity on conflict-cooperation dynamics in the region is high, because the region's water resources are transboundary. A comprehensive regional approach is needed in order to implement an effective and sustainable solution. Furthermore, water scarcity is a potential driver of migration flows within and outside the region, which can have irreversible impacts on neighboring countries in Europe, including many NATO members. NATO should monitor the situation, especially areas where water scarcity and struggles for control of transboundary resources are potential triggers for increased tension and conflict.

In the long term, any sustainable solution requires a combination of effective mitigation measures and international cooperation. Otherwise, the scope and intensity of the impact of water scarcity may cause irreversible harm. Ideally, this fact will enhance regional dialogue and serve as a step towards broader cooperation within the region. NATO, as relevant stakeholder in the international community, should incentivize and support this regional dialogue.

1. INTRODUCTION

Originally, the term "Middle East" was used to designate the area between Great Britain and India, therefore it was coined as 'utilitarian' and 'Eurocentric' term. Nevertheless, the region generally known as the Middle East is subjected to common dynamics, and one of its key features is water scarcity. In fact, together with North Africa, the Middle East is considered the most water scarce region in the world. The Middle East/North Africa (MENA) region has 1,100 m^3 of renewable water per capita per year. For comparison, Western Europe has 5,400 m^3 and North America 20,300 m3[1].

Water scarcity is defined as scarcity in availability due to physical shortage, or scarcity in access due to the failure of institutions to ensure a regular supply or due to a lack of adequate infrastructure. Almost 4.5 % of the world's population lives in the Middle East but they have only 1% of the global water resource availability. 61%[2] of the region's population is exposed to high or very high water stress, whilst elsewhere in the world, the average is 36%. In MENA, 60% of the population lives in areas affected by water scarcity and 71% of GDP is produced in these areas[3].

While the region's water resource challenges have been evident for hundreds of years, modern challenges are increasing the situation's complexity. Climate change, trends in urban development, displacement and forced migration flows within the region have led to population increases predominantly in water scarce areas[4]. In the absence of specific, long-term water security policies with a regional scope, these intertwined challenges have stressed regional political stability, and even contributed to or exacerbated civil wars and interstate conflicts.

Therefore, water scarcity should not be understood as a mere physical phenomenon, but indeed as a dynamic that can affect the population of an entire region, with even broader second order effects. As such, the concept of water scarcity is inextricably linked to "water security". In fact, according to the United Nation's definition, water security is "the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water to sustain livelihoods, human well-being, and socio-economic development, to ensure protection against water-borne pollution and water-related disasters, and to preserve ecosystems in a climate of peace and political

[1] World Bank 2008, Making the Most of Scarcity

[2] Water stress measures total annual water withdrawals (municipal, industrial, and agricultural) expressed as a percentage of the total annual available blue water. Higher values indicate more competition among users.

Score	Value
[0-1)	Low (<10%)
[1-2)	Low to medium (10-20%)
[2-3)	Medium to high (20-40%)
[3-4)	High (40-80%)
[4-5]	Extremely high (>80%)

https://www.wri.org/resources/data-sets/aqueduct-projected-water-stress-country-rankings

[3] World Bank. (2019). Beyond Scarcity: Water Security in the Middle East and North Africa.https://www.worldbank.org/en/topic/water/publication/beyond-scarcity-water-security-in-the-middle-east-and-north-africa

[4] World Bank. (2019). Beyond Scarcity: Water Security in the Middle East and North Africa.

stability"[5]. More specifically, without sustainable access to clean water, any society or economy will be disrupted. Thus, water is critical to ensure security in society, having a direct impact on political stability.

Geography adds yet another layer of complexity to the issue. Like many water sources around the world, surface and ground water resources in the Middle East are transboundary. Primary river basins and aquifers are shared by at least two countries, and some by three or four countries. Therefore, any single-sided solution to water scarcity, without a consensus between riparian countries, is likely to fall short. This is most evident by the effects on downstream countries resulting from policy decisions implemented by their upstream neighbors, which has often resulted in increased tensions. However, the region also offers examples of inter-state projects\cooperation as far as water resources are concerned, even without a comprehensive framework for broader cooperation in place.

The severity of the water scarcity problem in the region is compounded by a number of potential threat multipliers, such as worse case scenarios for climate change (that can lead up to an 8°C increase in temperatures in parts of the Middle East by the end of the century)[6], or the vicious cycle of conflict and fragility that prevents states from properly managing complex issues like water scarcity, eventually leading to increased tensions and wide-ranging governance failures. Indeed, recent academic works as well as NATO studies[7] acknowledge that climate change might also contribute to triggering conflicts due to declining food and water resources, which in turn can lead to economic crises and undesired spillover effects across the region and beyond.

Geographically speaking, while connecting Asia, Europe and Africa by land, the Middle East also has a strategic impact on major maritime corridors like the Strait of Hormuz, the Suez Canal and the Bab el-Mandeb, which are crucial for global trade and economy. In this sense, any type of instability or lack of any kind of security policy in the region has diverse effects all around the world. Therefore, adverse impacts can also affect NATO and its member countries, and primarily members of the alliance which are located on the Mediterranean basin. A stable Middle East (and North Africa) is, therefore, a high priority for NATO, so that it can ensure a safer and more secure alliance.

2. STATEMENT OF THE PROBLEM

2.1 CURRENT SITUATION

The Middle East region accounts for almost five percent of the total land area in the world and hosts 4.4% of its population, but the region's 484 km^3 of renewable water only represents 1.1% of the

[5] UN Water, Water Security & the Global Water Agenda, 2013, http://www.unwater.org/publications/water-security-global-water-agenda/

[6] https://research.csiro.au/foodglobalsecurity/wp-content/uploads/sites/63/2017/12/Waha-et-al-2017-Climate-change-impacts-in-the-Middle-East-and-Northern-Africa-MENA-region-and-their-implications-for-vulnerable-population-groups.pdf

[7] NATO, Food And Water Security in the Middle East and North Africa, 2017, https://www.nato-pa.int/document/2017-food-and-water-security-mena-region-martens-report-176-stc-17-e-bis

world's total renewable water resources[8]. Overall, water resources per capita in the region are one-sixth of the global average, or about 720 m^3 per capita per year[9]. Nine out of 15 countries in the region are characterized by absolute water scarcity[10]. This is especially true in the Arabian Peninsula, the most disadvantaged sub-region in the Middle East, which has only one percent of the renewable water resources in the Middle East while comprising 47% of its geography. Kuwait actually has no internal renewable water resources.

