WFP

wfp.org

Food in an uncertain future

The impacts of climate change on food security and nutrition in the Middle East and North Africa

World Food Programme
Regional Bureau for Middle East, North Africa,
Eastern Europe and Central Asia,
Nile Gardenia Building,
Intersection of Roads 108 & 161,
Hadaek El Maadi,
Cairo, Egypt.
http://www.wfp.org

Overseas Development Institute
203 Blackfriars Road
London
SE1 8NJ
Tel. +44 (0) 20 7922 0300
Fax. +44 (0) 20 7922 0399
E-mail: info@odi.org.uk
www.odi.org
www.odi.org/facebook
www.odi.org/twitter

Contents

Authors: Guy Jobbins and Giles Henley,
Overseas Development Institute

WFP is the world's largest humanitarian agency fighting hunger worldwide, delivering food in emergencies and working with communities to build resilience. Each year, WFP assists some 80 million people in around 80 countries.

ODI is Britain's leading independent think tank on international development and humanitarian issues. Our mission is to inspire and inform policy and practice which lead to the reduction of poverty, the alleviation of suffering and the achievement of sustainable livelihoods in developing countries. We achieve this by locking together high quality applied research, practical policy advice, and policy-focused dissemination and debate. We work with partners in the public and private sectors, in both developing and developed countries.

The Climate Adaptation Management and Innovation Initiative (C-ADAPT) is an initiative funded by the Government of Sweden's fast-track climate finance that allows WFP and partners to explore innovative climate-induced food insecurity analyses and programmes, with the goal of helping individuals, communities and governments meet their food and nutrition needs under a changing climate.

This publication is made possible through the generous contribution of:

SWEDEN

C-ADAPT Climate Resilience for Food Security: ANALYSES, INNOVATIONS & STANDARDS

Suggested citation: Jobbins, G., & Henley, G., 2015. Food in an uncertain future: the impacts of climate change on food security and nutrition in the Middle East and North Africa. Overseas Development Institute, London / World Food Programme, Rome

Acknowledgements

The authors would like to thank Oscar Ekdahl and Carlo Scaramella at the World Food Programme for their oversight of, and contributions to, the report. The authors also thank Maurice Saade (FAO), Sonja Vermuelen (CCAFS), Steve Wiggins (ODI), Emma Conlan (WFP), Michele Doura (WFP) and Helen Parker (ODI) for their thoughtful comments on earlier drafts of the report. Any errors remain those of the authors.

Photo: WFP/Rein Skullerud

Executive Summary

This report sets out the risks to food security in the Middle East and North Africa (MENA) from climate change, and how these vulnerabilities interact with other key trends and sources of risk, including population growth, urbanisation, and conflict. Focused on the year 2030, this report contributes to a better understanding of how these trends and risks may affect achievement of the Sustainable Development Goals (SDGs) and Zero Hunger in the MENA region. It highlights some particularly vulnerable groups, and also options for reducing climate risks to food security. Most studies in the region have focused on climate risks to food production. By contrast, this 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.

MENA is highly vulnerable to climate change. By 2030, people's food security will be affected by more frequent, longer, and more intense heat extremes and droughts. Beyond 2030, food security will be increasingly affected by changes in long term climate change trends: higher temperatures, precipitation changes, and sea level rise.

Climate change is certainly happening, yet uncertainties remain over the direction and magnitude of some changes. Some trends are clear. Higher frequencies of more intense heat waves and higher average temperatures will be felt across the region. More frequent and more intense droughts are expected to become the "new normal" in parts of the region, notably the Maghreb. Other trends are less clear. Although higher temperatures imply greater aridity, precipitation may increase or decrease in different parts of the region. Few assessments of climate change – such as those of the Intergovernmental Panel on Climate Change – consider the Middle East and North Africa as a whole. This makes it considerably more difficult to understand climate change from a regional perspective.

Climate extremes and climate change will act as a risk multiplier for food insecurity in MENA. However, the main drivers of food insecurity to 2030 will be population growth, urbanisation, and economic changes. Economic change will drive employment and income and people's ability to purchase food. This resonates with the SDG's and the post-2015 development agenda which recognizes that ending hunger and achieving food security is dependent on a range of factors that often lay outside of traditional food security concerns. Rapid urbanisation will change patterns of what food people eat, and how and where they get it. Population growth will increase demands on supply chains, infrastructure, and public services. Understanding how climate change and extremes intersect with these drivers of vulnerability and food insecurity will be crucial for making food systems more climate resilient and better able to meet changing needs.

Climate variability is already a critical factor in determining the livelihoods of many poor and vulnerable people in MENA. 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. Measures to help them cope with drought, to increase farming productivity, and to diversify away from farming will be key to improving their resilience and food security.

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. Heat extremes are likely to contribute to concerns over food safety, particularly in conjunction with increased competition over water.

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.

Increasingly integrated systems of food storage, distribution and retail in the region are likely to offer significant opportunities for managing climate risk. Adequate cold storage and refrigeration of food during heat extremes and managing risks at bottlenecks in exposed storage and transport infrastructure could all reduce vulnerabilities to the food security of large numbers of people.

Climate change will likely have discernable impact on food security by 2030. However, this should not divert attention from fundamental food security and development objectives. Instead, mainstreaming climate risk management into food systems can help address underlying vulnerabilities, weaknesses, and risks from other sources. More attention is needed on how climate change and variability will affect the access, stability and utilisation dimensions of food security. These are less well understood than climate risks to food availability, but likely to be at least as important to ensure food security in the region.

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. 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, macroeconomic management and reform of food subsidy systems, and reducing risks in food processing, storage, distribution, retail and consumption. Food security of households is interdependent with many other domains, ranging from income and employment to access to basic services and markets. Strengthening food security and reducing climate risks therefore requires integration and coordination across sectors and across stakeholders.

Investments in resilience and managing climate risks to food security can also address existing and underlying vulnerabilities and weaknesses in food systems and governance. By seizing the imperative to adapt, the problem of climate change can be turned into an opportunity to reform and strengthen food systems and food security. The findings and timeline of this report, focused on the year 2030, reinforces the need for urgent action and the importance of achieving the SDGs.

1 Introduction

Key points for policy makers

- Food security is an essential component of human development, and is interconnected with all other human securities. People in the Middle East and North Africa face shortfalls in water security, high rates of urban expansion and population growth, varying success in economic growth and job creation, and sustained pressures to food security at both household and national levels. Conflicts and refugee crises currently exacerbate these challenges in several countries.
- Climate change will affect all aspects of food security. Despite this, research and policy dialogue in the Middle East and North Africa has mostly focused on the impacts of climate change on food production. This is a critical issue, but so are potential climate impacts on food prices, on non-agricultural livelihoods and income, and on food safety. It is these risks that will most directly affect the majority of citizens by 2030, particularly the poorest and most vulnerable inhabitants of towns and cities.
- By 2030, extreme heat events and droughts - already important drivers of food insecurity and instability - will be more frequent and intense across the region. Long term trends in temperature increases and precipitation changes will be becoming noticeable, and will intensify into the future.
- Climate change presents risks to the whole food system. However, climate change is just one source of risk and stress to food security and human development. Responding to climate risks is an opportunity to reform and strengthen food systems and food security, and contribute to human security, stability, and longer term sustainable development in the Middle East and North Africa.

The Middle East and North Africa (MENA) is host to some of the most challenging settings in the world for addressing food insecurity. MENA is the only region outside of Sub-Saharan Africa where the number of undernourished people has increased since the early 1990s, and is the only region where the proportion of undernourished people has increased (FAO 2015). The region[1] includes some of the world's wealthiest countries and also some of the most fragile and least developed. This disparity creates sharp contrasts. 33 million people lack access to adequate nutrition and 18% of children under the age of 5 are developmentally stunted, yet obesity is also a growing public health problem (FAO 2014; UNICEF 2013, quoted in Schellnhuber et al., 2014).

This picture of varied food security and wealth is set against a backdrop of other development challenges. There are high rates of urban and population growth in many countries, increasing demands for scarce water, changing patterns of markets and provision of government services, pressures to sustain economic growth and create jobs, and political and security challenges. These - and other factors – all affect food security. Collectively they also pose both risks and opportunities for sustainable development in MENA countries.

Climate change will make these challenges even harder to address. Climate risks expose existing weaknesses in food systems, and add further complexity and uncertainty to decision-making. Departing from a broad food security and development perspective, this paper therefore summarises available evidence and knowledge about how a changing climate will affect food security in MENA. Although most studies consider climate change in terms of the year 2100, this paper focuses on more policy relevant medium-term time horizons of 2030 and 2050. This paper also focuses less on food production and availability, and emphasises understudied climate risks to food access, stability, and utilisation.

[1] For the purpose of this report, MENA is defined as Algeria, Bahrain, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Sudan, Syria, Tunisia, United Arab Emirates, West Bank and Gaza, and Yemen.

Photo, left: WFP/Marco Frattini

MENA is exceptionally vulnerable to the impacts of climate change (Schellnhuber et al., 2014). Warmer temperatures, more frequent and more intense heat extremes and droughts, and additional stresses on already scarce water resources will compound existing human development challenges. Climate change and extremes will also worsen existing natural (e.g. drought, land degradation, and crop disease) and human (e.g. conflict, socioeconomic inequality, competition for water, inflation and food price spikes) risks to food security (MET Office & WFP, 2013).

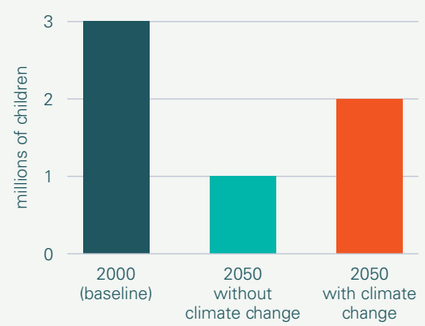
Climate change will affect all four dimensions of food security – the availability of food, and access to, stability, and use of food supplies. Despite this complexity, political dialogue and research in MENA has focused almost entirely on just one aspect of the problem: climate impacts on agriculture and food production. This is a serious issue, particularly for poor and small-scale food producers, but the potential impacts of climate change on food prices, non-agricultural livelihoods and income, and food safety are also critical. Indeed, it is these impacts - not impacts on food production – that will most directly affect the majority of citizens by 2030, particularly the poorest and most vulnerable inhabitants in urban areas.

Climate change and climate extremes will affect directly food production and availability in the region (Alexandratos & Bruinsma, 2012; Abou-Hadid, 2014). Impacts will vary considerably across the region, for different crops and production systems, and with different scenarios of climate change. Recent climate studies have projected that with temperature increases of 3C by mid-century, yields of key cereals could decline 20 to 55% in some parts of MENA unless agriculture is adapted to new conditions (Schellnhuber et al., 2014; Selvaraju, 2013). The region is increasingly dependent on food imports, and climate impacts on yields in source markets could also affect food availability in MENA.

The effects of climate change could lead to both lower incomes and higher food prices: in turn these affect the economic access of people, particularly poor people, to food. Risks to nutrition and the utilisation of food include infectious diseases and poor water quality. For example, diarrhoeal disease is correlated with increased temperatures, and poor water quality can result from droughts and floods. Increased drought risk will also affect the stability and prices of food supplies. Evidence shows that safety nets and social protection systems in MENA are challenged by food price shocks (Marcus et al., 2011; Wheeler & von Braun, 2013).

With continued economic growth and development, MENA can make further progress against poverty and food insecurity. However, climate change is likely to mean that progress is more difficult to achieve. For example, the number of malnourished children under five years of age in MENA was expected to fall from 3 million to 1 million between 2000 and 2050. Instead, due to climate change, 2 million malnourished children could remain by 2050 (G. C. Nelson et al., 2009). Managing climate risk throughout the food system will be therefore an increasingly critical element for policy makers to address if food security is to be achieved for all.

Figure 1: Climate change will delay progress in reducing the number of malnourished children in MENA



Source: Nelson et al, 2009

Table 1: Climate change will affect different aspects of food security

Food Security Dimension	Potential Impacts
Availability	• Reduced rainfall and increased evapotranspiration reducing yields from rainfed agriculture and pastoralism • Reduced soil fertility and increased land degradation from increased temperatures, evaporation, and drought • Climate change induced crop and livestock pests and diseases • Higher post-harvest losses as a result of climate change
Access	• Loss of agricultural income due to reduced yields and higher costs of production inputs such as water • Climate change impacts on food production could lead to higher global and local food prices • Difficulties in accessing food due to displacement driven by climate extremes and disasters
Stability	• Greater instability of supply due to increased frequency and severity of extreme events, including droughts • Instability of incomes from agriculture
Utilisation	• Impact on food safety due to increased temperatures • Impacts on nutrition resulting from reduced water quality and quantity • Climate induced morbidity

Source: FAO (2008)

Photo, top: WFP/Micah Albert

2

Current food security in the Middle East and North Africa

Key points for policy makers

- MENA is reliant on global food markets for much of its basic foodstuffs. As populations continue to rise this reliance will increase, especially for the staple cereals that feature prominently in the diets of the poor. While domestic agriculture remains a vital part of rural peoples' livelihoods and food security, its contribution to meeting national demand for food staples is shrinking.
- Ensuring citizens› access to affordable and nutritious food on markets should be the central focus of efforts to improve food security, rather than solely stimulating domestic agriculture for higher cereal production. Within agriculture, the recent growth in vegetable and fruit production offers promise for future diets, and deserves sustained support.
- Malnutrition remains a major concern across MENA. Poverty prevents many from affording nutritious food and leads to under-nutrition. But in addition, poor diets and changing lifestyles mean micro-nutrient deficiencies remain high and obesity is a growing problem. Improving the quality of diets is an important challenge for all countries.
- Food insecurity is worst in poor rural areas. However, because many people remain poor when they move to urban areas, urban food insecurity is an increasing problem. In particular, attention is needed to make that sure safety nets target the urban poor.

Food Security

The 1996 World Food Summit defined food security in terms of availability, access, utilisation and stability components (FAO 1996)

Availability: The supply side of food security, determined by the level of production, stock levels and exchange. Availability of foraged foods may also be important in certain contexts. Weather, yields, soil conditions, planting decisions, transport and storage infrastructure and a change in the trade regime can all affect availability;

Access: Economic and physical access to available food, mainly from the household perspective, is determined by overall household income, disposable income for food, food prices, as well as gifts and transfers. Within households culture can determine preferences for certain foods

Utilisation: The way individuals are able to consume food, which has a direct impact on nutritional status and is closely linked to feeding practices, preparation and distribution of food between household members. Health factors also critically determine individual's ability to digest food.

Stability: The maintenance of food security through time – while an individual or household may temporarily be food-secure, outside shocks such as food price volatility, unemployment or harvest failures may push them into food insecurity. The birth or death of a child or another family member may also affect the stability of a household's food security.

