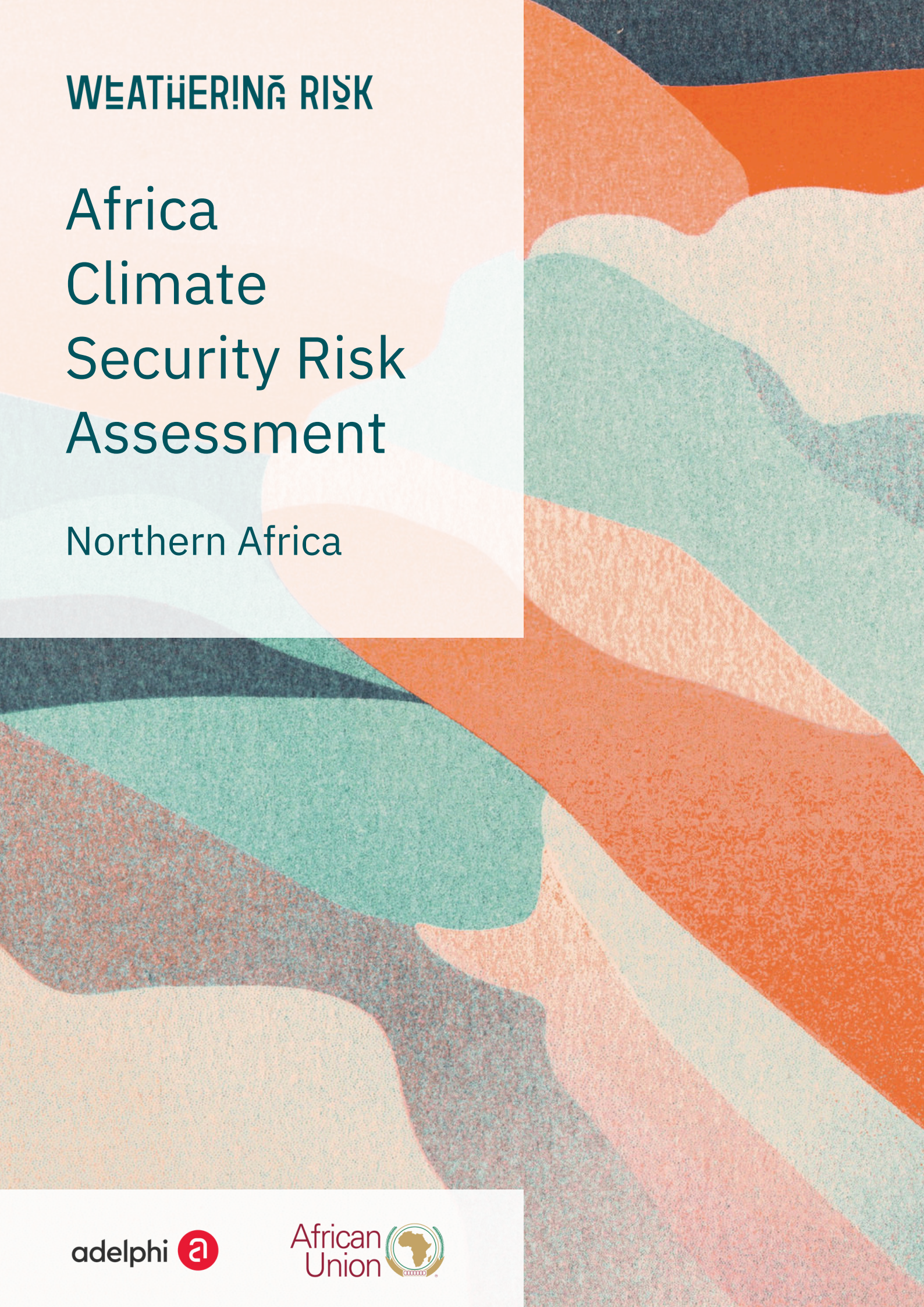
WEATHERING RISK

Africa Climate Security Risk Assessment

Northern Africa



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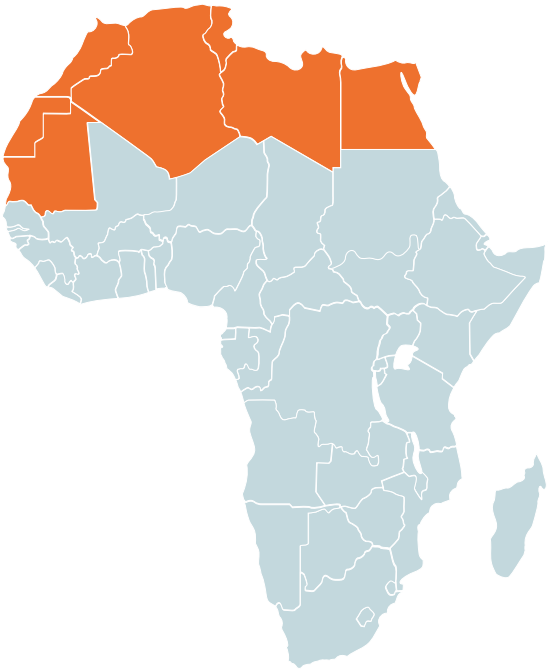


Summary

KEY CLIMATE IMPACTS

Temperature: Air temperature increases are particularly pronounced in the Northern Africa region, with increases higher than anywhere else on the African continent and twice as high as the global average. By 2080, air temperatures will very likely have increased by between 2.3°C and 4.3°C from pre-industrial levels. Temperature rise will be comparatively greater further inland and will correspond to an increase in the number of very hot days, with up to 37 more very hot days by 2030 and 84 more very hot days by 2080 in the most affected regions.

Precipitation*: Precipitation in Northern Africa is very low, but will see a sustained and steady decline. The extent and regional concentration of this decline have a high degree of uncertainty. Under a medium-to-high emissions scenario, it will further decline by up to 43 per cent in Egypt, 21 per cent in Algeria and 17 per cent in Libya by 2030.

Sea level rise: The region is very likely to experience at least 0.2 m and perhaps as much as 0.4 m or even 0.7 m of sea level rise by 2050, depending on future emissions pathways. Under high emissions scenarios, up to 1.0 m of sea level rise is possible by 2100, with a high degree of uncertainty.

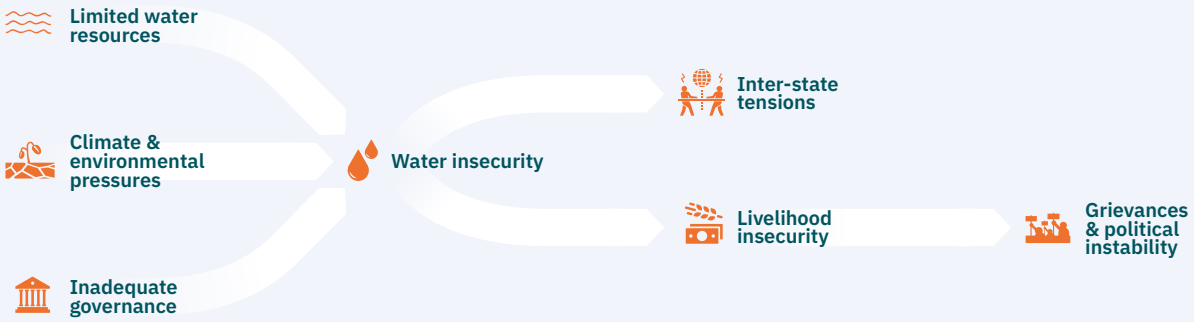
Flooding*: Floods caused by torrential rains in the otherwise dry region are already a regular feature of the Northern African climate. The frequency of floods has increased in recent decades and extreme precipitation patterns are predicted to increase further due to climate change with high certainty.

Droughts*: Northern Africa is already regularly exposed to droughts. The region will very likely see a further decline in rainfall, though variability of this remains uncertain. The reduction of precipitation will decrease resilience to prolonged periods of droughts.

* Climate projections with high uncertainty need to be interpreted with great caution. Please refer to the Annex for an explanation of uncertainty in climate projections.

CLIMATE SECURITY PATHWAYS IN NORTHERN AFRICA

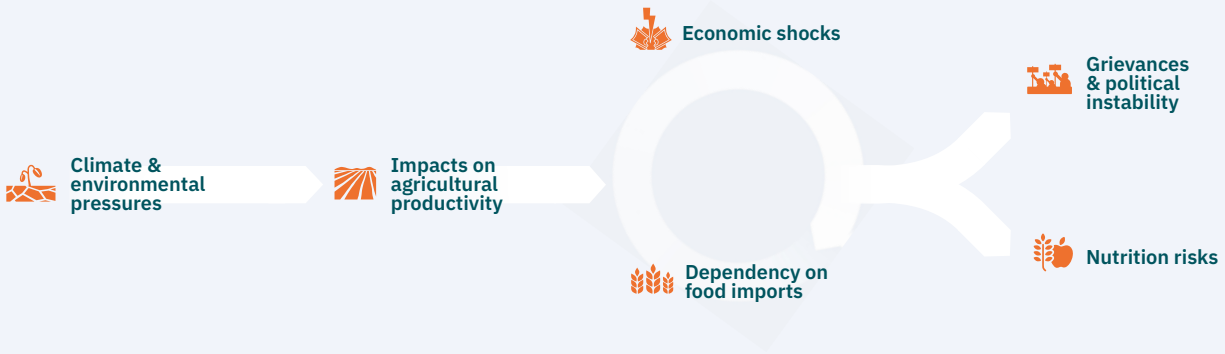
Pathway 1: Rising water insecurity



Northern Africa is already grappling with severe water scarcity, but a number of trends heighten this challenge. Depletion and (transnational) competition for water resources put further pressure on already vulnerable countries due to their dependency on fossil groundwater and the Nile River. Mismanagement can exacerbate supply issues through pollution and saltwater intrusion.

