EUROPEAN UNION
Institute for Security Studies

ARAB CLIMATE FUTURES

Of risk and readiness

By
Florence Gaub and Clémentine Lienard

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October 2021

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The EUISS Chaillot Paper series

The *Chaillot Paper* series, launched in 1991, takes its name from the Chaillot hill in the Trocadéro area of Paris, where the Institute's first premises were located in the building occupied by the Western European Union (WEU). The hill is particularly known for the Palais de Chaillot which was the site of the signing of the UN Universal Declaration of Human Rights in 1948, and housed NATO's provisional headquarters from 1952 until 1959.

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EXECUTIVE SUMMARY

Although the Middle East and North Africa has contributed only 3 % of total global CO_2 emissions since 1850, it will be one of the world regions hit the hardest by climate change. Unless a technological breakthrough occurs quickly that will make it possible to capture the carbon already present in the atmosphere in a safely managed and cost-effective way, temperatures in the region are certain to increase by around 2 °C between 2021 and 2039, with a possible maximum increase of 2.5 °C during summer and autumn. This means that climate change will affect the region severely *even if* emissions are cut according to the Paris Agreement.

As temperatures increase, water evaporates: it is sucked up by the air. Water is therefore the first victim of climate change. All other first order effects of climate change in the region are more or less the consequence of what climate change does to water. In the Arab world, water is already a rare commodity even without climate change. Water stress is a common problem: a study has shown that in 2019, 13 of the world's 20 most water-stressed countries were located here. Climate change alone is not to blame: water mismanagement, too, plays a role, as well as demographic growth. Algeria, Iraq, Morocco and Tunisia, for instance, will be impacted by water shortage *regardless of the scenario.* The region is already highly dependent on food imports, and will struggle even more to meet its food needs as agricultural output will decrease as a result of water shortages. 8 % of total Iraqi, Lebanese and Syrian arable land, for instance, will be lost. Looking further into the future, disasters such as floods caused by rising sea levels will also affect the region. As populations continue to grow and move into cities, meeting these challenges will become even more difficult: cities in the region are not climate-proof, with proliferating slums, poor public transport systems and inadequate resilience to extreme weather events.

But climate change is not an inescapable fate, and how the phenomenon plays out will depend on decisions taken both in the region and outside. Already, some states are displaying growing awareness of the dangers lying in store, and citizens are beginning to put pressure on governments to address issues such as water shortages and waste. The potential of renewable energy is as untapped as it is great. This means that it is not too late to avert the risks that climate change will bring.

According to a comprehensive quantitative climate change risk index developed by the authors of this *Chaillot Paper*, not all Arab states are in the same boat: some states, such as those in the Gulf, have the necessary resources to adapt to climate change and mitigate its effects, while others, such as Jordan or Morocco, have the necessary awareness and expertise. The worst placed, unfortunately, are those states that are currently experiencing conflict: Iraq, Libya, Syria and Yemen will be hit the hardest by both direct and indirect effects of climate change.

Assisting the Arab world in meeting the challenges posed by climate change will be a matter of strategic importance for Europe: not only because unmanaged risks will produce violent conflict and waves of migration, but also because other states, such as China or Russia, are beginning to exploit the vulnerabilities of the region for geopolitical purposes.

INTRODUCTION

Climate change in the Middle East and North Africa (MENA) is a story of injustice and paradox. Injustice because while the region has contributed a mere 3 % of total global CO_2 emissions since 1850 [(1)], it will be hit extraordinarily hard by its effects. This is because it is already a dry and hot region, with 82.5 % of its terrain covered in desert. But there is a paradox, too: although the International Panel on Climate Change (IPCC) noted as early as 1992 that Western Arabia and the Maghreb were two of the five world regions 'most vulnerable to the effects of climate change' and at 'greatest risk in terms of serious threats to sustaining the population' [(2)], public awareness and policy responses have been even slower to emerge than elsewhere [(3)].

There are several reasons for this. The IPCC's follow-up reports looking at regional effects came to confusing conclusions which had the effect of diluting the alarming message. In 1997, it noted that in the Arab world the effects of climate change were either positive, negative or unknown. Deserts would remain deserts, unspecified 'changes' were expected in the grasslands, and there would be *more* rain - a message that sounds positive in a dry region when, in reality, it meant exceedingly heavy rainfall. There was no mention of droughts. Instead, the IPCC noted some positive possibilities: with improved measures plant productivity, water use and land management could actually be enhanced. It added: 'native plants and animals are adapted to coping with sequences of extreme climatic conditions. In many of these ecological systems, the initial climatic changes are *unlikely* to create conditions significantly outside the present range of variation [(4)].' It concluded optimistically that: 'Win-win opportunities exist which offer the potential to reduce current pressures on resources and human welfare in the region.' Given the mixed messages and a certain element of ambivalence, this assessment was not read as a cry of alarm.

In defence of the IPCC, this was because the climate remains a highly complex system that is difficult to model - as attested by the vagaries of weather forecasting with which we are all too familiar. Levels of knowledge or computational capacity were not what they are today, and in the absence of historical precedent, scientific statements on climate have by default a speculative dimension abhorred by scientists. Only in 2001 did the IPCC state that it was 67 – 90 % 'likely' that 'half of the world's temperatures increase' was caused by humans. The fact that the Arab world is treated as the separate *geographic* entities of West Asia and North Africa (which it is) rather than as one *political* space (which it is, too) [(5)] also meant that a shared regional understanding of what climate change would mean took longer to develop.

(1) Data calculated by the authors on the basis of World Bank data and data from Our World in Data.

(2) IPCC, *Climate Change: the IPCC 1990 and 1992 assessments*, World Meteorological Organisation, United Nations Environment Programme, 1992, p.93, p.100 (https://www.ipcc.ch/site/assets/uploads/2018/05/ipcc_90_92_assessments_far_full_report.pdf); Watson R.T., Zinyowera M.C., and Moss R.H. (eds), *The Regional Impacts of Climate Change: An assessment of vulnerability*, IPCC, Cambridge University Press, Cambridge, 1997, p.51 (https://archive.ipcc.ch/ipccreports/sres/regional/index.php?idp=0)

(3) World Bank, Climate Change Knowledge Portal, data on average temperatures in the Middle East and North Africa for the period 1901-2016, 2021; Karami N., 'The modality of climate change in the Middle East: drought or drying up?', *The Journal of Interrupted Studies*, Vol. 2, No 1, 2019, pp.118-140.

(4) *The Regional Impacts of Climate Change*, op.cit.

(5) The Arab world consists of the member states of the League of Arab States (LAS) which comprises 22 Arab states, 10 of which are located in North Africa and 12 in West Asia.

Matters were not helped by the fact that the environment ranked even lower than elsewhere on regional policy agendas: although entities in charge of the environment began to emerge in the late 1970s, they were often attached to the ministries of interior, education, agriculture, water or local administration because they were not seen as having critical importance, and were not supported by a grassroots citizen movement.

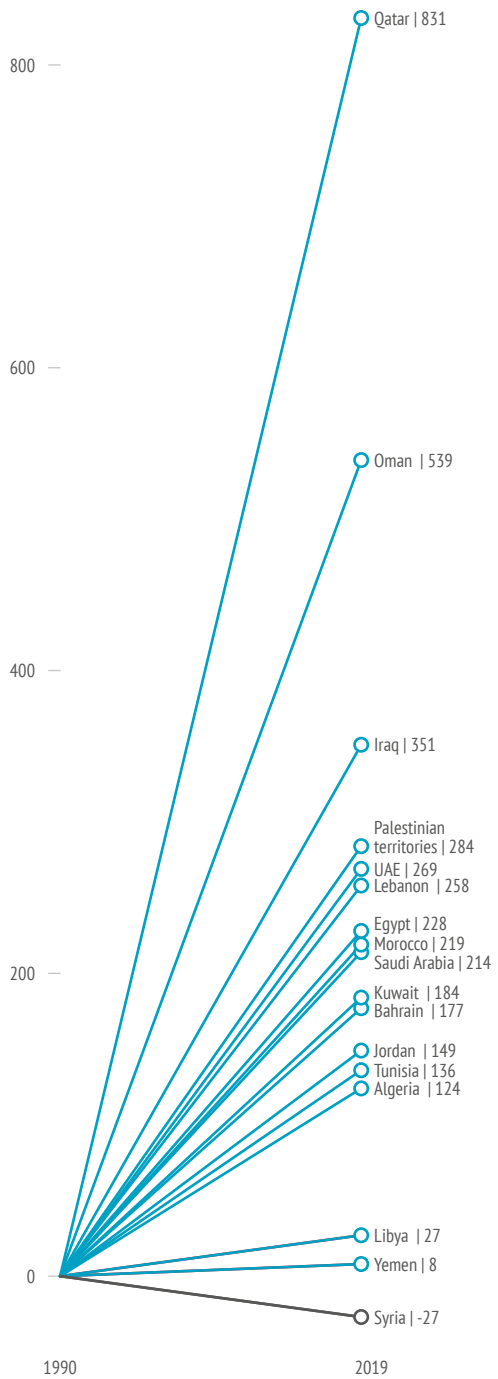
While European states began to curb emissions from 1990 onwards, the region did the opposite: since the 1992 report warning of climate change, it has increased its CO_2 emissions by more than double, approaching European Union levels. (6)

Things have changed rather dramatically since then. The IPCC's calculations have improved in accuracy and specificity thanks to larger datasets and other advances, making its predictions 5 to 20 times more precise than the first climate models. Now, it can make regional assessments with a precision calibrated at 25 to 50 km as opposed to 500 km in 1990 (7).

The Arab Spring, too, indirectly pushed climate change to the top of the agenda as the link between environmental degradation and social and political unrest was undeniable: in the five years prior to the 2011 uprisings, the region experienced one of its most severe drought cycles in 100 years, directly leading to loss of livelihood, high food prices and internal displacement. The most severely affected country was Syria, where 20 % of the population lost their source of income, and which was subsequently engulfed in the bloodiest civil war the region had seen since the end of World War II. At the same time, floods in Australia, and droughts in China, Russia and Ukraine pushed up the global wheat price, exposing Arab state food import dependency

Arab emissions levels

Annual CO_2 emissions, 1990 vs 2019, %-point change



Data: Global Carbon Project, Global Carbon Budget, 2020

(6) World Bank data, 'CO_2 emissions (kt) - Middle East & North Africa, European Union' (https://data.worldbank.org/indicator/EN.ATM.CO2E.KT?locations=ZQ-EU).

(7) Masson-Delmotte, V., P. Zhai, A. Pirani, et al. (eds), *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, IPCC, Cambridge University Press, in Press, 2021 (https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf).

and feeding into public unrest over the sudden doubling of the cost of bread.

The Arab Spring therefore confirmed an idea that had emerged from 2007 onwards: that climate change was a 'threat multiplier' (a term coined at the time in a publication by the American Center for Naval Analyses [8]) because its knock-on effects on human health and welfare in terms of agriculture, water availability and disasters, would in turn have effects on political stability and security.

The fact that climate change is now becoming visible – since 2015 the planet is 1 °C hotter than it was 100 years ago [9] – adds an emerging sense of regional urgency. Nearly half of the population in the region, or 40 %, have experienced drought or other climatic disasters [10]. Iraq and Saudi Arabia experience earlier, more frequent and longer heatwaves [11]. In 2020, flash floods occurred in Lebanon and Sudan, while heatwaves and fires hit Lebanon, Jordan, Syria and Iraq. In 2021, the entire region between Iran and the Middle East was hit by a record-breaking heatwave with temperatures reaching nearly 50 ° C – almost seven degrees hotter than is normal for this region at this time of the year. Wildfires – caused by a combination of high temperatures and strong winds - killed 65 people in Algeria [12].

Climate change still ranks below the many other issues the region is grappling with, particularly economic and security issues.

At the same time, climate change is also beginning to affect the energy sector. Because fossil fuels and industry are chief culprits in the emission of CO_2 (contributing 89 % in 2018), a large majority of importing states, especially in Europe, are accelerating their transition to alternative energy sources. The European Union's 2019 Green Deal, for instance, foresees a reduction in oil imports by up to 25 % by 2030, and by 79 % in 2050 compared to 2015 [13]. This will particularly affect Libya, which exports 63 % of its fossil fuel to Europe, but also Algeria (60 %) and Egypt (45 %). It is worth noting that while China is planning to be carbon-neutral by 2060, coal will be more affected in the medium-term than oil, meaning that Saudi Arabia (60 % of whose exports go to China) and Iraq (25 %) face no immediate problem in this regard [14]. In the best-case scenario, whereby global temperatures stay at 1.5 ° C, by 2035 20 % of global energy needs will be met by renewable energy, and 20 % of all kilometres travelled by cars, trucks, buses or bikes will be with vehicles powered by electricity rather than petrol or diesel. By 2050, this would increase to 90 % of energy needs being met by renewables and all vehicles being electric [15]. This means that energy exporters in the region will have to significantly shift their economic model within the coming years or face dire budgetary shortfalls.

(8) Center for Naval Analyses, *National Security and the Threat of Climate Change*, Alexandria, VA, United States, 2007 (https://www.cna.org/cna_files/pdf/national%20security%20and%20the%20threat%20of%20climate%20change.pdf).

(9) *Climate Change 2021: The Physical Science Basis – Contribution of Working Group I to the Sixth Assessment Report of the IPCC*, op.cit.

(10) UNDP, *Climate Change Adaptation in the Arab States – Best practices and lessons learned*, Bangkok, 2018 (https://www.undp.org/publications/climate-change-adaptation-arab-states).

(11) Alghamdi, A.S.A., 'Climatology of warm season heat waves in Saudi Arabia: a time-sensitive approach', PhD Dissertation, Kansas State University, 2018 (https://krex.k-state.edu/dspace/handle/2097/39035).

(12) Al-Monitor, 'Fires in northern Lebanon caused by high temperatures, winds', 20 August 2021 (https://www.al-monitor.com/originals/2021/08/fires-northern-lebanon-caused-high-temperatures-winds).

(13) Leonard, M., Pisani-Ferry, J., Shapiro, J., Tagliapietra, S., and Wolff, G., 'The geopolitics of the European Green Deal', *Policy Brief*, European Council on Foreign Relations, 3 February 2021 (https://ecfr.eu/publication/the-geopolitics-of-the-european-green-deal/).

(14) The Oxford Institute for Energy Studies, 'Unpacking China's 2060 carbon neutrality pledge', December 2020 (https://www.oxfordenergy.org/wpcms/wp-content/uploads/2020/12/Unpacking-Chinas-carbon-neutrality-pledge.pdf).

(15) International Renewable Energy Agency (IRENA), *World Energy Transitions Outlook – 1.5° C pathway*, Abu Dhabi, June 2021, p.25 (https://www.irena.org/publications/2021/Jun/World-Energy-Transitions-Outlook).

Taken together, these developments have contributed to a growing insight that climate change is not 'just' an environmental affair. It is a matter of economics, energy, security, stability, human welfare and geopolitics. Perhaps because of this, timid signs of change are beginning to show in the region – but climate change still ranks below the many other issues the region is grappling with, particularly economic and security issues.

The problem is therefore not just lack of awareness: it is a matter of prioritisation. Climate change, which appears to be a far-future problem, is in competition with pressing problems of the present. Its abstract and distant nature contributes to it still being relegated to a secondary priority behind solving issues such as violent conflict, youth unemployment, and regional tensions. But what makes climate change a formidable foresight problem is not just the perceived remoteness of its impacts: it is the fact that it interacts with several other complex trends with which the region wrestles. This complexity, together with uncertainties, scattered pockets of knowledge across different disciplines, and the wide range of choices, make it difficult to discern what lies in store for the region – and what the most pressing policy priorities are.

The European Union recognised this complexity early on: back in 2008, the EU Secretary General/High Representative Javier Solana published a paper identifying the 'threat multiplier' effects of climate change in relation to global security [(16)]. More recently, the EU's 2016 Global Strategy featured 26 references to climate change, and in its 2020 Climate Change and Defence Roadmap it recognised the 'need to have an accurate understanding of the security implications of climate change' and stressed the importance of efforts 'to increase understanding of the various impacts of climate change and environmental degradation on the defence sector' [(17)]. This *Chaillot Paper* is a contribution to this endeavour. It seeks not just to answer the question of the environmental effects of climate change on the region, but how these will interact with other human trends that will unfold at the same time, how this will help or hinder mitigation and adaptation measures – and how all of these together will affect stability and security.

The structure of this paper follows classical risk assessment patterns: in chapter one we look at the first order effects of climate change increasing risk exposure. In chapter two we look at those human trends that have the potential to increase risk further. In chapter three we assess the trends that could mitigate risk exposure. In the fourth chapter we combine these different trends in an index allowing for a nuanced understanding of levels of vulnerability, preparedness and mitigation potential classified by country. Lastly, we conclude with policy considerations for both the EU and its Member States, as well as actors in the region.

As always, this paper is a team effort: we thank Gearóid Cronin for his thorough editing, Christian Dietrich for producing visuals that make complex data understandable, and Daniel Fiott and Yana Popkostova for their collegial and valuable input that enhanced the quality of this paper.

(16) SG/HR Javier Solana and the European Commission, 'Climate Change and International Security', Paper from the High Representative and the European Commission to the European Council, S113/08, March 2008 (https://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/reports/99387.pdf).

(17) Council of the European Union, 'Climate Change and Defence Roadmap', EEAS(2020)1251, 9 November 2020 (https://data.consilium.europa.eu/doc/document/ST-12741-2020-INIT/en/pdf).

CHAPTER 1

FUTURE CLIMATE FACTS

What we know so far

A large part – indeed, the scariest part – of climate change is set in the future, even though we are beginning to get glimpses of what it could look like on an almost monthly basis. Because the future is the result of our choices, but also of complex interplays that are not necessarily foreseeable in advance, it is by definition impossible to make definitive statements about it. This is where foresight comes into play: it narrows down the scope of possibilities and identifies where the knowledge gaps are. It is for this reason that the IPCC offers broadly four possible scenarios, known as Representative Concentration Pathways (RCPs) [(1)]. Depending on the scenario, the IPCC calculates different temperature increases for the Middle East and North Africa.

The bad news first: unless a technological breakthrough occurs quickly that would make it possible to capture the carbon already in the atmosphere in a safely managed way and at reduced cost, the region is certain to experience a temperature increase of around 2 °C between 2021 and 2039, with a possible maximum increase of 2.5 °C during summer and autumn. [(2)]

(1) Le Treut, H., Somerville, U., Cubasch, Y. et al.., 'Historical Overview of Climate Change', in Solomon, S., Qin D., Manning, M. et al., (eds.), *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, IPCC, Cambridge University Press, Cambridge and New York, 2007 (https://www.ipcc.ch/site/assets/uploads/2018/03/ar4-wg1-chapter1.pdf).

(2) Varela, R., Rodríguez-Díaz, L. and de Castro, M., 'Persistent heat waves projected for Middle East and North Africa by the end of the 21st century', *Plos One*, 2020 (https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0242477).

What does RCP mean?

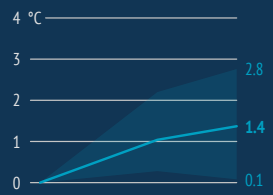
Four pathways for a future climate

What does RCP mean? The Intergovernmental Panel on Climate Change (IPCC) is a United Nations body which evaluates scientific research outputs on climate change, its implications and risks.

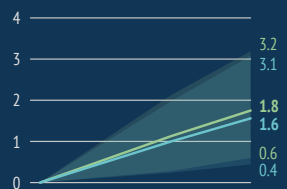
The IPCC uses four climate projection scenarios, called Representative Concentration Pathways (RCPs), which map different greenhouse gas emission trajectories and levels of CO2 concentration in the atmosphere, and how they are likely to evolve over time (up to the horizon of 2100).

Four scenarios were selected by the IPCC:

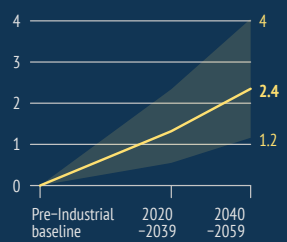
RCP 2.6 is the **BEST-CASE SCENARIO**. Considerable efforts are made to contain gas emissions and climate change impacts are significantly mitigated. In 2100, the overall temperature will have increased by 1 °C.



RCP 4.5 and **RCP 6.0** are the **'NOT ENOUGH' SCENARIOS**. Moderate efforts are made to curb carbon emissions, resulting in a temperature increase of between 1.8 °C and 2.2 °C by the end of the century.



RCP 8.5 is the **BUSINESS-AS-USUAL** or **WORST CASE SCENARIO**. Insufficient efforts are made to curb gas emissions, and an increase in the global temperature of more than 3.5 °C is to be expected by the end of the century, with a corresponding rise in extreme weather events.



Data: World Bank, 2021; IPCC, 2018; CoastAdapt, 2017

This means that climate change will affect the region severely even if emissions are cut according to the Paris Agreement.

This is because we will feel the effects of emission cuts only with some delay, from 2039 onwards. Beyond this date, the region's fate depends on global policy choices to be made now, and temperatures could increase between 2° C and 4 °C by 2059 (see diagram on opposite page) [(3)]. In the latter case, the number of hot days, meaning days with a temperature above 35 °C, will pass from 14 days today to 23 days per year. Days with a temperature of above 35 °C would not only occur during summertime but between April and October [(4)]. Hotter days are forecast to reach 47° C in the middle of the century [(5)]. Under the business-as-usual scenario RCP 8.5, the region could experience heatwaves with temperatures of up to 56 °C and higher over several weeks [(6)].

These temperature increases will not be evenly distributed regionally: under the business-as-usual scenario (RCP 8.5), temperatures are projected to increase by more than 2.5 °C by the end of the 2050s in Algeria, Iraq (+2.59 °C) and Saudi Arabia (+2.66 °C), while in Bahrain temperatures will rise only by 2° C. Rainfall will decrease by 13 % in Egypt but will increase by 5 % in Yemen, Qatar and Bahrain. Temperature increases will also differ within the countries: in Algeria, by the middle of the century, temperatures will rise by 2.25 °C in Algiers and by 2.74 °C in Tamanrasset in the southern part of the country. In Egypt, it will be 2.13 °C hotter in Cairo by 2059 whereas along the coast of the Red Sea temperatures will be 2.46 °C higher [(7)].

But even in the best case scenario, whereby temperature increases remain below 1.5 °C, the region faces a dire challenge according to the IPCC which notes an *important risk of extreme drought* conditions for the Middle East [(8)], and has described the Mediterranean as a region of 'high vulnerability' to wildfires, droughts, and heavy rainfall. Its assessments for the Arabian Peninsula were equally glum [(9)].

This increase in temperature has a series of first order and second order effects: it will decrease the availability of water in a first instance, which in turn will have effects on agriculture and food production. It will also increase the chances of floods and a rise in sea water levels.

BLUE IS THE NEW GOLD: ON WATER AVAILABILITY

Life on Earth, and therefore human life, is not possible without water: it is necessary for the human body to function, for agriculture, waste disposal, sanitation, hygiene, transport, electricity generation and industries. Without water, neither states nor individuals can function. It is in recognition of this fact that

(3) World Bank, Climate Change Knowledge Portal, Middle East and North Africa, projections.

(4) Ibid.

(5) Lelieveld, J. et al., 'Strongly increasing heat extremes in the Middle East and North Africa (MENA) in the 21st century', *Climatic Change*, Vol. 137, 2016, pp.245-260 (https://www.researchgate.net/publication/301610297_Strongly_increasing_heat_extremes_in_the_Middle_East_and_North_Africa_MENA_in_the_21st_century).

(6) Zittis, G., 'Business-as-usual will lead to super and ultra-extreme heatwaves in the Middle East and North Africa', *Nature*, March 2021 (https://www.nature.com/articles/s41612-021-00178-7).

(7) World Bank, Climate Change Knowledge Portal, Middle East and North Africa, projections.

(8) Hoegh-Guldberg, O. et al, 'Impacts of 1.5°C Global Warming on Natural and Human Systems', in Masson-Delmotte, V.et al.(eds.), *Global Warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*, In Press, 2018 (https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Chapter3_Low_Res.pdf).

(9) IPCC, 'Regional Factsheets' in *Climate Change 2021: The Physical Science Basis – Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, in Press, 2021 (https://www.ipcc.ch/report/ar6/wg1/downloads/factsheets/IPCC_AR6_WGI_Regional_Fact_Sheet_Asia.pdf).

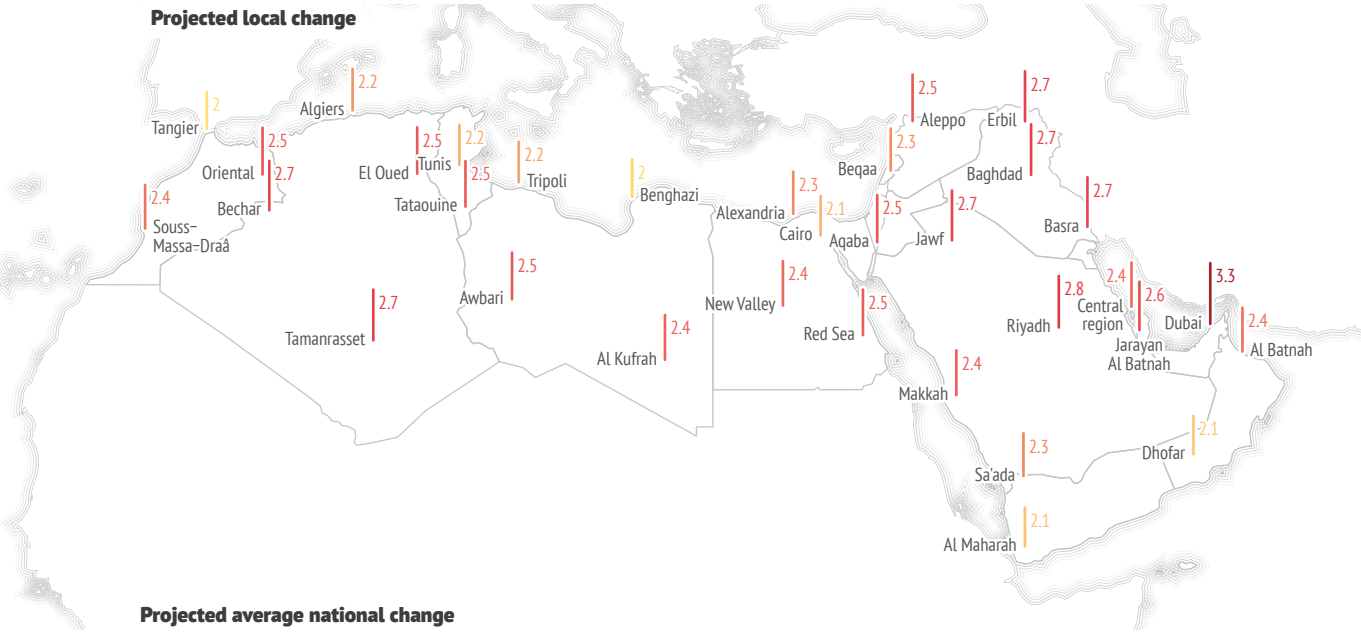
Temperature increase in MENA

Projected temperature increase 2040-2059 (1986-2005 baseline) under RCP 8.5

Temperature change

Projected mean annual temperature increases for countries in MENA by 2040–2059 under the RCP 8.5 scenario range from 2 (Bahrain) to 2.7 °C (Saudi Arabia) per country. At a local level, these vary more widely, from 2 to 3.3 °C in the locations listed below.

Projected local change



Projected average national change

Data: European Commission, GISCO, 2021; World Bank, Climate Knowledge Portal, 2021

in 2010 the United Nations General Assembly recognised 'the right to safe and clean drinking water and sanitation as a human right that is essential for the full enjoyment of life and all human rights' (10).

But as temperatures increase, water evaporates: it is sucked up by the air. Water is therefore the first victim of climate change. All other first order effects of climate change in the region are more or less the consequence of what climate change does to water.

In the Arab world, water is already a rare commodity even without the deleterious effects of climate change: most surface water sources, such as lakes and rivers, are replenished, directly or indirectly, by rain rather than groundwater – but there is little of it. A mere 173 mm of rain falls across the region a year, which is just a third of Europe's 756 mm

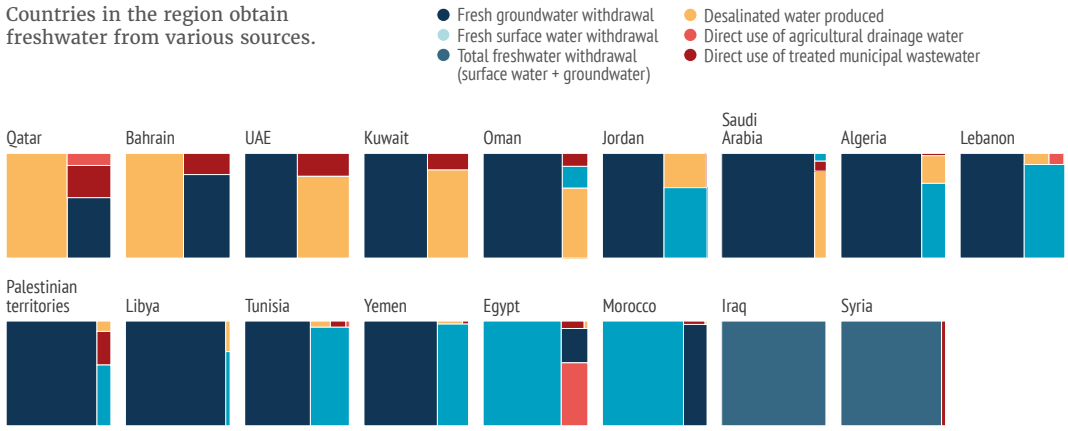
(10) United Nations General Assembly, 'A/RES/64/292: The human right to water and sanitation', 28 July 2010 (https://documents-dds-ny.un.org/doc/UNDOC/GEN/N09/479/35/PDF/N0947935.pdf?OpenElement).

Water sources

% of total water used, 2017

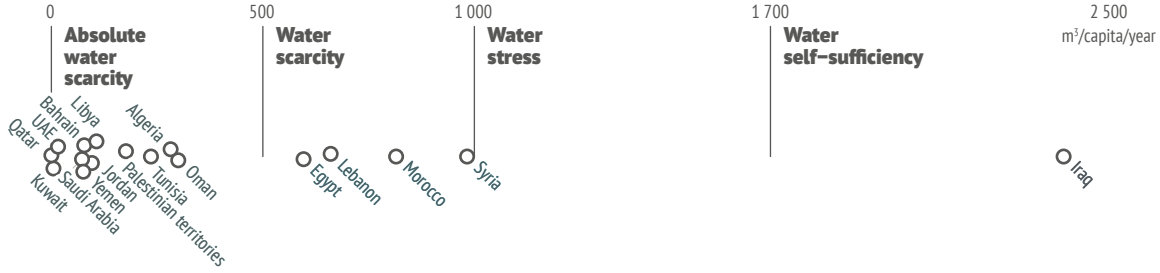
Water source

Countries in the region obtain freshwater from various sources.



Water scarcity per country

It is estimated that a country is facing water stress when its amount of fresh renewable water is below 1 700 m³ per capita per year.



Data: FAO, 2017 & 2021; European Commission, 2021; FAO, AquaStat, 2017; UNESCWA, *Moving Towards Water Security in the Arab Region*, 2019

(Lebanon being the exception with 825 mm [11]).Because of that, all the Gulf States, Libya, Jordan and Tunisia rely on groundwater withdrawal for domestic and drinking use (as does Lebanon, due to poor management of the water it receives from the rain) [12]. Egypt ranks last with 18 mm a year and as a consequence gets 85 % of its water from the surface, mostly the Nile [13]. Since the 1970s, rainfall in the region has decreased [14]. Desalination accounts for around 9 % of Saudi Arabia's total water use, 13 % for Jordan, 16 % for Oman,

(11) Calculations made by authors based on World Bank data – Average precipitation in depth (mm per year).

(12) MedECC, 'Summary for Policymakers' in Cramer, W., Guiot, J. and Marini, K. (eds.) *Climate and Environmental Change in the Mediterranean Basin – Current situation and risks for the future. First Mediterranean Assessment Report*, Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, September 2020 (https://www.medecc.org/wp-content/uploads/2021/05/MedECC_MAR1_SPM_ENG.pdf).

(13) World Bank Group, *Climate Risk Country Profile: Egypt*, Washington D.C., 2021 (https://climateknowledgeportal.worldbank.org/sites/default/files/2021-04/15723-WB_Egypt%20Country%20Profile-WEB-2_0.pdf); United Nations Economic and Social Commission for Western Asia (UNESCWA), *Moving Towards Water Security in the Arab Region*, Beirut, 2019.

