Chapter 9
Sea Level Rise and the National Security Challenge of Sustainable Urban Adaptation in Doha and Other Arab Coastal Cities

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Abstract The warming of the global ocean and the melting of ice caps have been continuously and increasingly rapidly driving the phenomenon of sea level rise (SLR) over the past century, threatening the safety and standards of living of the world's 800 million inhabitants of coastal cities. Despite renewed commitments to fight the causes of climate change during the COP26 climate negotiations in Glasgow, the current policies of the world's largest polluting countries still put humanity on a dangerous path toward high levels of global warming and SLR for the decades and centuries to come. Based on the latest scientific publications, including the IPCC's Assessment Report 6, this chapter sheds light on how this phenomenon is expected to affect in a multi-dimensional manner the safety and standards of living of coastal city inhabitants across the Arab region, and especially in the Arabian Gulf sub-region, in the decades and centuries to come. Studying the case of Doha, we highlight several policy challenges and opportunities that could influence the hazards as well as the levels of vulnerability and exposure to which individual Arab coastal cities are exposed to. The authors conclude that collectively fighting the causes of climate change, better planning urban and coastal development, as well as innovating for the climate adaptation of Arab coastal cities should be understood by policymakers, the private sector, and populations alike as a national security challenge that requires urgent individual and collective action.

Keywords Arab region · Coastal cities · Climate adaptation · Climate change · Environmental risks · Extreme environmental events · Sea Level Rise (SLR) · Urban governance

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9.1 Introduction

The literature on climate change issues and risks in the Middle East and North Africa (MENA) region has largely focused on the issues of temperature increase, water stress, and flooding events, as these phenomena have already been affecting the populations in an increasingly disastrous manner (Sieghart & Betre, 2018). This chapter highlights how the lesser-documented issue of Sea Level Rise (SLR) makes Doha, and more generally the coastal cities of the Arab region, increasingly vulnerable to various climate change risks. Indeed, the warming of the global ocean and the melting of the world's glaciers and ice caps have been continuously and increasingly rapidly driving the rise of the world's sea level for over a century (IPCC, 2021a). Based on a recent body of research on ongoing trends and calculated projections of SLR, and via the case study of Doha, we investigate two aspects of the SLR challenge. First, how this phenomenon is expected to directly affect the safety and standards of living of millions of inhabitants of the region's coastal cities in the decades to come. Second, what are the policy challenges and opportunities that could influence both the nature of the risks (which hazards) and the levels of risks (based on a place's specific exposure and vulnerability to these risks) to which Doha and many other Arab coastal cities are increasingly exposed.

9.2 The Literature on SLR, Related Urban Risks, and Economic Impacts

Over the past dozen years of fast accumulating scientific evidence and growing literature on climate change and SLR, the outlooks for our planet have appeared increasingly dystopian for the global environment and human habitat, particularly in coastal areas of the Global South (IPCC, 2007, 2013, 2021a, 2021b). Increasing average surface temperatures and heat waves have caused decimating consequences for populations across the Sahel, the horn of Africa, and the Arab region, while warmer ocean waters have already led to devastating consequences for marine life (IPCC, 2021a, 2021b; Stone, 2007). Since 2016, half of the Great Barrier Reef—a world biodiversity hotspot—has largely bleached due to the rising temperature of the water (Hughes et al., 2018). The ARC Centre of Excellence for Coral Reef Studies has estimated that 93% of tropical reefs have already suffered fatal bleaching, because water temperatures are too warm for corals, leading to their bleaching and death (ARC Centre of Excellence, 2016). The main problem with this trend is that coral reefs constitute hotspots of marine biodiversity and species reproduction sites, and that their partial loss negatively affects the global marine biodiversity and fish stock. In the already warm waters of the Gulf of Aden, the Arabian Gulf, the Red and Mediterranean Seas, which constitute the habitat and traditional source of seafood for the region's coastal cities and villages, bleaching corals are plainly evident in many areas. The overall marine fish stock has been declining almost everywhere in

the Arab region, partly due to climate change and the death of corals, but also due to over-fishing and the pollution from offshore oil and gas production (World Resource Institute, 2011). This decline in marine biodiversity represents a significant threat to many communities of fisherman and to coastal tourism, especially along the Red and Mediterranean Seas.

According to the world's most authoritative report on climate change, the United Nations' International Panel on Climate Change's (IPCC) (2022) sixth assessment report, coral reefs are expected to decline by no less than 70–90% at 1.5 °C of increased global mean temperature compared to pre-industrial average temperatures. This would certainly very negatively affect the marine biodiversity, livelihood, and food security of local populations all around the Red and Mediterranean Seas, the Arabian Gulf, Gulf of Aden, and well beyond. However, for many Arab states, the region's greatest risks are arguably on-shore, or more precisely, at the moving barrier of what is off- and what is on-shore.