The progressive depletion of existing groundwater resources (aquifers) is already evident across the region. Driven by agriculture, which accounts for 80% of total water withdrawals for the purposes of irrigation, the use of underground resources has reached a point where it is unsustainable[11]. The Middle East gets 1.564 km^3 of rainfall annually, which equals to a regional average of 238 mm per year, and this does not reflect large disparities between individual countries. For example, as the driest in the region, Oman only gets 67 mm of rain per year, whereas Lebanon is the rainiest with 823 mm[12]. Moreover, mainly due to fluctuations in rainfall patterns, annual surface water availability can deviate by as much as 75% from annual means. Considering that 300mm is the lowest volume of annual rainfall that allows for rain-fed agriculture, in much of the region groundwater extractions act as a necessary buffer against annual and seasonal changes in rainfall.

The fact that both ground and surface water are transboundary in nature adds an additional layer of complexity, implying that a certain degree of cooperation between countries is needed in order to manage water resources in a truly sustainable way. Indeed, there are nine different shared river basins in the region[13], with the main transboundary rivers in the Middle East region being the Tigris and Euphrates Rivers flowing to the Persian Gulf and the Jordan River flowing to the Dead Sea. These two transboundary river basins cover around 10% of the total area of the Middle East region. Also, there are twenty aquifers that are shared by a minimum of two countries, seven of which are shared by either three or four countries[14]. One of these aquifers, centered on the Arabian Peninsula, is a multi-layered aquifer system and covers an area of around 1.5 million km^2, stretching from Saudi Arabia into Jordan in the northwest and into the Gulf countries in the east. Even if the combined stock is estimated to be on the order of 2,000 km^3, these large aquifers generally receive low rates of recharge, with the actual replenishment ratio being around 1\2000 per year.

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[8] Renewable water resources are defined as the average manual flow of rivers and recharge of aquifers generated from precipitation.

9 World Bank (2007), Making the most of scarcity. http://siteresources.worldbank.org/INTMNAREGTOPWATRES/Resources/Making_the_Most_of_Scarcity.pdf

[10] UN Water defines absolute water scarcity as a quantity of annual water supplies below the threshold of 500 m^3 per person. See http://www.unwater.org/water-facts/scarcity/#

[11] In the Arabian Peninsula, with the exception of land serviced by spate irrigation, all irrigated production is reliant upon groundwater pumping and associated 'quanats' (underground aqueducts).

[12] FAO AQUASTAT, http://www.fao.org/nr/water/aquastat/countries_regions/profile_segments/meast-WR_eng.stm

[13] ESCWA 2013, Inventory Of Shared Water Resources In Western Asia, http://waterinventory.org/sites/waterinventory.org/files/00-inventory-of-shared-water-resources-in-western-asia-web.pdf

[14] ESCWA 2013, Inventory Of Shared Water Resources In Western Asia, http://waterinventory.org/sites/waterinventory.org/files/00-inventory-of-shared-water-resources-in-western-asia-web.pdf

Historical trends of water scarcity in the region, and the resulting present shortage, are mainly driven by two factors: climate change and population growth. While the former leads to a decrease in water supply, the latter implies a rising demand. Thus, the shortage is the combined impact of a sharply increasing water demand (some estimates predict an increase of 50% by the middle of the century) and a decrease in water supply (by about 12%)[15]. Unsatisfied demand for the entire MENA region, expressed as percentage of total demand, is expected to increase from 37% in 2020-2030 to 51% by 2040-2050[16].

Water stress is calculated by comparing water withdrawal by all sectors in relation to the available water resources[17]. Already the most water stressed region of the world, the Middle East is expected to become continually more strained. The global average for water stress is 13%, yet the majority of the countries in the Middle East stand at more than 60%. According to the World Resources Institute, Bahrain, Qatar and UAE are on top of the list of water stressed countries, with a score of 5.00, meaning "extremely high" water stress. All other countries in the region, except Egypt, have scores of 3.5, signaling "high" water stress. The Dead Sea and Tigris-Euphrates basin are also "extremely high" stress areas. By 2040, in a business-as-usual scenario, Israel, Palestine, Saudi Arabia and Kuwait will join others on top of the list and all other countries in the region will reach a water stress level of at least 4.5 with the exception of Egypt[18].

By all accounts, the current trends of water resource exploitation are unsustainable[19]. Mitigation measures currently in place, as a whole, are not enough to meet water demand even at current levels. Low water productivity rates and a general sub-optimization of existing resources only exacerbate the situation. Although the Middle East has nearly half of the world's desalination capacity, this is unevenly distributed across the region. In fact, the estimated amount of desalinated water produced in the Middle East is 3,22 km³/year, of which 87,4% is produced on the Arabian Peninsula.

2.2 The Relevance of the Water-Food-Energy Nexus

The problems associated with water scarcity are inextricably linked to the dynamics of food and energy. The availability of water and its variability affects all economic activity, and increasing water scarcity undermines food and energy security. In fact, the production of food requires large quantities of water, while in several cases a substantial amount of energy is needed to access water (e.g. desalination plants and pumping). As result, negative impacts in one sector have a potential to negatively affect the other two sectors. Understanding the cyclical dynamics associated with the

[15] P. Droogers et al. (2012), *Water resources trends in Middle East and North Africa towards 2050*, https://www.hydrol-earth-syst-sci.net/16/3101/2012/hess-16-3101-2012.pdf . The scenarios generated take into account uncertainty regarding the evolution and impact of climate change. According to Droogers, 22 % of the water shortage in the MENA region in 2050 can be attributed to climate change and 78 % to changes in socioeconomic factors.

[16] World Bank (2011), Middle-East and Northern Africa Water Outlook, http://siteresources.worldbank.org/INTMNAREGTOPWATRES/Resources/MNAWaterOutlook_to_2050.pdf

[17] FAO (2018), *Progress on level of water stress - Global baseline for SDG 6 Indicator 6.4.2 2018*, http://www.fao.org/3/CA1592EN/ca1592en.pdf

[18] https://www.wri.org/publication/aqueduct-country-and-river-basin-rankings

[19] According to World Bank (2018), the MENA region is a global hotspot of unsustainable water use.

water-food-energy nexus are crucial not only for achieving sustainable development, but also for managing a single natural resource and harmonizing different national policies[20].