Photo, left: WFP/Laure Chadraoui

The macro-picture: challenges in national food systems and strategies

All countries depend on imports to meet much of their food needs.
Environmental conditions in the MENA region limit the potential to grow food, and, with population growth, countries are importing more of their food needs and becoming less dependent upon domestic agriculture for most types of food (FAO 2015) (Figure 2). This dependence on international markets means all countries are exposed to fluctuations in international prices. This exposure is not risky in itself, but can be if countries are not wealthy enough to protect their citizens from food price inflation that results from high international food prices.

Food subsidies exist in most MENA countries, but are costly and do not always reach those most in need. Most governments in MENA provide food subsidies that reduce household food bills. Across the region, food subsidies cost $21.6 billion in 2011 and were highest in Iraq, Syria and Egypt where they represented over 2% of GDP in (Sdralevich 2014).

Most are paid in the form of blanket subsidies on common food items like flour or cooking oil, meaning all consumers benefit. While these untargeted food subsidies are easy to administer, when viewed as tools for social protection they are expensive and are rarely the most effective means of channelling resources to those most in need (Sdralevich, 2014). An IMF study concluded that at best, as in Iraq, the benefits of food subsidies are captured equally by all income groups but it is common for the wealthy to benefit more from subsidies than the poor. Such is the case in Jordan where around one fifth of the poorest 20% are unregistered and so do not have universal ration cards that grant access to subsidised food. Where subsidised goods are sold through government-operated shops like in Egypt and Mauritania, a common problem is that few are located in poor districts making it difficult for poor people to access these (Sdralevich 2014).

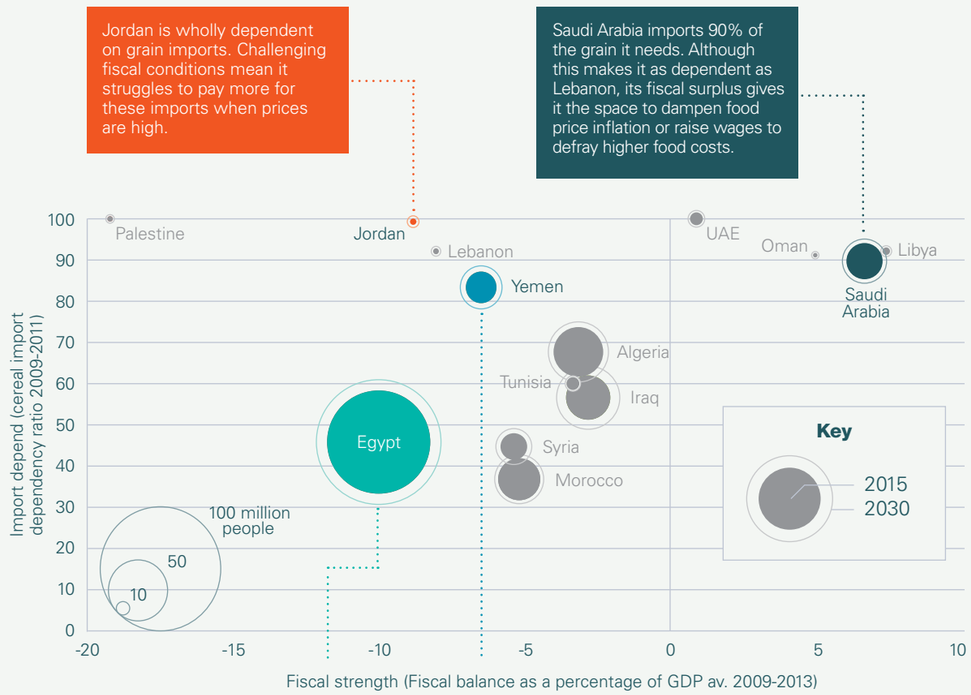
Import dependency and risk

In MENA, national food security is frequently equated with food self-sufficiency. Historical experiences of the role of food in global geopolitics and trade embargos, supply side risks due to conflict, and a lack of control over food availability and prices on world markets means that regional policymakers tend to regard dependency on imports as inherently risky (Woertz 2013). Despite this concern, most MENA countries import more than half of their cereal needs.

Looking to the future, while food imports to richer countries will fall slightly as demand slows, poorer countries are likely to see continued growth in food demand and imports (FAO, 2014). A common narrative in the region suggests that increased investment in domestic agriculture is necessary to reduce import dependency. Yet although some countries have been able to produce more food in recent years, this has grown more slowly than demand (FAO 2015). While it is possible to reduce spending on imports by reducing waste in supply chains, trying to import much less by producing much more is likely to be too costly for most countries.

Apart from the rare occasions when supply chains are severely disrupted, dependency is usually only a risk if countries cannot afford or act in time to mitigate food price spikes (Figure 3). So, while countries with positive fiscal balances and large currency reserves can pay to protect consumers from international food price spikes, less well-off countries will struggle to do so. The most vulnerable countries from this perspective are those that import almost all their food and have large fiscal deficits.

Figure 2: Countries are most vulnerable to food price shocks when neither citizens nor governments can defray the higher costs



The number of poor people per country is not displayed on the graph, but a ranking of countries by poverty headcount shows that in general across the region countries with large populations are also home to many poor people. Sudan is not shown on this graph because information on import dependency was not available.

Sources: IMF Regional Economic Outlook Update: Middle East & Central Asia (May 2014); United Nations, Department of Economic and Social Affairs, Population Division (2014).

Figure 3: Countries face growing demand for grain in the future; this is likely to mean more imports.

This figure shows how many Panamax-sized ships would be needed to deliver wheat imports to each country now and in 2030. Each ship represents a Panamax-sized vessel carrying 55,000 tonnes of wheat, and the numbers shown are estimated from reported import volumes not the actual number of ships arriving. Demand in 2030 is calculated based on populations growing at UN-estimated rates, and each country's food import dependency remaining at current levels.

Sources: UNPD (2014), Ianchovina (2014), FAOstat.

Most existing social protection systems face challenges during spikes in food prices. Blanket food subsidies come under strain when global food prices rise sharply because if - for example - prices rise by a third, the cost of the subsidy to the government also rises by a third. During the 2007-2008 global food price crisis, many countries saw a surge in their spending on food subsidies (Silva et al. 2013). Better targeted and more flexible transfer systems would make some of this expansion unnecessary. A blanket subsidy system is expensive, and takes up resources that could be used to provide wider coverage and more benefits to the poor (Silva et al. 2013).

Although targeted safety nets are better, they could still be enhanced. Programmes that aim to target the poor such as ration cards face challenges in effective targeting, resulting in significant inclusion and exclusion errors. With the exception of Palestine, social safety nets (SSNs) in MENA countries reach around two thirds of people in the bottom 20%, which is less than half the global average and below other countries at a similar stage of development (Silva 2013). Improvements could particularly be made to support better targeting, which often relies on categorical and geographical targeting rather than means-testing. At present, only 25% of SSN beneficiaries are in the poorest quintile, while 15% of beneficiaries are in the richest quintile (Silva 2013); improving targeting will facilitate better public support for SSNs, which is fairly low in most countries. Trials are underway in several countries to improve targeting of interventions, such as the use of smart cards in Egypt, where significant gains can be made in reaching the poorest members of society.

Jordan and the use of social safety nets to assist refugees

The Syrian conflict has led to an influx of over 570,000 refugees into Jordan, equivalent to 9% of Jordan's population. 80% of these refugees live in cities in the Governorates of Mafraq and Irbid, while around 20% are in refugee camps. Ensuring the food security of these people is a challenge for both Jordan's government and for international agencies: the budget needed for food and cash vouchers amounts to around US$570 million.
Uptake of voucher-based cash transfers and electronic payment systems means that refugees can purchase items in CBO-run shops and/or supermarket chains that rely on local and international supply chains. Supermarket chains tend to offer a wider range of items at lower costs. The costs of a food basket is the same in shopping outlets that accept cash vouchers as those that don't, and prices move up and down in unison.
The experience in Jordan and elsewhere suggests cash voucher programmes will increasingly rely on the mainstream market, with major industry players willing to accept refugees as new customers.

Source: WFP, 2014

The status of household food security and nutrition

The nutritional challenges that households face differ starkly in different types of countries but malnutrition remains a major challenge in much of the region.
MENA faces five major nutrition challenges: undernutrition, micronutrient deficiencies, obesity, noncommunicable diseases, and foodborne diseases. The mix of specific nutritional challenges varies between and within countries (Table 2). However, across the region as a whole undernutrition, which results from inadequate calorie or protein intake, remains the most important challenge. 33 million people in the region suffer from undernutrition, and moderate undernutrition contributes to half the region's deaths of children under five (FAO 2015, WHO 2011).

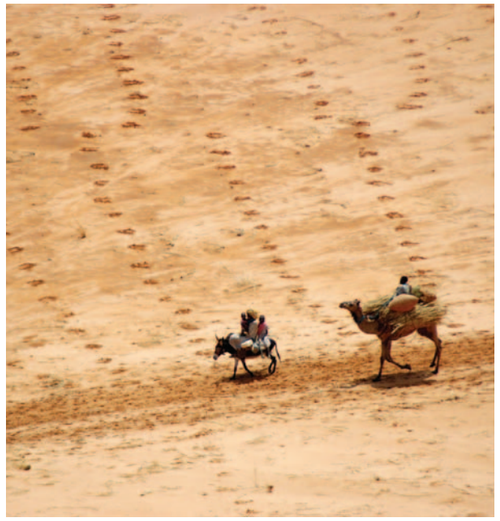


Table 2: Nutritional challenges across MENA

Category and countries or region	Description
Areas in long term complex emergencies.	Severe child and maternal undernutrition and widespread micronutrient deficiencies.
Areas with significant undernutrition e.g. Iraq, Yemen, and some population subgroups in the GCC, Iran, Palestine and Tunisia.	Particularly high levels of acute and chronic child malnutrition, widespread micronutrient deficiencies and emerging overweight obesity and malnutrition of affluence in certain socieoeconomic groups.
Areas in early nutrition transition (traditional diets high in cereals and fibre) e.g. Egypt, Jordan, Lebanon, Morocco and Palestine.	Moderate levels of overweight and obesity, moderate levels of undernutrition in specific populations and age groups and widespread micronutrient deficiency.
Countries in advanced nutrition transition (diets with high sugar and fat content) e.g. Iran, Tunisia, most GCC countries.	High levels of overweight and obesity and moderate levels of under nutrition and micronutrient deficiencies in some population subgroups.

Source: WHO (2011). Note: Categories provide a guide and some countries fit into several because of different nutritional profiles among different groups in society.

Photo, above: WFP/Diego Fernandez

2. Current food security in the Middle East and North Africa

Table 3: Levels of stunting and underweight in under five-year olds in MENA countries (% of under five-year olds).

Country and areas	Year of sample	Stunting (%)	Underweight (%)
Yemen	2011	46.6	35.5
Sudan	2010	35.0	32.2
Egypt	2008	30.7	6.8
Syrian Arab Republic	2009	27.5	10.1
Iraq	2011	22.6	8.5
Libya	2007	21.0	5.6
Lebanon	2004	16.5	4.2
Algeria	2005	15.9	3.7
Morocco	2011	14.9	3.1
West Bank and Gaza	2010	10.9	3.7
Saudi Arabia	2005	9.3	5.3
Jordan	2012	7.8	3.0
Iran	2011	6.8	4.1
Kuwait	2012	4.3	2.2

Source: UNICEF, WHO, World Bank. Joint Child Malnutrition Dataset, 2014 revision.

The drivers of malnutrition are complex. Levels of stunting in under five-year olds - a key indicator for chronic malnutrition - show that malnourishment is a concern across the region (Table 3). The underlying factors driving patterns of malnutrition are complex, and include poverty, weak access to markets and services, detrimental nutrition practices and behaviours, and exposure to drought, conflict, and political and economic instability. Malnutrition tends to be more prevalent where these factors are present. However, even wealthy countries have persistent nutritional challenges among vulnerable groups, which aggregate national statistics do not fully capture.

Micronutrient deficiencies are widespread. Across MENA, many household diets lack the essential micronutrients (iron, iodine, zinc, calcium, folic acid and Vitamins A and D). This is worst in countries in complex emergencies and for vulnerable groups including women of childbearing age, pregnant and breastfeeding mothers and children under the age of two. Micronutrient deficiencies are also high in countries where food markets are more stable and people are wealthier, because of the types of food households typically eat. A large share of the dietary energy in many households comes from unfortified wheat flour, refined sugar, milled rice and soya bean oil which have a low micronutrient content (FAO, 2014). As a result, in many MENA countries micronutrient-related health problems such as anaemia are high, have not improved over recent decades (WHO, 2011) and are considered important public health problems. These micronutrient deficiencies have economic consequences— vitamin and mineral deficiencies cost Morocco over US$173 million in GDP potential (World Bank, 2011).

Obesity is on the rise in many countries. Countries where fat and sugar play a larger role in diets have rising rates of overweight and obesity. This often takes place in countries that continue to have moderate rates of undernutrition—creating a double burden of malnutrition. Several countries already face this situation and the region has become a global obesity hotspot (IFPRI, World Food Programme, & CAPMAS, 2013; Keats & Wiggins, 2014). A challenge for MENA countries will be to shift diets of the existing and growing middle class while subsidised

calorie-rich staples and other processed foods remain considerably cheaper than more healthy alternatives. An important reason for optimism on nutrition is that MENA countries produce a large and growing quantity of fruit and vegetables, which are essential to overcome the region's nutritional challenges and improving diets (FAO 2015). At present, much of this produce is destined for overseas markets and efforts are needed to raise domestic consumption of fruit and vegetables through interventions across the food system, including shifting subsidies towards nutrient-dense foods and public education campaigns (FAO 2015).

Yemen's protracted nutritional crisis

The state of political instability and economic downturn in Yemen since 2011 has worsened its protracted food crisis. Although Yemen made some progress in reducing undernourishment in the early 2000s, the 2007-2008 food price crisis marked a turning point, and challenging conditions since have had impacts on food security. The number of people with diets classified as 'inadequate' rose 41% from 2011-2013.Under-five stunting is highly prevalent— 47% of children are stunted or chronically malnourished. Although the main social safety net, the Social Welfare Fund, has been expanded in recent years to cover half of poor Yemenis, the political crisis has meant funds have only been disbursed to beneficiaries intermittently in recent years. The continuation of the conflict raises concerns over possible higher food prices and lower household food stocks.

Sources: WFP (2008) cited in World Bank, FAO and IFAD (2009); FEWS NET (2015)

The geography of food insecurity

Poverty prevents many households from improving their nutrition and food security. Across countries, poor people are the most food insecure as they have limited resources to buy available food and face challenges accessing safety nets. Poor people are also most affected by food price spikes, and in response often reduce overall food consumption, or consume less nutritious foods (Compton et al. 2010). The 2007-08 food price spike had a major impact on poverty and food insecurity in the region: estimates suggest around 2.6 more million people entered into poverty and 4 million extra people became undernourished following the crisis (FAO 2008 and World Bank 2010, cited in Harrigan 2014). Households struggling to afford food also often cut back on other essentials. For example, analysis by WFP suggested that between 2006-2008 almost half of poor Yemenis cut back on healthcare spending (WFP 2008 cited in World Bank, FAO and IFAD 2009).