9.2.1 Ongoing Dynamics of SLR and Related Risks

In its 2014 landmark fifth assessment report, the IPCC had already summarized our planet's climatic crisis in a sober manner: "Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen" (IPCC, 2014, p. 2). In a more recent report of the IPCC, the scientific panel of the United Nations went further: "[s]ince the late nineteenth century many indicators of the global climate system have changed at a rate unprecedented over at least the last two thousand years" (IPCC, 2021a, 2021b, p. 367).

The notion of global warming essentially refers to ocean—and seas—warming, given that oceans play a dominant role in the storage of additional heat, with, between 1971 and 2010, more than 90% of the energy accumulated (IPCC, 2014, p. 4). The Arctic ice sheet was measured as melting six times faster than in the 1980s and, annually, Antarctic ice alone has been producing 0.6 mm of global sea level rise every year (Rignot et al., 2019; Shepherd et al., 2018).

SLR is the result of a combination of two factors: the thermal expansion of the oceans (warmer water takes more volume) and the increase in loss of land ice (glaciers and ice sheets). As the response times for these drivers of change are long yet different, Clark et al. (2016) have established that SLR will continue for centuries, irrespective of (potential) strong climate action by the international community in the coming years and decades. Only the pace of SLR can be altered. But for now, the pace is not good. Under four of the five different scenarios of greenhouse gas emissions for the decades to come, called 'Share Social-Economic Pathways' (or SSPs), the IPCC's (2022) projections consider that the 1.5 °C global warming level will be reached in the near term (2021–2040), and that even under the most optimistic (but unlikely)

scenario (SSP1–1.9), this dangerous threshold is nevertheless more likely than not to be reached during that short-term time frame (IPCC, 2022).

These climate risks and others have been increasingly understood by economists and the global business community. On January 15, 2022, the World Economic Forum (WEF) released its annual Global Risks Report on the major threats to the world economy. The respondents of the Global Risk Perception Survey ranked "extreme weather" and "climate action failure" among the top five short-term risks to the world. More importantly, they considered that the five most menacing long-term threats are all environmental and, more specifically, "climate action failure," "extreme weather," and "biodiversity loss" ranked as the three most potentially severe risks for the next decade (WEF, 2022). These environmental concerns predated the COVID-19 pandemic. Two years prior, the same annual global survey had already highlighted that environment-related risks account for three of the top five global risks by likelihood according to global business leaders, and four of the top five risks by economic impact, namely "Failure of climate-change mitigation and adaptation," "Extreme weather events," "Water crises," and "Natural disasters." And even then, this was not the first time, but the third year in a row that such a result was found. In 2019, the survey report had bleakly concluded, "[o]f all risks, it is in relation to the environment that the world is most clearly sleepwalking into catastrophe" (WEF, 2019, p. 15). What is new in 2022, however, is that the increasing concern with climate action failure is interpreted by the WEF as reflective of the survey respondents' lack of trust in the global ability to contain climate change, as economic issues and risks have deepened during the pandemic. Does that mean that the world has a decreased level of resilience toward climate risks?

Out of a growing concern for US national interests and the counter-productive policies of the Trump administration (2017–2021), US President Biden, shortly after his election, launched high-profile climate diplomacy initiatives, including the ambitious 'Leaders Summit on Climate.' In April 2021, the US and the world's largest industrialized countries gathered to express their resolute commitment to fight climate change and announced more ambitious action targets (The White House, 2021). The Summit has had some positive influence on several important countries' renewed commitments to the Paris Agreement, but the updated trajectories of global warming, based on the Summit's new commitments, indicated that the world was still on a trajectory of rapid increase in temperature, of around 2.4 °C above to pre-industrial temperatures by the end of this century (Climate Action Tracker, 2021). These commitments are thus still far from the collective ambition of limiting it "well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels," as it was agreed upon and inked in the Paris Agreement, in December 2015 (United Nations, 2015, p. 4). Although 1.5 °C or even 2.4 °C of global mean temperature increase may not appear as a massive temperature increase for many, it is worth resituating it in a geological perspective, with the great glaciations that covered the entire northern European and American continents with more than 3,500 m of ice resulting in a 120 m drop in sea level taking place at only 4 to 5 degrees below current mean global temperatures (Poitou & Braconnot, 2021).

And this kind of temperature difference is currently not far from possible future temperature increases.

The recent analysis made by the Climate Action Tracker (a well-respected coalition of scientists and specialized NGOs) of the actual climate policies by the largest emitting countries of greenhouse gases (GHGs) indicates that the world's leading economies are still far from being in line with their official commitments. If no major policy reforms were to materialize, the Climate Action Tracker assessed that the world is currently on a trajectory of global increase in the order of an estimated 2.9 °C by the end of the century (Climate Action Tracker, 2021). This is relatively in line with a recently released 3 °C estimation from the IPCC's 6th Assessment Report (IPCC, 2021a, 2021b). These are particularly high levels of temperature increase that had previously been assessed as capable of generating over 2 m of SLR by the end of this century, and several meters more during the next (DeConto & Pollard, 2016). Such a high level of SLR would see the disappearing of many coastal areas across the world. Recent studies, with different methodological approaches and a greater understanding of the dynamics of frozen parts of the world, have projected differing estimations of SLR for this century and over the next.

