

The projected impacts of climate change on food security in the Middle East and North Africa (MENA)

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Question

What are the projected impacts of climate change on food security in the Middle East and North Africa?

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1. Summary

Climate change, although a global issue, has differential regional effects on food security. The Middle East and North Africa (MENA) region is already highly dependent on food imports, making it also vulnerable to price shocks on the global markets and harvest failures in other world regions. This rapid review will focus on literature discussing the impact of climate change on food security, in terms of future water use and food import changes, for the region as a whole. Evidence is gender blind and does not focus on disability.

Peer-reviewed literature shows that the region will continue to be affected by future climate change, depriving more and more people of water of decent quantity and quality, as well as food security. Grey literature assessed for this rapid review include reports by experts and international institutions, including the Organisation for Economic Co-operation and Development and the Food and Agricultural Organization (OECD-FAO, 2018) and the World Bank (2018).

However, few assessments of climate change consider MENA as a whole. This makes it considerably more difficult to understand climate change from a regional perspective (Jobbins & Henley, 2015).

Key highlights of the projected impacts of climate change on food security in MENA are noted below:

- Water use: The climate, which is mainly arid to hyper-arid and highly variable, is changing and will continue to do so. Droughts will become more frequent, especially in the Maghreb (Jobbins & Henley, 2015). However, with or without climate change, freshwater scarcity will most likely persist in MENA for at least a generation (i.e. through to 2050) (Kandeel, 2019).
- **Competition between different water uses is growing and will continue to grow** (UNDP, 2013; Hoff et al., 2019). The Water Scarcity Initiative of the Food and Agricultural Organization (FAO, 2018) notes that **agriculture is struggling to compete for water with industry and other sectors**. Besides agriculture, water demands for industry, tourism, hydro-power, and municipal drinking water will continue to grow with climate change (Hoff et al., 2019). However, there is little predictive data on changes in sectoral uses of water.
- Literature available on water competition between agricultural and other uses is limited to using grey water (Kandeel, 2019). Policy measures that encourage industrial wastewater recycling are essential to reduce not just industry's freshwater use footprint, but also its freshwater pollution (or grey water) footprint (Keulertz, 2019). The latter could be more harmful than the former to freshwater and environmental security, as well as human health and food security.
- Food security: Most studies of the region have focused on climate risks to food production, rather than access to food (Jobbins & Henley, 2015). Beyond 2030, food security will be increasingly affected by changes in long term climate trends: higher temperatures, precipitation changes, and sea level rise (Jobbins & Henley, 2015). However, **uncertainties remain over the direction and magnitude of some changes** in the MENA region (Jobbins & Henley, 2015). Necessary changes in agricultural practices are dependent on the crop (Keulertz, 2019).
- Food imports: A dominant concern in the MENA region is its high and growing dependence on international markets for key staple food products (OECD-FAO, 2018). If food is imported, it carries with it a water tariff since water was used in its original production, even if it is not physically present i.e. 'virtual water'. In effect, food imported in

this way is a mechanism for reducing actual water use in the MENA region, and thus adds to food security (Joffé, 2016). There is little literature discussing importing of virtual water in relation to food security. However, simulations up until 2050 suggest that **dependence on agricultural imports is likely to continue** to increase in the MENA region, especially if the effects of climate change are pronounced (INRA, 2015).

- Although urbanisation is not extrinsically linked to climate change, their combined impacts are important to consider in terms of food security.

2. Food security

Food security is the ability to secure sustainable and sufficient food supplies for a population. It “exists when all people, at all times, have **physical, social, and economic access** to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life.”¹ Food security mainly depends on a country’s ability to **import or produce food** (macro level), and on households’ ability to **produce or buy food** (micro level) (World Bank, 2018: 35).

The Middle East and North Africa (MENA)² is the only region in the world with decreasing food security (FAO, 2015). The MENA region has long been disadvantaged by a climate and geography unfavourable to large-scale agriculture. This in turn affects food security in the region (Al-Ghwell, 2019). Climate change³ is predicted to affect food security in the region even further (OECD-FAO, 2018). The region has been classified as one of the Earth’s climate change “hot-spots”.⁴

Predicted environmental changes

The MENA region is highly vulnerable to climate change. Climate change is certainly happening, however, **uncertainties remain over the direction and magnitude of these predicted changes**.