Much of this poverty and food insecurity is concentrated in rural areas, although this may be changing. Most of the 33 million undernourished people across MENA live in rural areas, where poverty is also concentrated (FAO, 2014).[2] Table 4 below shows this is the case for almost all countries. However, recent crises have underlined the large and growing numbers of food insecure people in urban areas, including newly-arrived displaced people and refugee camps (IFPRI et al., 2013). As Table 4 shows, Jordan now has more poor people living in urban than in rural areas and this trend is likely to be seen elsewhere in the context of high out-migration from rural areas.

[1] Across MENA, around 75% of poor people live in rural areas (World Bank, FAO and IFAD 2009)

2. Current food security in the Middle East and North Africa

Table 4: The poor are concentrated in rural areas (source: World Bank, 2009)

Country	Percent of urban people who are poor	Percent of rural people who are poor	Percent of poor in rural areas
Yemen	21%	40%	84%
Eygpt	10%	27%	78%
Sudan	27%	85%	81%
West Bank and Gaza	21%	55%	67%
Jordan	12%	19%	29%
Algeria	10%	15%	52%
Morocco	5%	15%	68%
Tunisia	2%	8%	75%

Source: World Bank, FAO and IFAD (2009). Data for Iraq, Lebanon and Syria are not available

Photo, above: WFP/Marco Frattini

Demographic change in MENA: population growth and urbanisation

High fertility rates in some MENA countries translate into rapid population growth. Between 1970–2000 MENA's population grew more rapidly than any other region apart from Sub Saharan Africa, at an average annual rate of 2.57% (UN, 2014), with the fastest growth seen in the Mashreq and GCC countries.

In coming decades the highest growth will take place in cities, adding pressure to already stretched public services and water supplies. This demographic transition will impact all aspects of food security. It is unclear how availability will be affected by rural outmigration. In terms of access, large numbers of rural dwellers will effectively be removed from food production, and will need to rely more heavily on markets.
over possible higher food prices and lower household food stocks.

In rural areas, food production has a more important role in shaping food security. Farming (including agriculture, livestock, and fisheries) is an important source of livelihoods and contributor to food security in rural areas across MENA. In the developing countries, farming accounts for an average of 10% of GDP, and in countries such as Morocco and Egypt produces export earnings (FAO 2014). The high incidence of poverty in rural areas of MENA makes farming even more important for food security at the household level. Although most households rely more on markets than on their own production for food needs, farming is an important source of jobs and income. Agriculture employs around 40% of the workforce in Morocco and between 20%-30% in Yemen, Egypt and Iran (World Bank, 2014).

Urban food security is largely shaped by income and access to food. Although the urban poor generally face more stable food markets than their rural counterparts, they also face serious challenges to their food security. Social networks that act as safety nets during difficult times are weak, and as a result, urban households are heavily dependent on cash to meet their needs (WFP, 2014b). Unskilled or semi-skilled migrants are usually limited to poorly paid and irregular employment, and the potential advantage of higher incomes from urban employment can be eroded by higher prices for food and other necessities (Ahmed et al. cited in Battersby (2012). Incomes from some livelihoods, such as tourism or construction, may also be seasonal or weather dependent, which heavily influences access to food (Tacoli, Bukhari, & Fisher, 2013).

Both the lifestyles and environment of the urban poor contribute to unhealthy diets. Although urban markets offer a wide range of options most poor households consume relatively few types of food due to limited budgets, limited time, and distance from sellers. Despite the growing presence of supermarkets stocking fresh food, many poorer urban consumers rely more heavily on small shops, informal markets, and other food sources located nearer to their houses, and more relevant to their needs. For example, a lack of domestic facilities for storing and cooking food, and limited time for preparing food due to irregular working hours and long commutes, makes cheap, calorie-dense street food options popular for many (Battersby, 2012). These factors contribute to unhealthy diets of the urban poor, dominated by high amounts of fats and caloric sweeteners (Popkin 2003).

Photos, clockwise from top left: WFP/Marco Frattini, WFP/Debbi Morello, WFP/John Wreford, WFP/Berna Cetin, WFP/Ammar Bamatraf , WFP/Simona Caleo

3

The future climate of the Middle East and North Africa

Key points for policy makers

- By 2030 MENA will be noticeably warmer. Average summer temperatures will be 1-2C hotter, and this trend will continue to 2050 and beyond. Areas in the Maghreb and the Levant are likely to become drier, although some desert areas may become relatively wetter. Even small changes in precipitation and temperature may lead to large changes in water evaporation, runoff, and recharge in arid areas.
- By 2030, climate extremes will be more common and more intense. Heat extremes will be significantly more frequent across the region, with risks to human health and food safety.
- Widespread and severe droughts will be more common in the Mediterranean area by 2030, with impacts on food production and rural livelihoods, and the potential to exacerbate other social, economic and political problems. By 2100 MENA is likely to be a global hotspot for drought.

MENA's aridity and complicated geography makes projecting the region's future climate very difficult. Hyper-arid areas of the Sahara and Arabian Peninsula, and cooler, wetter mountainous areas of the Levant, Iraq, North Africa and Yemen, lie next to semi-arid coastal plains. Rainfall is highly seasonal and falls mostly in the winter. Rain also varies from year to year and from place to place - higher in coastal and mountainous areas, much lower in the interiors (Eshel et al., 2000;(Cullen et al., 2002). These factors make future changes in precipitation highly uncertain. There is much less uncertainty over average temperatures, which will rise over coming decades.

In addition to long term changes in average conditions, extreme heat events will be more common and more intense by 2030. Some parts of MENA will become more prone to drought, which is already the region's most significant natural disaster (Erian, 2011).

Photo, left: WFP/Abeer Etefa

A hotter, drier future: long term trends

Human-induced climate change is happening against a background of natural variation in the global climate. Signals of climate change against this background natural variation will be seen earlier in some regions than others. By 2030, most signals of climate change in MENA will be emerging from this background variation, with trends becoming stronger and clearer by 2050 and beyond. While temperature trends across the region are clearer, there are considerable uncertainties in projections over precipitation and drought patterns.

Average temperatures will increase steadily, particularly during summer months.
Results from the Intergovernmental Panel on Climate Change's (IPCC) 5th Assessment Report (AR5) suggest that by 2035 temperatures across the region will be higher than the period 1986-2005. Summer temperatures are likely to increase by 1C to 1.5C across MENA, and may increase by up to 2C in parts of Iran, Iraq, Saudi Arabia and Algeria. These trends intensify into the future, with potential increases of up to 3C across the region by 2065. Winter temperatures are likely to warm less quickly, but 1C increases across the region can be expected by 2030, possibly as high as 1.5C, with winter warming more likely in the Arabian Peninsula and Iraq. By 2065 increases of 2C are likely across much of the region, potentially increasing to 3C away from the coasts, including inland areas of the Arabian Peninsula, Iraq, Morocco, and Algeria (Van Oldenborgh et al., 2013). These results correspond with findings of Turn Down the Heat 3 (TDTH3), which suggest that temperatures across MENA are likely to increase by 2.2C by 2030, rising to 2.5C by 2040 (Schellnhuber et al., 2014).

Changes in precipitation are less clear, but some areas will probably become drier.
The IPCC AR5 and TDTH3 both found little agreement between models on the direction or magnitude of precipitation changes in MENA by 2035. Some models showed drying trends over Morocco and parts of the Levant of up to 20%, and others showed

wetting trends over areas of the Arabian Peninsula. The trends of these models continue to 2065, with drying in North Africa and the Levant and wetting over the southern Arabian Peninsula becoming more intense and widespread, but the results of different models do not converge (Schellnhuber et al., 2014; Van Oldenborgh et al., 2013).

This uncertainty is a cause for concern. In MENA countries there is already high competition for water resources, which are physically scarce in many place. Even small precipitation changes in arid areas can have large differences on runoff, river flow, and groundwater recharge. The additional uncertainties and variability resulting from climate change will challenge water policy, planning and management (Schilling et al., 2012).

Sea level rise is a long-term risk to coastal communities in MENA, but is unlikely to have widespread impacts by 2030.
With populations, cities, and agricultural areas heavily concentrated in coastal areas, MENA is one of the world's most vulnerable regions to sea level rise, a consequence of warmer oceans and melting sea ice. Particularly in densely-populated, low-lying coastal areas such as in Tunisia, UAE and Qatar, a sea level rise of 1m would place populations and economies at significant risk (Dasgupta, Laplante, Meisner, Wheeler, & Yan, 2009). However, sea level rise is a slow onset disaster: although it may have significant consequences for MENA by 2100, widespread impacts by 2030 are not likely. However, in locations such as the Nile Delta, sea level rise could exacerbate existing problems of subsidence, salt intrusion and poor drainage, with local consequences for housing, employment, and food production by 2030 (Hassaan & Abdrabo, 2013).

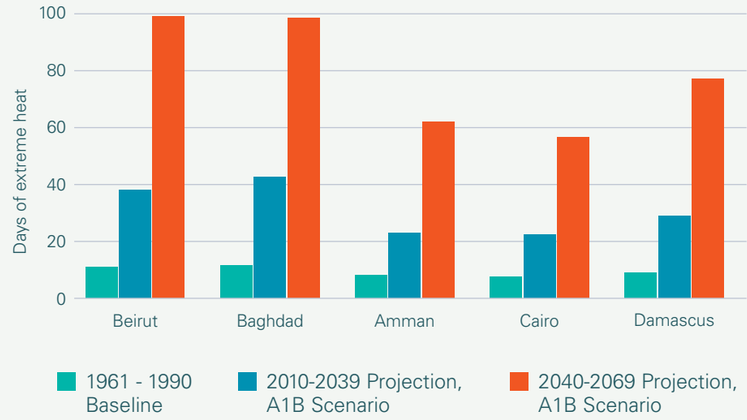
Climate projections in this study

The Intergovernmental Panel on Climate Change (IPCC) does not provide model results specifically for the MENA region (Van Oldenborgh et al., 2013; Field et al, 2014). Instead, it provides results for the regions of Africa, Europe and Asia, which need to be combined to cover the area of MENA. Similarly, regional chapters for Africa and Asia in the IPCC assessment reports focus little attention on West Asia (the Middle East) and North Africa. These constraints make it challenging to use the IPCC reports to understand future climate in MENA. By contrast, Turn Down the Heat 3 (TDTH3) provides regional modelling for MENA, but is focused on scenarios of 2C and 4C warmer worlds, rather than specific time periods (Schellnhuber, 2014).

In this report we have used both IPCC and TDTH3 results and the wider literature to identify likely climate risks in 2030. However, significant uncertainties are implicit in these interpretations. In most cases, results for different emission scenarios diverge markedly after 2050, and this report does not differentiate between high emission ('business-as-usual') and low emission ('decisive mitigation') scenarios.

3. The future climate of the Middle East and North Africa

Figure 5: An increasing frequency of heat waves in MENA cities will be an early and noticeable impact of climate change



Heat extremes are defined as days in the year when maximum temperatures are above the 90th percentile for six consecutive days or longer relative to the baseline

Source: Lelieveld 2013

More frequent, more intense extremes

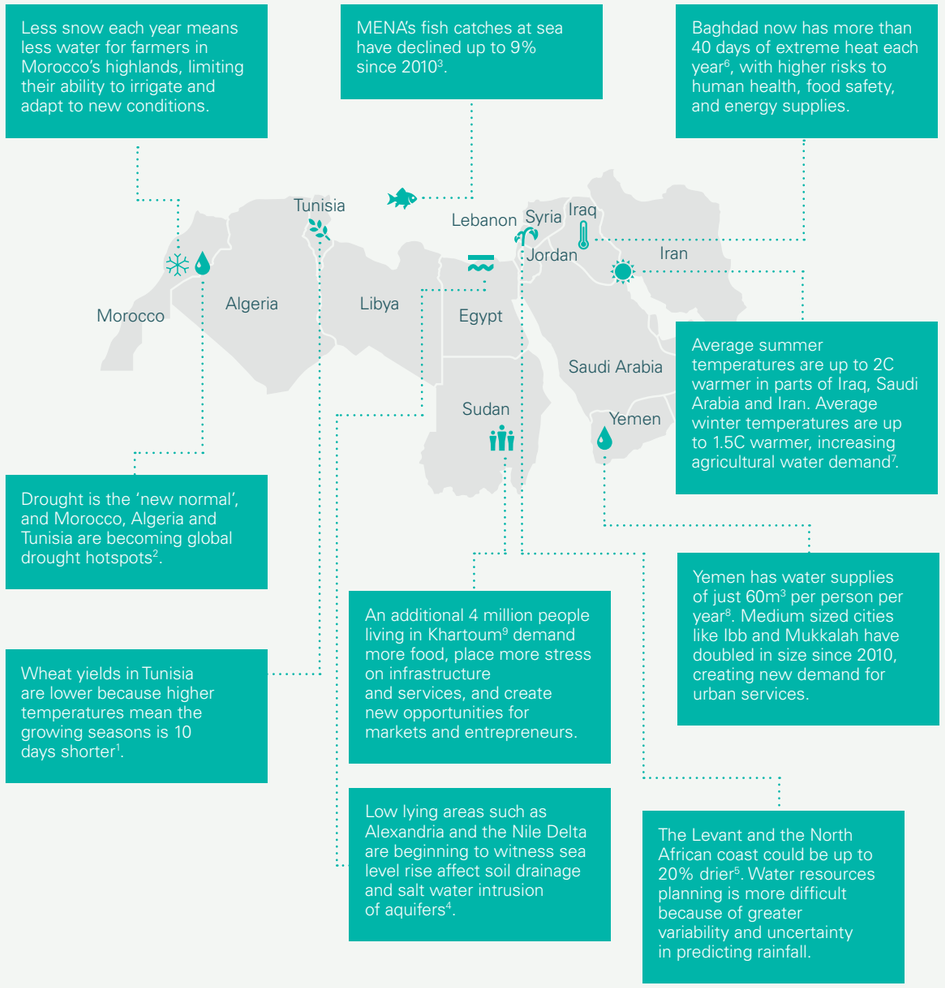
Heat waves will be more common and more intense by 2030. Since the 1960s, the number of heat waves across MENA has risen and there have also been increases in the durations of warm spells (Donat et al., 2014). These trends are expected to continue, and MENA is likely to experience increases in the frequency and intensity of heat waves that are substantially above the global average (Lelieveld et al., 2013; Schellnhuber et al., 2014) (see Figure 5). The frequency of heat extremes could plateau by mid-century under low-emission scenarios, but continue to increase to the end of century under high-emission scenarios (Schellnhuber et al., 2014). Heat extremes have serious consequences for human health due heat stress and consequences for food safety.

Compared to the 1960s, more people are now affected by floods.
Since the 1960s there have been fewer extreme precipitation events, although there have been localised increases (Schellnhuber et al., 2014). Even so, the number of people in the region killed or affected by floods has doubled over the last decade (Tewari et al., 2014). This is largely due to rapid urbanisation in flood prone areas, with poor urban planning and low investment in drainage (DiBaldassarre, 2010).