In 2019 the IPCC special report was released on the ocean and the cryosphere (i.e., the frozen parts of the world), which then foresaw a maximum of around one meter of SLR by the end of the century (IPCC, 2019), which would have severe consequences in the MENA region. This projection of a single meter of SLR is now considered optimistic by many. It was arguably based on a methodology that did not fully integrate all the complex dynamics of ice-melting in Antarctica and Greenland and the major issues of our planet's environmental thresholds also called tipping points. In 2020, a major study published in the journal *Nature* provided solid evidence of potentially much higher ranges for SLR to be expected in the forthcoming decades, along the century, and beyond. The authors have demonstrated that the Antarctic ice sheet, which stores more than half the planet's freshwater resources, reacts differently to different temperature increase thresholds, and not in a simple, linear manner. Beyond some thresholds, ice loss and SLR dynamics are irreversible at the human timescale. The new study finds that the ice sheet's temperature sensitivity to melt corresponds to +1.3 m of sea-level equivalent per degree of warming temperature up to 2 degrees C. above pre-industrial levels, but almost doubling to +2.4 m of SLR per degree of warming between 2 and 6 degrees Celsius (Garbe et al., 2020). As the authors concluded, "[o]ur results show that if the Paris Agreement is not met, Antarctica's long-term sea-level contribution will dramatically increase and exceed that of all other sources" (Garbe et al., 2020, p. 538). It also means that if there is no drastic and rapid reduction in our global emissions of GHGs, our current trajectory of global temperature increase could lead to a catastrophic level of SLR of more than 3 m by the end of the century. Based on their coast elevation and topography, some Arab coastal cities like Abu Dhabi, Aden, Alexandria, Algiers, Basra, Casablanca, Cairo, Doha, Dubai, Kuwait City, Manamah, Tripoli, Tunis, among others, would not exist anymore as we know them.[1] Large swathes of coastal land would be submerged under seawater, at the very least several days a year. Long-term submersion would

be particularly acute in the low-lying areas of Southern Iraq and the Arabian Gulf as can be seen on Fig. 9.1.

With over 3 m of SLR and as per currently available technology, it is worth mentioning that it would then not be possible to safely protect them by seawalls