Some trends are clear. The MENA region is predicted to become hotter and drier in the future due to climate change (Bucchignani et al., 2018; OECD-FAO, 2018: 70; Lange, 2019: 1). As well as higher average temperatures, higher frequencies of more intense heat waves will be felt across the region (Jobbins & Henley, 2015: 4). More frequent and more intense droughts are expected to become the “new normal” in parts of the region, notably the Maghreb⁵ (Jobbins & Henley, 2015: 4). Beyond 2030, sea level rise due to climate change poses a threat to agriculture in low-lying coastal areas in MENA (Barghouti, 2009; Jobbins & Henley, 2015: 4). Climate

¹ 1996 World Food Summit (WFS) definition.

² The MENA region is a large zone extending from Morocco in northwest Africa to Iran in southwest Asia. It includes the following countries: Morocco, Algeria, Tunisia, Libya, Egypt, Jordan, Israel, Lebanon, Syria, Iraq, Saudi Arabia, Yemen, Oman, United Arab Emirates, Bahrain, Qatar, Kuwait, and Iran. The Eastern Mediterranean is also included in some analyses of MENA, e.g. Lange, 2019.

³ Climate Change is any long-term significant change in the expected patterns of average weather over time.

⁴ Giorgi F (2006). Climate change Hot-Spots. *Geophys Res Lett*, 33, L08707.

⁵ The Maghreb includes Algeria, Libya, Mauritania, Morocco, and Tunisia.

Central⁶, a science organisation based in New Jersey, has recently identified both Egypt's second-largest city Alexandria and Basra in Iraq as areas facing high threat.⁷

However, other trends are less clear. According to Jobbins & Henley (2015: 4), although higher temperatures imply greater aridity, precipitation may increase or decrease in different parts of the region. Climate change projections expect a reduction of precipitation⁸ and water availability in the western part of the region (Bucchignani et al., 2018). However, few assessments of climate change – such as those of the Intergovernmental Panel on Climate Change – consider MENA as a whole. This makes it considerably more difficult to understand climate change from a regional perspective.

Predicted food security changes

Research on the MENA by the World Food Programme (WFP) and Overseas Development Institute (ODI) states that by 2030, people's food security will be affected by more frequent, longer, and more intense heat extremes and droughts (Jobbins & Henley, 2015: 4). Less water availability will also affect food security in the region.

3. Water

At the World Economic Forum 2015, experts on the MENA region stated that the water crisis is “the greatest threat to the region – greater even than political instability or unemployment”.⁹ With climate change, **water in the MENA region will continue to be extremely important** (OECD-FAO, 2018: 74), especially if water footprints are expected to rise for future consumption and production in the region.

Water is key to food security. It takes 2,000 to 5,000 litres of water per person per day to grow the food to support diets of 2,800 kilocalories daily that the UN Food and Agriculture Organization (FAO) deems the threshold for food security.¹⁰ In MENA, 468 billion cubic metres of water per annum is required for food self-sufficiency. The minimum water needed to avoid water stress is 796 billion cubic metres. Using multiple sources, the total water footprint¹¹ for MENA is estimated as 547 billion cubic metres (Bacon, 2017: 13). **The MENA region cannot support itself in terms of its internal renewable freshwater resources.** This is because the water available is used for matters other than food.

⁶ Coastal Risk Screening Tool:

https://coastal.climatecentral.org/map/5/58.9114/36.2516/?theme=sea_level_rise&map_type=coastal_dem_comparison&elevation_model=coastal_dem&forecast_year=2050&pathway=rcp45&percentile=p50&return_level=return_level_1&slr_model=kopp_2014

⁷ Why Middle East cities should worry about climate change (2020):

<https://www.arabnews.com/node/1608486/middle-east>

⁸ Precipitation is rain, snow, sleet, or hail — any kind of weather condition where something falls from the sky.