(14) Karami, N., 'The modality of climate change in the Middle East: drought or drying up?", *The Journal of Interrupted Studies*, Vol. 2, No 1, May 2019 (https://brill.com/view/journals/tjis/2/1/article-p118_118.xml?language=en).

25 % for Qatar and Kuwait, 38 % for the United Arab Emirates (UAE) and 55 % for Bahrain. As a comparison, desalinated water represents less than 1 % of Morocco's, Egypt's and Iraq's total water use, and merely 1 to 2 % of Libya's, the Palestinian territories', Tunisia's and Lebanon's total water use [15].

Water stress is a common feature of the region.

To make matters worse, the region is already living beyond its freshwater means: in one year, Jordan used 94 % and Egypt used 117 % of their total renewable freshwater resources [16]. Water stress (a term denoting a situation whereby the demand for water exceeds the available amount during a certain period, meaning states withdrawing more freshwater in one year than the total of their renewable sources) is a common feature of the region: a study conducted in 2019 found that 9 of the 17 countries in the world facing extreme water stress were Arab countries, and with Iran and Israel included 13 of the world's 20 most water-stressed countries are located in the region [17]. In the UAE and Kuwait, water stress reached more than 1 000 and 1 700 % respectively [18], and in Saudi Arabia and Qatar respectively 400 and 900 %. During the heatwave of 2021, the municipality of Algiers had to introduce a water rationing plan to ensure even distribution of its limited water resources [19]. During the 2021 heatwave, 12 million people in Syria and Iraq were at risk of total collapse of water and food production [20].

Things get even more complicated in conflict zones: less than 60 % of Palestinians have access to safe drinking water, and only 30 % of households in Gaza and 50 % in the West Bank are connected to water infrastructure delivery with daily limited supply. Most of the Palestinian population rely on supply from rainfall with personal water tanks at home [21]. In Libya, the Great Man-Made River (GMR) Project, which supplies 70 % of the population with water, has been severely damaged by the conflict, putting 4 million people at immediate risk of water shortage in February 2021. In Yemen, half of the population struggle to find or buy daily water supplies [22].

Climate change is not alone to blame: water mismanagement, too, plays a role. In Egypt, Iraq, Jordan and Lebanon, 50 % of water is lost during the distribution process, while in Syria the figure is 48 % and 40 % in the Palestinian territories [23]. Most policies are aimed at drilling more wells or building desalination plants rather than saving water and increasing water management efficiency.

Politics further complicate water availability. Almost all states in the region rely on rivers or aquifers that they share with neighbouring countries – Arab and non-Arab ones. Jordan and the Palestinian territories share the Jordan river with Israel; Iraq, Turkey, Syria and

(15) Food and Agriculture Organization (FAO), AQUASTAT (http://www.fao.org/aquastat/statistics/query/index.html?lang=en).

(16) FAO, AQUASTAT, Glossary: 'Ratio between total freshwater withdrawal by all major sectors and total renewable freshwater resources, after taking into account environmental water requirements.'

(17) Qatar, Lebanon, Jordan, Libya, Kuwait, Saudi Arabia, United Arab Emirates, Bahrain, Oman: see Hofste, U.W., Reig, P. and Schleifer, L., '17 countries, home to one-quarter of the world's population, face extremely high water stress', World Resources Institute, 6 August 2019 (https://www.wri.org/insights/17-countries-home-one-quarter-worlds-population-face-extremely-high-water-stress).

(18) FAO, AQUASTAT, 2017; UN Department of Social and Economic Affairs (DESA), Statistics Division (Indicators for SDG 6).

(19) *Morocco World News*, 'Algeria: Facing crisis, Algiers introduces water rationing', 26 June 2021 (https://www.moroccoworldnews.com/2021/06/343098/algeria-facing-crisis-algiers-introduces-water-rationin).

(20) Al-Monitor, 'Water crisis puts 12 million at risk in Syria, Iraq, aid groups say', 23 August 23 2021 (https://www.al-monitor.com/originals/2021/08/water-crisis-puts-12-million-risk-syria-iraq-aid-groups-say).

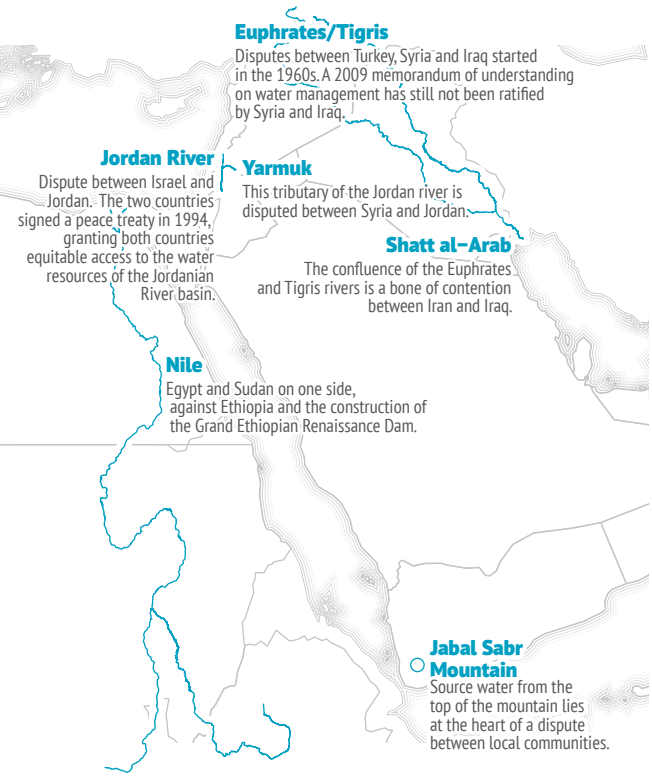
(21) FAO, AQUASTAT, 2017; *Moving Towards Water Security in the Arab Region*, op.cit.; World Bank Group, *Securing Water for Development in West Bank and Gaza*, Washington D.C., 2018 (https://documents1.worldbank.org/curated/en/736571530044615402/Securing-water-for-development-in-West-Bank-and-Gaza-sector-note.pdf).

(22) Schulman, S., 'Yemenis' daily struggles between conflict and climate change', *The RUSI Journal*, Vol. 166, 2021, pp.82-92.

(23) UNDP, *Water Governance in the Arab Region: Managing scarcity and securing the future*, New York, 2013.

Transnational water disputes

Ongoing and resolved



Data: European Commission, GISCO, 2021; OpenStreetMap, 2021

Iran share access to the Euphrates and Tigris, while the Yarmouk River is shared by Jordan, Syria and Israel, Mauritania shares the Senegal River with Senegal and Mali, and Egypt shares the Nile with Ethiopia and Sudan. Unfortunately, political agreements on the use of these shared sources either do not exist or are not enough to solve the problem.

The conflict between Egypt and Ethiopia over the use of Nile water following the construction of the Grand Ethiopian Renaissance Dam is a very prominent example. Egypt draws 95 % of its water from the Nile as it receives almost no rain. The dam, the filling of whose reservoir began in 2020, would reduce not only water quantity, but also make it more salty, making it less useful for agriculture [(24)]. Depending on how the dam is operated, Egypt could lose up to a third of its agricultural lands and between 20 and 30 % of the hydropower generated by the Aswan High Dam [(25)]. The dam would also have negative repercussions for Sudan. Because mediation efforts have failed, Egypt has not only informed the United Nations Security Council that the dam is an 'existential threat' to Egypt and its population, but hinted at military options should Ethiopia not make concessions [(26)]. Water is also a point of contention between Turkey, Syria and Iraq: the construction of the Southeastern Anatolia Project, which includes 22 dams on the Tigris and Euphrates, curtails almost 80 % of water flow into Iraq and Syria.

Water-sharing is not less problematic below the surface. 41 aquifers, or underground layers of water, are shared by all Arab states and accessed by pumping technology [(27)]. This is an issue for two reasons: firstly, not all states have the same access to this technology, or are politically barred from it. The most prominent case here is the Palestinian territories, whose access to water is nominally – but badly – regulated in the Oslo Accords. Palestinians require a permit from the Israeli military to drill new wells – which they normally do not receive – whereas 40 % of Israeli water is drawn from

(24) El-Nashar, W.Y. and Elyamany, A.H., 'Managing risks of the Grand Ethiopian Renaissance Dam on Egypt', *Ain Shams Engineering Journal*, Vol. 9, No 4, December 2018, pp.2383-2388 (https://doi.org/10.1016/j.asej.2017.06.004).

(25) Al-Monitor, 'How water has become a flashpoint in the Middle East', 23 July 2021 (https://www.al-monitor.com/originals/2021/07/how-water-has-become-flashpoint-middle-east#ixzz71uZrhfsc); Al-Monitor, 'Egypt to Security Council: Ethiopian dam an "existential threat"', 9 July 2021 (https://www.al-monitor.com/originals/2021/07/egypt-security-council-ethiopian-dam-existential-threat).

(26) Ibid; Al-Monitor, 'Egypt issues stark warning against Ethiopia over stalled Nile dam talks', 1 April 2021 (https://www.al-monitor.com/originals/2021/04/egypt-issues-stark-warning-against-ethiopia-over-stalled-nile-dam-talks#ixzz73PM6ktiO).

(27) *Moving Towards Water Security in the Arab Region*, op.cit.

West Bank aquifers [28]. Matters are even worse in Gaza, where up to 95 % of water supply is contaminated by sewage and seawater infiltration (the result of both over-pumping and rising sea-levels, see the last section of this chapter). Because Israel does not allow transfer of water from the West Bank to Gaza – and because Hamas uses water pipes to build rockets - water consumption there is well below what the World Health Organization (WHO) recommends. In total, Israeli water consumption is four times higher than that of Palestinians living in the territories.

Pumping aquifers is problematic also for a second reason: a lot of the regional aquifer water is from fossil groundwater reserves which are several thousand or even million years old - but once they are empty, they cannot be replenished. In the 1980s, Saudi Arabia launched desert agricultural projects that led to the depletion of four fifths of its fossil water supplies [29]. The projects are now being phased out. Libya's GMR Project also pumps entirely from 1 300 paleowater wells that are 75 000 years old, and Egypt, Jordan and Yemen also rely in important and unsustainable ways on this type of water. Scientists estimate that fossil water aquifers in the Middle East will run dry within up to 90 years, and within up to 300 years in North Africa [30].

Climate change is poised to make all these matters worse: because warmer air will hold moisture rather than release it, there will be less rain, and as a result, less water in lakes, rivers and soils across the region, making it quite literally the world's hotspot in the future [31].

From 2030, the extent of water availability will depend both on location and policy choices: Algeria, Iraq, Morocco and Tunisia for instance will be impacted by water shortage *regardless of the scenario.* Under the best case scenario (RCP 2.6), there will be 20 to 40 % less rainfall (something that Egypt or Lebanon, for instance, will be able to manage), but under the worst case scenario (RCP 8.5) this will increase to even 60 % [32]. Under the latter scenario, Iraq's Euphrates and Tigris rivers might carry 15 to 17 % less water by the end of the century [33]. With less rain, the Jordan river is expected to carry 7 % less water from 2030 [34], and the Nile to carry 6 % less by 2025. [35]

In Jordan, it is estimated that a 2 °C rise in temperature coupled with a 10 % decline in rainfall will reduce natural aquifer recharge by 45 to 60 % [36]. Jordan alone will experience two and a half months of droughts per year by 2040 instead of the two months it has experienced in the past. In 2040, Bahrain, Kuwait, Qatar, the UAE, the Palestinian territories, Saudi Arabia and Oman will be among the ten most water-scarce countries in the world, followed by Lebanon, Jordan, Libya, Yemen and Morocco. Annual renewable water resources

(28) Zeitoun, M., Messerschmid, C. and Attili, S., 'Asymmetric Abstraction and Allocation: The Israeli-Palestinian Water Pumping Record', *Ground Water*, Vol. 47, No 1, 2008, pp.146-60 (10.1111/j.1745-6584.2008.00487.x); Amnesty International, 'The Occupation of Water', 29 November 2017 (https://www.amnesty.org/en/latest/campaigns/2017/11/the-occupation-of-water/).

(29) Elhadj, E., 'Camels don't fly, deserts don't bloom: an assessment of Saudi Arabia's experiment in desert agriculture', *Occasional Paper* No 48, School of Oriental and African Studies/King's College London, University of London, , 2004

(30) Mazzoni, A. et al, 'Forecasting water budget deficits and groundwater depletion in the main fossil aquifer systems in North Africa and the Arabian Peninsula', *Global Environmental Change,* Vol.53, 2018, pp.157-173.

(31) *Climate and Environmental Change in the Mediterranean Basin – Current situation and risks for the future,* op.cit.; World Bank Group, Open Knowledge Repository, *Turn Down the Heat –Confronting the new climate normal*, Report no.3, November 2014

(32) World Bank, Climate Change Knowledge Portal, Middle East and North Africa, projections.

(33) *Moving Towards Water Security in the Arab Region*, op.cit.

(34) Embassy of the Federal Republic of Germany in Tel Aviv and Amman, Representation Office of the Federal Republic of Germany in Ramallah, EcoPeace Middle East, *Climate Change, Water Security, and National Security for Jordan, Palestine, and Israel*, 2019.

(35) Nour El-Din, M.M., *Proposed Climate Change Adaptation Strategy for the Ministry of Water Resources & Irrigation Egypt*, prepared for UNESCO Cairo Office, Cairo 2013.

(36) Sowers, J., Vengosh, A., and Weinthal, E., 'Climate change, water resources, and the politics of adaptation in the Middle East and North Africa', *Climatic Change*, Vol.104, 2011, pp.599-627 (10.1007/s10584-010-9835-4).

per capita might fall by 30 % in the Palestinian territories and Yemen between today and 2030, and by 50 % in the Palestinian territories and Syria between now and 2050. The amount of annual renewable freshwater for Egyptians, Moroccans and Algerians might drop by 20 to 25 % by 2050 [37]. By 2050, it is estimated that in the region, renewable water resources will decrease by the equivalent of 240 000 Olympic swimming pools per decade, or 1.5 times the volume of the Grande Dixence dam in Switzerland: from 250 km^3 in 2010 to 230 km^3 in 2030 - and 215 km^3 in 2050. Groundwater will decrease from 45 km^3 to 30 km^3 in 2050 [38].

Water scarcity, and the tensions that come with it, is already a problem in the Arab world, particularly its Middle Eastern part – climate change will worsen it significantly.

MAN AND NATURE: EFFECTS ON THE BIOSPHERE

As we have seen above, water will be scarcer in a climate-changed Arab world. This means that all those organisms that rely directly or indirectly on water - plants, animals and humans - will face existential difficulties. [39]

The first area of concern is agriculture, which accounts for 85 % of water use and is therefore the main consumer of water in the region – a remarkable difference to Europe, where only 40 % of water is used by this sector. This varies sometimes quite significantly by country. Egypt, Iraq, Libya, Morocco, Saudi Arabia, Syria and Yemen use more than 80 % of their water resources for agriculture, whereas Bahrain, Jordan, Lebanon, the Palestinian territories and Qatar use less than 50%. Considering that only 6.4 % of land in the region is arable (in the EU, the figure is more than 24 %), and agriculture's share in national GDPs is quite low, this suggests an inefficient use of water – both in agricultural and in economic terms [40].

When we add climate change to this equation, things become significantly more complicated. As we have seen, the region will have less rain in the future – which is the region's primary source of water for agricultural production. About 70 % of its products, such as tomatoes or olive trees, but also cereals such as maize and wheat, are watered by rain, and the rest is irrigated by surface and ground waters [41]. (This is not the case for Egypt and Iraq which use mainly irrigation systems for agriculture, applying water artificially to the soil using tubes, pumps, and sprays.) In total, this could mean the loss of 850 000 hectares of rainfed production by 2030 (8 % of total Syrian, Iraqi and Lebanese arable land) [42]. Saudi Arabia will lose 11 % of this agricultural land for crops by 2030, for Egypt and the Middle East this will amount to 2 % [43]. Beyond 2030, this will shrink further depending on which emission scenario materialises. Water shortage alone is

(37) Calculation made by authors thanks to FAO AQUASTAT data and Jobbins, G. and Henley, G., *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 and World Food Programme, London, 2015.

(38) Droogers, P. et al, 'Water resources trends in Middle East and North Africa towards 2050', *Hydrology and Earth System Sciences*, Vol.16, No 9, 2012, pp.3101-3114 (https://hess.copernicus.org/articles/16/3101/2012/hess-16-3101-2012.pdf).

(39) This is a reference to the 1864 book by George Perkins Marsh of the same title; it was one of the first to warn of resource depletion by humans and helped launch the conservation movement.

(40) Calculated by the authors on the basis of World Bank data - Agriculture, forestry, and fishing, value added (% of GDP).

(41) Climate Change Knowledge Portal, op.cit.; *Climate and Environmental Change in the Mediterranean Basin – Current situation and risks for the future*, op.cit.

(42) World Bank Group, *Climate Variability, Drought and Drought Management in Tunisia's Agricultural Sector*, Washington D.C,. 2018 (https://openknowledge.worldbank.org/handle/10986/30604).

(43) OCDE/FAO, *OECD-FAO Agricultural Outlook 2021-2030*, Éditions OCDE, Paris, 2021 (http://www.fao.org/3/cb5332en/cb5332en.pdf).

What comes after the rain?

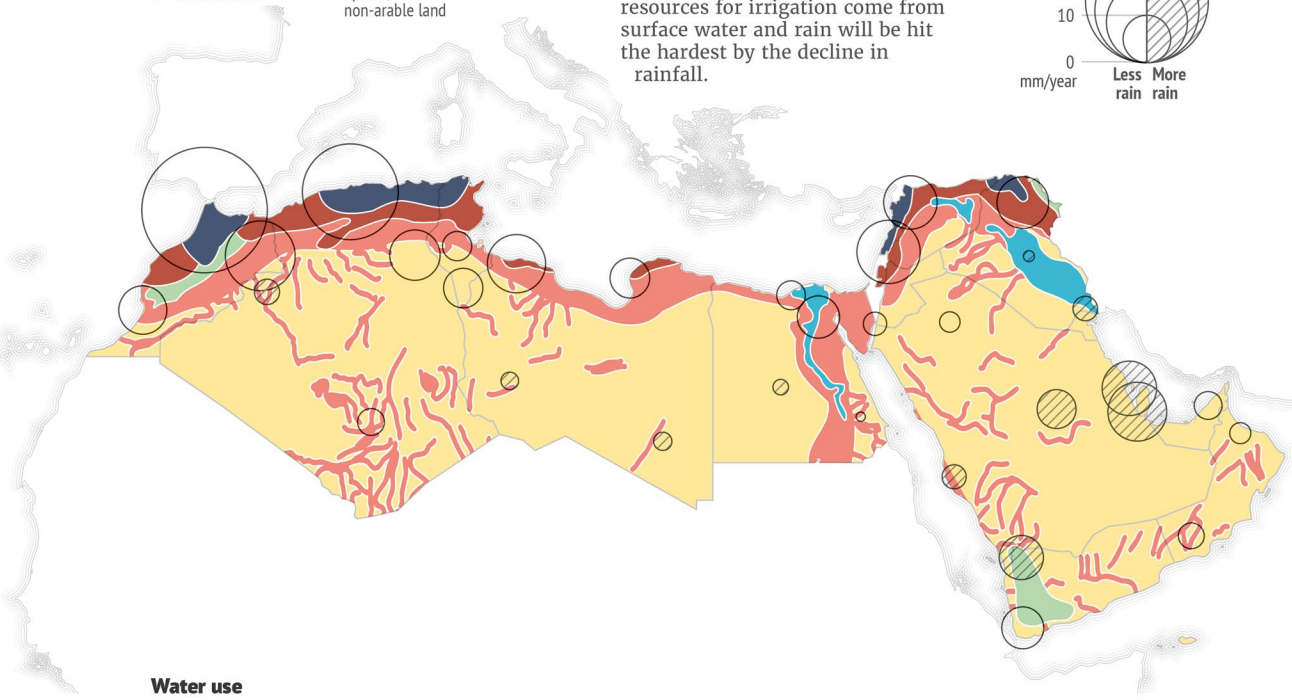
Farming systems and water use

Farming system

- Irrigated
- Highland mixed
- Rainfed mixed
- Dryland mixed
- Pastoral
- Sparse, non-arable land

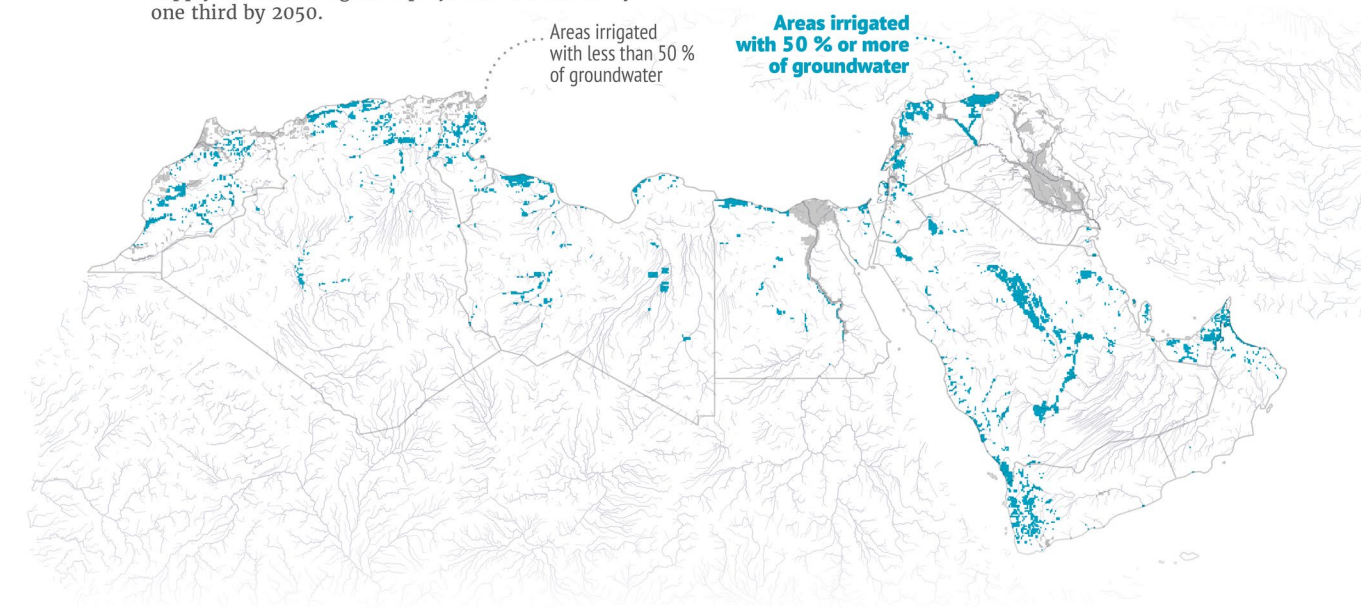
Rain by 2040-2059 under RCP 8.5

Changes in rainfall are not equally distributed across the MENA region. Regions where water resources for irrigation come from surface water and rain will be hit the hardest by the decline in rainfall.



Water use

Agriculture is the main consumer of water in the region, accounting for 85 %. The more groundwater is used for irrigation, the more stress is put on freshwater resources for other uses. Groundwater supply across the region is projected to decrease by one third by 2050.



Data: FAO, Farming Systems, 2017; European Commission, GISCO, 2021; World Bank, Climate Knowledge Portal, 2021

projected to cause between 6 and 14 % of regional GDP loss in 2050 – more than in any other world region – if no appropriate policy decisions are taken [44].

The duration of droughts will increase from two to three months under the business-as-usual scenario by 2040 [45]. Should one of the 'not enough' scenarios of a 3 °C increase by 2050 materialise, Jordanian barley and Syrian wheat crop yields, respectively the main cultivated cereals in both countries, could decrease by at least 20 to 50 % [46] [47].

Not just plants suffer from increased temperatures and lack of water: animals do, too. Especially livestock – cattle, sheep and goats – will be affected because they feed primarily on cereals, one of those products that will be difficult to produce in the region and probably more expensive to buy on the world market. Egyptians are among the biggest producers and consumers of meat in the region, mostly beef, mutton and goat meat. This sector alone makes up 25 % of the share of agriculture in Egypt's GDP [48]. Livestock that provide humans with milk and meat are vulnerable to increasing temperatures and reduction of water supply, especially those living in areas affected by droughts because they feed on cereal [49]. In Tunisia, cow milk and poultry in particular are threatened by reduced cereal availability, both making up respectively 13 % and 10 % of the agricultural GDP [50]. Instead of breeding livestock themselves, countries in the region will have to import meat and milk [51].

Animals living under water are also threatened by climate change. For one, growing levels of acidity in the ocean changes the temperature of water and the composition of the marine ecosystem. Marine species habitats, flora and fauna, algae and corals, are endangered by sea acidification and subject to food chain disruption. New predators are entering the Mediterranean waters, especially jellyfish that feed on plankton which are a basis of marine food, absorb CO_2 and emit oxygen. Seagrass and mussels will also decline due to rising sea temperatures. By the end of the century, 25 endemic marine Mediterranean species are endangered and 6 will be extinct, while 20 % of exploited fish and marine invertebrates will be extinct by 2050. Also, as sea temperatures are warming, there is less oxygen for fish so it is predicted that their size will shrink by 49 % by 2050 [52]. Fish are also likely to migrate into more oxygenated areas such as the Western Mediterranean, changing existing ecosystems.

In rivers, seas and lakes, warming of water also alters the composition of fauna, size and distribution of fish [53], which might lead

(44) World Bank, *High and Dry: climate change, water, and the economy*, 2016, p.13 (https://www.worldbank.org/en/topic/water/publication/high-and-dry-climate-change-water-and-the-economy).

(45) Rajeskhar, D. and Gorelick, S.M., 'Increasing drought in Jordan: Climate change and cascading Syrian land-use impacts on reducing transboundary flow', *Science Advances*, Vol. 3, No 8, 2017.

(46) *Food in an Uncertain Future*, op.cit.

(47) FAO, *Country Briefs*: *Jordan*, November 2020 (http://www.fao.org/giews/countrybrief/country.jsp?code=JOR&lang=en); FAO, *Country Briefs:Syria*, November 2020 (http://www.fao.org/giews/countrybrief/country.jsp?code=SYR&lang=fr).

(48) *Climate Risk Country Profile: Egypt*, op.cit.

(49) Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR), *Arab Climate Change Assessment Report – Main Report*, Beirut, 2017; ; IPCC, *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*, Cambridge University Press, Cambridge and New York, 2014.

(50) *Climate Variability, Drought and Drought Management in Tunisia's Agricultural Sector*, op.cit.

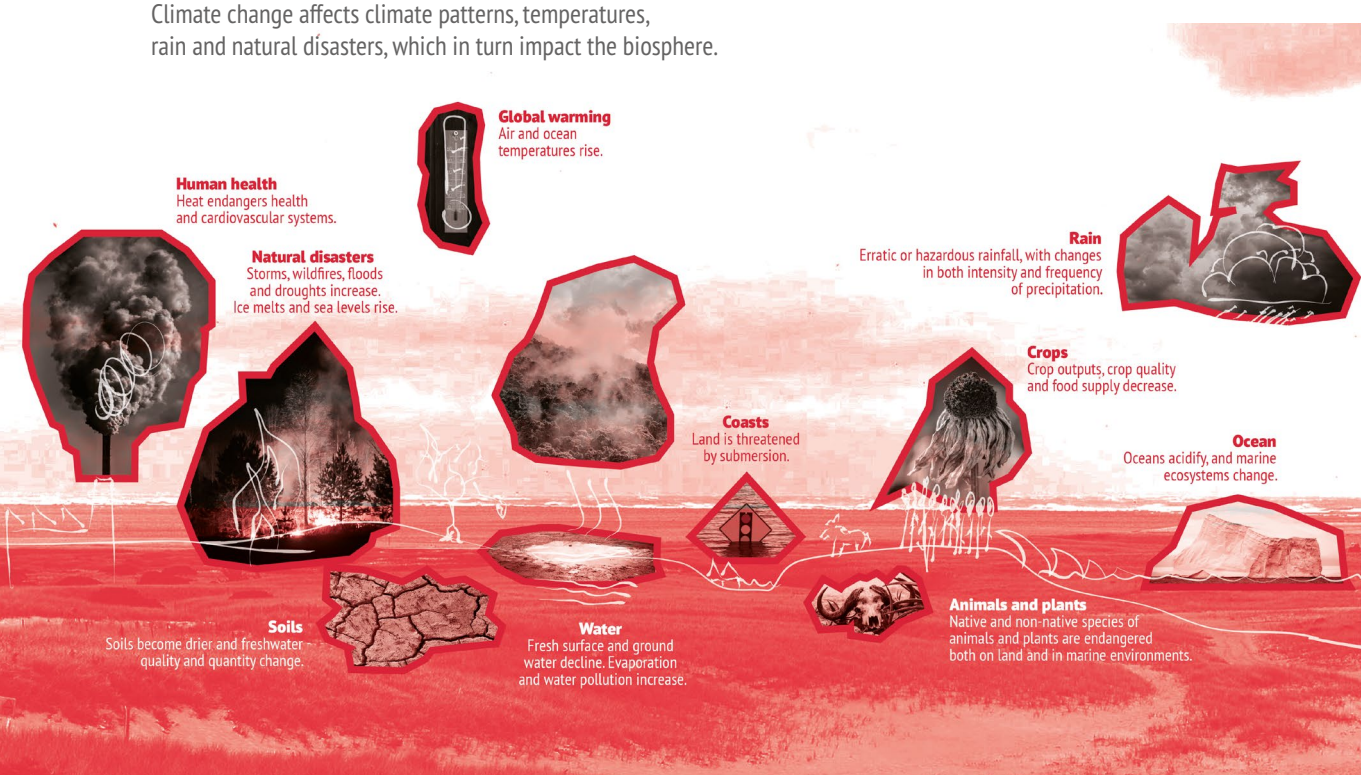
(51) Institut national de la recherche agronomique, *Addressing Agricultural Import Dependence in* the *Middle East-North Africa region through the year 2050 – Short summary of the study*, Paris, October 2015 (https://www.inrae.fr/sites/default/files/pdf/addressing-agricultural-import-dependence-in-the-middle-east-north-africa-region-through-to-the-year-2050-doc.pdf).

(52) *Climate and Environmental Change in the Mediterranean Basin – Current situation and risks for the future.*, op.cit

(53) Feidi, I., 'Influence of climate change on fisheries resources in the Arab region', FAO webpage (http://www.fao.org/in-action/globefish/fishery-information/resource-detail/en/c/338390/).

How climate change affects the biosphere in MENA

Climate change affects climate patterns, temperatures, rain and natural disasters, which in turn impact the biosphere.



Data: RICCAR, 'Arab Climate Change Assessment Report', 2017

to the extinction of 50 % of harvested fish by 2050 [(54)]. Fishery is not the region's key economic activity, but it contributes to food security and livelihoods in coastal areas, especially in Egypt, Oman and Morocco [(55)].

In sum, this means that the Arab food system will be in dire straits in the decades ahead. A poorer performing agricultural sector will first lead to food shortages, and as a result to an increase in regional food prices. To make matters more complex, food imported from elsewhere will increase in price as well because climate change will also affect agriculture in other countries. This is a real problem because the Arab population will continue to grow (see next chapter) - and with it, its food needs.

Lastly, climate change will also affect the functioning of the human body. Any wet-bulb temperature (WBT) — a measure that combines air temperature and humidity— above 35 °C will lead to sweating and increased heart rate in order to cool the body off. Above 39 °C WBT, oxygen levels fall critically past 45 minutes in the heat. Beyond this, extreme heat can cause heatstroke, where the body temperature rises above 40°C, leading to kidney and heart problems such as heart stroke, brain damage, anxiety and impaired cognitive functioning [(56)]. Already, cities such as Ras al Khaimah in the UAE are surpassing this temperature, meaning they are becoming uninhabitable by humans for portions of the year. Heatwaves as projected by the business-as-usual scenario, lasting for weeks at temperatures above 56° C will not be survivable without constant

(54) *Climate and Environmental Change in the Mediterranean Basin – Current situation and risks for the future,* , op.cit.

(55) BBC News, 'Can the body cope with 50°C?', 9 January 2013 (https://www.bbc.com/news/world-asia-20956421).

(56) Raymond, C., 'The emergence of heat and humidity too severe for human tolerance', *Science Advances*, Vol. 6, No 19, May 2020; Nag, P.K. et al, 'Human heat tolerance in simulated environment', *Indian Journal of Medical Research*, 1997, pp.226-234.

air conditioning [57]. Side effects of climate change are an increase in pollen and pollution, leading to a corresponding increase in respiratory diseases and allergies.

