Helpdesk Report

K4D Knowledge, evidence and learning for development

Climate change and stability in North Africa

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Question

What are the current and projected impacts of climate change on regional stability, prosperity and security in North Africa?

Contents

1. Overview
2. Climate change in North Africa
3. Projected impacts of climate change
4. Stability in North Africa related to climate change
5. Knowledge gaps
6. References

1. Overview

North Africa[1] is highly vulnerable to the consequences of climate change because of its strong exposure to increases in temperature, changes in freshwater availability, and population growth. The production of agricultural goods is sensitive to changing climate conditions across northern Africa, as economies strongly depend on agriculture or livestock. Due to the already existing water scarcity and this strong dependence on rain-fed agriculture, there is additional vulnerability, further exacerbated by an adaptive capacity that is limited by poverty and political instability. The impacts of climate change in North Africa are complex and not fully understood, they also interact and amplify other drivers and socio-economic factors, making attribution difficult to detangle. However, in general, climate change is expected to have important impacts on drought, water supplies and food security, which may impact on the stability, prosperity and security of the region. However, research in this emerging field has not yet succeeded in establishing a consensus on primary causes, mechanisms, links, and interventions between climate change and insecurity (Gemenne et al. 2014).

Other findings include:

- In North Africa, human-induced climate change is projected to increase temperatures over the 21st century, with the strongest warming projected to take place close to the Mediterranean coast and in inland Algeria, Libya and Egypt. An increase in the number of heat wave days is also projected. Precipitation projections are more uncertain, but a reduction in precipitation is *likely* over Northern Africa by the end of the 21st century.
- The concept of desertification is vague, making attribution of climate change impacts relative to other drivers difficult. Some argue that the term has been politicised and is no longer of analytical use, as drylands exist in a state of non-equilibrium and uncertainty. No study has attributed recent climate change as the single driver of desertification.
- North African countries (notably Morocco, Algeria, and Tunisia) are projected to become global hotspots for drought by the end of the 21st century. Drought can have both direct and indirect impacts in North Africa, and can act as a risk multiplier, destabilising populations, amplifying inequalities in access to water services and water resources, and reinforcing perceptions of marginalisation (World Bank, 2017).
- Freshwater scarcity ranks highest amongst the challenges facing North Africa, given its impact on food security, economic development and poverty reduction, and socio-political stability (Lezzaik & Milewski, 2017). Natural water scarcity, as a function of the predominantly (hyper-)arid environment of the Middle East and North Africa (MENA) region, is exacerbated by climate change (on both quantity and quality) but more importantly by increased water demand consistent with population growth, urbanisation, and economic growth.
- For North Africa, it is estimated that in 2050 climate change will account for 22% of future water shortages in the region while 78% of increased future water shortages can be

[1] Please note that assessments of climate change – such as those of the Intergovernmental Panel on Climate Change – consider regional climate changes with different groupings, some look at only North Africa (consisting of Algeria, Egypt, Libya, Morocco and Tunisia), whereas others take the Middle East and North Africa (MENA) region as a whole. This review refers to both these groupings, and this has been indicated where appropriate.

attributed to socioeconomic factors (Droogers et al, 2012 cited in Intergovernmental Panel on Climate Change (IPCC), 2014b: 1217).

- The MENA region strongly depends on food and associated virtual water imports (water embedded in agricultural commodities); it is projected that this dependency will increase. Import dependency results in a high vulnerability to fluctuating global food prices, which to some extent are also driven by climate impacts in food-exporting regions. On the other hand, food imports reduce the region's direct vulnerability to local climate risks.
- Although climate change will act as a risk multiplier for food insecurity in MENA (particularly around issues of water security, the rapid expansion of informal urban areas, and conflict and instability), the main drivers of food insecurity to 2030 will be population growth, urbanisation, and economic changes.
- Jobbins and Henley (2015) emphasise that most people in MENA will be affected by climate impacts on their income and health, livelihoods, food price volatility, and the potential for climate extremes such as floods and storms to disrupt food supply chains.
- The region is expected to have the greatest economic losses from climate related water scarcity as a share of Gross Domestic Product (GDP) by 2050 (World Bank 2016).
- The poorest and socially marginalised segments of the population are the most vulnerable to climate variability and extremes, particularly in developing countries.
- African women are particularly vulnerable to the impacts of climate change because they shoulder an enormous but imprecisely recorded portion of responsibility for subsistence agriculture. They are vulnerable to climate change, both in terms of lacking opportunities to fulfil their adaptive capacity and by being more reliant on natural resources that are likely to be affected by climate change.
- There is an ongoing debate on the links between climate variability and conflict; there are a number of contrasting opinions and empirical findings are inconclusive.
- The literature has found that the relationship between climate change and human security is not causal; the connection between climate change impacts and conflict outcomes is highly place and time-specific, and is the product of many different, intersecting factors. Hence, climate change is not the only important parameter of future violence and security considerations. Other factors such as human development, effective institutions, and governance also affect the likelihood of violent conflict.
- Climate change might act as a 'threat multiplier' for the security situation in the MENA region by placing additional pressure on already scarce resources and reinforcing pre-existing threats as political instability, poverty, and unemployment. However, this dominant 'threat multiplier' framing has been challenged by some academics who question the narrative's unidirectional flow from climate vulnerability to conflict.

A number of gaps were identified in the literature and these are discussed in the final section of this literature review.

2. Climate change in North Africa

Temperature projections

Africa as a whole is one of the most vulnerable continents to climate change due to its high exposure and low adaptive capacity (IPCC, 2014b: 1205). The Fifth Assessment Report (AR5) of the IPCC (2014b: 1202) finds that decadal analyses of temperatures strongly point to an increased warming trend across the African continent over the last 50 to 100 years. In recent decades, North African annual and seasonal observed trends in mean near surface temperature indicate an overall warming that is significantly beyond the range of changes due to natural (internal) variability (IPCC, 2014b: 1206).