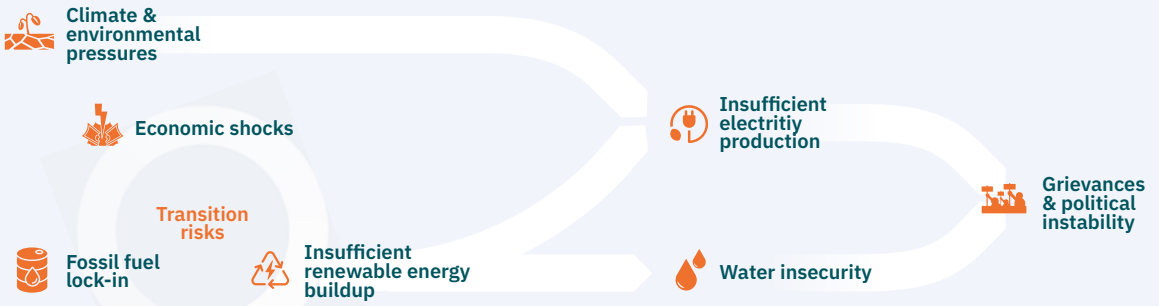
Meanwhile, a lack of cooperation and the mismanagement of transboundary water resources, such as aquifers and the Nile River, have ignited tensions and pose risks. At the same time, water shortages are already impacting economies and daily life, particularly in agriculture, and have the potential to exacerbate grievances and contribute to political instability.

Pathway 2: Ensuring the supply of food



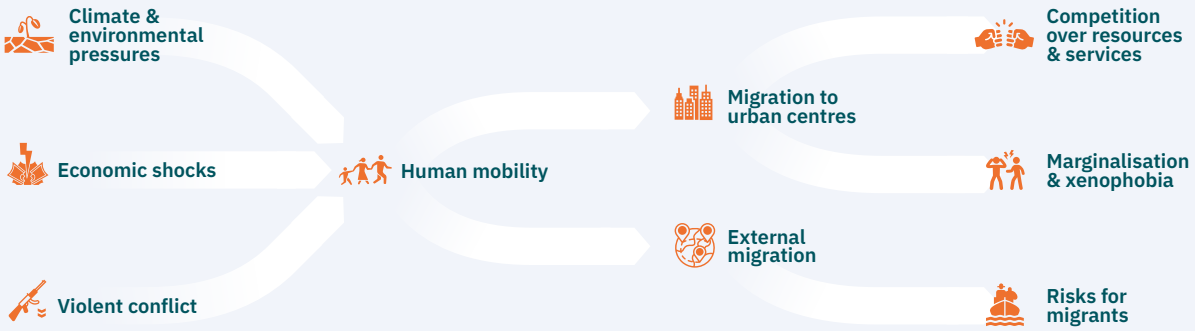
All Northern African countries are highly dependent on food imports, which entails a number of political and economic risks. Due to their small domestic sector already under pressure from climate change combined with import dependency, Northern African countries are reliant on the international availability and price stability of agricultural goods, mostly grain – two factors that are increasingly endangered by climate change effects. As a result, in moments of crisis, food imports can become a bottleneck, accelerate political grievances, and act as catalysts of political instability as happened during 2007, 2008 and 2011. Negative effects on populations are exacerbated by regressive subsidy policies and connected nutritional problems.

Pathway 3: Fossil fuel dependency and the Green Transition



Countries in the region have one of the lowest rates of renewable energy production worldwide. Meanwhile, a number of countries, such as Libya, Algeria and Egypt, remain invested in fossil fuel extraction and export. Though individual countries have made significant progress in their green transitions, this fossil fuel "lock in" effect hinders the adoption of renewable energy solutions and endangers the region's economic prospects as fossil fuel demand is set to decline. Beyond these macroeconomic risks, insufficient electricity supply has been a major part of public discontent. Growing populations and increased per capita electricity consumption, exacerbated by rising temperatures, will continue to place immense pressure on the region's inadequate energy infrastructure.

Pathway 4: Human mobility, migration and displacement



Human mobility is a growing issue in Northern Africa, as the region harbours some 1.5 million IDPs and three million migrants mostly from outside the region. While most movement within the region is currently conflict induced, projections forecast that up to six per cent of Northern Africa's population could be induced to move due to climate change effects, alongside migrants from other areas of Africa. While a vital adaptation strategy, poorly managed human mobility into urban centres intensifies pressures on communities, resources and services, which can intensify other climate security dynamics in the region.

Context

GEOGRAPHY

The Northern Africa region as defined by the African Union includes Egypt, Libya, Tunisia, Algeria, Morocco, the Sahrawi Republic (whose claims on Western Sahara are not accepted by a number of countries including Morocco) and Mauritania.[10] Unlike in other common definitions of North Africa, this does not include Sudan. The region is characterised by three distinct geographical and hydrological areas. In the east is the relatively small, but vitally important and fertile Nile Valley and Delta in Egypt. To the west, along the Mediterranean coast is the Maghreb, which stretches from Libya to Morocco following the Atlas Mountains. Moving south, the region gives way to the Sahel, a dry steppe region, which covers the majority of the Northern African region.

SOCIOECONOMIC CONTEXT

The combined GDP of the Northern Africa region is around USD 850 billion in 2022 (Statista 2022). The regional economy is heavily dominated by Egypt, Africa's second largest economy (World Bank 2023d). Northern African economies remain highly unequal, but have the lowest absolute poverty rate of all African regions at around three per cent (World Bank 2023e).

Northern African economies contracted sharply during the COVID-19 pandemic, pushing most of the region into recession. In 2022, the economy began to rebound with growth expected to be around five per cent, but this is unevenly distributed (Gatti et al. 2022). The war in Ukraine, however, has pushed up food and fuel prices, thereby favouring hydrocarbon export countries such as Algeria and Libya. The high commodity prices in combination with high public spending during COVID-19 created strong inflationary pressures, with Egypt registering the highest rate at 10 per cent in 2022 (Gatti et al. 2022). Although governments softened the inflationary impact with subsidies, the spending added to currency inflation and increased fiscal deficits, which nearly doubled in 2019 and 2020 (African Development Bank Group 2021).

POLITICAL INTEGRATION

Northern Africa is the least integrated region in Africa due to long-standing political enmities between countries in the region, such as between Morocco and Algeria (Lounnas and Messari 2018). Although Northern African countries are member states of multiple regional economic-political mechanisms, they are not all members of the same mechanism. The most important regional mechanism is the Arab Maghreb Union (AMU). Based in Marrakech, the AMU was created in 1989 to establish a common market with a view to prospective political integration (Mahjoub et al. 2017). However, due to Egypt not being a member and intra-regional rivalries, the AMU remains relatively weak leaving each state to develop their own bilateral trade agreements. The lack of intra-regional cooperation is reflected in the emphasis on bilateral rather than regional programming of key partners such as the European Union (Colombo 2018). Moreover, with the exception of the Maghreb region, Northern Africa is seldom perceived as a region on its own. Instead, Northern African countries form part of either Africa-wide, Arab or Mediterranean regional mechanisms, such as the African Union, the League of Arab States or the Union for the Mediterranean. The only strictly Northern African organisation is the North Africa Regional Capability (NARC), the military cooperation established in 2007 as Northern Africa's contribution to the African Standby Force.

DEMOGRAPHICS AND MOBILITY

The population in Northern Africa is diverse with the majority Arab population sharing the space with other ethnicities including the Amazigh, a population that has influence in Morocco and Libya. The majority of the region's approximately 210 million people live in the north along the coast, with nearly half of that number located in Egypt's Nile Valley (Haars et al. 2016). To varying degrees, the growth rates of Northern African countries have trended downwards as educational attainment, particularly of women, has improved and populations have urbanised. All populations, however, continue to grow quickly in total number due to exponential growth and population momentum (Khamis 2017).

The population growth in Northern Africa is spurred on by the inflow of migrants. Historically, the relative economic opportunity of the region made it a destination for migration from other parts of the continent (Kuschminder 2020). As of 2020, approximately 3.5 million international migrants reside in Northern Africa with the vast majority coming from within continent. Of this,

10 This report uses the African Union's classification system for geographic regions (https://au.int/en/member_states/countryprofiles2).

nearly half are now refugees and asylum seekers rather than economic migrants (IOM Migration Data Portal 2021). While most of these remain within the region, a small group continue towards Europe. In first half of 2022, over 35,000 migrants entered Europe from the central Mediterranean (Libya, Tunisia, Algeria) and over 6,000 from the western Mediterranean (Morocco) (Frontex 2022). Tragically, over 3,000 people have died on their way to Europe (UN News 2022).

PEACE AND SECURITY

Most of the countries in Northern Africa were affected by the Arab Spring, although the consequences of the uprising have differed significantly. While governments in the north-east, including Egypt, Libya, Tunisia and eventually Algeria, were swept aside by popular discontent in 2011, governments in the north-west, including Morocco and Mauritania, survived largely unscathed. After the governments in Egypt, Libya, Tunisia and Algeria were removed in the hope of installing more democratic and responsive institutions, the political situation in these countries consolidated.

Although the prospect of social unrest and political instability remains present (to varying degrees) in some Northern African countries, the overall security situation in the region has improved. Active incidents of social unrest have declined and, in parallel with global trends, terrorism has gradually reduced since 2014 (Institute for Economics and Peace 2022). Although Jihadi groups continue to operate in the Sahara, most of this activity is in countries to the south of Northern Africa (Institute for Economics and Peace 2020). The exception to this trend is Libya, which has experienced reoccurring and endemic conflict since 2011.

Climate change and impacts[11,12]

TEMPERATURE RISE

Since the 1970s, climate change in Northern Africa has increased annual air temperatures by between 0.2°C and 0.4°C every decade (Binder 2022b). The average rate of temperature increase is higher than in any other African region and approximately twice as high as the global average (IPCC 2022). By 2080, air temperatures will very likely have increased by between 2.3°C and 4.3°C from pre-industrial levels (WMO 2022). The temperature increase will be comparatively larger in central Algeria and southeastern Mauritania, while lower along the coastlines.