⁹ Water crises are a top global risk (2015): <https://www.weforum.org/agenda/2015/01/why-world-water-crises-are-a-top-global-risk/>

¹⁰ UNESCO/ Earthscan (2009). World Water Assessment Programme, United Nations World Water Development Report 3: Water in a Changing World (Paris/London), p.107.

¹¹ The water footprint is the entire water reliance of the MENA region – including renewable water use, non-renewable groundwater (blue water) use, and imported virtual water, not only agricultural imports.

Security

Renewable freshwater security¹² is of paramount importance to quality and stability, as well as food security (Kandeel, 2019). **However, the security of MENA's renewable freshwater¹³ is at risk with climate change.** Renewable freshwater security is a concern because the MENA region naturally experiences the highest variability globally in rainfall occurrence – inter-annually, seasonally, and spatially. This, and the frequency and intensity of extreme weather events including droughts and flash floods, are projected to increase due to climate change (Kandeel, 2019). Climate change's impacts on freshwater security will directly affect MENA countries that depend largely or entirely on internally generated renewable freshwater.¹⁴ These countries have to take into consideration climate change impacts, not only within their territories, but **also in external territories** where such resources emerge. According to the Atlantic Council, this creates an additional layer of complexity and uncertainty, involving extra-territorial factors, for policy-makers in these MENA countries to contend with (Kandeel, 2019).

Scarcity

Water availability is one of the main concerns in MENA – for agriculture and other sectors.

The availability of water plays a key role in the agriculture and food sector, and is one of the determining factors for food security in many countries of the world (Lange, 2019: 1). Globally, MENA reports to have the highest loss of freshwater in its food supply chain. Every country in the region is experiencing groundwater depletion, with overall very high rates of withdrawal of both surface and groundwater (Misra, 2014). Some MENA countries lose between 80 and 177 cubic metres per capita of freshwater resources in the food supply annually (Kharazi, 2018). This loss is predicted to increase with climate change.

“Water scarcity” is also concerned with the quantity of the renewable freshwater resource that is available, and of groundwater (blue water) specifically, which is the renewable supply of freshwater contained in surface and groundwater basins (Kandeel, 2019). This means **agriculture is and will continue to compete for water with industry and other sectors** (FAO, 2018).

Most countries in the MENA region fall below the generally accepted water scarcity line of 1,000 m³ per capita per annum of renewable water resources (OECD-FAO, 2018: 74). By 2050, it is estimated that all countries in the MENA region (except Iraq) will be subject to water scarcity (Michel et al., 2012), and one of the primary causes is **population growth**. The major river basins needed for local and regional food production will see dramatic population growth (McKee et al., 2017: 18). This is especially true for the Nile and Euphrates basins. Given both climate and population change, there is a >90% probability that per capita water availability will decrease by 10% or more in most countries in the region (Gerten et al., 2011). However, Kandeel (2019)

¹² Water security can be defined as the “capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability” (UNU-INWEH, 2013: 1).

¹³ Freshwater is any naturally occurring water except seawater and brackish water. It includes water in ice sheets, ice caps, glaciers, icebergs, bogs, ponds, lakes, rivers, streams, and even underground water (groundwater).

¹⁴ Some countries depend on groundwater as the main water resource (such as Jordan), others surface water (such as Egypt). Egypt's main freshwater resource is the Nile River and two groundwater aquifers (the first comprises groundwater in the Nile Valley and Delta, and a second aquifer which is non-renewable in the western desert) (Sakhel et al., 2017).

states that “with or without climate change, freshwater scarcity will most likely persist in MENA for at least a generation or so — through 2050.”

Water risk projections

Water demand in the Southern Mediterranean region is expected to rise by 25% by 2025, and this will mean greater use of the massive reserves of groundwater held under the Sahara (Joffé, 2016: 61). Specific impacts of climate change on water availability and security in MENA include heat extremes, a lengthening of the dry season for most MENA countries, and significant **reductions in surface and subsurface water availability** – the latter will have adverse consequences on food production and food security, adding to pressure on groundwater aquifers and surface water reservoirs in MENA countries (Jobbins & Henley, 2015: 44; Mohtar, 2017; Lange, 2019: 6).