Projections under medium emission scenarios indicate that extensive areas of Africa will exceed 2°C warming by the last two decades of this century (relative to the late 20th century mean annual temperature). Under high emission scenarios, all of Africa will exceed 2ºC warming (IPCC, 2014b). The IPCC AR5 (2014b: 1202) also found that it is likely that land temperatures over Africa will rise faster than the global land average, particularly in the more arid regions. For projected temperature extremes there is high confidence that heat waves and warm spell durations will increase in Africa, suggesting an increased persistence of hot days toward the end of the century (IPCC, 2014b: 1205). In northern Africa, there is a projected increase in the number of heat wave days over the 21st century (IPCC, 2014b: 1205).

In a study commissioned by the World Bank (2014: 114) on the likely impacts of present day (0.8°C), 2°C and 4°C warming on agricultural production, water resources, cities and ecosystems across the Middle East and North Africa (MENA), it was projected that, geographically, the strongest warming in North Africa was projected to take place close to the Mediterranean coast. Here, but also in inland Algeria, Libya and large parts of Egypt, warming by 3°C in a 2°C world was projected by the end of the 21st century. In a 4°C world, mean summer temperatures are expected to be up to 8°C warmer in parts of Algeria by the end of the century (World Bank. 2014: 113). By the end of the century, in a 2°C world, highly unusual (i.e. three standard deviations warmer than the mean temperature) heat extremes were projected to occur in about 30% of summer months almost everywhere in the MENA region (World Bank. 2014: 113).

Precipitation projections

Most areas of the African continent lack sufficient observational data to draw conclusions about trends in annual precipitation over the past century (IPCC, 2014b: 1207). Over the last few decades the northern regions of North Africa (north of the Atlas Mountains and along the Mediterranean coast of Algeria and Tunisia) have experienced a strong decrease in the amount of precipitation received in winter and early spring. However, in autumn (September-October-November) observations show a positive trend in precipitation in some parts of northern Algeria and Morocco (Barkhordarian et al, 2013 cited in IPCC, 2014b: 1207).

Precipitation projections are more uncertain than temperature projections and exhibit higher spatial and seasonal dependence (IPCC, 2014b: 1210). A reduction in precipitation is *likely* over Northern Africa by the end of the 21st century under the Special Report Emissions Scenarios (SRES) A1B and A2 scenarios[2] (IPCC, 2014b: 1202). According to the review of evidence in the IPCC AR5 (2014b: 1210), the annual and seasonal drying/warming signal over the northern African region (including North of Morocco, Algeria, Libya, Egypt, and Tunisia) is a consistent

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[2] A1B scenario describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies with a balance across energy sources. The A2 scenario describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities. See Special Report on Emission Scenarios, 2000 (https://ipcc.ch/pdf/special-reports/spm/sres-en.pdf) for more detailed descriptions of the A1B and A2 scenarios.

feature in the global and the regional climate change projections for the 21st century under the A1B and A2 scenarios. The AR5 highlights that estimates of possible precipitation changes in northern Africa vary, except for the region adjacent to the Mediterranean Sea as highlighted above (Link et al, 2015). Therefore, it remains unclear whether greenhouse-gas-induced climate warming will lead to more or less rainfall in most parts of the Sahara and Sahel.

The World Bank (2014: 114) commissioned study *Turn Down the Heat: Confronting the New Climate Normal*, found that future northward shifts of air moisture associated with a stronger North Atlantic Oscillation (NAO) anomaly are projected to reduce rainfall in North Africa and Maghreb. In a 4°C world, countries along the Mediterranean shore, notably Morocco, Algeria, and Egypt, are projected to receive substantially less rain. However, a projected northward shift of the Inter-Tropical Convergence Zone (ITCZ) is expected to increase moisture delivery to the southern parts of the region (which are already under the influence of monsoon systems). Consequently, the study found that projected annual mean precipitation changes show a clear North-South dipole pattern, with regions north of 25°N becoming relatively drier and regions to the south becoming wetter (World Bank, 2014: 114). The absolute increase in precipitation in the southern regions, however, will be very small, because these regions are already very dry today. Furthermore, the effect of an increase in precipitation on water availability should be counteracted by a simultaneous increase in temperature, resulting in a higher rate of evaporation (World Bank, 2014: 114).

Models that include atmosphere-land surface interactions indicate that there could be some greening in parts of the Sahel (Link et al, 2015). The near-surface atmosphere over the Sahara has warmed at a rate that is three times the global mean of the last 30 years. This amplified warming strengthened the Saharan heat low, as well as the meridional temperature and geopotential height gradients, which in turn leads to an increased transport of moisture into the Sahel, particularly eastern parts of the continent (Link et al, 2015). Climate models that predict the dynamics of vegetation change reveal some greening in the coming decades that extends into the Sahara. In some models this greening is caused by a stimulation of plant growth due to enhanced atmospheric carbon dioxide (CO^2) (i.e. CO^2 fertilisation). However, there are differences in the results of the various simulation models regarding the underlying atmospheric dynamics and plant processes, and the time horizons in which these occur, hence large uncertainties remain in these projections (Link et al, 2015: 1562).