The problems that result due to water-food-energy dynamics are particularly visible in the case of the Middle East for two main reasons: demographics and governance. The first reason is linked to the peculiar geographical and socio-economic landscape of the region. All of the most reliable forecasts indicate an increase in water scarcity in the coming decades, where, in a worst-case scenario, all the countries of the region will exhaust groundwater reserves by 2050. This trend is mainly due to the increase in demand due to population growth and urbanization, which increases water stress in certain areas. The latter, in turn, may be exacerbated by the decrease in arable land due to the increase in water scarcity. The impact on national economies is expected to be large. In some Middle Eastern countries, agricultural production is expected to fall by 60% and the region may lose between 6 and 14% of GDP due to water scarcity by 2050[21]. Considering that more than 80% of water resources in the Middle East are destined for agricultural use, and that agriculture employs about 30% of the population, water scarcity has the potential to deeply undermine the structure of society[22].

The second reason for the significant impact of the water-food-energy nexus on the Middle East lies in historical factors, namely, poor relations between countries in the region and the consequences of a lack of valid regional governance bodies. A high degree of conflict in the region, together with the scarcity of resources, has led many countries to consider the management of water resources and food production as national security issues[23]. As a result, it is difficult for regional organizations to develop and implement effective transnational policies regarding water resource management and food and energy security. Likewise, it is also difficult to develop comprehensive strategies that take into account all aspects of the nexus, even on a unilateral basis. In fact, quite often, the management of water and agricultural production is used to gain favor with different regimes distributing benefits to certain groups or social classes[24]. This is highly evident in the case of energy and fuel subsidy policies, which make it economically more convenient to continue exploiting aquifers instead of implementing reforms in agricultural production and irrigation methods. Finally, it should be noted that the ability to implement effective strategy varies considerably depending on the state of the economy of the individual countries. In fact, the countries with higher GDPs per capita (specifically, the countries of the Gulf Cooperation Council) are the countries that have invested most heavily in the exploitation of unconventional water resources (e.g. desalination and wastewater treatment)[25].

[20] UN Water, http://www.unwater.org/water-facts/water-food-and-energy/

[21] The Water-Energy-Food Nexus in the Middle East and North Africa : Scenarios for a Sustainable Future, p.4 https://openknowledge.worldbank.org/bitstream/handle/10986/29957/W18012.pdf?sequence=4&isAllowed=y

[22] FAO http://www.fao.org/3/y1860e/y1860e05.htm

[23] IFPRI, FAO, Agriculture and economic transformation in the Middle East and North Africa: A review of the past with lessons for the future, http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/132725

[24] Woertz, Eckart (2017) 'Agriculture and Development in the Wake of the Arab Spring' in G. Luciani (ed.) *Combining Economic and Political Development : The Experience of MENA*, International Development Policy series 7 (Geneva: Graduate Institute Publications, Boston: Brill-Nijhoff), pp. 144–169, https://journals.openedition.org/poldev/2274

[25] Beyond scarcity, p.61

Overall, the interdependence between the dynamics that regulate water, food and energy on the one hand and the factors that affect the development of efficient governance on the other hand, show how water scarcity has the potential to increase the overall fragility of a state, which in turn makes it extremely complex to adopt adequate mitigation and prevention measures. In this sense, the issue of water scarcity overlaps with the concept of water security, since it has a direct impact on the ability of a population to have guaranteed and adequate access to resources, and the ability of a state to support socio-economic development and to guarantee an overall climate of political stability.

2.3 Threat Multipliers

Against the background of the complex interconnections mentioned above, it must be noted that there are factors that can act as threat multipliers, or factors of regional or global scope that can exacerbate existing problems, undermine the overall resilience of a country or region, and compound risks. As for the issue of water scarcity in the Middle East, the looming threat multipliers are climate change and the potential for conflict.

There's a growing consensus in the scientific community and among policymakers that climate change will likely have a negative impact on global stability. To cite just one example, in the 2014 US Quadrennial Defense Review, the effects of climate change are defined as "threat multipliers that will aggravate stressors abroad such as poverty, environmental degradation, political instability, and social tensions; conditions that can enable terrorist activity and other forms of violence"[26].

The Middle East is the region of the world that is most exposed to negative impacts resulting from climate change. The region is already naturally prone to extreme temperatures and water shortages. Warming of about 0.2°C per decade has already been observed in the MENA region from 1961 to 1990 and even greater since then[27].

Climate change is expected to impact livestock production in various ways, such as changes in the quantity and quality of available feeds, changes in the length of the grazing season, additional heat stress, reduced drinking water and changes in livestock diseases and disease vectors[28]. The vulnerability of livestock production systems to droughts was recently demonstrated in northeastern Syria, where herders lost almost 85% of their livestock as a result of the recurring droughts between 2005 and 2010[29].

Crop yields are expected to decline by 30% with 1.5–2°C warming[30] and up to 60% with 3–4°C warming[31]. Whilst the region is already expected to dependent on imports of 50% of its food

[26] http://archive.defense.gov/pubs/2014_Quadrennial_Defense_Review.pdf
[27] https://research.csiro.au/foodglobalsecurity/wp-content/uploads/sites/63/2017/12/Waha-et-al-2017-Climate-change-impacts-in-the-Middle-East-and-Northern-Africa-MENA-region-and-their-implications-for-vulnerable-population-groups.pdf
[28] Thornton et al. 2009
[29] Selvaraju 2013
[30] Al-Bakri, Suleiman, Abdulla, and Ayad 2011; Drine 2011
[31] Schilling et al. 2012

requirements by 2050, the combined effects of population growth and climate change will require an increase in cultivated land of 71%, just to maintain imports at 50%[32].

Therefore, climate change might act as a threat multiplier in the Middle East region by placing additional pressure on already scarce resources and by reinforcing preexisting threats such as political instability, poverty and unemployment. Combined with poor human security, e.g. water, food, energy and health, this can create the potential for social uprising and violent conflict[33].

As individuals, communities, provinces or entire states experience such water challenges and fear mounts regarding future availability, they engage in competition over these resources with other actors. This has consequences, ranging from minor disagreements to broad-scale and intense conflict.

Indeed, the Middle East region is highly prone to conflict and conflicts have a major impact on water related issues. Water can play a role as a trigger or as an element among others that can be identified as root causes of conflict, where there is a dispute over the control of water or water systems or where economic or physical access to water, or scarcity of water, triggers violence.