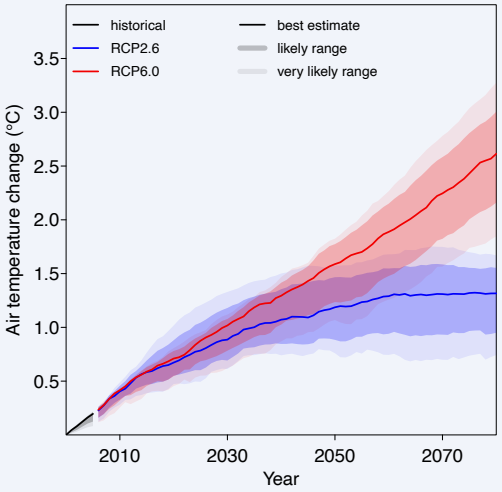


Figure 5: Temperature rise in Northern Africa (Binder 2022b)

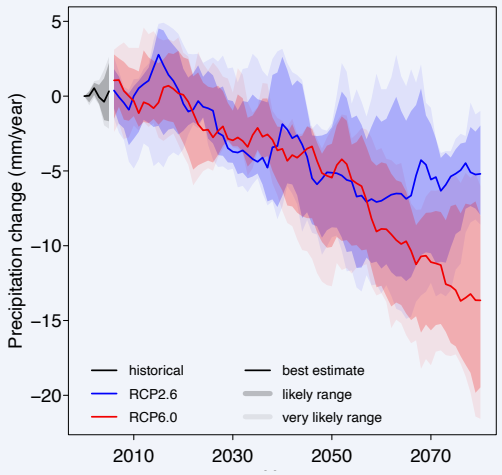


Figure 6: Changes in precipitation in Northern Africa (Binder 2022b)

The annual number of very hot days is projected to rise. Under medium-to-high future GHG emissions (RCP6.0), the largest increases are expected along the northeastern coasts, in southern Western Sahara and southeastern Mauritania, where the number of very hot days is projected to increase by up to 37 per cent by 2030 and by up to 84 per cent by 2080 (IPCC 2022). This will result in the hot season in Northern Africa lengthening by one month between 2021 and 2050 (Founda, Varotsos, Pierros and Giannakopoulos 2019). Heat waves will be most pronounced in the cities.

11 Please refer to the Annex for guidance on how to read the plots and an explanation of the concept of uncertainty in climate projections.
12 The summary of the key climate impacts in this section is based on: Binder L. 2022. Climate Change in North Africa. Berlin: Potsdam Institute for Climate Impact Research.

CHANGES IN PRECIPITATION

In Northern Africa, the amount of precipitation generally decreases from east to west, with Egypt's Alexandria receiving less than 200 mm of rain annually, while the coast of Morocco receives 1,200 mm (World Bank 2021b). Similarly, precipitation decreases as one moves away from the coast to the southern desert. The exception to this pattern is Mauritania, which receives most of its rainfall in the southern Sahelian region between June and October.

Precipitation levels have declined significantly since the 1970s, although there was some recovery in the 2000s (IPCC 2022). According to future projections, although there is uncertainty regarding the extent of decline and regional distribution, precipitation will steadily decline due to climate change. Under the RCP6.0, precipitation will decrease by -2.76 mm by 2030 and by -13.65 mm by 2080. Under this scenario, precipitation will decline by up to 43 per cent in Egypt, particularly in the Nile Delta, 21 per cent in Algeria and 17 per cent in Libya by 2030 (Gado et al. 2022). Though precipitation is already so low that countries in the region are dependent on other non-renewable water sources, this is set to exacerbate water scarcity. With all Northern African countries predominantly consisting of desert, water scarcity may contribute to further desertification.

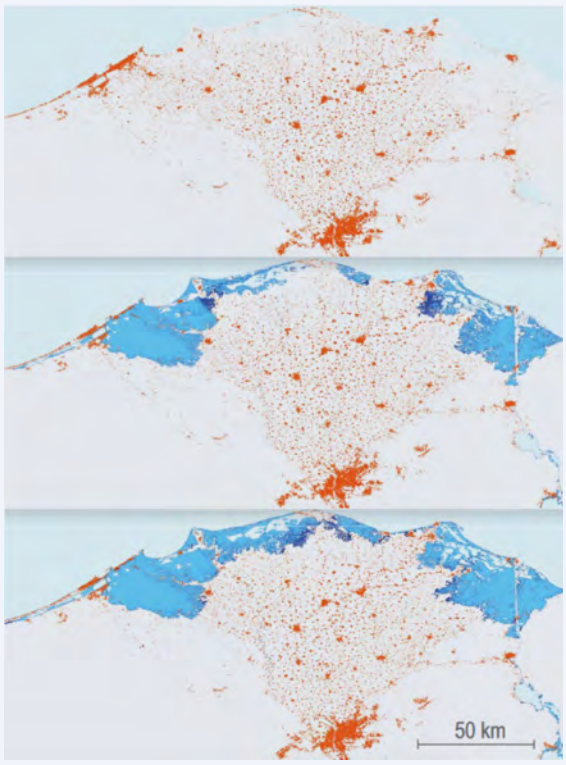


Figure 7: (Projected) flooding along the Egyptian coast, from top to bottom: present day, 2050 and 2100. Orange indicates existing infrastructure. Blue shows permanent flooding, with light blue for RCP2.6, and darker shades of blue for RCP4.5 and RCP8.5 (IPCC Africa Ch. 9)

SEA LEVEL RISE

In the Mediterranean Sea, the annual rise in sea level is between 2.5 mm and 3.1 mm annually, slightly lower than the global average (WMO 2022). Under a high emissions pathway following SSP1-2.6 this would result in 0.2 m sea level rise across the entire Mediterranean region by mid-century and 0.4 m sea level rise by 2100 (Zittis et al. 2021). Under a high emissions pathway following SSP5-8.5, the Mediterranean region including the Northern African coast could see up to 0.7 m sea level rise by the end of the century, with a low likelihood of a range of up to 1.0 m.

As the vast majority of the population is located along the coast or along the low-lying Nile Delta, Northern Africa's population is highly exposed and vulnerable to rising sea levels. Low-lying coasts in Tunisia and Egypt are particularly vulnerable (Hzami et al. 2021). The IPCC projects that by 2030, sea level rise will affect between 48.6 million and 52.3 million people in low-lying coastal areas in Northern Africa (IPCC 2022). The Nile Delta will see substantial land losses by as early as 2050 (see Figure 7). Beyond immediate infrastructure damage from higher water lines, rising sea levels will also result in saltwater intrusion into groundwater reserves and river deltas in the region. Saltwater intrusion already reaches 30 km into areas of the Nile Delta and some 100 m into coastal aquifers, depending on preventive pumping and water withdrawal (Agoubi 2021). Further sea level rises could render even larger delta areas and parts of aquifers unusable (USGS 2019).

FLOODING AND DROUGHT

Flooding caused by torrential rains is not uncommon in Northern Africa, particularly in communities located in or near mountain regions. River flooding can also be severe. In recent decades, flooding has increased in a third of river basins (Tramblay et al. 2022). Projected climate change is expected to increase extreme precipitation across most of the Sahara, although less so in the north (Seneviratne et al. 2021). That stated, due to sea level rise and changing precipitation patterns, all countries face the potential for greater flood damage along the coast.

Figure 8: Fossil aquifers of Northern Africa (Mazzoni 2018)

Droughts, in Northern Africa, are already a regular phenomenon. However, increasing aridity in the southern Mediterranean region is straining annual surface and ground water resources, making countries less resilient to droughts (Seneviratne et al. 2021). Rising temperatures and population growth will only increase water insecurity as demand for freshwater resources grows in the future.

Climate security risk pathways

RISING WATER INSECURITY

Northern Africa is already experiencing the impacts of water insecurity. The region is one of the driest in the world and has restricted water resources (Hofste et al. 2019). Egypt draws almost exclusively from its limited river sources and has a dependency ratio of 97 per cent (FAO 2016). Libya, Tunisia and Algeria draw their water almost exclusively from fossil water reserves in non-renewable deep aquifer systems. The three main aquifer systems – the Nubian Sandstone Aquifer System (NSAS), the North Western Sahara Aquifer System (NWSAS) and the smaller Murzuq Aquifer – are all being actively depleted. Morocco possesses no fossil water reserves and is fully dependent on renewable groundwater resources, while Mauritania depends on renewable groundwater but has some access to fossil aquifers. Climate change impacts and a rapidly growing population will further decrease the per capita availability of water throughout the region. In addition, water resources are increasingly under pressure from rising water consumption related to urbanisation and agriculture, and a lack of water management. This combination of declining supply and rising demand has a number of important security implications.

LIMITED WATER SUPPLIES

Northern Africa's limited water resources, on which all countries in the region depend, has the potential to be a source of regional tensions. The central Northern African countries' dependence on fossil groundwater makes them particularly vulnerable. While the joint management of the NWSAS by Algeria, Libya and Tunisia, and the NSAS between Libya and Egypt have been largely cooperative since the 1960s (African Development Bank 2022), competition for transnational water resources has led to mismanagement including unsustainable depletion. As a result of the high levels of exploitation, the extraction rate of the NWSAS is over three times its recharge rate (Mohamed and Gonçalvès 2021).

A further problem is pollution, particularly of the Bounaïm-Tafna Basin between Morocco and Algeria (Chibani 2022). Contamination from industrial discharge pollutants and, in particular, saltwater intrusion into excessively depleted coastal basins are likely to further decrease supply (Hamed et al. 2018). Even more than rising sea levels, unregulated groundwater extraction in coastal areas can lead to salt water inflows so significant as to potentially render large parts of the freshwater reservoir unusable (Mabrouk et al. 2018).

While the fossil water reserves of the NSAS and NWSAS are set to last for some 200–300 years at current extraction rates, the Murzuq Aquifer on

which Libya heavily relies could expire as early as the 2030s, putting the country under severe water stress (Mazzoni 2018). Libya's Great Man-Made River (GMMR) project, under construction and partially operational since the 1980s, aims to remedy this by channelling water from the NSAS to the dry north of the country. However, since the country began experiencing political instability in 2011, the construction and maintenance of the GMMR pipelines has been disrupted (MEI 2022). With areas of the country under militia control, security breaches against GMMR infrastructure have occurred, affecting its operation. In addition, management and future expansion of the project have been compromised by destruction, electricity outages and economic mismanagement.

The Nile as a flashpoint of tensions

In the eastern part of the region, tensions have centred around the Nile as a water source. Although the Nile is Egypt's primary source of water, its headwaters lie in Ethiopia. This fact underlies Egypt's concern over Ethiopia's building of the Great Ethiopian Renaissance Dam (GERD). From the Ethiopian perspective, the dam's potential to provide 16 GW of electricity is of vital strategic importance for its growing economy. Its success is a source of national pride as well as financial importance, particularly as nearly a million Ethiopians bought shares in the government bonds issued to finance the project (Abtew and Dessu 2019). Moreover, given that Ethiopia's hydropower earnings depend on maximising flows through the GERD near the border, it has effectively incentivised itself to release the water downstream rather than abstract it for domestic irrigation. From an Egyptian perspective, however, the construction of the dam threatens Egypt's water supply and gives a foreign power control over a resource of existential importance. As such, the filling of the reservoir was perceived to further threaten Egypt's water supply. As a result, Egypt virulently opposes the GERD and insists on binding guarantees from Ethiopia regarding water releases to which Ethiopia has refused to agree (Egypt Independent 2022). This situation increases tensions in the region and lowers the prospect for inter-regional cooperation.