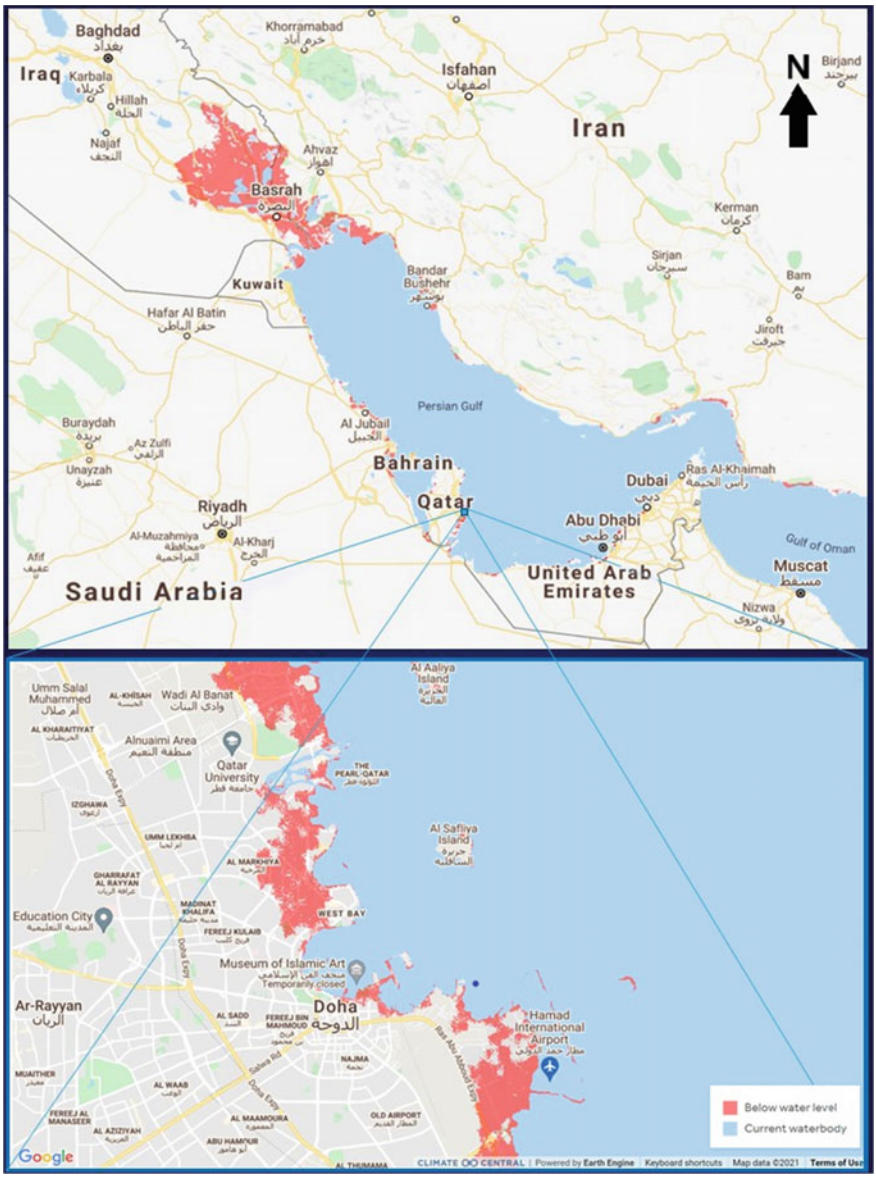

Fig. 9.1 Areas at risk in the Gulf Region and Doha's metropolitan area under 2 m of SLR (Laurent A. Lambert. Background sources: Climate Central, Google Maps, and Earth Engine)

since each sea surge (a particularly high wave generally created by a storm) could overwhelm these defenses and have a devastating impact on these cities. This is what happened when Hurricane Katrina's sea surge inflicted onto the New Orleans in 2005 and when Hurricane Harvey affected the coast of Texas in 2017, both killing scores of persons and generating damages approximately worth $125 billion and $161 billion US dollars, respectively (NOAA, 2022). Against this background, the city of New York is building elaborate seawalls to protect several vulnerable areas, for an initial cost of 1.41 USD billion, but potentially as part of a much larger program that could cost as much as 119 USD billion in total to protect the whole city for decades or more, provided the budget is accepted by all competent authorities (Barnard, 2020). If this figure seems far too high for the public budget of most Arab governments, it remains an appropriate investment for richer cities, with cities such as Shanghai, Saint Petersburg, and London, inter alia, having their expensive sea protections in place. And this is likely to become a feature in several other populated coastal urban centers of the USA due to the increasing costs and lethality of coastal extreme weather events. According to the US government's National Oceanographic and Atmospheric Administration (NOAA), tropical cyclones data from the past five years seems to indicate a sharp rise in multi-billion-dollar costs compared to previous periods.

> In 2021, there were 20 separate billion-dollar weather and climate disasters. The total cost for these events was $145 billion, making this the third most costly year on record, behind 2017 and 2005. (…)
>
> The total cost for the last five years ($742.1 billion) is more than one-third of the disaster cost total of the last 42 years ($2.155 trillion). (…)
>
> Of the 310 [separate] billion-dollar weather disasters between 1980 and 2021, tropical cyclones (or hurricanes) have caused the most damage: over $1.1 trillion total, with an average cost of $20.5 billion per event. They are also responsible for the highest number of deaths: 6,697 between 1980 and 2021. (NOAA, 2022)

Unless drastic and costly measures are taken and appropriate policies are co-designed with all relevant stakeholders, the joint dynamic of SLR, and increased extreme weather events, such as storms and tropical cyclones, mean that many coastal cities around the world could probably become very vulnerable to coastal hazards, with only a few decades left prior to becoming unsafe for urban life during the second half of the century.

9.3 Increasing Global Hazard Frequency, Exposure, and Vulnerability of Arab Coastal Cities

Across the world, 680 million people are directly vulnerable to SLR as they live in low-lying coastal zones, while an estimated 800 million people are living in more than 570 coastal cities that are vulnerable to only a 50 cm rise by 2050 (IPCC, 2019; WEF, 2019). From Nouakchott and Rabat in the West to Kuwait and Dubai in the East, including all North Africa and most of the Levant, the majority of the Arab

region's capital cities and largest metropolises are located on at-risk coastal areas, deltas, or nearby, and their populations are becoming increasingly at risk to SLR and the extreme environmental events that make it more dangerous, like storm surges, extreme swale waves of several meters, and coastal flooding.

If the case of SLR has been increasingly documented in Egypt's coastal cities over the past decade, SLR is a particularly threatening yet relatively understudied problem in the Gulf Arab states (Agrawala et al., 2004; El-Raey & Doluschitz, 2010; Neelamani et al., 2021). More than 90% of that region's population lives in cities and, with the exception of Saudi Arabia, all GCC capital cities are sprawling coastal urban bodies with strong demographic growth patterns (Population Division of the Department of Economic & Social Affairs of the United Nations Secretariat, 2018). This trend includes some of the world's fastest-growing cities—such as Abu Dhabi, Doha, and Dubai—which happen to be located on low-lying coastal zones and islands, and are thus particularly vulnerable to even lower ranges of SLR as we will see.