Informal settlements, refugee camps, and conflict-affected areas are particularly vulnerable. Refugee camps in Jordan, Lebanon and Yemen have been affected by flash floods in recent years, leaving residents without shelter and sanitation (UN News, 2013). Water infrastructure in Gaza has been damaged by conflict, and in 2013 5,000 people were evacuated after days of heavy rain (Reuters, 2013).

By 2030 floods are more likely to affect greater numbers of people.
Projections of future extreme precipitation events in MENA are inconsistent or inconclusive (Van Oldenborgh et al., 2013; Schellnhuber, 2014). Even so, the number of people exposed to flash floods by 2030 appears likely to increase due to continued and rapid urbanisation in flood prone areas.

Figure 6: MENA in 2030, showing some likely consequences of climate change and population growth



[1] Source: Mougou et al., 2011
[2] Source: Schellnhuber et al., 2014
[3] Source: Schellnhuber et al., 2014
[4] Source: Hassaan & Abdrabo, 2013
[5] Sources: Van Oldenborgh et al., 2013; Schellnhuber et al., 2014
[6] Source: Lelieveld 2013
[7] Sources: Van Oldenborgh et al., 2013; Schellnhuber et al., 2014
[8] Calculated with data from Aquastat and from UN 2014.
[9] Data from UN 2014, World Urbanization Prospects. http://esa.un.org/unpd/wup2014/CD-ROM/Default.aspx.

Droughts have become more frequent and more intense.
Recent decades have seen increases in drought frequency and severity in the region (Chbouki, Stockton, & Myers, 1995; Donat et al., 2014; Touchan, Akkemik, Hughes, & Erkan, 2007; Touchan et al., 2008). Inland countries such as Jordan and Syria have experienced warming and precipitation decline, with droughts increasing in severity, extent and duration (Al-Qinna, Hammouri, Obeidat, & Ahmad, 2011).

Between 2000 and 2010, 75% of the land area in Arab countries was affected by drought for 2 years or more: 38% of the area was affected for three or more consecutive years (Erian, 2011). These events exposed 156 million people to moderate or high levels of drought stress, most seriously in northeast Syria, southern Sudan, the northern areas of Tunisia, Algeria, Morocco, northeast Somalia, northeast Iraq, and the northeast of Saudi Arabia (Erian, 2011).

The livelihoods of more than 80% of MENA's rural population depend on drought sensitive pastoralism and rainfed agriculture, which also contribute half the region's food production (Dixon, 2001). The economic and food security impacts of drought can be extremely serious, particularly for the poor, and exacerbate other social, economic and political problems. Persistent drought in Morocco during the early 1980s resulted in food riots and contributed to a macroeconomic collapse (El-Said & Harrigan, 2014). Drought in Syria between 2006 and 2010 affected 1.3 million people, accelerating rural migration to cities, and compounded other stresses and sources of tension (Schellnhuber et al., 2014).

By 2030 drought is likely to be more common and more intense in parts of MENA, particularly the Mediterranean area.
Climate change is likely to exacerbate aridity in the region as temperatures increase. MENA countries, particularly Morocco, Tunisia and Algeria, are expected to become global hotspots for drought over the next century (Schellnhuber et al., 2014). Several studies suggest that severe drought is expected to be the "new normal" across the region as soon as 2030, with droughts becoming more severe and prolonged by 2065 with both more consecutive dry days and soil moisture anomalies (Dai, 2011; Seneviratne et al., 2012). However, the IPCC Fifth Assessment Report concluded that while the Mediterranean area is likely to be become drier and experience more drought, the signals for West Asia and the Arabian Peninsula were inconclusive (Field et al, 2014).

4

The impacts of climate change on food security

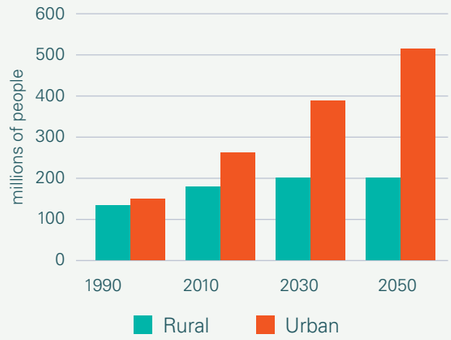
Key points for policy makers

- By 2030, higher temperatures will affect food crop production, reducing yields of some crops, increasing spoilage, and driving up production costs. Droughts will have more widespread impacts on yields in affected years, and will exacerbate processes of land degradation and desertification. Small producers in remote areas of marginal drylands and uplands will be most vulnerable to increasing climate shocks and the risk of poverty traps.
- Most people in MENA will be affected by climate impacts on their income and health, food price volatility, and the potential for climate extremes such as floods and storms to disrupt food supply chains. In urban areas, those living in densely populated informal areas with insecure employment and poor access to basic services will be most at risk.
- Climate change will synergise with other trends in population growth, urbanisation, and economic development to create new and unexpected risks. Climate change will act as a risk multiplier to food security by 2030, particularly around issues of water security, the rapid expansion of informal urban areas, and conflict and instability.

Climate change is a significant, long-term challenge for MENA. By 2030 increasingly frequent and intense droughts and heat waves will affect food production and food *availability* in the region. Climate change and extremes will also affect other aspects of food security – *access* to, and the *stability* and safe *utilisation* of food supplies. The food security of different social groups will be affected in different ways, depending on their livelihood strategies and physical and institutional environments. The food security of farmers is most at risk from lost income from agriculture, and reduced yields of food produced for household consumption. The food security of urban consumers may be most at risk from price fluctuations, supply chain disruptions and risks to human health.

Climate change is not the only change people in MENA will experience in coming decades. Populations are rapidly growing and becoming more urban, competition for water is increasing, and dietary and food purchasing habits are changing. Climate risks will interact with these other trends to affect people's food security. Population growth and urbanisation in particular will have profound implications for how people and countries in MENA feed themselves (Figure 7).

Figure 7: Population growth in MENA



Data from UN 2014, World Urbanization Prospects. http://esa.un.org/unpd/wup2014/CD-ROM/Default.aspx. Countries are Algeria, Bahrain, Egypt, Iraq, Iran, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Sudan, Syria, Tunisia, UAE, & Yemen.

Photo, left: WFP/Micah Albert

At a glance: MENA in 2030 and 2050

In 2030, MENA countries will import a larger proportion of their food to meet demand from a growing population. Higher frequency and intensity of droughts will affect crop and livestock production, particularly in the Mediterranean region. These drought impacts will mean that countries experience more frequent periods of higher reliance on food imports to feed their people. Warmer conditions and changes in precipitation patterns will be seen in some places. An extra 130 million people in cities and towns will be affected by more frequent and intense heat extremes.

By 2050, trends in increased temperature, drought, and heat extremes will intensify and inhibit crop and animal production. Food import dependency is likely to increase further, with imports making up persistent shortfalls between demand and supply. Particularly in urban areas, heat extremes and warmer temperatures will affect the economy and human health, and therefore people's ability to buy and use food safely.

In coming decades, climate change and extremes will impose additional stresses on MENA countries. These stresses will compound pressure drivers such as rapid population growth and urbanisation, increased competition for water, and social and economic transitions. Climate risks to food security, in particular, could exacerbate other social and political tensions.

How will food producers be affected?

Agriculture, livestock and fisheries are important sources of rural jobs and income in MENA: these sectors employ 20% - 30% of the workforce in Yemen, Egypt and Iran. The welfare and food security of rural producers depends on producing and selling food and non-food crops to generate income and, to a lesser extent, for their own consumption (Hertel, Burke, & Lobell, 2010). Climate impacts can therefore directly affect the *stability* of their food *availability* and their ability to *access* (purchase) food. We will therefore focus on those dimensions rather than *utilisation* for rural producers.

How will climate change affect food production?

By 2030, heat extremes and drought events due to climate change will affect crop yields across MENA.
By 2030 increased frequency, persistence and intensity of drought will be more prevalent, particularly in the Mediterranean, intensifying to 2050 (Dai, 2011; Seneviratne et al., 2012). Impacts are likely to include crop and livestock losses, reductions of soil fertility and increases in land degradation, and increased competition for water resources during dry spells, with the resilience of affected populations tested by more frequent and intense shocks (Field, Barros, Mach, & Mastrandrea, 2014; Schellnhuber et al., 2014).

By 2030, climate change will start to stress yields.
If temperatures rise by 1.5 – 2C by 2030, yields of some crops could decline by up to 30% in certain areas if producers do not adapt (Schellnhuber et al., 2014). Yields of summer legumes in the southern Mediterranean could decline up to 24%, and yields of key cereals up to 5% (Lobell et al. 2008; Giannakopoulos et al. 2009). However there is considerable variation in projections of impacts between crops, regions, and production systems. Increased water stress, resulting from precipitation changes and increased demand from other socio-economic uses, will impact irrigation and livestock production in some areas. Farmers and agricultural systems are likely to focus increasingly on stabilising rather than maximising yields in the face of increasing climate variability, particularly in rainfed agriculture (Schilling, Freier, Hertig, & Scheffran, 2012).

As temperatures continue to rise beyond 2030, yields will be more seriously affected.
For example, temperature increases of up to 3C by mid-century could see barley yields in Jordan decline 22% - 51%, and Syrian wheat yields decline 23% - 57% (Al-Bakri et al. 2011; Verner & Breisinger 2013). Many of these impacts are intensification of earlier trends. For example, the growing period of wheat in Tunisia is expected to shorten by 10 days for a temperature increase of 1.3C (~2030) and by 20 days for an increase of 2.5C (~2050) (Mougou, Mansour, Iglesias, Chebbi, & Battaglini, 2011). Favourable conditions are likely to shift northwards or to higher elevations for many crops, while increasing aridity will also affect soil moisture, soil fertility, and land degradation, which could result in the loss of up to 850,000 ha of rainfed agriculture across Syria, Lebanon and Iraq (Evans, 2009).

Both slow onset climate change and extreme drought and heat events are likely to impact the quality of produce and result in lower yields.
Higher temperatures can spoil food more rapidly, particularly where there is limited capacity for cold storage. As a result, producers are at risk of reduced farm incomes and reduced ability to purchase food (FAO, 2008).

The impacts of climate change and extremes will drive up the costs of production.
It is possible to counter impacts on agricultural yields by investing in adaptation. Investment in new techniques, new crop varieties, and adaptive institutions have the potential to drive up food production to more than compensate for potential climate losses (Godfray et al., 2010). However, the costs of these investments may affect the feasibility of some crops and production systems.

Which food producers will be most vulnerable?

Farming systems and livelihoods in MENA are diverse, with different environmental constraints and poverty profiles, which will be impacted by climate change in different ways. Vulnerability to climate change results from exposure and sensitivity to impacts, and adaptive capacity to respond to these impacts (see box). These three components of climate vulnerability help to distinguish between the risks to different livelihood groups.

Components of vulnerability

Exposure: mainly as a consequence of geography, different communities will be exposed to different hazards. Most farmers in MENA are exposed to drought, while communities near the sea may be exposed to coastal flooding and salt intrusion.

Sensitivity: people and communities may be more or less sensitive to different hazards. Farmers with irrigation can be less sensitive to drought than farmers in rainfed agriculture, and fishing communities will be more sensitive to coastal storms than to drought.

Adaptive capacity: the ability of people and societies to cope with and respond to the risks and impacts of climate change and extremes. Adaptive capacity is strongly influenced by access to information, and resources such as finances, infrastructure, social institutions, and natural resources. Poor people living in remote areas with weak natural resource bases are likely to be less adaptable than rich people living in well connected areas.

Photo, top: WFP/John Wreford

Small-scale pastoralists are highly vulnerable to the impacts of drought, and have low capacity to adapt to climate change.
Around 9% of MENA's agricultural population is engaged in pastoralism in inland areas of Morocco, Algeria, Libya, Egypt, and Syria. A further 14% are engaged in mixed dryland farming, combining livestock with barley, rainfed wheat, and fodder, in North Africa, Jordan, Lebanon and Syria (Dixon, Gulliver, & Gibbon, 2001). These areas will be exposed to higher temperatures by 2030, and some studies suggest they will also be exposed to greater aridity and drought risk as early as the 2030s, with drought risk increasing into the future (Dai, 2011). Pastoralists and dryland farmers are particularly sensitive to drought risk, and the health and productivity of pastoralist herds may be more affected by pests and disease (Selvaraju, 2013). Long term increases in temperature, aridity and water demand are likely to further reduce crop yields and livestock production, and further degrade natural resource bases. Poverty is extensive among small scale producers, and weak capital and assets and difficulty in accessing services reduces the adaptive capacity of these livelihood groups. The vulnerability of these systems is demonstrated by the 2006-10 drought in Syria's *Badia* that saw livestock losses of over 80% in some districts and millions of people migrating to urban areas (Erian, 2011). Due to their remoteness, yield losses in these areas can have dramatic impacts on local food availability and prices.

Farmers in remote highland systems are highly vulnerable to climate impacts because of extensive poverty, remoteness, and marginal resources.
Highland communities in Yemen, northern Iraq, Morocco, Algeria and Iran make up around 30% of MENA's agricultural population. This includes both rainfed farming of cereals, legumes, and trees on terraces, and sheep husbandry on communally managed lands. Farmers in Morocco are most likely to be *exposed* to drought and rapid rises in temperature by 2030. Reduced water from snow melt will also impact farmers in Morocco and Iraq. Like dryland farmers and pastoralists, highland farmers are highly *sensitive* to drought and long term stresses on natural resources, particularly water in communities making use of snowmelt. Due to temperature changes some crops may become viable at higher altitudes in the future, while other crops may pass out of production. *Adaptive capacity* in these areas is low due to extensive poverty, degraded natural resources, weak infrastructure, and poor access to government services and markets (Dixon et al., 2001).

Fisheries

Fisheries play an important role in the diets and livelihoods of some of the poorest members of society in certain MENA countries. Production from marine capture fisheries has increased significantly since the 1960s, and in the last twenty years international trade and aquaculture have been also made fish protein more widely available (Golzarand et al., 2012).

Around 2% of MENA's rural population are artisanal fishers living in small communities, mainly along the coasts of Yemen, Syria, Lebanon, Sudan, Egypt, Algeria, Tunisia and Morocco. In general members of these communities receive very limited social services, live in poverty, and are largely dependent on fisheries for their income and food security (IFAD, 2003; 2007).

Effects of climate change, such as temperature changes and ocean acidification, are likely to reduce marine capture fisheries production and slow the growth of aquaculture production. Marine capture production in MENA is projected to decline up to 9% by 2030, and total consumption of fish is projected to fall 2% despite increased trade and aquaculture production (World Bank, 2013). These figures imply impacts on the incomes and livelihoods of rural artisanal fishers, and reduced availability and higher prices of fish protein for poor urban consumers.