Concern over the effects of the GERD project is compounded by uncertainty about future water supplies in the Nile Basin. Evaporation already leads to losses of between 2.5 billion m3 and 10 billion m3 per year around Lake Nasser, and the new reservoir will add to these (albeit at smaller scale). Overall, higher losses to evaporation due to higher temperatures are expected (Gado and El-Agha 2021), while higher temperatures will tend to increase irrigation needs. Increasingly erratic precipitation patterns and the potential of lower precipitation in the Ethiopian highlands create the potential of lower water volumes in the Nile River. At the same time, rising sea levels threaten to lead to saltwater inflows into the Nile Delta, polluting Egypt's available freshwater. As 18.1 per cent of the delta lies below the mean sea level, and a further 12.7 per cent has an elevation of between 0 m and 1 m, the delta is highly vulnerable to flooding (Hereher 2010). Even just 0.5 m of sea level rise – which is likely to be reached by 2100, according to most scenarios – would displace two million people and cause over USD 35 billion worth of damages in lost property in Alexandria and surrounding coastal towns alone (Africa Center for Strategic Studies 2022b). This slow onset climatic pressure, in combination with increasing demand from all riparian countries, will compound tension over this vital natural resource (Berhane 2014). Unfortunately, despite repeated high-level interventions, tensions regarding the management of the Nile River have so far failed to be resolved through an agreement (Mbaku 2020).

Water shortages

In addition to these regional challenges, water shortages are already affecting economies and people's daily lives, particularly of those working in the agricultural sector. The agricultural sector is the largest consumer of water in the region. Egypt, for example, uses up to 85 per cent of its freshwater for agriculture, while the sector consumes around 80 per cent of freshwater in Morocco and Libya (Belhassan 2022).

As water resources are becoming scarcer and agricultural livelihoods are increasingly under pressure, these factors can contribute to grievances and political instability. For example, in April 2016, Egypt's government banned water-intensive irrigated rice crops in the Nile Delta to reduce water use, which led to demonstrations by farmers concerned about economic losses due to being unable to sell profitable rice (Hussein 2016). Conversely, in Morocco, the lack of regulation on the water-intensive farming of water melons has led to social unrest, with citizens blaming their own water scarcity on deregulated farming practises (Mekouar 2017). Persistent water shortages have also exacerbated wider grievances, which have led to popular protests in Libya. Water shortages and deteriorating infrastructure in Libya have

made water pipes a target for sabotage by militant groups, incentivising communities to drill private wells and exacerbating the water scarcity situation in the country (Gatenby 2017).

Reduced water access also has economic implications. While agriculture's contribution to GDP is decreasing across the region as countries shift to more service-based economies, agriculture continues to employ large segments of the population (Houdret et al. 2017). This is particularly the case for Morocco and Mauritania, where the agricultural sector constitutes 33 per cent and 31 per cent of employment, respectively (World Bank 2021d). Even in Libya, where agriculture's share in GDP is only around three per cent, some 18 per cent of the population are employed in this sector (TradingEconomics 2023). The agricultural sector still features as a central component of most national economic growth plans. Algeria, for instance, is working to nearly double its domestic wheat production to offset import costs (Ould Ahmed 2018). However, wider economic losses can have destabilising effects. The World Bank estimates that economic losses due to climate-related water scarcity could cost the region between six per cent and 15 per cent of its GDP by 2050 (World Bank 2018). The loss of government revenue can significantly impact the ability of Northern African governments to fulfil their functions, while simultaneously increasing livelihood insecurities for those dependent on agriculture, contributing to further political discontent and instability.

Water governance

In general, water governance has up to now often played an aggravating role in Northern Africa's water problems. Domestic policy has hitherto largely encouraged overconsumption by offering substantial subsidies to consumers. Despite being one of the most water-stressed regions in the world, Northern Africa has the highest level of water subsidies (World Bank 2018). The challenge for governments is that populations, particularly in countries such as Libya where water is essentially free, have become accustomed to low water tariffs. Unfortunately, low water tariffs inhibit water rationalisation and investment. When governments are no longer able to provide cheap water, grievances can escalate into political instability. Thus, unsustainable water subsidies exacerbate political instability when they are implemented instead of encouraging water efficiency through conservation and reuse.

On the supply side, insufficient government intervention is further endangering water resources. Since the 1980s, exploitation of fossil water has grown significantly. The total number of withdrawal points increased from 8,800 in 2000 to 18,160 in 2008, with the vast majority located in Algeria (Chekireb et al. 2022). Moreover, the agricultural sector accounts for most of this growth, with the vast majority being unauthorised. In Tunisia, for instance, out of the 5,600 wells drilled in to the NWSAS, only 80 have received a permit (Chekireb et al. 2022). Left unaddressed, such actions decrease water availability and further contribute to security issues in the region.

National investment into desalination plants could offer some relief for acute water scarcity, but has often been neglected in favour of the further expansion of groundwater pumping infrastructure, as seen in the case of Libya and the GMMR project (Altaeb 2021). Desalination plants have been constructed or are being planned (e.g. in Morocco and Egypt), but are energy-intensive and largely powered by non-renewable electricity from national grids, increasing fossil fuel demand and resulting in an energy-water nexus (Eljechtimi 2022; Lewis 2022).

Looking into the future, trends towards greater scarcity are set to accelerate. For the MENA region as a whole, demand is set to increase by 50 per cent by 2050 with a decrease in water supply of 12 per cent (Droogers et al. 2012). Per capita water resources, already well below the 1,000 m3 per year threshold in Northern Africa for water, is likely to fall further from 500 m3 per year in 2022 (al-Kady 2022) to 350 m3 per year by 2050 in Egypt, according to some projections (UNEP 2015b).

ENSURING THE SUPPLY OF FOOD

The combination of population growth, socioeconomic changes, and environmental and climate shifts places the supply of a number of key goods and services under intense stress. In no other sector, however, are these pressures felt as immediately as in the food sector. Food security is a well-known challenge for Northern Africa. Climate change, however, disrupts the delicate balance of the current model. Changing climatic conditions and rising water scarcity endanger domestic agriculture, with the region already heavily reliant on international exports. Given the macroeconomic challenges of the region, this dependence on food imports might itself become a risk as climate

change effects worsen. Essential for political buy-in, insecure access to food has repeatedly contributed to social unrest in the recent past.

The state of food insecurity

No Northern African country covers their food needs from domestic production alone. All countries in the region are net-food importers. Food imports make up a significant part of all imports, ranging from 25 per cent of all merchandise imports, in the case of Mauritania, to 12 per cent, in the case of Tunisia (World Bank 2023c). Food imports are significant not just compared to the overall economy, but also compared to domestic food supply. Egypt's capacity to grow enough food to satisfy domestic demand was surpassed in the 1970s and has been outpaced ever since (Nikiel and Eltahir 2021). Egypt is the world's largest importer of wheat; its imports account for about 62 per cent of its entire wheat consumption, of which 85 per cent comes from Russia and Ukraine (Abay and Diao et al. 2023). Algeria imports 75 per cent of its food (Tanchum 2021), while Tunisia imports 70 per cent of its grain (Agence Tunis Afrique Press 2021).

Reliance on food imports

By acting as an alternative to domestic agriculture, which would place further strain on limited water supplies, food imports help to circumvent climate challenges at home and alleviate water scarcity. However, dependence on food imports renders Northern African countries vulnerable to shocks within their own economies and the world market.

In non-crisis times, the export of commodities has allowed Northern African countries to retain a positive balance of trade, enabling them to finance food imports. However, during crises, this often changes. Most recently, the combined shocks caused by the COVID-19 pandemic, the war in Ukraine and reduced rainfall have led to sharply rising food prices worldwide. In 2022, some 60 per cent of regional inflation occurred in the food commodities sector, placing further pressure on a population that was already experiencing income losses due to the COVID-19 pandemic (IMF 2022). This decreases affordability, particularly for the poor. As a result, a third of Northern Africa's population were food insecure in 2022 (FAO et al. 2023).[13]

Higher food prices on international markets also bring macroeconomic problems for countries' trade balances. For some countries in Northern Africa, their direct exposure to trade shocks, as importers of Russian and Ukrainian cereals, combined with limited existing stocks, due to drought and crop failure prior to the eruption of the war in Ukraine, have aggravated food insecurity. Concurrently, there was a surge in the price of oil and natural gas, which has compounded the burden for oil-importing countries, such as Egypt, and created windfall revenues for oil-exporting countries, such as Libya and Algeria.

The price increase has led to higher import costs and diminished government resources for oil imports. Consequently, this has exacerbated macroeconomic disparities, triggering significant currency devaluations in Egypt and Morocco, and leading to additional price hikes across various goods and services (Abay and Karachiwalla et al. 2023). Thus, dependence on food imports increases vulnerability by accelerating moments of crisis.

Over the coming years, globally changing climatic zones and extreme weather events will likely lead to further supply shocks and more volatile grain prices on the international market (Zhang et al. 2022). Combined with the economic difficulties climate change poses for Northern African countries, the cost of food imports relative to GDP will further increase. This heightens food insecurity in the region, as both domestic and international climatic changes can result in shocks that will upset the sociopolitical balance.

Nutrition risks

Adding to this are underlying health risks related to malnutrition and food safety. All Northern African populations face a moderate problem of obesity and childhood stunting due to malnutrition (Global Nutrition Report 2023). Childhood stunting has remained a problem even as economic growth has accelerated. This is largely due to unbalanced diets that are too reliant on carbohydrates, and deficient in fruits, vegetables, legumes and nuts. The prevalence of such diets in Northern Africa leads to micronutrient deficiency, which results in additional health problems (Global Nutrition Report 2023).

The public health challenge of inadequate nutrition adds to wider food insecurity in Northern Africa. It also correlates with other issues of food security. In particular, widely employed food subsidies usually

13 In the FAO's classification, Northern Africa includes Sudan but excludes Mauritania, unlike in the official AU denomination.

apply only to select staple items, such as bread and oil. These foodstuffs guarantee a high carbohydrate intake, but are nutritionally incomplete. Consequently, subsidies can incentivise malnutrition. Egyptian food subsidies have been associated with negative health outcomes because of their emphasis on calorie-dense foodstuffs (Ecker et al. 2016). This effect is particularly pronounced during periods of economic shock and food price rises, when poorer Egyptians fall back on subsidised, less diverse and unhealthier diets (Abay and Karachiwalla et al. 2023).