Because warmer waters are more conducive to tropical storms and cyclones, the compounded effects of climate change and SLR will lead to more regular coastal flooding following tropical storms. In 2018, no less than three severe and very severe tropical storms (better known as 'tropical cyclones') have devastated parts of Yemen and, on the opposite side of the Gulf of Aden, created the worst cyclonic disaster ever recorded in Somalia (Lambert et al., 2021). There is now a strong and growing body of scientific publications showing that SLR risks of submersion are compounded by environmental processes such as high tides, coastal erosion, and extreme environmental events, like storms, swell waves, and sea surges, inter alia (Barnard et al., 2015; Serafin et al., 2017; Vitousek et al., 2017a). Coastal disasters can have profound social and economic implications. In 2007, for instance, severe tropical storm Gonu (generally called 'cyclone Gonu') directly killed more than 50 persons and affected 20,000 people and generated an estimated US$ 4 billion of direct damages in Oman alone and caused 28 deaths and US$ 216 million in damage in Iran (Al-Maskari, 2010). On May 18, 2018, the 'Sagar' tropical cyclone generated numerous casualties and heavy destruction in parts of the Arabian Peninsula and Horn of Africa, making history as the strongest tropical storm ever recorded in Somalia and also as the first of three tropical cyclones that brought devastation to war-torn Yemen in a single year. These tragic events are consistent with the literature on climatic changes in the North Indian Ocean that has been recording an increase in magnitude and frequency of tropical cyclones and other extreme weather events like coastal flooding (Vitousek et al., 2017a). In 2021, tropical cyclone Shahin was even more powerful and destructive than its predecessors, devastating areas in Oman and Iran, but also in the Northeast of the United Arab Emirates, a country generally off the reach of such extreme weather events. As the Northwestern part of the Indian Ocean where these cyclones form has featured several unusually stronger tropical cyclones in recent time, including powerful ones going far across the Gulf of Aden, this trend leaves the question open as to whether we are entering a period (rather than witnessing a series of anomalies) of increasing frequency and strength of cyclones battling the coasts of the Arab region (Lambert et al., 2021).

These events can impact essential services such as transport, logistics, schools, hospitals, as well as water and energy supplies. And if the toll and costs of such hazards keep on increasing, this may ultimately affect the levels of vulnerability of the populations, as repeated hazards can disrupt the resource base necessary for post-disaster resilience. Meanwhile, the vulnerability of several Arab cities is currently more acute than usual due to the COVID-19 pandemic toll on the national health systems and the economies of the region. This is especially true in coastal cities that have traditionally been depending on tourism.

The World Bank identified no less than 24 ports in the Middle East and 19 ports in North Africa at particular risk of SLR (WEF, 2019, p. 58). But the numbers could be higher. Until very recently, the global scientific literature on increased coastal flooding due to SLR generally did not integrate the risks posed by the additional factors of elevated water levels such as storms and sea surges, and thus underestimated the potential impact of SLR. In a watershed study, Vitousek et al. (2017a) quantified the risks of coastal flooding as doubling due to the joint risks of SLR and wave, tides, and sea surges. Their study calculated that even the limited 10 to 20 cm of SLR will more than double the frequency of extreme water-level events in the Tropics, a zone that includes many Gulf states and Red Sea countries. They concluded that even gradual sea level rise can rapidly increase the frequency and severity of coastal flooding by the mid-century and that it is the regions located in the Tropics that will suffer from the largest increases in flooding frequency (Vitousek, 2017b). The coastal cities, coastal groundwaters (increasingly salinized by seawater intrusion), as well as agricultural lands on and near the coasts and deltas in the MENA region, are expected to suffer from seawater flooding issues and the gradual salinization of soils and coastal water resources. In North Africa, the coastal areas (i.e., within 100 km from the sea) are where most agricultural production happens, as the south of the country is generally too arid for intensive production. These and other issues related to climate change are expected to significantly disturb—or in some cases, strongly disrupt—the growth of national economies of the MENA region and increase the vulnerability of most Arab countries.

Joint research by the international re-insurance company Swiss Re and the international NGO Oxfam has projected the economic impact of the world's regions by the mid-century under various scenarios of climate change. As it can be seen in Table 9.1, the Middle East and Africa region are expected to particularly suffer from the impacts, with an anticipated decrease of GDP by mid-century of −4.7% if the 2 °C temperature control target of the Paris Agreement is reached relative to a world without climate change (Swiss Re, 2021). However, the report also anticipates major decreases in GDP by mid-century, between −21.5 and −27.6% of GDP, relative to a world without climate change, if the global temperature increases between 2.0 °C to 2.6 °C by mid-century, a level which can be considered likely to happen given the world's current trajectory (Swiss Re, 2021, p. 2). Such a disruptive loss of economic growth would have important social and political consequences in a region already challenged by a young demography and high unemployment rates. Climate