Rainfed agriculture is vulnerable to drought and land degradation, and water stress and drought sensitivity is likely to increase over time.
Farmers in mixed rainfed agriculture in the semi-arid and sub-humid areas of Yemen, Morocco, Algeria, Tunisia, Lebanon and Syria, and northern Iraq make up 18% of MENA's agricultural population in areas with high population densities. Most of these areas are exposed to the same impacts as dryland farmers, with temperature increases, increased drought risk and aridity all challenging production. In coastal areas, farmers are also exposed to risks of saltwater intrusion into aquifers, particularly in areas of high groundwater pumping such as Morocco and Lebanon. Some studies have suggested that by 2050, large areas of these lands are likely to be unviable for rainfed agriculture (Evans, 2009).

In some areas traditionally dominated by rainfed agriculture, state irrigation schemes and adoption of small-scale private irrigation have reduced the *sensitivity* of some farmers to short-term drought and allowed cultivation of higher water intensity crops. However, in countries such as Morocco this has contributed to declines in groundwater and increased water stress (Kuper et al., 2012). By 2030 increased competition from other water uses may restrict farmers' access to irrigation water, particularly during periods of intense drought. Sensitivity to drought and water stress could therefore increase despite adoption of irrigation, particularly for farmers with insecure water rights. Yet, these farmers are likely to have higher *adaptive capacity* than pastoralists and dryland and highland farmers. Poverty is more moderate and confined mainly to small-holder households, farmers have better access to markets and services, and also benefit from more diverse off-farm incomes (Dixon et al., 2001).

Farmers in irrigated systems are less vulnerable, but over time they are likely to be affected by hydrological changes and increased competition for water.
Large scale irrigated systems dominate only along large river systems like the Nile and Euphrates valleys, but they support a relatively large proportion (17%) of MENA's agricultural population. Farmers in these areas are *exposed* to the impacts of long term temperature increases on crop yields and water demand. Like farmers in rainfed areas who have adopted irrigation, these farmers have reduced *sensitivity* to the impacts of increased crop water demand and short term drought. The *adaptive capacity* of people in these systems is also generally high as poverty is less extensive, and high population densities and high agricultural production have led to good access to markets and services. Many farmers in these systems cultivate cash crops, and their incomes are largely determined by market conditions and significant contributions from off-farm income (Dixon et al., 2001).

Individual farmers in these systems therefore have relatively low sensitivity and high adaptive capacity. However, these traits depend on the continued performance of the irrigation network, over which individual farmers have little or no control. Over the medium- to long-term, large irrigation systems may be vulnerable to hydrological and other impacts of climate change. Farmers in the Tigris-Euphrates, for example, may experience changes in seasonal water availability due to changing patterns of snow melt in river catchment areas and evaporation from water reservoirs (Özdogan, 2011). Major adaptations and alterations to the extensive physical and institutional infrastructure for irrigation in the Nile and Euphrates would have very large transaction costs. If those costs were to deter policy makers from necessary adaptation investments, the risks to large numbers of farmers would be very high.

Climate risks compound the challenges and risks of food producing livelihoods, and can exacerbate poverty.
All these food producing livelihoods are vulnerable to climate impacts, although some are more vulnerable than others. The poor are particularly at risk. For these groups climate impacts on yields and food production directly translates into lost incomes, less ability to purchase and access food, and debt accumulation and/or liquidation of assets to meet short term needs. In turn, asset liquidation and debt accumulation means that producers have less to invest in adaptation and resilience, potentially increasing their vulnerability to future climate impacts and other shocks and risks (Heltberg, Siegal &

Jorgensen, 2008). Conversely, management of climate risks by farmers can include strategies that minimise variability but also keep average productivity – and therefore incomes - low (Lybbert et al., 2009). Climate risks, and attempts to manage them, can therefore both exacerbate rural poverty traps.

Poor people, living in areas remote from public services and markets, and dependent on marginal natural resource bases will be most vulnerable. Lacking the assets or opportunities to invest in agricultural adaptation or entirely new economic strategies (such as migration), they are the most likely to be caught in poverty traps (Dorward et al., 2009). The people in MENA most sensitive and vulnerable to climate change may therefore be poor people living in drought-exposed, remote marginal areas with endemic poverty - especially highland systems, but also dryland and pastoral systems.

Table 5: Typical climate vulnerabilities of rural livelihood groups

	Exposure	Sensitivity	Adaptive capacity
Pastoralists & Dryland farmers	- Heat extremes and temperature increases - Aridity and drought	- Highly sensitive to drought - Sensitive to land degradation - Livestock pests and disease	- Poverty extensive among small producers - Poor access to markets and services - Little off-farm income
Highland farmers	- Heat extremes and temperature increases - Aridity and drought - Changes in water availability due to snow melt	- Highly sensitive to drought - Sensitive to degradation of natural resources - Changes in viable crops	- Poverty extensive - Poor access to infrastructure, markets and services - Little off-farm income
Semi-arid farmers	- Heat extremes and temperature increases - Aridity and drought - Salt water intrusion - Changes in patterns of precipitation and water availability	- Highly sensitive to drought and aridity - Lower drought sensitivity amongst irrigation adopters, but increasing in future	- Moderate poverty among small producers - Better connections to markets and services - Off-farm income more significant
Irrigated areas	- Heat extremes and temperature increases - Upstream hydrological changes - Changes in water availability	- Lower drought sensitivity, but may increase in future - Moderately sensitive to temperature increases - Reduced sensitivity is dependent on maintenance of irrigation networks and water supplies	- Moderate poverty - Good access to markets and services - Off-farm income significant

How will food consumers be affected?

With urban areas in MENA set to grow by 130 million people between 2010 and 2030, food security in towns and cities will become even more important. Although wealth tends to rise with greater urbanisation, economic growth often bypasses large sections of urban populations. When coupled with poor infrastructure and limited access to services, malnutrition and food insecurity can be as intense, if not worse, in cities than in rural areas (Tacoli et al., 2013).

Slow onset impacts of climate change could have a pronounced effect on incomes and urban consumers' *access* to food. Long-term climate changes and trends may act as a drag on economic growth and job creation through mechanisms including higher mortality, lower performance, and social unrest (Dell, Jones and Olken 2009), limiting households' ability to earn incomes and improve their purchasing power. Reduced economic growth could make it more difficult for governments to manage food prices and fend off higher and more volatile food prices. This would result in food becoming more expensive for poor households.

At the same time, climate change impacts on the economy and natural resource-based activities may threaten some livelihood activities underpinning food security. By 2030, climate sensitive sectors such as tourism, which generates significant employment in MENA countries such as Egypt and Morocco, could start to experience significant challenges and disruption. This will affect those who directly or indirectly depend on these sectors for income (Lanquar, 2011). In the medium to long-term sea level rise places low-lying coastal cities at risk. These areas have high concentrations of people and economic activities.. By 2030, assuming a 30 centimetres sea level rise, Alexandria Governorate could experience losses of 70,000 jobs if adaptation is inadequate (see Table 6).

Table 6: Sea level rise is projected to displace people and damage the economy in Alexandria Governorate

Year	2000 (SLR=5cm)	2030 (SLR=30cm)	2050 (SLR=50cm)
- Area at risk (km2)	32	190	317
- Population to be displaced (Thousands of people)	57	545	1,512
- Loss of Employment: (Jobs)			
a - agriculture	336	3,205	8,812
b - tourism	1,359	12,323	33,919
c - industry	5,754	54,936	151,200
- Total loss of employment	7,449	70,465	195,443

Source: El Raey, 2009.

Heat extremes could impact incomes and food access through reducing labour productivity and affecting sensitive sectors.
Temperature spikes will take an especially heavy toll on manual workers. The proportion of the workforce expected to be particularly affected between 2010 and 2030 by reduced productivity ranges between 10-20% in most MENA countries. For the countries of the Arabian Peninsula, the proportion is projected to be higher—ranging from 15-40% (DARA 2012). Tourism is likely to shift in seasonality, as visitors avoid hot months, and is projected to decline around 8% across MENA by 2050 (Bigano et al., 2008).

Heat extremes could have significant impacts on human health.
By the 2030s, urban areas will face disruptive extreme events that threaten incomes, health and food security. Heatwaves in particular are expected to become more common and more intense across the region. Heat extremes threaten health in several ways. Most relevant to food security are the impacts of heat stress on human physiology. Exposure to heat stress increases the risk of dehydration, strokes and heart disease as the human body has to work harder to maintain an average body temperature (Parsons, 2009), and dehydration can affect metabolisation of food. Preventing heat stress requires avoiding strenuous activity and drinking enough water, but this is a challenge for people in certain occupations and living conditions. Access to household water and electrical power are particularly important for staying cool (Parsons, 2009). Many households will struggle to afford these privately, and so access is unlikely without specific targeted provision.

Heat extremes could also affect food *safety* and *utilisation*.
Extreme climate events may also present shocks to food safety, affecting *utilisation*. Under scenarios of prolonged heat extremes, unchilled foods will spoil more quickly; if electricity grids are strained, breaks in the cold chain may raise spoilage in chilled foods too. Periods of high temperature also result in higher incidences of common forms of food poisoning, such as salmonellosis (Confalonieri et al., 2007) .

The incidence of diarrhoeal disease, a leading cause of death among children, is high in parts of MENA where warm weather, inadequate access to drinking water, poor sanitation, and poverty collide (Kolahi et al., 2010). A study in Beirut has projected climate change driven increases of 16-28% in food- and water-borne related morbidity by 2050 (El Fadel et al., 2012). Across the region, diarrhoeal disease could increase between 6-15% by 2040 if health infrastructure does not improve from its current status (Kolstad & Johansson, 2010; (Schellnhuber et al., 2014).

Impacts of climate variability and extremes on harvests and global food prices could make the food security of urban populations less *stable*.
With food accounting for 60% of household spending in the poorest countries (e.g. Yemen) and 35-45% of spending in middle-income countries (e.g. Algeria, Iraq), food price volatility has a large impact on the welfare of MENA's population (Ianchovichina 2014).

Global agricultural production is expected to continue rising, yet all regions can expect increasing risk of harvest failure due to climate shocks (Abou-Hadid, 2014). Expected increases in population and incomes combined with climate change mean prices for most food commodities are expected to rise by 2050 (G. Nelson et al., 2010). This contrasts with the second half of the 20th Century, when food prices fell. While an increase in food prices is enough to threaten the food security for those struggling with current costs, many more will feel the impact if food markets become more volatile and countries are unable to increase trade to offset unpredictable price spikes brought on by climate shocks.

Imports critical to stability of local food markets may be further affected by climate change.
While it is not possible to forecast developments on international grain supply chains, rising sea levels and increasing extreme events including storms and wave surges could potentially disrupt deliveries of supplies, for example if port infrastructure is damaged (Tacoli et al., 2013). Such events would likely push up prices, and possibly make food temporarily more scarce.

Food losses during transport and storage will remain high and vulnerable to climatic events unless infrastructure is well designed and maintained. Poorly constructed warehouses mean supplies are at risk from flooding and disease. For food that requires cooling, electricity systems are at risk from load-shedding as well as storms, and water-cooled systems are vulnerable to drought. With food storage and transportation systems already saddled with problems in many countries, climate change is expected to present more challenges. Temperature rises and more extreme weather events may lead to more post-harvest losses, for example if higher humidity of stored foods rises above safe levels and increases fungal or pest infection (Kitinoja, 2011). Losses of perishable foods including fruit and vegetables are already high, and more extreme temperatures could obstruct efforts to bring these down. This could limit potential export revenues but also impede strategies to raise domestic consumption of fruit and vegetables needed to improve diets. Countries that rely heavily on open storage to store grain such as Egypt (USDA, 2014) could experience higher losses of cereals.

Photo, top: WFP/Abeer Etefa

Climate is not the only change: intersections with other trends

Climate change will be not the only – or even the most apparent - driver of food security in the Middle East and North Africa in coming decades. Rapid population growth, urbanisation, economic, political and social transitions will all affect how and where people buy which food at what price. Climate change will interact with these other drivers to affect food security.

Conflicts and instability have recently become key drivers of food insecurity and vulnerability across the region.
In Yemen, Syria, Palestine, Iraq and Sudan armed conflict and physical insecurity are key factors affecting the food security and climate vulnerability of affected populations. Along with drought, conflict is a key driver of forced migration in the region: the Syrian conflict has resulted in more than 3.7 million refugees in Lebanon, Turkey, Jordan, Iraq and Egypt, and more than 6 million internally displaced people. Many refugees have been absorbed by cities such as Tripoli and Amman that already struggle to provide basic services such as sufficient potable water. Refugee camps, in some cases are large enough to be considered new urban areas, can be highly vulnerable to impacts from flash flooding and heat waves.

Population growth and urbanisation will be key forces acting on food security to 2030.
MENA's population is projected to grow by around 155 million people between 2010 and 2030. Almost 130 million additional people will be in the region's towns and cities. Numbers of rural people will remain stable after 2030, but by 2050 there will be 500 million urban inhabitants – almost double the number in 2010 (all figures from UN, 2014). These people will create huge additional demand for jobs, water, food, and basic services. Their concentration in cities implies urban centres become increasingly important political priorities.

Figure 8a: The fastest growing urban areas in MENA, 2010-2030, will be medium sized cities...

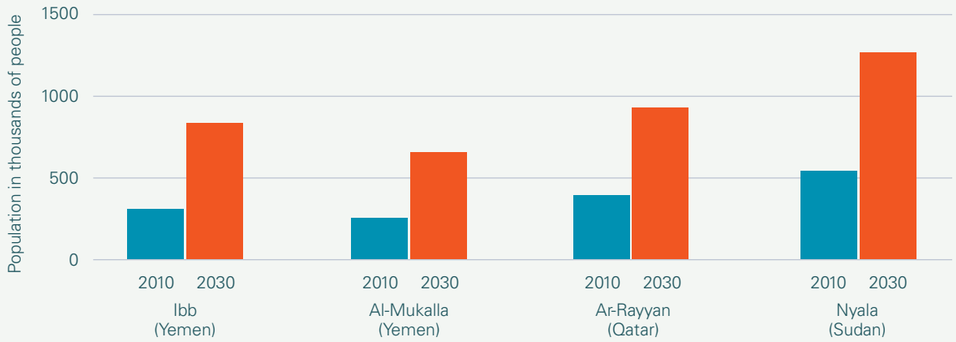
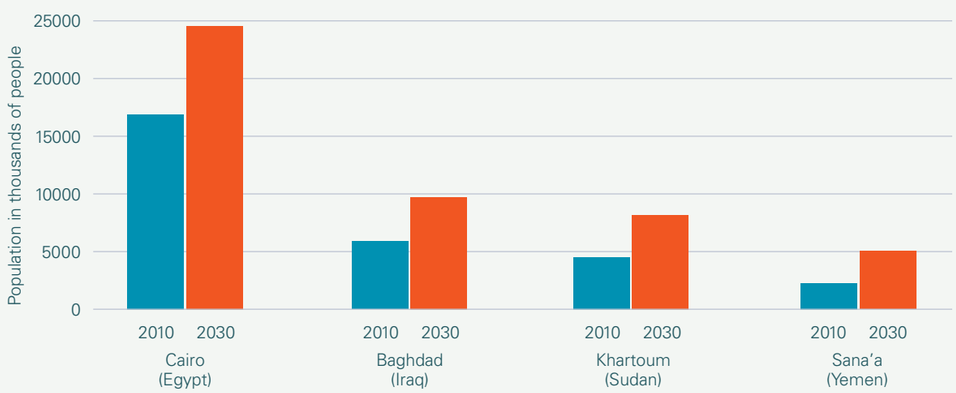


Figure 8b: ...but the large cities will absorb the most people.