Table 1 shows the predicted water risks for MENA areas and countries due to climate change:

Table 1: MENA country groups and projected risks due to climate change

Country group	Countries at risk	Predicted issues
Al-Mashreq	High risk: Iraq, Syria, Jordan, Palestine; Low risk: Lebanon	Exposure to complex risks linked to Tigris-Euphrates River system; Water security affected by hydro-political power dynamics
Al-Maghreb	High risk: Morocco, Tunisia	Vulnerability to reduction in rainfall
Nile Basin	High risk: Egypt, Sudan	Increase in aridity
Arabian Peninsula	High risk: Cooperation Council for the Arab States of the Gulf countries ¹⁵	Reduced annual rainfall
Sahel	High risk: Somalia	Increase in frequency and intensity of extreme weather; freshwater and socio-economic stress; continued food insecurity

Source: Author’s own. Data taken from Kandeel (2019), <https://www.atlanticcouncil.org/blogs/menasource/in-the-face-of-climate-change-challenges-of-water-scarcity-and-security-in-mena/>

4. Food production

Water is key to food production and food security. It takes 2,000 to 5,000 litres of water per person per day to grow the food to support diets of 2,800 kilocalories daily that the UN Food and

¹⁵ The Cooperation Council for the Arab States of the Gulf, originally known as the Gulf Cooperation Council (GCC), is a regional intergovernmental political and economic union consisting of all Arab states of the Persian Gulf except Iraq, namely: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates.

Agriculture Organization (FAO) deems the threshold for food security.¹⁶ 468 billion cubic metres of water is required for food self-sufficiency. However, the water footprint¹⁷ for MENA is already estimated as 547 billion cubic metres (Bacon, 2017: 13).

With climate change, scarce water supplies and mostly dry, arid lands will **continue to impede the MENA region's ability to achieve self-sufficiency in food production** (Al-Ghwell, 2019). Recent research shows that the MENA region cannot currently and in the future meet its food production requirements due to increased water scarcity (Keulertz, 2019: 2).

Impact on agricultural sector

The agricultural sector is facing challenges of water scarcity owing to climate change.

This is due to increased demand for irrigation, and growing rainfall variability (Nin-Pratt et al., 2018: 82). However, the **impact of climate change on production conditions varies within the region**.¹⁸ Higher temperatures and reduced precipitation will accelerate the loss of surface water, and droughts will become more frequent. The already low average yields of rain-fed crops will decline and become more variable (OECD-FAO, 2018: 75-76).

To deal with climate changes, agricultural sectors in the MENA region will have to move to **high-value crop production** with high-resource efficiency methods and higher water productivity. This requires a shift to integrated water management concepts. Lessons can be drawn from the water-energy-food nexus (WEF nexus) to **reuse wastewater** for food production, or **desalinated water** through the use of renewable energy to grow cash crops (Keulertz, 2019: 5). Another key resource in rainfall-prone areas of the MENA region is **green water** (Assi et al., 2018). Green water – rainfall over land that is stored in the soil and eventually flows back to the atmosphere as evapotranspiration – is the main source of water to produce food, feed, fibre, timber, and bioenergy. It is an essential part of any food security strategies in the MENA region. However, this water has very low opportunity costs as it cannot be pumped or diverted to be used as irrigation water.

Impact on non-agricultural sectors

Competition between different water uses will grow with climate change. Besides agriculture, water demands for industry, tourism, hydro-power, and domestic water consumption will continue to grow with climate change (UNDP, 2013: 59; Hoff et al., 2019). This will have a negative impact on the agricultural sector, and therefore food security. However, there is no numerical data available to support this prediction.

5. Access to food

Food access is closely linked to food supply, so food security is dependent on a healthy and sustainable food system.¹⁹ Heat extremes could impact incomes and food access through reducing labour productivity and affecting sensitive sectors (Jobbins and Henley, 2015: 36).

¹⁶ World Water Assessment Programme, United Nations World Water Development Report 3: Water in a Changing World (Paris/London: UNESCO/ Earthscan, 2009), p.107.

¹⁷ The water footprint is the entire water reliance of the MENA region – including renewable water use, non-renewable groundwater (blue water) use, and imported virtual water trade.