Food insecurity and political instability

Access to food has played a particularly critical role during the political turmoil of the past few decades. There have been incidents where increasing food prices were associated with the risk of political unrest and conflict. For instance, rapid price increases triggered civil unrest in areas of Egypt and Morocco in the 1970s and 1990s, respectively. In addition, rapid price increases contributed to the widespread unrests that unfolded during the Arab Spring across some Northern African countries (Zaki 2008; Johnstone and Mazo 2011; Alshammari and Willoughby 2017; Soffiantini 2020; Läderach et al. 2022). More recently, food price increases have also contributed to strikes and protests in Northern Africa (France24 2022).

These food price shocks have occurred despite high food subsidy regimes across the region. While food subsidies provided a social safety net during the 2007–2008 food price shock in Egypt, they also brought various problems. This included a reduction in availability due to smuggling and demand spikes for certain foodstuffs, which in turn led to fiscal shocks for the state (Trego 2011).

As climate impacts jeopardise natural resource-based sectors – if climate adaptation, mitigation and early action are not put in place – the supply risks associated with food, water and energy sectors will intensify. As discussed, agriculture already uses up the majority of the available freshwater in all Northern African countries. With water resources limited and under strain, domestic agriculture cannot easily scale up to meet growing food demand. In addition, local agriculture will increasingly come under pressure from changing climatic conditions in the region. Higher temperatures and lower precipitation increase soil salinity. In combination with unpredictable rains and heat stress on plants, this is lowering agricultural productivity (Molina et al. 2020). Projections expect that crop yields could fall by 20–55 per cent from their 2010 outputs by mid-century, with higher impacts on less resilient products including key cereals (WFP and ODI 2015).

FOSSIL FUEL DEPENDENCY AND THE GREEN TRANSITION

Northern Africa has one of the lowest shares of renewable electricity production globally (OurWorldInData 2022), and remains heavily invested in the extraction and use of fossil fuels. By continuing to rely on fossil fuel production and consumption, Northern African countries are endangering their domestic energy security and exposing their socioeconomic development to transition risks. At the same time, the green transition opens up new spaces to address socioeconomic development in Northern Africa more broadly.

Fossil fuel lock-in

Libya, Algeria and Egypt are major oil producers, while Algeria and Egypt are Africa's two largest gas producers accounting for some 60 per cent of the entire continent's production. Mauritania, though not historically a fossil fuel exporter, is in the process of becoming a natural gas exporter (Georges 2022). This makes their economies dependent on global oil and gas demand and prices. While the war in Ukraine has led to a temporary increase in fossil fuel prices and demand for new sources of gas, demand for oil and gas is likely to resume its long-term decline. The International Energy Agency, major multinationals as well as the Organization of Petroleum Exporting Countries all predict demand will decline by as much as 75 per cent by 2030 (IEA estimate), though estimates vary (bp 2020; Hodari and Elliott 2020; IEA 2021).

For major exporters, such as Algeria and Libya, falling demand and prices pose a great risk as hydrocarbons are currently the primary source of foreign exchange and a major source of public revenue. As stated by the World Bank, although there is uncertainty as to the pace of the decline of oil and gas, countries that are currently reliant on oil and gas exports cannot afford to wait to diversify their economies and invest in the low-carbon transition (Peszko et al. 2020). Falling oil and gas revenues pose a major macroeconomic problem for countries dependent on a delicate macroeconomic balance to provide economic growth and import food.

Energy subsidies for fossil fuels, as they have long been common in Northern African countries, further solidify domestic demand for oil and gas, and

thereby further lock in a fossil economy. Despite policy reforms, all Northern African countries continue to subsidise fossil fuels for consumers. Libya has one of the lowest petrol prices in the world, which encourages both domestic consumption and widespread smuggling (Eaton and Tim 2018). In turn, smuggling ends up hurting both the state, which loses subsidies to smugglers, as well as consumers, who end up paying more than the subsidised market rate because of shortages caused by smuggling (TRACIT 2019).

Transition risks

However, as long as fossil fuel prices remain high, the countries most exposed to transition risks have the least incentive to diversify their economies and so are the least prepared to deal with its effects. Algeria and Libya are examples of this dynamic and continue to have the lowest rates of electricity production from renewable energy sources in the region. While all the other countries in the region have made significant advances in renewable energy, electricity production from renewable energy (excluding hydroelectricity) remains below one per cent of the total energy mix (World Bank Data 2023). With an exceptionally narrow tax base and few other viable economic sectors, Libya has the additional exposure of having few other options for public revenue and, therefore, has the highest exposure to declining oil demand alongside Iraq (Cornish et al. 2021).

Other countries have begun their green transitions. Natural gas continues to account for an overwhelming share of electricity production in Egypt, although its solar capacity is growing. Morocco still mostly relies on coal for electricity production, but is leading the region for renewables, with renewable sources accounting for around 30 per cent of its electrical capacity and more than 10 per cent of its electricity supply (IRENA 2023c). This comes after a concerted investment effort into wind and solar energy in the last few years (Bennouna 2022). Mauritania has a renewable capacity of 27 per cent, while seven per cent of Egypt's energy capacity is currently renewable (IRENA 2023a, 2023b). Expanding renewable energy capacity has the additional advantage of increasing energy sovereignty for Mauritania, Morocco and Tunisia, which are currently highly dependent on fossil energy imports (IRENA 2023b, 2023c, 2023d).

Ensuring electricity supply

A lack of investment in green energy not only stunts economic growth prospects, but also endangers domestic energy supply. As Northern Africa's population is growing and consuming more electricity per capita, only reliable and readily available sources of energy, such as solar power, can match demand. Otherwise, the supply of electricity is at risk of becoming a focal point of popular discontent akin to water and food. A growing economy and population create constant pressure on utility companies to produce more electricity. Concurrently, higher ambient temperatures lower the efficiency of electricity production and per capita demand for electricity could increase by up to 25 per cent in Africa to account for greater cooling needs during hotter periods (van Ruijven et al. 2019). The additional stress on electricity grids to power air conditioning during summer months has already led to power outages across the region. In addition, lower precipitation and water runoff have the potential to impede hydroelectricity production in Egypt, which currently satisfies some five per cent of its electricity demands from hydroelectric plants along the Nile River (U.S. Energy Information Administration 2022).

Consequently, electricity demand already often outpaces supply. Frequent power outages have at numerous occasions become a triggering factor for wider frustration with governance, as evidenced by protests in Egypt in 2014, and in Libya in 2018 and 2022 (Middle East Monitor 2014; Elumami and Al-Warfali 2022). Insufficient supply forces electricity providers to react with load shedding, temporarily turning off sections of the national grid to avoid a complete blackout. In Libya in 2017 and 2020, local militias disabled emergency breakers to prevent electricity providers from shutting down electricity in their areas (Reuters 2020). This led to an inability to balance the grid, resulting in repeated and prolonged blackouts across the entire country. This led to demonstrations and anti-government unrest. The blackouts also damaged infrastructure, and incentivised Libyans to steal from and attach illegal connections to the grid (Libya Observer 2020). Thus, social unrest and the failing provision of electricity are mutually reinforcing.

Beyond immediate provision to consumers, electricity is crucial for providing other key goods and services. The reliance among all Northern African countries, excluding Egypt, on groundwater resources in turn increases energy demand. Electricity is necessary to ensure groundwater extraction and distribution, as in the case of Libya's GMMR project. Disruptions in the electricity sector could endanger the supply of water. In turn, an

ability to distribute and pump groundwater affects agriculture, which is reliant on groundwater. Retaliation can also be sociopolitical. In July 2020, local militias in Wersheffana cut power supply to Libya's south. Militias in the south responded by forcing the GMMR authority to disrupt the water supply to western and central Libya (Clingendael 2020). Problems in the electricity sector can, thereby, aggravate water and food insecurity.

HUMAN MOBILITY, MIGRATION AND DISPLACEMENT

Migration remains a dominant topic in Northern Africa. Countries within the region have around 1.5 million IDPs, mostly in Libya, and harbour some three million regional migrants, mostly from Western, Central and Eastern Africa. Both internal and regional migration are set to rise as a consequence of climate change, with environmental challenges triggering displacement and follow-on effects, such as loss of livelihood and conflict. While migration is an important adaptation measure, the lack of pre-emptive policy measures can become a driver of tensions and conflict. Insufficiently managed, migration can aggravate other climate security challenges by increasing population pressure on resources and services.

Displacement

Over recent years, Northern African countries have experienced an increased number of disaster-related displacements. Climate change increases the frequency and intensity of disasters, which are a push factor for displacement. Between 2010 and 2019, there were 17,000, 29,000 and 4,400 new disaster-related displacements recorded in Morocco, Algeria and Tunisia, respectively. At the same time, most of the new displacements recorded in Libya (1,409,000) and Egypt (30,000) were conflict-related (IDMC 2021). Weather-related events, particularly flooding, have been a key driver of disaster-related displacement in the region, accounting for 58 per cent of disaster-induced displacement in the MENA region. Poor soil absorption can result in seasonal rain, leading to flash flooding in the otherwise arid region (IDMC 2021).

Internal and regional migration

Northern Africa remains a destination for internal and regional migration (IOM Migration Data Portal 2021). Urban centres, particularly Libyan cities prior to the outbreak of the Libyan civil war, are major regional migration magnets for people looking to benefit from economic opportunities (IOM Migration Data Portal 2021).