Table 9.1 Expected impact on GDP loss by mid-century under various climate scenarios (Swiss Re, 2021)

	Temperature rise scenario, by mid-century			
	Well-below 2 °C increase	2.0 °C increase	2.6 °C increase	3.2 °C increase
	Paris target	*The likely range of global temperature gains*		*Severe case*
Simulating for economic loss impact from rising temperatures in % GDP, relative to a world without climate change (0 °C)				
World	−4.2%	−11.0%	−13.9%	−18.1%
OCED	−3.1%	−7.6%	−8.1%	−10.6%
North America	−3.1%	−6.9%	−7.4%	−9.5%
South America	−4.1%	−10.8%	−13.0%	−17.0%
Europe	−2.8%	−7.7%	−8.0%	−10.5%
Middle East & Africa	−4.7%	−14.0%	−21.5%	−27.6%
Asia	−5.5%	−14.9%	−20.4%	−26.5%
Advanced Asia	−3.3%	−9.5%	−11.7%	−15.4%
ASEAN	−4.2%	−17.0%	−29.0%	−37.4%
Oceania	−4.3%	−11.2%	−12.3%	−16.3%

change adaptation measures are thus urgently needed to protect societies, national economies, as well as local political stability.

9.4 Urban Planning, Proactivity, and Innovation Are Critically Important: Case of Doha, a Fast-Growing Middle East City

Everywhere in the world, classic adaptation strategies include restricting construction in the most at-risk urban areas, avoiding unplanned settlements, improving the reliability and durability of relevant existing real estate property (especially for collective housing in poorer areas), improving or constructing flood defenses, and preparing for contingency plans and potential relocation (similarly to what happens for cities at risks of earthquakes). Although these measures may affect some economic and financial interests in the short term, they may represent an undeniable necessity for the safety of the populations. All these policy measures assume that urban planning is key and operates with the premise that development control, by land use zoning generally, is enforceable. However, amid the impressive diversity of Arab cities, in terms of historical development and institutional culture, this is far from being the rule. The demographic growth of most Arab cities is often stronger in coastal cities and surrounding areas, which have become sprawling economic magnets in this era

of globalization. The domestic demographic pressure and working migrations from Africa and Asia, with their consequent youth bulge, explains why many Arab coastal cities are expanding so rapidly (McKee et al., 2017). Qatar is a useful example when it comes to documenting the efforts and challenges related to SLR risks and adaptation in the contexts of the Gulf sub-region.

9.4.1 The Case of Doha

Qatar, a small peninsular state, features several important coastal urban areas, including its capital city of Doha, which is located on the Arabian Gulf coast. Its hinterland does not extend beyond 80 km and its most economically and politically important areas (e.g., West Bay, Al Corniche, and Al Dafna) are all adjacent to the waterfront. Furthermore, recent developments and mega-projects (e.g., the Pearl and Lusail neighborhoods) are all located along the coast. Against the background of the negotiations on the Paris Agreement, the Ministry of the Environment published in 2015 a startling statement in Qatar's official communication (its Intended Nationally Determined Contribution) to the United Nations Framework Convention on Climate Change:

> Qatar is extremely vulnerable to sea level rise as it is liable to inland flooding of 18.2% of its land area, at less than 5m rise in sea level, along with the associated adverse impacts on the population as 96% are living on the coastal areas. (State of Qatar, 2015)

This specific issue was also prominently featured in Qatar's follow-up Nationally Determined Contribution to the Paris Agreement:

> Sea level rise receives most of the government attention because of the large coastal population at risk of inundation (particularly during extreme sea level events). (…) Qatar's ecology, environmental resources, infrastructure and human systems are vulnerable to the adverse impact of climate change, the latter includes coastal and offshore installations such as power and water cogeneration facilities, and the oil & gas infrastructure. (State of Qatar, 2021)

Neighboring countries Bahrain, the United Arab Emirates, and the Kingdom of Saudi Arabia are also highly exposed to climate change and SLR. In 2010, The Abu Dhabi Environmental Agency had published an announcement which shows that 85% of UAE's population would also be affected by rising sea levels as well as 90 percent of its infrastructure (Luomi, 2014).