¹⁸ Specific projection data for crop yields under different climate change scenarios is shown for Egypt and Tunisia in Nin-Pratt et al. (2018).

¹⁹ The food system includes the production, processing, distribution, marketing, affordability, and consumption of food. See Global Water Partnership – Water and Food Security: <https://www.gwp.org/en/CRITICAL-CHALLENGES1/Water-and-Food-Security/>

Economic change will drive employment and income, as well as people's ability to purchase food (Jobbins & Henley, 2015: 31).

Water access may also be affected: as the effects of climate change alter the timing of snowmelt and precipitation, tensions over water could easily flare throughout the basin. For example, normally low precipitation levels in the basin's Turkish headwaters, might cause Ankara to withhold water behind Turkish dams as a reserve to generate hydroelectricity and irrigate crops, to the detriment of downstream water users that rely on the same water to grow food and drive economic activity (Michel et al., 2012: 14).

Livelihood changes

For non-producers, food security is more closely linked to employment, developments in global markets, the national economy, and how well governments and food systems respond to shocks such as global food price volatility (Jobbins & Henley, 2015: 44).

Climate variability is already a critical factor in determining the livelihoods of many poor and vulnerable people in MENA. The poor and those dependent on natural resources for their livelihood – who are the least resilient to socio-economic stress and shocks due to freshwater insecurity – are the most vulnerable to climate changes (Kandeel, 2019).

Poverty increase

Most studies in the region have focused on climate risks to food production. By contrast, the ODI *Food in an Uncertain Future* report emphasises the importance of climate risks to other aspects of food security, particularly people's ability to **purchase** the food that leads to a safe and healthy diet (Jobbins & Henley, 2015: 24).

The challenges to energy and water security and their links to ongoing and future climate change, if not dealt with adequately and in a timely fashion, will risk the reinforcement of existing social inequalities (Lange, 2019: 17). **Poverty is also linked to food insecurity, malnutrition, and hunger** (UNDP, 2013: 70). Poor consumers in rapidly growing urban areas are likely to be most vulnerable due to income insecurity and poor access to safety nets and basic services. Ensuring their food security will require broad pro-poor development efforts including management of climate risk in the economy and employment, the design of social safety nets, the maintenance of strategic food reserves, and improvements in food storage and supply systems (Jobbins & Henley, 2015: 5). This may lead to more use of social protection programmes such as cash vouchers to buy food (Jobbins & Henley, 2015: 14).

Migration

According to a recent report by International Food Policy Research Institute (IFPRI) and FAO on the region (Nin-Pratt et al., 2018: 9), "sluggish growth in agriculture pushes migration from rural areas to the cities." Climate change may result in rural inhabitants transitioning to off-farm employment or relocating (OECD-FAO, 2018: 76). Although climate change is often related to increased conflict and issues such as migration, research from the Ecologic Institute shows that there is little to no empirical research that addresses this link.²⁰

²⁰ Water and Climate Change in the MENA-Region (2011): <https://www.ecologic.eu/4150>

6. Stability and economic access to food

The World Bank (1986) defines food security as “access by all people at all times to enough food for an active, healthy life. Its essential elements are the availability of food and the ability to acquire it.” **All MENA countries, share a common threat, which is that they are all highly vulnerable to climate change** (Borghesi & Ticci, 2019: 292). However, the MENA region shows remarkable differences between countries' responses due to their economics.²¹

Impact of random shocks

Random shocks affect the degree to which food markets and subsidy programmes generate desired results regarding food security. Weather conditions and pest problems due to climate changes can also affect agricultural production unexpectedly. Given this inherent uncertainty, a nation's food security objective is to maximise the likelihood that all citizens will have access to basic food requirements each year. From this perspective, **the potential roles of international trade and virtual water are enhanced**, as a nation will likely gain from maintaining a portfolio of food production, trade, and storage strategies to maximise the likelihood of achieving food security (Wichelns, 2001).

High-income countries in the area can rely on large budgetary resources to cushion possible food price shocks, and they largely invest in acquisitions of farmland (and implicitly in the associated freshwater resources) abroad. These defensive strategies, however, may not be affordable for low- and middle-income (LMI) countries²² which are particularly vulnerable to the direct and indirect effects of climate change, due to a lower ability to adapt and adjust to complex environmental changes (Borghesi & Ticci, 2019: 291).