While hydro-political tensions have existed in the region for centuries, recent examples of enduring tensions and full-fledged conflicts, related at least in part to water issues, are particularly abundant. During the '70s, Syria and Iraq were on the brink of conflict after Damascus completed the Tabqa Dam, leading to a significant decrease in water flow downstream. Iraq asked for Arab League intervention, citing that the flow of water reaching Iraq had fallen from the normal 920 m³/s to an "intolerable" 197 m³/s. While Arab League intervention did not help in easing tensions, later mediation by Saudi Arabia averted impending violence[34]. As for the Arab-Israeli conflict, during the Six Day War, one top Israeli priority on the Syrian front was gaining control of water sources. Israel destroyed the Arab diversion works on the Jordan River headwaters. The water resources of the occupied region were declared as state property. By many accounts, the political conflict that led to the war in Syria in 2011 has been aggravated by the multi-year drought that gripped the region between 2005 and 2010, resulting in massive migration westward to urban areas such as Aleppo, Hama, Homs, Damascus and Dara'a.

2.4 MITIGATION MEASURES

Water Resource Optimization

As already mentioned, the MENA region, is the most water stressed region in the world. However, the World Bank highlights two important facts: 82% of wastewater in the region is not recycled, presenting a massive opportunity to meet water demands; and total water productivity in the region

[32] INRA, PLURIAGRI, Addressing Agricultural Import Dependence In The Middle East - North Africa Region Through The Year 2050, https://inra-dam-front-resources-cdn.brainsonic.com/ressources/afile/308329-e5409-resource-addressing-agricultural-import-dependence-in-the-middle-east-north-africa-region-through-to-the-year-2050.html

[33] Scheffran et al. 2012

[34] Wolf, Aaron. "Middle East Water Conflicts and Directions for Conflict Resolution

is only about half the world's average[35]. Therefore, water in Middle East is not only scarce but largely sub-optimized. This section will elaborate on possible mitigation strategies. These strategies are not limited to technology and investment, but also include government reforms, combined with an overarching strategy of synergy and optimization. A good part of water resources in MENA region are transboundary. Consequently, effective strategies require international cooperation. The potential effects of such strategies may be reducing the use of water, relocating water, and creating water:

Reduce the use of water

Using less water is the most cost-effective way to address water scarcity. Reducing water does not imply rationing, but rather the use of water in a way that avoids waste. The measures to be applied are both technical and political and look to increase the efficiency of water distribution systems. To develop more efficient systems, the first step is to assess them for inefficiencies, which requires metering. Something as simple as basic operations and maintenance training has the potential to yield substantial positive results. For example, training staff members in areas such as pressure management and improving network operations has helped reduce water losses by up to 40 percent in Ain Al Basha in Jordan[36].

Placing a value or price on water would help to signal its extreme scarcity and promote its conservation in the Middle East. Currently water in Middle East is strongly subsidized (2% of GDP). These subsidies prevent changes that would otherwise be market driven, such as changes to less water demanding crops. Additionally, market pricing would more effectively cover the costs of service provision and provide financial resources for water resources protection, infrastructure maintenance, and service delivery. However, the significant short-term downside is the negative impact on the poorest segment of the population, which may lead to social unrest[37]. Nevertheless, available data for selected countries globally suggest that the poorest 20% of the population receive less than 10% of subsidies incurred by public water utilities, while the richest 20% capture over 30% of the subsidies[38]. A targeted system of subsidies may be a balanced solution.

Relocate water

Water productivity (WP) is defined as the economic output produced per cubic meter of fresh water. In the MENA region WP is about half of world's average. The situation is even worse in certain countries; while Israel and the Gulf Cooperation Council states have some of the world's highest productivities, Iraq or Iran are far below the regional average.

Water productivity also differs significantly by sector, with the lowest productivity in agriculture. One recent global study suggests that domestic water output capacity is double that of agricultural water and that industrial water is triple. Nevertheless, more than 80% of the water in the Middle East is dedicated to agriculture. The low productivity may be mitigated by repurposing agricultural

[35] (https://www.worldbank.org/en/topic/water/publication/beyond-scarcity-water-security-in-the-middle-east-and-north-africa)
[36] GIZ 2014, 206
[37] Protest in Egypt (2017) and Jordan (2018) against subsidy cuts.
[38] Fuente et al. 2016

water for domestic and industrial uses. The decrease in agricultural water can be balanced with more efficient water systems, less water demanding crops and the use of recycled water.

Create more water

Potable water is created through desalination, recycling and virtual water. Desalination and water recycling offer the potential for highly reliable water supplies independent of the effects of climate change. These technologies are appealing because they provide a "drought-proof" supply source, essentially allowing countries to break free from naturally occurring physical water scarcity.

Desalination offers a potential strategy to alleviate water scarcity, yet it is capital and energy intensive both to produce and to transport[39], making it an expensive solution for many countries in the region. Recycled water is another potential nonconventional supply source that is generally more cost-effective and less energy intensive than desalination[40]. However, its implementation remains in the early stages in the MENA region. Not all wastewater undergoes treatment; and of the wastewater that is treated, the majority is discharged unused into the sea. The discharge of treated wastewater into the sea wastes a useful supply source. Virtual water is the water needed to produce a particular commodity[41]. Therefore when a product is imported it remains associated with the water used in its production. Virtual water trading is a viable option; however, increasing imports also increase costs and may affect trade balances.

In conclusion, mitigating measures are available, but require significant investments, by both the public and private sectors, in technology and education, at a regional level. Such measures are essential to optimize water usage and to mitigate negative socio-economic consequences due to water scarcity. Therefore the results are directly related with the level of cooperation by all the stakeholders in the region.

[39] The average cost of desalination is roughly $5 for 1000 gallons of water while a typical municipal water supplier charges about $1.50 for 1000 gallons. Fairfax Water. Is Water Free?. Retrieved from http://www.fcwa.org/story_of_water/html/costs.htm