3. Projected impacts of climate change

Desertification and drought

Large parts of the North Africa region are covered with drylands, either semi-arid, arid or hyper-arid. Drylands are dynamic and are increasingly recognised as being better understood as in a state of non-equilibrium (Gregory, 2017). The concept of desertification is vague, it is a complex, multi-layered and dynamic phenomenon that simultaneously denotes both the process of landscape transformation, as well as the end state of degradation in dryland ecosystems; hence confusion exists around the concept (see Verstraete et al. 2009 in World Bank, 2014: 136; Oswald and Harris, 2016: 230 –for further information on the politicisation of the term ‘desertification’). Behnke and Mortimore (2016) argue that the concept of desertification is no longer useful as a distinct analytical concept as it distorts our understanding of social-environmental systems and their resilience, but the idea of desertification has been institutionalised at a global level and is resilient despite the scientific evidence (see also Gregory, 2017). Within their book (Behnke and Mortimore, 2016), various authors contend that the desertification narrative confuses three different ecological processes: drought, desiccation and land degradation (Gregory, 2017). This has made assessing desertification globally difficult, and there are no comprehensive or widely accepted assessment or mitigation strategies (Oswald and Harris, 2016: 248; Behnke and Mortimore, 2016). Further, no study has attributed recent climate change as the single driver of desertification; as a result, it is difficult to quantify the role of climate change relative to other drivers (World Bank, 2014: 137). Drought processes are linked to dryland environmental change. Drought is a natural hazard caused by large-scale climatic variability, but it is also difficult to define due to its long onset and varying impacts depending on its location and duration (World Bank, 2017).

Drought is a longstanding and recurrent challenge in North Africa (Kaniewski, Van Campo, and Weiss, 2012 cited in World Bank, 2017). Compared to coastal areas, North African drylands experience lower rainfall amounts and higher rainfall unpredictability, which may express in consecutive years of drought (Radhouane, 2013). The North African countries (notably Morocco, Algeria, and Tunisia) are consistently projected to become global hotspots for drought by the end of the 21st century under the Representative Concentration Pathway (RCP) 8.5 scenario[3] (see Dai, 2012; Orlowsky and Seneviratne, 2013; Prudhomme et al, 2013; Sillmann et al, 2013b all cited in World Bank, 2014: 125). Although projections of future droughts suffer from large model uncertainties (and also largely depend on the methodology and baseline periods chosen), the projections for an increase in extreme (more severe and intense) drought conditions around the Mediterranean and Northern Africa are consistent across a variety of studies (see IPCC, 2012 cited in World Bank, 2014).

Drought can have far reaching consequences in North Africa; reduced crop output, increased fire hazard, increased livestock mortality, and decreased water levels are all examples of the direct impacts of drought (World Bank, 2017). Drought can also act as a risk multiplier, destabilising populations, amplifying inequalities in access to water services and water resources, and reinforcing perceptions of marginalisation (World Bank, 2017). Poor people are more vulnerable to droughts than the average member of the population (World Bank, 2017: 93).

Water supply

The IPCC (2014b: 1202) found that climate change will amplify existing stress on water availability in Africa. Water resources are subjected to high hydro-climatic variability over space and time, and are a key constraint on the continent's continued economic development. MENA is the world's most water-stressed region, with its countries constituting 12 of the 15 most water-stressed countries globally (Lezzaik & Milewski, 2017). Most of the land area of the MENA region receives less than 300 mm annual rainfall (and 200–300 mm per year roughly represents the lower limit for rain-fed agriculture). Semi-arid belts along the coasts and mountains are the only water sources and provide productive land for rain-fed agriculture (Immerzeel et al. 2011 cited in World Bank, 2014: 130). The availability of renewable water resources is generally below 1000 m^3 per capita per year. Accordingly, withdrawal-to-availability ratios exceed the critical threshold

[3] For the IPCC AR5, four RCPs were selected and defined by their total radiative forcing (cumulative measure of human emissions of GHGs from all sources expressed in Watts per square meter) pathway and level by 2100. The RCPs were chosen to represent a broad range of climate outcomes, based on a literature review, and are neither forecasts nor policy recommendations. See http://sedac.ipcc-data.org/ddc/ar5_scenario_process/RCPs.html for more information.

of 40% in all North Africa countries (World bank, 2014: 130). This water scarcity prevents MENA countries from producing all required food domestically and makes the region dependant on food imports (World Bank, 2014). Among the serious challenges facing the North Africa region, freshwater scarcity ranks highest, given its impact on food security, economic development and poverty reduction, and socio-political stability (Lezzaik & Milewski, 2017). Natural water scarcity, as a function of the predominantly (hyper-)arid environment of the MENA region, is exacerbated by increased water demand consistent with population growth, urbanisation, and economic growth.

The IPCC AR5 (2014b: 1217) highlights that a growing body of literature generated since the AR4 suggests that climate change in Africa will have an overall modest effect on future water scarcity relative to other drivers, such as population growth, urbanisation, agricultural growth, and land use change. However, broad-scale assumptions about drivers of future water shortages can mask significant sub regional variability of climate impacts, particularly in water-stressed regions that are projected to become drier, such as northern Africa. For North Africa, Droogers et al (2012 cited in IPCC, 2014b: 1217) estimated that in 2050 climate change will account for 22% of future water shortages in the region while 78% of increased future water shortages can be attributed to socioeconomic factors. Abouabdillah et al. (2010 cited in IPCC, 2014b: 1217) estimated that higher temperatures and declining rainfall (A2 and B1 scenarios) would reduce water resources in Tunisia. On the other hand, according to a World Bank study (2017: xxviii), socioeconomic change will drive small increases in surface water stress in countries such as Algeria and Tunisia. Reduced snowpack in the Atlas Mountains from a combination of warming and reduced precipitation, combined with more rapid springtime melting is expected to reduce supplies of seasonal meltwater for lowland areas of Morocco (García-Ruiz et al., 2011 cited in IPCC, 2014b: 1217). Overall, according to the IPCC Working Group II report (2014a and 2014b), there is high agreement that climate change will reduce renewable surface water and groundwater resources considerably in most dry-subtropical regions, aggravating competition for water within and among sectors. Reductions in water availability will generally be greater than the underlying reductions in precipitation, due to increases in potential evapotranspiration from warmer temperatures and non-linearity in the hydrological system (e.g. as precipitation is transformed into river runoff or groundwater recharge). The trend towards decreasing average water availability will be compounded by higher variability and more extremes, such as droughts and flooding, although the effects of these are not so straightforward (García-Ruiz et al, 2011; Törnros and Menzel, 2014 all cited in World Bank, 2014: 132).