In addition, the region will host more than 50 million people aged above 65 years old [58]. An ageing population is more vulnerable to high temperatures and heat stress because older bodies process thermoregulation more slowly than younger bodies, a problem that is also exacerbated by some medications [59]. By 2050, 19 000 deaths a year will be attributed to heat in the region (15 000 in Europe) [60]. (Adaptative measures can reduce this by a third - see the policy recommendations in the concluding chapter of this paper.)

Heat will not just reduce water quantity, but also quality: extreme weather events alter it by increasing levels of salt in freshwater or by discharging pollutants in water. Droughts – which as we have seen will become more frequent – also affect water quality, because the reduction of water flow increases water temperatures and reduces the level of oxygen in the water. Moreover, the decline of waterflow limits the evacuation of pollutants and increases their concentration in rivers [61]. In addition, rising sea levels (see last section of this chapter) will also negatively impact water quality. Sea floodings result in saltwater intrusion into coastal surface and ground freshwater systems [62]. High levels of salinity alter the water composition and interfere with the equilibrium of micronutrients, elements composing water's biota [63]. Salinity of water poses major threats to the preservation of ecosystems and the quality of water used for agriculture.

Arab rivers and aquifers in Lebanon, Egypt and Iraq are already facing water pollution issues. In Iraq, in 2010, the amount of pollutants in drinking and irrigating water was three times higher than the average prescribed by the World Health Organisation (WHO). The quantity of Total Dissolved Salts (TDS), comprising inorganic salts such as calcium, potassium, sodium, chlorine and sulfates, as well as pesticides, in the Euphrates river, tripled between the 1980s and 2009 [64]. High levels of TDS in drinking water can cause cancer, heart and cardiovascular diseases [65]. In 2018, 118 000 residents of the southern city of Basra had to be hospitalised with symptoms related to poor water quality [66]. This sparked unrest during which protesters torched nearly every government building in the city.

In Tunisia and Gaza, the concentration of nitrate in drinking water exceeds 600 to 800 mg per litre, while the safe limit is determined as 50 mg [67]. Nitrate is used in inorganic

(57) National Institute of Environmental Health Science, *A Human Health Perspective on Climate Change: A report outlining the research needs on the human health effects of climate change*, 2010.

(58) Halsall, J. and Cook, G., 'Ageing in the Middle East and North Africa: A Contemporary Perspective', *Population Horizons*, No 14, 2017, pp.1-8.

(59) 'Heat stress and older people', Better Health Channel, Federal Government of the State of Victoria, Australia

(60) World Health Organisation, *Quantitative risk assessment of the effects of climate change on selected causes of death, 2030s and 2050s*, Geneva, 2014(http://apps.who.int/iris/bitstream/handle/10665/134014/9789241507691_eng.pdf).

(61) United Nations, 'Climate change and water', *UN-Water Policy Brief*, 2019; Eau France, le service public de l'information des eaux, *Les impacts de la sécheresse*, 2020.

(62) *Climate and Environmental Change in the Mediterranean Basin – Current situation and risks for the future.*, op.cit.; *Turn Down the Heat – Confronting the new climate normal*, op.cit.

(63) FAO, *Water Pollution from Agriculture: A global review – Executive summary*, Rome, 2017 (http://www.fao.org/3/i7754e/i7754e.pdf).

(64) UN in Iraq, *Water in Iraq – Factsheet*, March 2013.

(65) World Health Organization, *Total dissolved solids in drinking-water – Background document for development of WHO guidelines for drinking-water quality*, Geneva, 2003.

(66) Human Rights Watch, 'Basra is thirsty: Iraq's failure to manage the water crisis', July 2019 (https://www.hrw.org/report/2019/07/22/basra-thirsty/iraqs-failure-manage-water-crisis).

(67) United Nations Economic and Social Commission for Western Asia (UNESCWA), *Arab Sustainable Development Report 2020*, Beirut, 2020.

fertilizers, and a high concentration in drinking water can provoke cyanosis and, in the worst case, asphyxia [(68)]. Unsafe distribution of water can lead to waterborne diseases like cholera, diarrhoea, or hepatitis A [(69)]. Lastly, contaminated water also reduces crop outputs and developments when water is too saline, when the amount of toxic ions (sodium, chloride or boron) are too high or when there is an excess of nutrients. In those cases, crops are either damaged by toxicity or are not able to capture enough water from the soil [(70)].

The consequences of climate change will put even more pressure on systems Arab citizens need for survival: food production, water quality and even bodily functions will be impaired. This will lead to more political discontent and unrest.

DISASTERS IN THE MAKING: OF FLOODS, LANDSLIDES AND RISING SEA LEVELS

The climate is a complex system, meaning its many ramifications and side effects are not straightforward to understand or explain. This means that while we can say with reasonable certainty what impact an increase in temperature will have on the availability of water which in turn affects those depending on it – plants, humans and animals – we have a less clear picture of what other effects this will have. But we expect the change in climate to have several more sudden and more disruptive effects such as disasters of all types.

Over the last 50 years, Arab countries have been increasingly affected by hazardous events, like flash floods or storms, a trend that is highly likely to persist given the ongoing effects of climate change [(71)]. While the number of natural disasters around the world has almost doubled since the 1980s, it has almost tripled in countries in the Middle East and North Africa, with more than 370 natural disasters affecting 40 million people over the last 30 years, costing USD 20 billion [(72)]. The Saudi city of Jeddah for instance experienced several severe successive floods in 2009, 2010 and 2011, primarily because of the seasonal variability of rainfall, where urban infrastructures inhibited the flow of rainwater [(73)]. Iraq is also more often affected by water floods, especially in Basra and eleven other governorates in spring 2019 after weeks of rain which caused the Tigris to swell [(74)]. Impacts of floods on both the environment and people are considerable: floods damage urban infrastructure (buildings, bridges), housing, and disrupt basic services such as electricity supply. Floods can destroy crops and pollutants collected by water floods also contaminate the quality of water by the presence of sediment, nutrient and pollutant loadings in the water, carriers

(68) World Health Organization, 'Nitrate and nitrite in drinking water', Geneva, 2011.

(69) *Climate and Environmental Change in the Mediterranean Basin – Current Situation and risks for the future,* op.cit; *Turn Down the Heat – Confronting the new climate normal*, op.cit.; World Health Organisation, 'Drinking Water - Key Facts', Geneva, 2019 (https://www.who.int/news-room/fact-sheets/detail/drinking-water).

(70) Okorogbona A.O.M. et al., 'Water quality impacts on agricultural productivity and environment', *Sustainable Agriculture Reviews*, Vol. 27, 2018, pp.1-35 (https://doi.org/10.1007/978-3-319-75190-0_1); Ayers, R.S. and Wescot, D.W., 'Water quality for agriculture', FAO Irrigation and Drainage paper, 1989.

(71) *Climate and Environmental Change in the Mediterranean Basin – Current situation and risks for the future,* op.cit; *Turn Down the Heat – Confronting the new climate normal*, op.cit.

(72) Saghir, J., 'Urban planning can make the Middle East more resilient to outside forces', The National News, August 2019 (https://www.thenationalnews.com/opinion/comment/urban-planning-can-make-the-middle-east-more-resilient-to-outside-forces-1.901325).

(73) Ameur, F., 'Floods in Jeddah, Saudi Arabia: Unusual phenomenon and huge losses. What prognoses', King Abdel Aziz University, Faculty of Environmental Designs, Geomatics Department 7, 2016, pp.1-10 (10.1051/e3sconf/20160704019)

(74) United Nations Office for the Coordination of Humanitarian Affairs, *Iraq – Floods: Update No 1*, 3 April 2019.

of chemical elements like heavy metals from earth and rocks, caused by heavy rainfalls. Between 2017 and 2018, more than 15 000 people were declared either dead or missing because of disasters in Arab countries – as a comparison, around 7 000 people died in terror attacks in Syria and Iraq, and the two countries were at that time among the five countries the most impacted by terrorism [(75)].

It appears counterintuitive that floods would be a by-product of climate change given that we have just learned that climate change will lead to a reduction of water in the region. This is true in general: climate change leads to an increase in temperature, which in turn leads to an increase of the amount of water being absorbed by the air, and therefore less rain as we saw earlier in the chapter. But as the now warmer air can absorb more water than was the case under previous temperatures, when it does rain it pours torrentially. This happens when air that holds a lot of moisture suddenly cools, and releases its water in one go. Regarding this outcome, the IPCC has high levels of certainty, assigning more than 90 % of probability to an increase in heavy rains which will then lead to floods and landslides [(76)]. This can be either the result of overflowing rivers or places where heavy rainfall cannot run off [(77)]. Under the business-as-usual (RCP 8.5) scenario, the number of extremely wet days after 2070 will increase sharply everywhere in the region (except for in the north of the Arabian desert, south of Algeria and west of Libya); under the 'not enough' scenario (RCP 4.5), significant changes in rainfall will occur in the south of the Arabian desert only [(78)]. Here, we still do not know exactly which country will be affected the most, and within the countries, which regions [(79)]. Tunis for instance could witness an increase of torrential rain events of 25 %, meaning that because of extreme rain events and floods, between 2010 and 2030 the city will lose more than USD 1 billion due to damage to infrastructure and other economic assets [(80)].

What we do know, however, is that flood risk will be unevenly distributed and no blanket statements can be made. A look at the flood risk for three Arab rivers shows that flood intensity will increase substantially in some rivers and just a little in others, while it will actually decrease in others [(81)].

Rising temperatures will obviously lead also to a melting of the earth's coldest spots, its glaciers. While there are no glaciers in the Middle East and North Africa, the melting water will run into the oceans and increase sea levels everywhere. Sea levels are estimated to rise by between 20 and 30 centimetres by 2050, but could also attain two metres at the end of the 21st century according to the most pessimistic scenarios [(82)]. This will concern all the littoral in the world, but regions with many shores and densely concentrated cities by the seaside are in the frontline. The Middle East and North Africa is one of those regions: bordered by the Mediterranean Sea, the Atlantic Ocean, the Red Sea, the Indian Ocean and the Gulf. Tunisia and Egypt are 70 % more vulnerable

(75) UN DESA, Statistics Division (Indicators for SDG 1); Institute for Economics and Peace, 'Global Terrorism Index 2019 Briefing – Measuring the impact of terrorism' (https://reliefweb.int/sites/reliefweb.int/files/resources/GTI-2019-briefingweb.pdf).

(76) Parry, M.L. et al. (eds), *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge and New York, 2007.

(77) World Bank, *Natural Disasters in the Middle East and North Africa: A Regional Overview*, Washington, 2014 (https://openknowledge.worldbank.org/handle/10986/17829); Tabari, H., and Willems, P., 'Seasonally varying footprint of climate change on precipitation in the Middle East', *Nature Research*, Vol. 8, 2018, pp.1–10 (10.1038/s41598-018-22795-8).

(78) Driouech, F., Elrhaz, K., Moufouma-Okia, W. et al., 'Assessing future changes of climate extreme events in the CORDEX-MENA region using regional climate model ALADIN-Climate', *Earth Systems and Environment,* Vol. 4, 2020, pp.477–492 (https://link.springer.com/article/10.1007/s41748-020-00169-3).

(79) Ibid.

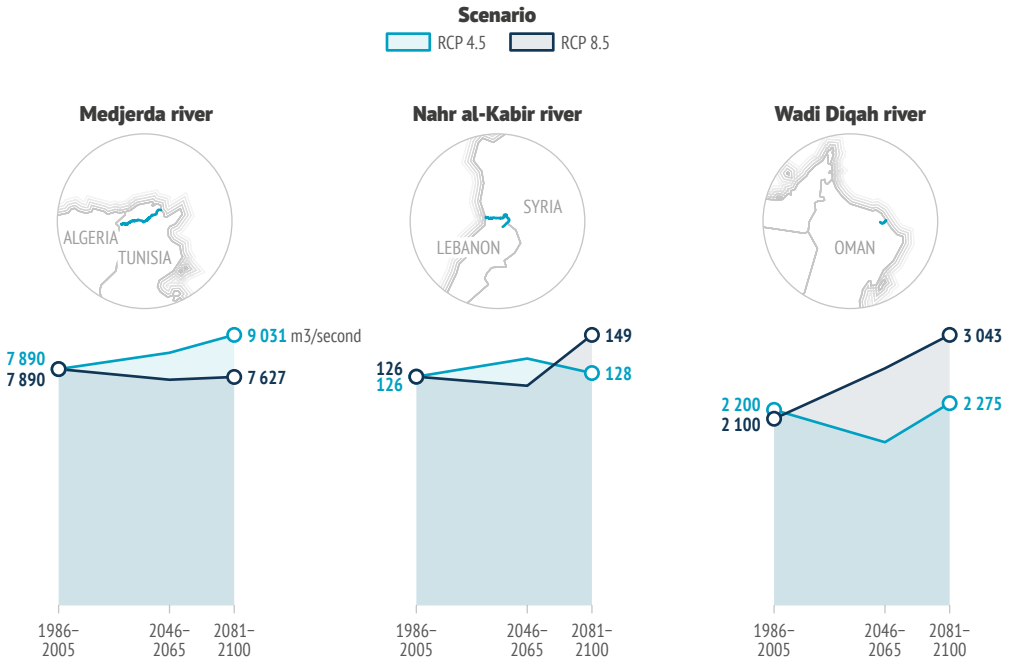
(80) World Bank Group, *Adaptation to a Changing Climate in the Arab Countries: A case for adaptation governance and leadership in building climate resilience*, Washington D.C., 2012.

(81) *Arab Climate Change Assessment Report – Main Report*, op.cit.

(82) Kulp, S.A. and Strauss, B.H., 'New elevation data triple estimates of global vulnerability to sea-level rise and coastal flooding', *Nature Communications*, Vol. 10, 2019, pp.1–12 (https://doi.org/10.1038/s41467-019-12808-z).

Flood intensity of three rivers

By timespan and scenario



Data: RICCAR, *Arab Climate Change Assessment Report*, 2017; European Commission, GISCO, 2021

to sea-level rise than any other coasts in the Mediterranean [83]: two thirds of the Tunisian population live on the coastline which also hosts 80 % of the country's economic activities, and 90 % of its tourism infrastructure [84]. In Egypt, 20 % of the population lives in areas below five metres of elevation.

Different projections yield different results, predicting the submersion of coastal areas to take place anywhere between 2030 and 2050, including Alexandria in Egypt, the region around Basra in Iraq, the neighbouring cities of Nasiriyah and Amarah, the coast from Misrata to Buerat in Libya and part of the Saudi shores off Bahrain, *regardless of any RCP scenarios* [85]. An increase of 30 centimetres for instance will put 190 km² of the Alexandria Governorate at risk and with it, 545 000 people. This would destroy more than 70 000 jobs, of which 3 000 are in agriculture, more than 10 000 in tourism and more than 50 000 in the industrial sector – meaning that the skills of the workers affected are not easily transferable. Predictions for mid-century estimate that 200 000 jobs will be at risk due to sea-level rise in Alexandria [86]. In 2050, if sea-level rise reaches 50 centimetres, more than 1.5 million people and 317 km² will be at risk in Alexandria [87]. In 2050, under the business-as-usual scenario

(83) Hzami, A. et al., 'Alarming coastal vulnerability of the deltaic and sandy beaches of North Africa', *Scientific Reports*, Nature Publishing Group, Vol. 11, January 2021 (https://www.nature.com/articles/s41598-020-77926-x).

(84) UNDP, *A Treasured Coastline: Addressing climate change vulnerabilities and risks in vulnerable coastal areas of Tunisia*, 2017 (https://www.adaptation-undp.org/projects/sccf-tunisia); World Bank, *Climate Risk Country Profile: Tunisia*, Washington D.C., 2021 (https://reliefweb.int/sites/reliefweb.int/files/resources/15727-WB_Tunisia%20Country%20Profile-WEB.pdf).

(85) *Climate Change Adaptation in the Arab States – Best practices and lessons learned*, op.cit.

(86) *Food in an Uncertain Future*, op.cit

(87) Ibid.

(RCP 8.5), Port Said city in Egypt might also be threatened by sea-level rise [88]. In Basra Governorate, under a scenario of a one metre rise in sea levels, around 950 km² of the region might be inundated, which represents nearly 5 % of the governorate territory. With a population within the district of Basra of around 1.5 million people in 2014 and more than 4 million inhabitants in the governorate, the region is of crucial importance to the Iraqi economy, as it hosts the main port of the country, contains extensive fertile agricultural land and is home to some of the country's biggest oil fields [89].

Climate change is also increasing the probability of wildfires occurring: already, these have increased in intensity and extent all over the region. In 2019, Lebanon experienced 194 wildfires (46 during the month of October alone), losing 3 155 hectares and 2 % of its forests [90].

While it is not clear to what extent, environmental hazards will increase migration [91]. In 2018, displacements due to natural disasters accounted for 94 % of total displacements around the world. 144 new camps and accommodation centres for displaced persons were due to natural disasters, while only 55 were due to conflicts and violence. The same year, drought displaced 1.3 million people worldwide [92]. In Yemen, 86 % of displaced people in the district of Socotra, amounting to more than 14 000, were forced to flee their homes because of natural disasters [93].

Some studies estimate that climate-induced migration will be mainly determined by extreme weather events or loss of livelihood due to a change in climate patterns, especially for rural communities living on fishery, pastoralism or farms. In that case, climate-induced migration is likely to mostly take the form of internal displacement [94]. This assessment is particularly true when talking about migration and sea-level rise. Indeed, people affected by floods do not always migrate and when they do, their decision is mainly motivated by social and economic factors. Moving from an area vulnerable to sea-level rise, regardless of whether there is a relocation programme or not, is only imaginable for people if they find acceptable social and economic opportunities in their new locations. This is why political, social and economic encouragement given by public policies and plans are more crucial factors driving migration than sea-level rise itself [95].

Arab citizens and states are threatened by an increase in disasters such as floods, landslides and sea-level rise. The economic and political cost of this is considerable, and migration and displacement appear certain as a result.

(88) See interactive threat maps at: coastal.climatecentral.org.

(89) Abbas, N., Nasrin, S., Al-Ansari, N. and Ali, S.H., 'The impacts of sea level rise on Basrah City, Iraq', *Open Journal of Geology*, Vol. 10, 2020, pp.1189-1197; UN Habitat, *Basra – Urban Profile*, 2019 (https://unhabitat.org/sites/default/files/2021/03/basra_urban_profile_-_english.pdf); populationdata.net, 'Iraq', 2020 (https://en.populationdata.net/countries/iraq/).

(90) EU Joint Research Centre, *Forest Fires in Europe, Middle East and North Africa 2019*, JRC Technical Report, Ispra, 2020 (https://www.euneighbours.eu/sites/default/files/publications/2020-11/jrc122115-annual_report_2019_final_topdf_1%20%281%29.pdf).

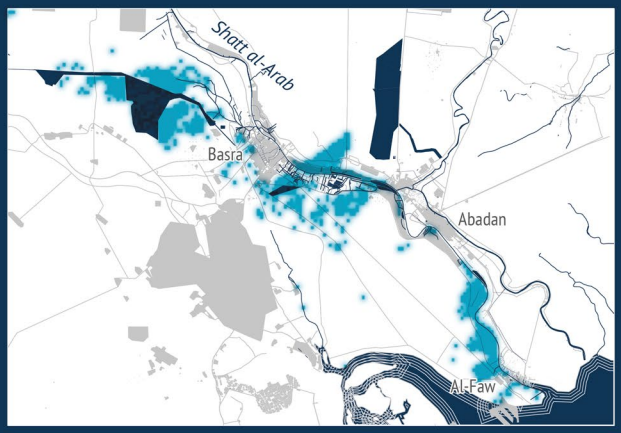
(91) World Bank, 'Groundswell: Preparing for Internal Climate Migration', Washington, 2018 (https://openknowledge.worldbank.org/handle/10986/29461).

(92) International Organisation for Migration, *World Migration Report 2020*, Geneva, 2019 (https://publications.iom.int/system/files/pdf/wmr_2020.pdf).

(93) Displacement Tracker Yemen: https://displacement.iom.int/yemen.

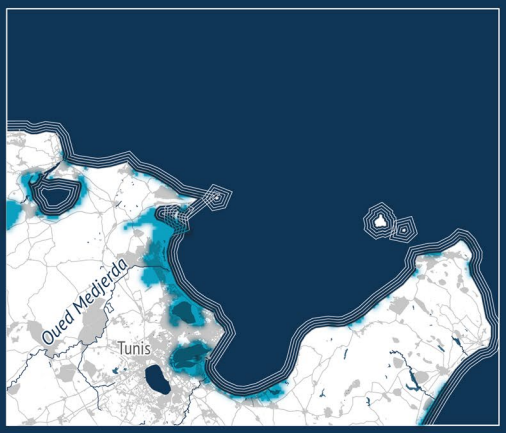
(94) Bilgil, O and Marchand, K., 'Migration, development and climate change in North Africa', Maastricht Graduate School of Governance & United Nations University, May 2016.

(95) Hauer, M.E., Fussell, E., Mueller, V. et al,. 'Sea-level rise and human migration', *Nature Reviews and Earth Environment*, Vol. 1, 2020, pp. 28–39 (https://www.nature.com/articles/s43017-019-0002-9); City Lab, 'Will sea-level rise claim Egypt's second-largest city?', 22 August 2019 (https://www.bloomberg.com/news/articles/2019-08-22/will-egypt-s-ancient-city-succumb-to-rising-seas).



Basra, Iraq

60 km



Tunis, Tunisia

40 km

Misrata, Libya

100 km

Rising sea levels

Areas below sea level given a mean sea level rise of 0.8 m by 2100 under a business-as-usual scenario of greenhouse gas emissions

According to AR6, the latest IPCC report, global sea levels will rise between 0.6 and 1 metre by the year 2100 under the RCP 8.5 scenario.

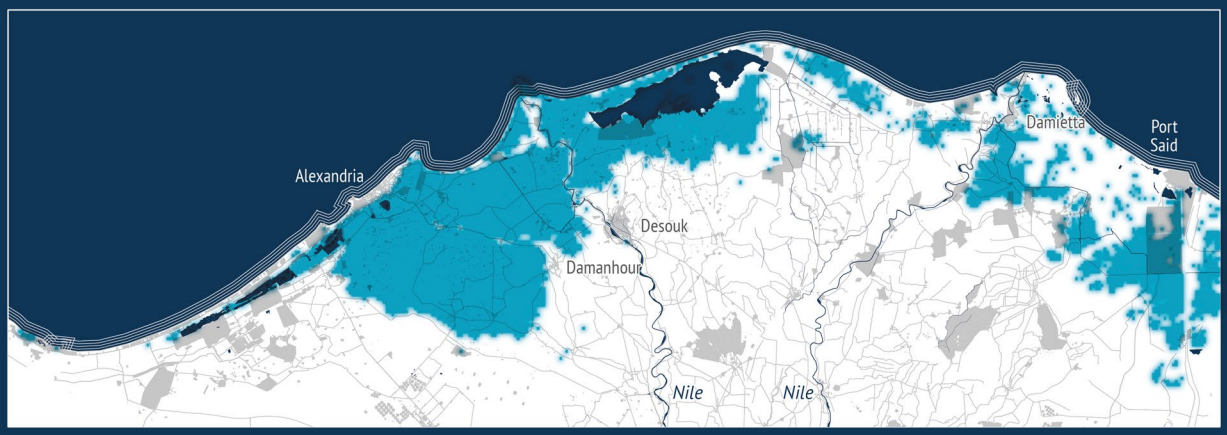
Arab coasts, infrastructure and settlements will be endangered by rising waters and floods across the region.

Data: NASA, IPCC AR6 Sea Level Projection Tool, 2021; NASA, SRTM 90m Digital Elevation Database v4.1, 2021; European Commission, GISCO, 2021; OpenStreetMap, 2021

- flooded land
- buildings
- major roads
- waterways
- lakes

Alexandria, Egypt

100 km



CHAPTER 2

ON COLLISION COURSE

Climate change meets humanity

In a first instance, climate change is an environmental phenomenon affecting the planet and all those living on it. But in a second instance, it affects human patterns of activity – and vice versa. After all, it was human activities – the way humans work, produce, live, and move – that created climate change. These activities will not just be on the receiving end of climate change, they will also affect climate change in a business-as-usual scenario. We identify three areas in particular where climate change will critically interact with human patterns in the region: population growth (how many people there will be); urbanisation (where people will live); and economic activity (what people will do to earn their livelihood).

All three have the potential to be negatively affected by climate change, and in turn make climate change worse. Conversely, necessary changes can break this vicious circle - which is why the scenarios outlined below have to be understood as projections under a linear equation whereby humanity makes no changes to its current trajectory.

MORE PEOPLE, MORE PROBLEMS? POPULATION GROWTH AND CLIMATE CHANGE

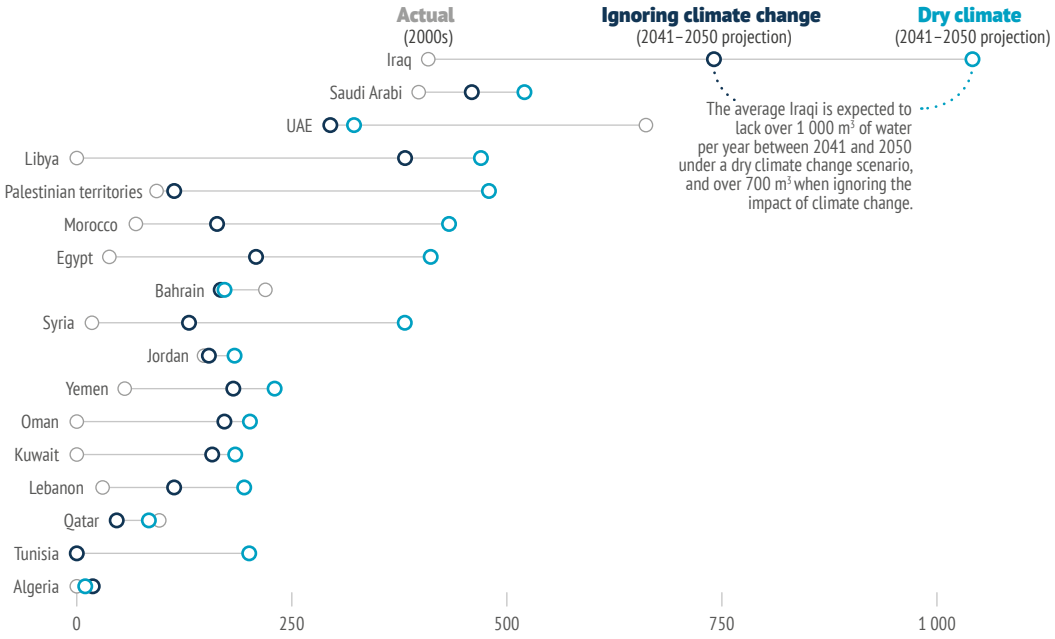
Demographics and climate change are two developments that reinforce each other generally negatively: on the one hand, climate change will make it more challenging to meet the needs – in terms of water, food, housing and energy - of a larger population, but on the other, a larger population will itself further contribute to climate change in the current economic and energy context. This is particularly the case in the region which will see important demographic growth all the way to 2050: its population will increase by 20 % by 2030 and by 50 % in 2050, and will begin to plateau thereafter. In absolute terms, the region's population will rise to 580 million in 2030 and more than 640 million in 2050 (Europe will still have a larger population with 741 million in 2030 and 710 million in 2050 [(1)]). After that, demographic growth will slow down and approach European levels - already, Emirati women have 1.4 children on average, with Qatar, Bahrain, Lebanon and Tunisia not far behind. But because life expectancy is rising at the same time, and child mortality is

(1) Calculation made by authors on the basis of World Bank data and UNICEF, *MENA Generation 2030: Investing in children and youth today to secure a prosperous region tomorrow*, 2019 (https://doi.org/10.1787/19428846-en).

Water shortage

Annual water shortage, m^3 per capita per year

While some countries in MENA do not face water scarcity at first sight, most will face mounting water shortages in the future due to a growing population, economic activities, urbanisation and poor and unsustainable water management. Climate change will make things worse.



Data: 'Water resources trends in Middle East and North Africa towards 2050', *Hydrology and Earth System Sciences*, 2012

declining, this means that the overall size of the population is not yet shrinking [2].

Even without climate change, population growth will lead to significant water shortages in every country in the region unless states change the way they manage water – in fact, this is already happening. Between 22 % and 49 % of the increasing demand for water is due to a growing population living in cities and engaging in economic activity [3]. In Jordan, a mere 11 % of the country's 2050 water demand will be the result of climate change [4].

States that are particularly affected by the adverse relationship of population growth and resource shortages are those suffering from conflict. This is, at least in part, because fertility is particularly high in states affected by conflict: population growth will be concentrated in Iraq, Syria, the Palestinian territories and Yemen by respectively 107 %, 99 %, 92 % and 65 % until 2050, confirming a trend observed elsewhere. There are several possible explanations for this: marriage regarded as providing social and economic safety, disruption of family planning services due to conflict, a drop in female educational levels and the rise of pronatalist ideologies during a

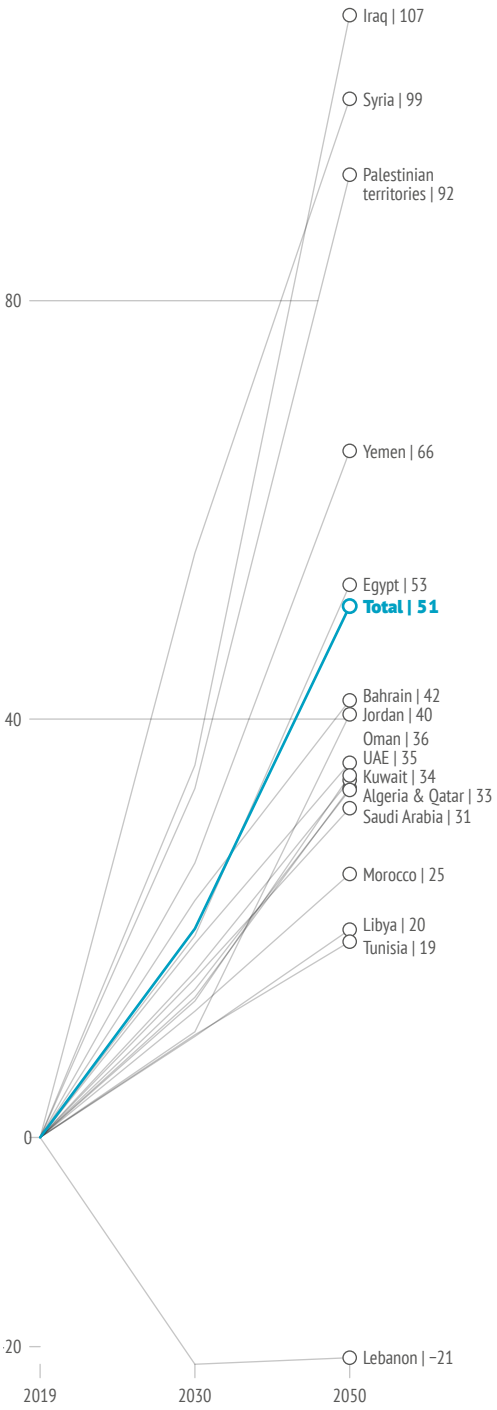
(2) Ibid.

(3) 'Water resources trends in Middle East and North Africa towards 2050', op.cit.

(4) Ibid.; *Food in an Uncertain Future*, op.cit.

Increase of population

By 2030 and 2050, with 2019 as baseline, %-point population growth



Data: World Bank, DataBank, 2021; UNICEF, *MENA Generation 2030*, 2019

time of existential violence have all been proposed as explanations [5]. But at the same time, states in conflict already face severe water and food shortages that climate change will make worse.

A growing population will also require more food – and as we have seen in the previous chapter, regional agriculture will not be able to meet these demands, and in fact has not been able to do so for decades. More than 25 % of internationally traded cereals, 20 % of poultry meat and 39 % of sheep meat go to this region which is home to just 6 % of the world's population. [6] There are vast differences between countries in this regard, mostly resulting from lack of arable land. Whereas Saudi Arabia, Oman, Kuwait, Bahrain, Jordan or the UAE import more than 90 % of their food staples, Algeria imports 'only' 70 %. [7] Food import dependency has increased from 10 % in the 1960s to 50 % today – and even without climate change, it is projected to reach 68 % by 2050. Egypt will be the most affected due to its spectacular population growth [8].