Within Northern Africa, excluding Mauritania, between 4.5 million and 13 million people – depending on mitigation and adaptation pathways – could move within their own country due to climate change by 2050. Most of these movements will be due to severe water stress pushing people out of coastal and urban areas, and into urban centres with better water availability (Clement et al. 2021). The number of people moving because of climate change effects could thus constitute up to six per cent of the entire Northern African popula-

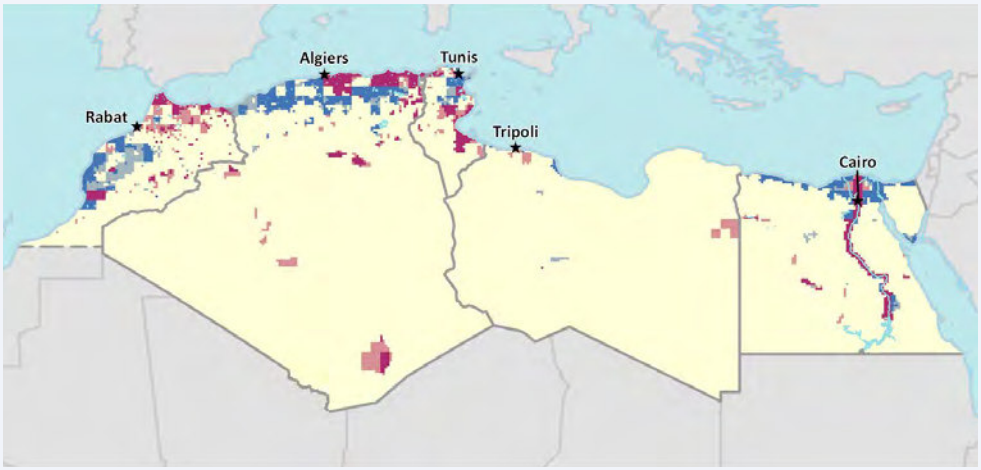


Figure 9: Projected in- and out-migration hotspots in Northern Africa, excluding Mauritania, by 2050 (Clement et al. 2021)

tion. These outflows could affect both rural areas as well as major towns, and result in migration to urban centres with better water access. As Figure 9 illustrates, coastal areas affected by rising sea levels and declining water availability, such as Alexandria, Kelibia, Oran, Agadir and Safi, could see outflows, similar to more rural inland areas with reduced water access (Clement et al. 2021). Migration is expected to largely flow towards urban areas with sufficient water availability including Cairo, and upstream along the Nile Valley and central Nile Delta, as well as Algiers, Tunis and Tripoli.

Combined with the region's high population growth, increased migration would place severe stress on resources and services in cities. In addition to water scarcity, overburdened electricity grids and insecure food provision could aggravate the tense situation in many Northern African cities. Migration will thus contribute to turning cities into climate security hotspots if the cities fail to adjust to higher demands and increase their capacities.

Migration beyond the region

Most migration in Northern Africa is cross-regional with inflows from Western, Central and Eastern Africa. Much of this migration involves short-term movements to pursue employment opportunities. In Libya, for instance, seasonal migrants from Chad, Niger and Sudan continue to arrive during the short agricultural season before returning to their countries of origin (Wenger and Abulfotuh 2019). Such seasonal migration is primarily associated with movement from areas where land is degraded and land-based livelihoods are endangered. Inhabitants of such regions where livelihoods are under pressure tend to move towards areas with more favourable conditions for pasture, agricultural production, water resources and employment opportunities, resulting in rural-rural, urban-rural and circular in-migration (Rusca et al. 2023). Such labour migration can serve as a well-established risk diversification strategy that is economically beneficial for both regions (Läderach et al. 2022).

Despite the risks and costs, migration pressure continues to push the population northwards. Currently, there are an estimated 3.2 million international migrants in Northern Africa (UN DESA 2020). According to the World Bank, climate induced migration from Eastern, Central and Western Africa could increase to 86 million by 2050 (Clement et al. 2021).

As irregular migration flows increase, so does pressure on migration routes. Initially, during the vacuum that followed the Libyan revolution in 2011, Libya became the main conduit of irregular migration to Europe. Entrepreneurial armed groups and criminal networks became increasingly adept at charging fees to the extent that profits from human smuggling were estimated to be as much as USD 978 million in 2016 (Eaton and Tim 2018). The dramatic rise in seaborn migration and the high number of deaths, however, caused Italy and the European Union to establish agreements with the Libyan government and local actors, many of whom had profited from smuggling, to reduce the number. As a result, arrivals from the central Mediterranean route, which includes Tunisia, Libya and Egypt, reduced from 119,369 in 2017 to 2,779 in 2019 (IOM 2021c). As migration flows follow the path of least resistance, restrictions in Libya pushed migration to the western corridor, with the number of irregular migrants crossing from Morocco to Spain increasing from 8,613 in 2016 to 58,525 in 2018 (IOM 2021c).

As EU policies seek to reduce irregular migration from Northern African countries, many migrants remain in transit countries, and lack integration into social and economic governance (Boubakri et al. 2021). Conflict with public authorities and local resentments can increase tensions. In addition to migration from other African regions, decreasing living conditions in Libya and Tunisia partly driven by climate change and high prices are causing an increasing number of Northern Africans to move to Europe. While previously viewed as transit countries, by 2020, the number of Tunisian, Libyan and Egyptian migrants doubled as livelihoods within these countries declined (Villa and Pavia 2023).

Migrant groups most at risk

Migratory experiences are not homogenous. Women, children and older people often face unique human security challenges. Women account for 80 per cent of people displaced by extreme weather events globally (UNDP 2016). It is estimated that around 6.3 million women and girls were internally displaced in the MENA region at the end of 2019 (IDMC 2021). Women often have unequal access to emergency relief and the disintegration of social networks undermines a critical resilience factor for women, amplifying pre-existing vulnerabilities and creating new ones (Rusca et al. 2023; Savelli et al. 2023). Despite this, there are persistent data gaps across governments and humanitarian organisations, which necessitate

capacity-building efforts to strengthen their abilities to collect, store and analyse data disaggregated by sex, age, and other social and economic factors, as well as enhance their capacity to assess small-scale displacement events (IDMC 2021).

Responses and good practices

Across Northern Africa, a number of successful responses to climate security risks are emerging. Some problems and solutions have long been identified by national and local actors, and are being implemented at various stages. Other challenges are novel and are being tackled through concentrated practises that are yet to be scaled up.

In this section, interventions are presented in three parts: (1) regional approaches, (2) national approaches and (3) local approaches.

REGIONAL APPROACHES

Interstate cooperation

Though political integration in the region has been slow, Northern African countries have found a number of ways to cooperate. This allows countries in the region to balance their strengths and weaknesses, reducing the vulnerability of those sectors most severely threatened by climate change, such as food and energy.

Northern African countries have begun preparations for what might be an eventual common electricity market. The North African Power Pool (NAPP) is one of five African power pools established in the 1970s as part of pan-African ambitions to create an integrated electricity system. The premise of the hubs is to enable countries to buy and sell electricity through interconnected grids, and leverage their comparative advantages. The central body operationalising the NAPP is the Maghreb Electricity Committee (COMELEC). Originally created in 1974 and based on the institutional framework of the Arab Maghreb Union (AMU), COMELEC brings together the various national electric companies. Membership in COMELEC was later extended to Mauritania. Although not formally a member, Egypt, which boosts a 220 kV connection to Libya, is in practice also integrated.

However, although further planning is taking place, grid connections are largely not operational at present (Hatim 2020). Morocco, Algeria and Tunisia have established multiple transmission interconnections since the 1950s (Tsebia et al. 2023). While five connecting lines between Algeria and Tunisia have been constructed, the lines connecting Algeria and Morocco are not utilised.

The potential benefits are extensive. Not only will these connections stabilise the regional grid, but – as more renewable energy projects harnessing Northern Africa's high radiant energy capacity come online – the region could potentially export electricity to Europe via Morocco and to the Middle East via Egypt. This could contribute significantly to an emerging Mediterranean electricity ring (MEDRING) or Mediterranean electricity grid (MEDGRID) (Ruggiero 2014; Medgrid 2023). The first steps towards such a pan-regional integration are underway. In December 2022, the European Union pledged a grant of about EUR 307 million for the construction of ELMED, a transmission line between Italy and Tunisia (MED-TSO 2022b). This follows the Masterplan of Mediterranean Interconnections proposed by the Association of the Mediterranean Transmission System Operators (MED-TSO), developed with EU sponsorship, to establish 19 interconnections along five corridors in the Mediterranean region (Lounnas and Messari 2018; MED-TSO 2022a).

Integration of European, Northern African and Middle Eastern grids would establish a common market for electricity. In the long term, an integrated Mediterranean grid would enable Northern African countries to capitalise on the region's abundant renewable energy potential, particularly solar power. Once they have expanded their renewable electricity production, Northern African countries could sell electricity to Europe on a larger scale, providing a secure source of revenue that would help to diversify fossil fuel-based economies (Werenfels and Westphal 2010). Consequently, ongoing efforts towards grid integration also contribute to the macro-economic stability of Northern Africa. In addition, energy partnerships between Northern Africa and the European Union could encompass renewable hydrogen exports to Europe (see National Approaches).

Managing fossil water reserves

As the fossil aquifers are largely transnational, their management requires monitoring on a regional level. International organisations such as the UN Economic and Social Commission for West Asia have played a crucial role in quantifying groundwater in Northern Africa, providing data that is essential for effective management (ESCWA 2019). Regional data on fossil aquifers can form

the basis for agreements and regulations regarding extraction, and unsustainable depletion and contamination.

Although no treaty exists regulating NWSAS water, an important step forward was taken in 2007 when the three countries came together with the support of the Sahara Sahel Observatory (OSS), the UN Environmental Programme (UNEP) and funding from the GEF. With the OSS acting as the coordination unit, the three countries established the Consultation Mechanism, which facilitates information sharing (e.g. shared databases) and common research initiatives between the countries.

Climate security networks

On the regional level, a number of non-governmental actors have facilitated knowledge gathering on climate change, peace and security. One such effort is the Climate Responses for Sustaining Peace (CRSP) initiative launched by the Egyptian COP27 presidency. The CRSP aims to facilitate knowledge sharing and capacity building within Africa, focusing on climate adaptation and peacebuilding, climate-resilient food systems, climate-induced displacement, and climate financing. The initiative has up to now focused on various activities, including capacity building. A first training session for African national officials was held in March 2023. The session aimed to enhance knowledge and understanding of how to comprehensively assess and respond to climate-induced risks to advance climate adaptation, resilience and peacebuilding in Africa. A second training session took place in September 2023. Furthermore, the CRSP co-hosted the Climate, Peace and Security Experts Academy in New York in June 2023 in collaboration with the UNDP. The academy invited government officials, including from fragile and conflict-affected countries and territories, UNDP country office staff, and experts on climate and environmental peacebuilding. In addition, the CRSP has begun the publication of research reports on the topic, including a joint report with UNDP, Re-envisioning Climate Change Adaptation Policy to Sustain Peace: A Typology and Analysis of National Adaptation Plans.