Groundwater in many water-scarce regions serves as a buffer for variable surface water availability. The buffering function of groundwater can only be maintained in the long term if there is a balance between recharge and withdrawal (World bank, 2014: 133). Groundwater resources are central to the healthy functionality of the MENA region as 76% of freshwater is primarily sourced from groundwater systems of which 65.6% are non-renewable fossil aquifers (Lezzaik & Milewski, 2017). In Algeria, 88% of the irrigated area relies on groundwater. In Morocco, better endowed with surface water, this figure is 42% (Kuper et al, 2017: 728). In most MENA countries, groundwater is severely over-extracted (World bank, 2014: 133). However, because of data paucity and the complexity of groundwater processes, comprehensive regional-scale assessments of groundwater resources in the MENA region have been lacking. Lezzaik and Milewski (2017) undertook an assessment of these resources using a distributed ArcGIS[4] model,

[4] A geographic information system for working with maps and geographic information.

finding that most of the reserves are located within large sedimentary basins in North Africa and the Arabian Peninsula, with Algeria, Libya, Egypt, and Saudi Arabia accounting for approximately 75% of the region's total freshwater reserves. As for groundwater changes between 2003 and 2014, all MENA countries except for Morocco exhibited declines in groundwater storage. Human demand is a key cause of this decline. Climatic conditions were also identified as an essential driver of groundwater changes in the region. On the other hand, positive groundwater storage anomalies were observed, particularly in the southern part of the Sahara, highlighting the complexity and uncertainty of groundwater resources and processes (Lezzaik and Milewski, 2017).

Changes in the global climate are already, and are projected to continue, adding pressure on the profile of groundwater impacts in dryland areas, primarily through the intensification of arid climates and occurrence of more frequent and severe droughts resulting in a lack of moisture (Taylor et al, 2012). Thus, climate change will influence groundwater systems directly by affecting the amount of groundwater recharge, but also potentially indirectly by creating heightened demand for groundwater supplies (Taylor et al, 2012; IPCC, 2014a).

Another important aspect of climate change in the region is that water availability will become more uncertain. Likely effects are that larger volumes of the water will arrive during shorter time periods, leading to changing patterns of groundwater recharge and flash floods, as well as less green water (soil moisture from precipitation) because arid soils are typically less able to absorb heavier rains (World Bank, 2017: 16). This will impair prospects for rain-fed agriculture in the region. Mountain areas in Morocco and Algeria also play an important role in the water supply of the region, as they store a fraction of precipitation as snow. With projected reduction in snowfall and snow water storage, peak flows of melt water will shift towards earlier months, with negative impacts for downstream river systems and water availability in distant regions (World Bank, 2014: 116). As uncertainty prevails, vulnerable and marginalised groups will face the greatest risks, and may be more likely to face the resulting economic and health challenges (World Bank, 2017: 16).

Water quality

Another important impact of climate change are changes in water quality. An increase in salinisation (seawater intrusion) under climate change is forecast for all water resources in the North African region (World Bank, 2014). The densely populated coastal areas in the region are most affected by climate-change-induced flooding and salinisation of deltas and aquifers, which is accelerated by climate-induced sea level rise (World Bank 2014, 2017). Low-lying deltas such as the Nile have been identified as at risk from the impacts of climate change (Tessler et al, 2015 cited in World Bank, 2017: xxxix), as have low-lying coastal areas such as Morocco's Mediterranean coastal zone (Snoussi, Ouchani, and Niazi 2008 cited in World Bank, 2017: xxxix). River salinisation, meanwhile, is documented in studies of the Nile. The salinisation process is complex, however, and climate change (while expected to compound other drivers) is but one important factor among others (including irrigation, water uptake and land subsidence) (World Bank, 2014: 116).

Food security

Impacts of climate change on food security depend on both production and non-production aspects of the food system, including not just yield effects but also changes in the amount of land in production and adjustments in trade patterns (IPCC, 2014a: 1077). The IPCC (2014b: 1221) defines food security as being “composed of availability (is enough food produced?), access (can people get it, and afford it?), utilisation (how local conditions bear on people’s nutritional uptake from food), and stability (is the supply and access ensured?)”. Strong consensus exists that climate change will have a significantly negative impact on all these aspects of food security in Africa (IPCC, 2014b: 1221). The IPCC AR5 (2014b: 1202) also highlights evidence that climate change will interact with non-climate drivers and stressors to exacerbate vulnerability of agricultural systems, particularly in semi-arid areas.

However, the impacts of climate change on agriculture are varied and complex, and uncertainty remains. Increasing temperatures and changes in precipitation are very likely to reduce cereal crop productivity (IPCC, 2014b). In water-limited regions, the length of the growing period is generally reduced if precipitation decreases while temperature and evaporative demand simultaneously increase. Higher rainfall variability with more intense and more frequent droughts, and possibly also floods, can cause more frequent crop failures. With increasing temperatures, several crops will exceed their temperature tolerance levels. All of these effects contribute to an overall reduction in crop yields (World Bank, 2014: 133). Food availability in North Africa could also be threatened indirectly by climate change through increased soil erosion from more frequent heavy storms or through increased pest and disease pressure on crops and livestock caused by warmer temperatures and other changes in climatic conditions (IPCC, 2014b: 1221). These will have strong adverse effects on food security. Increasing atmospheric CO^2 concentration, on the other hand, can decrease crop water demand and increase crop productivity (through the CO^2 fertilisation effect – increasing photosynthesis rate for a given level of incoming solar radiation), although uncertainties remain on these CO^2 effects (World Bank, 2014: 133). For example, a modelling study for the World Bank by Havlik et al (2015; 17-18) projected that the MENA region would experience positive yield impacts due to CO^2 effects, with crop yield increasing on average by 7.8% in the RCP8.5 scenario by 2080. However, if CO^2 effects do not materialise, overall impacts of climate change are more severe and the region experiences negative yield changes.