Data from UN 2014

Rapid urban growth across MENA will stress existing urban food systems, expose gaps in services and infrastructure, yet also provide new opportunities.
The biggest cities, such as Cairo, Khartoum and Sana'a, will absorb the most people. Most of these cities have aged infrastructure, services that already struggle to meet demand, and will require continued investment in social protection and food systems to meet rising needs. However, some of the fastest growth will be in smaller cities and towns such as Ibb and Nyala (Figure 8). Smaller towns have less capacity in their administration, services, and markets, require different interventions than larger cities, and can struggle to attract investment. However, rapid urbanisation and growth in population density may also lead to improved market coordination, retail, and distribution of food that could reduce food prices for the urban poor.

Changes in markets will drive changes in food production and distribution which could marginalise the rural poor.
As urban markets drive changes in coordination, retail and the distribution of food, these could increase pressures on rural food producers. Lower prices and changed opportunities for direct retail might all contribute to pushing small-scale producers out of business or into further marginalisation.

Similarly, investments in commercial agriculture can also marginalise the rural poor. Land tenure is insecure in many areas of MENA, making rural populations vulnerable to 'land grabs'. There are similar issues with customary water rights in many areas, particularly where the rights of traditional water resource users are not recognised by state authorities mobilising and allocating water for irrigation or other uses (e.g.(Houdret, 2012).

Expanding informal areas may prove a specific challenge to food security and social protection systems. Much of the recent growth in MENA cities has been in informal urban areas and settlements, a trend that looks set to continue. Partly due to the unplanned nature of these areas, but also due to their classification and zoning, these areas often have poor access to services and infrastructure. For example, around 65% of Greater Cairo's population lives in informal housing areas (World Bank, 2008). Many are classified as rural areas and have relatively poor penetration of social protection and food systems, such as state-subsidised bakeries, and low sanitation coverage (see Box).

Sanitation, informal urban areas, and nutrition

Although officially reported rates of urban sanitation coverage are above 90% for all MENA countries other than Iraq, Morocco, and Palestine, there are differences between rural and urban supply in many countries (World Bank 2007, cited in Zawahri, Sowers, & Weinthal, 2011). Rapid urbanisation means that some areas classified as rural in official statistics are actually new urban areas – either new rural towns or informal areas in large cities. In Egypt, for example, 'villages' of 10,000 people are considered rural, and around 65% of Greater Cairo's population live in informal areas (World Bank 2008, cited in Zawahri et al., 2011). Studies in several countries indicate that actual rates of coverage in informal urban areas are below those reported (Zawahri, Sowers, & Weinthal, 2011).

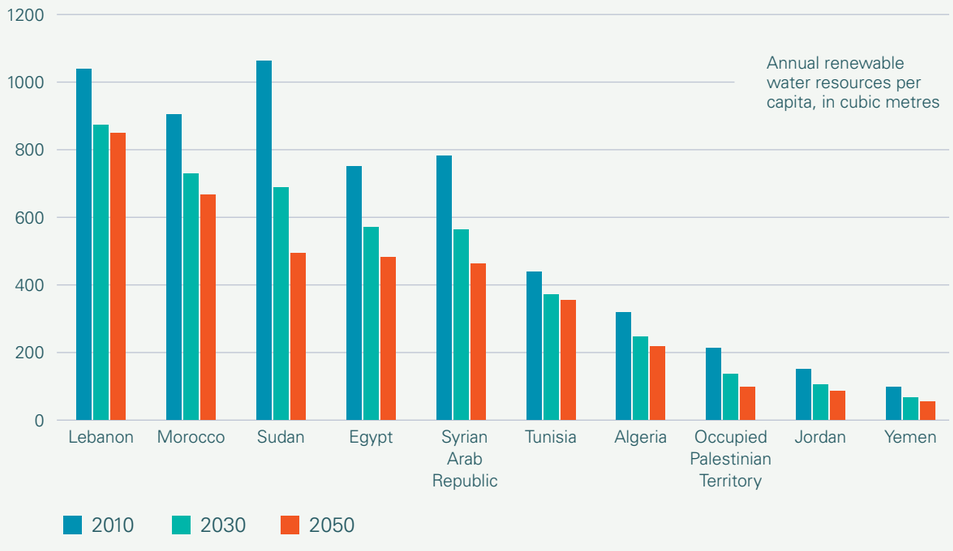
The importance of water supply, sanitation and hygiene to nutritional security is widely recognised in efforts to tackle child malnutrition. In areas with poor WASH services, children under the age of 5 are more likely to be developmentally stunted. Episodic bouts of diarrhoea and immune responses reducing the metabolisation of food in the gut due to high environmental loads of faecal bacteria are thought to be the key causes (Humphrey, 2009). These conditions are more common in informal urban areas due to poor penetration of WASH services and high population densities.

As informal urban areas in MENA continue to grow the delivery of WASH services will be an important component of strengthening food security.

Water security will become an even more critical issue affecting people in MENA in coming decades.
The region is already the most water precarious region in the world, and more people means more demand and competition for water. Figure 9 shows how population growth will reduce the average amount of water per person in in some countries by 2030 and 2050. Many of these figures are worryingly low. And yet as averages they disguise large variations in access to sufficient quantities of safe water by different groups in society. As competition for water increases, the water security of poor and marginalised people will be most at risk - a challenge of equity and politics rather than physical scarcity (Mason & Calow 2014). Water security will become even more critical not just for food production, but also for food *utilisation*.

Increasing agricultural water use efficiency will become even more important.
MENA countries have some of the highest rates of agricultural water use in the world: Egypt uses 86% of its water in agriculture, Morocco, Sudan and Yemen use more than 90%, and in many cases the demand for agricultural water is met by unsustainable extraction (Rached & Brooks, 2010; FAO 2014b). Increasing temperatures and drought risks due to climate change will increase agriculture's need for water. Additionally, unless farmers can meet higher crop water demands, any short- to medium-term benefits of CO2 fertilisation for food production will be lost (Elliott et al., 2014). Yet higher demand and competition for water will put more pressure on the agricultural sector to reduce consumption.

Figure 9: Growing populations mean growing demand and competition for water



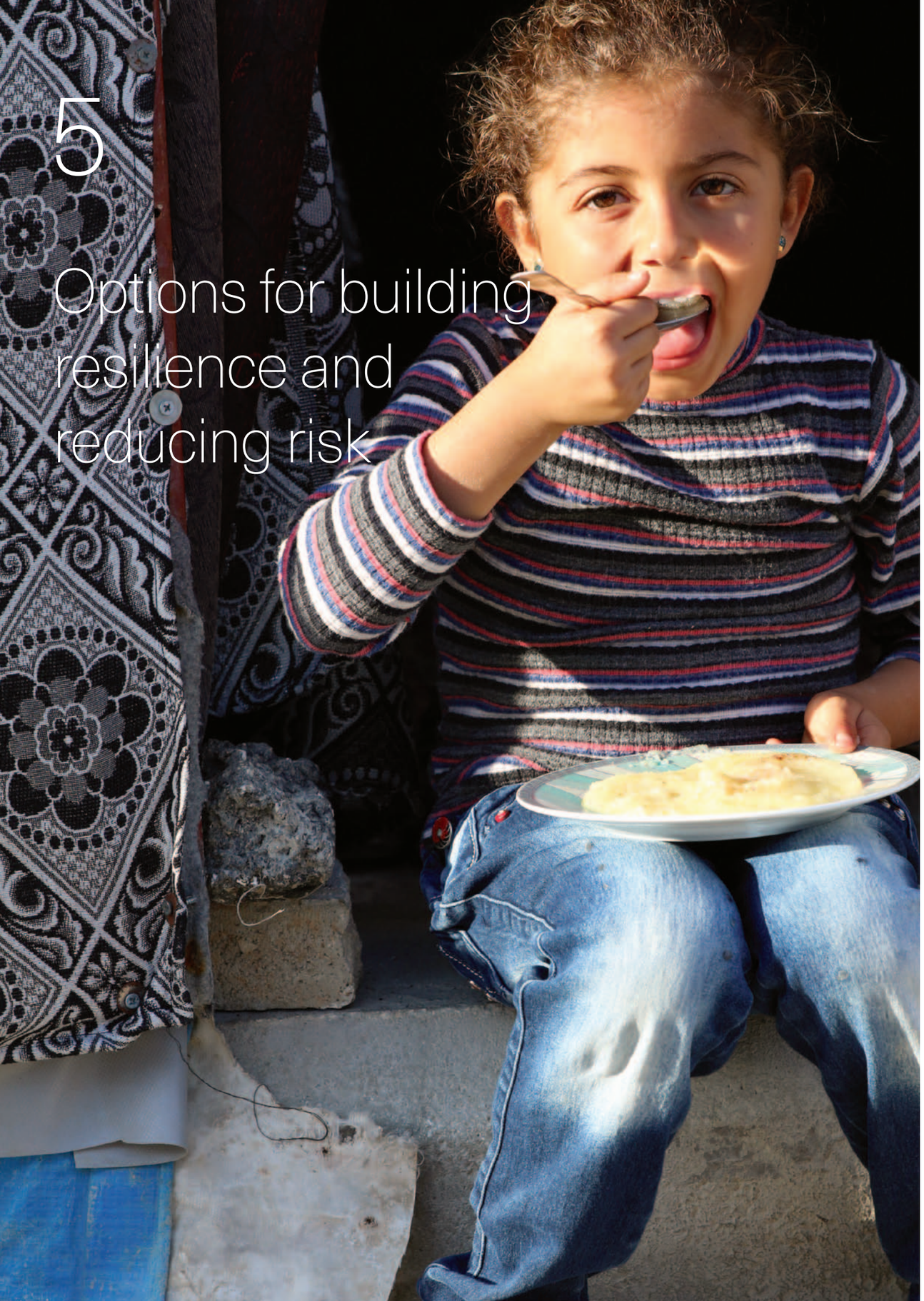
Calculated with data from Aquastat and from UN 2014.

Urban populations will also be affected by water security issues.
Rapidly growing urban populations will place more demands on water supplies, and also on infrastructure for water treatment and distribution. Shocks and stresses from climate change will expose vulnerabilities in water management. Some economic activities may be impacted by reduced water availability, with consequent impacts on productivity, income, and therefore food access. Perhaps more significantly, physical water scarcity leads to use of lower quality water, which has consequences for hygiene and food safety (FAO 2008b).

Agricultural land is under increasing pressure.
As in other regions, average farm size in MENA has declined since the 1960s due to population growth and fragmentation resulting from inheritance practices. Limited availability of water and fertile land constrains opportunities for small rural producers to develop new cultivated areas. Rather than expanding, agricultural lands are likely to come under increasing pressure from urbanisation. As an extreme example, one study for Gharbaia Governorate in Egypt has projected that 29% of agricultural lands will be lost due to urban sprawl between 2012 and 2030 (Hassanein et al., 2014). Increasing land productivity could compensate for reduced plot sizes, and small farms can be intensely productive and profitable, particularly for horticulture. However, the obstacles can be insurmountable for small farmers without technical expertise and access to the necessary finance.

Summary

MENA is a rapidly changing region. Growing populations and cities are driving changes in food markets, the provision of basic services, demand and competition for water and land occupation, employment and economies. These large-scale transitions raise questions about the resilience and performance of food markets, the adequacy of social protection, the political imperative of urban food supply, and the ability of people and systems to adapt to change. In this context climate risks are potentially serious, but are largely uncharted.



5 Options for building resilience and reducing risk

Key points for policy makers

- Mainstreaming climate risk in food systems will also help address underlying weaknesses and vulnerabilities from a wide ranges of sources, including global market risks, supply and distribution risks, and economic and financial risks. Addressing risks in food systems will help manage broader social, economic and political risks that can be exacerbated by widespread food insecurity. Reducing climate risk in food systems is an opportunity to strengthen food security and broader development outcomes.
- Essential components of climate resilient food systems are likely to include climate-proofed food logistics and supply chains, reducing post-harvest losses, policies and mechanisms reducing impacts of food price volatility on consumers, strengthening access to health care, clean water and sanitation, and improving the targeting and modalities of safety nets and social protection measures. Underpinning these measures is climate resilient, inclusive economic growth offering sustainable jobs and economic opportunities to the poor.
- Agriculture will require adaptation investments to increase productivity, and is likely to become more focused on areas of comparative advantage. Policies should support the resilience and choices of poor rural food producers as they respond to changing risk, whether they invest in agricultural adaptation or leave agriculture entirely to adopt new livelihoods. Drought management and poverty reduction efforts should be targeted at the most vulnerable poor food producers in remote marginal environments.

Climate risks to food security in MENA are serious, and amplify other natural and human risks.
The nature of climate risks – their diversity, uncertainty, and potential to shock different parts of the food system – makes them a useful lens to explore weaknesses and blind spots in current evidence and decision-making. As an example, this paper contrasts the attention on climate risks to food production and availability with a lack of knowledge about climate risks to food access, stability and utilisation.

Climate change and climate extremes will expose vulnerabilities and exacerbate existing problems in entire food systems, from production to consumption.
Addressing climate risk also offers opportunities to address broader systematic issues, vulnerabilities and problems in food systems. This not only reduces climate risk and food insecurity, but can help address broader sets of related challenges such as poverty and political risk.

A broader perspective on food security and climate risks is needed.
At the national level, greater focus is required on food access, use, and stability. For poor rural people, issues of production are critical for income and food availability. A twin strategy is needed to:

- improve access, stability and use components of food security, with particular attention to the needs of poor, marginalised and vulnerable social groups; and
- improve the production, yields, and incomes and livelihoods of rural producers, with particular attention to small-scale, poor and marginal producers.

Photo, left: WFP/Berna Cetin

Strengthen food systems and economic development for all

Climate change most threatens those who are already food insecure.
Rural and urban poor people unable to find, afford, or safely consume food predictably are already living in risk, and are vulnerable to climate impacts on food systems. Those living in remote rural or informal urban areas under-serviced by markets and public services are particularly at risk. Reducing their sensitivity to climate shocks on food systems is a combination of:

- climate-proofing food logistics and supply chains;
- reducing food prices volatility for consumers;
- strengthening safety nets and access to basic services; and
- building climate resilient economies that offer jobs and economic opportunities to the poor.