In addition, regional organisations partly or completely encompassing Northern Africa have initiated debate on climate security issues. The League of Arab States (LAS) hosts the Climate Security Initiative. Together with the Arab Water Council, the LAS also runs the Regional Climate Security Network, which aims to coordinate responses to climate security challenges and integrate a security perspective into climate action between states in the Arab region and Northern Africa (Arab Water Council 2022b). The NGO CGIAR hosts the MENA Climate Security Hub, conceptualised as a platform for convening regional expertise on climate security issues. Such regional efforts can be mobilised to close knowledge and data gaps, synergise efforts from the local to the regional level and build the capacities of key stakeholders in the region (CGIAR 2023b). Regional expert networks and platforms, whether hosted by NGOs or states, can provide technical expertise to governments and policymakers on how to integrate climate, peace and security considerations into climate, agriculture, water and energy policies, projects and interventions.

NATIONAL APPROACHES

Infrastructure and restoration projects

Northern African countries have demonstrated successful leadership with ambitious projects to restore and protect natural and man-made environments against climatic changes.

Originally conceptualised to fight desertification, Algeria's Great Green Dam was launched in 1962 and has since restored 300,000 ha of degraded forest previously threatened by the expansion of the Sahara desert (UNFCCC 2015). While the effects of climate change, in the form of higher temperatures and lower precipitation, eclipse desertification, the prevention of desertification remains a precondition for protecting arable land.

Responding more concretely to climate change challenges, Egypt is implementing an Integrated Coastal Zone Management plan, which will dredge and strengthen dikes, stabilise sand dunes with vegetation, create reed fences, and conserve marsh lands (UNDP 2023a). Such measures to protect against flooding are essential to prevent widespread displacement from populous coastal centres.

Subsidy reform

Northern African countries have begun to tackle subsidy policy reform. If conducted correctly, subsidy reform could reduce certain climate security risks and increase the resilience of Northern African populations. Though often driven by economic motivations, subsidy reform can also help to strengthen state capacity. Mauritania was prompted to reform its subsidy system by its fiscal deficit. However, this also offered an opportunity to rebalance its state budget and implement more

sustainable policies (Megersa 2020). Although often seen as helpful for the poor, subsidies are regressive. As those with higher incomes consume more, subsidies for consumption amplify inequalities. By encouraging price distortions, and opportunity for rents and smuggling, subsidies often contribute to shortages (Sovacool 2017). By replacing subsidies with more targeted social programmes, subsidy reform can improve the efficiency of government support for the most-in-need segments of the population.

The Egyptian government has begun reforming the Tamween food subsidy system, for example, by introducing a smart card for purchasing bread and other staple foods in 2015. By restricting subsidised purchases to the most-in-need segments of the population, the reform has slightly reduced the number of eligible recipients and freed up state resources. However, around 70 per cent of the population still consume subsidised bread. Replacing broad food subsidies with targeted cash transfers has been shown to significantly improve the welfare of the poorest households, assuming it does not increase state deficits to the point of stifling economic growth (Breisinger et al. 2023). Subsidy reform that does not dismantle the social safety net but rather restructures it to be more purposeful in protecting the most vulnerable can contribute to resilience.

Egypt has marginally increased the wheat flour extraction rate for its standard issue bread (SandP Global 2022). This move, intended to reduce the need for grain imports, has improved the nutritional quality of bread by moving closer to whole wheat production – tackling food dependency as well as nutritional problems.

More comprehensive subsidy reform has been undertaken in the energy sectors of some countries. In Morocco, expenditure for energy subsidies peaked at 6.6 per cent of GDP, while subsidies took up 12.5 per cent of GDP in Egypt in 2012. Both countries have since managed to reduce the overall size of their subsidy programmes (IEA 2022). Libya has reduced its subsidy spending, although it still spends a significant part of the state budget on subsidies (IEA 2022). Algeria, by contrast, has not yet reduced its energy subsidies. Tunisia announced subsidy reforms during IMF negotiations in 2022 (World Bank 2023h). However, these commitments have not yet been enacted, with its energy minister having been dismissed.

In 2022, Egypt spent around USD 3 billion on subsidies, with energy subsidies still not entirely eliminated in spite of previous commitments. However, Egypt has managed to reduce fossil fuel subsidy expenditure through a concerted policy effort since 2013 (WRI 2021). This phase out is increasing the price of fossil fuels, such as petrol, and is thereby discouraging wasteful and emissions-intensive behaviours. Morocco began a systematic reform process to dismantle the subsidy regime in 2012. By 2021, all energy subsidies had been removed except those on liquefied petroleum gas (typically butane gas used for cooking and heating). In 2013, a new pricing system, which was sensitive to global price changes, was introduced. This soon succeeded in significantly reducing the GDP share of subsidies (Auktor and Loewe 2022). Morocco's remaining subsidy for gas, however, resulted in record deficits for the state budget as global gas prices increased, exposing the continued macroeconomic risk of subsidies (Rahhou 2023).

Both Morocco and Egypt succeeded in at least partially reducing socially regressive and unsustainable subsidies in a way that addresses the social dimension of climate security risks. The Moroccan subsidy reform was particularly successful because it was accompanied by a comprehensive information campaign, as well as distributional and welfare policies, which ensured that poorer segments of the population were protected from cost of living increases (Verme and El-Massnaoui 2017; Innovation for Sustainable Development Network 2019). In Egypt, likewise, public discontent was muted by social benefits financed by increased taxation on the wealthy and business. However, discontent about energy subsidy reforms in Egypt was pacified by doubling-down on and increasing food subsidies (WRI 2021).

Green transition

To satisfy Northern Africa's ever-increasing demand for electricity, additional power will need to be brought on grid in a manner that is compatible with the current re-orientation to renewables. Regional investments in renewable energy are highest in Morocco and Egypt, the latter of which (excluding hydropower) increased by 560 per cent between 2010 and 2020 (IEA 2020b). This impressive result was made possible by creating a positive investment environment, which included reforming subsidy regimes. Here, Egypt was particularly effective. The result of these reforms cannot be understated. National expenditures on fuel subsidies, which consumed some USD 21 billion in

2013, dropped from 9.2 per cent of GDP to 2.2 per cent in the first year to 0.3 per cent by 2020. Over the next five years, Egypt will add 25.5 GW of new power, including 1 GW of photovoltaic and 840 GW of wind capacity (IEA 2020a). Larger infrastructure projects are being introduced, including the 1.8 GW Benban Solar Photovoltaic Park, which will be one of the largest in the world. This will allow Egypt to save revenue, while simultaneously shifting from an electricity deficit to a surplus. The country's long-term real GDP growth prospects have also improved significantly. Egypt now has a real prospect of achieving its national objective of sourcing 42 per cent of its electricity mix from renewables by 2035 (IRENA 2018).

Northern African countries have attracted international investments to boost their renewable capacity. For example, the Nexus on Water, Food and Energy is a partnership between Egypt, and the European Bank for Reconstruction and Development. As part of its energy pillar, the project received financial support from the U.S., Germany and a number of other partners, among others, to retire 5 GW of fossil fuel capacity by 2025, and to invest in at least 10 GW of solar and wind energy by 2028 in a just transition. Furthermore, the first EU-Northern African agreements have been concluded. Among other things, Egypt has signed a memorandum of understanding with the European Union to promote renewable hydrogen production (European Commission 2022). This partnership could see European investments enhance Egyptian production capacity, facilitating exports to the European Union, bolstering renewable energy generation in Egypt and strengthening Egypt's economy. The partnership serves as a model for the larger EU-Mediterranean Renewable Hydrogen Partnership, which will encompass Northern African countries. Multiple European countries are planning to partner with Northern African countries on a pipeline project to export hydrogen, termed SoutH2 Corridor (Ivanova 2023).

LOCAL APPROACHES

Adopting sustainability

Beyond broad policy changes, increasing resilience to climate security risks takes place locally. Northern African countries have begun adopting numerous projects at various scales to improve sustainability and address climate security risks.

Such projects can simply be dedicated to producing green energy locally, such as the planned project to install floating solar panels over Lake Nasser (Elshafei et al. 2021). Floating solar panels over Egypt's largest standing body of water would provide a local source of green electricity bolstering the national grid. Moreover, the solar panels would significantly reduce water evaporation from the lake, partly remedying lower inflows into the Nile River. Other local green electricity projects are found throughout the region, such as the GIZ-supported Green Municipalities project in Algeria (Communes Vertes 2020). Installing local solar panels eases the nationwide green transition and increases local resilience to potential blackouts.

Local sustainability efforts are even more tangible when addressing water scarcity, as this is a more localised phenomenon. In Libya, the IOM implemented its community stabilisation programme Together We Build with funding from the European Union in 2017. The project's aim was to engage community representatives in rehabilitating neighbourhood water wells in the city of Sabha (Gatenby 2017; IOM 2017). The programme represents a successful local-level intervention for sustaining access to water for households. By involving local stakeholders in the decision-making process, the programme strengthened water's status as a shared public good, while also diversifying local water supplies and preventing water scarcity.

Amplifying marginal voices

One of the most impactful means for local and community groups to address climate security threats is to influence national and regional policies through advocacy and participation. Platforms that provide a space for local knowledge and citizen science enable those most directly affected by the consequences of climate change and exposed to the security threats of these developments to contribute often highly valuable input for achieving sustainable and secure adaptation. Civil society organisations such as the Global Network of Civil Society Organisations for Disaster Risk Reduction (GNDR) have facilitated the sharing of information among various civil society actors in Northern Africa through reports such as Views from the Frontline (GNDR 2023). The North African Network for Food Sovereignty advocates for more local autonomy and the provision of resources to engage in farming in the region (Open Democracy 2020). Furthermore, a number of other organisations with a focus on the MENA region, such as the Arab Network for Food Sovereignty, integrate Northern African participation (APN 2023).

Initiatives targeted specifically at vulnerable groups, including women and young people, amplify the voices of groups who need greater representation. For example, a first youth dialogue entitled Empowering African Youth Voices for a Peaceful and Climate-Resilient Future was hosted by the Aswan Forum for Sustainable Peace and Development in 2022. The dialogue gathered recommendations about how to advance integrated climate change and security responses. The outcomes of the dialogue were presented at COP27 (Aswan Forum 2022). Such alternative voices not only highlight differentiated risks that are insufficiently addressed, but also provide positive impulses for solutions through entrepreneurship, innovation and technology. Accounting for specific needs and vulnerabilities across different demographics and localities builds resilience at all levels.

Transboundary waters: surging competition

Many of Africa's largest freshwater basins span several countries. Since pre-history, these basins have been a vital source of water for communities and civilisations across the continent. More recently, these basins have seen the development of major infrastructure projects, some of which have become points of contention between riparian countries, as the projects affect upstream and downstream water access and availability.