While domestic agriculture remains a vital part of rural peoples’ livelihoods and food security in MENA, its contribution to meeting national demand for food staples is shrinking (Jobbins & Henley, 2015: 11). The MENA region strongly depends on food and associated virtual water imports (water embedded in the trade of agricultural commodities). About 50% of regional wheat and barley consumption, 40% of rice consumption, and nearly 70% of maize consumption is met through imports (Verner, 2012 in World Bank, 2014), and the world’s top nine wheat importers are MENA countries. High levels of per capita net food imports are due to severe domestic water (and land) constraints. Import dependency results in a high vulnerability to fluctuating global food prices, which to some extent are also driven by climate impacts in food-exporting regions. On the other hand, food imports reduce the region’s direct vulnerability to local climate risks (World Bank, 2014: 118). For example, Egypt meets just under half of its food needs through imports, growing the rest. It runs a fiscal deficit of around 10% of its GDP which makes it difficult to shield domestic food prices from global food price spikes: increases in world food prices contribute to 40% of food price inflation. Higher food prices translate into greater food insecurity in Egypt, especially for around 13 million Egyptians who live on less than US$2 per day (Jobbins and Henley, 2015: 13). Jobbins and Henley (2015: 30) argue that by 2050, trends in increased temperature, drought, and heat extremes in MENA will intensify and inhibit crop and animal production, meaning food import dependency is likely to increase further.

Jobbins and Henley (2015: 4) highlight that although climate extremes and climate change will act as a risk multiplier for food insecurity in MENA (particularly around issues of water security, the rapid expansion of informal urban areas, and conflict and instability), the main drivers of food insecurity to 2030 will be population growth, urbanisation, and economic changes. Understanding how climate change and extremes in MENA 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 (Jobbins & Henley, 2015: 4). Jobbins & Henley (2015: 5) further argue that more attention is needed on how climate change and variability will affect the access, stability and utilisation dimensions of food security in North Africa, as these are less well understood than climate risks to food availability (Jobbins & Henley, 2015: 5).

4. Stability in North Africa related to climate change

The IPCC (2014a: 758) states that "Human security will be progressively threatened as the climate changes. Human insecurity almost never has single causes, but instead emerges from the interaction of multiple factors. Climate change is an important factor threatening human security through (1) undermining livelihoods; (2) compromising culture and identity; (3) increasing migration that people would rather have avoided; and (4) challenging the ability of states to provide the conditions necessary for human security". However, the evidence on the effect of climate change on violent conflict and human security is contested, and there is "little agreement about direct causality" (IPCC, 2014a: 758).

Prosperity

Livelihoods

Link et al (2015: 1563) highlight that northern Africa is highly vulnerable to the consequences of climate change because of its strong exposure to increases in temperature, changes in freshwater availability, and population growth. The production of agricultural goods is sensitive to changing climate conditions across northern Africa, as economies strongly depend on agriculture or livestock. Due to the already existing water scarcity and this strong dependence on rain-fed agriculture, there is additional vulnerability, further exacerbated by an adaptive capacity that is limited by poverty and political instability. With its high and growing import dependency, the region is particularly vulnerable to worldwide and domestic agricultural impacts and related spikes in food prices (World Bank, 2014: 117). Jobbins and Henley (2015) emphasise that most people in MENA will be affected by climate impacts on their income and health, livelihoods, 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, particularly hit hard by rising food prices (Jobbins and Henley, 2015: 29; World Bank, 2014: 117). The rural poor would be hard hit by agricultural impacts, as poor farmers in rural areas are particularly vulnerable to hunger and malnutrition (World Bank, 2014: 117). In North Africa, poorer populations are the most vulnerable to weather-related shocks (both drought and floods) (Hallegatte et al. 2016; Wodon et al. 2014 all cited in World Bank, 2017). The World Bank (2014: 117) emphasises that "while never mono-causal, such climate-related market signals may fuel the potential for social unrest and migration and have a lasting effect on poverty in the region".

Water scarcity

As previously discussed, while specific water security challenges vary across North Africa, their principal underlying driver is the scarcity of water available to meet growing and competing demands from diversifying economic activities (especially agriculture) and burgeoning populations (World Bank, 2016). The difficulties and costs of securing reliable sources of sufficient water are a challenge for growth and diversification of the region's stagnant economies. The 2015 Global Risks Perception Survey, for example, ranked the water crisis as the most likely risk to MENA businesses and economies over the next 10 years, alongside unemployment and ahead of social instability and failures in governance (World Economic Forum, 2016 cited in Jobbins et al, 2016). The region is expected to have the greatest economic losses from climate related water scarcity as a share of GDP by 2050 (World Bank 2016). According to a study by the World Bank (2016) the many impacts of climate change on water scarcity have the potential to impair economic activities in the MENA region, causing reductions in GDP of between 6% and 14% of GDP by 2050 (depending on the underlying economic and climate trajectories used in the analysis and policy scenario) (World Bank, 2016; World bank, 2017: 15).

Migration

Link et al (2015) highlight that in northern Africa climate change places an additional burden on the abundance of resources, aggravating already existing conflicts and reducing the options of people to successfully address these challenges to their livelihoods (Link et al, 2015). In this context, migration plays a vital role. Migration can be the trigger of conflict by increasing the pressure on resources and people in the receiving areas, thus leading to a destabilisation of society. On the other hand, migration can be an useful tool to prevent the onset of conflict because people voluntarily move to other areas to work and to send back remittances, which help increase prosperity and development in the originating areas (Link et al, 2015). A literature review carried out by the World Bank (2014: 116) argued a link between climate change and migration in the MENA region. As it is expected that migration options will be more limited in a warmer world, internal migration will continue to be important in MENA, but traditional patterns of mobility might be disrupted. Many people will be forced to move, while others trapped in poverty will be forced to stay. However, so far, research on the link between migration induced by climate change and environmental disasters has produced inconclusive results (Link et al, 2015).