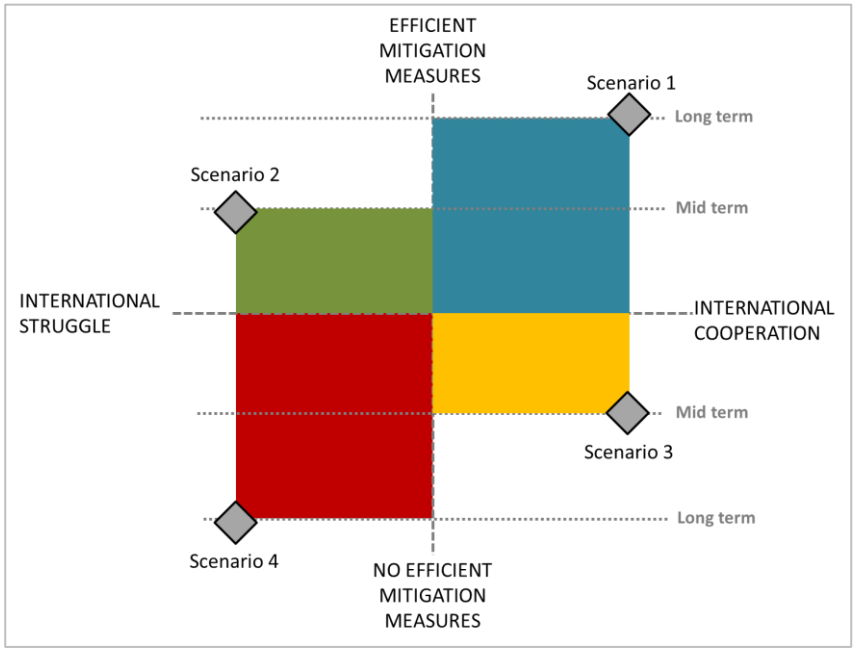
[40] The overall cost for desalination is 2.21 times higher than for reuse (Côté et al., 2005).

[41] John Anthony Allan introduced the virtual water concept. "The water is said to be virtual because once the wheat is grown, the real water used to grow it is no longer actually contained in the wheat. The concept of virtual water helps us realize how much water is needed to produce different goods and services. In semi-arid and arid areas, knowing the virtual water value of a good or service can be useful towards determining how best to use the scarce water available."

3. POTENTIAL SCENARIOS

As mentioned above, the Middle East is one of the most water stressed regions in the world and water scarcity may have a huge impact at a regional and even global level. This impact could then be exacerbated by global warming associated with climate change. Nevertheless, at this moment, both water scarcity and its effects could be reversed, or at least softened, if appropriate actions are taken. What the Middle East may look like in the future is directly dependent on what, if any, actions are taken.

In order to anticipate different plausible scenarios for the Middle East, these actions are divided into two categories: mitigating measures at the national level and regional/international cooperation. The first category, mitigation actions at the national level, is measured by the level of implementation of the actions mentioned in section 2.4. Regional/ international cooperation calculated based on the prevailing paradigm regarding transnational water resources: struggle for their control or cooperative management. This paradigm may materialize in tensions or conflicts, or agreement and cooperative strategies. The picture to the right provides a graphic representation of the previously mentioned categories on an axis diagram with four potential resulting scenarios plotted on the diagram. A brief explanation of each scenario is presented below.



Scenario 1: Efficient mitigation measures and international cooperation

The impact of water scarcity is mitigated by employing modern technologies including treatment and reuse of wastewater for industrial and agricultural purposes, affordable desalination technology, and more efficient irrigation systems in agricultural production. Improvements in agriculture production costs as well as in the production of treated water for industrial purposes will, in turn, have a positive impact on the regional economies and supplies of potable water in urban areas. Increased cooperation also has positive second order effects on reducing migration and slowing urbanization. Even though some areas in the region become unfit to support agriculture or human life, migration rates are low, thus leaving enough room for some spillover into neighboring countries, whose economies can cope with the rate of influx. In general, cooperation and efficient mitigation measures regarding water scarcity lead to increased security and stability in the region.

Scenario 2: Efficient mitigation measures and international struggle

Generally speaking, mitigation measures have been successfully implemented at national levels. Nevertheless, regional actors try to control the water resources to their exclusive benefit. This situation may happen within a broader geopolitical struggle and not necessarily due to tensions related exclusively with water resources. This scenario is hardly sustainable in the long term since without a regional/international strategy able to manage the transboundary resources, national level measures will have only limited and temporary positive effects. Thus, this is a transition scenario that may lead to scenarios one or four.

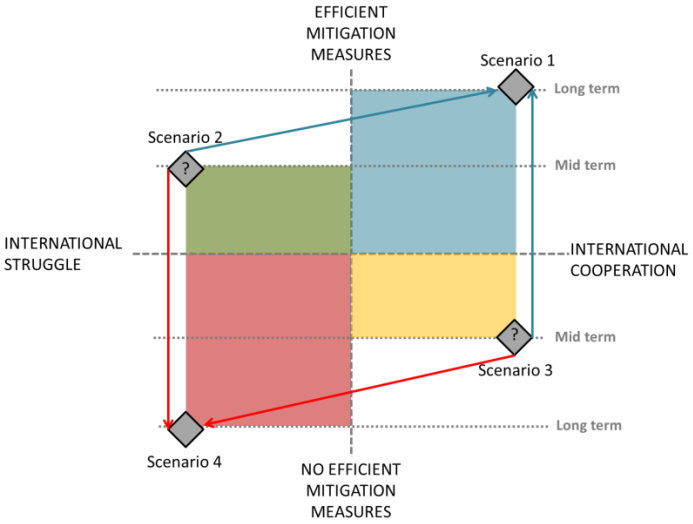
Scenario 3: No efficient mitigation measures and international cooperation

Although regional actors have adopted a cooperative approach to deal with transboundary water resources, the mitigation measures have not been implemented or have not been enough to solve the problem, perhaps due to the effects of climate change. As in the previous case, this scenario is a transition scenario. The most likely evolution is increasing water scarcity that leads to scenario 4. Climate change is likely an exacerbating factor in this scenario. However, international cooperation due to climate change could contribute to increase the efficiency of mitigation measures and drive to scenario 1.

Scenario 4: No Efficient mitigation measures and international struggle

In this scenario, water scarcity and conflict are high. Due to water scarcity, alone, habitable areas have been significantly diminished and remaining sources of water have been overexploited across the entire region. The lack of water has also led to food scarcity and prevents economic development. Further complicating the scenario, the overall security environment is significantly degraded and conflict exists at several levels, compounding the previously mentioned economic impact and also strongly impacting governance. Water scarcity reinforces existing conflicts and triggers new ones.

Increasingly, large portions of the population are forced to migrate, igniting new struggles to control access to water and other resources. As a result, governance degrades rapidly. Institutions cannot cope with massive migrations and all of their associated problems, especially in an insecure environment. The regional economy fails, and as socio-economic conditions worsen, water scarcity drives food scarcity. The economic center of gravity of the region, oil production and distribution, is disrupted partially or completely. Since the regional dynamics are linked with the surrounding regions, the risk of conflict spillover increases.



In conclusion, only a combination of mitigation measures within the framework of international cooperation is sustainable in the long term.

To translate this theoretical approach into the practical domain, two case studies related to their corresponding scenarios have also been developed.