Impact on food producers

Fisheries and aquaculture are important in the MENA region as providers of livelihoods and as sources of nutritious food. Both are particularly vulnerable to the impacts of climate change, as these sectors are not easily adaptable to climate change or resilient to natural disasters (OECD-FAO, 2018: 82).

Small producers in remote areas of marginal lands – particularly uplands and drylands – are most vulnerable to climate risks due to fragile natural resources, low incomes, limited access to markets and government services, and the risk of being caught in poverty traps (Jobbins & Henley, 2015: 48).

Climate change effects on agriculture and freshwater can interact with other critical factors in the region, such as the rural-urban divide and social or political instability (Borghesi & Ticci, 2019: 291). The consequences of changes in temperature, extreme weather conditions, and rainfall superimposed on a severe water crisis, are all destabilising issues likely exacerbated by climate change (Abouelnaga, 2019).

Climate change presents risks to the whole food system, from production, through distribution to consumption. These risks also need to be understood in the broader regional context of human and economic development (Jobbins & Henley, 2015: 47). The following four issues have been addressed in the literature for consideration:

²¹ World Bank (2019). World development indicators. <http://data.worldbank.org/indicator>

²² LMI countries include Algeria, Djibouti, Egypt, Iran, Iraq, Jordan, Lebanon, Libya, Morocco, Syria, Tunisia, Yemen, West Bank, and Gaza.

1. Increased crop failure

An increase in pest infestations in warmer climates will lead to increased likelihood of crop failure (Barghouti, 2009). Climate-induced crop failure or loss of pasture can mean a dramatic drop in income, and limited material and human capital can aggravate the situation by narrowing the range of livelihood options, e.g. sources of employment, access to food (FAO et al., 2017: 56).

2. Adapting farming systems

By 2030, the farming activities of food producers, particularly in remote and marginal environments dependent on rain-fed agriculture, will be impacted by climate change and extremes (Jobbins & Henley, 2015: 4). This will result in a **move away from rain-fed agriculture**.

The effects of climate change on agriculture are expected to vary by farming system.²³ In some cases, farmers can respond to changes through adaptation. In other regions, agriculture may become untenable, and rural inhabitants will need to transition to off-farm employment or relocate (OECD-FAO, 2018: 76).

3. Adapting food production

Adapting to climate shocks and stresses on food security will require investment, mainstreaming climate risk management and strengthening resilience throughout the food system. This will include adaptation of food production, improving water and energy security, macro-economic management and reform of food subsidy systems, as well as reducing risks in food processing, storage, distribution, retail, and consumption (Jobbins & Henley, 2015: 5).

By employing **enhanced irrigation technology**, water and energy efficiencies can actually improve agricultural productivity, gross margins, and food security (Hoff et al., 2019; Lange, 2019: 12). Improved technology and better management have helped boost production, which may continue into the future.²⁴ In parts of Egypt's Nile River Delta, farmers have increased yields while decreasing water intensity by using special drills to plant grain on beds, rather than in traditional rows. Improved seeds bred specially for dry climates are also helping farmers.

4. Changing trades

The joint OECD-FAO *Agricultural Outlook 2018–2027* report describes farming trends and trade that will influence health and societies over the next decade (OECD-FAO, 2018). The findings provide an opportunity to align agricultural policies more closely with health, including planetary health. For example, almost two-thirds of arable land in MENA is planted with water-thirsty cereals that result in a limited diet. Instead of subsidies for cereals and water, the report encourages governments to champion new farming technology and support crop diversification in preparation for further climate change. Such strategies would promote rural development, alleviate poverty, and deliver a healthier diet.

²³ See Table 2.6 for climate change impacts on different farming systems in the MENA Region (OECD-FAO, 2018: 76).