Food import dependency is not *per se* a problem, but it can become one if supply chains are interrupted, or if a commodity is in short supply, leading to an increase in food price. According to the IPCC, cereal prices could go up by 29 % by 2050 [9]. In regions and states with sufficient income these increases should be easier to absorb, but not so much in the

(5) Cetorelli, V., 'The effect on fertility of the 2003–2011 war in Iraq', *Population and Development Review*, Vol.14, No 4, pp.581–604, 2014 (https://doi.org/10.1111/j.1728-4457.2014.00001.x); Madsen, E.L. and Finlay, J.E. 'The long-lasting toll of conflict on fertility and early childbearing', *Population Reference Bureau*, 2019 (https://www.prb.org/resources/the-long-lasting-toll-of-conflict-on-fertility-and-early-childbearing/).

(6) OCDE/FAO, *OECD-FAO Agricultural Outlook 2018-2027*, Éditions OCDE, Paris/FAO, Rome, 2018 (https://doi.org/10.1787/agr_outlook-2018-en).

(7) *Addressing agricultural import dependence in the Middle East-North Africa region through the year 2050*, op.cit.

(8) Ibid.

(9) Mbow, C., Rosenzweig, C. et al, 'Food Security' in Shukla, P.R., Skea, J., Calvo Buendia, E., V. Masson-Delmotte, V. et al. (eds.), *Climate Change and Land: An IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*, In Press, 2019.

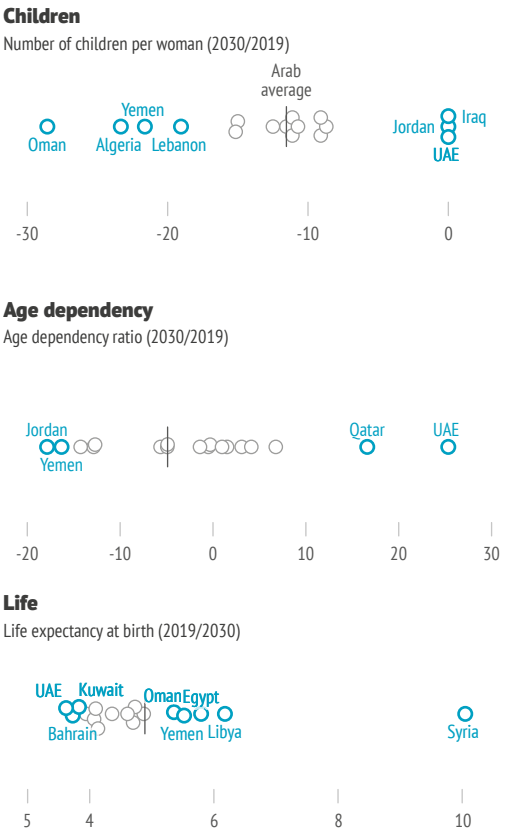
Arab states: 44 % of households' income (13 % in the EU [10]) is spent on food items and cereals [11].

Food price volatility is not just a matter of subsistence – it also has implications for political stability. 'Bread riots' over high food prices have shaken the region on several occasions in the past – in Egypt in 1977, in Morocco in 1984, Algeria in 1988 and Jordan in 1989 and 1996 – but the problem has gained more prominence since the Arab Spring. In the months preceding the uprisings, food prices had increased by a third or a half in Egypt and Syria despite generous subsidies. 'Bread, freedom and dignity' was one of the slogans protesters chanted in the streets of Cairo. It is for this reason that many states in the region subsidise food items; Egypt, for instance, spends $500 million a year on its food subsidy system which allows those registered in it to buy items such as cooking oil, rice, sugar and bread for less than 20 % of market value. In Libya, citizens receive flour at 7 % of the market price [12]. There have been several – partly successful – attempts to reform these subsidy systems, but in a future environment where multiple pressures will be exerted on the food system as a whole, this will be even more challenging.

In general, the political impact of food price spikes depends on the extent to which the state in question can absorb the shock. This in turn depends on factors such as the role of agriculture in the national economy, agricultural productivity and structure, food import dependency, institutional coherence, wealth – but also on political systems [13]. This means that future Arab food security will depend largely on how well states prepare to manage the coming changes.

Indicators slow, as populations grow

Projected change from 2019 to 2030, %



Data: World Bank, DataBank, 2021; UNICEF, *MENA Generation 2030*, 2019

Growing populations will not just be at the receiving end of climate change, they are also a factor in aggravating it. In the current economic and energy context (meaning that change is possible), a larger population correlates with a larger CO_2 footprint – roughly 1 % in population increase leads to 1 % in emission increase, although other factors such as GDP growth and urbanisation levels

(10) Eurostat, 'How much are households spending on food?', 2021 (https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20201228-1).

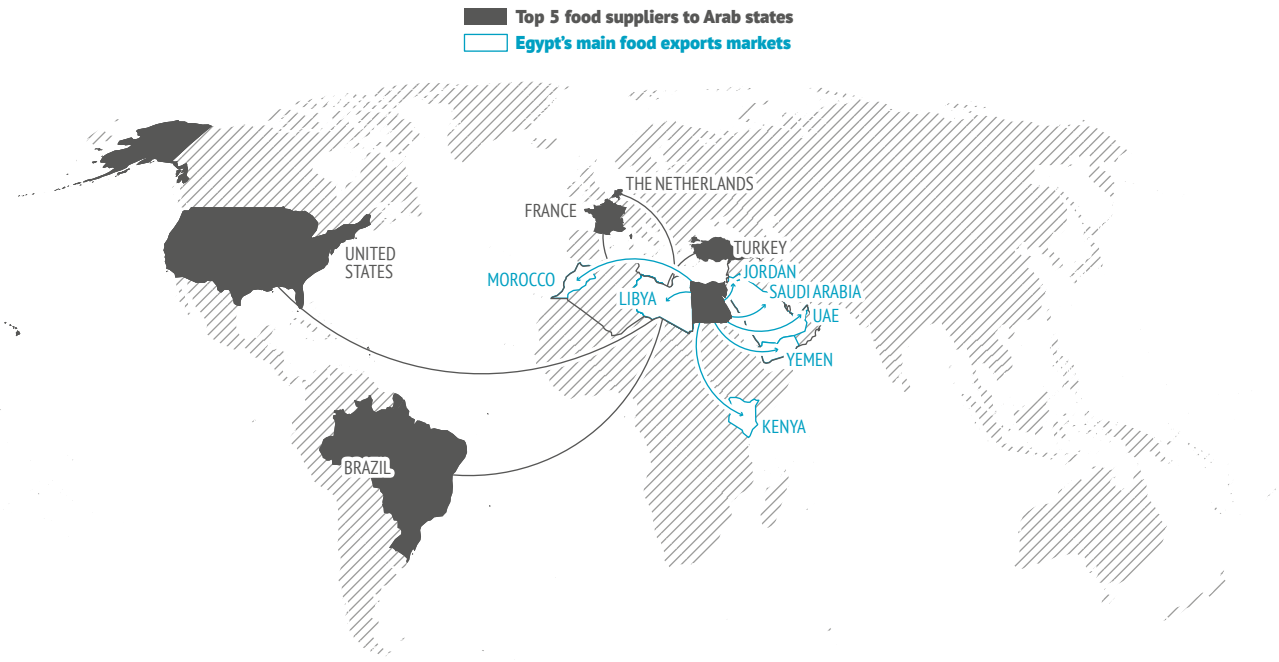
(11) *OECD-FAO Agricultural Outlook 2018-2027*, op.cit.

(12) Verme P. and Abdelkrim A., *The Quest for Subsidies Reforms in the Middle East and North Africa Region: A microsimulation approach to policy making*, World Bank, 2017 (https://openknowledge.worldbank.org/handle/10986/25783).

(13) Jones, B.T., Mattiacci, E. and Braumoeller, B.F., 'Food scarcity and state vulnerability: Unpacking the link between climate variability and violent unrest', *Journal of Peace Research*, Vol. 54, No 3, 2017, pp. 335-350; Ismail, Z., 'Interaction between Food Prices and Political Instability', *Knowledge, Evidence and Learning from Development*, 2021; Hendrix, C.S. and Haggard, S., 'Global food prices, regime type, and urban unrest in the developing world', *Journal of Peace Research*, Vol. 52, No 2, 2015, pp. 143-157.

Geopolitics of food

Sources and markets of Arab food



Data: World Bank, World Integrated Trade Solution, 2021; European Commission, GISCO, 2021

play a role as well (see also the next section in this chapter) [14]. In part this is because a larger population will require more energy: by 2050, regional energy needs are projected to triple [15]. Climate change itself will also increase needs for energy: already, cooling takes up 9.3 % of buildings' energy need, emitting almost 100 million tons of CO_2 [16]. During the 2021 heatwave, Tunisia suffered power outages as the energy grid crumbled as a result of the demand for air conditioning [17]. If current trends continue, just 13 % of these needs will be met by renewable energy by 2040 – half of the world's average. [18] Where a state cannot provide its population with the required energy, its entire system collapses. Lebanon's 2021 crisis was an illustrative preview of this. All of these developments are linear extrapolations of ongoing trends: should states in the region manage to move to CO_2-neutral energy, and decouple economic growth from greenhouse gas (GHG) emissions, a different scenario is not just imaginable but possible.

> **The needs of a larger Arab population will be more difficult to meet because of climate change; but population size itself will also contribute to even more CO2 emissions.**

(14) Population Action, 'How do recent population trends matter to climate change?', 2009, p.6 (http://pai.org/wp-content/uploads/2012/01/population_trends_climate_change_FINAL.pdf.pdf).

(15) International Energy Agency, *World Energy Outlook 2019*, November 2019 (https://iea.blob.core.windows.net/assets/98909c1b-aabc-4797-9926-35307b418cdb/WEO2019-free.pdf).

(16) International Energy Agency, *The Future of Cooling: Opportunities for energy-efficient air conditioning*, 2018.

(17) Al Arabiya News, 'Tunis heatwave hits record 49 degrees Celsius', 3 August 2021 (https://english.alarabiya.net/News/north-africa/2021/08/11/Tunis-heatwave-hits-record-49C-).

(18) British Petroleum (BP), 'BP Energy Outlook – 2019: Insights from the evolving transition scenario – Middle East', 2019 (https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2019-region-insight-middle-east.pdf).

LIVING IN THE HOT SEAT? URBANISATION AND CLIMATE CHANGE

As with demographics, regional urbanisation is closely interlocked with climate change: climate change will accelerate and challenge urbanisation, but urbanisation itself can contribute to more emissions and therefore climate change if it is not well managed. In part, this is because both are part of the same phenomenon: increased human agglomeration and activity.

Even without climate change, the region would inevitably follow the global and long-established trend of humans moving to live in cities. This is because there are compelling reasons to do so: jobs, doctors, education, culture and food are all easier to find in cities. [(19)] Climate change will add even more reasons: jobs in agriculture will be lost, living conditions in the countryside will be harsher, and natural disasters will make cities the best possible option as a place to live [(20)]. Because of this, it is estimated that rural exodus rates will increase by 20 %, pushing urbanisation in the region to 62 % in 2030 and 70 % in 2050 (in comparison, 83.7% of Europeans will live in cities in 2050 [(21)]). Some of this growth is occurring very fast: the population of Baghdad will almost double between 2010 and 2030, while Cairo's population will reach 38 million in 2050, up from 23 million in 2020 [(22)]. As European urbanisation rates show, this is not *per se* negative, but it comes with challenges that need to be managed – challenges that climate change will make even more difficult.

To start, cities will feel the heat even more than the rest of the country. This is because cities concentrate not just people and their economic activities, but also solar radiation and CO_2 emissions, which leads to an increase of temperature within cities, a phenomenon called 'urban heat island' [(23)]. In Amman and Cairo, the number of extreme heat days is projected to double from 10 (before 1990) to 20 days per year by 2039. In Baghdad and Beirut, it will even increase to 40 days. After 2040, Amman and Cairo will experience around 60 days of extreme heat per year, and Beirut and Baghdad almost 100 [(24)]. Because of climate change, temperatures in urban areas will not only increase during the day, but also during the night since the number of tropical nights (nights with a temperature exceeding 20°C) will rise from 18 by 2030 to 33 by 2050 in the Middle East under a business-as-usual scenario (RCP 8.5) [(25)]. This means that cities will have to climate-proof their existing infrastructure, make sure the new infrastructure can withstand the heat, and provide adequate housing. There are multiple ways to achieve this: sites such as Masdar City in the

(19) Arouri, M., Youssef, A.B., Nguyen-Viet, C. and Soucat A., 'Effects of urbanization on economic growth and human capital formation in Africa', Program on the Global Demography of Aging at Harvard University, Working Paper 119, 2014; Bakewell, O., 'Some reflections on structure and agency in migration theory', *Journal of Ethnic & Migration Studies*, Vol. 36, 2010, pp.1689-1708. (https://doi:10.1080/1369183X.2010.489382); Menzi, L., 'Migration from rural areas to cities: challenges and opportunities', International Organisaton for Migration (IOM), 2016 (https://rosanjose.iom.int/SITE/en/blog/migration-rural-areas-cities-challenges-and-opportunities).

(20) Warner, K., Ehrhart, C., de Sherbinin, A. and Adamo, S., *In Search of Shelter: Mapping the effects of climate change on human migration and displacement*, Columbia University, CARE international, UNHCR, UN University and World Bank, 2009 (http://www.ciesin.columbia.edu/documents/clim-migr-report-june09_final.pdf).

(21) *Arab Sustainable Development Report 2020*, op.cit.; United Nations, Department of Economic and Social Affairs, *World Urbanization Prospects – Final Report: the 2018 Revision*, New York, 2019 (https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf).

(22) *Food in an Uncertain Future*, op.cit.; *World Urbanization Prospects*, op.cit.; El Hefnawi, A., 'Cairo Vision 2050: the strategic urban development plan of greater Cairo region' presented to UN HABITAT, 2010 (https://mirror.unhabitat.org/downloads/docs/8635_42944_AymanEl-hefnawi.pdf).

(23) 'Urban Heat Island'. Encyclopedia of National Geographic, (https://www.nationalgeographic.org/encyclopedia/urban-heat-island/)

(24) *Food in an Uncertain Future*, op.cit.

(25) Climate Change Knowledge Portal, op.cit.

UAE explore innovative ways to cool cities in a climate-neutral way, reducing commutes and emissions at the same time. But the insights need to be implemented, and regional urban planning still lags behind new developments and innovations.

By some estimates, housing needs will be three times greater than today by 2050 due to population growth and urbanisation conflating [(26)]. Where cities cannot provide housing at this speed, informal housing (defined as 'areas where groups of housing units have been constructed on land that the occupants have no legal claim to, or occupy illegally; unplanned settlements and areas where housing is not in compliance with current planning and building regulations' [(27)]) proliferates. Slums are already a feature of the region, with 25 % of its urban population living in such conditions [(28)] – Lebanon (71 %), Yemen (67 %) and Iraq (46 %) are particularly affected [(29)]. Nearly a third of Baghdad's 7.5 million, and almost half of Cairo's 10 million inhabitants, live in such settlements, and many other cities, such as Alexandria, Casablanca or Tripoli, are surrounded by slums [(30)]. By 2030, slums are projected particularly to grow in Yemen, Mauritania and Sudan, essentially because most urban growth is projected to occur in those countries. Because people displaced by conflict tend to return to cities rather than villages, more 'slumification' might follow in Syria, Yemen but also Iraq.

The problem is that slums, even less so than the other parts of the cities, are ill-equipped to absorb the consequences of climate change. Because of their structure, poor access to sanitation, electricity and sewage, they are even more vulnerable to extreme weather events such as floods and landslides that are set to become more frequent due to environmental degradation [(31)].

But slums are not just a problem of sanitation and human dignity: they are also a breeding ground for crime syndicates, violence and terrorism. In part this is because poor living conditions provide a recruitment pool, but in part this is also because state penetration of slums is low. Sadr City, for instance, Baghdad's poorest district and home to about 2 million people, was originally built in the 1960s as low-cost housing for new urban dwellers often arriving from the countryside. As a home to communists opposed to the Baath regime it suffered from state neglect; later, inhabitants opposed coalition forces, and as a result the neighbourhood became the site of violent clashes, severely damaging the infrastructure and deteriorating living conditions further. To American troops, Sadr City was largely off-limits, and it became a stronghold for several militias actively fighting their presence in the years after 2003. Similar patterns can be observed in slums in Lebanon: Palestinian refugee camps are not accessible to Lebanese security forces, and other parts of Beirut are best visited in the company of Hizbullah. Organised crime, too, takes advantage of the state vacuum that slums provide, be it in Iraq or Egypt. Because of this, in 2019 the government in Cairo launched a plan to make Egyptian cities 'slum-free' by 2030.

Unmanaged urban growth will also make other climate-change challenges harder to meet. For instance, without an urban planning policy the surface area of Jordan's capital Amman

(26) Brown, L.R., 'Chapter 11: Housings' in Brown, L.R., Gardner, G. and Halweil, B., *Beyond Malthus: Nineteen dimensions of the population challenge*, Earthscan, London, 2000, p.70, 2000.

(27) OECD, Glossary of Statistical Terms, 'Informal Settlements' (https://stats.oecd.org/glossary/detail.asp?ID=1351).

(28) UNDP, DERASAT, UN Habitat, *The State of Arab Cities 2020: Financing sustainable urbanization in the Arab region,* 2020.

(29) UN Habitat, Urban data, 'Urban population living in slums by country or area, 1990–2018' (https://data.unhabitat.org/datasets/urban-population-living-in-slums-by-country-or-area-1990-2018-thousands/explore).

(30) Al-Arabiya, 'Can Egypt's slums be replaced by "safe zones"?', 31 March 2019 (https://english.alarabiya.net/features/2019/03/31/Can-Egypt-s-slums-be-replaced-by-safe-zones-)

(31) *Natural Disasters in the Middle East and North Africa: A Regional Overview,* op.cit.; Pal, J. and Eltahir, E., 'Future temperature in southwest Asia projected to exceed a threshold for human adaptability', *Nature Climate Change*, Vol. 6, 2016, pp.197–200.

will increase by 14 % by 2030, eating into arable land that could be used for agriculture, producing more pollution and making service delivery costly [32].

But cities are not just on the receiving end of climate change, they contribute to it, too: globally, they account for 70 % of CO_2 emissions. Four of the world's 20 most emitting cities in absolute terms are located in the region: Riyadh (#10), Dubai (#11), Benha in Egypt (#17) and Al-Ahmadi in Kuwait (#20) [33]. As these cities are projected to grow, so is their carbon footprint – again, unless important changes are made. The largest emitting sector within these cities is transportation: already, 32 % of Arab countries' gas emissions comes from this sector, and within it, 75 % comes from road traffic, which will increase to 80 % by 2030 because of population growth [34].

The problem is that Arab cities are already facing a transportation crisis – primarily caused by private vehicles. In 2019, Cairo was congested 40 % of the time – reaching 77 % during the early evening rush hour [35]. While these numbers are almost the equivalent of Paris, Parisians have access to a public transport system that most Arabs do not have.

Cities are not just on the receiving end of climate change – they contribute to it, too.

This is a problem because public transportation has the potential to significantly reduce emissions from transport: the more people travel together, the smaller the carbon footprint of each person. In addition, development of public transport increases mobility capacity, assuming that public transport networks are accessible to a large majority of people [36]. Efficient public transport systems are also less costly for households than using private cars, and investing in public transportation drives job creation and provides new job opportunities thanks to enhanced mobility. [37]

There are some signs of change: metro lines are now operating in Algiers, Cairo, Dubai and Doha, metro construction projects are underway in Baghdad and Riyadh, tramway systems operate in Algiers, Rabat, Casablanca and Tunis, and in 2020 Amman launched a Bus Rapid Transit service, a system run on segregated lanes. Special representatives – called 'bicycle mayors' – are now pushing for bicycle lanes in Beirut and Tripoli and Lebanon [38]. But much more remains to be done to meet the transport challenge. Arab cities fare particularly poorly when it comes to walkability and to the use of bicycles. In part, this is an infrastructure problem, but social status plays a role, too: cars are status symbols whereas public transport, walking or cycling are seen as indicative of low levels of income, or unsafe, especially for women. (An image that NGOs like the Lebanese Chain Effect or BYCS are seeking to improve.) In part, this is of course also because temperatures rise to levels that are too hot for cyclists for about three months a year.

(32) World Bank, *Greater Than Parts: A Metropolitan Opportunity* (Vol. 5) – *Metropolitan Amman: Comprehensive Climate Plans*, 2020 (https://documents.worldbank.org/en/publication/documents-reports/documentdetail/520781605297422379/metropolitan-amman-comprehensive-climate-plans).

(33) City Carbon Footprints, 'Global Gridded Model of Carbon Footprints (GMCF)' (http://citycarbonfootprints.info).

(34) UN Habitat, *Local Climate Action in the Arab Region: Lessons learned and way forward*, Giza, 2019.

(35) Traffic Index 2020 (https://www.tomtom.com/en_gb/traffic-index/ranking/); El-Geneidy A., Diab E., Jacques, E. and Mathez, A., 'Sustainable Urban Mobility in the Middle East and North Africa', Thematic study prepared for Global Report on Human Settlements 2013, Nairobi, 2011.

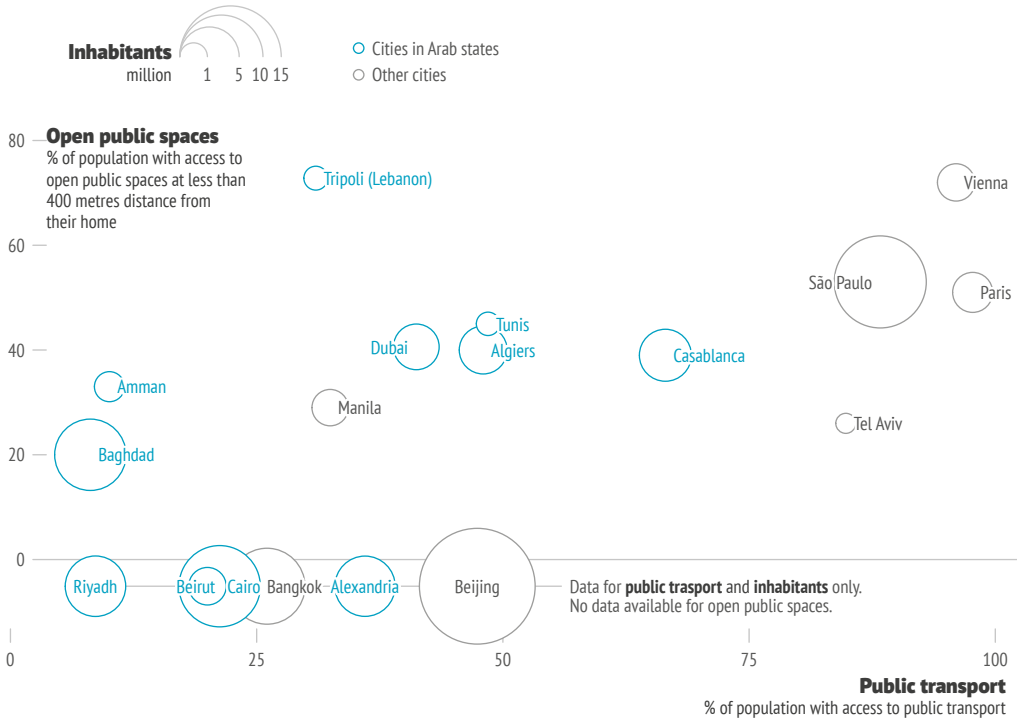
(36) Buchanan, M., 'The Benefits of Public Transport', *Nature Physics*, Vol. 15, No 876, 2019 (https://doi.org/10.1038/s41567-019-0656-8).

(37) Weisbrod, G. and Reno, A., 'Economic impact of public transportation investment', Transit Cooperative Research Program, 2009; American Public Transport Association, *Economic Impact of Public Transport Investment*, 2014 (https://www.eesi.org/files/Economic-Impact-Public-Transportation-Investment-APTA.pdf).

(38) Middle East Eye, 'The battle to make Lebanon more bicycle friendly', 2 September 2021, (https://www.middleeasteye.net/discover/lebanon-bicycle-battle-make-more-friendly).

Walking the walk

Access to public transport is better in cities with greater access to open public spaces. Arab cities lag behind.



Data: Source: UN Habitat, *Data and Analytics*, 2020

States and cities in the region also miss an opportunity to reduce the effects of climate change because they have very limited public space such as parks, playgrounds or waterfronts. This increases heat further [39]. Natural green spaces, but also fountains, ponds, lakes and even roof gardens moderate extreme temperatures and reduce urban heat islands [40]. Every shade-providing tree can reduce emissions from power plants by 10 kg. Here, too, some positive developments are underway, especially in the Gulf: both Riyadh and Dubai have ambitious plans for parks and playgrounds – but at the same time, public space is being reduced by construction plans for a motorway in Cairo [41]. But not all trees are equal in terms of their ecological benefits and performance: although palm trees have become one of the region's symbols, they require watering several times a week. Instead, Qatar is now opting for the Sidr tree along motorways, a much more resilient tree when it comes to water needs.

(39) Mercer, 'Quality of living city ranking', 2019 (https://mobilityexchange.mercer.com/insights/quality-of-living-rankings); Woolley, H.and Rose, I. (Department of Landscape, University of Sheffield) and Carmona, M. and Freedman, J. (Bartlett School of Planning, University College London), 'The Value of Public Space, How high quality parks and public spaces create economic, social and environmental value', CABE Space, London (https://www.designcouncil.org.uk/sites/default/files/asset/document/the-value-of-public-space1.pdf); UN Habitat, League of Arab States, *Towards an Arab Urban Agenda*, 2016.

(40) Akbari, H., 'Shade trees reduce building energy use and CO2 emissions from power plants', *Environmental Pollution*, Vol. 116, 2002, Supplement 1, pp. S119-126. (http://webmail.seedengr.com/documents/Shade%20trees%20reduce%20building%20energy%20use%20and%20CO2%20emissions%20from%20power%20plants.pdf).

(41) *Arab News*, 'The incredible plan to create the largest public park in the world at the heart of Riyadh', 21 March 2019 (https://www.arabnews.com/node/1470066/saudi-arabia).

Climate change and urbanisation interact in several ways: while climate change pushes more people into cities, it also makes cities hotter. Urban centres will have to adapt fast to both a rapid influx of people, and the extreme effects climate change will have – but they also have to reduce their emissions.

THE PRICE TAG: ECONOMIC EFFECTS OF CLIMATE CHANGE

As with demographics and urbanisation, climate change and human economic activity can have mutually negative repercussions: human economic activity has caused climate change in the first place, but climate change itself will have negative economic effects – if we continue along the business-as-usual trajectory.

In the region, the first sector to be impacted by climate change is agriculture - and with it, the jobs attached to it. While agriculture might not play a large role in the region's GDP, it does provide work: 33 % of the labour force in Morocco, and 20 % in Egypt and Iraq work in agriculture [(42)]. In North Africa and Syria, almost two thirds of the rural population rely on rainfed crop production for subsistence, income and food [(43)]. In Tunisia, 62 % of wheat, whose yields will decrease, is produced by small farmers [(44)]. Farmers living in remote areas, in the Maghreb or Iraqi mountains for instance, using snow melts as water resources will also be highly impacted by climate change. This means that the rural population, which represents 25 % of the Arab population – 26 % of Algerians, 29 % of Iraqis, 36 % of Moroccans or 62 % of Yemenis [(45)] – are the most vulnerable to losing their jobs to the effects of climate change. They are already the poorest of society: more than 65 % of the rural population in the Palestinian territories, Morocco and Tunisia are poor, and 50% in Algeria [(46)]. Because of their low levels of income and reduced access to technology, farmers have not been able to invest adequately in means of adaptation to climate change [(47)]. In stability terms, the countryside is normally not a cause for concern: unrest, terrorism or street demonstrations are primarily urban phenomena. But as we have seen in the previous chapter, loss of livelihood in the countryside is projected to push people into cities, where their lack of professional skills, low levels of education and precarious financial situation will make their integration difficult.

Tourism, another prime source of income for several Arab countries, will also be affected by climate change. In 2019, it accounted for 8.9 % of the GDP in the Middle East and employed some 7 million people [(48)]. In Egypt alone, tourism employs more than 2 million people and contributes to 9 % of GDP. In Jordan tourism contributes to 15 % of the GDP and employs 17 % of the population. In Morocco and the UAE, 10 % of the countries' economies stem from tourism, which also employs more than 10 % of the workforce [(49)].

(42) World Bank data - Agriculture, forestry, and fishing, value added (% of GDP) and Employment in Agriculture (% of total labour force).

(43) Ibid; FAO and UNESCWA, *Arab Horizon 2030: Prospects for enhancing food security in the Arab region*, 2017.

(44) *Climate Variability, Drought and Drought Management in Tunisia's Agricultural Sector*, op.cit.

(45) World Bank data - Rural population (% of total population).

(46) *Food in an Uncertain Future*, op.cit.

(47) Ibid.; Arab Forum for Environment and Development, *Food Security: challenges and prospects*, Arab Environment No 7, Beirut, 2014

(48) World Travel and Tourism Council, *Economic Impact Reports – Regional Overview 2019*, 2021 (https://wttc.org/Research/Economic-Impact).

(49) Ibid.

Tourism will be affected by climate change because it is a highly water-demanding sector (especially in exclusive hotels and resorts with swimming pools, saunas, golf courses etc) [50]. In Arab countries, water consumption per tourist, depending on the level of commodity, can go from 200 to 600 litres of water used per tourist per day – this represents double or triple the volume of regular domestic consumption [51]. Tourism and agriculture are both sectors that exert a lot of pressure on water, and therefore might also end up in competition for this precious resource during the summer period, when water is needed both for irrigation purposes and for the peak tourist season [52].

Climate change is also likely to reduce the appeal of Arab destinations for tourists as they become too hot in the summer; in addition, coral reef tourism (currently contributing 3.5 % to Egypt's GDP) is under threat as the reefs are being destroyed by rising sea temperatures. For Egypt, this could mean a loss of €5.3 billion by 2060 [53]. Although temperatures might be more tourist-friendly in spring and autumn, climate change is projected to bring heavy rains in both seasons. Ancient and archaeological sites in Jordan, Lebanon and Egypt which attract tourists are also highly vulnerable to extreme weather conditions and the rise of temperature. Tourism hotspots like the city of Alexandria are threatened with destruction by rising sea levels [54]. And even though religious tourism will be least impacted by climate change, especially in Saudi Arabia, harsher climate conditions might constrain pilgrimages. In addition, extreme weather events will cause economic damage. The floods of 2008 and 2009 in Yemen and Saudi Arabia alone caused destruction worth more than USD 1 billion US [55].

The rural population are the most vulnerable to losing their jobs to the effects of climate change.

Heat stress alone will be responsible for the destruction of 1 % of working hours in the Arab world, corresponding to more than 600 000 full-time jobs under the best case scenario (RCP 2.6) in agricultural, industrial, construction and service sectors by 2030. Loss in productivity will result in a loss in the region's GDP of more than 1 % in 2030, which represents more than USD 36 billion according to calculations based on MENA'S GDP in 2019 [56]. Heat stress constrains most outdoor activities during the day and might place limitations on some working activities, like construction works for instance. Heat also adversely affects the productivity of workers, especially in places that lack cooling systems, as workers are required to limit their working hours or to take more breaks [57].

A World Bank study determined the quantitative impacts of climate change on households in three Arab countries, Tunisia, Syria and Yemen, by 2050. It is projected that income per household will decrease substantially. Total losses of national incomes will represent 2.5 % of Syrian GDP in 2030 (more than USD 1.2 billion) and 6.4 % of the country's GDP in

(50) United Nations, *WWAP Presentation: Launch of the UN World Water Development Report 2016*, Paris, 2016.

(51) Eurostat, *MEDSTAT II: Water and Tourism' pilot study*, Luxembourg, 2009; El Amine, Y., 'Rethinking Water Service Provision in Lebanon', Lebanon Water Forum, Issam Fares Institute for Public Policy and International Affairs, 2016.

(52) *Climate and Environmental Change in the Mediterranean Basin – Current situation and risks for the future*, op.cit.; *Turn Down the Heat – Confronting the new climate normal*, op.cit.

(53) UNDP, *Potential Impacts of Climate Change on the Egyptian Economy*, Cairo, June 2012; Fine, M. et al., 'Coral reefs of the Red Sea — Challenges and potential solutions', *Regional Studies in Marine Science*, Vol. 25, January 2019.

(54) Ibid.

(55) *Natural Disasters in the Middle East and North Africa: A regional overview*, op.cit.

(56) World Bank Data – GDP.

(57) International Labour Organization, *Working on a Warmer Planet: The impact of heat stress on labour productivity and decent work*, Geneva, 2019.