Vulnerability

The IPCC (2014b: 1213) highlights that from a livelihoods perspective, African women are vulnerable to the impacts of climate change because they shoulder an enormous but imprecisely recorded portion of responsibility for subsistence agriculture, the productivity of which can be expected to be adversely affected by climate change and overexploited soil. In northern Africa, even though informal or self-employment is less predominant, the gender gap is stark, with a much higher proportion of women compared to men in the more vulnerable informal and self-employed status (56.7% of women compared with 34.9% of men) (UN DESA Population Division, 2011 cited in IPCC, 2014b: 1213). Peters and Vivekananda (2014: 21) highlight evidence that suggests women are more vulnerable to climate related disasters, both as victims of disasters and in the aftermath (with increases in domestic and sexual violence). They are vulnerable to climate change, both in terms of lacking opportunities to fulfil their adaptive capacity and by being more reliant on natural resources likely to be affected by climate change. They are vulnerable to conflict through lack of voice, exploitation and increased responsibility as breadwinners. There are also well documented gender differences in displacement caused by extreme events, such as women losing their social networks or social capital (Peters and Vivekananda, 2014: 21).

Otto et al (2017) reviewed recent scientific literature on social vulnerability to climate change, aiming to determine which social and demographic groups, across a wide range of geographical locations, are the most vulnerable to climate change impacts within four well-being dimensions: health, safety, food security, and displacement. They found that many social groups already exhibit high levels of vulnerability to existing climate variability. The poorest and socially marginalised segments of the population are the most vulnerable to climate variability and extremes, particularly in developing countries where the infrastructure, social safety nets and economic resources, needed to support vulnerable groups, are often insufficient. The evidence they referred to shows that intra-household differences of gender and age produce markedly different forms of vulnerability with women, young children and the elderly being more likely to suffer. Young children from disadvantaged households are especially vulnerable to slow-onset well-being impacts of climate extremes. This raises concerns about intergenerational climate justice and the risk of suffering intergenerational poverty cycles. The evidence Otto et al (2017: 1658) presented showed that social vulnerability to climate change is shaped equally by physical changes in the climate system and by demographic, economic, institutional, and sociocultural drivers.

Security

Uncertainty

There is an ongoing debate on the links between climate variability and conflict; there are a number of contrasting opinions, and empirical findings are mixed and often inconclusive (see Scheffran et al, 2012 for a detailed discussion of the debate). So far, the body of research attempting to establish an empirical link has failed to converge on a consistent and robust climate effect (Bernauer et al 2012, Adger et al 2014, Buhaug et al 2014, Salehyan 2014 all cited in Buhaug et al, 2015; Gemenne et al 2014). The IPCC AR5 (2014b: 1204) states that “climate change and climate variability have the potential to exacerbate or multiply existing threats to human security including food, health, and economic insecurity, all being of particular concern for Africa”. However, the causality between climate change and violent conflict is difficult to establish due to the presence of these other drivers and interconnected causes, including country-specific socio-political, economic, and cultural factors (IPCC, 2014b: 1204). Hence, the relationship between climate change and human security is not causal; the connection between climate change impacts and conflict outcomes is highly place and time-specific, and is the product of many different, intersecting factors (Abrahams and Carr, 2017: 233).

Lewis and Lenton (2015: 385) highlight that one of the issues with discussing climate and security is the lack of clear definition of what is meant by the concept of security. They further elaborate that in a national or international sense, it refers to a state’s ability to maintain its interests in the global arena, but from a human perspective, this can manifest itself at a range of scales from global down to the individual. Security can be defined in terms of protection or freedom from conflict and violence, but can also refer to more complex ideas relating to human well-being (including concepts such as economic security, food security, environmental security, political security etc). In a political discourse and security analysis context, climate security often refers to instability or conflict, migration, or resource availability and access (Lewis and Lenton, 2015: 385). A framework by Scheffran et al. (2011 cited in World Bank, 2014: 144) summarises the climate-society interaction. Climate change puts pressure on natural resources, which in return can have adverse impacts for human security. Elements which make up human security include access to water, food, energy, transportation, health, and livelihoods, as well as education, lifestyle, and community. Where these aspects of human security are no longer guaranteed, possible consequences include societal instability (both violent and non-violent conflicts).

Water scarcity

Fragility and political instability can slow or reverse gains in water security, and water insecurity in turn can compound fragility (World Bank, 2017: xlii). Water scarcity in the MENA region will increasingly constitute a problem for the population, in particular, for those engaged in agriculture (World Bank, 2014: 201). The World Bank study (2014: 116) argues that climate change might act as a 'threat multiplier' for the security situation in the MENA region by placing additional pressure on already scarce resources and reinforcing pre-existing threats as political instability, poverty, and unemployment. This can create the conditions for social uprising and violent conflict. However, the study acknowledges that establishing a direct link between climate change and conflicts and insecurity is challenging due to contradictory conclusions and methods, and that further research is needed (Gemenne et al. 2014; see World Bank, 2014: 144 for a discussion of the literature).

Drought and food security

Previous research reporting correlational patterns between climate anomalies and violent conflict routinely refers to drought-induced agricultural shocks and adverse economic spill over effects as a key causal mechanism linking the two phenomena (Buhaug et al, 2015). During the last few years, violent land-use conflict in the Sahel has become the most popular example of the alleged link between global climate change and conflict. Benjaminsen et al (2012) explored this climate-conflict nexus in detail, focusing on a distinct area at the heart of the Sahel, the inland delta of the Niger river in the Mopti region of Mali. They argue that instead of climatic factors, three structural factors were the main drivers behind the conflicts: agricultural encroachment that obstructed the mobility of herders and livestock, opportunistic behaviour of rural actors as a consequence of an increasing political vacuum, and corruption and rent seeking among government officials.