As a result of those identified climate risks, important urban planning efforts have been undertaken in the cities of Qatar over the past years, such as the Qatar National Master Plan and the Climate Change Strategy for the Urban Planning and Urban Development Sector.[2] But as these new plans and strategies will only provide substantial benefits via future designs and constructions, Qatar reiterated in clear terms this coastal vulnerability issue in its 2021 Intended Nationally Determined Contribution (INDC) to the UN:

> Given its geographic location, Qatar is likely to suffer from severe consequences of global warming. Under the major impact of climate change, Qatar is extremely vulnerable to rising

> sea level and air temperature increase, leading to inland flooding and heat exhaustion of its population, in addition to the potential risks to the marine biodiversity, food security, loss and damage due to climate change. Sea level rise receives most of the government attention because of the large coastal population at risk of inundation (particularly during extreme sea level events). Subsequently, climate change also poses a threat to the tourism industry of Qatar, largely due to the increase in temperature and frequency of dust storms. (State of Qatar, 2021, p. 10)

This statement reflects a deep understanding of the multi-dimensional climate risks and what is at stake for the country. It also reflects a more systemic perspective toward coastal risk management rather than the classic approach to hazards punctually disrupting the population's life, as in the INDC previously submitted to the UN. Worth mentioning, in the 2021 communication, the government of Qatar announced its ongoing studies of the coastal ecosystems and its plan to reforest with mangrove trees some coastal areas, thereby linking mitigation and the action of a known climate sink (mangroves' deep root system sequestrate large quantities of atmospheric carbon), to the coastal protection from erosion and storms that mangrove forests are known for (State of Qatar, 2021). In other words, this represents an ecosystem-based adaptation policy to climate change coastal risks with mitigation benefits (Fig. 9.1).

9.4.2 Contributions from the City, State, and Other Stakeholders Are Essential

In Doha, as in many cities of the MENA region, there are important economic challenges, such as the need to rapidly generate large numbers of jobs for a growing, young, and increasingly educated population, while continuously shifting the economy from a model of commodity-dependent rentierism and toward a more diversified national economy. Despite repeated grand projects and diversification policies over the past decades (Gray, 2011), reforms to give greater room to the private sector (Lambert, 2014), and cuts in the welfare state to decrease the citizenry's reliance on the generous state expenditure (Gengler & Lambert, 2016), the economies of hydrocarbons exporting countries of the Middle East and North Africa have largely failed to transform the structure of their national economy, which is still largely dependent on the export of a few commodities to provide the majority of government revenues and finance both the redistributive welfare state and state-led economic growth. Against that background of mixed results in economic reforms and diversification, short-term opportunities to develop tourism, including in at-risk areas, often tend to take precedence over sustainable coastal development. In Doha, Abu Dhabi, Dubai, or Manamah, the artificial islands for luxury hotels, villas, and resorts of the previous decades have been built on reclaimed areas which have depended on large quantities of sand dredging of fragile marine areas and thus have had an overall negative impact on the local marine environments, despite increasing remediation measures. Finding an appropriate balance between risks and economic activities will

now have to be made with enough transparency for all stakeholders, for them to be able to assess, and eventually invest into, the appropriate environmentally friendly practices to start with, as well as the appropriate risk mitigation measures. Additionally, this information will be increasingly needed to contract insurance contracts to cover the climate risks. Unfortunately, most insurance in the Gulf States currently do not cover climate-related disasters. This is something national authorities will have to deal with, as the risks are rising, and the costs may become very substantial in the years and decades to come. New insurance products could be introduced, with the support of government entities initially to develop the market, for instance with government buildings being insured. The old model may not be appropriate anymore, and modern insurance services will be needed to increase Doha's climate resilience as well as that of other Arab cities, especially where powerful storms and/or cyclones might disrupt the economic activities and lead to corporate and individual bankruptcy.

Another economic challenge, which is more acute in low- and medium-income Arab states, is the planning and implementing (and staying committed to) the necessary but costly risk mitigation infrastructure developments given that national budgets vary significantly due to their heavy dependence on a few commodities, from phosphate and agricultural products in Morocco, to crude oil in Kuwait, and natural gas in Qatar. The government commitment to long-term infrastructure development, such as Doha has overall successfully managed over the past two decades, will be critically important for low-lying coastal cities as they seek to adapt to the formidable challenge of SLR.

Lastly, throughout the MENA region, the limited capacities of government agencies in charge of urban planning tend to generate problems of poor planning quality, underestimated risks, selection of inappropriate technologies, and suboptimal returns on investment. In Qatar, for instance, despite strong efforts by the government to make its urban development more sustainable, some mega-projects have been assessed as not sufficiently taking into consideration SLR and other related risks to urban environments (Rizzo, 2014). The general lack of pro-activity on this matter across the region is likely to cost more over time in adaptation, climate disaster disruptions of the economy, and remediation measures than it would have initially with climate-smart designs, planning, and commitment.

9.5 South-South Transfers of Expertise and Innovation

The global phenomenon of SLR is undeniably a global threat for coastal populations around the world but is an even greater threat in the Arab region, wherein most of the population lives within 100 km from the sea, including in deltas and estuaries and in cities where rapid demographic growth already exacerbates urban planning challenges. In line with the United Nations Sustainable Development Goal 11 (Sustainable Cities and Communities), vulnerable cities, such as Amsterdam, Copenhagen, Queensland, Shanghai, and New York City, among others, have already accumulated

a precious experience in assessing and deploying adaptation solutions at a large scale. Local and international ideas, projects, and cooperation will be needed to simultaneously face the formidable challenges of SLR, economic diversification, job creation, and, ultimately, poverty eradication.