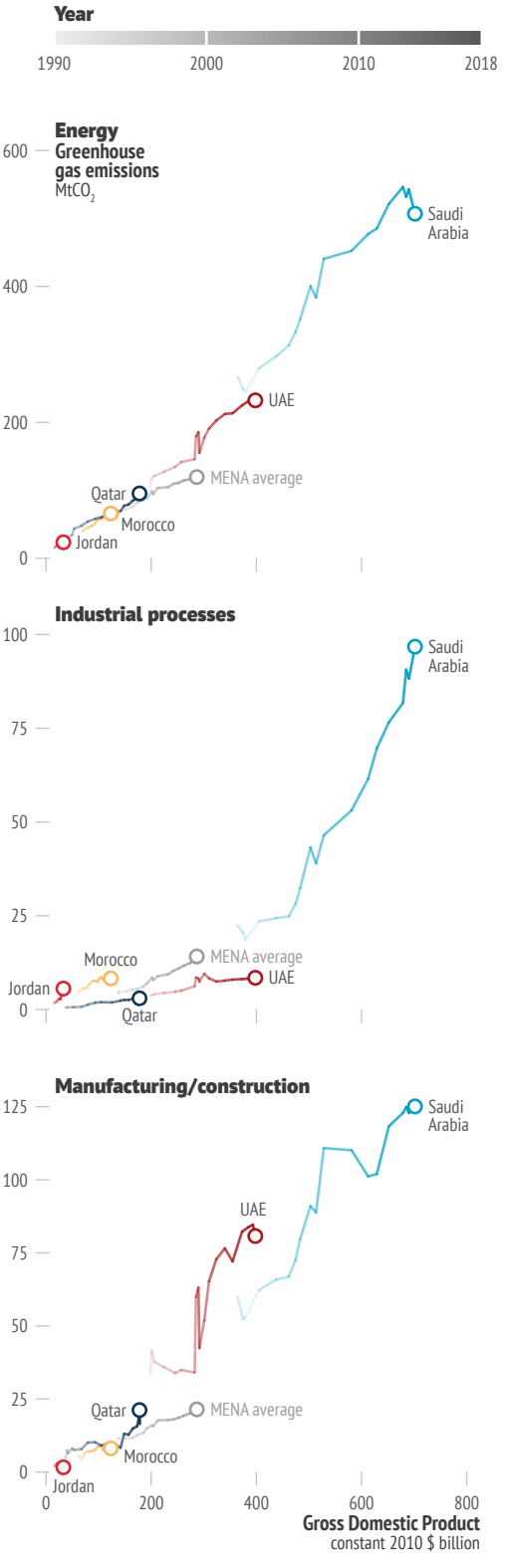
2050 (USD 3.4 billion). The impact of climate change on household incomes in Tunisia is estimated to reach USD 2 billion in 2030, meaning 6 % of the country's GDP, and in Yemen 23 % of the national GDP in 2050 [58]. In Lebanon, under the worst case scenario (RCP 8.5), rural households will see their income fall by 47 % by 2040. In urban areas, the poorest households' incomes will decrease by 49 % whereas the most privileged social categories will see their income dwindling by 32 % [59].

All of this will occur within economic structures that are already challenged even without climate change. Except for the countries of the Gulf Cooperation Council (GCC), MENA countries tend to be characterised by a massive public sector and a weak private sector. Most of the jobs created, pressurised by high population growth, are in low value added sectors like transport, construction or commerce. Such a lack of economic opportunities has led to an increase in the number of people turning to informal jobs and informal markets over the last decade [60].

But Arab economies of the future could also contribute further to climate change: until now, population and economic growth went hand in hand with increased emissions. This applies particularly to the energy sector – which is the top CO_2 emitting sector in the region (primarily based on electricity and heat needs as well as fugitive gas from water pumping or resources mining and from fuel combustion) and as we know, energy demand will increase in the future (as outlined in the first section of this chapter) [61].

Emissions and GDP

As countries' GDP increases, so do their emissions (selected sectors)



Data: World Bank, World Bank Open Data, 2021; Climate Watch, Data Explorer, 2021

(58) *Adaptation to a Changing Climate in the Arab Countries: A case for adaptation governance and leadership in building climate resilience*, op.cit.

(59) Republic of Lebanon, Ministry of the Environment, GEF, UNDP, *Economic Costs to Lebanon from Climate Change – A First Look*, Beirut, 2015.

(60) World Bank Group, *Striving for Better Jobs: The challenge of informality in the Middle East and North Africa*, Washington D.C., 2014.

(61) CAIT Climate Data Explorer via Climate Watch, data for 2016 (https://climatewatchdata.org/data-explorer/historical-emissions?historical-emissions-data-sources=cait&historical-emissions-gases=all-ghg&historical-emissions-regions=All%20Selected&historical-emissions-sectors=total-including-lucf&page=1).

Manufacturing and industry sectors contribute also for the most part to greenhouse gas emissions in MENA. The more industrialised a country is, the more it develops its economy and the more it requires energy to produce outputs, goods and services [(62)]. Between 2000 and 2018, while the GDP of the region went up by more than 100 %, [(63)] CO_2 emissions from the industrial sector increased by 241 %, by 111 % in the manufacturing sector and by 119 % for electricity and heat requirements [(64)]. The link between economic growth and CO_2 emissions is even clearer for the Gulf States. In the UAE and Saudi Arabia between 2000 and 2018, CO_2 emissions from industry, manufacturing and electricity/heat sectors are those which increased the most, respectively by 419 %, 123 % and 91 % in Saudi Arabia and by 124 %, 139 % and 152 % in the UAE (along with transport and waste incineration in the UAE). In the meantime, Saudi GDP grew by 108 % and the UAE's GDP doubled between 2000 and 2018 (+101 %). In Qatar, CO_2 emissions in the industrial sector increased by more than 484 % in this period and the country's GDP also increased exponentially by 393 %. [(65)] If Arab states continue on the same economic trajectory in the future, their CO_2 emissions will keep escalating. That said, signs are beginning to emerge that economic growth and emissions are decoupling in advanced economies, meaning that this trend has the potential to peter out. Over the last 15 years, economic growth has been decoupled from emissions in 32 states – most of which are located in Europe and the Americas [(66)].

Arab economies will be hit hard by the direct and indirect effects of climate change, reducing jobs in agriculture and tourism. At the same time, business-as-usual economic activity will contribute even more to climate change.

(62) Yearg, K., 'Energy and Economy' in *Global Energy Assessment: Toward a sustainable future*, Cambridge University Press, Cambridge and New York, and the International Institute for Applied Systems Analysis, 2012, pp. 385-422; Sharma, N., Smeets, B., and Tryggestad, C., 'The decoupling of GDP and energy growth: A CEO guide', McKinsey, 24 April 24 2019 (https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/the-decoupling-of-gdp-and-energy-growth-a-ceo-guide).

(63) Calculations made by authors based on World Bank data. Calculations exclude Syria and Palestine.

(64) Calculations made by authors based on Our World in Data.

(65) Calculations made by authors based on Our World in Data and World Bank data.

(66) The Breakthrough Institute, 'Absolute decoupling of economic growth and emissions in 32 countries', 6 April 2021 (https://thebreakthrough.org/issues/energy/absolute-decoupling-of-economic-growth-and-emissions-in-32-countries).

CHAPTER 3

AVOIDANCE MANOEUVRING

Encouraging trends

The future will not just be the result of the trends outlined in chapters 1 and 2: it will also be the result of other human trends that can significantly alter the trajectories previously outlined. The most important trend with regard to climate change is, of course, the reduction of CO_2 emissions – particularly by the main polluters: China, the United States and Europe, who together are responsible for slightly more than half of global emissions, accounting for 23.7 %, 15 % and 10% of emissions respectively. But pledges by the three largest emitters to reduce their GHG emissions are not enough: the rest of the world will have to cut its carbon output too. The extent to which climate change will affect the Middle East region therefore hinges in large part on states that are not located in this part of the world.

That said, the effects of climate change in the Middle East and North Africa also depend on the way states in the region mitigate and adapt to them. This, in turn, can be propelled forward by three trends elaborated below: signs of growing awareness in the region of the risk posed by climate change, an increase in knowledge and capacity when it comes to both effects and solutions, as well as subtle shifts in the use of existing assets such as energy and a burgeoning young population. Together, these trends can significantly change the projected course of events outlined in the previous chapter.

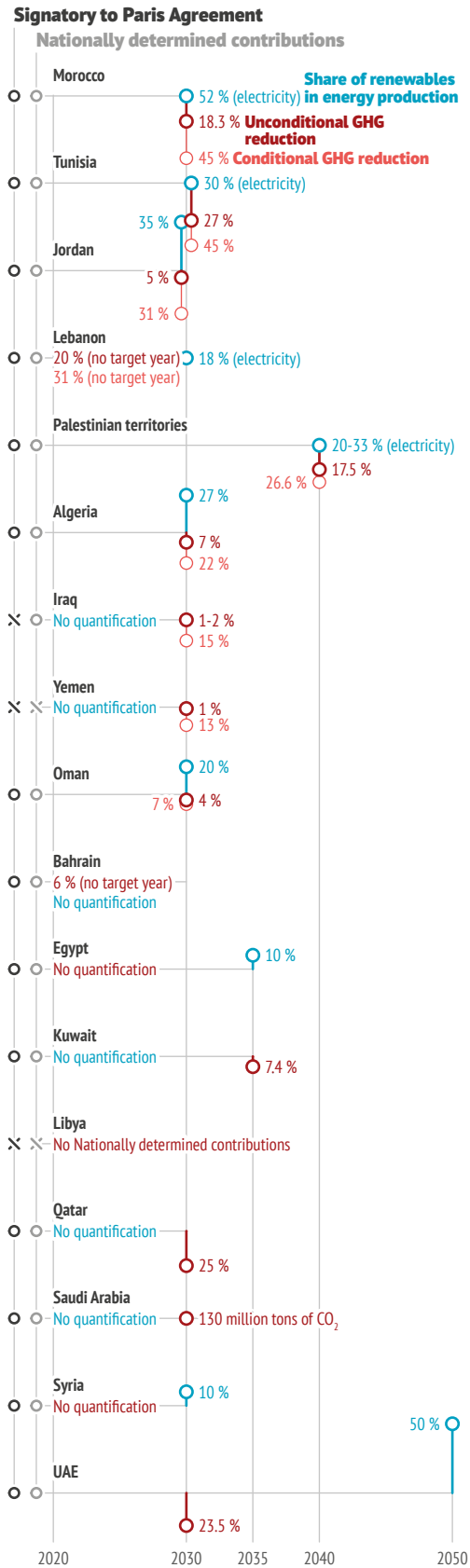
BETTER LATE THAN NEVER: GROWING INSTITUTIONAL AWARENESS

A problem cannot be solved, and policies cannot be developed without a general consensus that said problem exists, on what the scale of the problem is, and what could be done about it. When it comes to such policy problems, the journey between detecting the first signs of its existence and steps to address it can be much longer than desirable: evidence that smoking can cause lung cancer first emerged in 1912, but 40 years later more than half of Americans were still not convinced of this [(1)]. Only in 2005, nearly 100 years after the first warnings, did member states of the WHO agree to a convention on tobacco control.

When it comes to climate change, this journey is also remarkably long. A scientific consensus first emerged at the end of the 1970s that human activity leads to an increase in greenhouse gases and therefore a subsequent increase in temperature. In 1992, the United Nations Framework Convention on Climate Change (UNFCCC) first addressed the problem, followed by the 1997 Kyoto Protocol which operationalised it by committing industrialised countries as well as economies in transition

(1) Proctor, R.N., 'The history of the discovery of the cigarette–lung cancer link: evidentiary traditions, corporate denial, global toll', *Tobacco Control*, 2012, pp.87–91 (https://tobaccocontrol.bmj.com/content/21/2/87).

Paris Agreement reduction targets



Data: UNFCCC, Global Climate Action, 2021

to the reduction of greenhouse gases. Due to a lengthy ratification process, it only entered into force in 2005 and was subsequently ratified by all Arab states. But even so, the protocol foresaw no binding targets for the states in the region – although an IPCC study of 2007 clearly indicated that it would not be enough for the main emitters to cut their emissions. It noted that 'developed countries as a group would need to reduce their emissions to below 1990 levels in 2020 (on the order of –10 % to 40 % below 1990 levels for most of the considered regimes) and to still lower levels by 2050 (40 % to 95 % below 1990 levels), *even if* developing countries make substantial reductions' [(2)]. Instead, all of them increased their emissions substantially – with the exception of Syria, where this happened less by design and more by default because of its civil war.

There are many reasons that explain why this was a particularly long period of growth in public awareness, but one of them is that for a long time it was a virtual problem: the effects of climate change were not yet felt, and human responsibility for it not clearly expressed. It was only in 2015 that global temperatures reached 1° C above pre-industrial levels, and that tangible signs of climate change began to be felt. From June to September, temperatures reached above 40° C in the Maghreb and in parts of the Middle East, Iraq and Qatar notably, above 50° C. Nearly 100 people died in Egypt as a result [(3)]. That same summer, a deadly dust storm hit Syria as well as parts of Lebanon, Israel, Turkey and Cyprus. Although initially blamed on the Syrian civil war, studies showed it was the result of reduced vegetation which in turn was the result of water

(2) IPCC, 'Chapter 13 – Policies, instruments, and co-operative arrangements' in *IPCC Fourth Assessment Report: Climate Change 2007*, 2007 (https://web.archive.org/web/20121210151654/http://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch13s13-3-3-3.html).

(3) Al Jazeera, 'Summer heatwave engulfs Middle East', 17 August 2015 (https://www.aljazeera.com/news/2015/8/17/summer-heatwave-engulfs-middle-east).

scarcity [4]. In the autumn, torrential rainfall hit the entire region but affecting Egypt, Lebanon and the Western Sahara in particular [5]. In Alexandria, a cable powering the city's tram system fell into the water and electrocuted seven people. Pictures of cars and rubbish floating in the streets, flooded refugee camps and destroyed mud-brick houses not only made headlines but were quickly linked to climate change.

At the same time, the Paris Agreement – albeit being non-binding – is the first document that recognises that the *entire* international community (including the Arab states), rather than primarily the main emitters, are committed to the goal of 'holding the increase in the global average temperature to well below 2° C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels' [6]. All states in the region have signed the agreement, and all but two (Libya and Yemen) have also ratified it. With the exception of Saudi Arabia and Oman, all states in the region defined their reduction targets (dubbed nationally determined contributions or NDCs) along two lines: conditionally and non-conditionally. Whereas the former depend on financial and technical assistance, the latter are independent and solely the committing state's responsibility. The difference between the two can be quite stark: Iraq for instance has committed to reduce its emissions conditionally by 13 % - and by 1 to 2 % unconditionally [7].

Iraq has committed to reduce its emissions conditionally by 13 % – and by 1 to 2 % unconditionally.

Since then, climate change has begun to become more prominent in the policies and actions of Arab states, albeit with some significant differences. Although worldwide only one state (The Gambia) is meeting its Paris Agreement commitments according to the Climate Action Tracker, one Arab state, Morocco, is among the seven whose actions are deemed 'almost sufficient' (and none of these are from the European Union.) [8] Morocco has not only been on track but increased its ambitions in June 2021 to reduce its CO_2 emissions by not just 17% but by 18.3% below the level of emissions it generated before the Paris Agreement, and defined this scenario even more conservatively. By 2030, Morocco will therefore have cut 21 % more than it originally planned [9]. Granted, it is not just a global but also a regional exception. In addition to Morocco, Bahrain, Jordan, Kuwait, Lebanon, Oman, the Palestinian territories, Qatar, Tunisia and the UAE submitted more

(4) Parolari, A.J., Li, D., Bou-Zeid, E., Katul, G.G. and Assouline, S., 'Climate, not conflict, explains extreme Middle East dust storm', *Environmental Research Letters*, Vol.11, No11, 2016 (https://iopscience.iop.org/article/10.1088/1748-9326/11/11/114013).

(5) Middle East Eye, 'Torrential rain, heavy flooding hit Middle East', 26 October 2015 (https://www.middleeasteye.net/news/torrential-rain-heavy-flooding-hit-middle-east).

(6) United Nations, *Paris Agreement*, 2015 (https://unfccc.int/sites/default/files/english_paris_agreement.pdf).

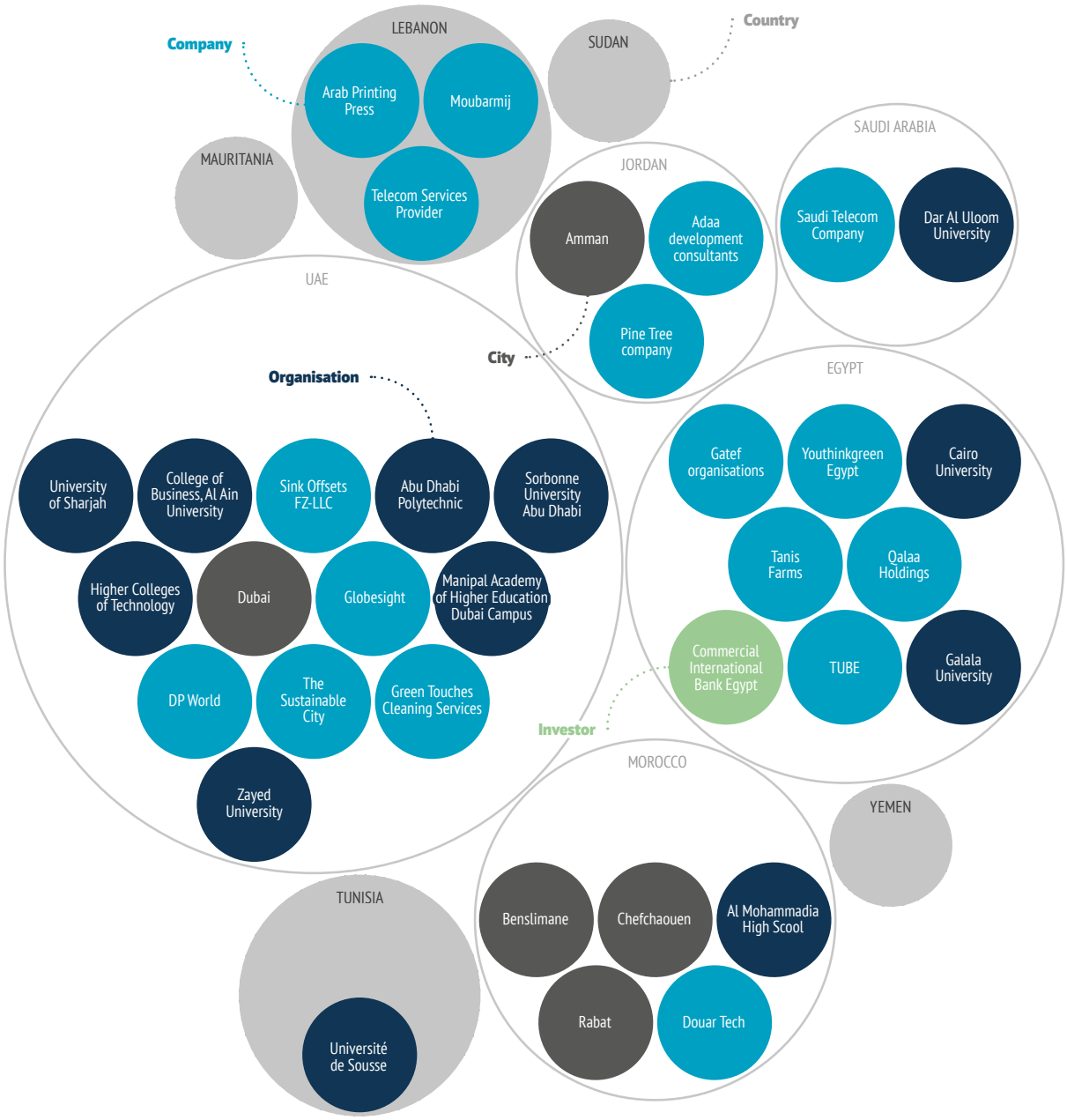
(7) Republic of Iraq, 'Nationally Determined Contributions of Iraq', October 2021 (https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Iraq%20First/Iraq%20NDC%20Document.docx)

(8) Climate Action Tracker, Morocco (https://climateactiontracker.org/countries/morocco/).

(9) Morocco, 'Nationally determined contribution under the UNFCCC', 18 September 2016 (https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Morocco%20First/Morocco%20First%20NDC-English.pdf).

The Climate Ambition Alliance

Arab engagement



Data: UNFCCC, Climate Ambition Alliance, Net Zero 2050, 2021

ambitious targets in 2021 [(10)]. In 2021, the UAE was the first Arab state to pledge net-zero emissions by 2050, while Saudia Arabia has recently followed suit with an announcement of a target date of 2060 [(11)].

Not just states have become more active; other bodies have, too. The Climate Ambition Alliance, an initiative launched in 2019 by the United Kingdom and Chile, expands the network of those wishing to commit to net-zero CO_2 emissions by 2050 to not just states, but also organisations and institutions. Although the engagement of regional states is low – only Lebanon, Mauritania, Sudan, Tunisia and Yemen have joined – five cities (Amman (Jordan), Benslimane (Morocco), Chefchaouen (Morocco), Rabat (Morocco), Dubai (UAE)) and 17 companies from the region – specifically from Egypt, Jordan, Lebanon, Morocco, Saudi Arabia and the UAE – have signed up [(12)]. Amman and Dubai are also two Arab cities that joined the C40, the network of cities that formed to combat climate change in 2005.

There are other signs that the issue is moving up on the policy agenda, too. In the early 2000s ministries of environment began to emerge in all Arab states, with Saudi Arabia being the last one to join this trend in 2016, when it established the Ministry of Environment, Water and Agriculture. That same year, the UAE was the first state to create a dedicated ministry of environment *and climate change*. The budget of these ministries has grown over the past few years: in Tunisia, the Ministry of Environment saw a 13.4 % increase in funding to €306 million in 2019, receiving a substantially bigger budget than the ministries of foreign affairs, justice or finance [(13)]. The Algerian Ministry of Environment received more than €13 million for the year 2020, a budget that is on a par with the defence budget [(14)]. While Egypt's environmental ministry received a mere 0.2% of the budget in 2014, it is set to increase by 30 % in the next budgetary cycle [(15)].

But not just ministries have gained in importance: new institutions are being created to manage the challenge of climate change. In 2015, Egypt replaced the National Committee on Climate Change with the National Council for Climate Change which in turn disposes, since 2017, of the Adaptation Task Force which

(10) Sultanate of Oman, 'Second nationally determined contribution', July 2021 (https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Oman%20Second/Second%20NDC%20Report%20Oman.pdf); UAE, 'Second nationally determined contribution of the United Arab Emirates', December 2020 (https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/United%20Arab%20Emirates%20Second/UAE%20Second%20NDC%20-%20UNFCCC%20Submission%20-%20English%20-%20FINAL.pdf); Kingdom of Bahrain, 'Nationally Determined Contribution of Kingdom of Bahrain under UNFCC 2021', October 2021 (https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Bahrain%20First/NDC%20of%20the%20Kingdom%20of%20Bahrain%20under%20UNFCCC.pdf); Kingdom of Jordan, 'Updated Submission of Jordan's 1st Nationally Determined Contribution (NDC)', October 2021 (https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Jordan%20First/Final%20Jordan%27s%20updated%20NDC%2012%20OCT.pdf); State of Kuwait, 'Nationally Determined Contributions (updating the first NDC)', October 2021 (https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Kuwait%20First/Kuwait%20updating%20the%20first%20NDC-English.pdf); Republic of Lebanon, 'Lebanon's Nationally Determined Contribution, Updated 2020 Version', March 2021, (https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Lebanon%20First/Lebanon%27s%202020%20Nationally%20Determined%20Contribution%20Update.pdf); State of Qatar, 'Nationally Determined Contribution (NDC)', August 2021 (https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Qatar%20First/Qatar%20NDC.pdf); State of Palestine, 'The State of Palestine's First Nationally Determined Contribution (NDCs) "updated submission"', October 2021 (https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/State%20of%20Palestine%20First/Updated%20NDC_%20State%20of%20Palestine_2021_FINAL.pdf); République Tunisienne, 'Contribution Déterminée au niveau National (CDN) actualisée', Octobre 2021 (https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Tunisia%20First/Tunisia%20Update%20NDC-french.pdf).

(11) Al-Monitor, 'A net-zero Saudi Arabia? Not so fast', 25 October 2021 (https://www.al-monitor.com/originals/2021/10/net-zero-saudi-arabia-not-so-fast).

(12) Climate Ambition Alliance, 'Net Zero CO_2 emissions by 2050' (https://climateaction.unfccc.int/views/cooperative-initiative-details.html?id=94).

(13) ilBoursa, La Référence Économique, 'Tunisie : Répartition du Budget de l'Etat pour 2019 par Ministère', 11 November 2018 (https://www.ilboursa.com/marches/tunisie-repartition-du-budget-de-l-etat-pour-2019-par-ministere_15250).

(14) Assemblée Nationale Populaire, 'Lors de la présentation du budget du secteur de l'environnement: les députés soulèvent le problème du recyclage des déchets et demandent un traitement plus rapide', 13 September 2021 (http://www.apn.dz/fr/plus/liens-importants/actualite/3323-fhhd); Algérie Eco, 'Repartions de budget dans le PLF 2021 : Aucun changement de priorité pour l'Etat', 17 November 2020 (https://www.algerie-eco.com/2020/11/17/repartions-de-budget-dans-le-plf-2021-aucun-changement-de-priorite-pour-letat/).

(15) *Egypt Today*, 'Egypt aims to increase its investment in green projects by 30% during 2021/2022', 14 March 2021 (https://www.egypttoday.com/Article/3/99657/Egypt-aims-to-increase-its-investment-in-green-projects-by).

serves as its operational arm [16]. In 2021, this council commissioned a study of 10 countries similar to Egypt to learn from their best practices [17]. In 2016 Morocco created an environmental police force, and in 2020 Algeria launched its Ministry of Energy Transition. Of course, these institutions are not yet operating at full capacity – budgets are limited, and staffing has to be improved – but the trend points in the right direction. For instance, in the first decade of the 2000s spending of Arab national and regional development institutions on environmental projects was more than double what it was in the previous 40 years [18].

In April 2021, Saudi Crown Prince Mohammed bin Salman announced the Green Middle East initiative which seeks to bring together countries from the region to plant 40 billion trees. According to the announcement, this would help restore 200 million hectares of land and reduce global carbon levels by about 2.5 %. In the same statement, the Crown Prince also acknowledged that air pollution resulting from greenhouse gases contributes to shortening Saudi life expectancy by 1.5 years [19].

The same year, Morocco announced the creation of an Environment Code, a streamlining and strengthening of all legal texts pertaining to environmental protection. [20] In 2019, Egypt's environmental ministry announced a plan to plant one million trees and 2 700 feddans of gardens and green spaces nationwide. In 2020, President Sisi launched the Go Green initiative designed to promote behavioural change and increase citizen awareness about climate change.

Egypt – which has had a climate change action plan since the 1990s – even has a long-term public strategy, the *Sustainable Development Strategy: Egypt Vision 2030*. Climate change adaptation and mitigation action plans compose a key part of the multidimensional ambition articulated around three pillars: economic, social and environmental. This plan is setting the environmental goal Egypt is planning to achieve for 2030 on water governance, waste management and urban planning [21]. In 2021, spurred not just by climate change but also by its tensions with Ethiopia, it presented a four-point plan to cope with the looming water crisis: rationing water use, improving water quality, providing additional water sources and creating a suitable climate for optimal water management [22]. To achieve this, Egypt has proposed a 2050 water resources strategy funded with USD 50 billion. At the same time, it announced its intention to act, if necessary with force, against illegal encroachments on the Nile [23]. It also has proposed to host the COP 27 in 2022, making it the third Arab country – Morocco hosted COP 7 in 2001 and COP 25 in 2016, and Qatar hosted COP 18 in 2012 – to do so. (The COP or Conference of the Parties is the annual meeting of the signatories of the United Nations Framework Convention on Climate Change.)

Jordan also has a National Climate Change Policy since 2013, which serves as the umbrella document for other policies, e.g. the 2016

(16) UNDP, 'National Adaptation Plans in focus: Lessons from Egypt', 2018 (https://www.adaptation-undp.org/sites/default/files/resources/naps_in_focus_lessons_from_egypt.pdf).

(17) Al-Monitor, 'Egypt announces plan to address climate change following heat wave', 23 August 2021 (https://www.al-monitor.com/originals/2021/08/egypt-announces-plan-address-climate-change-following-heat-wave).

(18) AFED, 'Arab Environment in 10 Years', 2017 Report of the Arab Forum for Environment and Development, Beirut, 2017, p.15 (http://www.afedonline.org/uploads/afed_reports/AFED-REPORT-2017-FINAL.pdf).

(19) Al-Monitor, 'Cairo backs Riyadh's Green Middle East initiative', 12 April 2021 (https://www.al-monitor.com/originals/2021/04/cairo-backs-riyadhs-green-middle-east-initiative).

(20) Morocco World News, 'Climate Change: Morocco to Introduce Environment Code', 4 May 2021 (https://www.moroccoworldnews.com/2021/05/341417/climate-change-morocco-to-introduce-environment-code).

(21) Al-Monitor, 'Can Egypt avoid being harmed by second filling of Nile dam?', 25 May 2021 (https://www.al-monitor.com/originals/2021/05/can-egypt-avoid-being-harmed-second-filling-nile-dam).

(22) Al-Monitor, 'Egypt develops ambitious projects to meet growing water needs', 21 September 2021 (https://www.al-monitor.com/originals/2021/09/egypt-develops-ambitious-projects-meet-growing-water-needs#ixzz78VLSkkOJ).

(23) Al-Monitor, 'Egypt threatens to send military to remove encroachments along Nile', 4 October 2021 (https://www.al-monitor.com/originals/2021/10/egypt-threatens-send-military-remove-encroachments-along-nile#ixzz78VPJCdCL).

Climate Change Policy for a Resilient Water Sector. More recently, Jordan issued six 2021-20205 Action Plans on Climate Change in the water, agriculture, tourism, transportation, energy and waste sectors, setting the scene for intensified actions in green development until 2025. Algeria launched its National Climate Plan (NCP) in September 2019 that defines the actions taken to implement the commitment of the 2016 NDC for 2020-2035. The NCP will be updated in 2023 [(24)]. Adaptation actions will focus on water and littoral management, agriculture and infrastructure and natural disaster risk assessment. Mitigation strategy focuses on industry, energy, the waste sector, transport, housing and forestry. The need to build strong climate resilience will require more than USD 1.11 billion, the equivalent of less than 1 % of Algeria's GDP in 2019, but of 30 % of the annual resources allocated to environmental remediation.

While all these trends are positive, the great risk is that conflict countries are falling further behind when it comes to climate change mitigation and adaptation. Iraq, Libya, Syria and Yemen have neither the resources nor the capacity to begin to take policy action. Iraq is raising its environmental ambitions and has launched its first clean energy reform programme. It aims to achieve 63 % of electricity generation from renewable energy by 2026 and in September 2021 set up a committee of experts to oversee the shift to alternative energy and the green economy – although ongoing violence and political instability could easily derail this initiative [(25)].

In sum, several Arab states have proposed plans, developed institutions and provided funds to tackle climate change. The exceptions to this are states facing violent conflict.

WE WANT TREES: RISING CITIZEN AWARENESS

Not just the awareness of institutions has evolved; that of citizens has, too. A poll from 2008 showed that the region ranked second only to sub-Saharan Africa in terms of climate change *unawareness*: almost half of the population responded that they had never heard of it [(26)]. A report from the same year noted that 'the scientific community in most Arab countries still harbours many suspicions regarding climate change phenomena and remains hesitant to acknowledge the risks' [(27)].

Since then, a lot has changed: in three different surveys (conducted by the Arab Forum for Environment and Development in 2017, Arab Barometer in 2019 and the 2021 Peoples' Climate Vote by UNDP), nearly 64 % of Arabs estimated that climate change is a very or somewhat serious concern [(28)]. Broken down by country, Kuwait was the only country where a minority felt that way; in Algeria, Jordan, Lebanon and Sudan more than two thirds of the population did. Over the last decade, Arab universities have integrated environmental studies into

(24) République Démocratique Algérienne, Ministère de l'Environnement et des Énergies Renouvelables, *Plan National Climat*, Septembre 2019.

(25) Al-Monitor, 'Iraq opts for clean energy in ambitious energy reform program', 26 October 2021 (https://www.al-monitor.com/originals/2021/10/iraq-opts-clean-energy-ambitious-energy-reform-program#ixzz7AURGBRkK).