4. CASE STUDIES

4.1 THE RED SEA-DEAD SEA (RSDS) WATER CONVEYANCE PROJECT

Jordan is one of the top 10 countries having the lowest rate of renewable freshwater per capita[42]. The Jordanian Ministry of Water and Irrigation predicts that countries population will double by 2050 (from the current 9.7 million) and the demand in water for domestic use will increase by 50-60%[43]. Steadily increasing population, environmental challenges due to global warming, and a growing deficit between freshwater resources and demand have pushed Jordan to find ways to overcome this problem by cooperation with its neighbors.

Figure: 1 Red Sea-Dead Sea Canal (Source: WaterWorld.com)

The depletion of the Dead Sea has been an issue of high concern since 1994, when the first Peace Treaty between Jordan and Israel was signed. These two nations, together with the newly-created Palestinian Authority (PA), began a slow

[42] https://data.worldbank.org/indicator/ER.H2O.INTR.PC?year_low_desc=false

[43] www.mwi.gov.jo/sites/en-us/Hot%20Issues/Strategic%20Documents%20of%20%20The%20Water%20Sector/National%20Water%20Strategy(%202016-2025)-25.2.2016.pdf

walk towards cooperation with talks of cooperation on a water conveyance project to "save" the Dead Sea. In 2005 Jordan, Israel and the PA agreed on a joint venture called the Red Sea-Dead Sea (RSDS) Water Conveyance project (i.e. Red Sea-Dead Sea Canal). With estimated costs around 11 billion US dollars, it aims to meet the following three objectives: a) Save the Dead Sea from drying out by 2050; b) provide fresh water for Jordan, Israel and the Palestinian Authority by desalination; c) set an example of cooperation in a region that suffers from seemingly perpetual conflict.

On 9 December 2013, the three parties signed a new agreement, initiating the first phase of RSDS.[44] Specifically, this phase includes the construction of a desalination plant at the Jordanian port of Aqaba, which will desalinate 800-1,000m cubic meters (mcm) per year and will be shared by the neighboring countries. Secondly, it calls for the construction of a 180 km pipeline/canal to pump brine from the Red Sea to the Dead Sea, in order to rehabilitate the Dead Sea.[45]

As shown in Figure 1, the RSDS project will also include hydropower plants to produce electricity, while water from the Red Sea is carried through a pipeline with the help of more than 400 meters of elevation change. Once it is finished, the project is meant to produce about 65 million cubic meters per year of desalinated water for people living in Aqaba, Eilat, Amman and territories under the Palestinian Authority[46], totaling 850 million cubic meters per year for all three beneficiaries[47]. All beneficiary countries' officials continuously show their commitment to the project. However, it must be noted that, even amid these positive statements from all sides, no concrete terms have been set since 2005, when negotiations first started.

Today, Jordan faces chronic water scarcity, complicated by traditional overuse which has been increased due to refugee arrivals since 2011. However, the Ministry of Water and Irrigation of Jordan estimates that the Red Sea Dead Sea (RSDS) project will reduce water demand by 6% by 2025. This appears plausible if all other variables affecting the project such as the availability of foreign aid, renewable water resources and cooperation between the countries involved occurs as predicted. However, in a region that has been historically plagued by political instability, and where many of these same variables may impact the realization of the project, it could be argued that, even if RSDS becomes operational, it will only provide temporary relief rather than serve as a sustainable long term solution. Also, statistically, the project is a small step to satisfy the annual anticipated water demand in the year 2050 for Jordan, Israel and the PA, predicted to be 3 km^3 to meet "basic human needs" of an estimated population of 30 million[48]. In other words, it will mitigate water scarcity but not reverse the trend.

[44] www.mwi.gov.jo/sites/en-us/Hot%20Issues/Strategic%20Documents%20of%20%20The%20Water%20Sector/National%20Water%20Strategy(%202016-2025)-25.2.2016.pdf

[45] www.mwi.gov.jo/sites/en-us/Hot%20Issues/Strategic%20Documents%20of%20%20The%20Water%20Sector/National%20Water%20Strategy(%202016-2025)-25.2.2016.pdf

[46] https://www.al-monitor.com/pulse/originals/2019/02/red-dead-sea-project-cooperation-israel-jordan.html#ixzz5jAzyz5Ao

[47] http://siteresources.worldbank.org/EXTREDSEADEADSEA/Resources/5174616-1416839444345/SoA-FINAL_March_2014.pdf

[48] http://siteresources.worldbank.org/EXTREDSEADEADSEA/Resources/5174616-1416839444345/SoA-FINAL_March_2014.pdf

The RSDS, being a regional initiative requiring high interstate cooperation, fits into the "High cooperation-High Water Scarcity" scenario. Although, like in the scenario, this initiative has the potential to reduce the effects of water scarcity in the region, if we look at the history of cooperation in the Middle East, it is hard to foresee the uninterrupted cooperation necessary for the timely and successfully completion of the RSDS. Even though cooperation between Jordan and Israel has steadily increased since the Peace Treaty in 1994, there have still been fluctuations and minor incidents (like the events that occurred at the Israeli Embassy in Amman in 2017). Additionally, disputes over Holy Sites in Jerusalem have the potential to halt the project for a long time. Furthermore, it is not entirely implausible that such political disruptions may result in outright conflict or asymmetric warfare, which would freeze efforts to cooperate. Thus, it must be noted that there remains substantial room for conflict between the three parties of the RSDS, conflict which would move the situation towards the "High conflict-High water scarcity" scenario.

4.2 South Iraq Case Study

Introduction

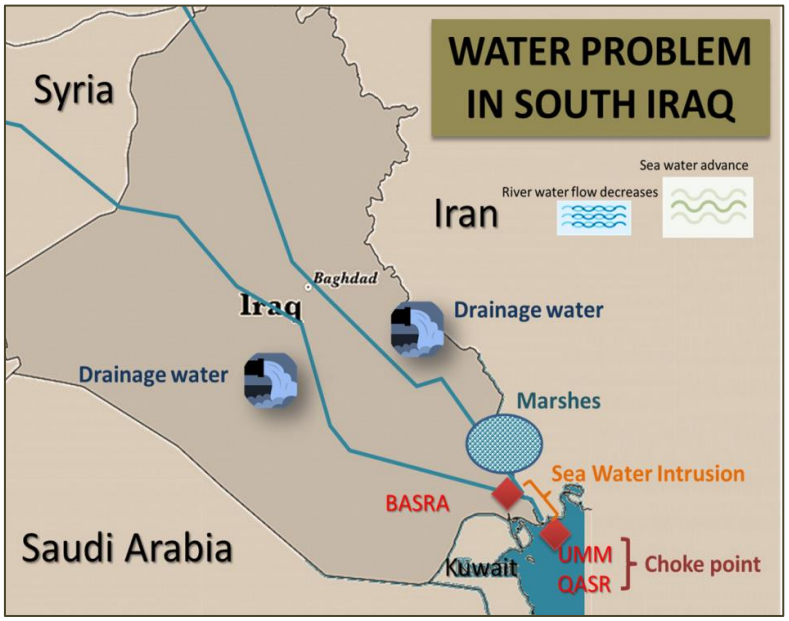
South Iraq depends almost entirely on the Tigris and Euphrates rivers for water. In the last decades, river water flow has decreased drastically due to several reasons such as lack of international cooperation, poor governance, and internal tensions and conflicts. The decrease in water flow has provoked seawater intrusion in the Shatt el-Arab, which is steadily advancing further and further inland. This seawater intrusion, together with massive dumping of sewage into the rivers, has contributed significantly to declining water quality. This has, in turn, led to health problems, increasing tensions and social unrest, and even migration.