The United Nations system provides numerous vehicles for facilitating and partly or wholly financing this process of transformation of MENA coastal cities. Yet, a review by the authors of the projects supported by the various climate finance facilities reveals that they have been under-utilized by Arab countries. For instance, the UN Climate Technology Centre and Network, in charge of green technology transfer to developing countries, has been under-utilized to facilitate technology transfers with UN funding and expertise, such as climate adaptation strategy designs, or for capacity building in climate-smart technologies, including solar desalination or projects of waste transformation into energy. As of June 2021, and out of the African continent's 154 funded projects (called "requests" in UN terminology), only 9 were called for by governments of North Africa.[3] This 5.84% share of total funded projects for Africa is particularly low as the population of North African states represents nearly 20% of the continent's total population, and with particularly daunting climate challenges in terms of SLR, water stress, droughts, food insecurity, and desertification, inter alia. Similarly, at the time of publishing this chapter, Arab countries have far from fully availed themselves of the UN's Clean Development Mechanism (CDM), the Adaptation Fund, the Green Carbon Fund (GCF), or the World Bank's Green Environment Fund (GEF). By contrast, some emerging countries, such as China, India, and Kenya, have been more proactive in requesting and obtaining multilateral resources for their sustainable development. This is something that most Arab countries will have to work on.

Sharing experiences, knowledge, lessons learned, and technological solutions and innovations among coastal cities in different parts of the world should be supported, as a relevant and cost-efficient way to adapt to climate change. This is especially relevant between and among metropolises of the Global South, as in Southeast Asia and Africa. This adoption of technology from outside the OECD economies holds the potential to greatly benefit Arab coastal cities, some of which must look for cost-efficient solutions, while others are widely known for developing and branding themselves as smart global cities. Against the backdrop of limited proactive action on climate change and SLR in many of the Global South's coastal cities, consistently investing in the management of sea-related urban risks could transform a major challenge for Arab cities into a structural competitive advantage and economic opportunity.

9.6 Conclusion

Based on the latest body of research, and using the case study of Doha, this chapter highlighted how the poorly documented hazard of SLR makes the populations, economies, and ecosystems of Arab cities, depending on their specific exposure

and vulnerabilities, increasingly vulnerable to climate change and coastal hazards. Coastal risks are expected to directly affect the safety and standards of living of millions of inhabitants of the region's coastal cities in the years and decades to come, if appropriate policies are not devised and implemented in a rapid, consistent, and efficient manner. SLR is not the often-portrayed slow-onset and long-term risk that can wait; it is also a short- to medium-term major challenge for coastal cities, as it strongly increases coastal flooding risks and the frequency of several other important hazards, including the salinization of agricultural lands and water reserves, inter alia. The policy challenges and opportunities that could influence the nature of the risks (coastal flooding, erosion, and destructive storms) and the exposure of Arab coastal cities are first and foremost related to the urban planning strategy, risk transparency (to prepare and involve all stakeholders), the rule of law (implementing for all the same rules and regulations), greater cooperation with multilateral organizations, and locally relevant adaptation policies. By contrast with global trade regulations or global health issues, the global warming challenges constitute a policy field in which the governments of the region can be proactive and effective, if they decide so. Climate finance, though not yet at the scale decided in Copenhagen in 2009, is already available to most Arab states, but they need to process and submit the requests, something that most countries of the region have neglected so far.

Adequate technologies must be selected and appropriately used, and innovation will be necessary on a case-by-case scenario. State and city leadership involvement in SLR risks and measures are necessary, as well as stakeholders' participation, including the private sector, to ensure that the measures selected are appropriate to the cities and their communities. Regional and international collaboration is also critical to tackle the issue not only at the national level, but also collaboratively among the cities of the same region to ensure alignment and coordination in policies and actions. It must also be emphasized that SLR may also be an opportunity for new public–private partnerships for stakeholders to integrate global value chains in the blue economy perhaps, if opportunities are appropriately used and developed. Finally, the authors call for more anticipation in the region's urban planning of the general risks posed by climate change, which should be officially identified as, and treated like, any other national security challenges in Qatar's city of Doha, Arab countries and cities, and the world at large.

Notes

1. The topography of a city can be observed on https://en-us.topographic-map.com/maps/pdau/Abu-Dhabi/.
2. The Qatar National Master Plan can be accessed online at: www.mme.gov.qa/QatarMasterPlan/default.aspx, but the Climate Change Strategy for the Urban Planning and Urban Development Sector in the State of Qatar, completed in 2018, is not available to the public. The lead author of this chapter was consulted during its preparation and peer-reviewed parts of it, such as its executive summary.
3. See 'Requests by region' on the website of the United Nations' Climate Technology Centre & Network, https://www.ctc-n.org/technical-assistance/request-visualizations.

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