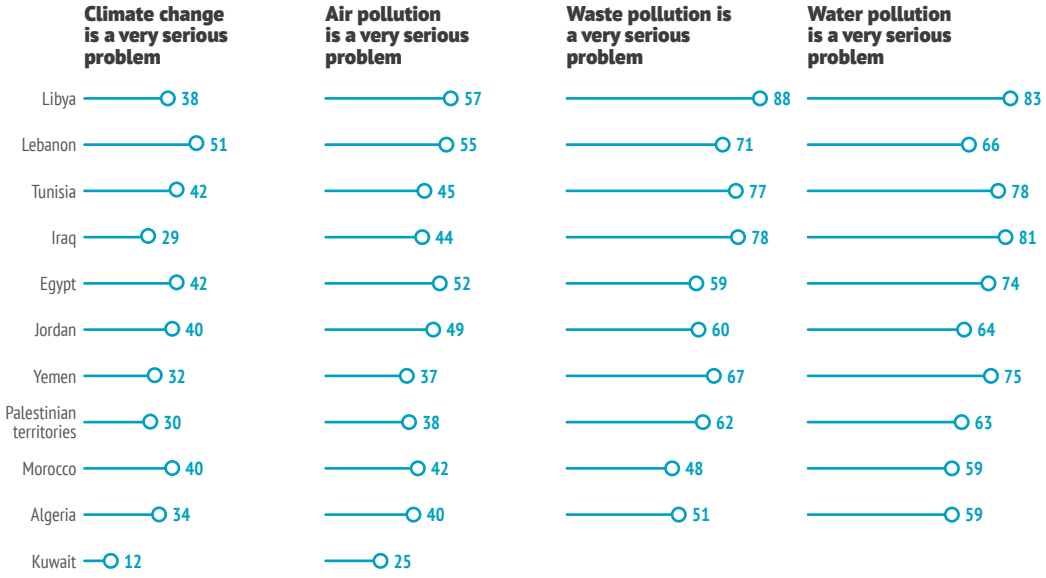
(26) Gallup, 'Awareness of climate change and threat vary by region: Adults in Americas, Europe most likely to be aware, perceive threat', 11 December 2009 (https://news.gallup.com/poll/124652/awareness-climate-change-threat-vary-region.aspx).

(27) AFED, *Arab Environment: Future challenges*, 2008, p.128.

(28) Green, J., 'Environmental issues in the Middle East and North Africa, Wave V', Arab Barometer, October 2019 (https://www.arabbarometer.org/wp-content/uploads/environment-10-17-19-jcg.pdf); 'Arab environment: a tertiary concern for Arab citizens', Arab Barometer, 20 April 2020 (https://www.arabbarometer.org/2020/04/climate-change-a-tertiary-concern-for-arab-citizens/).

Climate change awareness in Arab states

2019, % of respondents



Data: Arab Barometer, 'Environmental Issues in the Middle East and North Africa', October 2019

their programmes at every level – there are 221 degrees in 54 Arab universities all around the region, covering specialisations such as environmental engineering, construction, water management, physics and biochemistry [(29)].

Although the region lags behind Western Europe and North America, where 72 % of the population feel that climate change is a global emergency, it is not far behind Eastern Europe and Central Asia (65 %), and ahead of Latin America and the Caribbean (63 %), Asia and Pacific (63 %), and sub-Saharan Africa (61 %). [(30)] Another survey by the Arab Forum for Environment and Development (AFED) – though less representative as participants were self-selected – showed that 60 % of respondents felt that the environment has deteriorated in their countries over the last decade, and 75 % felt that their country was not doing enough in this regard [(31)]. This represents a substantial increase within the span of a decade.

In yet another survey, respondents from the region (Bahrain, Egypt, Kuwait, Oman, Qatar, Saudi Arabia and the UAE) were far more convinced than Europeans or Americans that climate change would lead to another world war, or even the extinction of the human race [(32)].

Beyond climate change broadly, citizens from the region also display concern over environmental issues that are either the result of climate change, or contribute to it – even if these are perhaps not perceived as a climate change issue. For instance, 90.5 % of respondents across the region felt that water pollution was a serious or very serious problem, with 97 %

(29) AFED, *Environmental Education: For sustainable development in Arab countries*, Beirut, 2019.

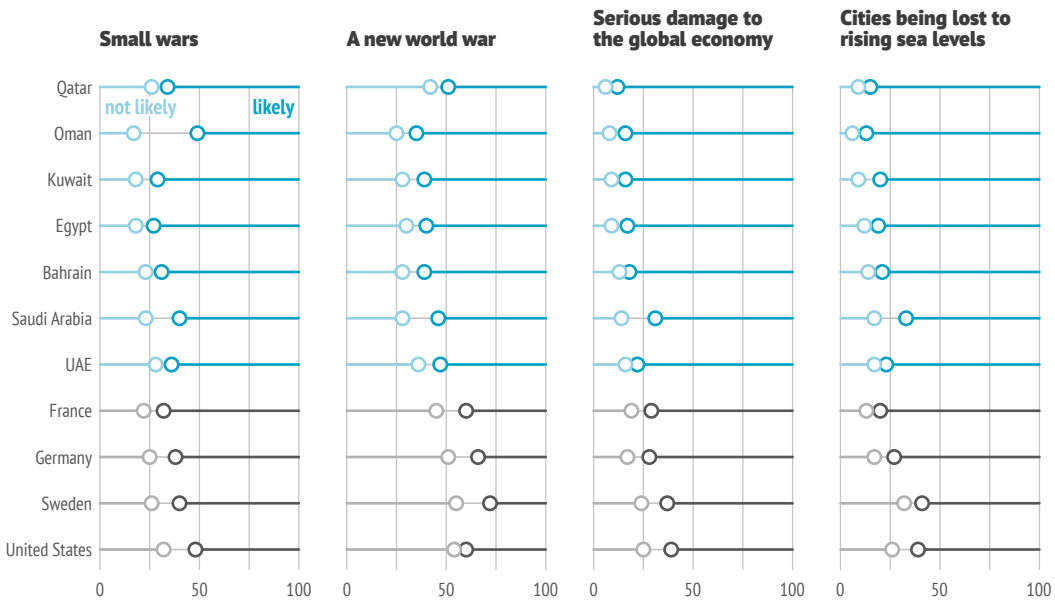
(30) UNDP, *People's Climate Vote – Results*, January 2021 (https://www.undp.org/publications/peoples-climate-vote#modal-publication-download).

(31) 'Arab Environment in 10 Years', op.cit.

(32) Smith, M., 'International poll: most expect to feel impact of climate change, many think it will make us extinct', Yougov, 15 September 2019. (https://yougov.co.uk/topics/science/articles-reports/2019/09/15/international-poll-most-expect-feel-impact-climate).

What are the consequences of climate change?

How likely do you think it is that climate change will cause each of the following? 2019, % of respondents



Data: YouGov, International Climate Change Survey, 2019

in Iraq and 96 % in Lebanon saying so. Water pollution is to a significant extent a knock-on effect of rising temperatures: droughts lead to reduced water flow which increases the concentration of pollutants in rivers as well as salt levels. As we noted earlier, citizens in the region are beginning to feel the effects of poor water quality physically, especially in Iraq's southern region.

Water pollution in the region is, of course, not just the result of increasing temperatures: poor water management, too, is to blame. At the moment, only Gulf countries and Jordan treat their wastewater. In Algeria, Lebanon, Libya or Morocco, between 7 % and 26 % of wastewater is treated. In addition, poor waste management is also responsible for water pollution.

Waste, in turn, is also linked to climate change: decomposing organic waste for instance emits greenhouse gases, as does dropping non-organic waste, such as plastic, into oceans or incinerating it. Perhaps the only positive news here is that the region's share of waste in GHG emissions is below that of other world regions [33].

Most importantly, however, citizens have strong feelings about waste: 66 % of respondents felt that waste was a *very* serious problem – with 88 % of respondents in Libya, 78 % in Iraq and 77 % in Tunisia saying so. In Lebanon, where 71 % felt this way, discontent over waste disposal even led to the protest movement 'You stink' in 2015–2016.

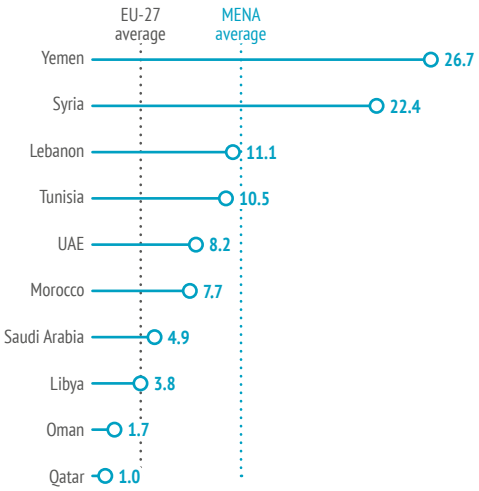
There is some positive news in this regard, however: the vast majority of regional waste is food and green waste, offering the potential of composting. Although this is currently being done at typically low levels of about 1–8 %, the trend is clear, and out of 21 countries surveyed, 9 engaged in composting to some degree. Two-thirds of the region's waste derives from food and other natural elements, meaning that

(33) Rahman M.M. et al., 'Greenhouse gas emissions from solid waste management in Saudi Arabia—Analysis of growth dynamics and mitigation opportunities', *Applied Sciences*, Vol. 11, No 4, 2021 (https://www.mdpi.com/2076-3417/11/4/1737).

a focus could be placed on reducing food waste and improving organic waste management. Another third is composed of dry recyclables such as paper and plastic.

CO_2 emissions from waste

Share of waste in country CO_2 emissions, 2016, %



Data: Climate Watch, CAIT Climate Data Explorer, 2016

Most importantly, 'citizen engagement initiatives are strong' [34] when it comes to this issue, putting pressure on states to pursue institutional and legal reforms with regard to waste management. In Egypt, NGOs organise clean-ups to raise awareness, train educators, and help communities understand better the impact that climate change is having on their lives. They report high levels of activism and long waiting lists to participate in such activities – perhaps also because 'the environment is the only space we have left to be politically active' [35]. In Morocco, trashpickers formed a cooperative supported by the World Bank, recycling rubbish and capturing the methane gas produced by the decomposing organic waste [36].

Lastly, air pollution, too, is an issue about which citizens are expressing concern, with this preoccupation ranking third behind water and waste [37]. Although here, too, there are some regional differences (57 % in Libya felt it to be a very serious problem, but only 25 % in Kuwait), the regional average shows that about half of citizens feel strongly about air pollution. And for good reason: Cairo, Doha and Riyadh are among the top 35 polluted cities in the world, and dangerous levels of nitrogen oxides were recorded in Dubai, Al Ahmadi in Kuwait, Baghdad, Cairo, Doha, Erbil in Iraqi Kurdistan, Jounieh in Lebanon and Riyadh [38]. One in ten deaths in the region, or half a million, is linked to air pollution, causing economic damage of $9 billion [39]. Half of the pollution is the result of human activities such as transport and industry – when it comes to mobility, Arab countries are among the highest global emitters of carbon monoxide (CO) and nitrogen oxide (NOx) – while the other half is the result of sand, dust, and sea salt. Dust and sand storms, while of natural origin, are increasing in frequency and intensity also because of human activities that cause climate change [40].

As in Europe, younger people feel more strongly about the environment: self-selected respondents to one climate-related survey aged up to 29 made up 41 % of respondents,

(34) World Bank Group, *What a Waste 2.0: A global snapshot of waste management to 2050*, Washington D.C., 2018 (https://openknowledge.worldbank.org/handle/10986/30317).

(35) Author interview with member of civil society, Cairo (via Zoom), May 2021.

(36) World Bank, 'In Morocco, a trashpicker cooperative fights climate change', 16 February 2016 (https://www.worldbank.org/en/news/video/2016/02/16/in-morocco-a-trashpicker-cooperative-fights-climate-change).

(37) 'Environmental Issues in the Middle East and North Africa, Wave V', op.cit.

(38) Jashman, J., 'The most polluted cities in the world', The Eco Experts, 31 March 2021 (https://www.theecoexperts.co.uk/blog/most-polluted-cities).

(39) Khanjani, N., 'Air pollution and its health effects in the Eastern Mediterranean region – Challenges and gaps', The International Society of Environmental Epidemiology (https://www.who.int/airpollution/events/conference/CAPH1_Plenary_session_III_4_AP_and_its_health_effects_in_EM_region_Narges_Khanjani.pdf); World Bank Group and Institute for Health Metrics, *The Cost of Air Pollution: Strengthening the economic case for action*, Washington D.C., 2016 (https://openknowledge.worldbank.org/handle/10986/25013).

(40) AFED, *Health and the Environment in Arab Countries*, 2020 Report of the Arab Forum for Environment and Development, Beirut 2020, p.94 (http://www.afedonline.org/en/reports/details/health-and-the-environment-in-arab-countries).

with only 13 % being over 50. To leverage this activism, several states in the region (Egypt, Lebanon, Qatar, Saudi Arabia) have created independent bodies enhancing environmental education or climate change advocacy all around the region, such as the Arab Youth Council for Climate Change (AYCCC). Those bodies are in large majority composed by young people aged under 30 [(41)].

Where citizens of the region differ from others is that the sense of urgency *vis-à-vis* climate change is less pronounced. Whereas three quarters of citizens in Europe felt that 'we should do everything necessary, urgently' against climate change, this number dropped to 58 % in Egypt, 56 % in Iraq, 53 % in Algeria and Tunisia, and 52 % in Morocco [(42)]. Citizens also tended to support a smaller number of climate change measures than in other world regions. They were particularly supportive of climate-friendly farming, the use of renewable power, and conserving forests and land. (The least-popular policy across all regions, including the Arab world, was plant-based diets.) In large part, this is because the region faces many other urgent problems that take priority over climate change. Surveys show that socio-economic issues, such as unemployment, inequality and low standards of living are the most pressing ones [(43)] – but these surveys are also flawed because climate change is mostly not even featured as a response option [(44)].

As mentioned earlier, environmental matters are also increasingly the cause of protests. In 2011 and 2012, Egypt saw demonstrations against a fertiliser plant in Damietta, and against gas drilling practices in a village near Aswan. In 2014, the Alexandrian campaign 'Egyptians against Coal' protested against the use of coal by a cement company. In Algeria, protests against the extraction of shale gas in several southern cities erupted in 2014 and fed into the 2019 Hirak movement. While mostly focused on corruption and poor political representation, the movement also demanded access to clean drinking water [(45)]. One of its chants, 'There will be no gas, there will be no oil, tell France to exploit [shale gas] in Paris!' [(46)] was only one indication of how much the environment, including water and air pollution, merged with other political grievances. In the hot summer of 2021, protests erupted in Algeria, Iraq, Sudan and Yemen over water scarcity [(47)]. In Jordan, governmental plans to open a copper mine in a natural reserve were met with substantial public resistance [(48)]. In sum, environmental matters are becoming increasingly politicised, and pressures on governments to act are mounting.

> **Arab public awareness of climate change and its detrimental consequences has been growing significantly over the last decade. Discontent over how governments have managed environmental matters shows the potentially disruptive nature of this policy issue.**

(41) See Gulf News, 'Arab youth centre launches Arab youth council for climate change', 12 August 2021 (https://gulfnews.com/uae/arab-youth-centre-launches-arab-youth-council-for-climate-change-1.81533071).

(42) *People's Climate Vote – Results*, op.cit.

(43) Arab Center for Research and Policy Studies, 'The 2019-20 Arab Opinion Index: Main Results in Brief', 2020 (https://www.dohainstitute.org/en/Lists/ACRPS-PDFDocumentLibrary/Arab-Opinion-Index-2019-2020-Inbreef-English-Version.pdf).

(44) Zogby Research Service, *Middle East Public Opinion*, 2018 (https://static1.squarespace.com/static/52750dd3e4b08c252c723404/t/5c0fcb2e758d461f72dc37ca/1544538926539/2018+SBY+FINAL+WEB.pdf).

(45) Sleet, P., 'Water protests in Algeria are giving cause for concern about its long-term stability', Global Food and Water Crises Research Programme, Future Directions International, 1 May 2019 (https://www.futuredirections.org.au/publication/water-protests-in-algeria-are-giving-cause-for-concern-about-its-long-term-stability/).

(46) Belakhdar, N., '"Algeria is not for sale!" Mobilizing against fracking in the Sahara,' *Middle East Report* No 296, Fall 2020 (https://merip.org/2020/10/algeria-is-not-for-sale-mobilizing-against-fracking-in-the-sahara/).

(47) VOA News, 'Water protests roil Mideast, alarm region's governments', 27 July 2021 (https://www.voanews.com/middle-east/water-protests-roil-mideast-alarm-regions-governments).

(48) Al-Monitor, 'Environmentalists object to copper mine in Jordanian nature reserve', 26 August 2021 (https://www.al-monitor.com/originals/2021/08/environmentalists-object-copper-mine-jordanian-nature-reserve).

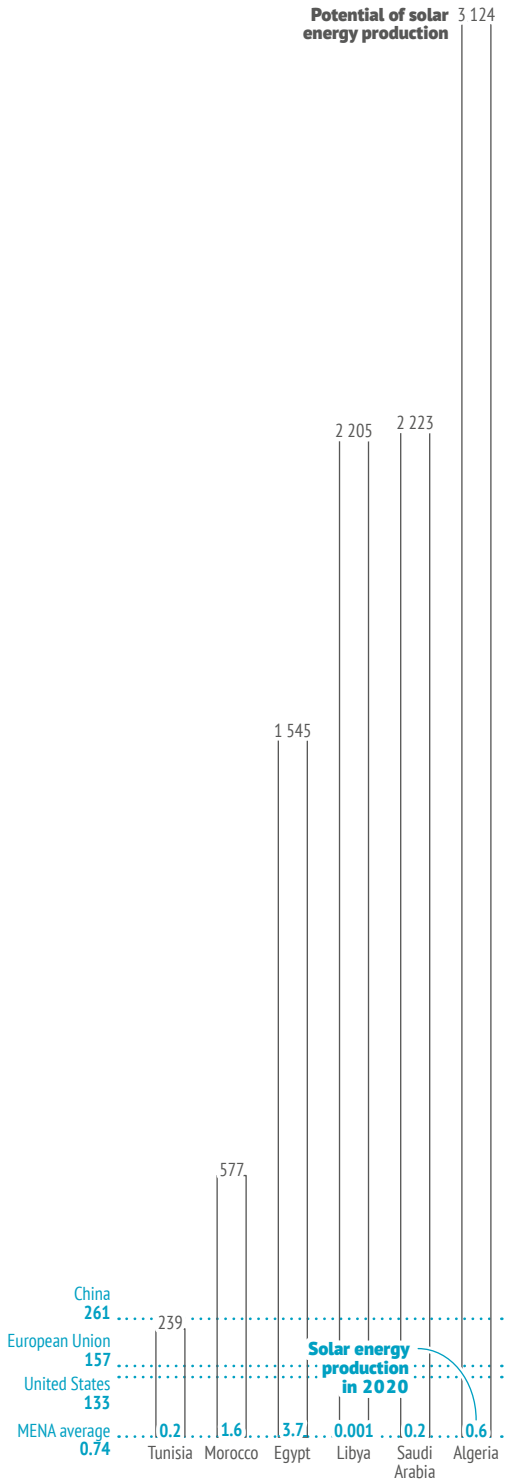
OF POTENTIAL AND POSSIBILITY: ENERGY INNOVATION

In addition to growing governmental responsiveness and public awareness, the region is also affected by other trends that can shape its mitigation of and adaptation to climate change.

The first of these is, of course, the growth of renewable energy. Although the region is primarily known for its fossil fuel exports, it also possesses the world's highest rates of sunshine [49]. In addition, it also has very high wind energy potential, particularly Jordan. Taken together, this makes the region's transition to renewable energy not only attractive, but also much more feasible than elsewhere [50]. The potential of concentrated solar power could be a hundred times more powerful in producing electricity than the current energy consumption of Europe and MENA combined [51].

This means that the region could have an energy surplus: Algeria's solar potential (3124 TWh in total) can cover its domestic electricity supply (at 2020 levels), France's (424 TWh), Germany's (489 TWh), Russia's (906 TWh), Canada's (556 TWh) Brazil's (530 TWh) and more. Algerian solar potential alone could provide energy for the EU, because the total electricity consumption by the EU in 2019 was 2780 TWh [52]. This entails that the Middle East and North Africa could become the EU's main electricity producer, by supplying

Solar energy
Production in 2020 and potential, TWh



Data: BP, *Statistical Review of World Energy*, 2020

(49) IRENA, *Renewable Energy in the Arab Region: Overview of developments*, Abu Dhabi, 2016 (https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_Arab_Region_Overview_2016.pdf).

(50) IRENA, *Pan-Arab Renewable Energy Strategy 2030: Roadmap of actions for implementation*, 2014.

(51) Ibid.

(52) Eurostat, 'Electricity production, consumption and market overview' (https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Electricity_production,_consumption_and_market_overview).

its European neighbours with cheaper energy and easing the burden of energy transition for both regions [53]. This idea is, of course, not new: the solar potential of the deserts was first calculated in 1986 by German physicist Gerhard Knies, which later inspired Desertec, an energy grid delivering renewable energy from North Africa throughout the region and Europe. It faced several problems related to transportation, cost-inefficiency and political cooperation.

Meanwhile, given the falling prices of renewable energy and new technologies, the idea is being revived on a smaller scale. There is already an electricity transmission corridor between Morocco and Spain aiming to have a technical capacity of 700 MW in the 2020s that could relay North Africa to the European continent [54]. In 2018, a joint declaration was signed between the European Internal Energy Market (France, Germany, Portugal and Spain) and Morocco to develop together a roadmap for sustainable electricity trade and network integration [55]. In 2019, Italy and Tunisia signed an agreement for the development and joint construction of a 600-megawatt (MW) electricity link [56]. British company Xlinks is now launching a subsea cable transmitting Moroccan energy from photovoltaic plants (rather than concentrated solar power, which is more expensive) directly to the United Kingdom (rather than through interconnectors on the continent, which also reduces the cost [57].)

Both solar and wind energy have made global inroads since photovoltaic cells capable of generating electricity when exposed to light were first invented in the 1950s [58], growing faster than any other energy source [59]. In 2000, solar energy produced only 1.07 TWh and at that time, solar energy cost around USD 5 per watt. Today, solar energy produces more than 844 TWh, which represents 11 % of global renewable energy generation (which itself contributes to 11 % of worldwide energy production) and costs USD 0.2 per watt [60]. Wind energy contributes to more than 20 % of the world's renewable energy production today (the second-highest source of renewable energy used globally after hydropower) [61].

Although the region has been a latecomer to this trend, it is now beginning to be part of it. Since the 2010s it has invested increasingly in renewable energy capacity, mostly in hydropower (which is somewhat ironic given its lack of water resources). In 2014, 6 % of MENA energy production came from renewables, 5 % from hydro energy and solar and wind energy

(53) Gaub, F., 'What if… the MENA switched to solar power?', in 'What if…? 14 futures for 2024', *Chaillot Paper* No 157, January 2020, EU Institute for Security Studies, January 2020 (https://www.iss.europa.eu/sites/default/files/EUISSFiles/CP_157.pdf).

(54) *PV Magazine*, 'Spain's third interconnection with Morocco could be Europe's chance for African PV – or a boost for coal', 20 February 2019 (https://www.pv-magazine.com/2019/02/20/spains-third-interconnection-with-morocco-could-be-europes-chance-for-african-pv-or-a-boost-for-coal/).

(55) European Commission, 'Joint Declaration on the establishment of a roadmap for sustainable electricity trade between Morocco and the European internal energy market', 17 November 2016 (https://ec.europa.eu/energy/sites/ener/files/documents/2016_11_13_set_roadmap_joint_declaration-vf.pdf); Center for Mediterranean Integration, 'Morocco, France, Germany, Portugal, and Spain Agree to Foster Corporate Trade of Renewable Electricity Between Each Other', 6 February 2019 (https://www.cmimarseille.org/blog/morocco-france-germany-portugal-and-spain-agree-foster-corporate-trade-renewable-electricity).

(56) Deutsche Welle, 'Elmed interconnector aims to bring solar power from the Sahara to Europe', 24 May 2019 (https://www.dw.com/en/elmed-interconnector-aims-to-bring-solar-power-from-the-sahara-to-europe/a-48843725).

(57) GreenTechMedia, 'Xlinks revives Desertec's dream, with a few twists', 4 December 2020 (https://www.greentechmedia.com/articles/read/xlinks-revives-desertecs-dream-with-a-few-twists).

(58) Energy Sage, 'The history of solar energy', 3 May 2018 (https://news.energysage.com/the-history-and-invention-of-solar-panel-technology/).

(59) Center for Climate and Energy Solution, 'Renewable Energy' (https://www.c2es.org/content/renewable-energy/).

(60) International Energy Agency, 'Evolution of solar PV module cost by data source, 1970-2020' (https://www.iea.org/data-and-statistics/charts/evolution-of-solar-pv-module-cost-by-data-source-1970-2020); BP, *Statistical Review of World Energy 2021* (https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html).

(61) BP, *Statistical Review of World Energy 2021* (https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html).

accounted for a share of only 1 % [62]. Morocco has declared that it is aiming for a 50 % share of renewables in its energy mix by 2030 and has launched a number of projects to achieve this, including several wind parks and a solar plant in Ouarzazate capable of supplying the energy needs of more than one million Moroccans [63]. The UAE has declared its intention to reach 50 % by 2050, and is currently operating the world's biggest solar power plant in Al Dhafra near Abu Dhabi capable of supplying electricity to more than 160 000 families [64]. In 2021, it was the first Arab state to open a nuclear power station – although nuclear power is not a renewable energy, it is still less CO_2 emitting than fossil fuel. Still, the project drew protests from neighbouring Qatar which feared the consequences for regional stability and safety. Saudi Arabia is planning to build 16 nuclear reactors across the country by 2040 with assistance from the United States.

Saudi Arabia, which has joined the renewable energy train rather late, is now attempting to catch up. In 2021 it inaugurated a solar power plant in Sakaka, able to supply more than 180 000 households. The same year it broke two world records for solar pricing.

Libya also aims at replacing traditional energy supply by solar systems but its plans are regularly disrupted by violence. In 2013, the country launched its renewable energy strategic plan 2013–2025 with the objective to achieve 7 % of the electricity mix with renewables in 2020 [65]. With less than 1 % of renewable energy contributing to electricity supply in 2019, the country is far from reaching its goal but has nevertheless launched several localised projects. The energy supply from the city of Kufrah, located in the Sahara Desert, comes from a thermal power plant and should be replaced by the construction of a photovoltaic solar power plant of 200 hectares. The country is also building very specialised solar grids for 15 hospitals in six cities including Benghazi and Tripoli with the help of the United Nations Development Programme (UNDP) [66]. Libya has experienced several power cuts due to the disruption caused by the armed conflict. Places like hospitals need electricity 24 hours a day. Investing in mini solar networks for hospitals is not only a matter of reducing the country's footprint, it is also a way to ensure that hospitals, which perform a vital service especially in times of war, have more energy independence and a more reliable supply of electricity [67].

Moving to solar and wind energy would reduce the region's environmental footprint.

Moving to solar and wind energy would reduce the region's environmental footprint, which could lead to a 10 % reduction in gas emissions by 2030 [68]. In Saudi Arabia, for instance, the same amount of electricity from solar energy equals nearly 3 tons of gas emissions from fossil energy

(62) *Pan-Arab Renewable Energy Strategy 2030*, op.cit.

(63) Kingdom of Morocco, Ministry of Energy, Mines and the Environment, 'Énergies Renouvelables', (https://www.mem.gov.ma/Pages/secteur.aspx?e=2); World Bank, 'Morocco to make history with first-of-its-kind solar plant', 20 December 2015 (https://www.worldbank.org/en/news/feature/2015/11/20/morocco-to-make-history-with-first-of-its-kind-solar-plant).

(64) Gulf News, 'World's biggest solar power plant project in Abu Dhabi secures funding', 22 December 2020 (https://gulfnews.com/business/energy/worlds-biggest-solar-power-plant-project-in-abu-dhabi-secures-funding-1.1608614046317).

(65) International Energy Agency, 'Libya: Key energy statistics, 2018' (https://www.iea.org/countries/libya).

(66) Afrik 21, 'Libya: Government launches construction of a solar power plant in Kufra', 16 March 2020 (https://www.afrik21.africa/en/libya-government-launches-construction-of-a-solar-power-plant-in-kufra/).

(67) *Libya Herald*, 'UNDP installs solar panels in 15 Libyan hospitals, plans more in 2018', 18 January 2018 (https://www.libyaherald.com/2018/01/18/undp-installs-solar-panels-in-15-libyan-hospitals-plans-more-in-2018/).

(68) Calculations made by the authors based on IRENA, *Renewable Energy Market Analysis – GCC 2019* and Climate Watch, 'Historical GHG Emissions' (https://www.climatewatchdata.org/ghg-emissions?end_year=2018&start_year=1990).

production [(69)]. Renewable energy production also allows for saving water because renewable energy production requires less water per kilowatt than fossil fuel or nuclear energy – in the case of the Gulf countries, this would mean reducing freshwater needs by 17 % [(70)]. Renewable energy could also help meet the growing energy demand resulting from a growing population. Several studies estimate that if Saudi Arabia continues to rely on oil, domestic demand may consume all of the country's production, leaving nothing to export, as early as the mid-2020s or by the 2030s at the latest [(71)].

In addition, this shift would benefit employment: in Egypt, investment in renewables could create 28 000 jobs by 2035 and 200 000 in the Gulf States [(72)]. In general, it has been estimated that investing in clean technology – not only renewables but any activities that reduce environmental degradation and carbon footprint – would create more than 12 million jobs all around the region by 2030. Two thirds of jobs in this sector require an engineering background. This is an area that regional universities cover well: 29 % of graduates hold a degree in this field, in mathematics, science or technology [(73)] – but more are needed not just to meet the needs of the energy sector, but to meet the needs of the economies of the future.

While the region has enormous potential to not just cut emissions through the use of renewable energies, it could also find a new source of income by exporting green energy to Europe. Obstacles however remain in political and technical terms.

(69) Power Technology, 'ACWA Power unveils Saudi Arabia's first renewable energy project', 12 April 2021 (https://www.power-technology.com/news/acwa-power-renewable-project/); NS Energy, 'ACWA Power opens 300MW Sakaka solar project in Saudi Arabia', 12 April 2021 (https://www.nsenergybusiness.com/news/acwa-power-opens-sakaka-project-in-saudi/).

(70) Ibid.

(71) IRENA, *Renewable Energy Market Analysis – GCC 2019*, Abu Dhabi, 2019 (https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Jan/IRENA_Market_Analysis_GCC_2019.pdf).

(72) Ibid; Kotb, A., 'Egypt's growing green energy sector likely to boost jobs,' *Ahram Online*, 14 March 2018 (http://english.ahram.org.eg/NewsContent/3/12/292765/Business/Economy/Egypts-growing-green-energy-sector-likely- to-boost.aspx).

(73) World Economic Forum, *The Future of Jobs and Skills in the Middle East and North Africa: Preparing the region for the Fourth Industrial Revolution*, May 2017 (https://www3.weforum.org/docs/WEF_EGW_FOJ_MENA.pdf).

CHAPTER 4

READY OR NOT?

A climate risk assessment

Climate change is a risk producer, meaning it increases human exposure to risk. But what exactly is risk? Although often confused with threats (which we are exposed to but do not manage) or uncertainty (which is simply a state of not knowing for sure), risks are a *combination* of the possibility (i.e. non-zero probability) of something dangerous happening and the extent of this danger's impact.

> **Risk = Extent of potential loss x probability of dangerous event**

This means that risk assessment, too, is a multi-step process: firstly it includes the analysis of hazards, i.e. events and developments that have the *potential* to cause harm - these are the elements laid out in chapter one outlining the exposure of Arab states to climate change. Exposure alone, however, will not determine the magnitude of the risk: vulnerabilities will amplify it (see chapter two), but strengths (chapter three) will reduce it. Together they create the conditions under which Arab states can mitigate or adapt to climate risks.

In this chapter, we merge the three components into a more refined risk assessment by state. We begin with a qualitative risk assessment and then follow with a quantitative one, outlining what we already know when it comes to Arab state risk. We end with a comprehensive index using complex data in which we rank Arab states according to their climate risk.

Qualitative risk assessment

Qualitative risk assessment has broadly three functions: in contrast to quantitative risk assessment, it can give more details on the elements of risk, reproduce the complexity of a risk, and provide a more nuanced picture of the nature of the risk. Qualitative risk assessment can also offer valuable insights when the data is too scarce for a quantitative risk assessment – especially when we have no historical antecedent for a given problem.

When it comes to climate change in the region, we have seen that exposure to climate change is particularly high when it comes to water shortage in the near-term, and to sea-level rise in the medium-term. We also find that there are broadly two categories when it comes to how ready Arab states are to manage this exposure: states that are ready and have the capacity to manage climate change should they choose to do so, and those that do not. Algeria, the Gulf States, Egypt, Jordan, Morocco and Tunisia fall into the first category; Iraq, Lebanon, Libya, Syria and Yemen fall into the second category.