Description of the problem

Iraq is heavily dependent on the Tigris and Euphrates river basin, which supplies over 90% of the water used in the country; groundwater accounts for only 2-9% of all withdrawals[49]. In a February 2018 report, Iraq realistically claims that the water flow of the two rivers has been reduced by 30% since the 1980s and is expected to further decline by up to 50% before 2030. This also affects hydro-energy production at Iraq's large dams, which account for more than 75% of the country's supply of electricity. Moreover, the water crisis puts agriculture and food production at risk. Iraq's bread basket is the south-central part of the country, which experienced a 50% decline in food production over the last two decades due to salinization of the river basin.

Flow reduction is partially due to a lack of international agreements regarding water use. There is no legally binding, comprehensive or long-term treaty between riparian states to address water management or basin-wide planning. Over the last 40 years, 56 large dams have been erected throughout the Tigris and Euphrates basin, including many for hydroelectric power and flood irrigation.

[49] Al Ansari, N. op. cit.



Conflicts have had a huge negative impact over the last four decades. Some of them such as the Iran-Iraq war degraded the country economically, which prevented needed investments in water infrastructure. Others have had direct effects on the resources themselves. In 1991, for instance, Saddam Hussein drained the Marshes[50] to punish the local Shiite population for an uprising against his regime. More recently, water sources were routinely targeted as part of combat operations during the war against Daesh[51]. Tensions between the Government of Iraq and the Kurdish Regional Government may also affect the water flow to South Iraq due to the geographic position of the regional government at the upstream branches of the Tigris.

In addition to the reduction in the quantity of water, the quality has also been severely degraded due to lack of treatment and high salinity. Massive dumping of sewage into the rivers contributes significantly to declining water quality. The reduction in water flow leads to seawater intrusion, which is increasingly pushing inland – up to 45 miles upriver and as high as Basra at high tide, further contributing to water and land degradation[52.] The deterioration of water quality in southern Iraq is also destroying a delicate ecosystem along the river basin and affecting the Gulf nations of Saudi Arabia, Qatar, and the United Arab Emirates, which now get most of their drinking water through desalination.

The results are water and food scarcity in southern Iraq, where in some cases the water is so heavily salinized that it can no longer be used for agricultural purposes. Decreasing amounts of water of course means a lack of supply for the widely spread irrigation systems. As a consequence, agricultural activities and food production have been declining over the last decade, particularly in the provinces of Basra, Dhi Qar and Maysan. Consequently, this has resulted in declining socioeconomic trends that provoke migration and social unrest. Specifically concerning migration,

[50] Wetland area located in southern Iraq and partially in southwestern Iran and Kuwait. Historically the marshlands, mainly composed of the separate but adjacent Central, Hawizeh and Hammar Marshes, used to be the largest wetland ecosystem of Western Eurasia.

[51] Matthew Machowski, a Middle East security researcher at the UK houses of parliament and Queen Mary University of London declared: "It is already being used as an instrument of war by all sides. One could claim that controlling water resources in Iraq is even more important than controlling the oil refineries, especially in summer. Control of the water supply is fundamentally important. Cut it off and you create great sanitation and health crises,"

[52] The water in some areas contains an estimated 40,000 milligrams of total dissolved solids, a measure of salinity, compared to an acceptable level of 2,400 to 2,600, according to Alaa al-Badran, the head of the Agricultural Engineers Syndicate. https://www.bloomberg.com/news/articles/2018-08-02/water-crisis-salts-the-earth-in-iraq-s-long-neglected-south

in the last decade more than 90% of inhabitants have fled the above mentioned marshes, leaving only 20,000 people who remain exposed to the risk of poverty and malnutrition.

The southern province of Basra is home to over 70% of Iraq's oil reserves, which makes it an oil rich area. Nevertheless, people lack basic amenities such as clean water, electricity and waste management. This apparent paradox has exacerbated the social unrest in the region with periodic protests over the last decade. The latest occurred in the summer of 2018 when drought, water contamination and political tensions triggered protests. Violent demonstrations took place in Basra and other southern provinces, including Iraq's only deep water port, Umm Qasr. Therefore, protests threatened oil exports from Umm Qasr as well as oil field operations. Protesters attacked and burned government and political party offices, prompting security forces to open fire. Eleven protesters were killed and more than 800 wounded. The protests have stopped but the situation has not improved. By the end of October 2018, hospital admissions of those suffering from poisoning exceeded 100,000 according to health officials. Crops and animals in the rural areas have been severely affected by lack of water and current levels of salinity, and thousands of citizens are migrating to Basra.

This case study most closely fits the "high conflict – high water scarcity" scenario. A complete lack of cooperation at the regional level is provoking a severe reduction in water flow in Southern Iraq. Even at the national level, tensions with the Kurdistan Regional Government have the potential to exacerbate this problem. The Government of Iraq has not been able to implement a comprehensive water strategy, and, especially in recent years, the war against Daesh has prevented any national efforts to improve the water management system. At the same time, Daesh has used water as a weapon, further reducing water flows to Southern Iraq. These factors have combined to provoke migration, worsening of socioeconomic conditions and violent social unrest. Internal conflict with Daesh together with political tensions has accelerated the degradation.