²⁴ Arsenault C (2015). Fears grow as Middle East food import bill set to double by 2035 – expert: <https://www.reuters.com/article/food-climatechange-mideast-idUSL5N11G4AP20150911>

As well as improving agricultural productivity and maximising water productivity, national food security can be achieved by governments **increasing trading in virtual water by expanding food imports** (UNDP, 2013: 4).

a. Expanding food imports

In terms of food production China, Australia, Europe, and North and South America will be little affected by climate change, or will see increases in cereal production, implying static or increased precipitation (Parry et al., 2004: 59). However, for future food security, **MENA countries should be prepared to import more food from international markets in the near future**. However, food imports are associated with water risk (Maten, 2017: 1).

Currently, about 27% of international shipments of cereals, 21% of sugar, 20% of poultry meat, 39% of sheep meat, 20% of skimmed milk powder and 30% of whole milk powder go to the MENA region (OECD-FAO, 2018: 97). Climate-related events can increase food insecurity, in terms of both availability and access, through a number of channels (FAO et al., 2017: 55). **Large increases in net imports are projected**, as consumption will continue to outpace production for most basic food commodities.

b. Increasing trade in 'virtual water'²⁵

If food is imported, it carries with it a water tariff since water was used in its original production and thus implicitly forms a component of the imported food as 'virtual water', even if it is not physically present. In effect, food imported in this way is a mechanism for reducing actual water use, and thus adds to food security (Joffé, 2016: 59). Such reliance on food imports may, however, increase general instability because regional countries face the unquantifiable danger of unpredictable fluctuations in global market prices, as occurred in 2010, a development which led directly to the events of the 'Arab Spring' (Joffé, 2011).

With climate change, virtual water embodied in food imports and exports will remain a valid concern for water-short nations seeking to maximise the value of their limited water supplies (Wichelns, 2001). Islam et al. (2007) have observed that a significant share of the population in the MENA and Sub-Sahara region are highly dependent on virtual water imports from other countries. Research shows that the MENA region exports virtual water for a far higher opportunity cost than is borne by those countries that export virtual water to the MENA region (Bacon, 2017: 2).²⁶

7. Conclusions

Many MENA countries are confronted with a **dual challenge**: they need to conserve their often small and fragile resource base, while also facing high and rising food import dependencies. Climate change will add to these challenges, further limiting production capacities and adding to import needs. These challenges are most pronounced in the countries of the Cooperation Council for the Arab States of the Gulf (originally known as the Gulf Cooperation Council, GCC),

²⁵ This is defined by Professor J A Allen as the volume of water embodied in food crops that are traded internationally. For example, if 1,000 m³ of water are required to produce 1 tonne of wheat, then importing 1 million tonnes of wheat is equivalent to importing 1 billion m³ of water.

²⁶ Estimated to be between USD293.6 billion and USD582.8 billion per year by exporting its scarce blue water resources (i.e. water from rivers and aquifers), and an opportunity cost of between USD19 and 35 trillion per year for its agricultural sector overall.

where import dependencies can exceed 90% of domestic food needs, and where both fertile cropland and renewable water resources are practically exhausted (OECD-FAO, 2018: 94).

Policies and dependence on international markets

An extreme decline in crop yields in arid and semi-arid areas globally has caused food shortages and a manifold increase in food inflation. Policies in the region support grain production and consumption, with the result that 65% of cropland is planted with water-thirsty cereals, in particular wheat which accounts for a large share of calorie intake (OECD-FAO, 2018: 67). Unsustainable abstraction is also supported by policy and deficient water governance (OECD-FAO, 2018: 74).

Supply disruptions are of growing concern due to the increasing incidence of extreme-weather events, mainly influenced by climate change (Al-Ghwell, 2019). A dominant concern in the MENA region is its high and growing dependence on international markets for key staple food products. This concern has led to a suite of policies which appear strikingly inappropriate given the region's resources. For example, while MENA is one of the most land and water constrained regions of the world, it has the lowest water tariffs in the world and it heavily subsidises water consumption at about 2% of its GDP. As a result, the productivity of water use is only half the world average (OECD-FAO, 2018: 68).