To further empirically assess this purported indirect relationship between climate change and violent conflict, Buhaug et al (2015) compared half a century of statistics on climate variability, food production, and political violence across Sub-Saharan Africa. Their analysis revealed a robust link between weather patterns and food production where more rainfall generally is associated with higher yields. However, the second step in the causal model was not supported; agricultural output and violent conflict are only weakly and inconsistently connected, even in the specific contexts where production shocks are believed to have had particularly devastating social consequences. The authors highlight that although this null result could, in theory, be fully compatible with recent reports of food price-related riots, it suggests that the wider socioeconomic and political context is much more important than drought and crop failures in explaining violent conflict in contemporary Africa (Buhaug et al, 2015).

‘Threat multiplier’

Peters and Vivekananda (2014) in their topic guide on *Conflict, Climate and Environment* argue that the policy relevance of the current academic literature on climate change and conflict is limited because research questions focus on establishing causality: whether or not climate change contributes to conflict. Without long-term multi-year research that seeks to unpack the role of climate, environment and natural resources in violent conflict, the evidence base which informs policy responses can only be considered partial. Peters and Vivekananda (2014: vii) further state that climate change “will continue to be a ‘risk multiplier’ of conflict, insecurity and fragility unless it is effectively embedded into the management of risk and building of resilience. […] What determines whether (or how) climate change will lead to conflict lies in the ‘intermediary factors’ which affect the relationship between climate and conflict”.

Another important view is put forward by Abrahams and Carr (2017) in their review of literature emerging from the fields of geography and political ecology on the connections between climate change and conflict. They highlight that this literature uniquely challenges the dominant ‘threat multiplier’ framing of climate change impacts on conflict, questioning this narrative’s unidirectional flow from climate vulnerability to conflict, exploring how climate change can create opportunities for peacebuilding as well as conflict, and identifying how climate adaptation activities can themselves become catalysts for conflict. This is an important consideration. The ‘threat multiplier’ discourse was popularised by the Centre for Naval Analysis (CNA) and persists despite the CNA more recently reframing climate change as a ‘conflict catalyst’ that accelerates instability (Abrahams and Carr, 2017: 236). Abrahams and Carr (2017: 236) also highlight the use of the Arab Spring as a commonly referenced, though contested, example of the role of climate change as a threat multiplier, with research linking the uprisings to increases in food prices due to crop failures elsewhere in the world (see Abrahams and Carr, 2017 for further references).

Interlinking factors

It is difficult to identify the impacts of climate change on stability and security in North Africa, as these links have not been definitively made. An international workshop held in Germany in 2014 (Link et al, 2015) highlighted the importance of considering the drivers and interactions in the nexus of climate change, land use, and conflict in northern Africa in a combined manner, as there is no simple causal relationship from climate change to land-use change to possible conflict. Feedbacks need to be considered, as well as the roles of resource abundance, migration, and human livelihood, in the assessment of whether large-scale environmental changes lead to conflict or to increased cooperation (Link et al, 2015). Scheffran et al (2012) argue that comprehensive approaches are needed to disentangle the complex climate-conflict nexus. In their review of literature on the nexus, they further argue that countries with low human development are particularly vulnerable to the double exposure of natural disasters and armed conflict. This further highlights the point that climate change is not the only important parameter of future violence and security. Other factors such as human development, effective institutions, and governance also affect the likelihood of violent conflict. Economic, political, and social factors on local, regional and global levels are interlinked with broader effects of climate change.

5. Knowledge gaps

A number of knowledge gaps have been identified in relation to climate change impacts in North Africa (although not exhaustive), especially related to migration, security and stability (Ariza and Rueff, 2016: 10; IPCC, 2014b: 1204):

- Improved regional and national climate data collection and monitoring and development of climate change scenarios.
- Improved analysis of existing climate and environmental data and predictions that incorporate complexities (global/local processes) at a national level, at medium as well as long term scales.
- High levels of uncertainty for key variables and processes, including precipitation, dust storms, and desertification.
- Improved drought recording; insufficient systems are in place for drought monitoring, given this hazard's slow onset nature and lack of solid definition.
- Better understanding of resilience, adaptive capacity and successful coping strategies for environmental degradation and climate processes at national and local levels.
- Better understanding of the links between long-term climate change, instead of single climatologic hazards, to migration and social unrest.
- Gaps in understanding of how the climate-conflict-environment nexus relates to vulnerabilities on multiple scales, and how these vulnerabilities might change over time.
- Research on how climate change and variability will affect the access, stability and utilisation dimensions of food security in North Africa (Jobbins & Henley, 2015: 5).
- Gaps between the type of information contained in climate projections and environment and security studies, with differences in the types of information produced including analytical methods, language, and scale issues. This makes research conclusions difficult to reconcile (Lewis and Lenton, 2015).