Adding to these pressures are various socioeconomic and environmental factors. Economic and population growth are fuelling demand for food, water and energy in and around Africa's major water basins. Climate change, through its impacts on rainfall and interannual variability in river flow, will likely put additional pressure on transboundary water resources and could further increase competition (Siam and Eltahir 2017; Roth et al. 2018). These pressures are particularly urgent as the majority of transboundary water resources in Africa – 65 per cent of all transboundary river basins and more than 90 per cent of all transboundary aquifers – are not regulated by any transboundary agreement (African Development Bank 2022).

Political tensions and competition

Political tensions and conflicts over transboundary waters have history in Africa. For example, the construction of two major dams on the Senegal and Bafing rivers, in response to severe droughts in the 1970s, altered the rivers' hydrology and disrupted local production systems. Consequently, these changes sparked land tenure disputes between ethnic groups and elites along the Mauritanian-Senegalese border, as well as violent conflicts between farmers and herders. These incidences resulted in thousands of people being killed or displaced, and led to Mauritania and Senegal breaking diplomatic ties, which nearly resulted in war between the countries (DeGeorges and Reilly 2006; Salmone 2010).

Today, competition and tensions are rising over many transboundary waters. A particularly contentious issue has been Ethiopia's Grand Ethiopian Renaissance Dam (GERD) in the eastern Nile Basin. Construction of the GERD began in 2011, but has since been marred in disputes. For Ethiopia, the GERD represents an important source of hydropower for economic development and poverty eradication. For Egypt, the GERD's operations could threaten the country's water security, particularly as Egypt grapples with worsening water scarcity as a result of increasing salinisation in the Nile Delta and growing irrigation demands. As the third riparian of the Nile Basin, Sudan's stance has alternated between supporting upstream Ethiopia and downstream Egypt (Climate Diplomacy n.d.e, n.d.f).

Disputes can also be seen over other freshwater bodies, such as Lake Turkana and Lake Victoria. Competition over natural resources in the basins, including water and fish stocks, have led to cross-border communal clashes and, in the case of Lake Victoria, armed conflict (Le Ster 2011; Glaser et al. 2019). The impacts of climate change are affecting access to and the availability of lake resources, as well as pushing people to extend fisheries activities deeper into lakes and potentially across borders, potentially intensifying competition and political tensions in the region.

Multilateral efforts to address transboundary water competition

At the same time, riparian countries across Africa have taken steps to strengthen cooperation and mutual capacities on transboundary water management.

The Nile has long been the subject of diplomatic negotiations. **The Nile Basin Cooperative Framework Agreement (CFA)** has been under negotiation since 1995, but was delayed by disagreements about whether to recognise older water-sharing agreements (African Development Bank 2022). When a treaty was finally presented in 2010, only three countries ratified it, with Egypt and Sudan choosing not to. In parallel, the **Nile Basin Initiative (NBI)** was established in 1999 and consists of 10 member states that share the Nile Basin. The NBI provides an important platform to strengthen development and water resource cooperation between riparian countries. Furthermore, the NBI has signed multiple memorandums of understanding with other regional organisations, including the Lake Victoria Basin Commission (LVBC) and IGAD, which provide

vertical linkages to broader political forums to support sustainable and cooperative water governance (NBI 2020). However, the NBI has had limited success in addressing tensions and disagreements over transboundary water development in the Nile Basin. Attempts to establish a permanent Nile Basin Commission have been held back by opposition to the CFA by several member states, and the inability of member states to resolve ongoing political and legal disputes Krampe et al. 2020). A trilateral treaty between Egypt, Sudan and Ethiopia, the Agreement of Declaration of Principles (DOP), was signed in 2015 to address political tensions around the GERD construction (Agreement of Declaration of Principles 2015). However, the DOP requires further negotiations about the operation of the GERD, which have not yet yielded agreement.

Transboundary resource management is vital for climate security, with water management being an essential aspect. The Lake Chad Basin Commission (LCBC), established in 1964, is the oldest African transboundary water management commission and promotes sustainable water resource management and conflict resolution in the basin. The LCBC also created the Multi-National Joint Task Force, composed of troops in Benin, Cameroon, Chad, Niger and Nigeria, to address crime and violence, including extremist groups like Boko Haram. Security coordination includes harmonising border control measures and exchanging defence information. Meanwhile, the Authority of the Niger Basin (ANB) promotes integrated development in various fields, such as energy, agriculture, fishing, forestry industry and fluvial navigation.

Meanwhile, the **Senegal River Basin Development Organisation (OMVS)** tackles hydropower, fluvial navigation, sustainable and concerted use of water, and livelihoods in the Senegal River Basin. The OMVS was established by Mali, Mauritania and Senegal in 1972 to support food security, strengthen economic resilience to extreme weather, accelerate economic growth, and preserve ecosystems and local livelihoods (Ndiaye n.d.). The OMVS is recognised as an exemplary model of integrating divergent water needs into projects that would not have been feasible for any single member state (OiEau 2010; Bruckmann 2021). Thanks to a robust financial and legal framework, the OMVS has been able to co-plan and manage infrastructure (World Bank 2021g). These installations are key to the region's water and energy security, supplying 60 per cent of drinkable water in Dakar, and 100 per cent in Nouakchott and Saint Louis, as well as 800 GWh per year of electricity (Komara 2014). The OMVS integrated Guinea in 2006 (Ndiaye n.d.). Initially focused on economic development, the OMVS is increasingly shifting to climate change adaptation and participation to address local conflicts (Bruckmann 2021). Consequently, the OMVS is becoming more responsive to civil society organisations, which are now included in monitoring and mitigating the environmental impact of the OMVS (Ndiaye n.d; Grain de Sel 2005).

In addition, there have been **advancements in the management of aquifers in Southern Africa and Northern Africa.** This includes the management of groundwater and surface water within Southern Africa's shared watercourse systems, which is governed by agreements signed in 2000. There is also the SADC's Regional Strategic Action Plans for Integrated Water Resource Management (IWRM), which promotes sustainable groundwater management (UN Water 2021). In Northern Africa, the agreement of the Joint Authority for the Study and Development of the Nubian Sandstone Aquifer System (NSAS) is supported by Egypt, Libya, Sudan and Chad. While the agreement does not regulate water management, subsequent agreements defined monitoring and data-sharing guidelines. The UN-supported Regional Action Programme for the Integrated NSAS Management led to the signing of the Regional Strategic Action Plan for the Nubian Sandstone Aquifer System in 2013 (African Development Bank 2022). The NWSAS is governed by the trilateral Mécanisme de concertation for management and study, and is supported by steering and scientific institutions in each of Algeria, Libya and Tunisia (African Development Bank 2022). However, while transboundary agreements for the region's most important aquifers exist, these agreements do not always translate into effective action for sustainable water use.

14 Member states include Burundi, the DRC, Egypt, Ethiopia, Kenya, Rwanda, South Sudan, Sudan, Tanzania and Uganda, with Eritrea as an observer.

15 For more information, refer to the Southern Africa chapter section on responses and good practices.

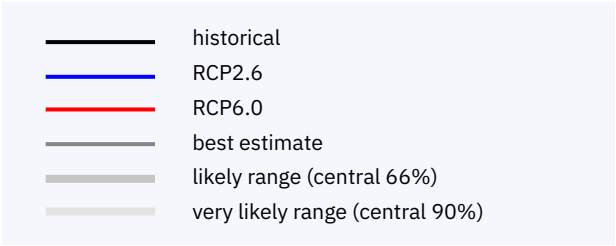
Annex

How to read the plots

The maps and plots included in this report provide an overview of projected climate change parameters and related sector-specific impacts in African regions until 2080 under two different climate change scenarios (RCPs). RCP2.6 represents a low emissions scenario that aims to keep global warming below 2°C above pre-industrial temperatures, while RCP6.0 represents a medium-to-high emissions scenario. Projections are provided up to 2080, with each year showing the mean value of a 31-year period.[65]

The **line plots** show climate impact projections averaged over the whole country, with the blue colour representing the RCP2.6 scenario and the red colour representing the RCP6.0 scenario. While the lines depict the best estimate (representing the multi-model median of 10 climate models), the shaded areas represent the likely range (strongly shaded area) and the very likely range (lightly shaded area), indicating the range of model agreement of at least 66 per cent and 90 per cent of all model projections, respectively.

How to read the plots



The **map plots** display regionally explicit climate information under RCP2.6 and RCP6.0, in a spatial resolution of approximately 50 x 50 km. While the leftmost column represents the baseline period as found in the model data, the other three columns represent future projections in comparison to that baseline period. The colour values depict the multi-model median of the underlying models at each grid cell. The presence of a dot means that at least 75 per cent of the models agree on the sign of change depicted for the specific grid cell and scenario (i.e. whether an increase or a decrease can be expected). Conversely, the absence of a dot represents the lack of model agreement on the predicted change.

UNCERTAINTIES IN CLIMATE CHANGE PROJECTIONS

It is important to acknowledge that uncertainties are always part of climate change projections. Uncertainties arise from a variety of factors, including natural variabilities, uncertainties in GHG emissions scenarios and differences in the models use. Consequently, no future (climate change) projection comes without some level of uncertainty. The levels of (un)certainties, however, differ. We present the results of 10 different global models. To indicate the (un)certainty of the projections, we consider model agreement. The more these models agree the higher the certainty, the more they disagree the lower the certainty. For example, if different models project a similar result under the same scenario, the projected changes demonstrate low levels of uncertainty. However, if the models project very different changes (in terms of range and even direction) under the same scenario, then the projections are uncertain.

Line plots and map plots depict uncertainty differently and cannot be compared. The line plots indicate the level of certainty through the shaded areas, depicting the likely (central 66 per cent) and very likely (central 90 per cent) range of all model projections. Generally, the smaller the shaded areas, the more certain the projections. The map plots depict the level of certainty through the presence or absence of dots. If dots are present, at least 75 per cent of all models agree on the direction of change or, in other words, on an increasing or a decreasing trend. If the dots are absent in a specific region or scenario, then model agreement within this specific region and scenario is below 75 per cent.

To simplify the interpretation of the projections, all line plots and map plots that are subject to high levels of uncertainty are marked with a symbol ( ).

This does not imply that these plots have no informational value, but rather draws attention to the limitations of such projections for future planning. Consequently, they should be very carefully interpreted when they are used for planning measures. In the case of high uncertainty, additional information will be provided on how to interpret the data.

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