L'Institut national de la recherche agronomique (INRA, 2015) undertook a project to analyse several potential future scenarios for the MENA region through to the year 2050. These simulations suggest that **dependence on agricultural imports is likely to continue to increase in the region**, especially if the effects of climate change are pronounced. Taken individually, **none** of the three mechanisms proposed for reducing agricultural import dependence (improved agricultural productivity, moderation of dietary habits, or a reduction in food waste) is capable of correcting this trend in the Maghreb, the Middle East, or the Near East. Such mechanisms may be effective in Egypt, however, and have the potential to strengthen Turkey's role as a net agricultural exporter.

Impact of food grain prices

There is little literature discussing importing of virtual water in relation to food security. Allan (1996) suggests that for many years the low prices of food grains have enabled some Middle Eastern countries to delay addressing serious domestic water allocation issues by importing virtual water in international markets (Wichelns, 2001). Some public officials in MENA countries are reluctant to acknowledge the role of virtual water in their food security strategies, despite the economic rationale for importing some portion of a water-short nation's food supply (Wichelns, 2001). Failure of these policies has led Arab governments to import more food (UNDP, 2013: 4). This will continue in the future as climate changes further.

Impact of virtual water mismanagement on food security

Futile attempts to achieve food self-sufficiency are behind much of the over-exploitation of water in agriculture. As competition for water from sectors (e.g. hydropower and agribusiness) and users (e.g. upstream and downstream) increases, major challenges remain, such as clarifying mandates, coordinating agencies, collaborating across sectors, managing disciplinary and administrative boundaries, and planning multi-sector/multi-stakeholder consultations (UNDP, 2013: 103).

With further climate changes, governance of water will become more of a priority.²⁷ Bacon (2017: 2) discusses the region's reliance on imported virtual water backgrounds that conceals policies of water mismanagement and misallocation – policies which are then perpetuated by nationally and internationally funded major water engineering projects that prolong unsustainable practices. Virtual water imports keep food on the shelves, which ensures water management reform remains a low political priority (Bacon, 2017: 4). At the same time, the existing and inefficient water management policies that allocate the majority of water to agriculture keep farms operating, thus giving the illusion of domestic food security.

Impact of urbanisation on food security

Although, urbanisation is not linked to climate change, their combined impacts are important to consider. Over the last three decades, the Arab region has experienced a development boom, with rapid population growth. To meet the accompanying rising demand for food, many countries have prioritised food security and socio-economic development through policies to expand agricultural land and irrigated cultivation. However, they have failed to consider water's limited availability and the need for conservation and demand management (UNDP, 2013: 41). Therefore, **international** freshwater law principles would need to be applied to mitigate complex risks along different sub-regions of a transboundary river basin (Kandeel, 2019).

According to the IFPRI, the share of people living in urban areas is projected to overtake the share living in rural areas in most MENA countries by 2030 – with the notable exceptions of Egypt, Somalia, Sudan and Yemen.²⁸ Fast-growing cities are encroaching on (often fertile) agricultural land. In combination with population growth and rising incomes, urbanisation can be expected to increase the demand for processed foods. **This likely trend provides an opportunity for agroindustry-led economic transformation in the MENA region to generate employment opportunities, improve food security, and reduce poverty.**

Rapid urbanisation is making people more vulnerable to the impacts of climate change.²⁹ Declining rural populations may influence agricultural import dependency ratios and related concerns about food sovereignty and food security (McKee et al., 2017: 18). **Urban sprawls will compete with agriculture for water and land (and energy)** (Hoff et al., 2019: 7). Urbanisation can have implications for an ageing population, where joint family support structures are typically less cohesive when compared to those in rural regions, thus increasing the burden upon national social protection systems.

²⁷ Tunisia was one of the first countries to adopt a national water-saving strategy for urban and agricultural water use (UNDP, 2013: 43). It has been able to assure food security and improve the quality of life in the urban, rural and Saharan zones while satisfying the needs of the industry and tourism sectors.

²⁸ Financial Tribune (2017). Water Scarcity, Food Imports Will Worsen in MENA Region:

<https://financialtribune.com/articles/world-economy/65446/water-scarcity-food-imports-will-worsen-in-mena-region>

²⁹ United Nations (2017). Initiatives in the area of human settlements and adaptation:

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Key websites

- FAO AQUASTAT: <http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en>
- Ecologic Institute: www.ecologic.eu

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