Managing climate risk requires a broader view of risks to the food system, rather than a piecemeal approach based on subsectors or supply chain links.
Many risks can be managed by improving general efficiency in supply chains. As food systems and supply chains in MENA countries develop, there will be opportunities to improve efficiency, reducing both financial costs and post-harvest losses. There are different challenges to maintaining the food supply chains of different MENA countries – some countries have bottlenecks in ports, while others have inefficient inland transportation systems (Ianchovichina, 2014). Embedding climate risk management throughout the food supply system could help reduce long term costs and increase efficiency, for example by minimising the impact of heat extremes on post-harvest losses in food storage and distribution. Climate risk management should also mitigate the potential for cascading impacts, where risks to key bottlenecks in the food supply system result in widespread consequences – e.g. the impact of a flash flood on a major port or storage facility.

Government policies can reduce the sensitivity of food prices in local markets to volatility in international markets.
Maintaining food reserves and managing exchange rates, tariffs and subsidies can all reduce the volatility of prices in food importing countries. In the past, efforts by MENA countries to dampen transmission of global food prices onto domestic markets have had mixed success (Ianchovichina, 2014). Between 2006 and 2010, food prices in Egypt, Iraq, West Bank and Gaza, and UAE responded quickly and strongly to changes in global food markets, squeezing the urban poor. Good macroeconomic management, providing government with enough resources to buy food on international markets when prices are rising, may become even more important in a context of climate change and increased climate extremes.

Social safety nets and the provision of basic services should target the poorest, most food insecure and vulnerable people.
People in remote rural areas and rapidly growing and informal urban areas have the greatest challenges in accessing safety nets and basic services. Addressing the needs of these communities is likely to require both more resources and reforms in policies and systems but are likely to provide benefits towards increased social stability. Food subsidy programmes in most MENA countries could be further enhanced to better meet the needs and targeting of the poor. Options such as cash transfers and smart cards can strengthen access to food, help with targeting, both for expanding and contracting support, and smooth the impact of price shocks (Holmes & Bhuvanendra, 2013). Here in particular, monitoring trends and using early warning or alert systems to allow timely, effective and transparent decision making represents important elements of a strengthened risk management system. Ensuring access to clean water and sanitation will be a key factor in the utilisation and safety of food as temperature extremes and competition over water both increase, particularly in urban areas.

5. Options for building resilience and reducing risk

Investments in the wider economy should consider climate risk and climate impacts on employment and income.
Economic growth which provides a large number of unskilled and semi-skilled jobs is key to improving the incomes and food security of poor people. Climate adaptation in the broader economy that protects jobs is therefore important to ensuring the food security of employees and their families. Managing the economy's sectoral composition, discouraging investments that lock-in increasing vulnerability, and incentivising investments in climate adaptation can all help manage climate risks to the economy and employment. However, climate risk management needs to be pro-poor, as some climate adaptation options could have distributional impacts on poverty and food security. Adaptation that reduces or changes patterns of labour, either by replacing labour with capital assets or by changing the seasonality or timing of labour inputs, can all reduce climate risk of a business or sector but increase poverty and food insecurity.

Photo, top: WFP/David Furst

Improve the yields, income, and choices of poor food producers

Adaptations in agriculture will be important for maintaining productivity. While projected yield losses appear large, modern history suggests that countering these impacts is at least technically possible – after all, the global production of grains such as wheat, maize and rice almost tripled between 1960 and 2010 (Godfray et al., 2010). Adoption of new agricultural techniques, selecting crop varieties for drought and heat tolerance, and improving the management of agricultural water use are likely to benefit yields. Technologies promoting water efficiency, such as drip irrigation, will be important but must be tailored to specific hydrological and institutional contexts (see e.g. Jobbins et al., 2015).

Focus on comparative advantage in agriculture.
Maintaining and increasing yields in the face of climate change will be technically possible. The real question is the extent to which modes of production will be financially feasible. By 2030 agriculture in MENA will not meet all internal demands for food. Nor should it aim to. Importing cereals, oilseeds, and

animal feed will be cheaper than local production. Instead, farming can focus on high value perishable produce for the rapidly growing cities and export to Europe during the winter. Pastoralism – a system traditionally adapted to drought – will remain an important source of animal products, but will increasingly rely on purchased animal feed and proactive drought management to manage climate risks.

Small, poor producers in remote, marginal environments will be particularly vulnerable to climate change and extremes.
Food producing households have three broad types of responses to climate risk and new economic opportunities (Dorward et al., 2009):

- Hang-in: maintaining existing activities to survive in the face of difficult circumstances;
- Step up: investing in existing activities to increase returns, such as adopting new technologies and crop varieties, acquiring new land, and other adaptations; and
- Step out: where existing activities are used to accumulate assets as a basis for investing in alternative, often non-agricultural or urban livelihoods.

The ability of producers to choose between these three strategies depends on their assets, supportive policies, and access to markets, appropriate services, and information.

Reducing drought risk will be critical in assisting small producers to *hang in.* Historically, drought management in MENA has been responsive, focused on emergency measures. These crisis-driven approaches have been criticised for being slow to mobilise and for underwriting unsustainable practices (Karrou & El Mourid, 2008). Reducing drought risk requires anticipatory approaches that protect critical productive assets and reduce the drought sensitivity of livelihoods. Social protection mechanisms can support such anticipatory measures and limit asset liquidation and debt accumulation during crises, particularly when combined with risk transfer programmes, such as crop insurance.

Improving access to markets, finance, goods, services, and technical knowledge will help small producers *step up.*
Producers able to access credit, new crops and technologies, information, and markets are better able to invest and adapt to changing conditions. In many countries, long-term under-investment in agricultural extension means that the state may not be prepared to lead implementation in these areas. Alternatives include non-governmental organisations that work with farmers to test new technologies, establish reliable climate services for farmers and other end-users, provide health care to livestock, and offer credit, and commercial farms and private sector organisations that support small producers in accessing markets.

Helping small producers *step out* requires measures to protect their rights and enable them to make the best decisions for their families.
Policies and supporting measures should be in place to assist small producers who wish to step out of agriculture. These measures should protect the rights of small producers, and ensure that they are able to maximise their assets in searching for new opportunities and transitioning to new livelihoods. Ensuring rural populations have access to education programmes, recognised and protected land rights, and to credit, services and markets will all assist with stepping out.

Improving women's rights, land tenure and water governance will strengthen resilience.
In many rural communities men have migrated to find off-farm work. This has contributed to significant feminisation of agriculture in countries such as Jordan, Libya, and Syria, but without necessarily changing the political or institutional power of women (Abdelali-Martini & Dey de Pryck, 2014). Women farmers in MENA find it more difficult to access credit, state services, and land and water management institutions, hindering the ability of female-headed households to hang-in, step up, or step out. Improvements in gender inclusion, and improved recognition of land and water rights, are likely to be key to strengthening the resilience and adaptive capacity of rural communities in MENA.

Photo, right: WFP/John Wreford

Conclusions

Climate change presents risks to the whole food system, from production through distribution and to consumption. However, climate change should not divert attention from fundamental food security and development objectives, and achievement of the Sustainable Development Goals. Instead, mainstreaming climate risk management into food systems can help address underlying vulnerabilities, weaknesses, and risks from other sources. By seizing the imperative to adapt, the challenge of climate change can be an opportunity to reform and strengthen food systems and food security, and also the human security, stability, and longer term sustainable development of the region as a whole.

1 By 2030 climate change in MENA will be noticeable. Summer temperatures will be 1-2C warmer on average, and heat waves will be more common and more intense. 156 million people were affected by drought in MENA between 2000 and 2010, and by 2030 severe droughts are likely to be more common in the Mediterranean area, particularly in the Maghreb.

2 Already vulnerable and food insecure populations are a particular group of concern, as they are likely to be more susceptible to climate impacts. However, climate change is just one dimension of change that will affect people's food security by 2030. Economic change will drive employment, income, and people's ability to purchase food. Rapid urbanisation will change patterns of what food people eat, and how and where they get it. Protracted crises, conflict, and the fragility of states may also drive migration and patterns of food insecurity. By 2030, without reform of water management, higher competition for water is likely to severely affect poor people, with implications for their food production and food safety. Climate change will interact with other these other transitions, resulting in changing patterns of vulnerability and food insecurity.

3 More attention is needed on climate risks to access, stability and utilisation dimensions of food security. These are complex and less well understood than risks to food production and availability, but in MENA, are at least as important. Ensuring access to affordable and nutritious food for all people should be at the centre of efforts to improve food security. Poor farmers have a specific set of risks, as their ability to purchase food depends on income from crop yields that may be affected by climate impacts. However, the food security of an increasing majority of people is conditioned by factors such as food prices, not the availability of food.

4 By 2030 farmers of some crops in certain regions will see changes in temperatures and precipitation affect crop yields. Droughts will have more frequent and widespread impacts. Those with fragile farming systems unable to cope with higher levels of risk will be most affected. 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.

5 Climate risks to the food security of poor rural producers can be reduced by helping them:
a. cope with droughts through improved programmes that anticipate and reduce the impact of shocks and help affected people recover quickly;
b. increase farm productivity and income despite increasing temperatures and water stress, by improving access to appropriate techniques and technology, and to markets, services, and financing; and
c. diversify away from agricultural production and adopt new livelihood activities.

6 Most people will not be directly affected by climate risks to domestic agriculture. Their food security is much more closely linked to systemic risks such as changes in global markets, and how well their governments respond to shocks such as global food price volatility due to widespread harvest failure. Poor consumers in remote rural areas and rapidly growing informal urban areas are likely to be most vulnerable, due to low incomes and access to markets, and weak provision of basic services.

7 Climate risks to the food security of poor food consumers, particularly those in informal urban areas and remote rural areas, can be reduced by:
a. addressing climate vulnerabilities in employment and income, such as impacts on infrastructure and labour productivity;
b. increasing access of the poor to social protection systems resilient to food price volatility; and
c. improving food safety, including food storage and provision of improved water and sanitation.

8 Looking at food security through a climate change lens adds to the calls for governments to improve risk management in general. In particular risks related to food import dependencies can be reduced to ensure food is accessible to poor people. Enhancing social safety net infrastructure must remain a priority to address the needs of the most food insecure people.

9 Strengthening supply chains, including supporting integrated systems of food storage, distribution and retail in MENA will offer significant opportunities for managing climate risk and reducing post-harvest losses. Ensuring cold storage and refrigeration of food during heat extremes and reducing risks at bottlenecks in exposed storage and transport infrastructure could all reduce vulnerabilities to the food security of large numbers of people.

10 Support is needed for action by a broad range of stakeholders, including governments, international organisations, academia, civil society, and the private sector. Finance and political leadership is required for making specific investments and reforms, and also for long term strategic planning and ensuring cross-sectoral coordination. Different sources of finance will be needed, including from the private sector and mechanisms for international climate adaptation finance. The Sustainable Development Goals provide an important framework for these streams to come together and strengthen the food security of the most vulnerable and at risk populations in the MENA region.

References

Abdelali-Martini, M., & Dey de Pryck, J. (2014). Does the feminisation of agricultural labour empower women? Insights from female labour contractors and workers in northwest Syria. Journal of International Development.

Abou-Hadid, A. F. (2014). Arab Environment: food security. Arab Forum for Environment and Development, Beirut, Lebanon

Al-Bakri J., Suleiman A., Abdulla F. and Ayad J. (2011), "Potential impact of climate change on rainfed agriculture of a semi-arid basin in Jordan," Physics and Chemistry of the Earth, Parts A/B/C, 36(5-6), 125–34.

Al-Qinna, M. I., Hammouri, N. A., Obeidat, M. M., & Ahmad, F. Y. (2011). Drought analysis in Jordan under current and future climates. Climatic Change, 106(3), 421-440.

Alexandratos, N. and Bruinsma, J. (2012). World Agriculture towards 2030/2050: the 2012 revision. ESA Working Paper No.12-03. A. D. E. Division. Food and Agricultural Organization of the United Nations. Rome, Italy

Bailey, R., & Willoughby, R. (2013). Edible Oil: Food Security in the Gulf. Chatham House. London, UK.

Battersby, J. (2012). Urban Food security and the urban food policy gap. African Centre for Cities. Paper presented at "Towards Carnegie III", University of Cape Town, September 3-7 2012.

Bigano, A., Bosello, F., Roson, R., & Tol, R. S. (2008). Economy-wide impacts of climate change: A joint analysis for sea level rise and tourism. Mitigation and Adaptation Strategies for Global Change, 13(8), 765-791.

Chbouki, N., Stockton, C. W., & Myers, D. E. (1995). Spatio-temporal patterns of drought in Morocco. International Journal of Climatology, 15(2), 187-205.

Compton, J., S. Wiggins, and S. Keats. (2010). Impact of the global food crisis on the poor: what is the evidence? London, Overseas Development Institute.

Confalonieri, Ulisses, Bettina Menne, Rais Akhtar, Kristie L. Ebi, Maria Hauengue, R. Sari Kovats, Boris Revich, and A. J. Woodward. (2007). Human health. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK: 391-431.

Cullen, H. M., Kaplan, A., Arkin, P. A., & Demenocal, P. B. (2002). Impact of the North Atlantic Oscillation on Middle Eastern climate and streamflow. Climatic Change, 55(3), 315-338.

Dai, A. (2011). Drought under global warming: a review. Wiley Interdisciplinary Reviews: Climate Change, 2(1), 45-65.

DARA (2012). "Labour Productivity Indicator." Climate Vulnerability Monitor: A Guide to the Cold Calculus of a Hot Planet, 2nd ed., DARA: Madrid, Spain.

Dasgupta, S., Laplante, B., Meisner, C., Wheeler, D., & Yan, J. (2009). The impact of sea level rise on developing countries: a comparative analysis. Climatic Change, 93(3-4), 379-388.

Dell, M., Jones, B. and Olken, B. (2009). Temperature and Income: Reconciling New Cross-Sectional and Panel Estimates. American Economic Review Papers and Proceedings. 2009;99(2):198-204

Di Baldassarre, G., Montanari, A., Lins, H., Koutsoyiannis, D., Brandimarte, L., & Blöschl, G. (2010). Flood fatalities in Africa: from diagnosis to mitigation. Geophysical Research Letters, 37(22).

Photo, left: WFP/Tim McKulka

Dixon, J., Gulliver, A., & Gibbon, D. (2001). Farming systems and poverty: improving farmer's livelihoods in a changing world. FAO. Rome, Italy

Donat, M. G., Peterson, T. C., Brunet, M., King, A. D., Almazroui, M., Kolli, R. K., et al. (2014). Changes in extreme temperature and precipitation in the Arab Region: Long-term trends and variability related to ENSO and NAO. International Journal of Climatology, 34(3), 581-592.

Dorward, A., Anderson, S., Bernal, Y. N., Vera, E. S., Rushton, J., Pattison, J., & Paz, R. (2009). Hanging in, stepping up and stepping out: livelihood aspirations and strategies of the poor. Development in Practice, 19(2), 240-247.