6. References

Abrahams, D. and Carr, E.R. (2017) 'Understanding the Connections Between Climate Change and Conflict: Contributions From Geography and Political Ecology', *Current Climate Change Reports*, 3(4), 233-242. https://doi.org/10.1007/s40641-017-0080-z

Ariza, C. and Rueff, H. (2016) *The climate change, migration and economic development nexus in North Africa: An overview*. Thematic Input Paper - Agadir Regional Thematic Exchange Meeting. Swiss Agency for Development and Cooperation: Bern, Switzerland. https://www.weadapt.org/knowledge-base/sdc-climate-change-environment-network/the-climate-change-migration-and-economic-development-nexus-in-north-africa

Behnke, R. and Mortimore, M. (2016) *The end of desertification?* guest blog IIED. https://www.iied.org/end-desertification

Buhaug, H., Benjaminsen, T.A., Sjaastad, E., and Theisen, O.M. (2015) 'Climate variability, food production shocks, and violent conflict in Sub-Saharan Africa', *Environmental Research Letters,* 10, 1-11. doi:10.1088/1748-9326/10/12/125015 http://iopscience.iop.org/article/10.1088/1748-9326/10/12/125015

Gemenne, F., Barnett, J., Adger, W.N., and Dabelko, G.D. (2014) 'Climate and Security: Evidence, Emerging Risks, and a New Agenda', *Climatic Change*, 123(1), 1–9. https://link.springer.com/article/10.1007/s10584-014-1074-7

Gregory, P.J. (2017) Book Review: 'Roy H. Behnke and Michael Mortimore: the end of desertification? Disputing environmental change in the Drylands', *Food Security*, 9(4), 881-882. https://link.springer.com/article/10.1007%2Fs12571-017-0697-8

IPCC (2014a) *Climate Change 2014: Impacts, Adaptation, and Vulnerability*. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1132 pp. http://www.ipcc.ch/report/ar5/wg2/

IPCC (2014b) *Climate Change 2014: Impacts, Adaptation, and Vulnerability*. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 688 pp. http://www.ipcc.ch/report/ar5/wg2/

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. http://documents.wfp.org/stellent/groups/public/documents/communications/wfp279986.pdf

Jobbins, G., El Taraboulsi, S. and Pichon, F. (2016) *Development finance for water resources: trends in the Middle East and North Africa*, ODI: London. https://www.odi.org/publications/10661-development-finance-water-resources-trends-middle-east-and-north-africa

Kuper, M., Amichi, H. and Mayaux, P-L. (2017) 'Groundwater use in North Africa as a cautionary tale for climate change adaptation', *Water International*, 42(6), 725-740, DOI: 10.1080/02508060.2017.1351058 http://www.tandfonline.com/doi/abs/10.1080/02508060.2017.1351058

Lewis, K. H. and Lenton, T. M. (2015) 'Knowledge problems in climate change and security research', *WIREs Climate Change*, 6(4), 383-399. doi: 10.1002/wcc.346 http://onlinelibrary.wiley.com/doi/10.1002/wcc.346/abstract

Lezzaik, K. & Milewski, A. (2017) 'A quantitative assessment of groundwater resources in the Middle East and North Africa region', *Hydrogeology Journal*. https://doi.org/10.1007/s10040-017-1646-5

Link, P.M., Brücher, T., Claussen, M., Link, J.S. and Scheffran, J. (2015) 'The Nexus of Climate Change, Land Use, and Conflict: Complex Human–Environment Interactions in Northern Africa', *Bulletin of the American Meteorological Society*, 96(9), 1561-1564. http://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-15-00037.1

Oswald, J. and Harris, S. (2016) Desertification, Chapter: 11.1, In Shroder, J.F. and Sivanpillai, R. (Eds.) *Biological and Environmental Hazards, Risks, and Disasters*, Oxford, UK: Elsevier, pp.229-256. DOI: 10.1016/B978-0-12-394847-2.00015-2 https://www.researchgate.net/publication/312041888_Desertification

Otto, I.M., Reckien, D., Reyer, C.P.O., Marcus, R., Le Masson, V., Jones, L., Norton, A., and Serdeczny, O. (2017) 'Social vulnerability to climate change: a review of concepts and evidence', Regional Environmental Change,17(6), 1651-1662. https://doi.org/10.1007/s10113-017-1105-9

Peters, K. and Vivekananda, J. (2014) *Topic Guide: Conflict, climate and environment*. Evidence on Demand, UK, viii + 59 pp. https://www.gov.uk/dfid-research-outputs/topic-guide-conflict-climate-and-environment

Radhouane, L. (2013) 'Climate change impacts on North African countries and on some Tunisian economic sectors', *Journal of Agriculture and Environment for International Development - JAEID* 107: 101-113. http://www.iao.florence.it/ojs/index.php/JAEID/article/view/123/106

Scheffran, J., Brzoska, M., Kominek, J., Link, P.M., and Schilling, J. (2012) 'Disentangling the Climate-conflict Nexus: Empirical and Theoretical Assessment of Vulnerabilities and Pathways', *Review of European Studies*, 4(5), 1-13. http://www.ccsenet.org/journal/index.php/res/article/view/19277/0

Taylor, R.G., Scanlon, B., Döll, P., Rodell, M., van Beek, R., Wada, Y., Longuevergne, L., Leblanc, M., Famiglietti, J.S., Edmunds, M., Konikow, L., Green, T.R., Chen, J., Taniguchi, M., Bierkens, M.F.P., MacDonald, A., Fan, Y., Maxwell, R.M., Yechieli, Y., Gurdak, J.J., Allen, D.M. Shamsudduha, M., Hiscock, K., Yeh, P.J.-F. Holman, I., and Treidel, H. (2012) 'Ground water and climate change', *Nature Climate Change,* 3(4), 322-329. https://doi.org/10.1038/nclimate1744

World Bank (2017) *Beyond Scarcity: Water Security in the Middle East and North Africa*. MENA Development Report, Washington, DC: World Bank. Licence: CC BY 3.0 IGO https://openknowledge.worldbank.org/handle/10986/27659

World Bank (2016) *High and Dry: Climate Change, Water, and the Economy*, Washington, DC: World Bank. Licence: CC BY 3.0 IGO https://openknowledge.worldbank.org/handle/10986/23665

World Bank (2014) *Turn Down the Heat: Confronting the New Climate Normal*. Washington, DC: World Bank. Licence: CC BY-NC-ND 3.0 IGO. http://documents.worldbank.org/curated/en/317301468242098870/Main-report

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About this report

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