The first category does not imply, however, that these states are ready *now*, but rather that they have the necessary elements to become ready. Several elements make states better equipped to withstand the pressures of climate change: both awareness and resources at state level are important preconditions for plans to build resilience.

Algeria, Egypt and Jordan

Climate policies

General framework	Water security	Food security	Resilient housing and green cities	Waste management	Sustainable tourism	Public transportation	Energy transition plan
Algeria							
Plan National Climat	Plan national de l'eau 2035	Algerian Agriculture Roadmap	Algiers sustainable city project	Plan d'action national MCPD (Modes de consommation et de production durable)	**X**	**X**	Renewable Energy and Energy Efficiency Development Plan 2015-2030
Egypt							
Egypt Vision 2030	National Water Resources Plan	Sustainable Agriculture Development Strategy towards 2030	National Strategic Plan for Urban Development 2052	Egypt Vision 2030	**X**	**X**	Egypt Vision 2030
Jordan							
National Climate Change Policy of the Hashemite Kingdom of Jordan 2013-2020	National Water Strategy of Jordan 2016-2025	National Strategy and Action Plan for Sustainable Consumption and Production – Agriculture and Food Security (2016-2025)	**X**	National Strategy and Action Plan for Sustainable Consumption and Production – Waste sector (2016-2025)	Jordan Green Growth National Action Plans 2021-2025: Tourism sector	National Strategy and Action Plan for Sustainable Consumption and Production – Transport sector (2016-2025)	Jordan Green Growth National Action Plans 2021-2025: Energy Sector

States from the first group have generally already taken measures against effects of climate change. Jordan, for instance, 'has made significant progress in the reuse of treated wastewater, demonstrating the vast potential in the region' [(1)]. It has also increased the renewable energy share in electricity production from 1 % in 2015 to 13 % in 2019 [(2)], and improved food security by increasing grain storage capacity in the Port of Aqaba. Egypt, too, has undertaken some projects designed to increase food security, primarily by improving existing irrigation and cultivation systems in the Nile delta, and by creating 1.5 million acres of new agricultural areas in the desert in the eastern and western regions [(3)]. Along the coast, the United Nations funds measures designed to prevent flooding caused by rising sea-levels, such as the construction of dykes [(4)]. Egypt has also begun to resettle people living in slums in Alexandria Governorate, particularly in flood-risk areas, or people whose homes were destroyed by previous natural disasters [(5)]. But more needs to be done, as safety measures are considered moderate rather than high in effectiveness [(6)].

Algeria, too, has made significant progress, particularly when it comes to water use. Since the 2000s, it has built 80 dams and 11

(1) *Arab Sustainable Development Report 2020*, op.cit.

(2) Our World in Data - Renewable energy.

(3) FAO Agroecology, *A National Mega Project*, 12 June 2020 (http://www.fao.org/country-showcase/item-detail/en/c/1287924/).

(4) UNDP, 'Enhancing Climate Change Adaptation in the North Coast of Egypt' (https://www.adaptation-undp.org/projects/enhancing-climate-change-adaptation-north-coast-egypt).

(5) 'Will sea-level rise claim Egypt's second-largest city?', op.cit.

(6) Frihy, O. E. and El-sayed, M.K.H., 'Vulnerability risk assessment and adaptation to climate change induced sea level rise along the Mediterranean coast of Egypt', *Mitigation and Adaptation Strategies for Global Change*, Vol. 18, No 8, 2013, pp.1215-1237.

desalination plants, as well as water towers [7]. But despite these measures, Algeria still has some way to go to ensure sustainable water use, particularly in the face of a growing population [8]. It also launched a vast programme of irrigation across the country, doubling the surface of irrigated lands by almost 800 000 hectares [9]. There are plans to transform Algiers into an 'eco-city' by 2035; the relocation of the port, and the greening of the shores of Oued el Harrach, are only two examples of many measures designed to increase the number of green spaces, improving housing and developing public transport [10].

These states display a capacity at a par with the risk; they will need to ensure political stability in order to maintain the trajectory they are on – which in itself will be challenging given the magnitude of issues in the socio-economic realm.

Matters are much worse in Iraq, Lebanon, Syria and Yemen. Although Lebanon has revised its Paris Agreement NDC from 15 % emission cuts by 2030 to 20 % in 2020 [11], it is not clear how it will find the requisite funding to implement necessary food, water and infrastructure reforms. These are estimated to amount to USD 10 billion, which amounts to almost 20 % of the Lebanese GDP in 2019 [12]. The only positive element in this regard is that Lebanon's population is projected to decrease by 20 % by 2030, reducing some of the country's demographic pressures created in part by the presence of Palestinian and Syrian refugees [13].

Iraq aims to reduce 14 % of its emissions by 2035, 13 % depending on forthcoming international aid, and 1 % being unconditionally the results of its own fundings [14]. Unlike its neighbours, actions to combat climate change have not been developed into a multidimensional long-term public strategy. UNDP has now integrated climate change, and the need to improve Iraq's resilience against it, in its 2020-2024 programme [15]. Projects that are developed with UNDP or with the UNFCCC are mostly sectoral rather than mainstreamed into Iraqi policies. For instance, UNDP develops projects on energy transition and promotion of solar energy and disaster risk management [16].

Low levels of climate risk preparedness increase existential risks when it comes to human habitat, water and food security - which in turn leads to an overall higher exposure to conflict risk. Climate change therefore exposes these states in particular not 'just' to environmental risks, but also to political ones.

Although conflict research is far from having achieved a breakthrough when it comes to understanding the precise reasons for conflict onset, conflict does correlate with several elements that climate change is likely to produce

(7) The People's Democratic Republic of Algeria, *Algérie, Rapport National Volontaire 2019 – Progression de la mise en œuvre des ODD*, 2019 (https://sustainabledevelopment.un.org/content/documents/23441MAE_rapport_2019_complet.pdf).

(8) Business France, 'Algérie - Les projets prévus par le ministère des ressources en eau à horizon 2030', 21 March 2019 (https://www.businessfrance.fr/algerie-les-projets-prevus-par-le-ministere-des-ressources-en-eau-a-horizon-2030)

(9) Business France, 'Algérie - Agriculture : la superficie irriguée passe à 1,4 million d'hectares', 18 November 2020 (https://www.businessfrance.fr/algerie-agriculture-la-superficie-irriguee-passe-a-1-4-million-d-hectares).

(10) Chabbi-Chemrouk, N., '"Alger ville durable" : ambitions et aspirations', *France Info Afrique*, 22 October 2019. (https://www.francetvinfo.fr/monde/afrique/societe-africaine/alger-ville-durable-ambitions-et-aspirations_3669159.html).

(11) Republic of Lebanon, *Lebanon's Intended Nationally Determined Contribution under the United Nations Framework Convention on Climate Change*, Updated 2020 version, Beirut, March 2021 (https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Lebanon%20First/Lebanon%27s%202020%20Nationally%20Determined%20Contribution%20Update.pdf).

(12) Calculation made by the Ministry of Environment and the UNDP during an interview with the authors.

(13) *MENA Generation 2030: Investing in children and youth today to secure a prosperous region tomorrow*, op.cit.

(14) World Bank Group, *Iraq: (Intended) Nationally Determined Contribution*, Washington D.C., 2016 (http://spappssecext.worldbank.org/sites/indc/PDF_Library/IQ.pdf).

(15) Executive Board of the United Nations Development Programme, the United Nations Population Fund and the United Nations Office for Project Services, *Country Programme Document for Iraq (2020-2024)*, New York, February 2020.

(16) Ministry of Foreign Affairs of the Netherlands, *Climate Change Profile – Iraq*, The Hague, 2018 (https://reliefweb.int/sites/reliefweb.int/files/resources/Iraq_3.pdf).

The link between climate change and conflict

Data: RICCAR, 'Arab Climate Change Assessment Report', 2017

more of: economic loss, growing competition for resources and deterioration of living conditions frequently appear in the run-up to conflicts, unrest and other violence [(17)]. But the link between the effects of climate change and conflict is not straightforward, and 'scholarly attempts to draw automatic correlations between environmental variables and conflicts, let alone terrorism, have so far yielded inconclusive results. Profound methodological disagreements persist, and the lack of contextualisation and socio-political analysis make large-scale empirical studies and big data highly unlikely to generate consensus. Overall, however, the hypothesis that a causal link, or nexus, does indeed exist between climate events, dwindling resources and violent conflicts, let alone terrorism, is not adequately supported by conclusive scientific evidence' [(18)].

What we know with certainty about the link between conflict and climate is the following:

> Climate plays an *indirect* role in the development of conflicts: harsh climate is a second-order catalyst [(19)] of conflicts, involving either public armed groups or non-state armed groups, and impedes conflict resolution and peace building. Climate change does not have *direct* effects on conflicts but can exacerbate grievances and fuel political, economic and social tensions that may culminate in violence [(20)].

(17) Sofuoğlu E. and Ay, A., 'The relationship between climate change and political instability: the case of MENA countries', *Environmental Science and Pollution Research International*, Vol 27, 2020,pp.14033-14043.

(18) Raineri, L., 'Sahel climate conflicts? When (fighting) climate change fuels terrorism', *Brief* No 4, EUISS, December 2020 (https://www.iss.europa.eu/content/sahel-climate-conflicts-when-fighting-climate-change-fuels-terrorism#_climate_conflicts___evidence___or_myth_based).

(19) Mustasilta, K., 'The future of conflict prevention: Preparing for a hotter, increasingly digital and fragmented 2030', *Chaillot Paper* No 167, EUISS, 2021 (https://www.iss.europa.eu/sites/default/files/EUISSFiles/CP_167_0.pdf).

(20) World Bank, *World Development Report 2011: Conflict, security, and development*, Washington D.C., 2011.

- Countries in conflict are stuck in a vicious circle when it comes to climate change: for instance, conflict damages infrastructure needed to manage the fallouts of climate change. In Syria, combat damaged most of the country's water distribution infrastructure, reducing water supply levels to 5 - 20% of pre-war levels [(21)]. In 2018, in seven of the country's north-western and central districts, the World Bank estimated that the total damage of the war against the so-called Islamic State of Iraq and Syria (ISIS) cost USD 45.727 million, with USD 16 million of damage caused to housing [(22)]. Water infrastructure damage in the whole territory has been estimated to be as high as USD 600 million [(23)]. Conflict also takes a heavy toll on national budgets, reducing financial resources needed for climate-related reforms even further. To take again the example of Syria, its economy has shrunk by 60 % since the beginning of the war [(24)]. Lastly, climate change, as an apparent distant policy problem, frequently takes a backseat when states are focused on fighting or resolving a conflict [(25)]. Regarding agriculture, the war destroyed most of the country's tools, machinery and irrigation systems: before the war, 65 % of farmers had access to irrigation systems in Iraq but only 20 % did in 2018 [(26)].

- Climate-induced deterioration of living conditions and tensions among communities can provide a recruitment opportunity for terrorist organisations. For instance, ISIS used to take advantage of the impoverishment of farmers in Iraq to gain recruits, as they could propose financial alternatives to agriculture [(27)]. It also – quite literally – fanned the flames of conflict further by setting fire to crops in Iraqi Kurdistan [(28)]. Other terrorist organisations did the same in Algeria [(29)]. In Somalia, in 2017 following a prolonged drought the displacement of hundreds of thousands of people in informal settlements around Mogadishu facilitated al-Shabaab's recruitment drive [(30)].

- Displacement of people in the region due to conflicts in Libya, Syria and Yemen can serve as an indication of what more conflict will do to states that are already struggling in terms of water management and urbanisation. In Lebanon, for instance, domestic water consumption increased by 20 % with the arrival of refugees from Syria [(31)].

- Because climate change will affect the region unevenly, its negative effects might overlap with other, pre-existing tensions between communities. In Iraq, for instance, areas primarily inhabited by Shiites in the South (especially the governorates of Al-Mutana, Al-Najaf, Al-Qaddisiya,

(21) *Moving Towards Water Security in the Arab Region*, op.cit.

(22) World Bank, Open Knowledge Repository, *Iraq Reconstruction and Investment: Damage and needs assessment of affected governorates*, Washington, 2018.

(23) Von Lossow, T., 'More than infrastructures: water challenges in Iraq', Clingendael, Netherlands Institute of International Relations, July 2018 (https://www.clingendael.org/sites/default/files/2018-07/PB_PSI_water_challenges_Iraq.pdf).

(24) Barrett, A. and Ahlam, 'Syria's economic collapse and Its impact on the most vulnerable', *The Path Forward*, Center for Strategic and International Studies, 18 February 2021 (https://www.csis.org/analysis/syrias-economic-collapse-and-its-impact-most-vulnerable).

(25) International Institute for Sustainable Development, Ministry of Foreign Affairs of Denmark, *Rising Temperatures, Rising Tensions: Climate change and the risk of violent conflict in the Middle East*, Manitoba, 2009.

(26) *Iraq Reconstruction and Investment: Damage and needs assessment of affected governorates*, op.cit.

(27) 'Climate change and conflicts in the Middle East and North Africa', op.cit.

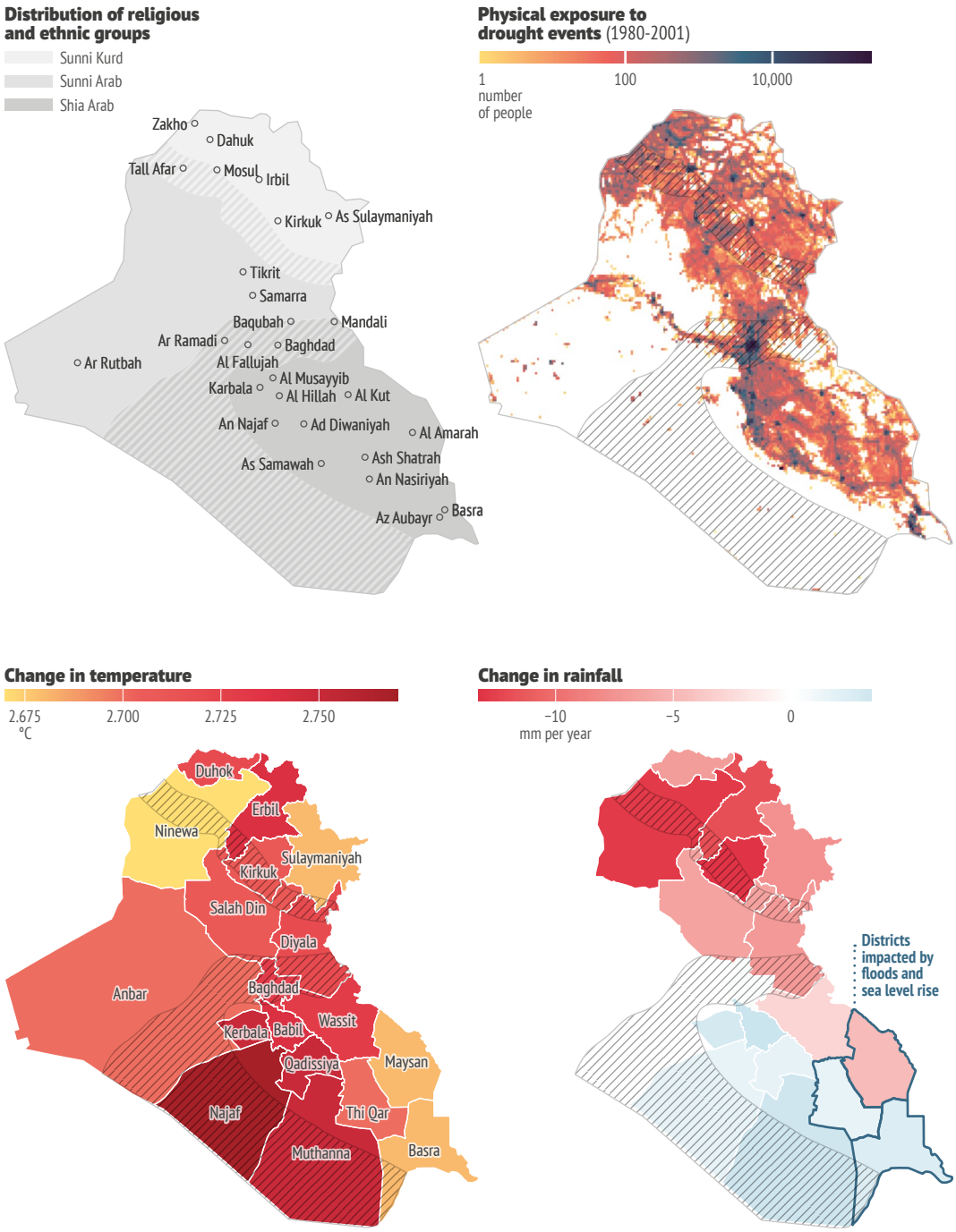
(28) Al-Monitor, 'Islamic State believed behind crop fires in Iraq's disputed territories', 13 May 2020 (https://www.al-monitor.com/originals/2020/05/farm-fires-resume-iraq-disputed-territories-islamic-state.html).

(29) Al-Monitor, 'Algeria blames Israel, Morocco for deadly wildfires', 19 August 2021 (https://www.al-monitor.com/originals/2021/08/algeria-blames-israel-morocco-deadly-wildfires).

(30) Krampe, F., 'Climate change, peacebuilding and sustaining peace', SIPRI Policy Brief, Stockholm International Peace Research Institute, June 2019.

(31) Jaafar, H., Ahmad, F., Holtmeier, L. et al, 'Refugees, water balance, and water stress: Lessons learned from Lebanon', *Ambio*, Vol. 49, 2020, pp.1179–1193.

Ethno-religious partition and vulnerability to climate change in Iraq



Data: World Bank, Climate Change Knowledge Portal; UNEP, Globe Risk Data Platform, 2021; Climate Central, Coastal Risk Screening Tool (year SLR and SLR + annual floods); European Commission, GISCO, 2021

Missan, Thi-Qhar or Al-Muthanna, but also Basra) will struggle more with water shortages and be more affected by sea-level rise than other parts of the country [32]. In a larger context of grievance and conflict, this could exacerbate tensions further [33].

Resource competition is a regular feature of state-on-state conflict; as climate change diminishes the availability of certain resources such as water, interstate conflict is set to become more likely, especially between states that share transboundary water systems [34]. In the region, this is the norm more than the exception, with 14 countries sharing groundwater tables and 21 water basins [35]. Egypt, one of the rain-poorest countries in the world, relies almost entirely on the Nile for its water supply, but the Nile originates in Ethiopia. The ongoing feud between the two states over the Grand Ethiopian Renaissance Dam is a prominent example of such disputes. Disputes over water have also caused tension between Turkey and Iraq, and between Jordan, Israel and the Palestinian territories [36].

In sum, this means that we cannot say with certainty how likely *new* conflict is to erupt, or where - but we do see high levels of risk for those states that are already experiencing conflict.

By numbers: Quantitative risk index

Quantifying risk comes with some challenges: a number of factors and variables (e.g. levels of awareness, readiness or resilience) cannot be easily measured in numbers, and often data is not available allowing for full and extensive comparison. This is why numbers alone will not give us a detailed or close-up understanding of the level of risk in a very specific context.

That said, indices can be useful particularly when the issue at hand is complex, encompasses many different areas, occurs over a longer timespan, and involves a sizeable number of different actors. Quantified risk assessment allows for simplification of complex issues, speed of understanding, and direct comparison.

The objective of our risk index is therefore to compare and rank the levels of risk by country in order to allow for policy prioritisation – not

List of sub-indices

Current resources management performance
- Water resources
- Food resources
- Waste
- Energy
- CO_2 and pollution
- Public transportation and urban well-being
- Ecosystem and biodiversity
- Security and peace
- Public awareness
- Sustainable tourism

Projections on climate-related vulnerabilities and trends
- Climate change impacts
- Potential for sustainable economy
- Demography and behavioural patterns

Readiness and capabilities
- Implementation of climate policies
- Governance and capacity

(32) International Organization for Migration, *Water quantity and water quality in central and South Iraq: a preliminary assessment in the context of displacement risk*, 2020.

(33) Robert Malley, CEO of the Atlantic Council, 'Climate change is shaping the future of conflict', UN Security Council's virtual Arria Session, 5 May 2020 (https://www.crisisgroup.org/global/climate-change-shaping-future-conflict); Saghir, J., 'Climate Change and conflicts in the Middle East and North Africa', Issam Fares Institute for Public Policy and International Affairs (IFI), American University of Beirut (AUB), 2019.

(34) 'Climate change Is shaping the future of conflict', op.cit.

(35) Ibid.

(36) Gaub, F., 'Arab Futures 2.0: the road to 2030', *Chaillot Paper* No 154, EU Institute for Security Studies, September 2019 (https://www.iss.europa.eu/sites/default/files/EUISSFiles/Chaillot_154%20Arab%20Futures.pdf); UNESCO, *Jordan Case Study*, 2003 (https://unesdoc.unesco.org/ark:/48223/pf0000133300).

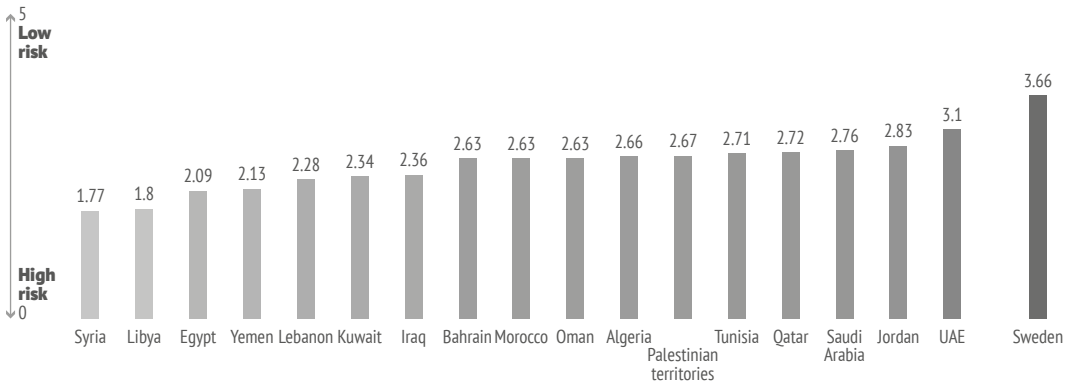
just by state, but also by policy area. Our index builds on other, similar ones of its kind. Like those, it takes into account levels of exposure to climate change, sensitivity, potential impacts and adaptive capacity to respond [37]. In contrast to those, it adds the potential for adaptation and even innovation (e.g. in areas such as energy and tourism). To do so, indicators are noted from 0 (very bad performance) to 5 (very good performance).

There are other indexes, of course. The Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socioeconomic Vulnerability in the Arab Region (RICCAR), for instance, covers sectors such as water, food and floods – but its results are divided into low, moderate and high vulnerability categories and the focus is primarily on the local level. It does not contain national-level analysis and no clear indications of what policy action can be taken. Another index, the ND-Gain, assesses resilience particularly when it comes to six sectors: water, food, health, ecosystem, infrastructures and human habitat until the end of the century. It also includes political governance and stability indicators from the World Bank, but it does not assess the level of readiness when it comes to policy reforms and institutional readiness on climate change. Also, this analysis does not provide an assessment of the direct effects of climate change on countries, such as the increase in temperature, change in rain patterns, or disaster probability.

Building on these existing indexes, our index rests on three categories: the present situation (level of performance/governance), the challenges of the future (level of vulnerability to climate change), and what needs to be done regarding the current political and economic situation (level of willingness and feasibility). More than 90 indicators and tools were used to fine-tune our assessments with the most recent data available. Some indicators are taken from pre-existing quantitative indexes, such as the Environmental Performance Index or the World Energy Trilemma Index, and their results have been transposed to our own notation system (from 0 to 5). When it comes to raw data, for instance the share of CO_2 emissions in world global emissions or the percentage of population with access to public transport or working in agriculture, the system of notation was based either on a scale of comparison with best and worst performers, or on a qualitative analysis of the extent to which a certain sector contributes to or is at risk from climate change. Some indicators are also the results of calculations made by the authors to take account of the evolution of a phenomenon, for example the extent of freshwater collection over a decade, or a ratio, such as the ratio of gas emissions per capita compared to world emissions per capita average.

Who is the most at risk from climate change in MENA?

Total index score



(37) *Arab Climate Change Assessment Report –Main Report*, op.cit.; Chen, C. et al, 'Country Index Technical Report', University of Notre Dame Global Adaptation Index, November 2015 (https://gain.nd.edu/assets/254377/nd_gain_technical_document_2015.pdf).

Who is the most at risk from climate change in MENA?

Score by sub-index

Regarding indicators which are not based on quantified data, such as sea-level rise or climate policy planning, notation was assigned according to the existence or the absence of these elements in the respective countries. (A full list of the indicators used can be consulted in the annex, pages 70–74).

Our index is aimed to provide an assessment until the middle of the century, projections until 2050 for socioeconomic data and 2059 for climate data. By setting the timeframe in the medium term, it ensures that our analysis is as accurate as possible, because the more we look forward in time, the more the accuracy of projections and climate models is uncertain [38]. In order to have a point of comparison with a country external to the region, Sweden has been added as a country of reference. Sweden is seen as a model when it comes to green policies and practices, because the country managed to halve its gas emissions between 1990 and 2018 and also because the Swedish population is among the most ready in the EU to

(38) Collins, M., R. Knutti et al., 'Long-term climate change: Projections, commitments and irreversibility', in Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor et al. (eds.), *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge and New York, 2013.

take action to combat climate change both individually and at the state/European levels [39].

When it comes to mapping the current situation, we have included ten elements that determine the level of risk today, including how well states manage water, waste, and food resources, how reliant they are on fossil fuels, how sustainable the tourism sector is, how high their emission and pollution levels are, to what extent their respective publics are aware of climate change and whether a state is experiencing a conflict situation, as well as their energy performance, sustainability, access and security. We have also included the state of public transportation as well as biodiversity management. In the category on future challenges, we added the environmental impacts of climate change in terms of temperature rise, change in rainfall patterns and exposure to sea-level rise (calculating scenario RCP 8.5, the business-as-usual scenario) for both 2039 and 2059. We also added the potential to move to a green economy as well as demographic developments. In addition, we calculated readiness in terms of the extent to which states implemented climate-related policies (e.g. readiness to transition to renewable energy, CO_2 emission reduction targets, whether a given state is a signatory to the Paris Agreement or not, etc). Lastly, we have also accounted for political stability as an enabler of climate-readiness, including government effectiveness, levels of corruption, rule of law, business resilience and state resilience to fragility. These elements determine the extent to which states can implement climate-related policies efficiently.

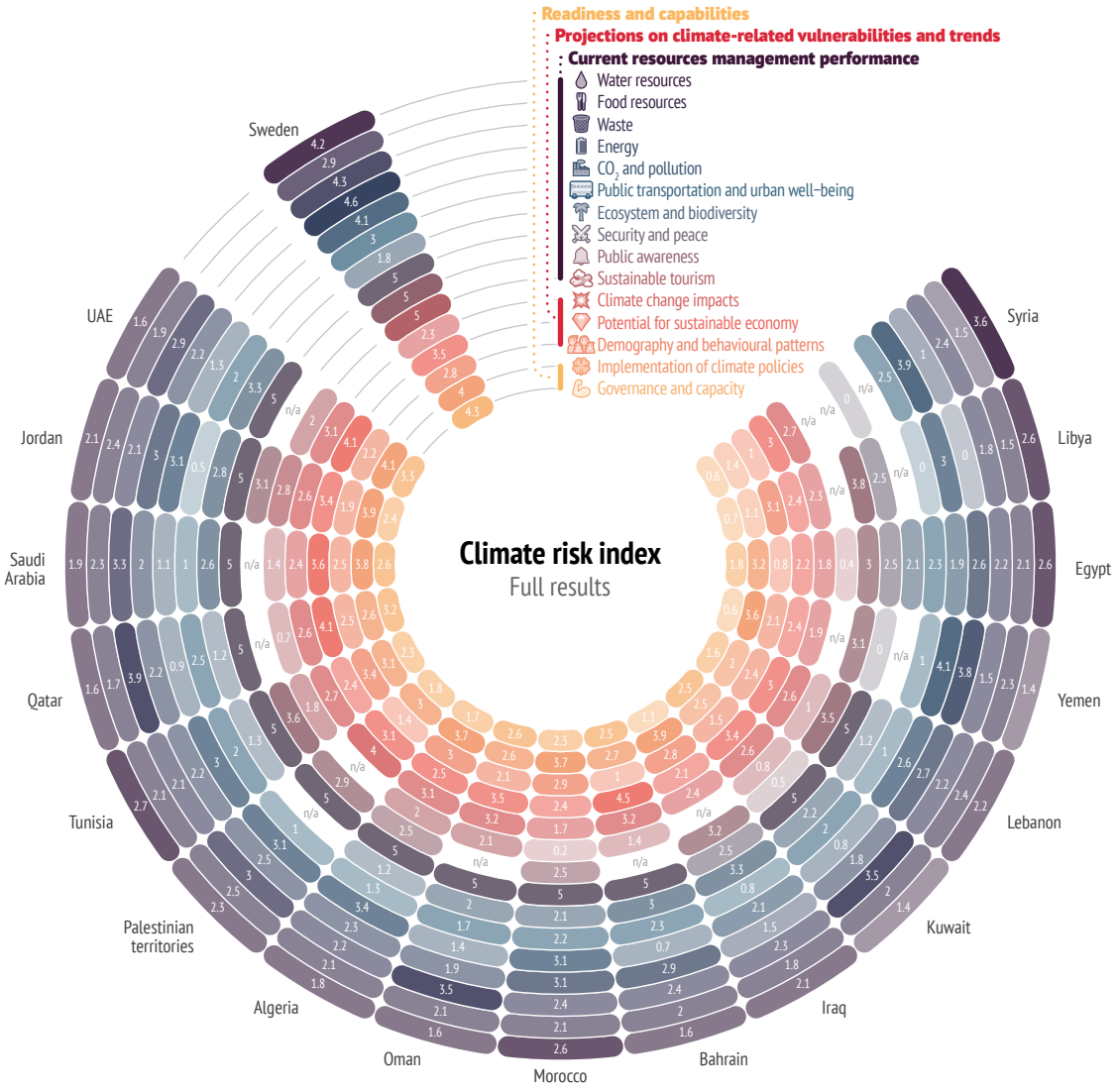
There are, however, limitations to our assessments. Data is often missing for war-affected countries: Iraq, Libya, the Palestinian territories, Syria and Yemen. Out of 93 indicators, 33 results are missing for Syria, 28 for Libya, 26 for the Palestinian territories, 18 for Yemen and 9 for Iraq. For the Palestinian territories and Iraq especially, data are missing in indicators where we assume them to have poor performance grades: energy transition readiness, energy system performance, ambient quality of water or sustainable tourism for Iraq; for the Palestinian territories, cooperation agreement on transboundary waters, ecosystem performance, contribution of the economic sectors to gas emissions (agriculture, waste and transport), energy transition and performance, use of renewable energy. This means that the total scores of these two countries, and the ranking for the Palestinian territories and Syria in the category 'current resources management', are probably poorer than the index reflects.

Our index finds that the UAE represents the lowest level of climate risk in the region. This is because it ranks first in terms of political readiness but it is also the Arab state that is the least vulnerable to the direct and indirect effects of climate change. Jordan comes second: this is because it ranks second in terms of political readiness, and is the Arab country that manages its resources the most efficiently. However, Jordan will be hit more severely by direct and indirect effects of climate change than the UAE: when it comes to climate change it is the eighth most impacted Arab country according to our vulnerability category. The Gulf Cooperation countries [40] generally display a lower level of climate risk (except Kuwait, ranked 12th), showing the importance of financial resources in managing its effects. But states such as Jordan, Morocco or Tunisia are not far behind, showing the value of policy awareness and the space for policy action. Both hinge on an important aspect: the absence of armed conflict.

In general terms, countries that are not affected by an armed conflict or that have not been recently affected by a conflict all have readiness and capabilities graded above the average (>2.5). Their score is between 3.70 (UAE) and 2.51 (Kuwait) out of 5, while Sweden scores

(39) Climate Watch, CAIT Climate Data Explorer, 2021; European Commission, 'Climate Change', Special Eurobarometer Report 513, March-April 2021 (https://ec.europa.eu/clima/system/files/2021-07/report_2021_en.pdf).

(40) Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.



4.15. Of course, best grades do not indicate best possible grades: much remains to be done. The exception to this is Lebanon: although not in armed conflict, it displays very poor levels of readiness and therefore high risk exposure with a grade of 1.79/5. Despite submitting an updated NDC with higher ambitions in terms of climate mitigation, Lebanon scores 2.03/5 when it comes to the implementation of climate-related policies and 1.56/5 on governance effectiveness, political stability and capacity.