Eastwood, R., Lipton, M., & Newell, A. (2010). Chapter 65. Farm size. In P. Pingali & R. Evenson (Eds.), Handbook of agricultural economics (Vol. 4, pp. 3323-3397). Elsevier.

El-Fadel, M., Ghanimeh, S., Maroun, R., & Alameddine, I. (2012). Climate change and temperature rise: Implications on food-and water-borne diseases.Science of the Total Environment, 437, 15-21.

El-Said, H., & Harrigan, J. (2014). Economic reform, social welfare, and instability: Jordan, Egypt, Morocco, and Tunisia, 1983–2004. The Middle East Journal, 68(1), 99-121.

El-Zein, A., Tewtel-Salem, M., & Nehme, G. (2004). A time-series analysis of mortality and air temperature in Greater Beirut. Science of The Total Environment, 330(1–3), 71-80.

Elliott, J., Deryng, D., Müller, C., Frieler, K., Konzmann, M., Gerten, D., Glotter, M. et al. (2014). Constraints and potentials of future irrigation water availability on agricultural production under climate change. Proceedings of the National Academy of Sciences, 111(9), 3239-3244.

Erian, W. (2011). Drought vulnerability in the Arab Region: Case study - drought in Syria, ten years of scarce water (2000 - 2010). Arab Centre for the Studies of Dry Areas and Arid Zones, Damascus, Syria.

Eshel, G., Cane, M. A., & Farrell, B. F. (2000). Forecasting eastern Mediterranean droughts. Monthly Weather Review, 128(10), 3618-3630.

Evans, J. P. (2009). 21st century climate change in the Middle East. Climatic Change, 92(3), 417-432.

FAO (1996). Rome Declaration on World Food Security and World Food Summit Plan of Action. Food and Agricultural Organization of the United Nations. Rome, Italy.

FAO (2008). Climate change and food security: a framework document. Food and Agricultural Organization of the United Nations. Rome, Italy.

FAO (2008b). Climate change: implications for food safety. Food and Agricultural Organization of the United Nations. Rome, Italy.

FAO (2012). Food Security and Nutrition in the Arab Region: Key Challenges and Policy Options. A discussion paper prepared by FAO, WFP, UNICEF and AOAD for the LAS-UN cooperation meeting, 22-23 February2012. Cairo, Egypt, FAO.

FAO (2014). FAO Statistical Yearbook 2014: Near East and North Africa. Food and Agricultural Organization of the United Nations, Regional Office for the Near East and North Africa. Cairo, Egypt.

FAO (2014b). AQUASTAT database. http://www.fao.org/nr/aquastat

FAO (2015) Regional Overview of Food Insecurity - Near East and North Africa:

Strengthening Regional Collaboration to Build Resilience for Food Security and Nutrition, Cairo, Egypt, FAO.

FEWSNET (2015). Conflict leaves at least 6 million without enough food; further deterioration possible. Yemen Food Security Alert. June 18 2015. FEWSNET

Field, C. B., Barros, V. R., Mach, K., & Mastrandrea, M. (2014). Climate change 2014: Impacts, adaptation, and vulnerability. Working Group II Contribution to the IPCC 5th Assessment Report-Technical Summary, 1-76.

Financial Times (2013). Currency crisis hits Egypt's wheat supply. February 20th 2013.

Giannakopoulos, C., Le Sager, P., Bindi, M., Moriondo, M., Kostopoulou, E., & Goodess, C. M. (2009). Climatic changes and associated impacts in the Mediterranean resulting from a 2C global warming. Global and Planetary Change, 68(3), 209-224.

Godfray, H. C. J., Beddington, J. R., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., Pretty, J., Robinson, S., Thomas, S.M., & Toulmin, C. (2010). Food security: the challenge of feeding 9 billion people. Science, 327(5967), 812-818.

Golzarand, M., Mirmiran, P., Jessri, M., Toolabi, K., Mojarrad, M., & Azizi, F. (2012). Dietary trends in the Middle East and North Africa: An ecological study (1961 to 2007). Public Health Nutrition, 15(10), 1835-1844.

Harrigan, J. (2014). The Political Economy of Arab Food Sovereignty, Palgrave Macmillan.

Hassaan, M. A., & Abdrabo, M. A. (2013). Vulnerability of the Nile Delta coastal areas to inundation by sea level rise. Environ Monit Assess, 185(8), 6607-16.

Hassanein, M. K., Fahim, M. A., Khalil, A. A., Abolmaty, S. M., Refaie, K. M., Taqi, M. O., & Abou Hadid, A. F. (2014). Impact of urbanization on agricultural land losses and climate change case study: Gharbiah governorate, Egypt. Journal of American Science, 10(1).

Heltberg, R., Siegel, P. B., & Jorgensen, S. L. (2009). Addressing human vulnerability to climate change: toward a 'no-regrets' approach. Global Environmental Change, 19(1), 89-99.

Hertel, T. W., Burke, M. B., & Lobell, D. B. (2010). The poverty implications of climate-induced crop yield changes by 2030. Global Environmental Change, 20(4), 577-585.

Holmes, R., & Bhuvanendra, D. (2013). Social protection and resilient food systems: The role of cash transfers. London, UK: Overseas Development Institute.

Houdret, A. (2012). The water connection: Irrigation, water grabbing and politics in southern Morocco. Water Alternatives, 5(2).

Humphrey, J. H. (2009). Child undernutrition, tropical enteropathy, toilets, and handwashing. Lancet, 374, 1032-35.

IFPRI, World Food Programme, & CAPMAS. (2013). Tackling Egypt's Rising Food Insecurity in a Time of Transition. IFPRI. Cairo, Egypt.

Jobbins, G., Kalpakian, J., Chriyaa, A., Legrouri, A., & El Mzouri, E. H. (2015). To what end? Drip irrigation and the water-energy-food nexus in Morocco. International Journal of Water Resources Development, 31(3), 393-406.

Karrou, M., & El Mourid, M. (2008). Drought management and planning strategies in semi-arid and arid agro-pastoral systems of West Asia and North Africa: a review. Options Méditerranéennes. Série A: Séminaires Méditerranéens, 80, 179-184.

Keats, S., & Wiggins, S. (2014). Future Diets: Implications for agriculture and food prices. Overseas Development Institute. London, UK.

Kitinoja, L. (2011). Developing and promoting sustainable postharvest technologies for India and Africa. Centre for Alleviation of Poverty through Sustainable Agriculture Palawija. Newsletter, 28(3).

Kolahi, A. A., Rastegarpour, A., Abadi, A., & Gachkar, L. (2010). An unexpectedly high incidence of acute childhood diarrhea in Koot-Abdollah, Ahwaz, Iran. International Journal of Infectious Diseases, 14(7), e618-e621.

Kolstad, E. W. and K. A. Johansson (2011). Uncertainties associated with quantifying climate change impacts on human health: a case study for diarrhea. Environmental Health Perspectives 119(3): 299-305.

Kuper, M., Hammani, A., Chohin, A., Garin, P., & Saaf, M. (2012). When groundwater takes over: linking 40 years of agricultural and groundwater dynamics in a large scale irrigation scheme in Morocco. Irrigation and Drainage, 61(S1), 45-53.

Lanquar, R. (2012). Tourism in the Mediterranean: Scenarios Up to 2030.SSRN Working Paper Series.

Lelieveld, J., Hadjinicolaou, P., Kostopoulou, E., Giannakopoulos, C., Pozzer, A., Tanarhte, M., & Tyrlis, E. (2013). Model projected heat extremes and air pollution in the Eastern Mediterranean and Middle East in the twenty-first century. Regional Environmental Change, 1-13.

Lobell D.B., Burke, M.B., Tebaldi, C., Mastrandrea, M.D., Falcon, W.P. & Naylor, R.L. (2008), "Prioritizing climate change adaptation needs for food security in 2030.," Science, 319(5863), 607– 10.

Lybbert, T. J., Kusunose, Y., Magnan, N., & Fadlaoui, A. (2009). Drought risk and drought response in Morocco: vulnerability, risk perceptions and drought coping among rainfed cereal farmers. Selected Paper for the Agricultural & Applied Economics Association Meeting, Milwaukee, Wisconsin, July 26-29, 2009.

Marcus, R., Pereznieto, P., Cullen, E., & Jones, N. (2011). Children and social protection in the Middle East and North Africa. Overseas Development Institute. London, UK.

Mason, N. & Calow, R. (2014). The real water crisis: inequality in a fast changing world. Working Paper. Overseas Development Institute, London, UK.

MET Office, & WFP. (2013). Climate impacts on food security and nutrition: A review of existing knowledge. Met Office. Exeter, Devon, UK..

Mougou, R., Mansour, M., Iglesias, A., Chebbi, R. Z., & Battaglini, A. (2011). Climate change and agricultural vulnerability: A case study of rain-fed wheat in Kairouan, Central Tunisia. Regional Environmental Change, 11(S1), 137-142.

Nelson, G. C., Rosegrant, M. W., Koo, J., Robertson, R., Sulser, T., Zhu, T., Ringler, C., et al. (2009). Climate change: Impact on agriculture and costs of adaptation (Vol. 21). International Food Policy Research Institute. Washington DC, USA

Nelson, G. C., Rosegrant, M. W., Palazzo, A., Gray, I., Ingersoll, C., Robertson, R., Tokgoz, S., et al. (2010). Food security, farming, and climate change to 2050: Scenarios, results, policy options (Vol. 172). International Food Policy Research Institute. Washington DC.

Özdogan, M. (2011). Climate change impacts on snow water availability in the Euphrates-Tigris basin. Hydrology and Earth System Sciences, 15(9), 2789-2803.

Parsons, K. (2009). Maintaining health, comfort and productivity in heat waves. Global Health Action, 2, 10.3402/gha.v2i0.2057.

Popkin, B. M.,(2003) The nutrition transition in the developing world. Development Policy Review, 21(5–6), 581–597.

Rached, E., & Brooks, D. B. (2010). Water governance in the Middle East and North Africa: an unfinished agenda. Water Resources Development, 26(2), 141-155.

Reuters (2013) More than 5,000 evacuated from Gaza 'disaster area' floods. Reuters. December 14th 2013.

Schellnhuber, H. J., Reyer, C., Hare, B., Waha, K., Otto, I., Serdeczny, O. et al. (2014). Turn Down the Heat 3. World Bank. Washington, D.C., USA

Schilling, J., Freier, K. P., Hertig, E., & Scheffran, J. (2012). Climate change, vulnerability and adaptation in North Africa with focus on Morocco. Agriculture, Ecosystems & Environment, 156, 12-26.

Sdralevich, M. C. A., Sab, M. R., Zouhar, M. Y., & Albertin, G. (2014). Subsidy reform in the Middle East and North Africa: recent progress and challenges ahead. International Monetary Fund, Washington DC, USA.

Selvaraju, R. (2013). Implications of climate change for agriculture and food security in the Western Asia and Northern Africa region. In Climate change and food security in West Asia and North Africa (pp. 27-51). Springer, Dordrecht, The Netherlands.

Seneviratne, S. I., Nicholls, N., Easterling, D., Goodess, C. M., Kanae, S., Kossin, J., Luo., Y. et al. (2012). Managing the risks of extreme events and disasters to advance climate change adaptation (pp. 109-230). A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, Cambridge, UK, and New York, NY, USA.

Silva, J., Levin, V., & Morgandi, M. (2013). Inclusion and resilience: the way forward for social safety nets in the Middle East and North Africa. World Bank Publications, Washington DC, USA.

Tacoli, C., Bukhari, B., & Fisher, S. (2013). Urban poverty, food security and climate change. Human Settlements Working Paper No. 37. I. H. S. Group. International Institute of Environment and Development. London, UK.

Tewari, D., Zanon, A., Burtonboy, C., Hamad, O., Linares-Rivas, A., Safaie, S., Banerjee, A., Bhavnani, R., 2014. Natural disasters in the Middle East and North Africa : a regional overview. The World Bank Global Facility for Disaster Reduction and Recovery (GFDRR). World Bank Group. Washington DC, USA.

Touchan, R., Akkemik, Ü., Hughes, M. K., & Erkan, N. (2007). May-June precipitation reconstruction of southwestern Anatolia, Turkey during the last 900 years from tree rings. Quaternary Research, 68(2), 196-202.

Touchan, R., Anchukaitis, K. J., Meko, D. M., Attalah, S., Baisan, C., & Aloui, A. (2008). Long term context for recent drought in northwestern Africa. Geophysical Research Letters, 35(13), L13705.

UN (2014). World Urbanization Prospects: The 2014 Revision, CD-ROM Edition. United Nations, Department of Economic and Social Affairs, Population Division. New York, USA.

UN News (2013). Syria: amid severe weather, UN agency flags worsening situation for children in Jordanian refugee camps. UN News Centre. January 10th 2013.

UNDP (2009). Arab Human Development Report 2009: challenges to human security in the Arab countries. United Nations Development Programme Regional Bureau for Arab States. New York, USA.

USDA (2014). Egypt grain and feed annual 2014. G. A. I. Network, United States Department of Agriculture Foreign Agriculture Service. Washington DC, USA

Van Oldenborgh, G.J., Collins, M., Arblaster, J., Christensen, J.H., Marotzke, J., Power, S.B., Rummukainen, M.T. and Zhou, T. (2013) Annex I: Atlas of Global and Regional Climate Projections. In: Stocker, T.F., Qin, D., Plattner, G.K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V. and Midgley, P.M., Eds., Climate Change 2013: The Physical Science Basis, Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, and New York.

Verner D. and Breisinger C. (2013), Economics of Climate Change in the Arab World: Case Studies from the Syrian Arab Republic, Tunisia and the Republic of Yemen, The World Bank: Washington DC.

WFP (2014) Economic Impact Study: Direct and Indirect Impact of the WFP Food Voucher Programme in Jordan. World Food Programme, Rome, Italy.

WFP (2014) Seasonal Livelihoods Programming: Adapting the WFP Seasonal Livelihood Programming Consultation to Urban Contexts – Draft Concept. World Food Programme. Rome, Italy

Wheeler, T., & von Braun, J. (2013). Climate change impacts on global food security. Science, 341(6145), 508-513.

Woertz, E. (2013). Oil for food: the global food crisis and the Middle East. Oxford University Press, Oxford, UK.

World Bank, FAO and IFAD (2009). Improving food security in Arab countries. World Bank Publications, Washington DC, USA

World Bank. (2011). Nutrition at Glance: Morocco. The World Bank, Washington, D.C., USA

World Bank. (2013). Fish to 2030: Prospects for fisheries and aquaculture. The World Bank, Washington DC., USA

World Bank (2014). World development indicators. The World Bank, Washington DC., USA

Zawahri, N., Sowers, J., & Weinthal, E. (2011). The politics of assessment: water and sanitation MDGs in the Middle East. Development and Change, 42(5), 1153-1178.

ODI is the UK's leading independent think tank on international development and humanitarian issues.

The views presented in this paper are those of the authors and do not necessarily represent the views of ODI or the World Food Programme.