Potential evolution

The evolutionary course and potential long term effects of this situation depend on several factors. If the prevailing strategy continues to be a single-sided control of water resources instead of cross-border cooperation, water flow in Southern Iraq will continue to decrease to the point where the implementation of mitigating measures becomes impossible. The water will be salinized and polluted beyond repair. This will affect the national economy and socioeconomic conditions in the South will continue to deteriorate, leading to severe water and food insecurity and increased health problems. Migrations and social unrest will affect the surrounding areas, exacerbating existing tensions. This situation, in an already fragmented society, may spread out from the affected area to the periphery, increasing tensions with neighboring countries. Since oil exports via the Gulf have to go through the only deep water port of Umm Qasr, exportations may be also at risk. With the agricultural and oil sectors affected, the state capacity to adopt mitigating measures may be even more limited. Since Iraq is an important player in the oil market, the impact of this situation is global. This may drive to a potential 'internationalization' of the crisis.

On the other hand, cooperation among all the stakeholders could potentially lead to improvements and even reversals of current trends. At the national level, improvements in the water management system can slow down the degradation, providing more time to the authorities to deal with water and food insecurity, migrations and health problems. However, political consensus at the national

level is necessary to avoid the use of social unrest as a weapon. Although not directly addressing the problem, searching for alternatives to current oil distribution though the Umm Qasr port can reduce the likelihood of international economic impacts.

5. WATER HOTSPOTS

Rub' al Khali (the Empty Quarter), in the southern part of the Arabian Peninsula, is likely the driest area in the Middle East. However, almost nobody lives there and, thus, there is no struggle related to water resources. On the other hand, there are hotspots where the needs may exceed the available water and provoke conflicts to control critical water resources. These hotspots can be divided in two categories: internal and transboundary. Internal hotspots are states or territories where water is scarce and can trigger social unrest and migration. Transboundary hotspots involve water resources shared by two or more countries and have the potential to generate interstate conflicts.

Internal Hotspots

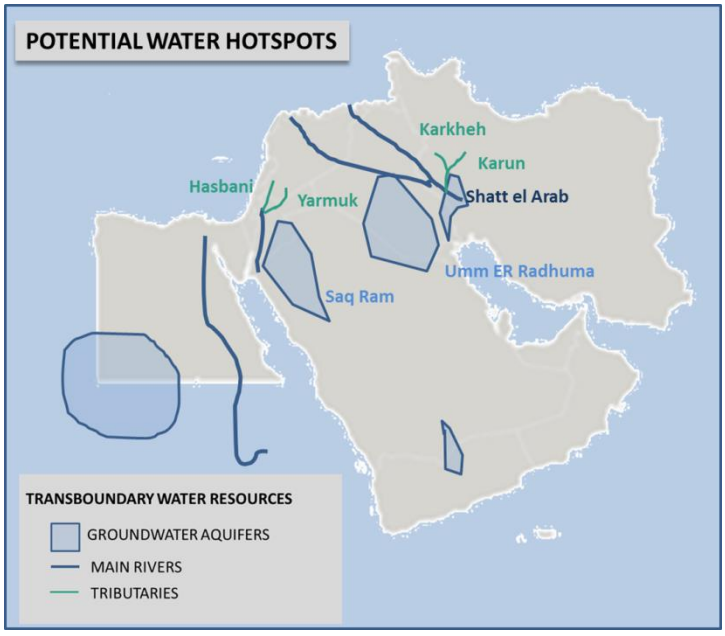
Yemen, besides having one of the world's fastest-growing populations, has one of its most rapidly depleting water tables. Nature cannot recharge groundwater fast enough to keep pace with growing demand for water. Also, the availability of fresh water in Yemen is among the lowest in the world, yet agriculture accounts for 90 percent of all water use in Yemen – one of the highest rates in the world.

Palestinians also face one of the highest levels of water scarcity in the world, partly due to unequal sharing of water from aquifers in the West Bank. Israeli settlers consume an average of 620 cubic meters per person every year, while Palestinians consume less than 100 cubic meters. Many Palestinians living in the West Bank must rely on water bought from the Israeli national water company, Mekorot.

Jordan and the southern part of Iraq, as detailed in the previous section, also serve as internal hotspots.

Transboundary Hotspots

Most of the water resources existing in the Middle East are transboundary. The sharing of these critically scarce resources could easily lead to conflict. The management of water flow in the region's main rivers (Nile, Jordan, Tigris and Euphrates) is already a controversial issue. However, attention must also be paid to their tributaries. The Hasbani in Lebanon and the Yarmuk in Syria feed the Jordan river in the Golan Heights. The Iranian Karkheh, Karun and Dez, meet the Tigris and Euphrates in the Shatt



el Arab. Aquifers shared by Jordan and Saudi Arabia; Saudi Arabia, Iraq and Kuwait; and Saudi Arabia and Yemen are also transboundary hotspots.

6. CONCLUSIONS

Water scarcity is a major problem in the Middle East, and could potentially lead to severe consequences for the region. Although it may not seem specially menacing because its effects are diluted over time, water scarcity should be considered the most worrisome challenge due to its deep destabilizing potential. Some states in the region appear to be well aware of the situation and well equipped to counter the threat. Indeed, some mitigation measures are already in place. Nonetheless, it must be noted that there is a lack of effective international cooperation and of a long-term overarching strategy. As such, water scarcity is likely to intensify existing threats to regional peace and stability, while these same conflicts will also hamper efforts to find comprehensive solutions. The inevitable effects of climate change further limit the amount of time to act and make the establishment of a multilateral strategy urgent.

The scope and intensity of the impacts of water scarcity may vary, but even minor or local events have the potential to trigger a domino effect across much of the region. This aspect is particularly evident when analyzing patterns of displacement and migration flows. As exemplified by the case study of Southern Iraq, a looming degradation of both the natural environment and the security situation forces people to consider the option of migrating. This, in turn, may result in an additional water stress in neighboring areas and countries due to the influx of displaced people. Therefore, these dynamics expose the region to the risk of recurring and self-reinforcing humanitarian crises. Lastly, it must be noted that in the long term, a wider destabilization of the Middle East may result in a significant decrease in or a broader disruption of oil production, which would have an impact at the global level. These two consequences alone appear enough to draw attention, not only from regional stakeholders, but from the wider international community.

Even against such an adverse background, the possibility that water scarcity may serve as a catalyst for water diplomacy in the region cannot be discarded. As a result, NATO should support a positive political dialogue for the purposes of increasing international cooperation in order to pave the way for sustainable solutions to water scarcity in the Middle East. NATO should also closely monitor the hotspots of endemic water scarcity, both internal and transboundary, described in paragraph 5, in order to better anticipate and react to potential crises. Persistent drought in these areas is not uncommon, and could easily push several areas of the region into conflict over water resources.