Egypt will be the country most vulnerable to the direct and indirect effects of climate change in the decades leading up to the middle of the century. Along with Morocco, Egypt will be the country most negatively affected by environmental damage (sea-level rise, rise of temperature, decrease in rainfall and exposure to disasters) induced by climate change, but it also – along with Iraq – has low adaptive capacity when it comes to the transition to a sustainable economy and, more importantly, is highly vulnerable in terms of future resource management due the rapid pace of its population growth. Egypt is therefore at an important junction: any political unrest or worse, conflict, could derail its efforts at meeting the climate change challenge. Conversely, if Egypt undertakes policy reforms and ensures that it has sufficient financial resources at its disposal, then it will be in a stronger position to withstand the impacts of climate change.

CONCLUSION

Policy considerations

Climate change will affect the Arab world remarkably hard, particularly by reducing scarce water resources, thereby putting pressure on already challenged systems providing food, transport, energy, and housing. Human trends that evolved independently from climate change, such as demographic growth and urbanisation – but also economic growth, which caused it – will have a negatively reinforcing effect on how climate change unfolds in the region. Taken together, this cannot be interpreted otherwise than as an important warning of substantial existential risk. Time is of the essence, as the region is warming 20 % faster than the rest of the world [(1)].

That said, there is nothing predetermined in this risk. States and citizens, both in the region and outside, can take measures to reduce the likelihood of dangerous events occurring in the first place, and to mitigate their negative effects, should they materialise. How the future will unfold under the influence of climate change largely depends therefore on human action – in the region and elsewhere.

The following recommendations are therefore to both states in the region as well as the European Union, its Member States, or international organisations involved in the region. Because climate change is a global phenomenon, managing its outcome is a shared responsibility. We have structured the recommendations following the logic of risk assessment: after identification of risk and an evaluation of probability and impact (as laid out in chapters 1, 2 and 3), risk management requires three elements. These are mitigation (reducing the chance of the risk occurring in the first place), monitoring (keeping an eye on the evolution of the risk) and lastly, adaptation (preparing measures that will reduce the risk's impact).

One important aspect should be borne in mind: because the future is the outcome of not just one but several complex systems interplaying, attempts to solve one problem are likely to have knock-on effects on other areas. For instance, addressing the challenge of high temperatures using air conditioning inadvertently increases energy needs which in turn can increase CO_2 emissions further – unless the energy source is rendered climate-neutral. Solutions therefore require 'greenproofing', i.e. checking for unintended consequences.

Risk mitigation

> The extent of the effects of climate change depends on whether global temperatures will increase by 1.5, 2 or more degrees – which in turn depends on the reduction of CO_2 emissions at the global level. To remain under the limit of +1.5°C, emissions need to be cut by 7.6 % each year by 2030, the equivalent of 32 gigatons [(2)]. The longer action is put off, the more severe the effects will be, and the more costly: for every

(1) Mediterranean Experts on Climate and Environmental Change, 'First Mediterranean Assessment Report: Climate and environmental change in the Mediterranean Basin – Current situation and risks for the future', September 2020 (https://www.medecc.org/first-mediterranean-assessment-report-mar1/).

(2) United Nations, 'Cut global emissions every year by 7.6 percent for next decade to meet 1.5°C Paris target – UN Report', External Press Release, 26 November 2016 (https://unfccc.int/news/cut-global-emissions-by-76-percent-every-year-for-next-decade-to-meet-15degc-paris-target-un-report).

year of delay, additional costs amounting to USD 0.3 to 0.9 trillion are to be expected [3]. This is a task for the entire world, including the EU.

> To achieve this in both the region and beyond, the European Council has already stated that climate diplomacy must be scaled up, using 'all our external policy instruments, including sustainable financial instruments and trade policy, to promote safe and sustainable low greenhouse gas emission and climate-resilient development.' Member States, the High Representative for Foreign Affairs and Security Policy and the Commission are called on to 'greenstream' engagement with states in the region, and to adopt preventive measures [4]. This means going beyond the classical 'green' fields such as environment, water or agriculture, and including security, conflict, energy, the economy and politics. Ultimately, the risk is shared: while it might be existential for the region, it will have serious knock-on effects on Europe, whether because of spillover effects of conflict, migration, or disrupted or energy transfers. The 2020 Climate Change and Defence Roadmap recognises this by suggesting the creation of environmental advisors as a standard position in common security and defence policy (CSDP) missions and operations [5].

> Climate change and its effects also come with a geopolitical risk for the EU: states that do not subscribe to European policy objectives are exploiting the vulnerabilities of states currently seeking assistance. Egypt for instance has deepened its cooperation with China on water management, and Russia is actively engaging in 'wheat diplomacy', building dependence on this resource for other purposes. [6] For Europe, this means that assisting states in the southern neighbourhood is a geopolitical, rather than purely environmental, endeavour.

> The region, too, will have to cut emissions to ensure the lowest possible temperature increase. For the EU and other donors, this could mean supporting the implementation of conditional Paris Agreement targets by states in the region. This alone would reduce CO_2 emissions by more than 288 million tons, meaning 14 % of the region's total CO_2 emissions in 2019 by 2030–2040. An increase of these targets would reduce emissions further.

> Where states are incapable of cutting emissions further, or unwilling to do so, partners can be found at other levels, such as the municipal one. For instance, the Jordanian city of Karak cut its emissions by 14 % in 2020 and aims to reduce them by 40 % by 2030. It has built a solar power plant that would cover 55 % of the city's electricity consumption and lead to a reduction of more than 5 000 tons of CO_2 produced annually [7]. Cooperation can occur through the C40 cities network or the Committee of the Regions.

> Risk mitigation will not be possible without public support and input: behavioural change of populations – whether with

(3) Sanderson B. M. and O'Neill, B. C. , 'Assessing the costs of historical inaction on climate change', *Scientific Reports*, Vol. 10, 2020.

(4) Council of the European Union, 'Council conclusions on Climate Diplomacy', 20 January 2020 (https://data.consilium.europa.eu/doc/document/ST-5033-2020-INIT/en/pdf).

(5) Council of the European Union, 'Climate Change and Defence Roadmap', EEAS (2020)1251, November 2020 (https://data.consilium.europa.eu/doc/document/ST-12741-2020-INIT/en/pdf).

(6) Marsad Egypt, 'Egypt turns to China for water advice amid Nile dam crisis', 4 June 2021 (https://marsad-egypt.info/en/2021/06/04/egypt-turns-to-china-for-water-advice-amid-nile-dam-crisis/.); Astrasheuskaya, N., 'Russia starts to sow seeds of "wheat diplomacy"', *Financial Times*, 2 September 2021 (https://www.ft.com/content/4d925bae-fa89-4e64-9063-0c01e3b5690c).

(7) Connective Cities, 'Karak in Jordan: local actions for climate protection – Implementation of sustainable energy & climate action plan in Karak municipality', July 2021 (https://www.connective-cities.net/en/good-practice-details/gutepraktik/karak-in-jordan-local-actions-for-climate-protection).

What is climate diplomacy?

Climate diplomacy means using the diplomatic toolbox to promote and enhance multilateral and domestic initiatives to counter climate change and its adverse consequences. According to the European Commission, climate diplomacy comprises 4 pillars.

Data: Climate Diplomacy, 'What is climate diplomacy?', 2021

regard to energy and water consumption, food waste, transport, or diet – will be key to reducing emission growth. Public awareness of climate change has increased substantially but needs to grow further, and translate into personal choices with regard to transport, diet, and use of water and electricity. For instance, a projected increase in meat consumption will increase CO_2 emissions, too. By 2030, people in the region are projected to consume 3 200 kcal per day, and Qatar and Saudi Arabia already consume as much meat as Western states [(8)]. In addition, existing issues, such as water pollution, need to be linked to climate change to tap further into public concern. Awareness can be raised in multiple ways: media campaigns, leveraging of environmental NGOs, educational institutions such as universities or exchange programmes can all contribute.

> The energy transition is both a measure of risk mitigation and adaptation. As states move towards renewable energy, they reduce their CO_2 emissions and, consequently, the likelihood of higher temperatures. For the oil-exporting states of the region, this move is also an adaptive measure as Europe, but also China, moves away from fossil fuel imports. Exporting renewable energy to Europe – as Morocco is already exploring – could kill two birds with one stone for both Europe and the region [(9)]. The European Commission has already recognised this in its 2021 Joint Communication, promising to 'propose to partner countries comprehensive initiatives promoting climate neutral, low carbon and renewable energy' [(10)].

> The EU is exploring different ways of achieving carbon neutrality and published a Hydrogen Strategy in 2020 – hydrogen is an energy source that does not emit CO_2 or create air pollution [(11)]. The Gulf States, Oman, Saudi Arabia and the UAE are investing in developing their industrial capacities for hydrogen production – Saudi Arabia aims to produce 29 million tons of green and blue hydrogen per year by 2030. The Union could engage more actively in cooperation with the Gulf States on transfers of energy generated from green hydrogen.

(8) Alexandratos, N. and Bruinsma, J., *World Agriculture towards 2030/2050: The 2012 revision*, ESA Working Paper No 12-03. FAO, Rome, 2012.

(9) Baumann B., 'Green hydrogen from Morocco – no magic bullet for Europe's climate neutrality', Heinrich Boll Stiftung, 9 February 2021 (https://eu.boell.org/en/2021/02/09/green-hydrogen-morocco-no-magic-bullet-europes-climate-neutrality).

(10) European Commission, Joint Communication to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions, 'Renewed partnership with the Southern Neighbourhood – A new Agenda for the Mediterranean', JOIN(2021) 2 Final, 9 February 2021 (https://op.europa.eu/fr/publication-detail/-/publication/e355a7df-6b96-11eb-aeb5-01aa75ed71a1/language-en).

(11) European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, 'A Hydrogen strategy for a climate-neutral Europe', COM(2020) 301 Final, 8 July 2020 (https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf).

The cost per kilogram woud be at least half the price of domestically produced hydrogen and acquiring different sources of clean energy from various partners is also a way to diversify and secure Europe's energy supply [(12)].

> The European Carbon Border Adjustment Mechanism adopted by the European Commission in July 2021 places a carbon tax on some imported products [(13)]. By sanctioning its partners for their carbon emissions, the EU is encouraging the world to move towards the green transition and align with its climate ambitions. This sanctioning tool can also be used to leverage green reforms among hesitant southern partners [(14)].

Monitoring

> Monitoring shared regional risks and their development should be centralised in a platform that includes public authorities such as ministries, international organisations (UNDP, FAO, UNEP, among others) but also the private sector and civil society (universities, NGOs). This platform would also create diplomatic capital allowing for joint initiatives at the international level.

> Risk indices like the one developed in chapter 4 should be updated yearly, and states with high vulnerability results should be prioritised with assistance programmes.

> Early warning systems should, where they do not already do so, include detailed elements concerning climate change, such as the impact of extreme weather events compiled by locality, demographic profile of farmers, and exposure of population to disasters in order to assess where unrest could unfold.

Adaptation

> Managing water scarcity will be imperative for the region. Wastewater treatment and desalinating water are suitable options in this regard. Some states have made considerable progress: Jordan, Kuwait, Oman, Qatar and the UAE reuse more than 75 % of their safely treated wastewater, mainly for agricultural purposes. In comparison, Iraq, Egypt and Algeria reuse respectively 0.2 and 7 % of their treated wastewater [(15)]. Wastewater can also be used for energy production as it contains organic waste that turns into methane gas [(16)]. Desalination can become cost effective the larger its market is - the UAE and Saudi Arabia have the cheapest desalinated water of the region. To expand desalination capacity and alleviate the high consumption of energy this technology requires, countries must invest in research and technological innovation but also in personnel training and maintenance. Modernising and upgrading agricultural irrigation systems, too, is a way to reduce water waste [(17)].

(12) Bianco, C., 'Power Play: Europe's climate diplomacy in the Gulf', *Policy Brief*, European Council on Foreign Relations, October 2021 (https://ecfr.eu/publication/power-play-europes-climate-diplomacy-in-the-gulf/).

(13) European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, '"Fit for 55": delivering the EU's 2030 Climate Target on the way to climate neutrality', COM(2021) 550 Final, 14 July 2021 (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021DC0550&from=EN).

(14) 'Power Play: Europe's climate diplomacy in the Gulf', op.cit.

(15) UNESCWA, *Wastewater – An Arab Perspective*, Beirut, 2017 (https://www.unescwa.org/sites/default/files/event/materials/l1700174_web_-_waste_water_-_march_2017.pdf).

(16) *Moving Towards Water Security in the Arab Region*, op.cit.; Fu, X., Schleifer L. and Zhong, L., 'Wastewater: The best hidden energy source you've never heard of', The Zorld Resource Institute, 17 March 2017 (https://www.wri.org/insights/wastewater-best-hidden-energy-source-youve-never-heard).

(17) World Bank, 'Modernizing irrigation improved water security for farmers in Egypt', 1 April 2020 (https://www.worldbank.org/en/results/2020/04/01/modernizing-irrigation-improved-water-security-for-farmers-in-egypt); FAO, 'Does improved irrigation technology save water? A review of the evidence', Regional Initiative on Water Scarcity for the Near East and North Africa, Cairo, 2017 (http://www.fao.org/3/i7090en/I7090EN.pdf).

- Tourism needs to become less water-intensive in order to be a contribution rather than a burden. Installing low-flow shower heads, reducing the amount of linen washed and laundered for longer-stay customers or installing low-capacity flushing cisterns [18] are only a few ways to cut water use in hotels by 20 to 50 %. Most importantly, awareness needs to be raised both among staff and guests, and new forms of environmentally friendly tourism can be developed.

- Citizens can install water harvesting systems on roofs at home, on buildings or at schools. In a place where it rains 500 mm per year, a roof can collect 80 000 litres per year while the equivalent of toilet flush water consumption per year is more than 65 000 litres [19]. Water can be harvested for recharging aquifers, for domestic use or for storage. This is an adaptive measure that is used already by some Arab populations, mostly Palestinians who face chronic water shortages, but can be extended across the region [20].

- Climate-smart agriculture will be key to improve agricultural output [21]. Projections on food needs for 2050 vary: some claim that to feed the future world population agricultural production will need to double, others estimate a range of global increase between 25 and 70 % [22]. To achieve this, investment in technological research is as necessary as information sharing with and education of farmers [23]. Digital services can be a solution. Mobile apps and radio can provide advice to farmers on how to adapt to the changing climatic conditions and give them access to information and knowledge. Such practices exist already in Malawi, where an inter-ministerial committee on agriculture dispenses information and advice to rural farmers in order to help them navigate uncertainties regarding altered weather and rainfall patterns [24].

- Promoting urban gardening, at school, at home or on the roofs of buildings is a solution to enhance food security in cities. This can also create new types of job opportunities for urban dwellers as well as provide fresh food all the year round [25]. This initiative has been implemented by some inhabitants of Cairo, promoted by the governorate of the city and extended nationally in 2019. By launching the green roof projects, the government also expects to reduce urban air pollution, through plant absorption of carbon dioxide [26].

(18) Biosphere Tourism, '7 Tips for saving water in hotels', 22 March 2016 (https://www.biospheretourism.com/en/blog/7-tips-for-saving-water-in-hotels/53).

(19) Down to Earth, 'Catch water where it falls: Urban rainwater harvesting', 3 July 2019 (https://www.downtoearth.org.in/news/water/catch-water-where-it-falls-urban-rainwater-harvesting-65422).

(20) Schillinger, J., 'Adapting to Water Scarcity in the Israeli-Palestinian Conflict: An analysis of the influence of conflict on water governance and the implementation of adaptation strategies', M.Sc. Thesis, Chairgroup Earth System Sciences, 2016 (https://edepot.wur.nl/424633).

(21) UNESCWA, FAO, *Arab Horizon 2030: Prospects for enhancing food security in the Arab region*, Beirut, 2017 (https://www.unescwa.org/sites/default/files/pubs/pdf/arab-horizon-2030-prospects-enhancing-food-security-arab-region-english_0.pdf).

(22) Hunter, M.C. et al., 'Agriculture in 2050: Recalibrating targets for sustainable intensification', *BioScience*, Vol. 67, No 4, 2017, pp.386–391 (https://doi.org/10.1093/biosci/bix010).

(23) *Food Security: Challenges and prospects*, op.cit.

(24) Ferdinand, T., Rumbaitis del Rio, C. and Fara, K., 'To tackle food insecurity, invest in Digital Climate Services for agriculture', World Resource Institute, 29 July 2021 (https://www.wri.org/insights/tackle-food-insecurity-invest-digital-climate-services-agriculture?utm_campaign=wridigest&utm_source=wridigest-2021-8-3&utm_medium=email&utm_content=title).

(25) The Green Prophet, 'What urban rooftop gardening could do for The Middle East', 15 December 2010 (https://www.greenprophet.com/2010/12/rooftop-garden-middle-east/); Modibedi, T.P., Masekoameng, M.R. and Maake, M.M.S., 'The contribution of urban community gardens to food availability in Emfuleni Local Municipality, Gauteng Province', *Urban Ecosystems* Vol. 24, pp.301–309, 2021 (https://doi.org/10.1007/s11252-020-01036-9).

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> As global food prices are expected to rise (rice alone by 21 % by 2030 [27]) Arab states will also have to reduce their food import dependency. Investing in food import infrastructure for instance reduces the cost of transportation from one country to another. Developing farmland (as Egypt is currently doing) or expanding the domestic food storage capacity, especially for grain, is another option [28].

> Risk is not just the result of increased temperatures, but also of uncontrolled urbanisation. Green urban planning will not just reduce risks of disasters from extreme weather events, but also of political unrest and violence. Cities can be transformed into green areas by planting trees, creating green parks or investing in roof or vertical gardens on buildings [29]. Narrow streets, as in Dubai's old town, are also a way to reduce temperatures within a city because they block solar radiation [30]. Developing green transportation, electric tram systems, electrified bus fleets or metro lines, are also ways to reduce the effect of urban heat island as this would reduce the amount of private vehicles driving within the city [31]. Heat inside buildings can also be reduced by 2 to 5° C [32] by using cooling materials in construction. Internal gardens and patios, like those of the famous Riads in Morocco, permit the circulation of air and create shade during the day. In the past, wind towers were also used to ventilate and cool down buildings, working as inverted chimneys to channel wind currents inside the building. This cooling method has been used throughout ages and may have been invented as long ago as 7 000 years ago, having originated in Iran [33].

> Relocating people living in areas exposed to climate change impacts and/or living in informal dwellings is another way of reducing risk exposure. Although such projects are already underway in Egypt and Morocco, overall the number of people living in slums and informal settlements is still too high as they are the most vulnerable to extreme weather events [34]. To avoid further urban migration due to climate change, rural areas could be developed further by promoting alternatives to agricultural livelihoods and improving substandard housing [35].

> A joint EU-MENA partnership on environmental research and innovation could

(27) Chen, C., Mccarl, B. and Chang, C., 'Climate change, sea level rise and rice: Global market implications', *Climatic Change*, Vol. 110, No 3-4, 2012, pp.543-560.

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(31) REGlobal, 'Green Mobility: Achieving carbon neutrality through transport in the Middle East by 2030', 25 February 2021 (https://reglobal.co/green-mobility-achieving-carbon-neutrality-through-transport-in-the-middle-east-by-2030/); De Gruyter, C., Currie, G. and Rose, G., 'Sustainability measures of urban public transport in cities: A world review and focus on the Asia/Middle East region', *Sustainability*, Vol. 9, No 1, 2016 (Sustainability Measures of Urban Public Transport in Cities: A …https://www.mdpi.com › pdf).

(32) 'After another hot summer, here are 6 ways to cool our cities in future', op.cit.

(33) BBC Travel, 'An ancient engineering feat that harnessed the wind', 27 September 2018 (https://www.bbc.com/travel/article/20180926-an-ancient-engineering-feat-that-harnessed-the-wind).

(34) UN Habitat, *Informal Settlements in the Arab region: 'Towards Arab cities without informal areas' –Analysis and Prospects*, Nairobi, February 2020 (https://unhabitat.org/sites/default/files/2020/12/regional_is_report_final_dec_2020.pdf).

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be created to find collective solutions and adaptation projects to address present and future climate change challenges, not only working on expertise and assessments.

> Most European climate change assistance focuses on states that are not in conflict (Egypt, Jordan, Morocco and Tunisia). Our index shows, however, that countries in conflict are the most vulnerable to climate change effects and the least prepared [(36)]. Conflict resolution and conflict prevention initiatives must take into account the urgencies of today and the challenges of the future [(37)].

(36) Cooper, R., 'Donor support for climate change initiatives in the Middle East and North Africa', K4D – Knowledge, evidence and learning for development, 2020 (https://opendocs.ids.ac.uk/opendocs/bitstream/handle/20.500.12413/15795/903_Donor_support_for_climate_change_in_MENA.pdf?sequence=1&isAllowed=y); EU Aid Explorer data (https://euaidexplorer.ec.europa.eu/content/explore/recipients_en).

(37) Brun, M., 'Environmental vulnerabilities and socio-political inequalities in the Middle East: underestimated links?', *The Global Diwan*, No 8, May 2021 (https://theglobaldiwan.org/wp-content/uploads/2021/05/TheGlobalDiwanNewsletterMay2021.pdf).

ANNEX

LIST OF INDICATORS USED FOR THE RISK INDEX AND THEIR SOURCES

1. Current resources management performance

1.1 Water resources

- Amount of freshwater withdrawn/used as a % of total renewable water resources (source: FAO, AQUASTAT)
- Water stress (source: FAO, AQUASTAT)
- Evolution of renewable freshwater per habitant between 2007 and 2017 (source: FAO, AQUASTAT)
- Evolution of water dam capacity per capita between 2007 and 2017 (source: FAO, AQUASTAT)
- Evolution of freshwater collection between 2007 and 2017 (source: FAO, AQUASTAT)
- Amount of freshwater per capita per year (source: FAO, AQUASTAT)
- % of population with access to drinking water (source: Federal Competitiveness and Statistics Authority, UN SDG Goal 6 'Clean Water and Sanitation', 2021)
- % of water with an estimated good water quality (or % of water polluted) (source: UN DESA Statistics Division, UN SDG Goal 6 'Clean Water and Sanitation', 2021)
- In total water use (water withdrawn, treated and desalinated), % of desalinated water (source: FAO, AQUASTAT)
- % of transboundary water basins under operational cooperation agreement (source: UN DESA Statistics Division, UN SDG Goal 6 'Clean Water and Sanitation', 2021)
- % of transboundary water aquifers under operational cooperation agreement (source: UN DESA Statistics Division, UN SDG Goal 6 'Clean Water and Sanitation', 2021)

1.2 Food resources

- Ratio food exports/food imports (source: World Bank, World Development Indicators, 2021)
- Average amount of protein eaten in grams per capita per day (source: FAO, Food security indicators, 2021)
- % of cereal import dependency (source: FAO, FAOSTAT, 2020)
- Value added per worker in agriculture compared to GDP/capita (source: World Bank, World Development Indicators, 2021)
- Share of CO_2 emissions by the agriculture sector (source: Climate Watch, CAIT Climate Data Explorer, 2021)
- Food insecurity index (source: Global Food Security Index, *The Economist*, 2020)
- % of adults suffering from obesity (source: World Health Organization, Global Health Observatory data repository, 2017)

- % of population undernourished (source: UN DESA Statistics Division, UN SDG Goal 2, 'Zero Hunger', 2021)
- Inequality in caloric supply (only for developing countries) (source: FAO, Food security indicators, 2021)
- Sustainable Nitrogen Management Index (Source: Yale Center for Environmental Law and Policy, Environmental Performance Index, 2020)

1.3 Waste 

- % of municipal waste water collected (source: FAO, AQUASTAT)
- % of municipal waste water treated (source: FAO, AQUASTAT)
- % of municipal waste water reused (source: FAO, AQUASTAT)
- Ratio waste emitted per capita/regional waste average per capita (source: World Bank, *What a Waste 2.0*, data, 2018)
- % of waste collected in urban and rural areas (source: World Bank, *What a Waste 2.0*, data, 2018)
- % of waste recycled (source: World Bank, *What a Waste 2.0*, data, 2018)
- Waste contribution to CO_2 emissions in % (source: Climate Watch, CAIT Climate Data Explorer, 2021)

1.4 Energy 

- % of oil rents in GDP (source: World Bank, World Development Indicators, 2021)
- Share of renewable energy in primary energy consumption (source: *BP Statistical Review of World Energy*, 2020)
- % of electricity that comes from renewables (source: *BP Statistical Review of World Energy*, 2020)
- Energy System performance (source: World Economic Forum, *Energy Transition Index Report*, 2021)
- Energy security (source: World Energy Council, World Energy Trilemma Index, 2021)
- Energy equity (source: World Energy Council, World Energy Trilemma Index, 2021)
- Energy environmental sustainability (source: World Energy Council, World Energy Trilemma Index, 2021)

1.5 CO_2 and pollution 

- Share of CO_2 emissions in world global emissions (source: Climate Watch, CAIT Climate Data Explorer, 2021)
- Ratio of gas emissions per capita compared to world emissions per capita average (source: Climate Watch, CAIT Climate Data Explorer, 2021)
- Air pollution, PM2.5 micrograms per cubic metre (source: World Bank, World Development Indicators, 2021)
- % of deaths from air pollution (source: Institute for Health Metrics and Evaluation (IHME), *Global Burden of Disease Study*, 2018)
- Ratio of CO_2 emissions compared to share of the world surface (source: Climate Watch, CAIT Climate Data Explorer, 2021 and Nicholas LePan, 'Visualizing Countries by Share of Earth's Surface', *Visual Capitalist*, 23 January 2021)
- Ratio CO_2 emissions compared to share of world population (source: Climate Watch, CAIT Climate Data Explorer, 2021 and UN

Population Division, *World Population Prospects 2019*, 2019)

> Evolution of gas emissions between 1990 and 2019 (source: Climate Watch, CAIT Climate Data Explorer, 2021)

1.6 Public transportation and urban well-being

> Share of emissions from transport (source: Climate Watch, CAIT Climate Data Explorer, 2021)

> Main urban agglomerations, % of people living in slums (source: UN Habitat urban data statistics, 2018)

> Main urban agglomerations, % of population with access to public transport (source: UN Habitat urban data statistics, 2018)

> % of people with access to open public spaces within less than 400m (source: UN Habitat urban data statistics, 2018)

1.7 Ecosystem and biodiversity

> Biodiversity performance (source: Yale Center for Environmental Law and Policy, Environmental Performance Index, 2020)

> Ecosystem services performance (source: Yale Center for Environmental Law and Policy, Environmental Performance Index, 2020)

> Fishery services performance (source: Yale Center for Environmental Law and Policy, Environmental Performance Index, 2020)

1.8 Security and peace

> Number of deaths due to political violence in 2020 (source: UPPSALA Conflict Data Programme, 2021)

1.9 Public awareness

> Water pollution (source: Arab Barometer, 'Environmental Issues in the Middle East and North Africa', October 2019)

> Air pollution (source: Arab Barometer, 'Environmental Issues in the Middle East and North Africa', October 2019)

> Climate change (source: Arab Barometer, 'Environmental Issues in the Middle East and North Africa', October 2019)

> Waste pollution (source: Arab Barometer, 'Environmental Issues in the Middle East and North Africa', October 2019)

1.10 Sustainable tourism

> Sustainable Tourism rankings (Euromonitor International, 'Top Countries for Sustainable Tourism, Embracing a Green Transformation for Travel Recovery', 2020)

2. Projections on climate-related vulnerabilities and trends

2.1 Climate change impacts

> Impacted by sea-level rise in the future? (source: Coastal Climate Central, 2021)

> Exposure to climate risks and disasters (source: IMF, Climate-driven INFORM Risk, 2020)

> % of change in rainfall by 2039 under RCP 8.5 (source: World Bank, Climate Change Knowledge Portal, 2021)

- % of change in rainfall by 2059 (source: World Bank, Climate Change Knowledge Portal, 2021)
- Rise of temperature by 2039 under RCP 8.5 (source: World Bank, Climate Change Knowledge Portal, 2021)
- Rise of temperature by 2059 under RCP 8.5 (source: World Bank, Climate Change Knowledge Portal, 2021)

2.2 Potential for sustainable economy

- Potential for solar energy: proportion of land suitable for solar energy in % (source: IRENA, Country Profile, 2020)
- Potential for wind energy: proportion of wind suitable for solar energy in % (source: IRENA, Country Profile, 2020)
- % of active population working in agriculture (source: International Labour Organization, ILOSTAT Database, 2021)
- Resilience to low-carbon economy transition (source: IMF, Transition Risks, 2019)
- Age dependency ratio in 2030 (source: UN Population Division, *World Population Prospects 2019*, 2019)
- Age dependency ratio in 2050 (source: UN Population Division, *World Population Prospects 2019*, 2019)
- Human Capital Index 2020 (source: World Bank Group, HCI, 2020)
- Digital Readiness Index (source: Cisco, 2019)

2.3 Demography and behavioural patterns

- Evolution of meat consumption per capita per year since 1961 (source: FAOSTAT, 'Food Balances', 2018)
- Beef and buffalo meat consumption per capita per year compared to world average consumption (source: FAOSTAT, 'Food Balances', 2018)
- Water demand in 2040 (source: World Resource Institute, BETA Aqueduct, Water Risk Atlas, 2020)
- % of rise of population in 2050 (source: UN Population Division, *World Population Prospects 2019*, 2019)

3. Readiness and capabilities

3.1 Implementation of climate policies (1)

- Energy transition readiness (source: World Economic Forum, Energy Transition Index Report, 2021)
- NDC Ambitions (source: UNFCC, NDC, 2021)
- States party to the Paris Agreement (source: UNFCC, 2021)
- Policy planning for water security
- Policy planning for food security
- Policy planning for resilient housing and green cities
- Policy planning for waste management

(1) Sources for 'policy planning' indicators rely on multiple national public sources.

- Policy planning for sustainable tourism
- Policy planning for public transportation
- Policy planning for energy Transition
- Environment protection expenditure as % of GDP (source: IMF, Climate Change Indicators Dashboard, 2021)

3.2 Governance and capacity 

- Control of corruption (source: World Bank, DataBank – Worldwide Governance Indicators, 2021)
- Government effectiveness (source: World Bank, DataBank – Worldwide Governance Indicators, 2021)
- Political stability and absence of violence/ terrorism (source: World Bank, DataBank – Worldwide Governance Indicators, 2021)
- Regulatory Quality (source: World Bank, DataBank – Worldwide Governance Indicators, 2021)
- Rule of Law (source: World Bank, DataBank – Worldwide Governance Indicators, 2021)
- Voice and accountability (source: World Bank, DataBank – Worldwide Governance Indicators, 2021)
- State resilience to fragility (source: The Fund for Peace, Fragile States Index, 2021)
- Business resilience (source: FM Global, FM Global Resilience Index, 2021)

ABBREVIATIONS

AFED
Arab Forum for Environment and Development

COP
Conference of the Parties

CSDP
common security and defence policy

FAO
Food and Agriculture Organization

GCC
Gulf Cooperation Council

GDP
gross domestic product

GHG
greenhouse gases

GMR
Great Man-Made River project

IMF
International Monetary Fund

IPCC
International Panel on Climate Change

ISIS
Islamic State in Iraq and Syria

MENA
Middle East and North Africa

MW
megawatt(s)

NCP
National Climate Plan

NDC
nationally determined contribution

NGO
non-governmental organisation

RCPs
Representative Concentration Pathways

RICCAR
Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socioeconomic Vulnerability in the Arab Region

SLR
sea-level rise

TWh
terawatt hour(s)

UAE
United Arab Emirates

UN
United Nations

UNDP
United Nations Development Programme

UNEP
United Nations Environment Programme

UNESCWA
United Nations Economic and Social Commission on Western Asia

UNFCCC
United Nations Framework Convention on Climate Change

USD
United States dollars

WBT
Wet-bulb temperature

WHO
World Health Organization

Climate change in the Middle East and North Africa is a story of injustice and paradox. Injustice because while the region has contributed a mere 3 % of total global CO_2 emissions over the past century and a half, it will be severely impacted by its effects. Paradoxical because although the alarm was raised already several decades ago that the region is at risk from the fallout of climate change, public awareness and policy responses have been even slower to emerge than elsewhere.

Although recent developments have contributed to a growing insight that climate change is not 'just' an environmental affair, it still ranks below the many other challenges the region is grappling with, particularly economic and security issues.

This *Chaillot Paper* shows that successfully tackling this phenomenon will depend on decisions taken both in the region and outside. Assisting the Arab world in meeting the challenges posed by climate change will be a matter of strategic importance for Europe: not only because unmanaged risks will produce violent conflict and waves of migration, but also because other geopolitical players are beginning to exploit the vulnerabilities of the region for their own purposes.

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